Adaptations of Offshore Wind Operation and Maintenance Models for Floating Wind

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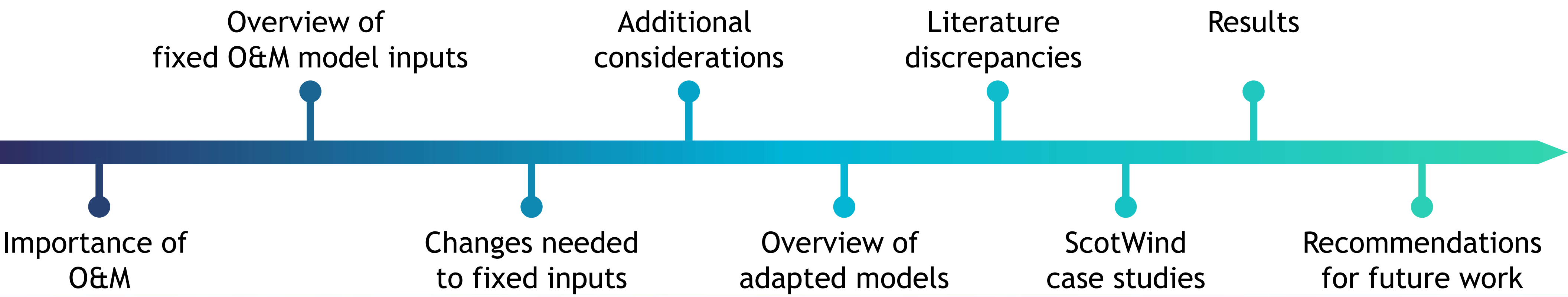
Contents and Introduction

- PhD students at University of Strathclyde
  - Based in the EEE and NAOME departments
  - Strathclyde Floating Wind Research Group



Possibility of new strategies such as Tow to shore

Why O&M?

O&M costs can be up to 30% of total LCOE*[1]

Harsher conditions and increased distance means weather windows are more critical

Additional requirements needed for safety of asset and personnel

LCOE – Levelised Cost of Energy

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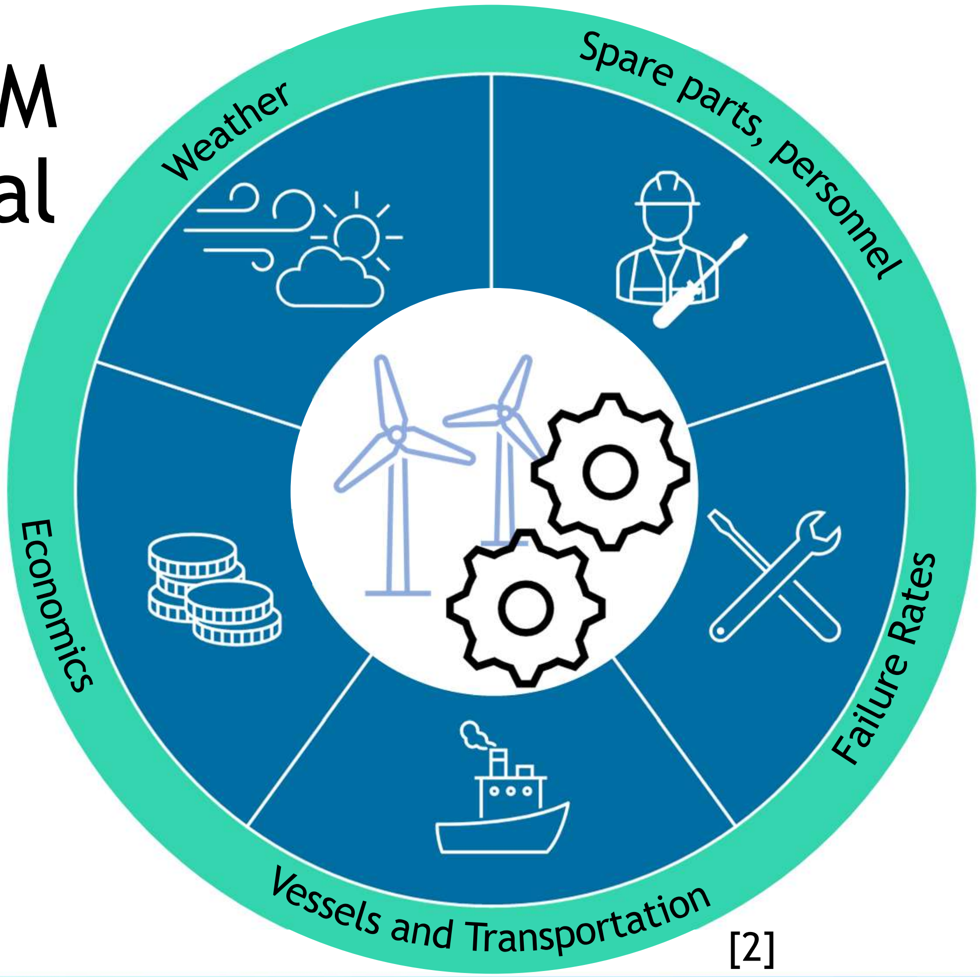
Offshore Wind O&M Influential Factors



