Lessons learned in UK offshore wind farm developments

Matthias Henke
June 2014
Outline

• Introduction / Overview
• SgurrEnergy
• UK offshore wind industry development
• Comparison UK – Germany
• Common risks and issues experienced
• Lessons learned
• Solutions
• Conclusions
Introduction / Overview

• High growth rates in the European offshore wind industry,
• Especially Germany has expanded rapidly
• Construction costs are not reducing as project numbers increase,
• In many cases budget overruns and construction delays have become more common place.
• Many German projects have been affected by a combination of grid and supply chain difficulties.
• Experiences and lessons learned from offshore wind farm developments in the UK could help to improve developments in future projects
About SgurrEnergy

• Leading engineering consultancy
• Formed in 2002 and joined Wood Group in 2010
• Consulted on over 110GW of renewable energy developments
• Worked in over 70 countries around the world, delivering advice to projects on six continents
• A network of 11 international offices (UK, Ireland, France, Germany, Norway, China, America, Canada, India, South Africa, Brazil)
• Over 200 experienced personnel
• Company wide triple BSI accreditation and UKAS ISO/IEC accreditation for wind farm power curve analysis
Key Offshore References

- 11 LTA Assignments
- >30 IE acquisition assignments
- 5 projects under construction monitoring
- 4 projects under operation monitoring
- Experience with next generation turbine technology:
  - Siemens SWT-6.0-154
  - Alstom Haliade™ 150-6MW
  - AREVA M5000-135
- Ground-breaking lidar wind measurements
Installed capacity EU end of 2013

- **UK:**
  - 1,040 in operation
  - 1,638 under construction
  - 2,610 permitted

- **Denmark:**
  - 664 in operation
  - 207 under construction
  - 400 permitted

- **Belgium:**
  - 30 in operation
  - 165 under construction
  - 651 permitted

- **Germany:**
  - 72 in operation
  - 448 under construction
  - 8,056 permitted

Source: The European offshore wind industry - key trends and statistics 2013; January 2014; A report by the European Wind Energy Association
## Water depth and distance to shore

<table>
<thead>
<tr>
<th></th>
<th>water depth</th>
<th>distance to shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>10-25m</td>
<td>1-20km</td>
</tr>
<tr>
<td>Germany</td>
<td>17-40m</td>
<td>25-100km</td>
</tr>
<tr>
<td>All (weighted)</td>
<td>20m</td>
<td>30km</td>
</tr>
</tbody>
</table>

Source: The European offshore wind industry - key trends and statistics 2013; January 2014; A report by the European Wind Energy Association
Offshore Wind Power Forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>UK</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>3,681</td>
<td>508</td>
</tr>
<tr>
<td>2014</td>
<td>4,581</td>
<td>1,308</td>
</tr>
<tr>
<td>2015</td>
<td>5,081</td>
<td>2,208</td>
</tr>
<tr>
<td>2016</td>
<td>6,081</td>
<td>3,108</td>
</tr>
<tr>
<td>2017</td>
<td>7,581</td>
<td>3,908</td>
</tr>
<tr>
<td>2018</td>
<td>9,581</td>
<td>4,708</td>
</tr>
</tbody>
</table>

Source: Navigant Research World Market Report 2013
Some scene-setting

- Offshore wind is not quite “mainstream” but is getting closer all the time
- A lot of similarities and some standardisation apparent across the majority of capacity installed to date
  - Still mostly Vestas and Siemens WTGs on monopiles
  - Relatively shallow and close to shore
- Therefore a lot of commonality in the problems and solutions experienced to date
- Can all previous problems be avoided in the future?
- How much past experience is going to be relevant as projects get bigger, deeper and further offshore?
Commercial problems – examples

- The supply chain isn’t big enough, and won’t be big enough for several years
  - Adverse effect on contract prices and terms, and availability of experience and financially secure contractors
  - Issues already manifesting themselves in component quality on many projects and significant schedule delays after contract execution
  - Supply chain-related delays on several German projects highlight the challenges facing UK Round 3 projects and associated grid connections

- Commercial terms can vary widely between different parties;
  - Important to have a mix of experienced advisors and experience from other projects/contracts to set acceptable benchmarks
Commercial problems – examples

• **Serial defects and warranty provisions**
  - Always critical, but more so due to rapid changes in turbine technology offerings, and issues with some foundation designs

• **Interface risks always exist;**
  - better to have direct control over these if you cannot find a robust contracting structure and experience contractors

• **The more interfaces, the more contingency burn when something goes wrong**

• **Ultimately, all risks find their way back to the Project**
Construction problems – examples

- Most frequent and costly problems well known:
  - Interface issues
  - Weather
  - Foundation installation
  - Cable installation
  - Supply chain delay

- Contingency spends can range between 6% and 26%:
  - Multi-contracting (e.g. 10+ main contracts) causing the largest cost overruns
  - Bad weather, cable installation and contractor variations make up the largest uses
Construction problems – examples

• Design re-work and certification delays impacting on manufacture
• Marine Warranty Surveyor activities
• Safety issues; fires in factories, poor environmental management, offshore accidents and fatalities
• Hammer and piling equipment break-downs
• Dropping components
• Forgetting parts of workscopes
• Vessel delays, malfunctions and accidents
• Welding and fabrication defects on foundation components
• Contractor insolvency during construction
Operation problems – examples

