

Wave power.  
To power the planet.





# CorPower Ocean in short

- Leading developer (OEM) of turnkey wave energy systems
- Started in 2012. Offices in Sweden, Norway, Scotland & Portugal
- Physics providing competitive LCOE, verified through step-by-step approach
- Traction with energy majors, including Simply Blue, ESB, EDP, ENEL Green Power
- Broad backing across Europe. 75 MEUR funding secured to date

SEB granitor TOGETHER TO SETBACK almi invest



# 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

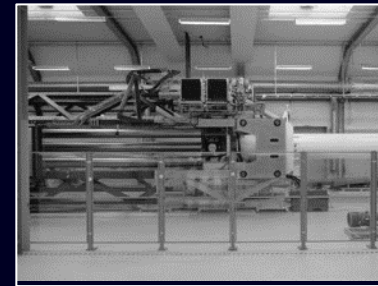
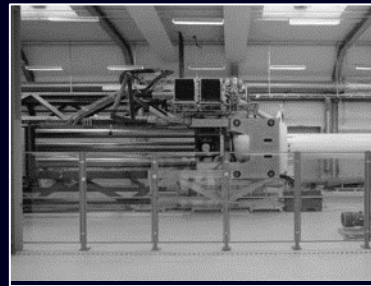
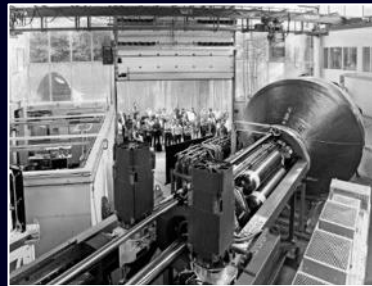
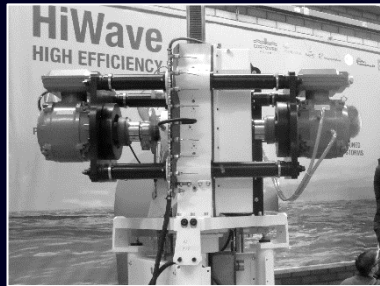
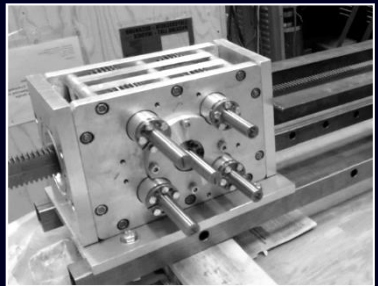
Dry and ocean demo



2024—2026

Stage 5  
4 device array

Pilot array (4 WECs)



# C4 operations in Agucadoura

## Powering the Portuguese grid





# Copernicus data

## Why do we use Copernicus Marine Services?

- Accessible data with good spatial and temporal resolution

## Which Copernicus Marine Service products are we using?

- Wave reanalysis products
- Wave forecasting products



# Global Ocean Waves Reanalysis



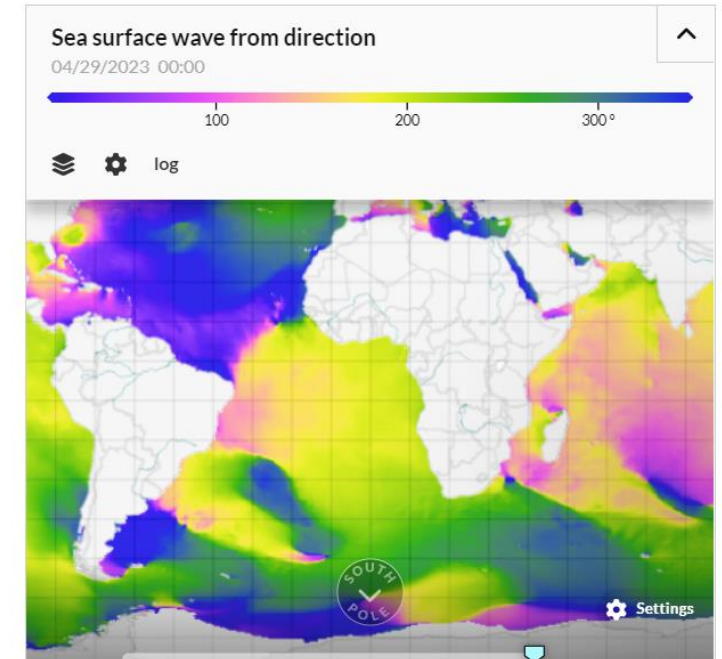
Home > Marine Data Store > Product

Description	
Notifications	
Data access	
Contact	
DOCUMENTATION	
User Manual	
Quality Information Document	
Synthesis Quality Overview	
Licence	
How to cite	
DOI	
10.48670/moi-00022	

## Overview

GLOBAL\_REANALYSIS\_WAV\_001\_032 for the global wave reanalysis describing past sea states since years 1993. This product also bears the name of WAVERYS within the GLO-HR MFC, for correspondence to other global multi-year products like GLORYS, BIORYS, etc. The core of WAVERYS is based on the MFWAM model, a third generation wave model that calculates the wave spectrum, i.e. the distribution of sea state energy in frequency and direction on a 1/5° irregular grid. Average wave quantities derived from this wave spectrum, such as the SWH (significant wave height) or the average wave period, are delivered on a regular 1/5° grid with a 3h time step. The wave spectrum is discretized into 30 frequencies obtained from a geometric sequence of first member 0.035 Hz and a reason 7.5. WAVERYS takes into account oceanic currents from the GLORYS12 physical ocean reanalysis and assimilates significant wave height observed from historical altimetry missions and directional wave spectra from Sentinel 1 SAR from 2017 onwards.

