



Offshore Wind Project Logistics & Unique Site Technology

Investigation – Fabrication - Installation

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Foundation Requirements for OW Turbines

- Foundations & Substructures are the components you can not see beneath the sea
- Investigation – Fabrication – Installation

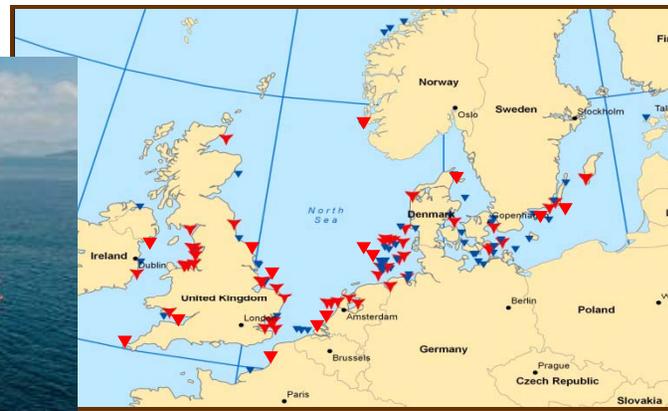


- Large structures
- Many of them
- Heavy industry required to manufacture & fabricate
- Large plant required to install
- Type, design, installation & performance depend on subsurface



Fugro - Investigates Planet Earth

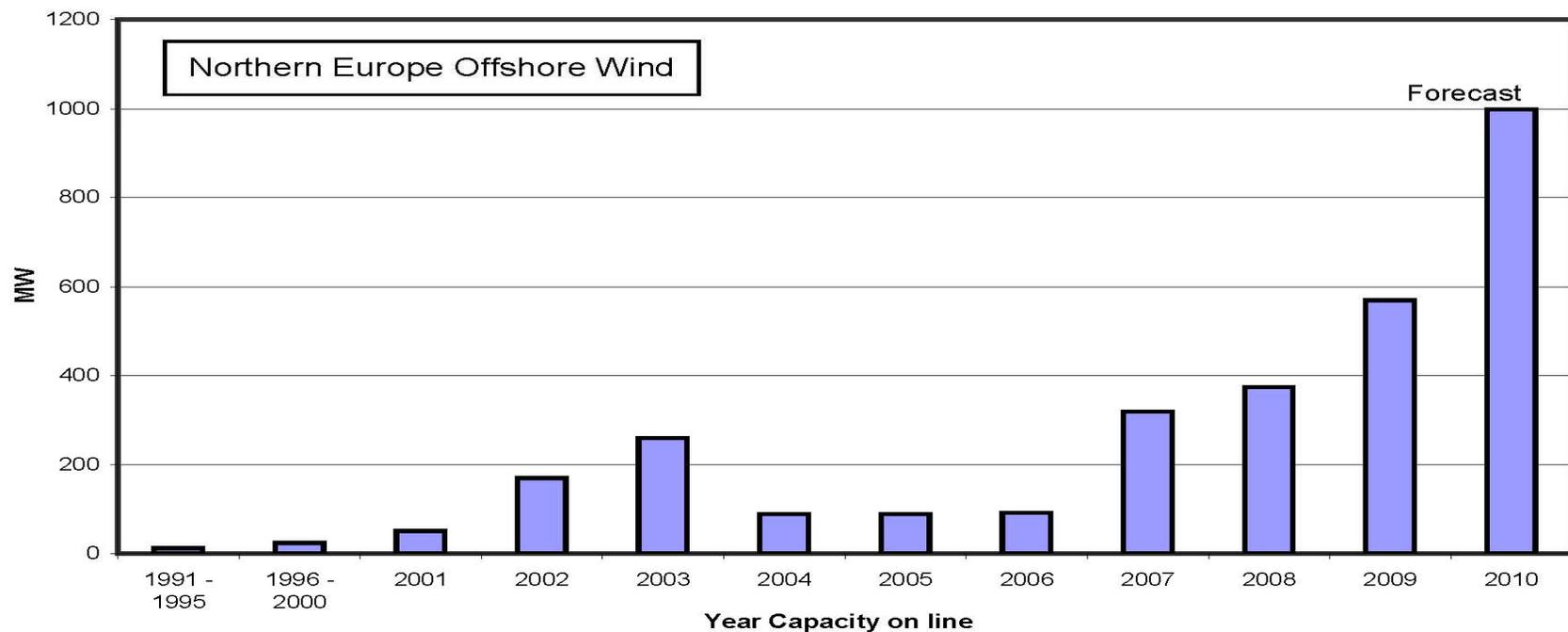
- Fugro is the world's largest and most technologically-advanced firm that:
 - collects, interprets, and analyzes data from and below the earth's surface and
 - provides advice for projects based on that data.
- Primary supplier of our services to the offshore Oil & Gas (O&G) industry in the Gulf of Mexico (since the late 1940s) and around the world
- Primary supplier of these services to the European offshore wind industry since its inception (> 100 OW developments)



