

Foundation Ex 2022 - Bristol
**Design Challenges for Monopile
WTG Foundations in the US
Market**

Phil Combes

RAMBOLL

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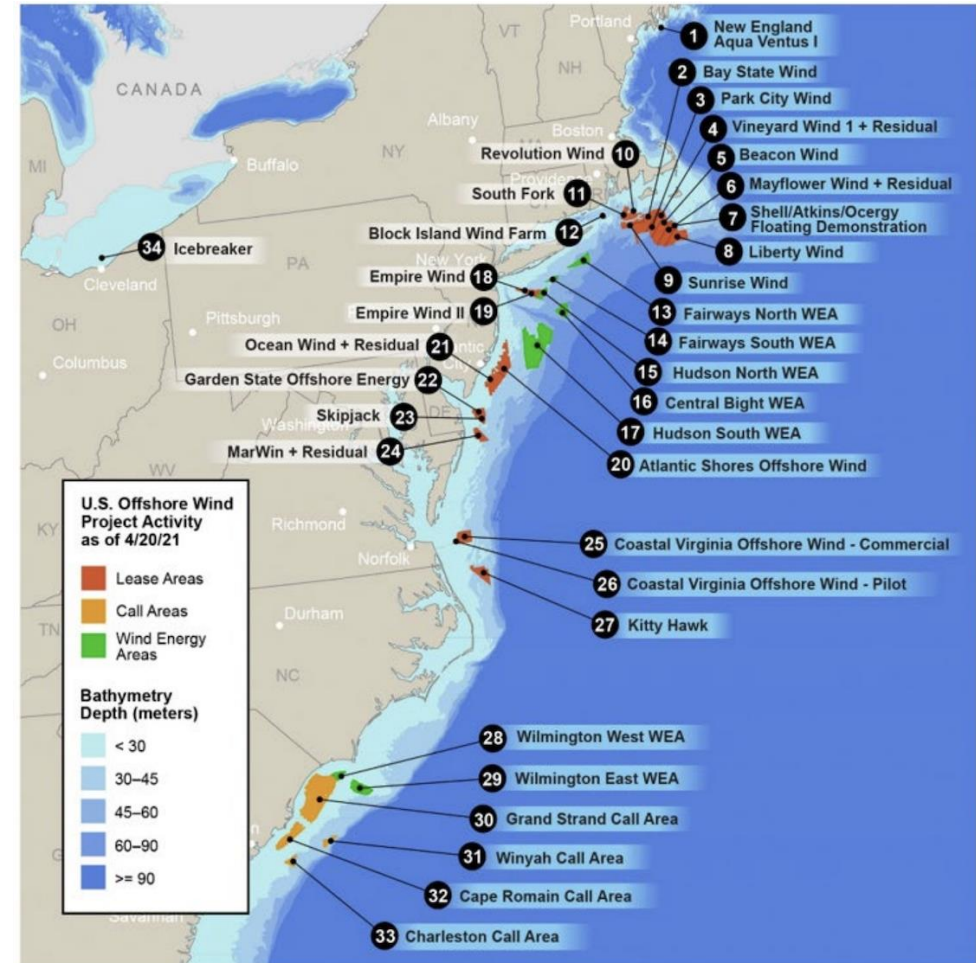


Agenda

1. Introduction
2. Hurricane/Tropical Cyclone Loads
3. Vessel Impact Requirements
4. Fabrication/Supply Chain Limitations
5. Transatlantic Sea Transport
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7. Conclusion