DOI (product): <https://doi.org/10.48670/moi-00022>



# Copernicus data

## How do we use Copernicus products at CorPower?

### Modelled historical sea states

- Wave height and period data

			Te																							
			0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Hs	0.25	0	0.5	0	0	0	0	5E-05	2E-04	6E-04	9E-04	9E-04	3E-04	6E-05	0	0	0	0	0	0	0	0	0	0	0	0
	0.75	0.5	1	0	0	0	2E-05	1E-03	0.007	0.018	0.026	0.021	0.017	0.009	0.003	0.001	5E-04	2E-04	5E-05	9E-06	3E-05	1E-05	5E-06	0	0	0
	1.25	1	1.5	0	0	0	0	8E-04	0.018	0.038	0.047	0.046	0.037	0.026	0.016	0.008	0.003	1E-03	3E-04	2E-04	8E-05	1E-05	9E-06	0	2E-05	0
	1.75	1.5	2	0	0	0	0	0	0.007	0.027	0.04	0.042	0.039	0.03	0.022	0.013	0.005	0.002	6E-04	2E-04	2E-04	4E-05	9E-05	3E-05	0	0
	2.25	2	2.5	0	0	0	0	0	1E-04	0.006	0.018	0.029	0.031	0.027	0.02	0.012	0.006	0.003	8E-04	3E-04	2E-04	1E-04	5E-06	0	0	0
	2.75	2.5	3	0	0	0	0	0	0	3E-04	0.005	0.014	0.019	0.021	0.016	0.01	0.006	0.003	8E-04	4E-04	1E-04	2E-05	9E-06	0	0	0
	3.25	3	3.5	0	0	0	0	0	0	9E-06	0.001	0.007	0.013	0.015	0.012	0.009	0.005	0.002	0.001	3E-04	1E-04	3E-05	9E-06	5E-06	0	0
	3.75	3.5	4	0	0	0	0	0	0	0	1E-04	0.003	0.006	0.01	0.009	0.006	0.004	0.003	6E-04	3E-04	1E-04	5E-06	2E-05	9E-06	0	0
	4.25	4	4.5	0	0	0	0	0	0	0	0	7E-04	0.003	0.006	0.007	0.005	0.003	0.002	7E-04	2E-04	5E-05	9E-06	9E-06	5E-06	0	0
	4.75	4.5	5	0	0	0	0	0	0	0	0	1E-04	0.001	0.003	0.005	0.004	0.002	0.001	7E-04	4E-04	8E-05	3E-05	1E-05	5E-06	0	0
	5.25	5	5.5	0	0	0	0	0	0	0	0	0	0	4E-04	0.002	0.003	0.003	0.002	0.001	6E-04	3E-04	2E-04	2E-05	1E-05	0	0
	5.75	5.5	6	0	0	0	0	0	0	0	0	0	0	3E-05	6E-04	0.001	0.001	0.001	6E-04	3E-04	5E-05	5E-05	1E-04	0	0	0
	6.25	6	6.5	0	0	0	0	0	0	0	0	0	0	0	2E-04	4E-04	8E-04	8E-04	7E-04	4E-04	5E-05	3E-05	9E-06	9E-06	0	0
	6.75	6.5	7	0	0	0	0	0	0	0	0	0	0	0	3E-05	3E-04	4E-04	5E-04	4E-04	2E-04	1E-04	0	0	0	0	0
	7.25	7	7.5	0	0	0	0	0	0	0	0	0	0	0	5E-06	1E-04	3E-04	3E-04	3E-04	1E-04	1E-04	9E-06	0	0	0	0
	7.75	7.5	8	0	0	0	0	0	0	0	0	0	0	0	0	3E-05	1E-04	2E-04	3E-04	5E-05	2E-05	0	0	0	0	0
	8.25	8	8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	3E-05	1E-04	2E-04	4E-05	5E-06	0	0	0	0	0
	8.75	8.5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	5E-06	2E-05	3E-05	3E-05	0	0	0	0	0	0
	9.25	9	9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9E-06	0	0	0	0	0	0	0	0
	9.75	9.5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.25	10	10.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10.75	10.5	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.25	11	11.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.75	11.5	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12.25	12	12.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12.75	12.5	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13.25	13	13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13.75	13.5	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

