CorPower Ocean

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Breakthroughs in wave energy

Dr. Gabriel Forstner, *Lead control engineer*

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Why Wave?

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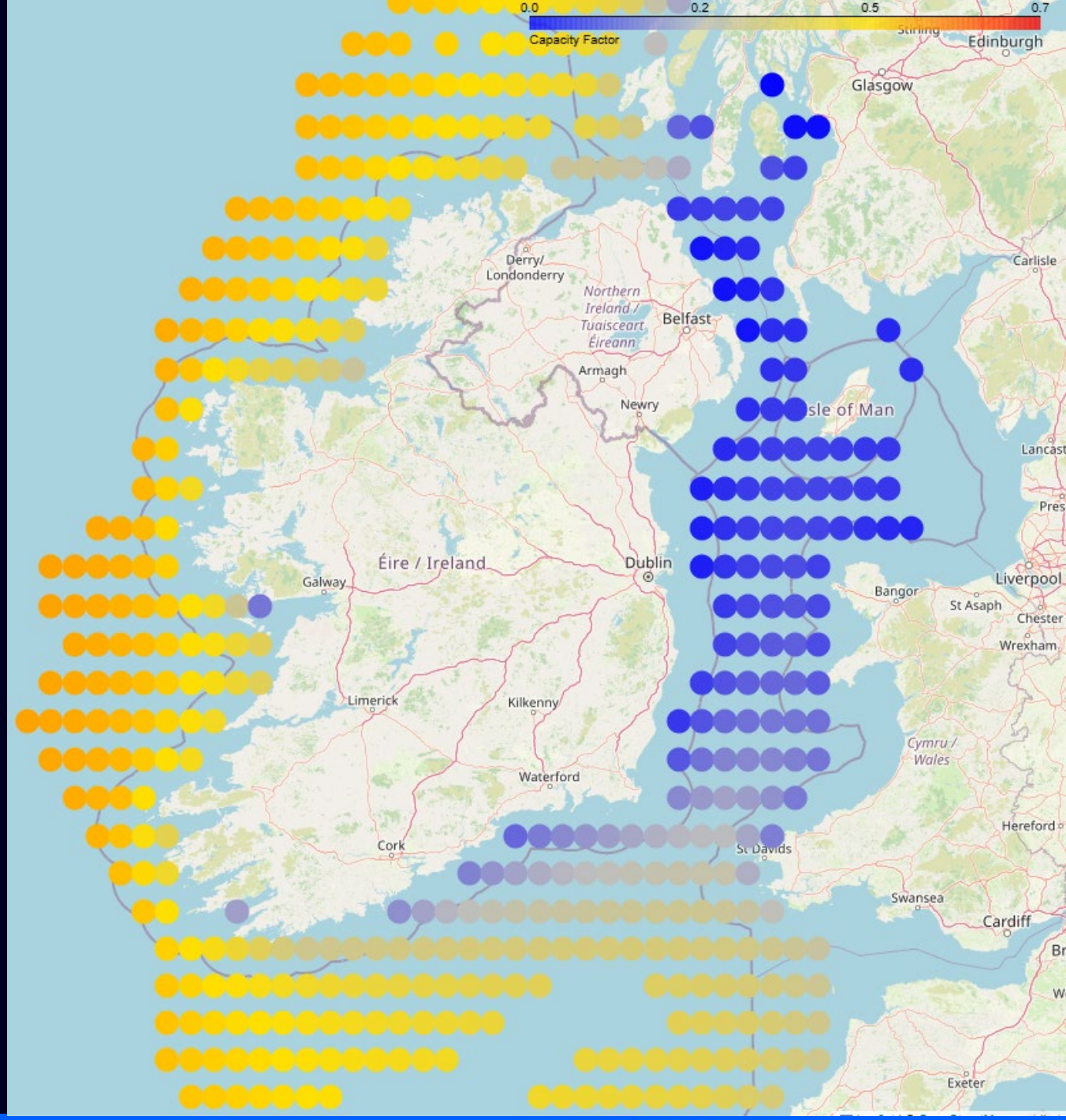
The Opportunity