Timeline of Development of Offshore Wind in Europe - What Can We Learn from Europe?



- Mid 1990s - Initial demonstration projects (a few WT of 700kW to 1.5MW)
- Early 2000s - Initial small projects (5 to 30 WT of 1.5 to 2.5MW)
- Mid to Late 2000s – Additional projects with more and larger WTs
- Circa 2009 – Evolution from projects to an industry
- Starting in 2008 – Each year add 50% of the previously installed capacity





The Status of Offshore Wind Industry in U.S.

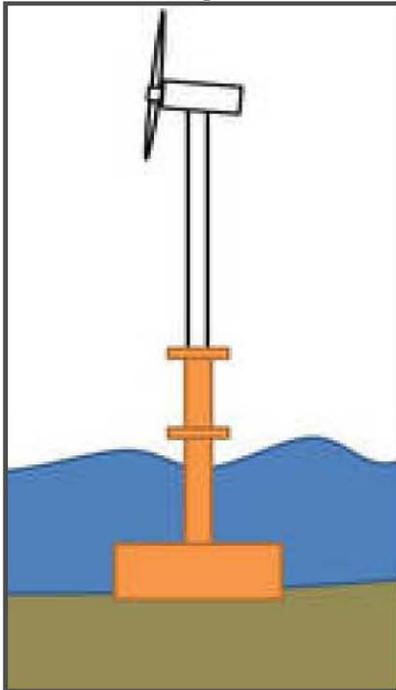
- Initial project proposed early to mid 2000s
 - Of those initial legacy projects, only Cape Wind is still alive
- Starting about 2008, additional developer projects proposed
- Regulatory authority (in federal OCS) passed to former MMS in 2009
 - MMS renamed BOEMRE in summer 2010
- No federal legislation allowing sizable credits or feed in tariffs
- Only 1 met mast installed and no Wind Turbines installed to date
- Areas:
 - Northern Mid Atlantic
 - Great Lakes
 - Central Mid Atlantic
 - Texas
 - Maine
- What opportunities does this provide to the Commonwealth?



