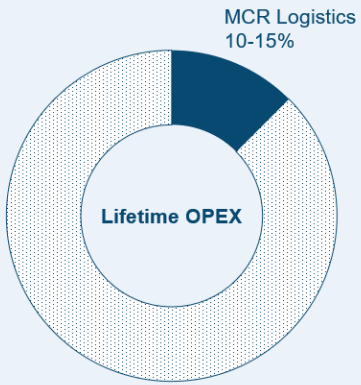
Validating floating wind O&M numerical models vs real data: status, approach and outlook

WESE Workshop
DTU Risø
December 4th, 2024

Relevance of a numerical tool for floating wind O&M

Strategic insights, both early stage & during operations

Tow-to-port (TTP) is the current proven solution to perform major component ceplacement (MCR) on floating wind turbines	**TTP:** turbine is first disconnected from its moorings and cables before being towed to a port, where the MCR is performed. • **Complex operations** → ~7 marine vessels involved + 1 onshore crane at port • **Lengthy operations** → usually more than a month • **High uncertainties** → maturing operations
MCR logistics is one of the main OPEX drivers throughout the wind farm lifetime	
Key insights at early stage and during operations	**Model TTP = estimate total duration** → enables to model costs of the operation + mitigate uncertainties • **Early stage:** increase accuracy of OPEX budgets and wind farm availability, supports in identifying value levers • **During operations:** facilitates planification of TTP and procurement of tools, components, vessels

Elaboration of PEAK Wind's in-house tool

A collaboration between PEAK Wind and Sea Impact

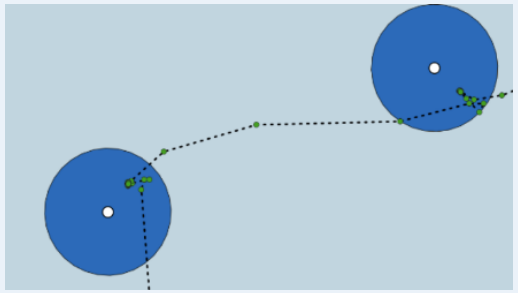
Sea Impact

LAUTEC

PEAK Wind

Sea Impact is a joint venture created by PEAK Wind and LAUTEC

Market intelligence platform that tracks and analyses vessels' AIS data

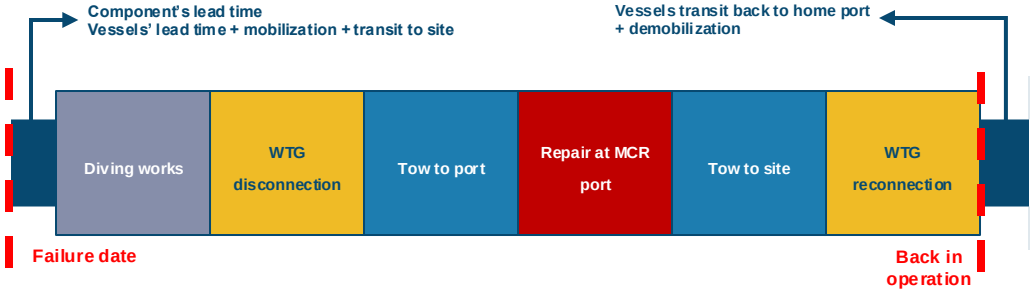


Developed a framework to **track TTP operations**, starting with the 2 TTP that occurred at Kincardine wind farm in Scotland in 2022 & 2023

PEAK Wind

From the analysis of the 2 TTP at Kincardine, the following information has been deducted:

- Overall **process** of a TTP operation, with clear steps
- **Effective time** of each step
- **Weather limitations** of each step



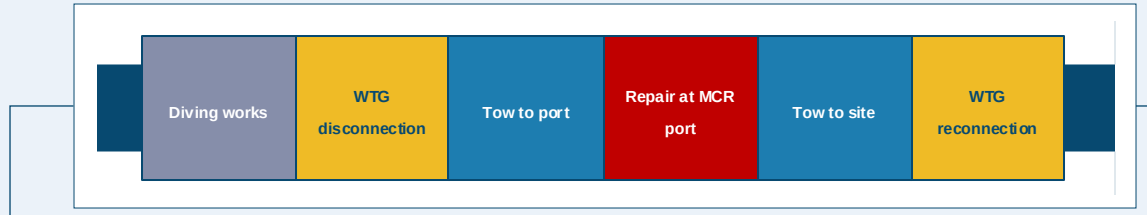
To estimate the total time of a single TTP operation, the wait-on-weather (WoW) for each of these steps must be estimated and added on top of the known effective times.