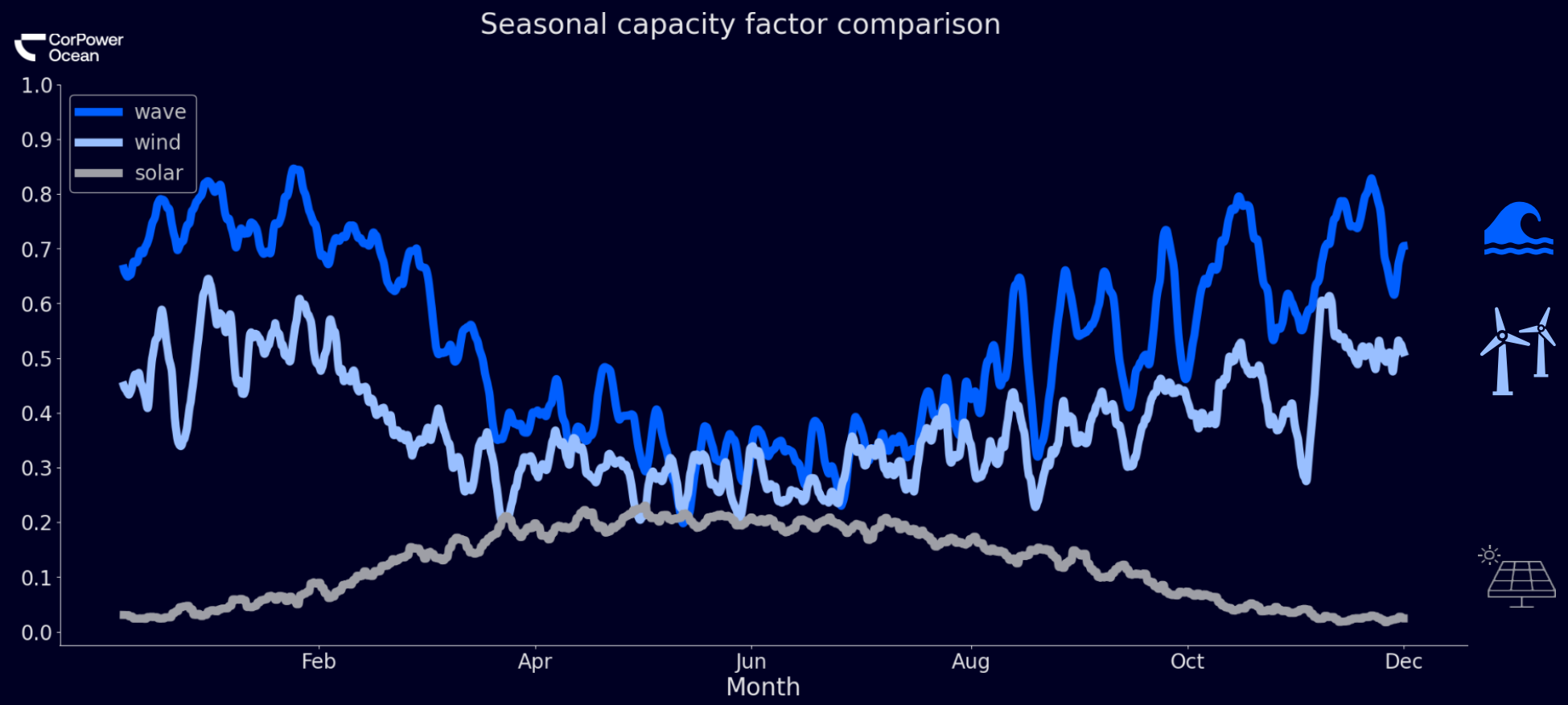
Ireland

- Strong wave resource around Ireland
- Map shows Copernicus Global (0.2x0.2 degree) datapoints, filtered for water depth between 40-150m and no more than 100km from shore
- CorPower Ocean C6 power matrix shows capacity factors greater than 50% in Irish waters



Wave and wind generation profiles

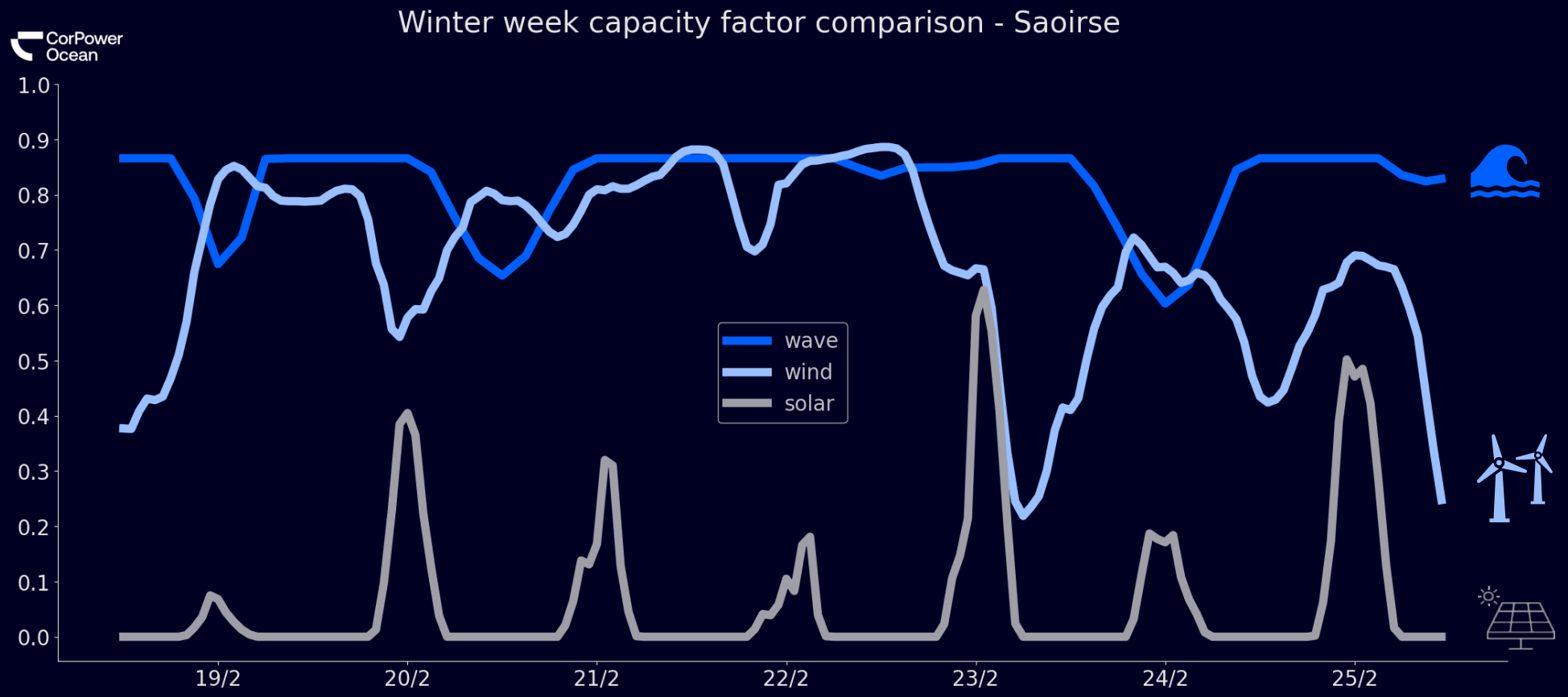
Saoirse, Ireland (52.757°, -9.636°)



(hourly data with moving average applied over 4 days)

Wave and wind generation profiles

Saoirse, Ireland (52.757°, -9.636°)