### Spatial analysis – site studies around the world

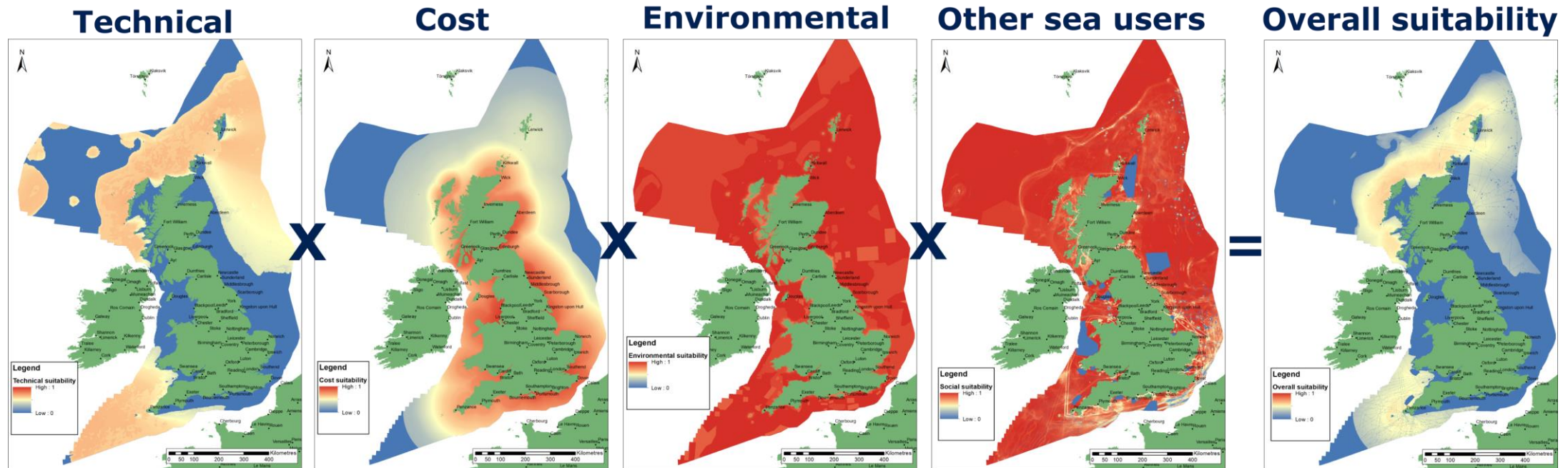
- Example: EVOLVE project spatial modelling