PEAK Wind's in-house Python model estimates the WoW associated to each step of the TTP operation, considering weather limitations

PEAK Wind's in-house Python model

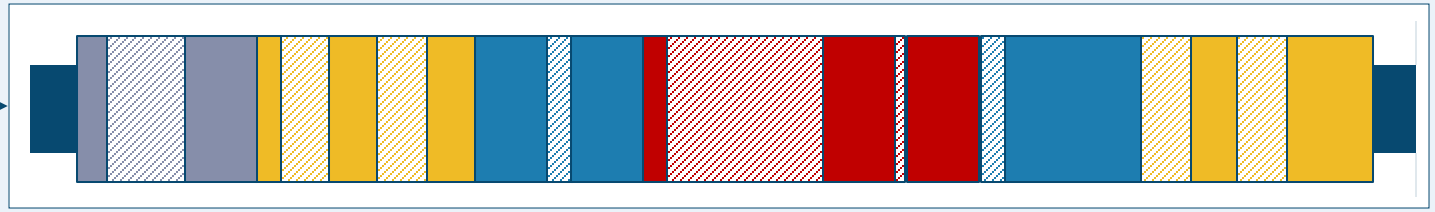
Estimation of WoW over a TTP operation

What?



If weather conditions are all calm along the way
→ weather limitations never met

Real operations: there is WoW



How?

Hourly wave height and wind speed data

Site
Towing route → consistent weather data along towing route
Port

Operations times

Diving works, WTG discon./recon. → #mooring lines, water depth
Towing → towing distance @ 3 knots
Port → major component exchange estimated time

Modelling assumption

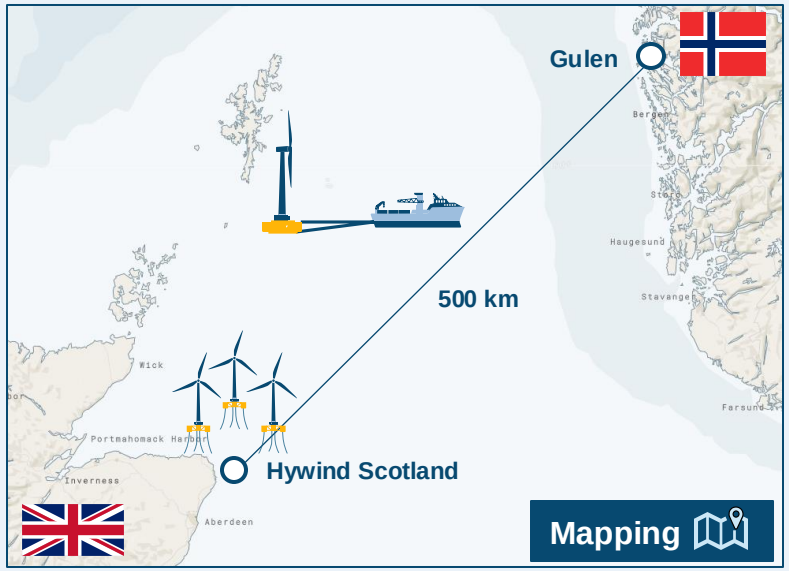
No delays assumed

PEAK Wind's in-house Python model for TTP operations

Case study – Hywind Scotland

Comparison between PEAK Wind's in-house model and Sea Impact data

Hywind Scotland TTP – May 2024

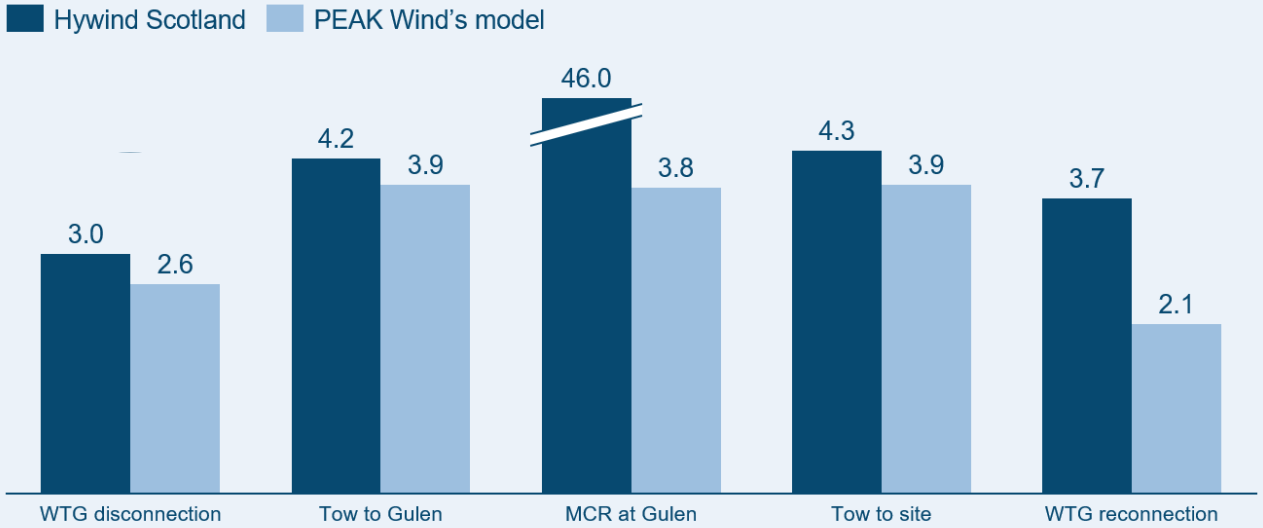


Preparation works	WTG disconnection	Tow to port	Repair at MCR port	Tow to site	WTG reconnection
7 days	3 days	4.2 days	46 days	4.3 days	3.7 days