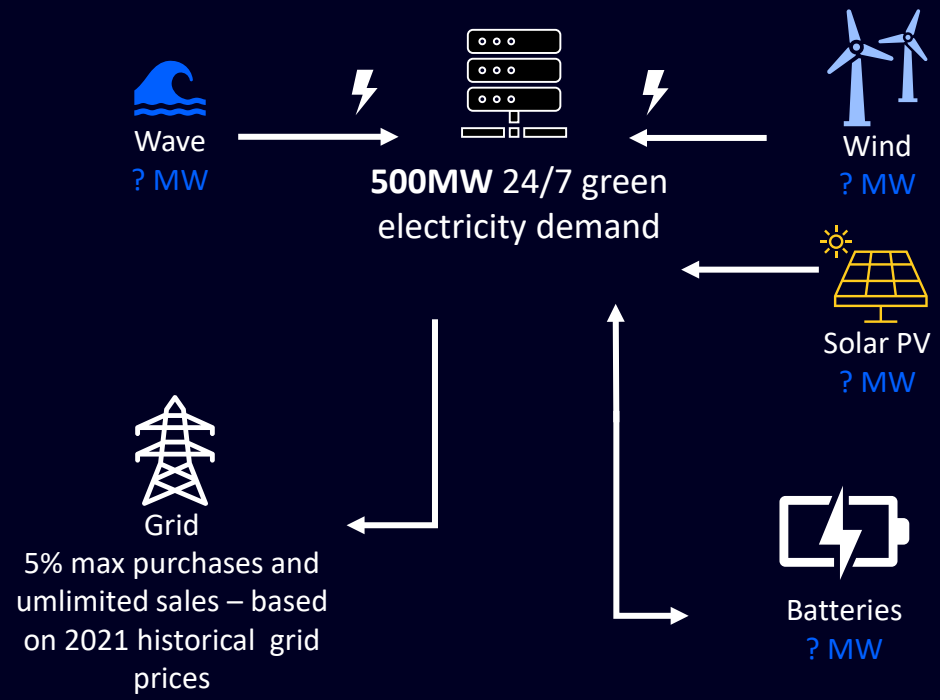
Wave resource has lower variability compared with wind resource and solar resource (hourly data)

Cost optimal mix in 2032 – 95% CFE for flat demand profile

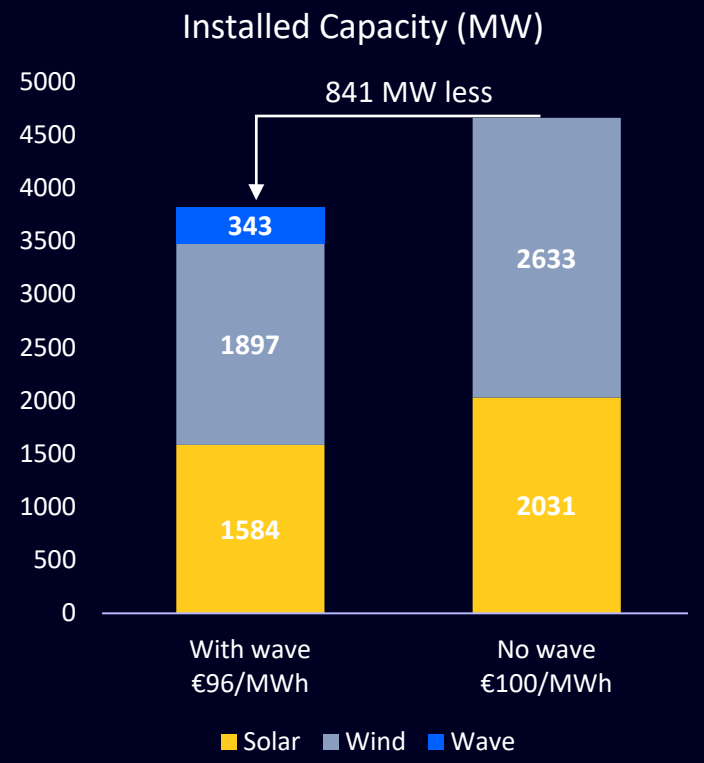
Orkney – 500MW flat demand

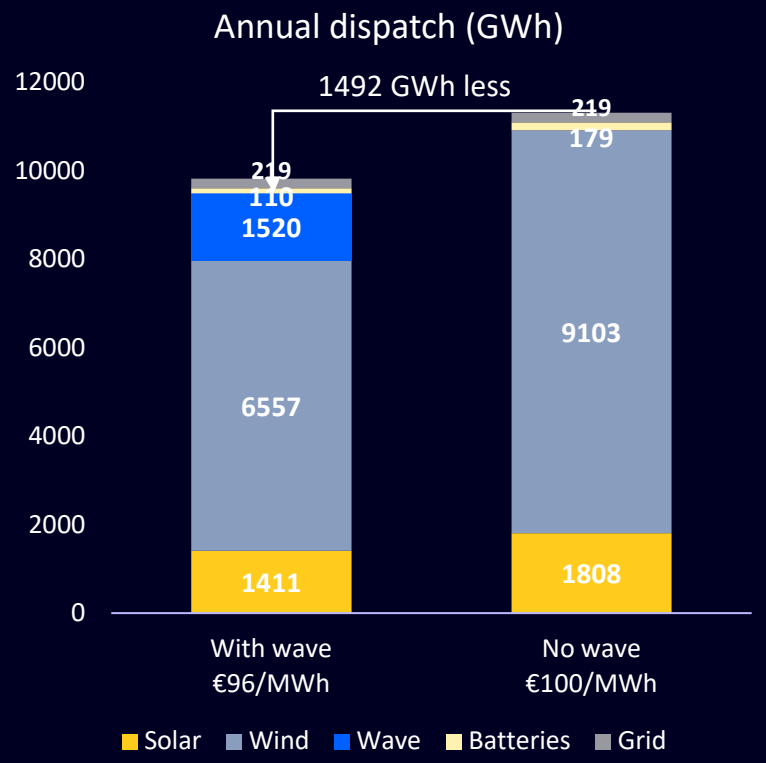
Method: minimizing global costs defined as :

$$CAPEX + OPEX \ - SALES$$



Results: cost optimal energy mix:





Cost optimal mix in 2032 – 95% CFE for flat demand profile

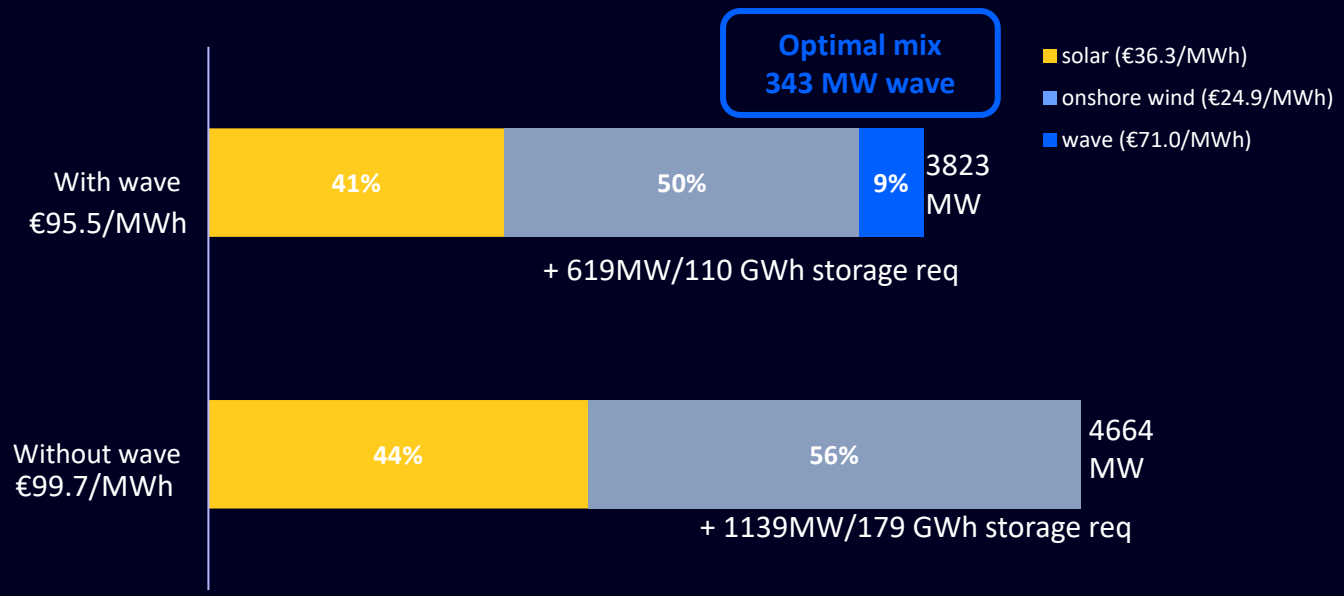
Orkney – 500MW flat demand

Optimal scenario

- 343 MW wave installed
- 1584 MW solar installed, 1897 MW onshore wind
- 219 GWh (5% of demand) bought from grid
- 5.3 TWh over generation (120%) sold back
- €95.5/MWh LCOE with sellback at 10% historical prices

No wave scenario:

- 2031 MW solar installed, 2633 MW onshore wind
- 219 GWh (5% of demand) bought from grid
- 6.6 TWh over generation (152%) sold back
- €99.7/MWh LCOE with sellback at 10% historical prices



Optimal scenario has <u>343 MW</u> wave and is €4.2/MWh (4%) cheaper than no wave scenario, with 841 MW lower inst capacity required

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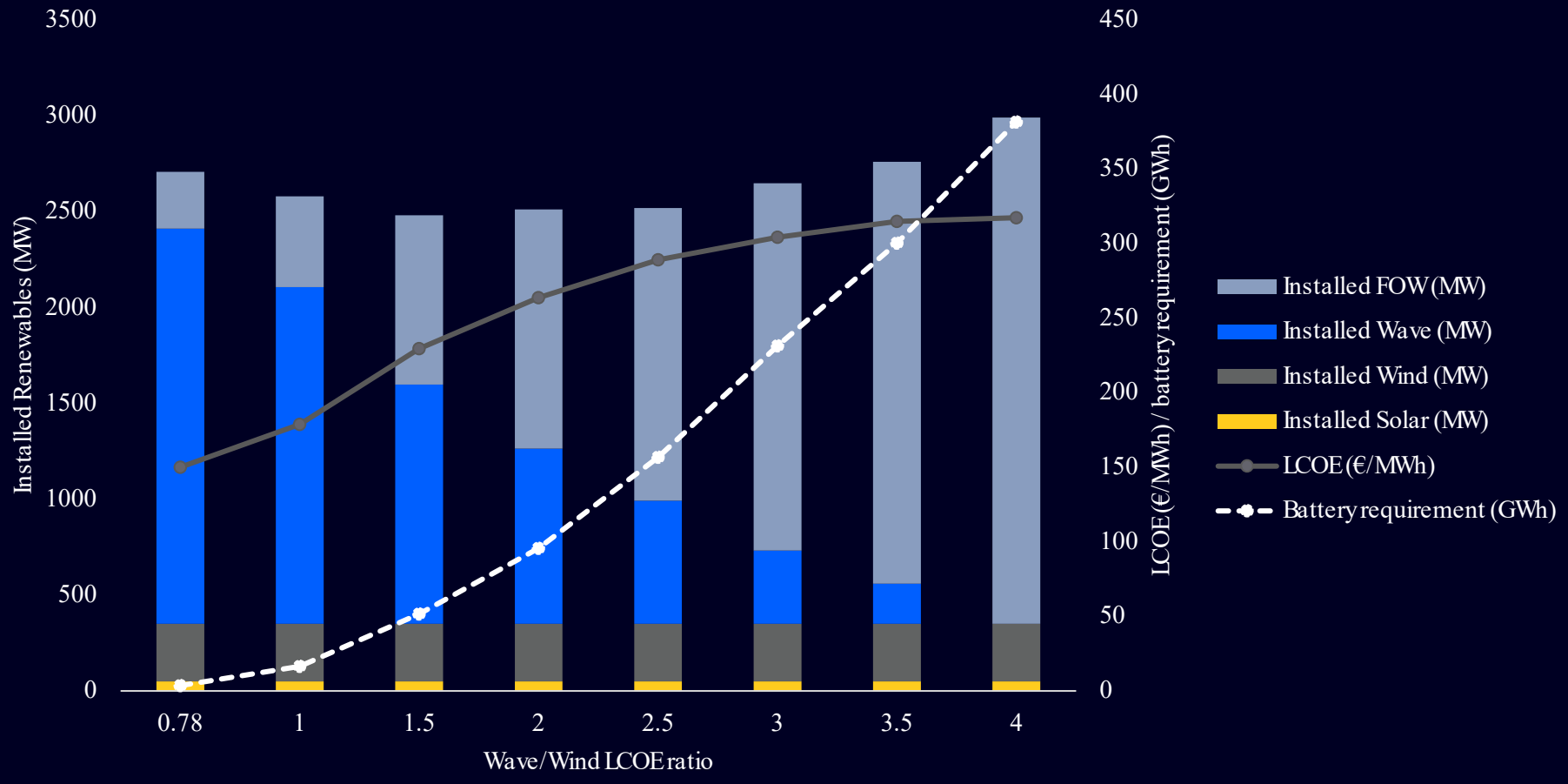
Cost optimal mix – Onshore renewable constraints – Orkney 2040