Introduction

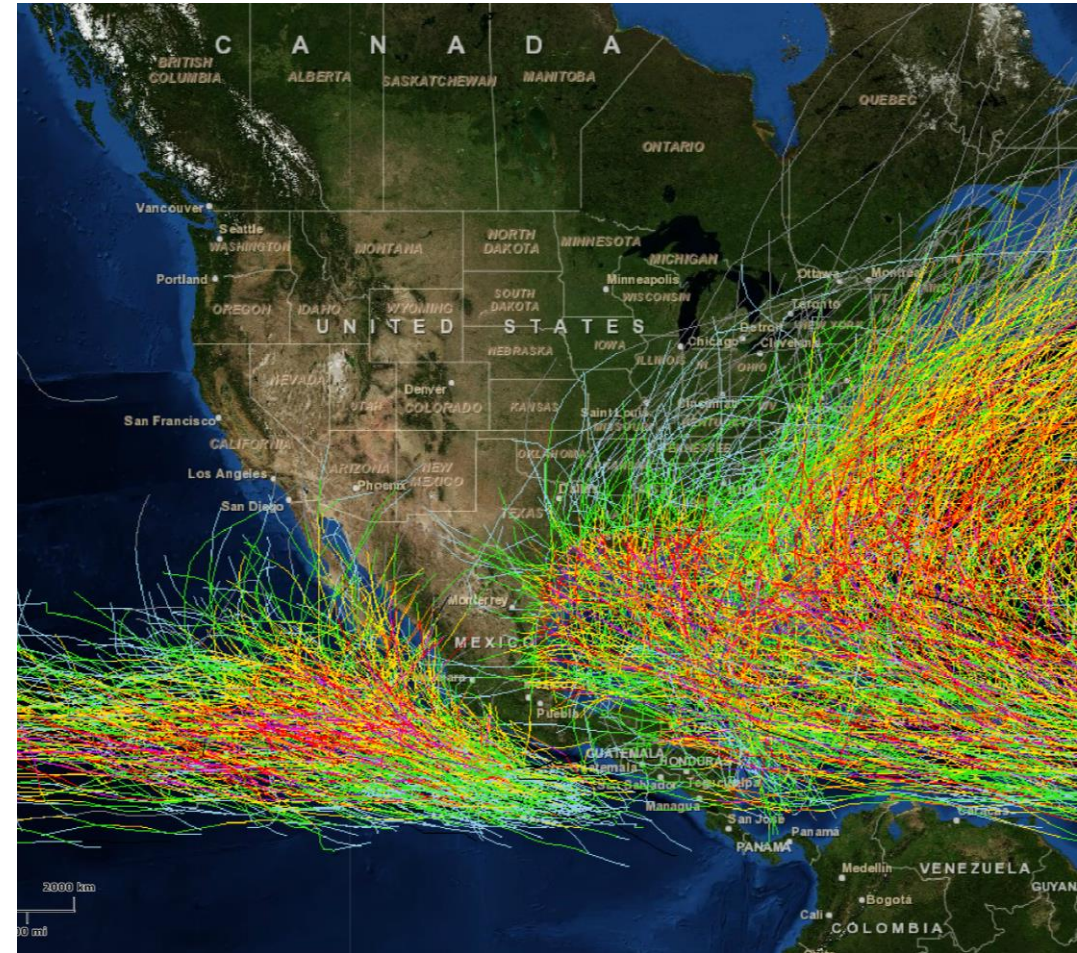
- Who am I and why should you listen to me on this topic?
- Are MPs not just the same old boring technology that has been used for years?
- In principle, yes, however...
- The US market presents unique challenges
- Challenges span technical, supply chain and regulatory topics
- The market is extremely young and we expect the landscape to change significantly over coming years
- What is a challenge today may not be in years to come



Source: John Frenzi, National Renewable Energy Laboratory

Hurricane/Tropical Cyclone Loads

- Requirement for US waters from OCRP and IEC 61400-3
OCRPs = Offshore Compliance Recommended Practices from the American Clean Power Association
- DLC i.1: 500 year return period event with PLF = 1.0
- DLC i.2: as per i.1 but with loss of electrical network power and yaw function → significant load increase due to misalignment
- High variability on wind conditions may also have an impact on the 'conventional' DLCs (6.1 and 6.2) due to high CoVs found (>15%)
- Can have *significant* impact on substructure and tower → CAPEX implications for projects
- Soil Cyclic Degradation: BSH applicability should be verified with detailed hurricane study. Ramboll's Asia-Pacific cyclone experience shows modified storm durations may be needed



Historical hurricane events, source: NOAA

Vessel Impact Requirements

- Historical approach for MP vessel impact has *generally* focussed on CTVs rather than SOVs due to anticipated O&M logistics strategies
- OCRP requires “impact scenarios found to be *likely* within the lifetime of the wind farm” to be assessed → Risk assessment of different collision types is required
- Risk Assessment should consider redundancy systems e.g. DP2/DP3, anchor back-up when determining likely impact scenarios
- Leaves door open for interpretation → SOV impacts come into play
- Can pose problems for MPs, TPs and WTG Towers → CAPEX impact
- Resultant loads varies significantly with input parameters
- Have we underestimated the risk up to now? See Hollandse Kust Zuid incident. Might damage have been less severe if SOV impact was a design case? Is risk based approach still appropriate?



Hollandse Kust Zuid TP damage, source: Vattenfall

Fabrication/Supply Chain Limitations

- Currently no capacity for OFW-scale monopile foundations
- US O&G heritage means jackets more feasible, but OFW knowledge lacking
- Investments being made e.g. EEW facility in New Jersey, new market entries such as Marmen Welcon
- Not just investment in facilities; skills/experience need time to develop
- Open question: how long before we see a fully US fabricated project?
- Introduces design challenges if MPs made in Europe...



Source: EEW

Transatlantic Sea Transport

- Generally ULS not an issue for MPs/TPs, is for jackets
- 'Old' approach of neglecting FLS due to short distances or applying a conservative margin no longer appropriate
- Analysis requires cooperation with transport contractor for provision of vessel motions
- Spectral fatigue analysis method combined with FE models to determine resultant damages at different welds/details on the MPs
- Significant piece of analysis requiring close cooperation with vessel provider and transport contractor
- Risk for projects where design is highly progressed or finalised before contractor is in place



Source: ALE-Giant/JDN/SHL

Additional Considerations

- New market players– fresh and sometimes ‘unique’ perspectives
- Complex and new regulatory environment – BOEM, USCG, OSHA, State Legislation, EPA etc
- Jones Act compliance (simple version...)- US flagged vessels required to move between 2 US ports
- Local political resistance, fisherman etc, however not unique to US
- West Coast: seismic considerations may be significant

Conclusion

- Some interesting challenges in the US market, however *massive* potential
- Hurricane/cyclone loading not only unique to US, already significant in APAC region
- Larger vessel impacts may become more widely considered outside of US- let's see
- Fabrication capacity will develop- question of how quickly/widely?
- Transatlantic sea transport may become less common as supply chains in US build up
- Very exciting times ahead to watch the market grow...

Thank you!

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