[2]

FOWT Modelling influential factors:

- *Metocean conditions*
- *Taxonomy & reliability*
- *Transport*
- *Site logistics*
- *Cost data*
- *Crew availability*

Influential factors for FBW and FOW

Fixed Wind

- Hs
- Wind speed

- CTV
- SOV
- HLV

- Standardized failure rates
- Suitable for DFIG systems

- Crew availability
- Part availability

- Cost of energy
- Cost of repair/
- resources

+ + + + +

Floating Wind

- Peak wave period
  - Characterize motions
  - working limits

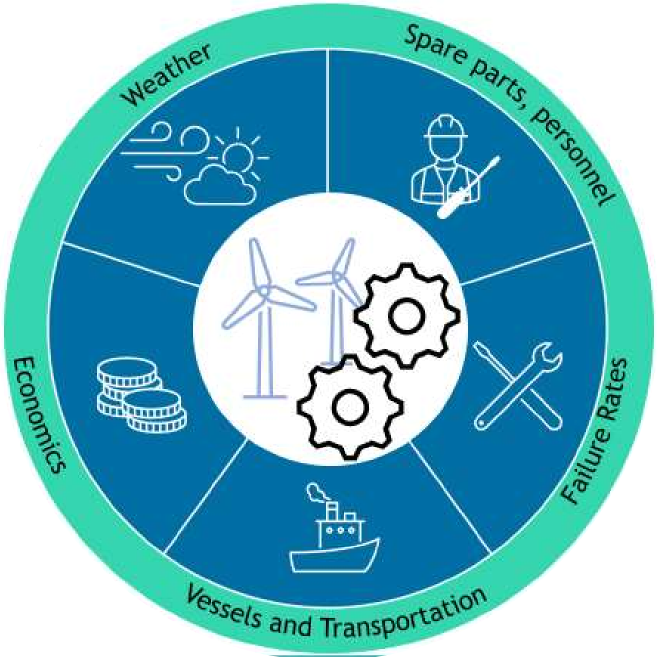
- Tugboats
- Floating crane
- Onshore Crane
- AHV