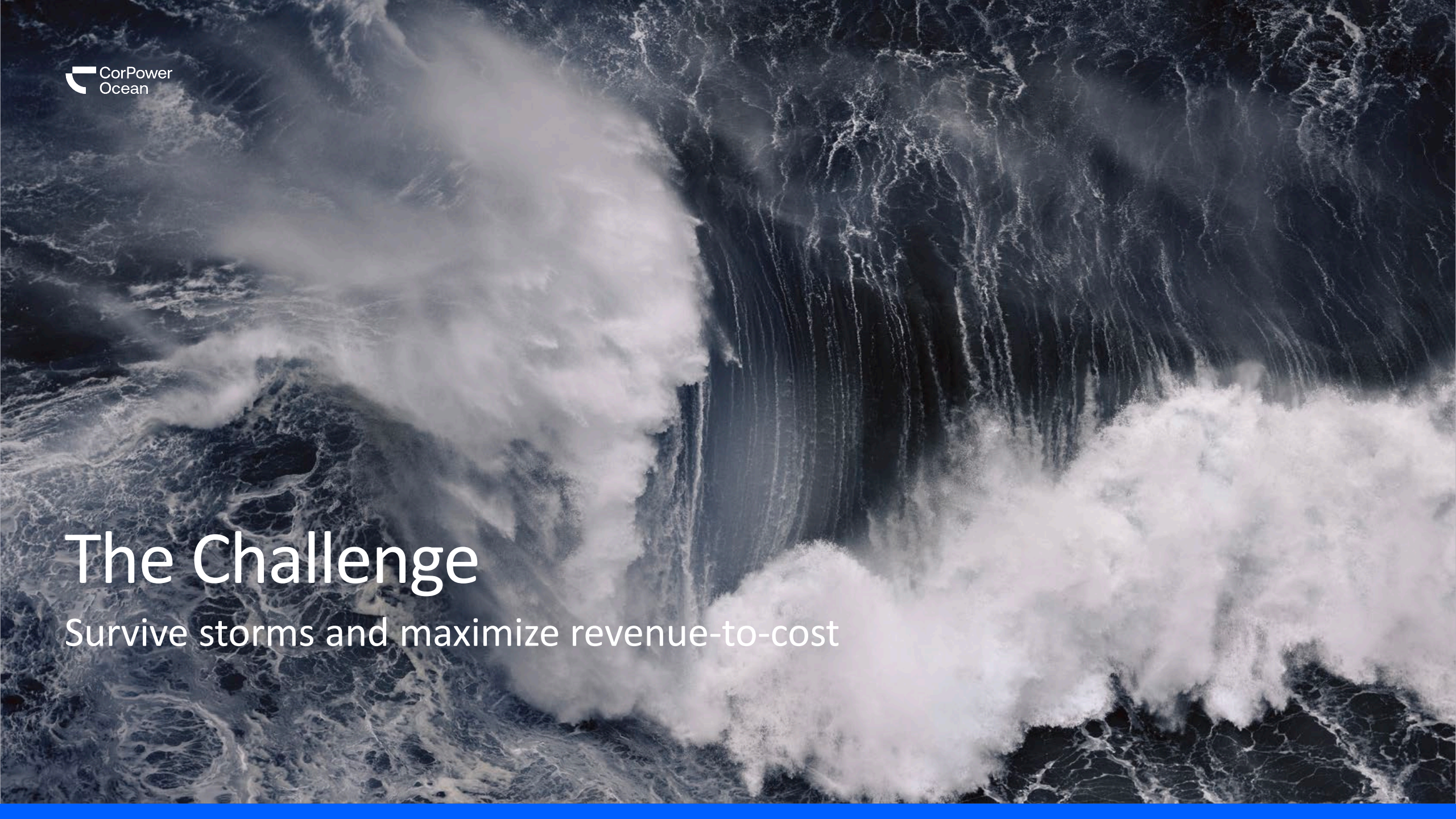
Varying wave LCOE in proportion with floating wind LCOE (1x, 2x, 3x…)

In 2040 wave makes up 68% of total installed capacity when LCOE is equal to offshore wind (€62/MWh)

16.5 GWh battery requirement (0.4%) with 68% wave, 382 GWh battery requirement (9% of energy) with zero wave

Wave is still part of optimal mix (210MW) when 3.5x the LCOE of offshore wind (€217/MWh)





