

NZWEA Offshore Wind Wānanga

23 August 2022

Offshore Wind 101

Giacomo Caleffi – Copenhagen Offshore Partners

Steps into Offshore Wind



Vindeby (1991 - Denmark)
11 x 450kW turbines



Horns Rev (2002 - Denmark)
80 x 2MW turbines



Hywind (2017 - Scotland)
5 x 6MW floating turbines



Timeline of an Offshore Wind project



Wind farm layout

2 The energy yield team

Windy Less windy

To increase the AEP (annual energy production), turbines are placed at the windiest region and spaced apart as far as possible from each other. No consideration is given to other costs, such as foundations, electrical cables or installation and maintenance logistics.

Energy production: ♥♥♥♥♥♥
 Cost of support structures: ♥♥♥♥♥♥
 Cost of electrical infrastructure: ♥♥♥♥♥♥
 Cost of maintenance: ♥♥♥♥♥♥

3 The foundations team

Shallower Deeper

Rock

Only water depth and soil conditions influence the wind farm layout. Shallower waters reduce foundation costs, and generally it's a good idea to avoid piling them into hard rocks. Many turbines end up too close to one another, increasing wake effects and reducing AEP considerably. No consideration is given to the distance from the offshore electrical substations.

Energy production: ♥♥♥♥♥♥
 Cost of support structures: ♥♥♥♥♥♥
 Cost of electrical infrastructure: ♥♥♥♥♥♥
 Cost of maintenance: ♥♥♥♥♥♥

4 The electrical inter-array team

Turbines are placed as close as possible around the offshore substations to minimise electrical cable lengths and losses. AEP is hit pretty bad and there is no consideration whatsoever for bathymetry or soil conditions.

Energy production: ♥♥♥♥♥♥
 Cost of support structures: ♥♥♥♥♥♥
 Cost of inter-array cables: ♥♥♥♥♥♥

5 The electrical export team

If this team was in charge of designing the layout, they would remove the offshore substations to save all the costs, and put the turbines as close as possible to the onshore electrical substation. Not only do other disciplines pay a big price for this absurd design, but also it would most likely not even be allowed by the authority.

Energy production: ♥♥♥♥♥♥
 Cost of support structures: ♥♥♥♥♥♥
 Cost of electrical export system: ♥♥♥♥♥♥

6 The O&M team

Energy production: ♥♥♥♥♥♥
 Cost of support structures: ♥♥♥♥♥♥
 Cost of maintenance: ♥♥♥♥♥♥

If turbines must be placed offshore, then these would be in a nice tight grid close to shore.

●●●●● AEP is extremely low, and who knows what the seabed looks like right here.

If they could, this team would undoubtedly install the turbines onshore!

8 The commercial team

More seriously though, one thing they would want to do is make the lease area smaller to reduce fees. Wake effects would be tremendously high, and AEP would suffer perhaps unnecessarily.

Energy production: ♥♥♥♥♥♥
 Lease fees: ♥♥♥♥♥♥

Wind Farm layout

9 All teams

No single discipline dominates this design, and instead is achieved with all teams working together. No more barriers, no more competing objectives. Most disciplines make a small sacrifice, but the entire system has the highest performance.

Everyone is happy.



Cost of electrical export system	♥♥♥♥♥
Cost of inter-array cables	♥♥♥♥♥
Cost of support structures	♥♥♥♥♥
Cost of maintenance	♥♥♥♥♥
Energy production	♥♥♥♥♥
Lease fees	♥♥♥♥♥