### Power system optimisation – wave in combination with other renewables

- Example: EVOLVE project power system modelling

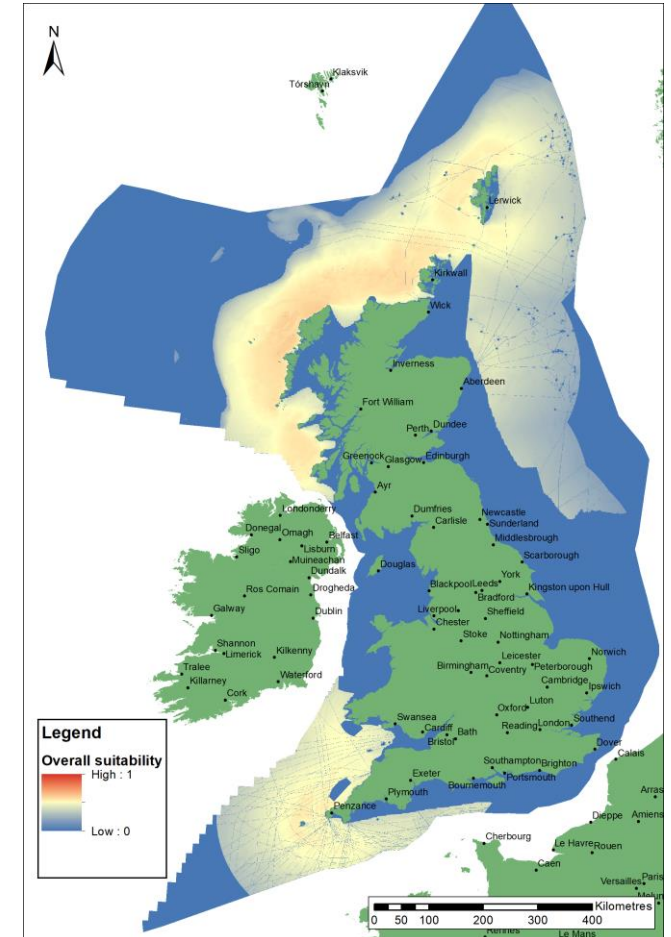
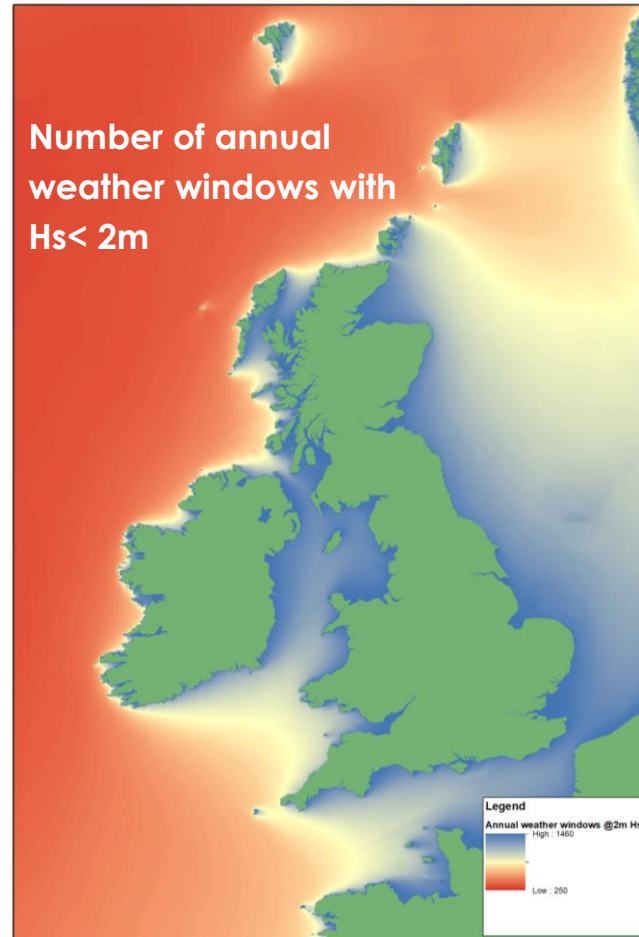
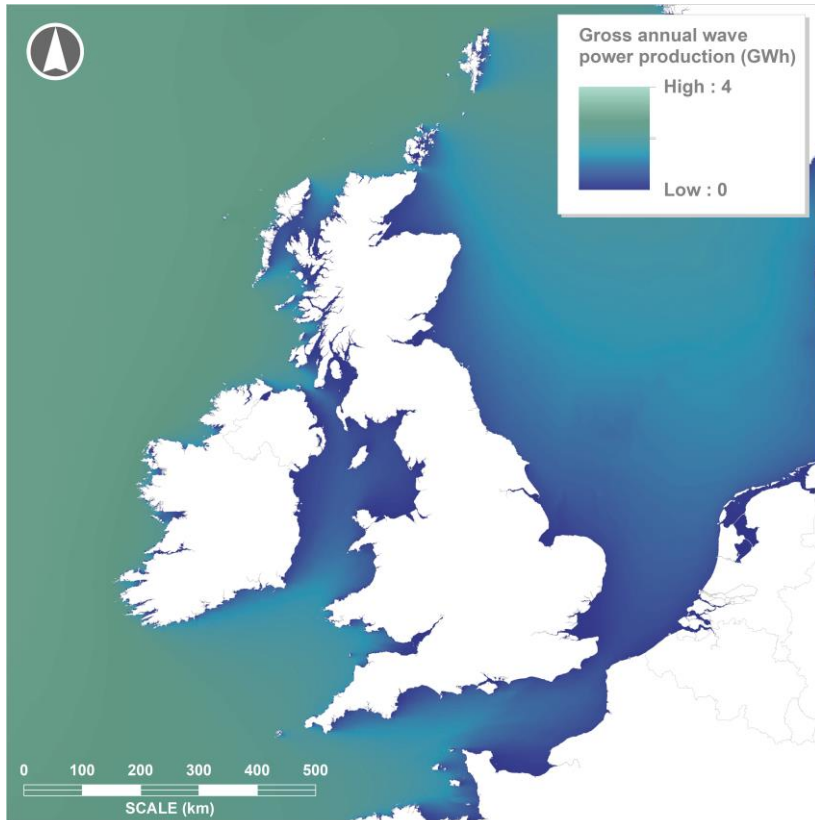
# EVOLVE spatial modelling