The Challenge

Survive storms and maximize revenue-to-cost

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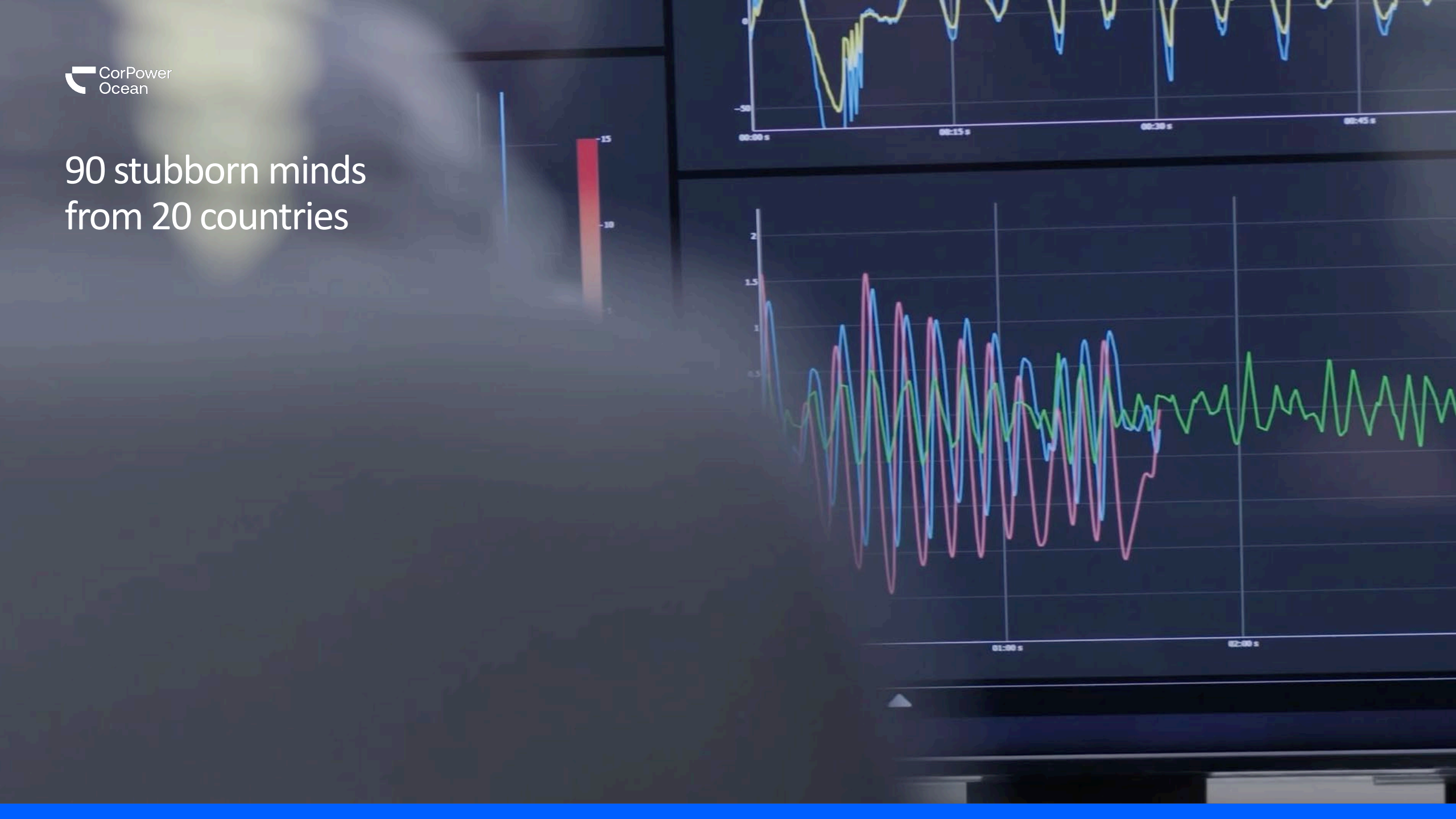
90 stubborn minds from 20 countries



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Structured product verification

5-stage program according to IEA-OES / ETIP Ocean best practice

2012—2013

Stage 1
Concept

Validation

2014—2015

Stage 2
Critical System tests

Dry and tank testing

2015—2018

Stage 3
1:2 scale device

Dry and ocean testing

2018—2023

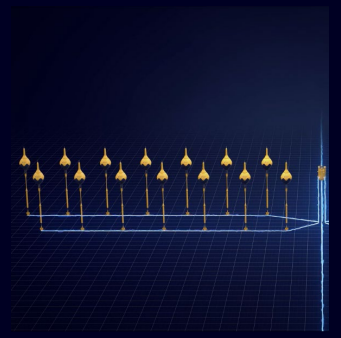
Stage 4
Full scale device

Dry and ocean demo

2024—2026/2027

Stage 5
4 device array

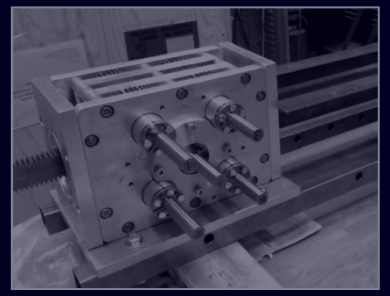
Pilot array (4 WECs)

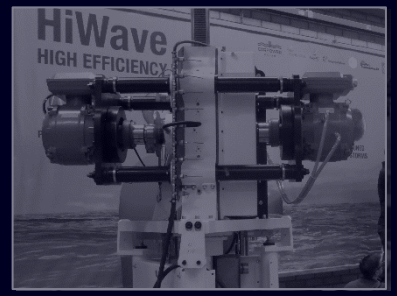


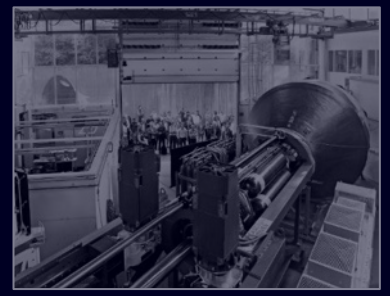
Installed in 2028+

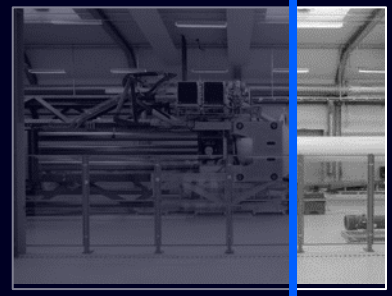
Commercial Projects
5-30MW arrays

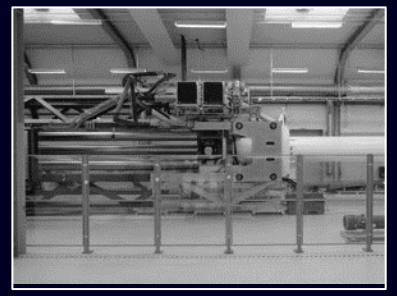
Array (15-84 WECs)











