A LOGISTICS ANALYSIS OF NIGERIA’S OFFSHORE WINDFARM SECTOR

1CHINEDUM ONYEMECHI, 2CHINEMEREM, C. IGBOANUSI 3ANTHONY EKENE EZENWA
1Senior Lecturer Department of Maritime Management Technology, Federal University of Technology Owerri NIGERIA
2Assistant Lecturer, Department of Transport Management Technology, Federal University of Technology Owerri NIGERIA
3Graduate Assistant Department of Transport Management Technology, Federal University of Technology Owerri NIGERIA
E-mail: 1c_onyemechi@yahoo.com, 2c.igboanusi@yahoo.com 3 anthonyezenwa@ymail.com

ABSTRACT

The work investigated the suitability of the Nigeria’s offshore environment for the installation of offshore wind farms. Cost comparative assessments of the advantages of adopting this renewable energy option vis a vis fossil fuel and other energy alternatives were carried out. In terms of costs and benefits, the offshore wind farm though costlier was found to possess abundant benefits not present in non-renewable energy alternatives. The benefits of the offshore wind farms presently being tapped by European Union nations were surveyed vis a vis the Nigerian offshore environment. Suggestions were finally made for Nigeria. The benefits of the offshore wind farms presently being tapped by European Union nations were surveyed vis a vis the Nigerian offshore environment. Suggestions were finally made for Nigeria.

Keywords offshore windfarm, Nigeria, wind turbines, logistics analysis, marine technology, optimization.

1. INTRODUCTION

The use of wind energy converters (WEC) in the hub/nacelle of the wind turbine has provided ways through which the wind energy can be converted into electrical energy providing clean source renewable energy with zero carbon emission. However, these forms of energy can only be harvested in areas with high wind speeds. The facts that wind speeds are significantly higher offshore than onshore have made the offshore sector a special sector for the installation of wind turbines. Krohn [1] The above trend has led to a situation where wind turbines are installed in arrays at chosen distances offshore, adjacent to most European Countries as source for clean electrical energy.

The competition is now tense and is presently extending to countries like United States of America and China.

European nations presently utilizing offshore wind farm as a renewable energy source include Belgium, Denmark, Germany, Estonia, France, Netherlands United Kingdom, Sweden etc. The turbines in the European offshore sectors are located between 0.5km and 25km from the shoreline, in wind farms located at different places. The number of turbines installed in a wind farm usually varies depending on the power rating/output expected from the wind farm.

At Vindeby, Denmark for example 11 turbines were installed about 3km from the shoreline to provide 450kw of energy. This was installed in the year 1991. However, in the year 2004, at Nysted, still in Denmark, 72 turbines were installed 12km from the shoreline, providing 2.3MW of energy. Water depths at Nysted farm is about 10metre. The type of foundation carrying the wind turbines in this area was of the concrete gravity type. Hassan [2]

1.1 PROBLEM DEFINITION

The generation of electricity through fossil fuel based sources has resulted in excessive carbon dioxide (CO2) emission into the atmosphere. This has further increased the amount of emission in the earth’s greenhouse, thus adding to global warming. Nigeria’s energy policy, in conjunction with the
Kyoto protocol has called for investments in alternative and renewable sources of energy with low carbon emission.

Given, the level of investments in offshore wind farms with no carbon emissions, this sector has proven to be a reliable source of renewable energy especially to households adjacent to the coast. The offshore wind farm sector thus offers itself as a sustainable energy source for Nigeria’s coastal cities.

1.3 OBJECTIVE
Given Nigeria’s rich coastal waters and Lake Resources, this work focuses on appraising Nigeria’s coastal cities suitability for offshore wind farms using a logistics framework.

2.0 LITERATURE REVIEW
Nnadili [3] outlined three major logistical challenges likely to be encountered in harvesting electricity by operators in the off-shore wind farm sector. They include:-
(i) The interaction between distances from the shore to locate a wind farm given increasing speeds must be understood.
(ii) The marginal impact of distance from shore on revenue generated from electricity sales from the offshore wind farm must be understood.
(iii) The inventory policy for wind turbine components in operating an offshore wind farm must be determined.

However, Hassan (2009) outlined the necessary stages of involved in the construction and installation of an offshore wind farm. These include:-
(a) Physical land logistics planning often involving land transportation of working materials to land construction site.
(b) Staging: This involves the pre-planning and prefabrication of offshore wind farm construction parts at the land site, and its arrangement in the manner in which offshore construction will be executed.
(c) Physical movement of construction materials on land will be dictated by the physical dimension of towers, nacelles and rotor blades as well as the closeness of fabrication site to port.
(d) Sea transportation and
(e) Offshore construction.

3.0 RESEARCH METHODOLOGY
The paper utilizes a logistics technique that ensures optimization of inventories in the installation of wind turbines in the most feasible geographical areas of Nigeria’s offshore sectors. Cities lying adjacent to the offshore sector were analyzed to ascertain best possible position for an offshore wind farm given wind availability and existence of other necessary conditions.

4.0 REPORT OF FINDINGS
The major Nigerian States lying adjacent to the Atlantic coastline include: Lagos, Ondo, Akwa Ibom, Delta, Rivers State, Bayelsa, Cross River, Edo etc.

Out of these, high population concentrations exist adjacent to the coastline in such cities as Lagos, Victoria Island, Lekki, Ikorodu, Badagry all in Lagos State. In Rivers State Brass, Bonny and Opobo also have good city population lying close to the Atlantic. The towns of Burutu, Escravos and Forcadoes all in Delta State are large cities lying close to the Atlantic.