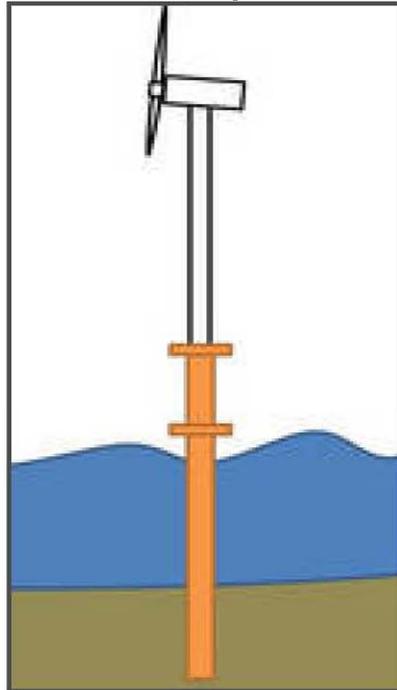
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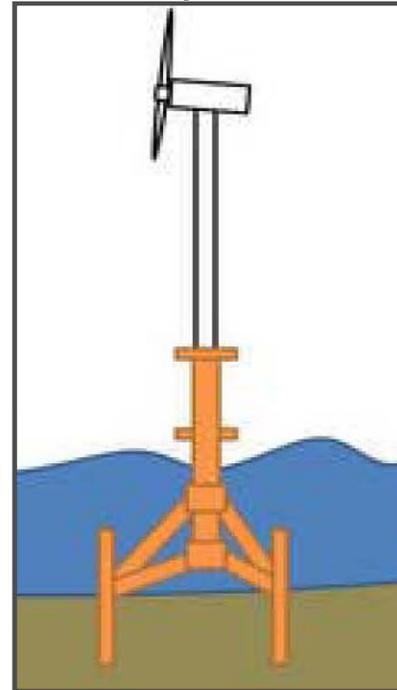
Gravity Base