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C4 operations summary

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C4 operations summary

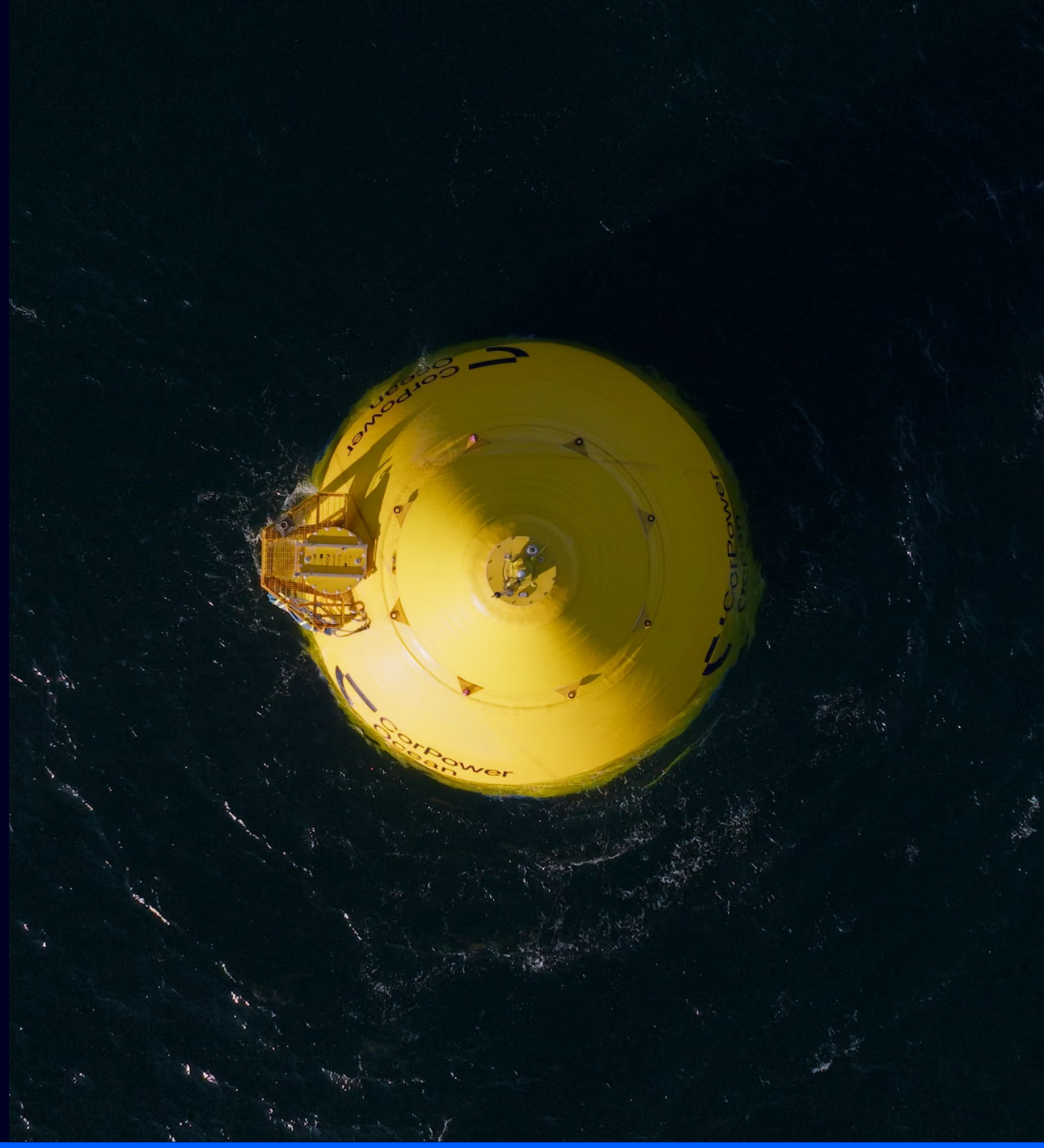
Successful commissioning program

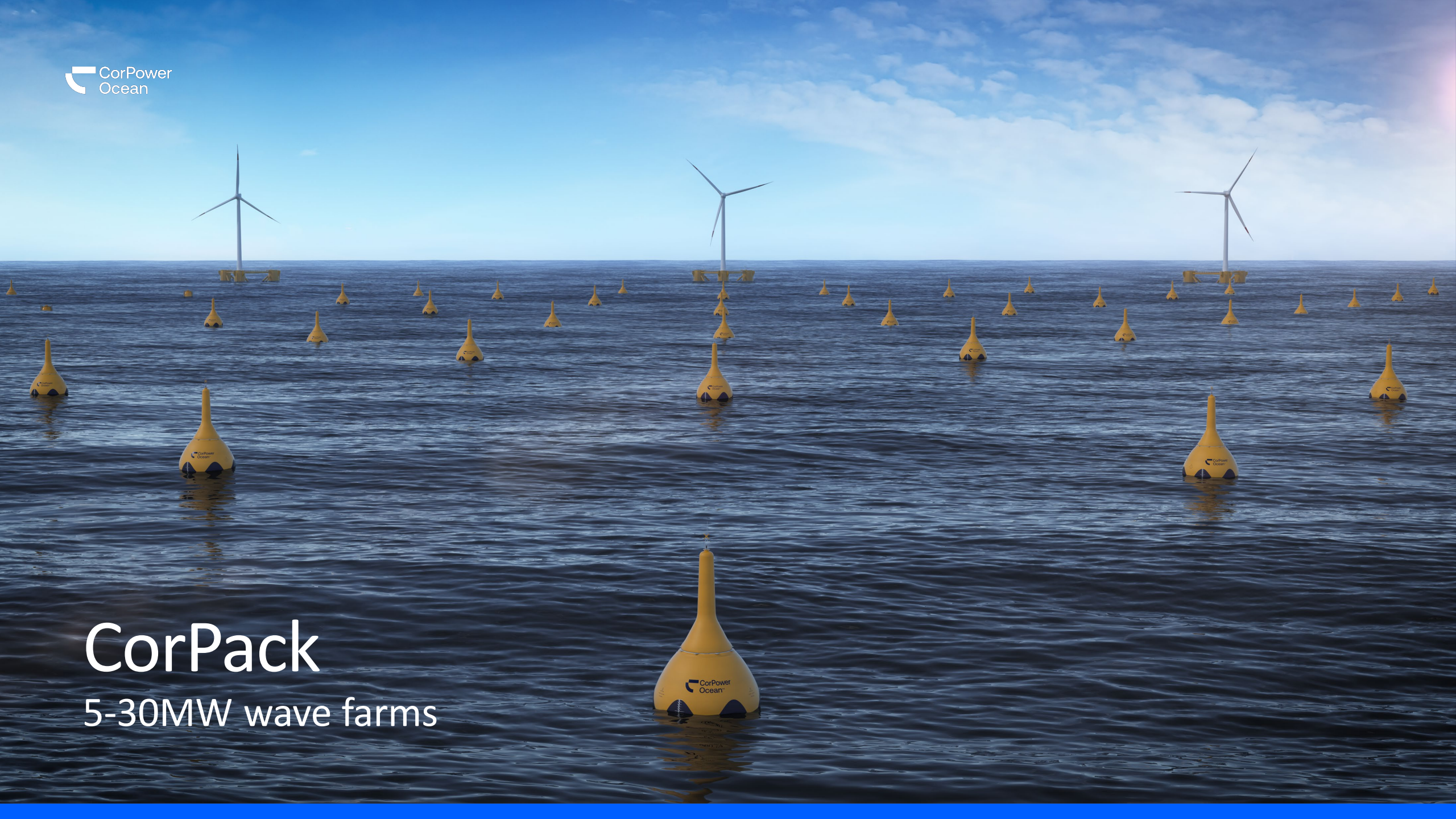
- Confirmed machine safety and survivability
- 24/7 shift in control centre during first month of operation -> autonomous operation.

