FLOATING OFFSHORE WIND FARMS: DEMAND PLANNING & LOGISTICAL CHALLENGES OF ELECTRICITY GENERATION

Christopher Nnadili
Thesis Advisor: Dr. Chris Caplice
Agenda

- Background & Motivation
- Economic Determination of a 500 MW Floating Offshore Wind Farm Location
- Marginal Effect of an Additional Turbine on Electricity Generation
- Inventory Policy of Offshore Wind Turbine Components
- Conclusions
- Questions
Background & Motivation

This map shows the annual average wind power estimates at 50 meters above the surface of the United States. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas as unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.

Background & Motivation

Economic Location of Wind Farm

- Higher Offshore Wind Speeds = Higher Electricity Generation
- Access to High Load Centers
- Access to Transmission Lines with Lower Capacity Utilization
- Environmentally Friendly: Out of view, less noise pollution
Economic Location of Wind Farm

Economic Location of Wind Farms

Source: Google Earth
Economic Location of Wind Farms

- Revenue from Electricity Sales at 10 cents/kWh
- Operations and Maintenance Costs = 30% of Revenue Generated from Electricity Sales
- Amortized Cable Cost for 50 year Life Span of HVDC Submarine Cable
- Levelized Production Cost of 6 cents/kWh for transmission and grid connection
Economic Location of Wind Farms

2006: Revenue, Costs and Profit Vs. Distance

- Revenue
- Total Cost
- Profit

Graph showing the relationship between distance in miles and revenue, costs, and profit in dollars.
Economic Location of Wind Farms

2007: Revenue, Costs and Profit Vs. Distance

- **Dollars**
  - Revenue
  - Total Cost
  - Profit

- **Distance (miles)**
  - Linear (Revenue)
  - Linear (Total Cost)
  - Linear (Profit)
Economic Location of Wind Farms

2008: Revenue, Costs and Profit Vs. Distance

- **Revenue** (Blue Diamonds)
- **Total Cost** (Red Squares)
- **Profit** (Green Triangles)

**Graph Details:**
- **Y-axis:** Dollars
- **X-axis:** Distance (miles)
- **Linear Trend Lines:**
  - Revenue
  - Total Cost
  - Profit
Marginal Effect of Additional Turbines

- Additional Wind Turbine Increases Revenue with Marginal Impact on Total Costs
- Optimal to Install more than 100 Wind Turbines, 50 miles from Shore
- Increased Cranage and Transmission Costs
Inventory Policy for Wind Farms

- Inventory Policy for Wind Turbine Components = Maintenance Strategy
- Maintenance Strategies Examined:
  - Calendar Based Maintenance
  - Unplanned Corrective Maintenance
  - Condition Based Maintenance
- Inclement Weather (Wave & Wind) on Wind Farm Accessibility and Availability
- Cranage Availability and Costs
Inventory Policy for Wind Farms

- Reliability (failures/year)
- Maintainability
- Serviceability

Accessibility of the site

Theoretical availability

Maintenance strategy

Actual availability
## Inventory Policy for Wind Farms

<table>
<thead>
<tr>
<th>Wind Turbine Component</th>
<th>Onshore failure frequency (failures/year)</th>
<th>Offshore Failure frequency (failures/year)</th>
<th>Wind Turbine Components Demand (100 turbines)</th>
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<td><strong>1.28</strong></td>
<td><strong>128</strong></td>
</tr>
</tbody>
</table>
Conclusions

- Increase in Revenue Generation from Electricity Sales with Distance from Shore
- Optimal to Install over 100 Wind Turbines 50 Miles from Shore
- More profitable for Manufacturers to hold Inventory of Wind Turbine Components
Questions