Viable cities in Akwa Ibom State also suitable for offshore wind farm utilization include, Qua Iboe, Eket and Oron. In Cross-River state, the city of Calabar is another viable option for offshore wind farm. All the cities in the States mentioned above serve as first level recipients of electricity arising from offshore wind farm installed adjacent to their coastline. A second level option also exists through the extension of the generated energy via subterranean cables to their various state capitals.

4.1 Option Optimization Of Installation Technologies For Nigeria’s Offshore Wind Farm Sector
Each of the coastal states of Nigeria can adopt to install an offshore wind farm of her coastline. However, logistics considerations will determine the most feasible option among a variety of choices. The preference of the offshore sector for the location of the wind turbine has been found to yield 20 percent increase in wind speeds in some cases, with energy yield of some 73 percent higher than on land. Krohn (2002).

Assessed from the direction of cost, the optimum size of an offshore wind farm is from 100MW. This implies installation of large number of wind turbines each producing between no less than 2MW of electrical energy. If a 5MW wind turbine is installed, it will reduce the number of wind turbines required in generating say 100MW from the wind farm. What determines the number of wind turbines to install lies on cost and logistics as well as the policy of the government or corporation demanding installation?
For our analysis, we will consider a hypothetical 160MW of offshore wind farm recommended for installation at Lekki, off Nigeria’s coast of Lagos State.

Two options are considered, based on distance from the shoreline, a three kilometer location and a five kilometer location from the shore. A comparison is made between a 2MW wind turbine and a 5MW wind turbine serving as unit installation for the operation of the offshore wind farm.

Table 1 Logistics options for Lekki offshore wind farm sector

<table>
<thead>
<tr>
<th></th>
<th>3km</th>
<th>5km</th>
<th>Required number of turbines for 160 mw farm</th>
<th>Installation requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2mw turbine</td>
<td>Vessel maintenance servicing only</td>
<td>Helicopter vessel servicing</td>
<td>80</td>
<td>Monopile/ gravity foundation option</td>
</tr>
<tr>
<td>5mw turbine</td>
<td>Vessel maintenance servicing only</td>
<td>Helicopter vessel maintenance</td>
<td>32</td>
<td>Monopile/ gravity foundation option</td>
</tr>
</tbody>
</table>

Water depth is not expected to exceed 15metres (Depth ≤15m)

Source : Compiled by Author.

Logistics demand that work inventories be present at the right place, at the right time, all at an optimum price. Applying this concept, then, a staging area will then be required to be prepared at Lekki for prefabrication of offshore field construction materials. These will include:- foundation parts, blades, hub/nacelle of wind turbines, barges for water transportation, parking spaces for Lorries arriving with materials for construction works, cables, cathodic protection instruments.

4.11 SEA TRANSPORTATION

The blades of a 2MW wind turbine will have a rotor diameter of 75 – 85 metres. This implies the employment of a water barge with length sufficient to accommodate the long span. Approximately, two materials barges with one crane barge will be put to use for materials transport to the offshore installation site. One material barge will be positioned in site to assist the crane barge during the installation of the wind turbines at site. The other barge then transports materials from the land site to replace the one employed at the offshore site, thus eliminating operational time slacks.

4.12 OFFSHORE CONSTRUCTION

Estimated period of construction is 2 years this estimation is based on the time it took to complete similar projects in Denmark. The offshore installation will be accomplished using a single sea crane ship and two material barges of 120 meter length.

4.2 COST COMPARISON WITH NIGERIA’S POWER HOLDING PLC.

Using data derived from Denmark by the Danish utilities, cost of energy from the offshore is available to the community at 0.36 DKK/KWH = 0.05 EUR/KWH. Kronhn (2002). When converted to Nigeria’s naira, this will be 0.05 EUR x N196 = N9.80/kwh. In arriving at the above figure use was made of the exchange rate of N196 per Euro. Importation cost consideration is neglected since this was considered in Denmark before arriving at the final consumer cost. The above figure is quite competitive when we consider that present power holding cost of energy in Nigeria gets to the community at the rate of N4.40/kwh. Other renewable energy sources are likely to produce very high cost rates. The Danish utility figures in arriving at the cost of N9.80 per kwh assumed the application of present technologies with an expected lifetime of 20 years. Such an assumption is certainly quite conservative. There have been areas in Britain where a life cycle of 40 years was applied.

The interpretation of the above simply means that if the above figures are calculated with an expected life cycle of 40 years, energy from the offshore wind farm sector will be available at the rate of N4.90/kwh.
4.3 Foundation Cost
Offshore wind farm foundations are usually built to last 50 years. If we however stick to the 20-25 years lifecycle for the wind turbine, it then means that two successive wind turbines can be applied to a single foundation with a cost reduction from 0.05 EUR/KWh to 0.04 EUR/KWh. The new cost will then be 0.04 EUR/KWh x N196 = N7.84/KWh, for a lifecycle of 20 to 25 years. For projects with 5-10m water depth, foundation cost tends to constitute about 23% of total project cost. The cost of foundation will certainly vary as we move further into the high seas to install wind turbines.

5.0 CONCLUSION
This paper reviews logistical considerations in installing offshore wind turbine off Nigeria’s coastal waters. Different stages of the installation process are considered using procedures that optimizes materials transport from the coast to the offshore installation site. Cost comparisons of realizable energy output of this renewable energy sector with that of Power Holdings Corporation in Nigeria was made, using data from Danish Utilities. The result was quite competitive when compared to present cost of energy from Nigeria’s Power Holdings Plc.

REFERENCES