- Substructure
- Mooring system
- Direct drive WTs
- Longer repair times

- Working limits
- F2F transfers
- Workability limits

- Cost of additional resources
- Cost of new components

Additional Requirements for FOW



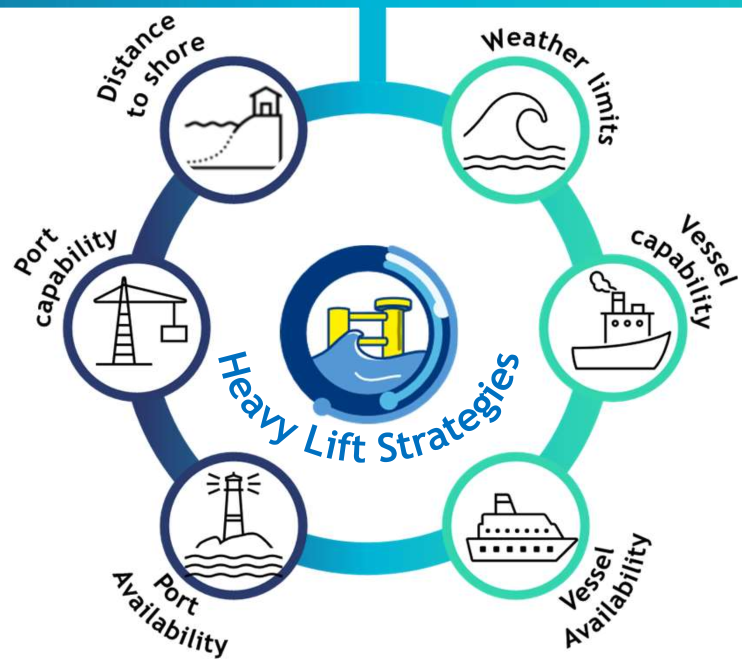
“traditional” model inputs

+

FOW additional considerations

Port Considerations

- Is distance to shore viable for a T2S strategy. Alternate strategy may be more cost effective
- Available port infrastructure
- Accommodate a specific floater type at a given port
- Port availability and available weather window must coincide



Vessel/Weather

- Vessel limits used to determine available weather windows
- Adopted strategy depends very much on local site conditions
- Capability of vessel such as crane reach and lifting heights.
- Vessel availability and waiting times when required

Increased safety concerns/limits

Additional time for disconnection and transfer

Splitting weather windows

Existing Adapted Models

	Rinaldi et al. 2020 [3]	ECN [5]
Original Model	Rinaldi et al. 2016 [4]	“ECN O&M Access tool”
focus	Direct comparison between fixed and floating	Creation of baseline scenarios for near- and far-from shore
Key details	• Fixed cheaper than floating • Comparison of different tow to shore strategies	• Motion compensated gangway of SOV utilised for floating-to floating transfer

Existing Model Adaptations

			Tow to Shore				
			Included?	Strategy	Components	Towing	Timings
Rinaldi et al.	• Hs • Tp • U • 70%↓ in Hs limit	• CTV • SOV • tug	✓	• Continuous (single WW) • Discontinuous (split WW)	• 8/16 components • Same taxonomy as floating	• 30%↓ vessel speed	• 1 hour disconnection & reconnection times
ECN	• Hs • U	• SOV • tug	✓	• discontinuous	• Weight >3T	?	?

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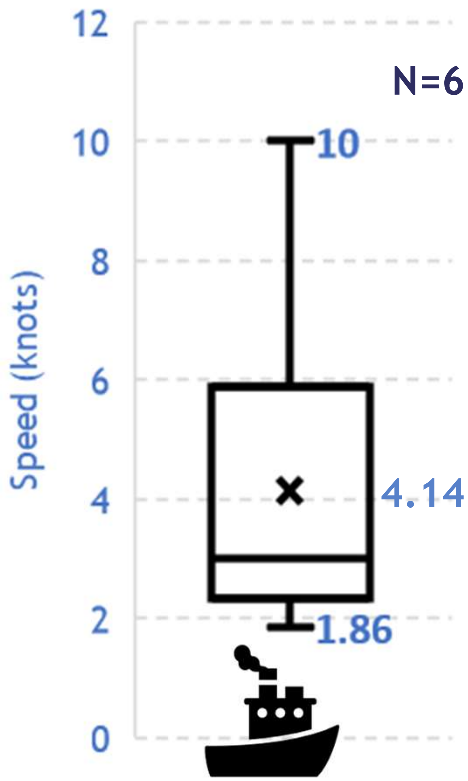
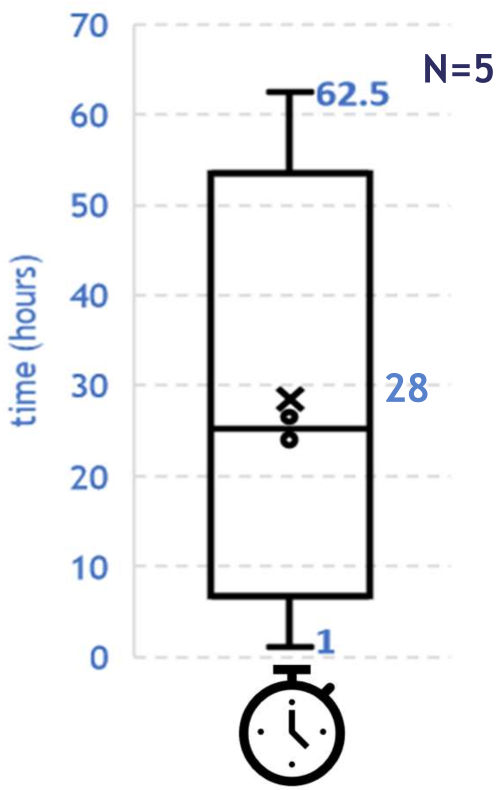
Literature Standard Values