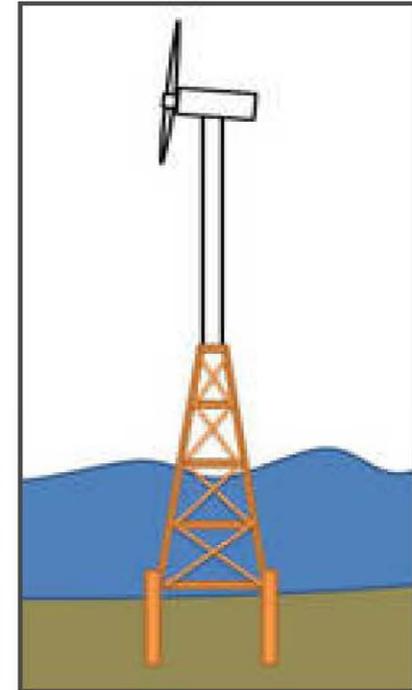
Monopile



Tripod



Jacket





Foundation Requirements for OW Turbines



Monopile



Transition Piece



**Jacket
Construction**



**Tripod
Construction**

**Tripile
Construction**



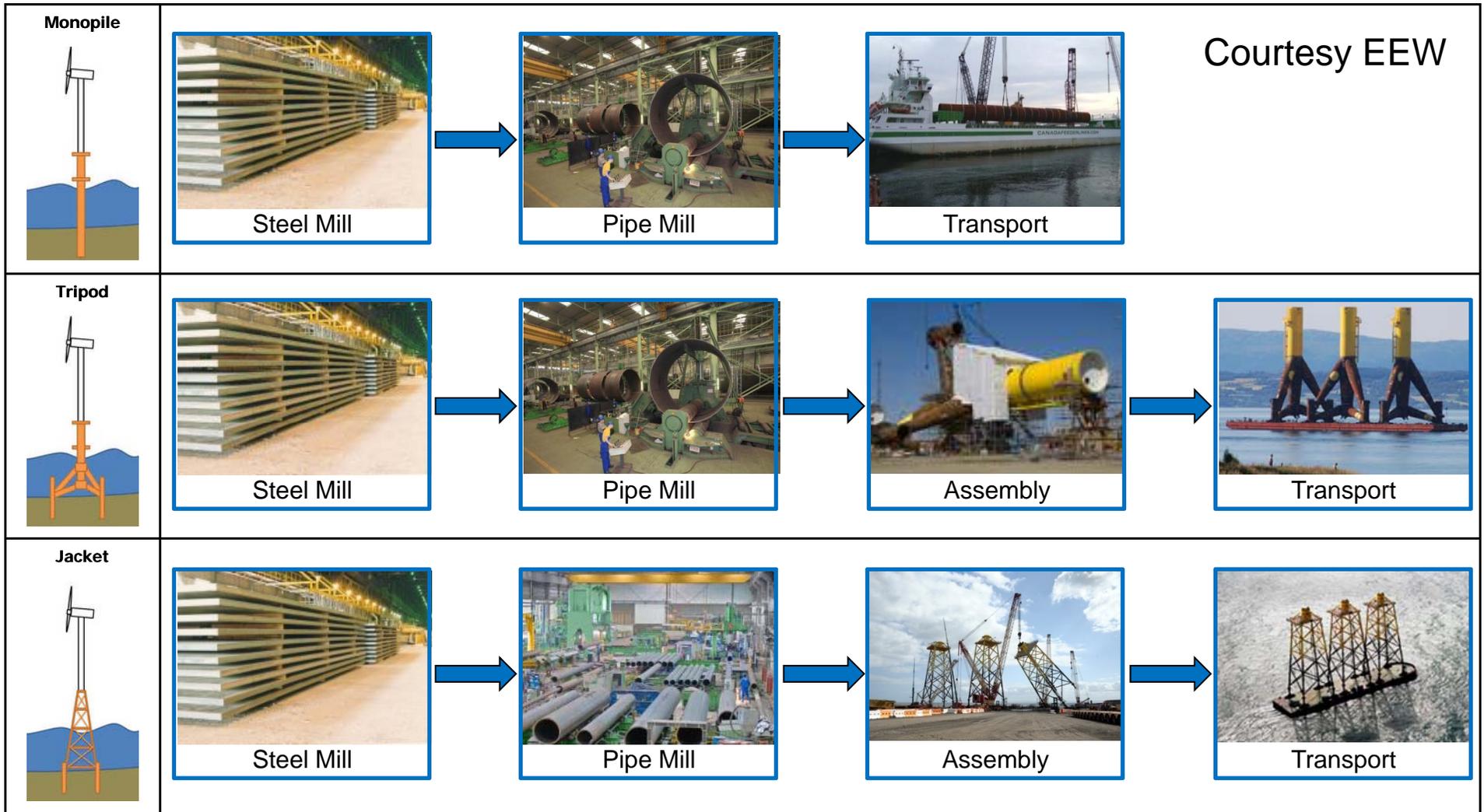
Understanding the Importance of the Subsurface



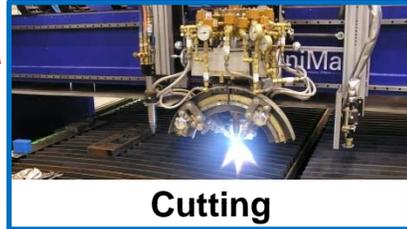
- What you can't see can hurt you - The mysteries beneath the sea
- It costs significant \$s to define and understand the mysteries beneath the sea
 - Open ocean surveys and investigations require large vessels, sophisticated equipment, and experienced personnel
 - HSE Exposure
 - This is often the 1st major expense of an OWF project



