Offshore Wind Challenges for the Insurance Industry
AIMU Marine Insurance Issues 2011
Offshore Wind Power

- Unlike the typical usage of the term “offshore” in the marine industry, offshore wind power includes inshore water areas such as lakes, fjords, and sheltered coastal areas.
- Siemens and Vestas are the leading turbine suppliers for offshore wind power.
- Dong Energy (Denmark), Vattenfall and E.on are the leading offshore operators.

Worldwide Status

- Total worldwide installed capacity: 3,118 MW.
- Europe is the world leader in offshore wind energy with a total offshore installed capacity of 2,396 MW as of 30 June 2010.
- The UK, Denmark, Netherlands, and Belgium are the top countries in offshore installed capacity.
  - In the UK, Ireland, and Denmark, offshore wind farms are usually 8 to 10 km from shore at depths of 15 to 25 meters.
  - Germany has chosen to build their offshore wind farms on the high seas, up to 100 nautical miles from shore and at depths of up to 60 meters.
- In early 2010 China completed its first offshore wind farm, with 34 turbines off the coast of Shanghai and 102 MW total capacity.
- The US has no offshore wind farms in operation but has several projects in various stages of development.
  - Cape Wind – under construction
  - Atlantic Coast – 10 East Coast states have established the Atlantic Offshore Wind Energy Consortium
  - NY State – proposals for projects off Long Island and Lakes Erie and/or Ontario.


May 10, 2011
Offshore Wind Farms are Expensive

- More expensive to build and maintain than onshore wind farms due to higher costs for:
  - Larger turbine structures
  - Offshore turbine foundations
  - Sea transmission cables

- Costs for offshore wind farms have risen in recent years and are now around 2X – 3X the cost for an onshore wind farm.
  - Some current offshore plants planned or under construction come in at more than €4 million per MW.
  - DOE estimates at least $2,400 / kw of capacity for construction and installation, compared to $1,650 / kw for onshore wind.

- Cost breakdown:
  - Development: 2.5% (Permitting, legal fees, preliminary design, interconnection studies, site investigation, land acquisition)
  - Turbines: 40%
  - Foundation procurement: 10%
  - Other supply costs: 7.5% (Platforms, cables, substation equipment)
  - Installation & erection: 15%
  - Other costs: 25% (Owner management costs, contingencies, bank fees, insurance, interest)

- However, because of a lack of interference from hills and other onshore obstacles, offshore wind farms can also expect to generate 20% more electricity per turbine than onshore farms partially offsetting project costs.

Costs

• Offshore wind costs have been increasing over time as projects have been moving from shallow coastal waters to deeper waters.

• Current investment projections: $3 to $5 million / MW

• O&M costs are difficult to project for US projects.
  > No regional vendors
  > No experienced ships or crews

• O&M costs estimated at $150,000 to $200,000 / MW for projects in Europe, depending on distance from shore and contract conditions.

• Roughly $0.05 / kWh for O&M alone.

Financing

- Financial crisis / global economic downturn have made financing offshore wind projects on non-recourse basis difficult.
- Situation has affected utilities and independent project developers differently.
- Utilities have been able to fund projects by relying on their balance sheets.
- Independent project developers have been severely affected and have been unable to obtain project financing.
  > Banks have taken a more conservative approach to lending and are reluctant to underwrite loans for offshore wind projects: there is a lack of precedent for the offshore wind industry which is curtailing the banks’ appetite for the sector.
- The European Investment Bank and export credit agencies are providing support in an attempt to bring the non-recourse market back to life for offshore wind.

Challenges

- Wind farms are being located further offshore, requiring the installation of offshore substations and complex subsea power distribution networks.
- The greater the distance from the coast, the longer it takes to make repair and maintenance trips resulting in tighter time frames to perform such work.
- Hard bedrock, great depths, strong currents, and heavy swells make project planning and implementation highly challenging.

Components

- Offshore wind farms share similarities with their onshore counterparts but the marine environment poses unique technical design challenges.

- Main components:
  - Turbines
  - Foundations
  - Inter-Array Cables
  - Offshore Platform Substation / High Voltage Export Cable
  - Interconnection Facilities

Turbines

- Offshore wind projects now under development will probably utilize 5+ MW turbines as the technology continues to develop.
- $2.5 million / MW average cost (not installed)
- Turbines are spaced approximately ½ mile apart to reduce wake effect.

Foundation Types

Foundation Types – cont.

**TRIPOD**
- Work Platform
- Intermediate Platform
- Central Column
- Internal J tubes
- Boat Landing
- Substructure
- Emerging Internal J tubes
- Diagonal Braces
- Pile Sleeves
- Mudmats
- Sea Bed
- Piles or Suction Caissions

**GRAVITY TYPE**
- Work Platform
- Intermediate Platform
- Boat Landing
- Shaft
- Internal J tubes
- Under-base grouting
- Scour protection
- Skirt
- Foundation

Turbine Installation Vessels

- Foundations and turbines are erected using large jack-up barges customized for turbine erection. The depth of water is a limiting factor and alternate means of erection are being investigated for future deep water projects.
- The newest types of jack-up turbine installation vessels are self-propelled and designed to transport and erect up to six 6MW wind turbines, complete with rotors.