## Method - RADMAPP





# EVOLVE Spatial Modelling Analysis





# EVOLVE Spatial Modelling Results

## Ireland

18.9 GW, 89.7 TWh

## Great Britain

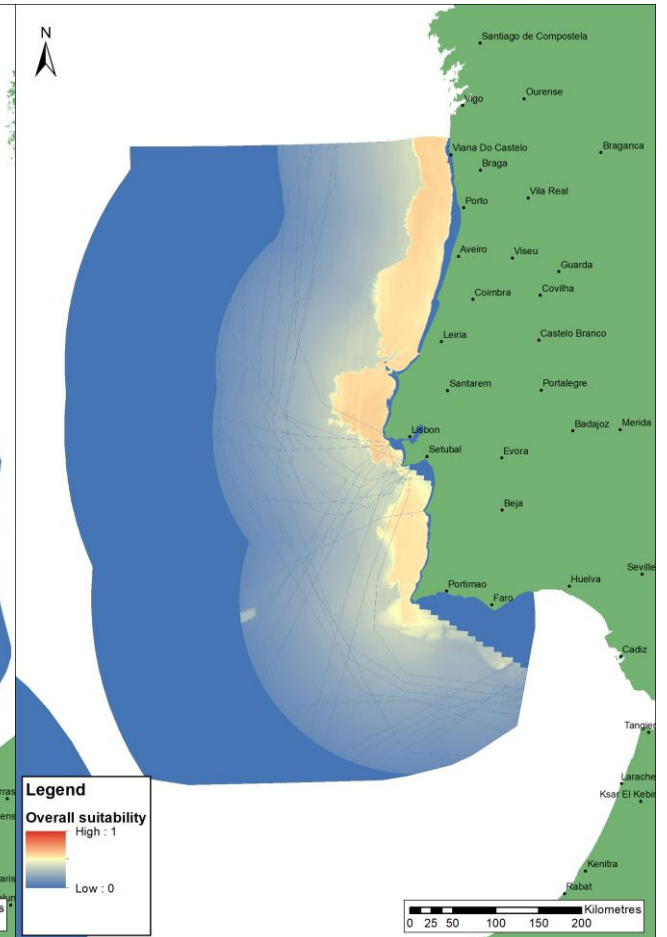
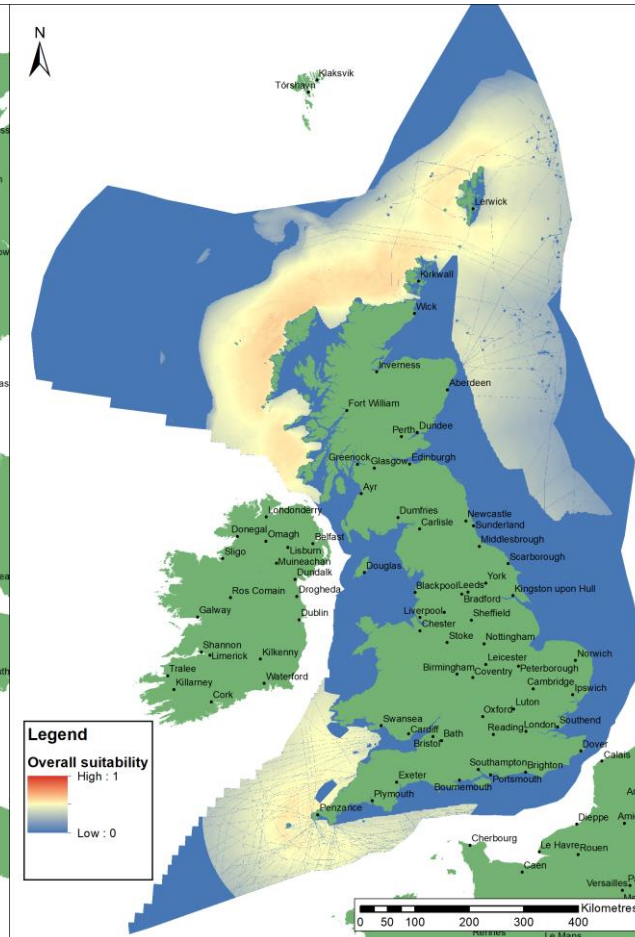
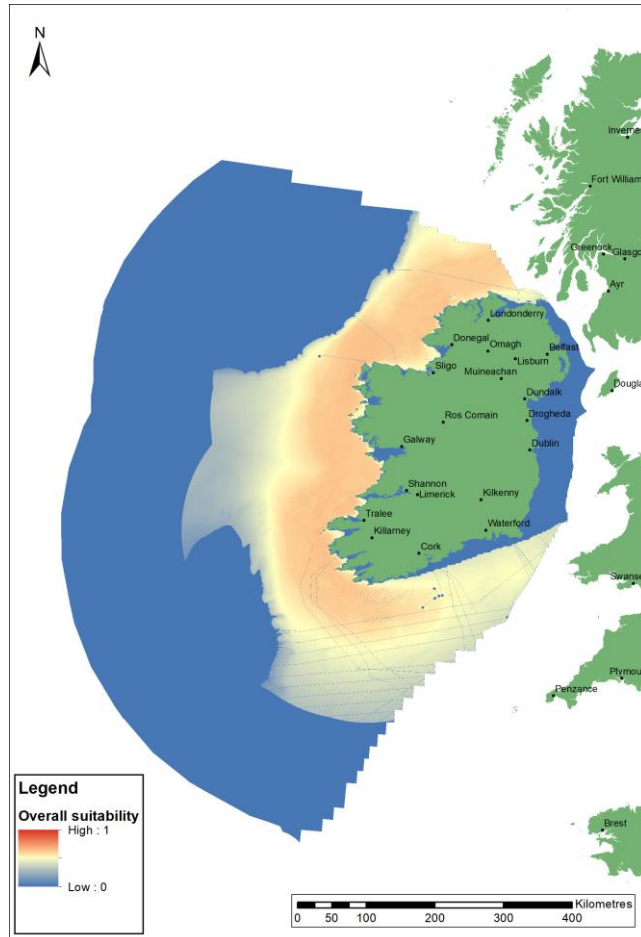
24.8 GW, 106.7 TWh