- General factors
  - Inclusion of Tp
  - Hs altered limits due to motion
- Varying data surrounding tow to shore strategy
  - Tug-boat speed
  - Disconnection/reconnection times

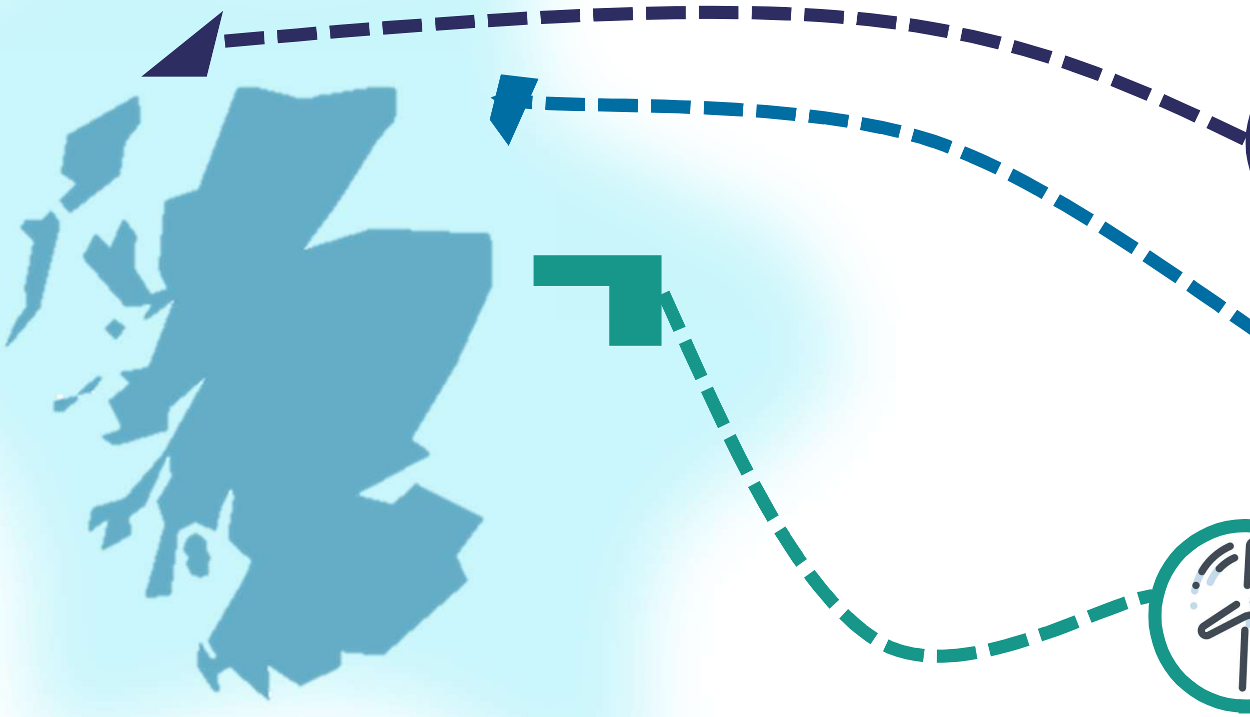


[5 -10]



[3,6,9,10]