Foundation Requirements for OW Turbines Manufacturing – Fabrication Process

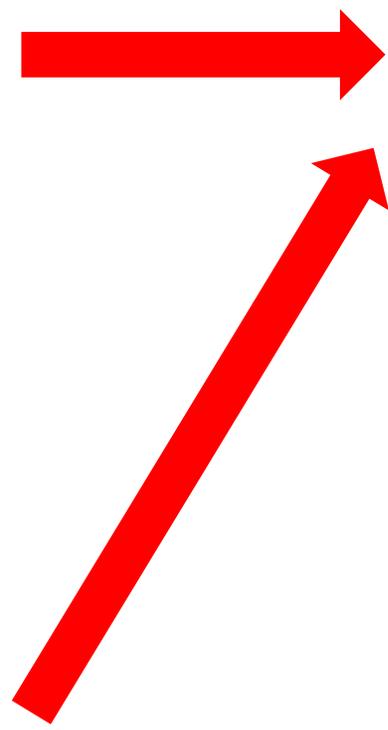


Monopile Manufacturing – Fabrication Process





Transition Piece Fabrication Process



Courtesy EEW

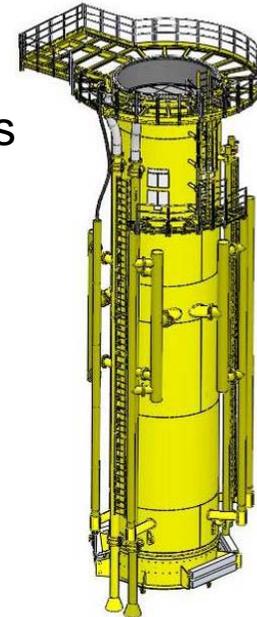


Foundation Requirements for OW Turbines

- Typical Commercial OWF – Thanet in UK
- Monopile Foundations
- 100 Wind Turbines
 - 13- to 17-ft-diameter
 - 130- to 200-foot-long
 - 38,000 tons of steel
 - 1,600# 2.5- to 3.75-inch plates
- Transition Pieces
 - 70-foot-long
 - 12,000 tons of steel
 - 700# 2.25- to 3-inch plates
 - 5,000 tons of secondary steel
- Coatings
 - 40,000 gallons of coatings



Courtesy Smulders



Foundation Requirements for OW Turbines

- For the 350 MW Thanet project
 - 18 different fabrication facilities
 - 500,000 man-hours
 - 55,000 tons of steel



The tons of steel required for the foundations for 100 WT \approx the tons of steel required for a nuclear aircraft carrier



Logistics for OW Turbine Foundations

- Staging area requirements
- Dock side requirements
- Transportation fleet
- At sea requirements



Transportation Requirements for OW Foundations



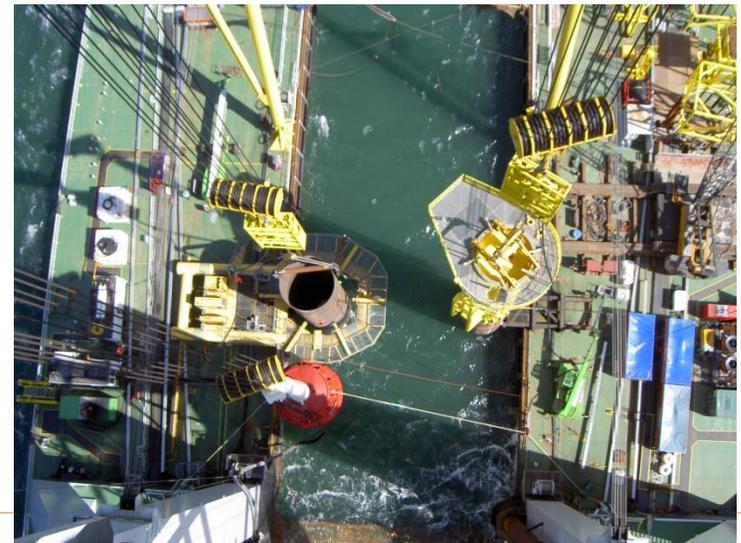
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- Dock side requirements
- Transportation fleet
- At sea requirements





