Building an Offshore Wind Industry with the Atlantic Wind Connection

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Strong offshore winds close to population centers
Offshore wind technology

- Offshore turbines initially followed terrestrial example
  - Now scaling up and becoming specialized – e.g. Vestas V164 7MW

Starting with shallow, fixed foundations, moving to floating foundations.

80m
V164 - 7.0MW blade length

8,38m
London Routemaster length

Courtesy: Vestas
# Cost of Energy

**DOE goal:** 54 GW at $0.07/kWh by 2030  
\[
\text{COE} = \frac{(\text{DRF} \times \text{ICC}) + \text{O&M} + \text{LRC} + \text{Fees})}{\text{AEP}}
\]

**Potential Path to Reduce Cost of Offshore Wind Energy in Class 6 Wind ($2009 USD) (NREL 2010)**

<table>
<thead>
<tr>
<th>Component</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2010 -Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capital Cost ($/kW)</td>
<td>$4,259</td>
<td>$2,900</td>
<td>$2,600</td>
<td>$2,120</td>
</tr>
<tr>
<td>Discount Rate Factor (DRF)</td>
<td>20%</td>
<td>14%</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>Turbine Rating (MW)</td>
<td>3.6</td>
<td>8.0</td>
<td>10.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Rotor Diameter (m)</td>
<td>107</td>
<td>156</td>
<td>175</td>
<td>77</td>
</tr>
<tr>
<td>Annual Energy Production / Turbine (MWh)</td>
<td>12,276</td>
<td>31,040</td>
<td>39,381</td>
<td>4,684</td>
</tr>
<tr>
<td>Capacity Factor</td>
<td>39%</td>
<td>44%</td>
<td>45%</td>
<td>36%</td>
</tr>
<tr>
<td>Array Losses</td>
<td>10%</td>
<td>7%</td>
<td>7%</td>
<td>15%</td>
</tr>
<tr>
<td>Availability</td>
<td>95%</td>
<td>97%</td>
<td>97%</td>
<td>98%</td>
</tr>
<tr>
<td>Rotor Coefficient of Power</td>
<td>0.45</td>
<td>0.49</td>
<td>0.49</td>
<td>0.47</td>
</tr>
<tr>
<td>Drivetrain Efficiency</td>
<td>0.9</td>
<td>0.95</td>
<td>0.95</td>
<td>0.9</td>
</tr>
<tr>
<td>Rated Windspeed (m/s)</td>
<td>12.03</td>
<td>12.03</td>
<td>12.03</td>
<td>10.97</td>
</tr>
<tr>
<td>Average Wind Speed at Hub Heights (m/s)</td>
<td>8.8</td>
<td>9.09</td>
<td>9.17</td>
<td>7.75</td>
</tr>
<tr>
<td>Wind Shear</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.143</td>
</tr>
<tr>
<td>Hub Height (m)</td>
<td>80</td>
<td>110</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>Cost of Energy ($/kWh)</td>
<td>0.27</td>
<td>0.10</td>
<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>Cost of Energy ($/kWh) at constant 7% DR</td>
<td>0.12</td>
<td>0.08</td>
<td>0.07</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Many opportunities for efficiency through technology and policy

- System Engineering
- Site Surveys
- Permitting
- Outreach
- Vessel Fabrication & Operations
- Foundation Installation
- Submarine Cable Supply & Installation
- Electric Interconnection
- Turbine Supply & Installation
- Foundation Design & Fabrication
AWC: a unique solution for a unique commodity

- We can’t store electricity efficiently.
- We make it and use it simultaneously.

Balance is essential.

AWC is the best way to balance a variable load and a variable supply, while making the grid stronger and more efficient.
Radial ties using alternating current (AC) technology connect along the coast where the grid is generally weak.
The “superhighway” for offshore wind energy

The AWC offshore network uses HVDC to provide efficient transmission at scale, plus additional benefits:

1. balances variability
2. strengthens the grid
3. improves efficiency
AWC is funded by a team of global investors

Development Led by Experienced Independent Transmission Company
• Edison argues advantages of direct current
  • Safety
  • Consistent with battery technology (allows for backup and storage)
  • Worked with existing lights, meters and motors
• Westinghouse advances with alternating current
  • Transformers allow for multiple voltage levels
  • Higher voltage, less copper, remote generation, less expensive
  • Used in new, reliable induction motors
• Standards war ensues
  • Then: Topsy and the electric chair
  • Today: insulated gate bipolar transistors (IGBTs) make HVDC a smart grid solution
Offshore wind makes sense and it is affordable!

- The goals are:
  - Jobs
  - Energy Independence
  - Economic Stability

- Creative approaches to the technical, financial and policy challenges we face will bring success.

Henry Ford lived by the maxim: "Everything can always be done better than it is being done." The Model T was introduced at a price of $825 in 1908. Over 15 million units later the last Model T rolled off the assembly line priced at $380. Like other manufactured goods, land-based wind energy has experienced dramatic cost reductions over time, and offshore wind can achieve the same success.