Preparation works had different scope than diving works in PEAK Wind's model → no comparison will be made

Repair at MCR port did not take 46 days, WTG was kept at MCR port due to a full retrofit campaign carried on WTG while secured at quayside → project-specific

Comparison between Hywind Scotland TTP and PEAK Wind's in-house model



PEAK Wind's results were obtained by computing failures on each day of May (month of the Hywind Scotland TTP) over 5 years of representative data → 155 data points

- **TTP operations are still immature** (7 TTP on utility-scale projects so far) → they differ from a project to another (WTG type, ML type, floater type)
- Hard to capture **project-specific considerations** (delays, time at port, etc.)
- PEAK Wind's model uses **historical weather data** to estimate future events' durations
- **Continuous improvement:** as more TTP are carried out, assumptions will be updated

Industry outlook for floating wind farms O&M

Innovative concepts to perform MCR

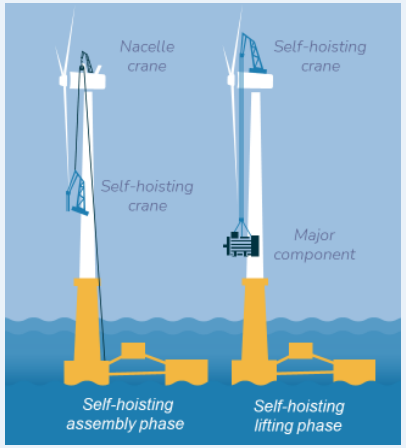
A proven on-site MCR technology

LIFTOFF MAJOR COMPONENT EXCHANGES

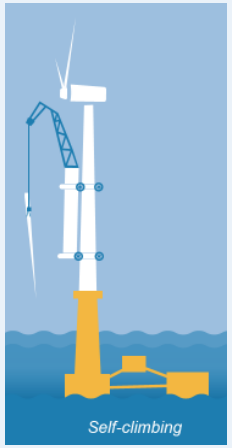
LIFTOFF performed the first in-situ major component exchange (generator) at Kincardine in Summer 2024.

→ Costs reduced by 50-60% vs TTP

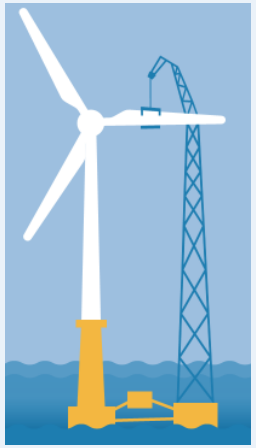
→ Operation complexity and risk are reduced vs TTP



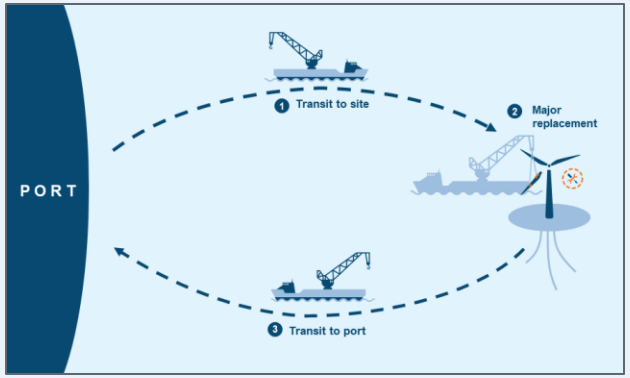
Other on-site MCR concepts



Self-climbing crane



Platform-based crane



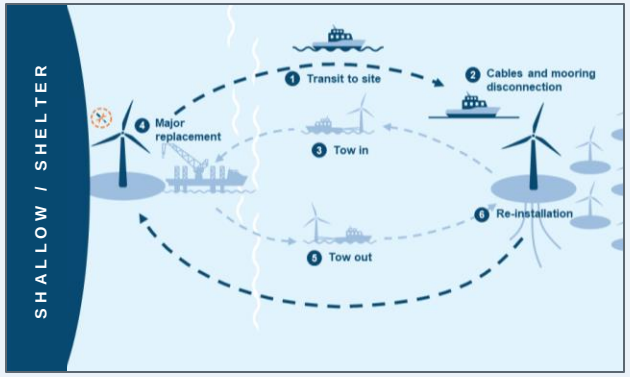
Floating-to-floating

Anther towing concept:

TTS

Tow-to-shallow

Tow-to-shelter



Sources: WEO - Onsite major component replacement technologies for floating offshore wind: the status of the industry
Kincardine Offshore Windfarm - Generator Exchange

Thank you

Find out more at peak-wind.com