Foundation Installation for OW Turbines

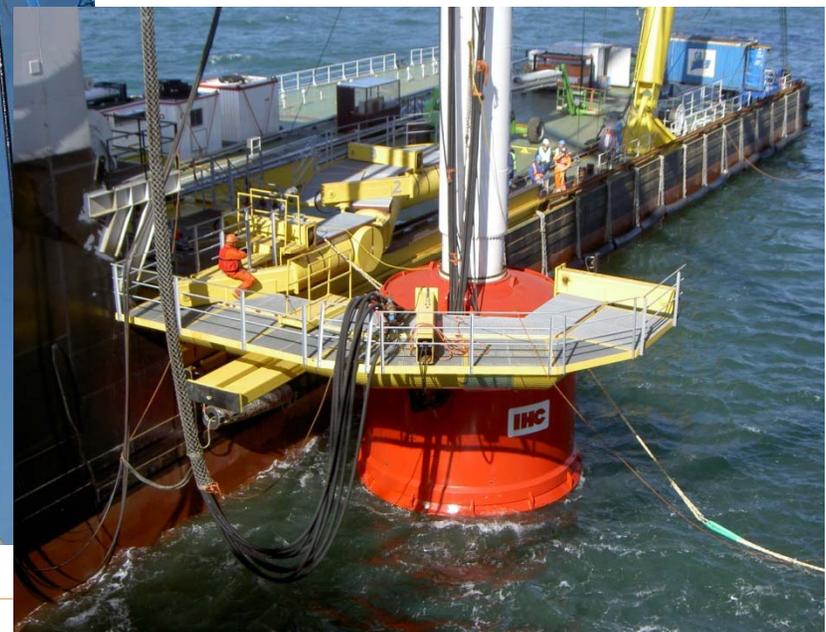
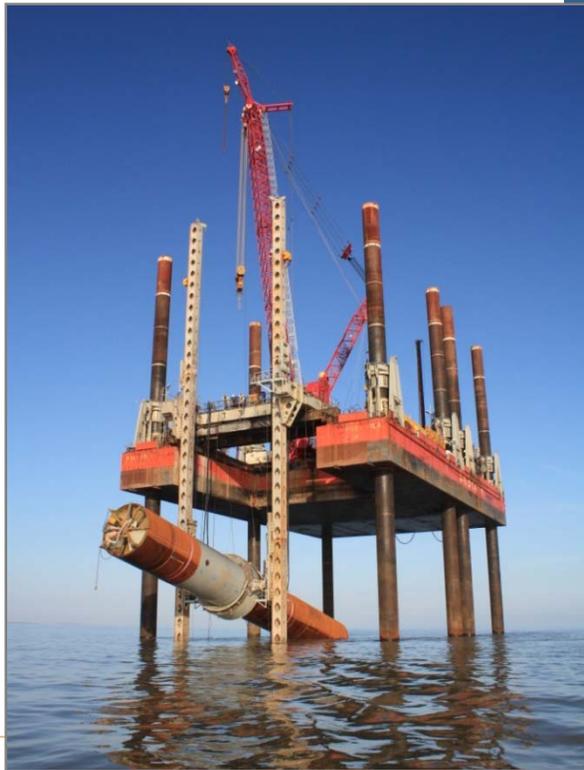
- Open ocean environment
- Large & heavy lifts
- Many lifts
- Tolerances