ScotWind Case Studies

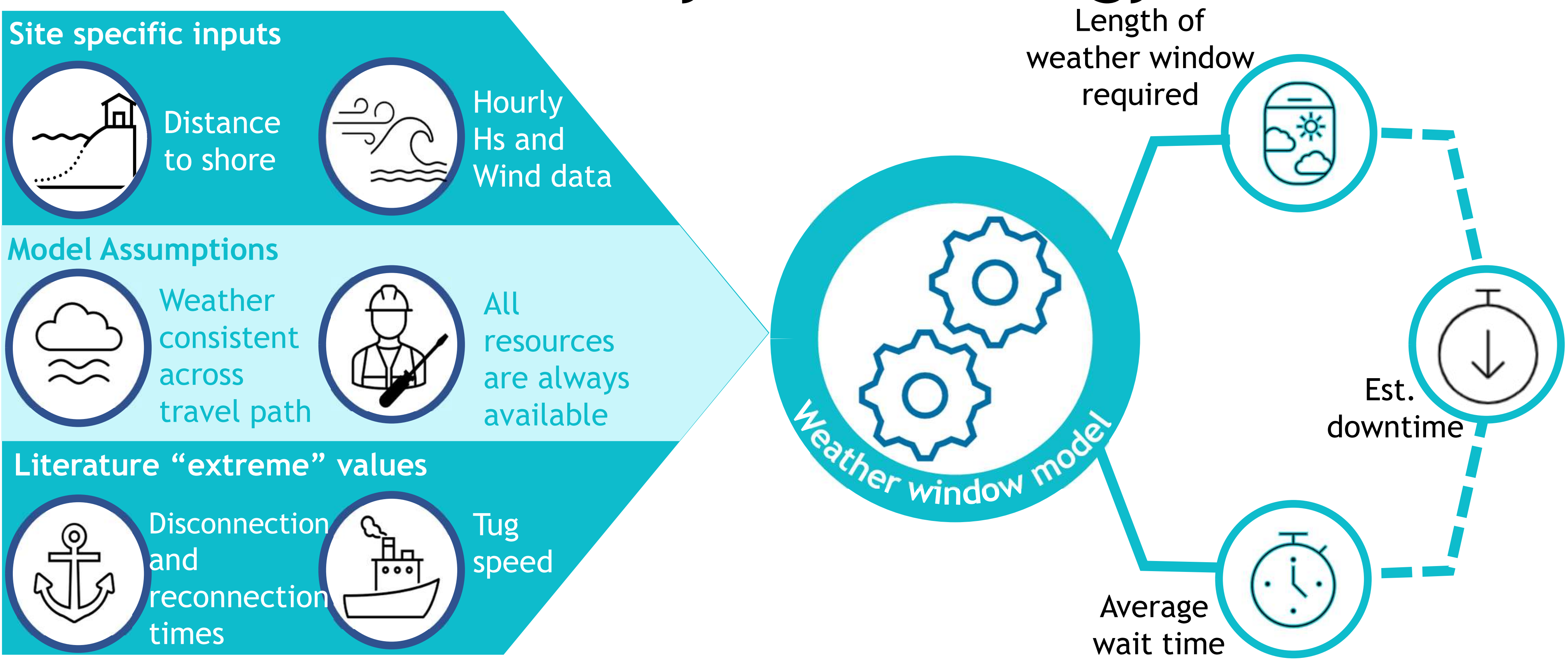


Site: N2
Water Depth: ~100m
Distance to shore:~40 km

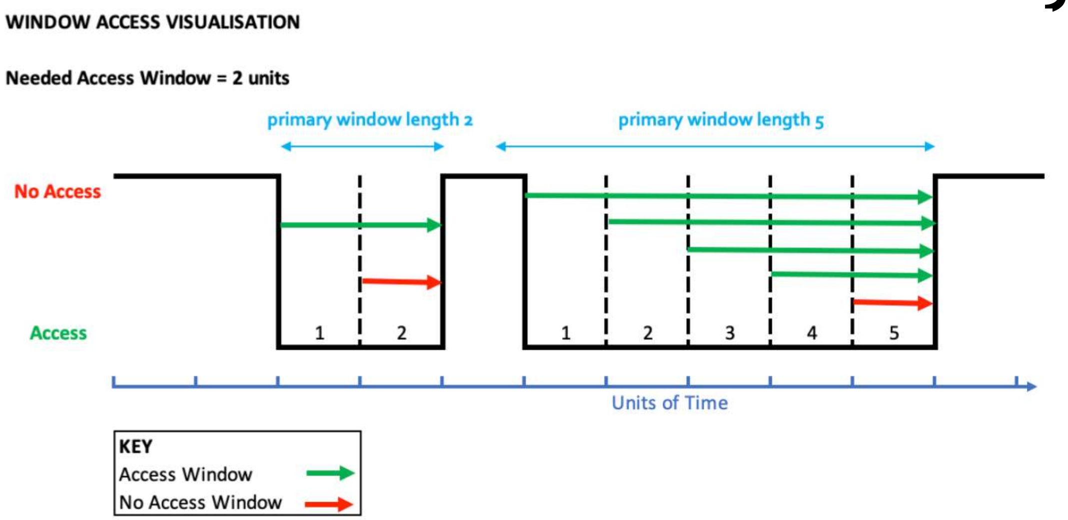
Site: NE8
Water Depth: ~135m
Distance to shore:~80km