## Portugal

15.4 GW, 57.3 TWh

## Combined:

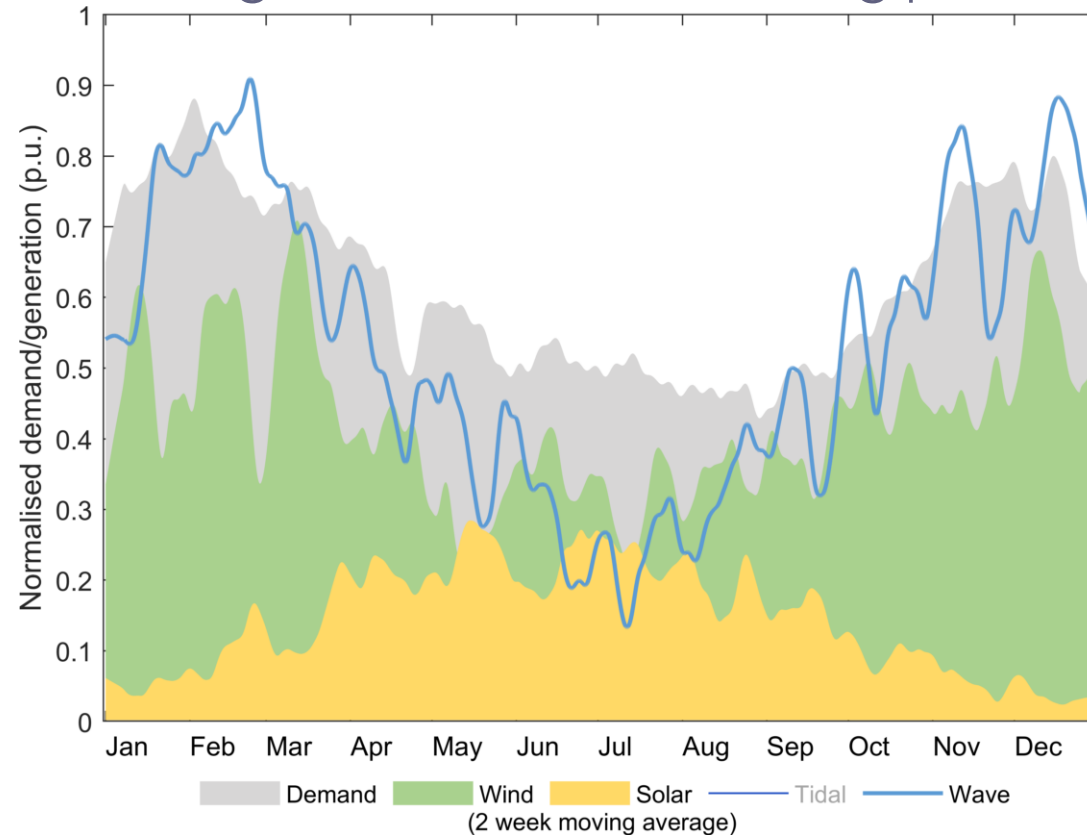
59.1 GW, 253.7 TWh



# EVOLVE power system modelling

## Data inputs

Electricity demand is highly seasonal in GB  
Wind Generation is higher in winter, Solar Generation is higher in summer  
Wave is higher in winter – matching peak demand





# EVOLVE power system modelling

## Method - PyPSA

Great Britain model split into nine zones based on selected National Grid boundaries