Verified

- Storm survivability: up to 18.5m (Hmax) waves
- Exporting power to the grid
- All system functions verified
- Model calibration for motion and power
- UMACK anchor: Stable station keeping verified.
- O&M: Offshore O&M access is C4 verified.
- O&M: disconnection / tow-back / on-land O&M cycle

Ongoing: On-land O&M cycle, for 3rd deployment

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5-30MW wave farms

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Selected projects

Saoirse, Ireland

- The Saoirse Wave Energy project is a pioneering 4.9 MW wave farm located 4 km offshore from County Clare, Ireland

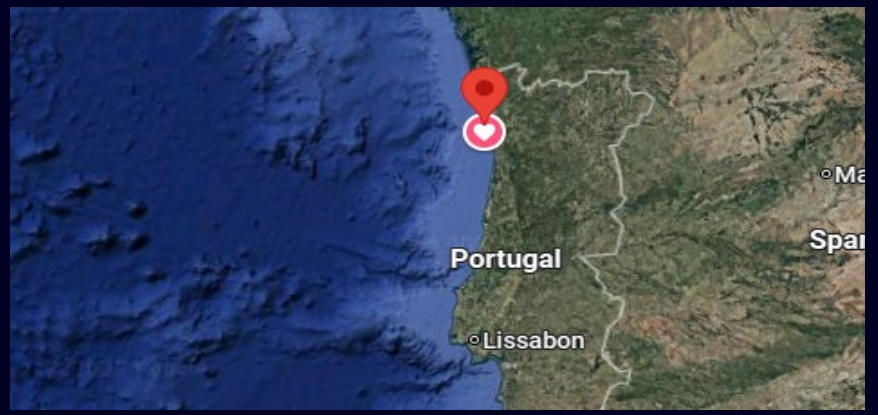
- Coordinated by ESB with full operation scheduled by 2030 and supported by the EU Innovation Fund

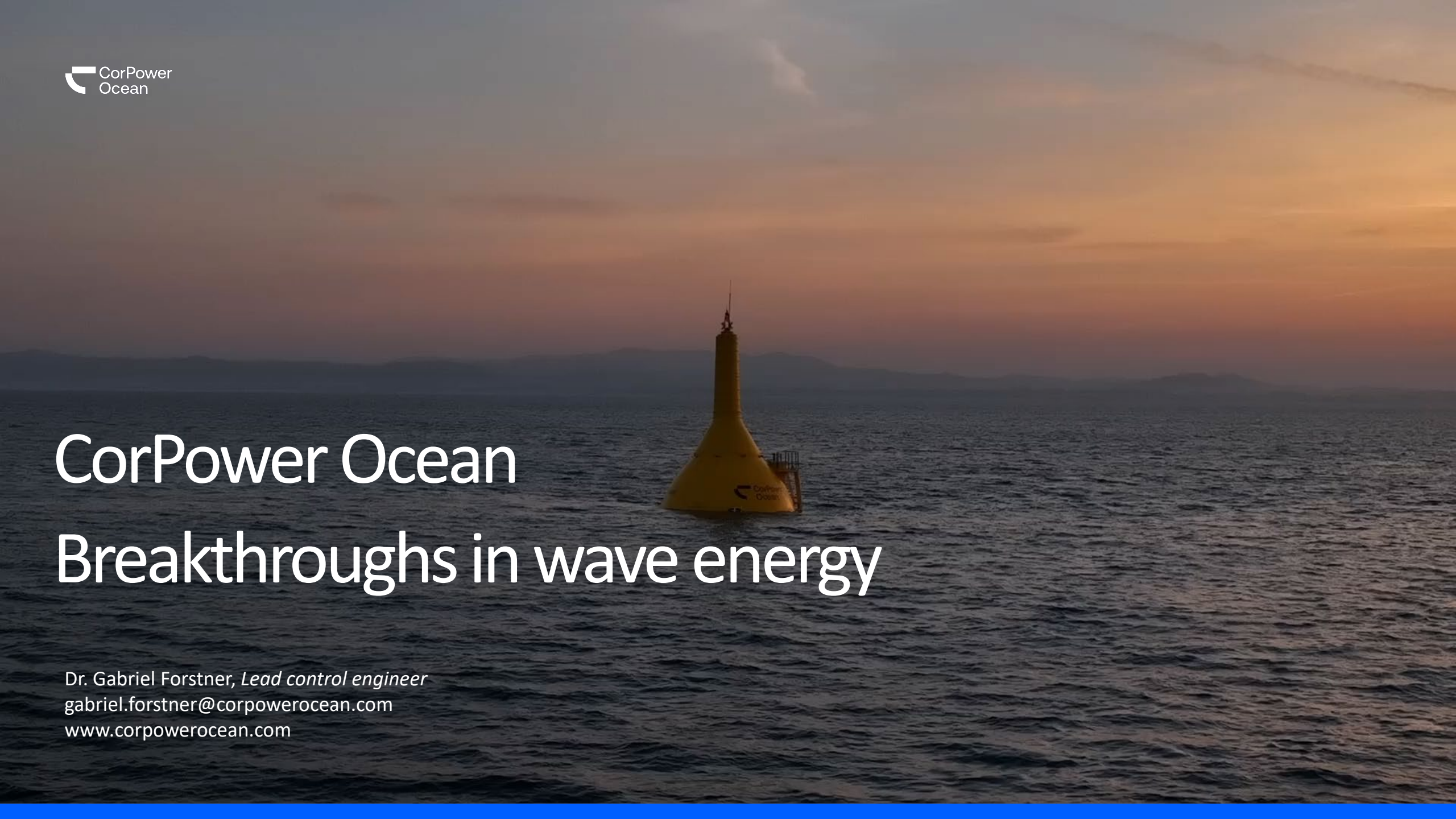
Selected projects

VianaWave, Portugal

- The VianaWave project aims to develop and operate a 10 MW pre-commercial wave energy farm located 4 km offshore off the coast of Aguçadoura, Portugal

- Coordinated by CorPower Ocean with full operation scheduled by 2030 and supported by the EU innovation fund





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