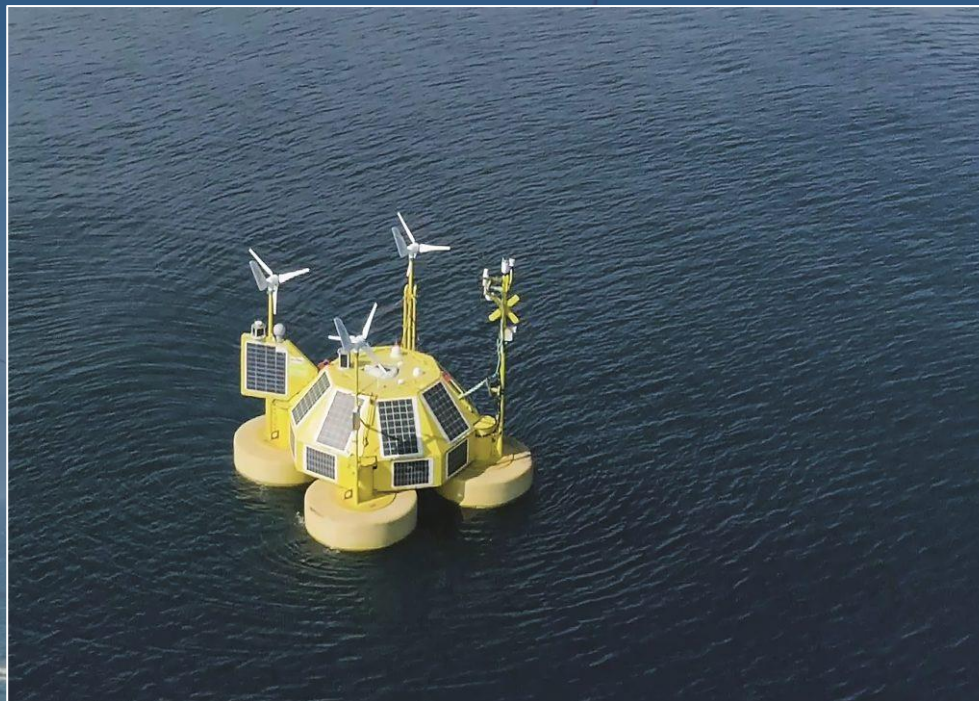
Development

Wind measurements

Metmast



Floating LiDAR



Development

Environmental monitoring

Benthic environment



Fish



Marine mammals



Seabirds



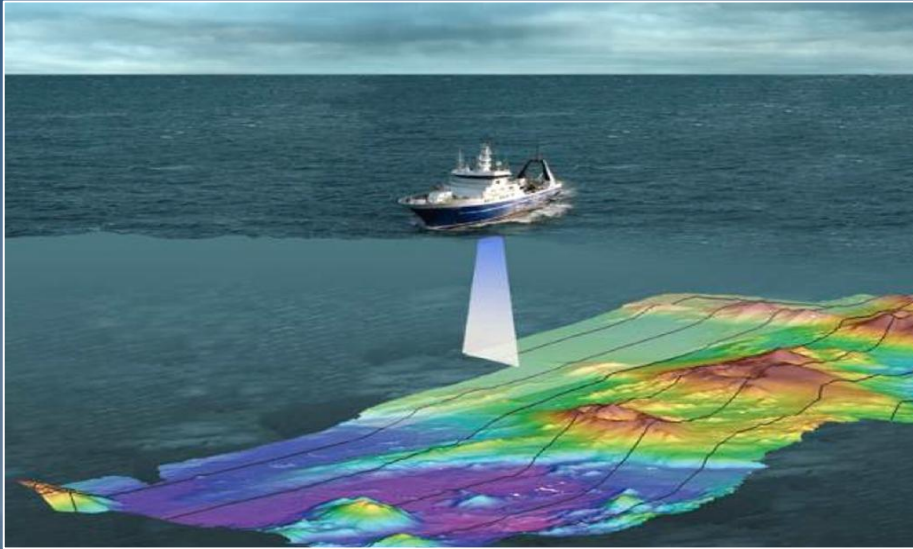
Coastal processes



Development

Geophysical and Geotechnical

Bathymetric survey



Seabed sampling vessel



Development

Minimize visual impact



Engage local communities



Partner with iwi



Social License

Support regional economies



Coexist with fisheries



Construction



SG 14-236 DD

IEC class	I, S
Nominal power	14 MW
Rotor diameter	236 m
Blade length	115 m
Swept area	43,500 m ²
Hub height	Site-specific
Power regulation	Pitch-regulated, variable speed

Wind turbines



HALIADÉ-X14 MW

GE Renewable Energy is developing **Haliade-X 14 MW**, the most powerful offshore wind turbine in operation in the world, with **220-meter rotor**, **107-meter blade**, leading capacity factor (**61%**), and **digital capabilities**, that will help our customers find success in an increasingly competitive environment.

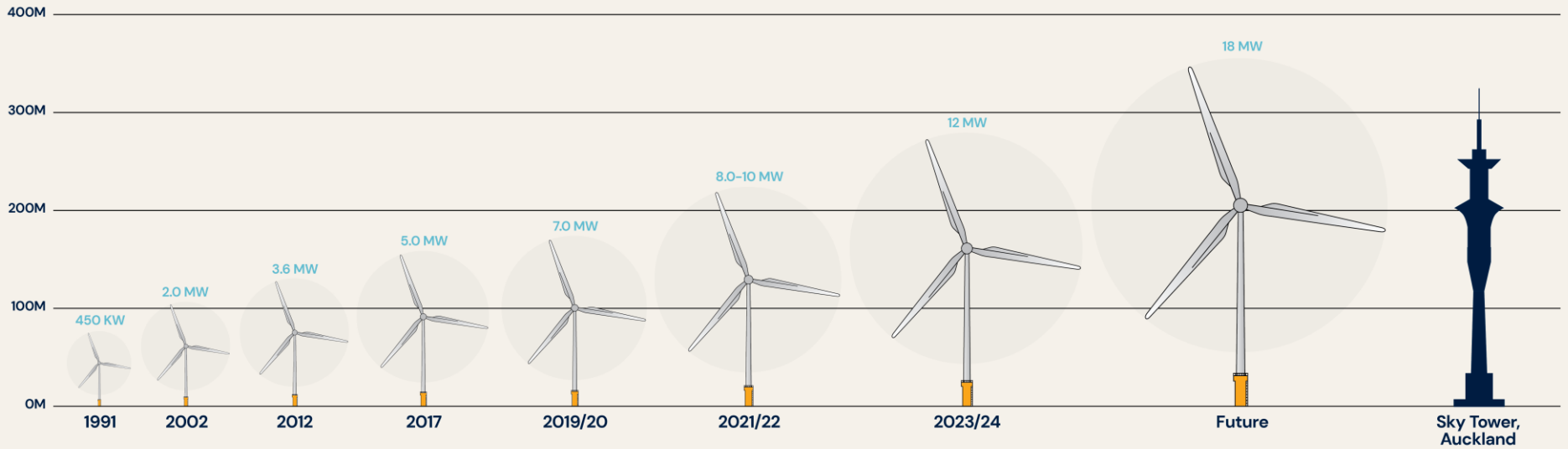
- 14 MW** capacity
- 220-meter** rotor
- 107-meter** long blades
- 260 meters** high
- 74 GWh** gross AEP
- 61%** capacity factor
- 38,000 m²** swept area
- Wind Class IEC: IC**