Site: E2
Water Depth: ~110m
Distance to shore:~140km

Scotwind Case Study Methodology



Weather Window Analysis



Accessibility is defined as the time based % in which a weather window of the required length is available

Scenarios

1

Speed: 10 knots
Connection: 24 hours

2

Speed: 1.86 knots
Connection: 63 hours

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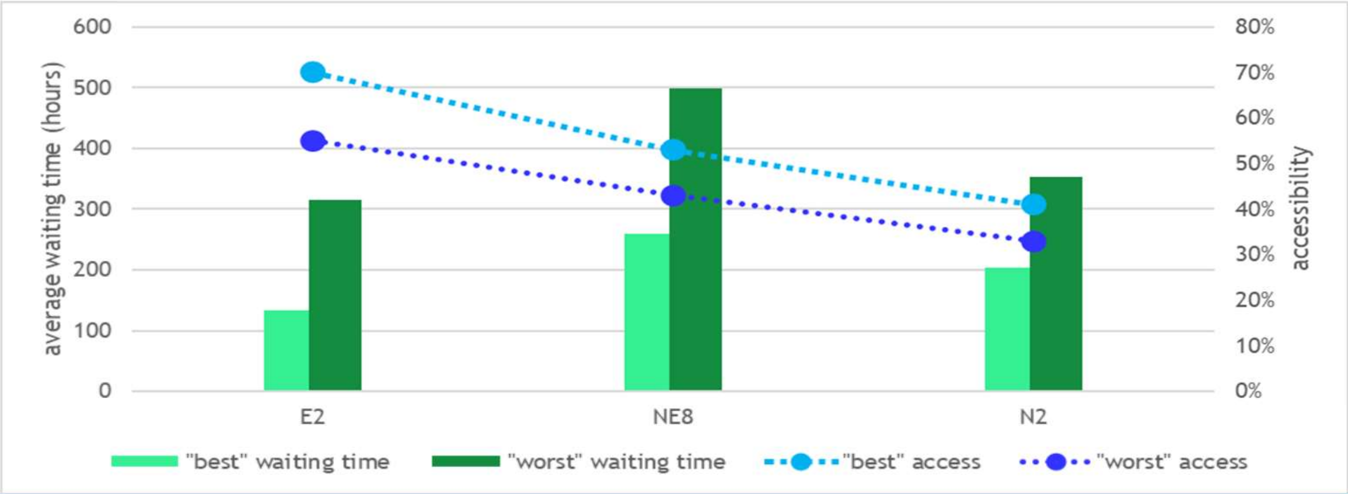
Results - Graphs



Site	Distance to shore	Scenario	Required Weather Window (hours)	% Accessibility	Average Wait Time (hours)
E2	140 km	1	32	70%	133
		2	104	55%	315
NE8	80 km	1	28	53%	260
		2	86	43%	498
N2	40 km	1	26	41%	203
		2	75	33%	353

Conclusions

- Additional elements need to be added to existing O&M models for FOWT use
- Clear need for consistent and reliable data across the sector for tow to shore operations
- Importance of waiting time
  - Tow to shore operations: Tow-in and Tow-out
  - Two periods of waiting for weather conditions
- Direct link between O&M modelling and project financing
  - Inaccurate modelling leads to unrealistic project projections

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