Foundation Installation for OW Turbines

- Open ocean environment
- Massive pile hammers





Foundation Installation for OW Turbines

- Completed installation
 - Pile in the ground
 - Transition piece in place





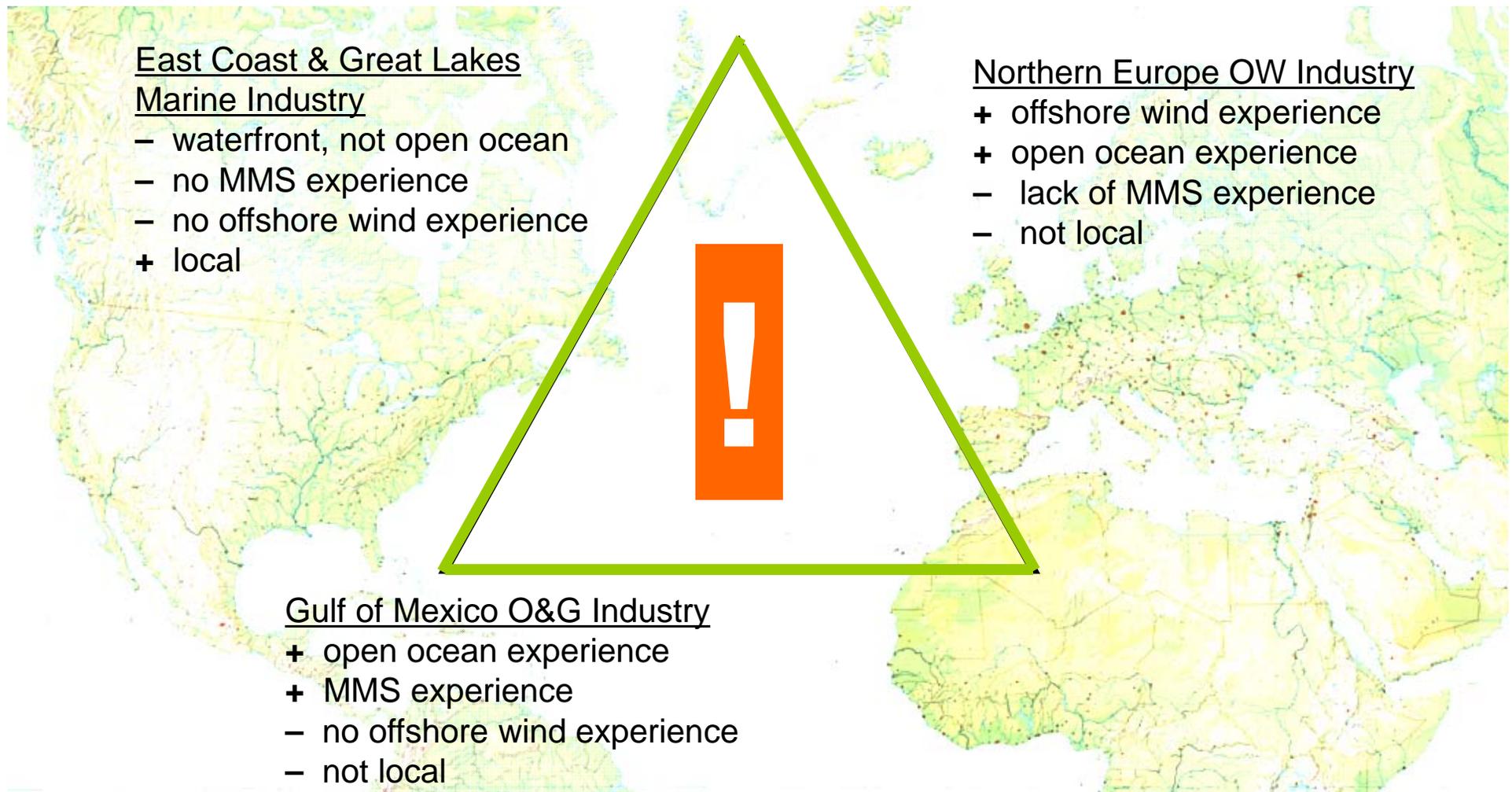
Desirable Experience Requirements

- What are the Desirable Attributes and Experience for Firms who wish to be involved on Offshore Wind in the US?
 - Experience with projects in the Open Ocean
 - Experience with Offshore Wind development
 - Knowledge/track-record dealing with the MMS/BOEMRE
 - Knowledge of the Local conditions
- These needs apply to:
 - Siting & environmental considerations
 - Investigation and engineering considerations
 - Design
 - Fabrication
 - Installation
 - Operations & Maintenance



Where will the Industry Find Appropriate Expertise?

- Where will the U.S. Offshore Wind Industry find supply chain expertise for offshore wind energy development?





Opportunities for the Commonwealth

- Leverage the on-the-water assets in Hampton Roads
 - Protected harbor with ocean access
 - Existing at dock capacity
 - Ample on water marshalling area
 - Suitable water depth
 - No air height restrictions
- Leverage the business friendliness of the Commonwealth
- Access to businesses and people with appropriate skills
 - Ship repair, manufacturing
 - Technical, blue collar work force
 - Ex Navy personnel
- Connectivity with the Great Lakes / Heartland region



Fugro

Global Experience – Local Presence



On behalf of Fugro, I appreciate the opportunity to present these thoughts, and look forward to future opportunities to advocate the development of offshore wind energy in the U.S.

Thank You

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