POWER REGULATION	Pitch regulated with variable speed
OPERATING DATA	
Rated power	15,000 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	30 m/s
Wind class	IEC S or S,T
Standard operating temperature range	from -10°C to +25°C* with a de-rating interval from +25°C to +45°C <small>*high ambient temperature variant available</small>
SOUND POWER	
Maximum	118dB(A)
ROTOR	
Rotor diameter	236 m
Swept area	43,742 m ²
Aerodynamic brake	three blades full feathering

Construction

Wind turbines



Construction

Monopile



Jacket



Floating



Construction



Offshore substation



Construction

Cables



Vessels



Construction

Construction and marshalling port



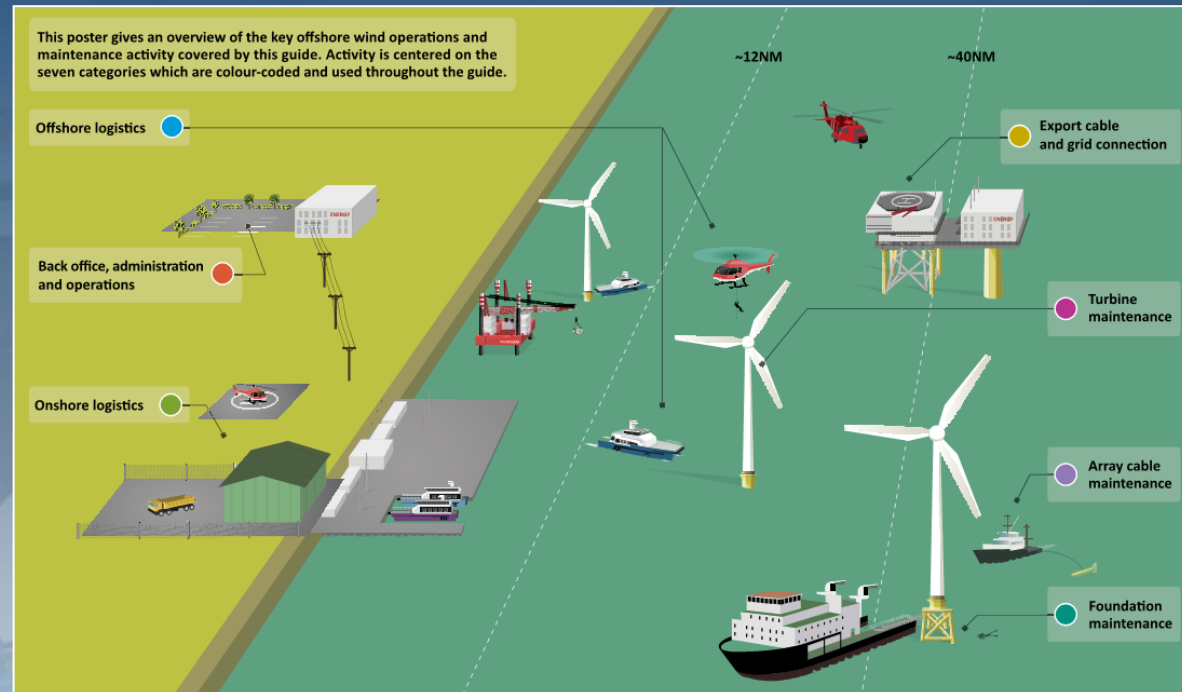
Ports

Operations and Maintenance port



Operations and Maintenance

Onshore logistics
Workboats
Aviation
Crane barge services
Offshore accommodation
Turbine maintenance
Turbine spare parts
Offshore substation maintenance
Export cable surveys and repairs
Onshore electrical
Array cable surveys and repairs
Scour and structural surveys
Foundation repairs
Lifting, climbing and safety equipment
SCADA and condition monitoring
SAP and marine coordination
Weather forecasting
Environmental monitoring
Administration



Thank You

For further information:

 [taranakioffshorewind.co.nz](https://www.taranakioffshorewind.co.nz)

 gca@cop.dk