• Measurement uncertainty
  – lack of on-site measurement;
  – both a performance and a financing issue
• Lack of *independent* visibility on actual versus expected performance
• Availability levels have been very mixed
  – Combination of access, hard-wearing environment and technology issues
• Every offshore WTG installed to date has had problems
  – These range from low level but frequent electrical equipment issues to major drive chain serial defects
Operation problems – examples

• Operating costs for offshore wind
  – remain 2-3 times higher than for onshore wind
  – Fundamentally more challenging to access and service machines at sea
  – Lack of competition
  – OEMs now offering long term (10-15 year) contracts that are very comprehensive but result in costs remaining high

• Design issues with foundations
  – have led to operations-phase headaches and costs
  – much more care needed with design codes and design verification as we scale up and move into deeper water
Operation – power curve verification

- Met mast necessary according to current standards
- Alternative: Remote sensing device on transition piece
- IEC standards currently being updated
Offshore power curve verification

- The elevation is set to acquire hub height inflow wind speeds 2.5 rotor diameters upwind in the free stream sector ...
Offshore power curve verification

LoS 1
LoS 2
LoS 3
LoS 4
LoS 5

2.5 D

Freestream sector
Low level jet

- Moderate shear profile measured
- Severe complex shear profile

Galion Low level jet
Lessons learnt & key mitigants – commercial

• Evaluate your options carefully and do it early
  – What is the best structure for YOU
  – What balance do you want to achieve between cost and risk?
  – Get the right balance between bankability and practicality

• Multi-contracting
  – may bring down the base CAPEX but contingency usage is much higher when something goes wrong (and things always go wrong)

• Can you change the scope or method if it isn’t working?
  – Flexibility during construction is important but does it come with a price premium?
Lessons learnt & key mitigants – commercial

• Are you paying a risk premium for something you can manage better yourself?
• Are contract prices structured to maximise variation claims?
• Contractors are very good at finding reasons for variations, even in EPC-style contracts
  – Be prepared; careful scoping, careful contract drafting, close contract management
• Do your homework on supplier and contractor expertise, track record and financial strength
  – It’s a small industry so make use of your contacts
Lessons learnt & key mitigants – construction

Supply chain

• Supply chain has caused problems after financial close on several projects
• Mitigants include float for ensuring sufficient time for design finalisation and certification, earlier and more intensive QA/inspection activities by Project Co.
• Sufficient contingency and schedule float, combined with a skilled project team, allows key activities to be rescheduled with minimum overall impact
• There are still wide variations in skill and experience levels within the supply chain
Lessons learnt & key mitigants – construction

- Experienced project teams
- Flexibility in contingency and schedule
- Weather is always a factor
- Projects frequently minimise weather impacts through careful scheduling,
- Selection of right vessels and installation methods,
- Maximising onshore preparation
Lessons learnt & key mitigants – construction

• Test schedule and budget for a range of scenarios, e.g.:
  – Equipment failure/breakdown
  – Supply chain delays and failure, including insolvency
  – Certification delays and adverse impacts on existing designs
  – Weather delays significantly higher than statistical averages
  – Opportunities to avoid problems or minimise delays through major strategy changes

• Use of “mini-EPC” structures
  – Strikes a good balance between utility-style multi-contract approach and the lenders’ ideal of a single turnkey contract
Lessons learnt and key mitigants – operation

- Onshore wind measurement and analysis is improving and improvements are being transferred to offshore projects.
- Remote sensing is providing much greater understanding of specific wind regime issues and reducing measurement uncertainties.
- UK Round 3 projects are investing in on-site measurements proportional to the size and value of the projects.
- Still concern over full effect of large array wakes.
Lessons learnt and key mitigants – operation

- WTGs are becoming more reliable but new models will always have some issues during early years
- New projects are benefiting from experience of older projects
- Significant changes in contracting strategy, asset management planning and access technologies
- Again, German far-shore projects indicating what could lie ahead for the wider industry
  - Manned platforms, “flotels”, significant use of helicopters, next generation of access vessels
- Strong warranties and clearly defined maintenance scopes of work remain essential
  - Long term reliability and performance of offshore WTGs still unproven
Recommendations – be prepared

• Realistic financial model, with contingencies, at early stage
• Realistic construction programme, with contingencies
• Never stop planning ahead for problems
• Problems will occur at various stages:
  o Plan ahead for time and effort needed to reach financial close
  o Identify plans and resources for tackling different scenarios during construction and operation,
  o Choose realistic sensitivity tests for the financial model
• Sponsors can, and do, use bank-style due diligence to achieve a strong balance between financial objectives and technical risk
Conclusions

• No offshore wind farm has been built without problems and or use of contingency
• New lessons will be learned as projects get bigger, further offshore and deeper
• With a small number of exceptions, projects are being delivered within expectations
• Improvements are being made consistently
  – The devil is always in the detail
• No one has all the answers
  – developers who can act as a catalyst for building experienced and flexible teams will be the ones who succeed with the least number of new lessons being learned the hard way
• Focus on doing it safely and effectively, with the right people and cost efficiencies will follow
Thank you for your attention

Contact Details
Matthias Henke
Director of German Operations
Phone: +49 40 311 82 39 81
Email: matthias.henke@sgurrenergy.com
www.SgurrEnergy.com

Come talk to us at our booth #B31