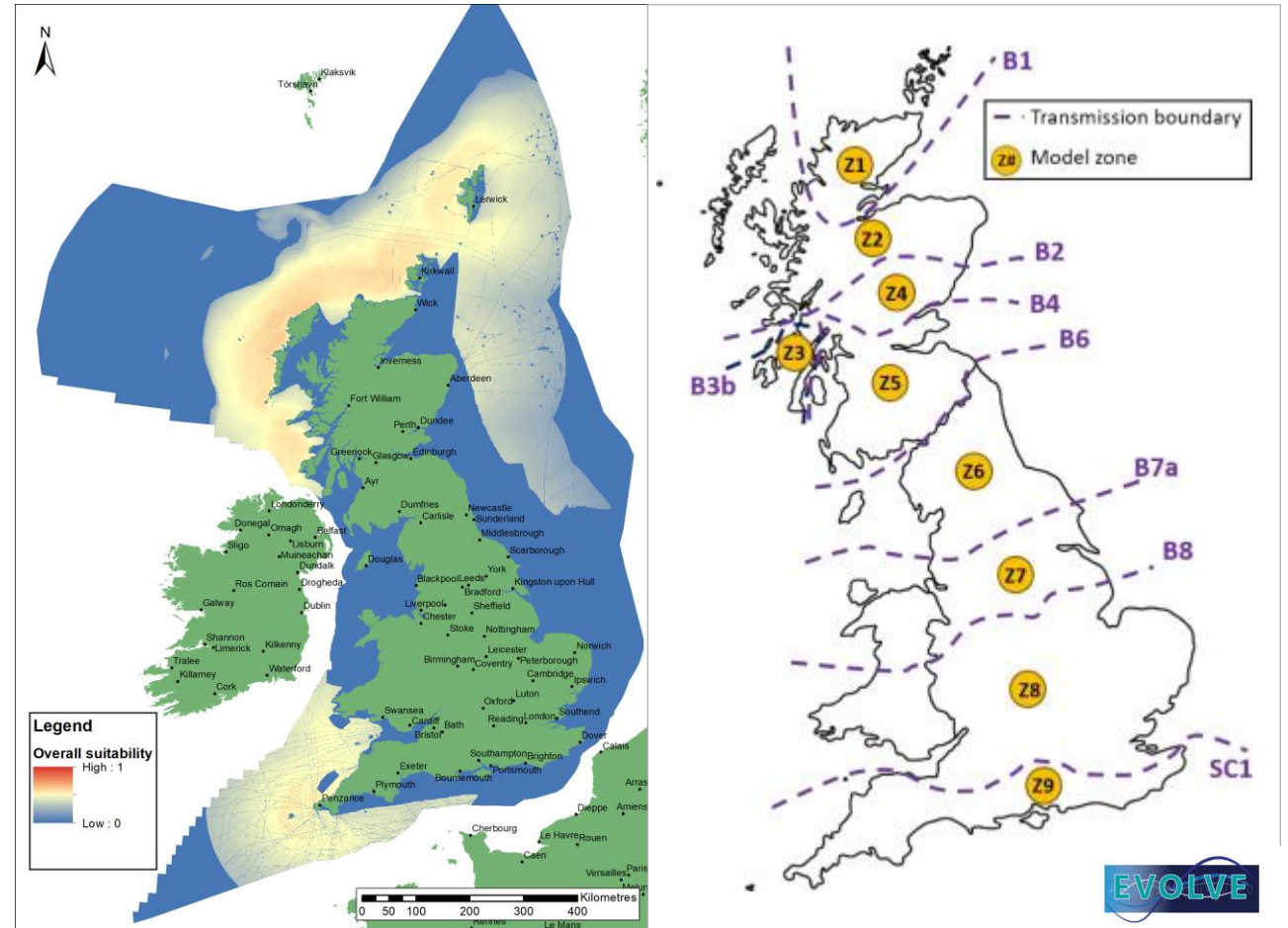
Computes hourly optimal dispatch: supply-demand matching

Key model inputs:

- Hourly demand profile data
- Hourly availability of intermittent renewables
- Fuel prices, carbon costs