Chartis Marine Currents: “Wind Power. Harder, faster, deeper, stronger”, February 2011, Issue #41
Transmission Cables

- Current method for interconnecting offshore wind generation farms with onshore utility transmission systems is through AC submarine cable systems such as High Voltage AC (HVAC).
- As the distance between the wind farm and the onshore interconnection increases, the limitations of HVAC cable technology emerge.
- Utilities are starting to look at High Voltage DC (HVDC) submarine cable systems. Though not yet commercially proven, it may be more cost effective for far offshore (GT 50 – 100 km) applications once available.

Offshore Substation Platforms

- Necessary for projects larger than 35 MW to consolidate inter-array cable feeders and step voltage up to suitable transmission levels.
- For projects larger than 200 MW multiple platforms may be necessary.
- Cabling requires significant planning:
  - Subsurface investigations may show obstacles that need to be avoided (shipwrecks).
  - Closer to shore, human, fish, plant, and animal habitats may restrict access to shore. Shore landing typically requires directional drilling or sawing.

Transportation Risks

- “Normal” transportation risks are enhanced by the specialized nature of the components in a wind farm.
- Rotor blades are relatively fragile, usually manufactured in sets to match a particular turbine, and can be greater than 50 meters long.
- Nacelles contain many relatively delicate parts such as the gearbox, generator, electric controllers, transformer that can be sensitive to shock or moisture damage.
- Nacelles can also be heavy, weighing in excess of 80 metric tons, with limited lifting points and an offset center of gravity.
- Tower sections are bulky and heavy.
- Step-up transformers are usually very large and heavy, and extremely sensitive to shock damage. The replacement time for a transformer damaged or lost in transport can be in excess of one year.

Ocean Transport Risks

- Ocean transport represent the highest potential exposure for shipments of wind turbine generator (WTG) and their components.
- One vessel alone may be transporting a number of WTG, potentially representing an entire project and total values exceeding $100,000,000.
- During a voyage, a vessel is exposed to number of potential perils including heavy weather, stranding or collisions, and fire.
- Vessels are subjected to six different motions when in a seaway: rolling, pitching, yawing, surging, heaving, and swaying.
- These motions, specially rolling and pitching can be magnified immensely during periods of heavy weather.
- Cargo can be subjected to pronounced external accelerations that can continue for many hours or even up to several days.
- Cargo may also be exposed to “sea sloshing” (green water on deck) as well as significant wind or sea spray if stowed on deck.

Loading/Discharge of blades

Blades in “HJ frames” can be handled with crane in three different ways:
- With one crane using an 80` spreader
- With two cranes
- With two cranes using an 80` spreader

The CFC container is the only equipment which is able to carry 2 blades at a time. Weight: approx. 28 t. Return shipment is by 2 40 ft HC containers.
Offshore Wind
Loading/Discharge of blades
Barge transport
Loading of Towers

Lifting bracket, shipping bracket and eye-lets are delivered by the tower manufacturer. Chains, hooks and other devices for lashing and securing are not part of transport delivery.
Loading of towers

Properly designed lifting brackets must be used for lifting the tower sections onto the trailer, ship etc.

Tower section handled with slings. To prevent damage on the coated surface, the slings are wrapped with plastic.
Lashing and securing of towers

To minimise lashing damage on the coated surface it is possible to use a piece of webbing.

Steel “knees” welded on the deck to prevent any movement of the foundation.
Risk and Insurance Management

- **Offshore wind farm industry is very young.**
  > The first UK offshore wind farm began generating electricity about 7 years ago.

- **Potential financial losses are high.**
  > Loss of a substation can cost around £60 million.
  > £6 million for the loss of a turbine.

- **Risk survey/engineering reports are essential to help identify potential areas for offshore wind farm operators to mitigate property damage, business interruption, and liability risks.**

- **Business interruption risks are key.**
  > The major losses incurred to date in offshore wind relate to the high-voltage cables that carry the electricity to shore.
  > Delay in start-up is potentially biggest issue for some companies.
  > Larger turbines potentially mean greater business interruption delays.

- **Serial loss coverage may be hard to obtain, and project owners may pass much of this risk to contractors.**

*Sources: JLT Group Risk Specialist: “Harness the winds of change”, May 2010*
Operations and Maintenance Risks

- Maintenance is a huge job for offshore wind.
- In the operations phase, availability of specialist vessels are a serious exposure.
  > At present there are just a handful of suitable vessels for offshore wind turbine installation.
  > Some offshore wind owners, such as Dong Energy, are investing in their own vessels.
  > It may cost an operator €1 million to replace a turbine for repair purposes. But leasing special vessels for this job will cost many times this amount depending on availability and weather.

- In addition to typical wear and tear, consideration must be given to high-seas environmental factors.
  > Powerful storms, heavy swells, and highly corrosive salt water can cause individual parts in wind power stations to wear out much faster than in an onshore system.

- Without a suitable maintenance plan, an offshore wind power station will be unlikely to last its advertised 20-year lifespan.
  > Parts will need to be regularly replaced, but this will require tremendous effort and is expensive, thus reducing the return on investment.

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