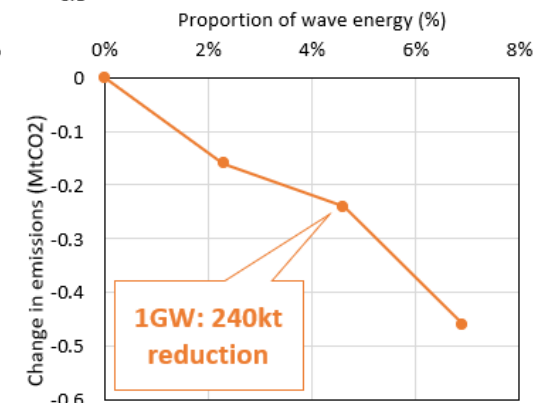
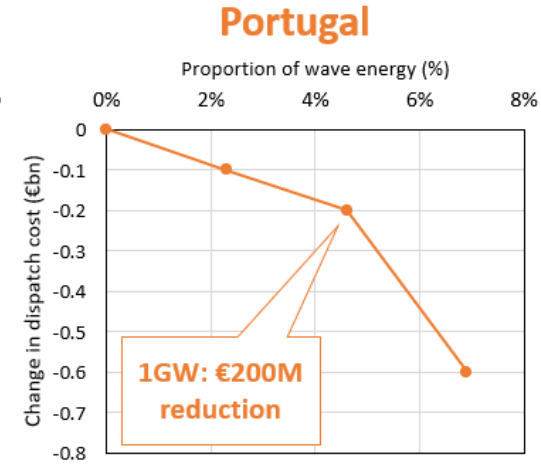
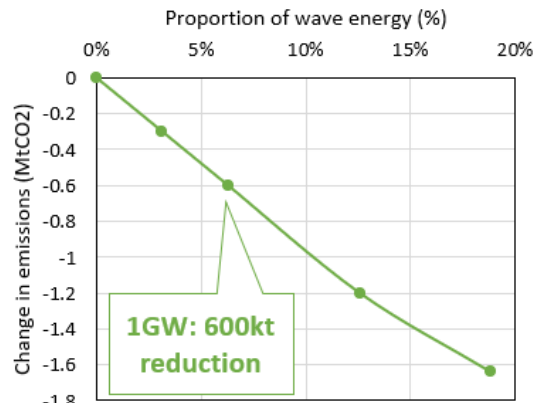
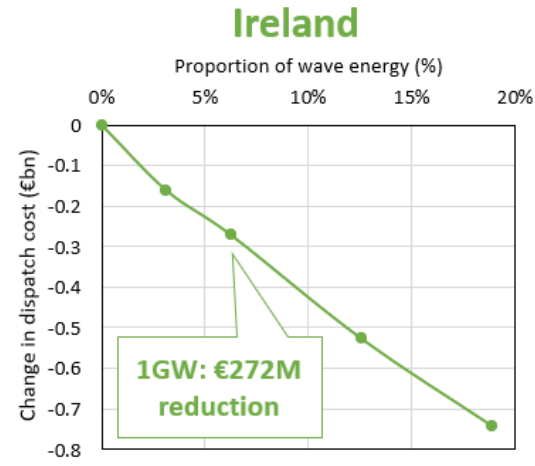
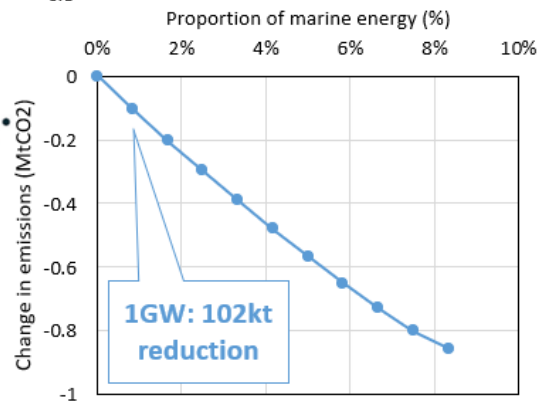
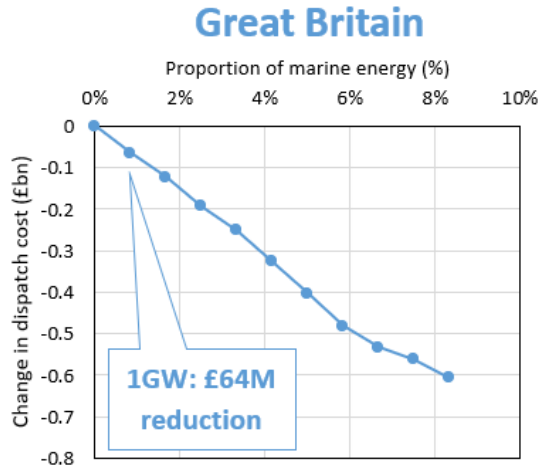
Key model outputs:

- Hourly generation, prices, carbon emissions



# EVOLVE power system modelling

## Results



Dispatch costs reduce

Carbon emissions reduce

Marine energy installed capacity increases





# Conclusions

Copernicus Marine Services data products are an incredibly useful and powerful tool for ocean energy research and development

Wave data from Copernicus is being used for:

- Site studies and resource assessments
- Power system modelling
- Lifecycle assessments
- Technoeconomic assessments



# Research outputs

## Studies using Copernicus data

- EVOLVE Project Consortium, “Technical Note: The system benefits of ocean energy to European power systems”, 2023. <https://evolveenergy.eu/project-outputs/>
- EVOLVE Project Consortium, “Technical Note: A review of practical deployment locations for European ocean energy projects”, 2023. <https://evolveenergy.eu/project-outputs/>
- S. Pennock and H. Jeffrey, “What are the UK power system benefits from deployments of wave and tidal stream generation?”, 2023.  
[http://www.policyandinnovationedinburgh.org/uploads/3/1/4/1/31417803/supergen\\_ore\\_power\\_system\\_benefits\\_study\\_2023.pdf](http://www.policyandinnovationedinburgh.org/uploads/3/1/4/1/31417803/supergen_ore_power_system_benefits_study_2023.pdf)
- S. Pennock, D. Coles, A. Angeloudis, S. Bhattacharya and H. Jeffrey, “Temporal complementarity of marine renewables with wind and solar generation: Implications for GB system benefits,” Applied Energy, vol. 319, 2022.  
<https://doi.org/10.1016/j.apenergy.2022.119276>
- EVOLVE Project Consortium, Technical Note: The system benefits of ocean energy to islanded power systems, 2023.  
<https://evolveenergy.eu/project-outputs/>
- D. Keiner et al, “Powering an island energy system by offshore floating technologies towards 100% renewables: A case for the Maldives,” Applied Energy, vol. 308, 2022. <https://doi.org/10.1016/j.apenergy.2021.118360>



Wave power.  
To power the planet.



[shona.pennock@corpowersocean.com](mailto:shona.pennock@corpowersocean.com)