Waterbouwdag 2025

Harnessing Marine Renewable Potential in Accelerating the Energy Transition.

Dr George Lavidas

TU Delft

Impact for a better society

At TU Delft, we aim to make an ‘***impact for a better society***’**.** We take on global challenges that affect everyone personally: the climate, the energy transition, urban growth, digital society, health.

We do all of this **the Delft way** – thoroughly, hands on, pragmatically, innovatively, with guts, outside the box and socially engaged. We always work on the basis of multiple perspectives and interests. Our solutions are future-proof. We do not work alone, but together with our partners.

Inspired by ambition, TU Delft works to achieve positive change through ***world-class*** research, teaching and innovation.

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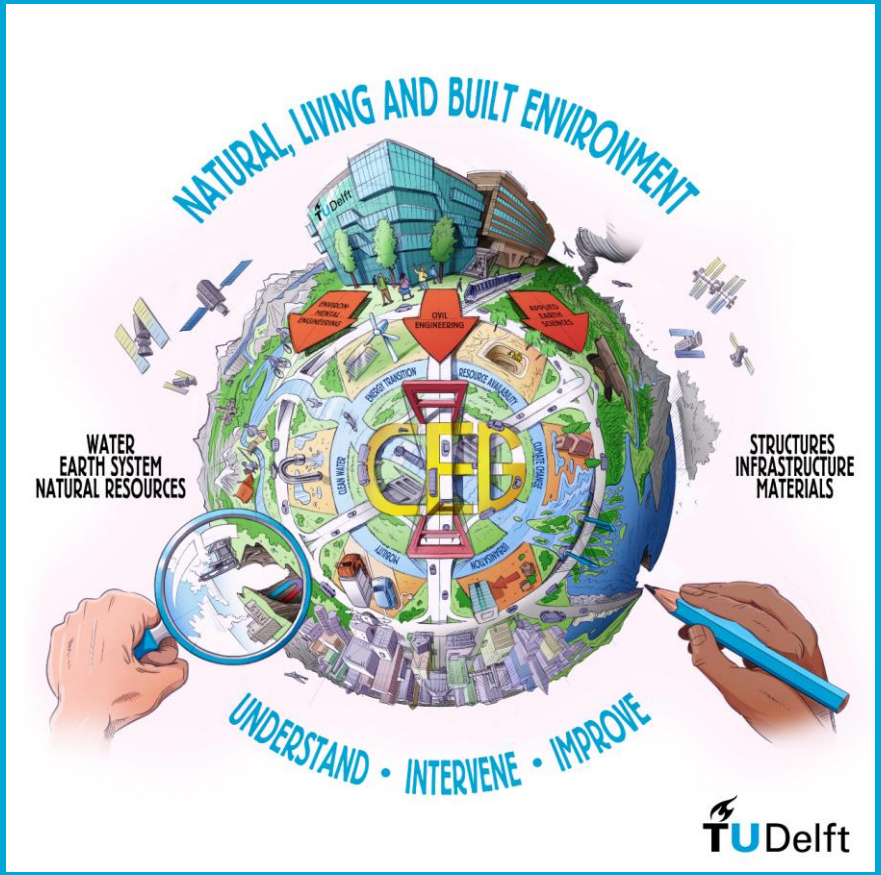

Marine renewable energies will allow us to meet our own needs without compromising the ability of future generations to meet their own needs.

In addition, socio-economic resources can benefit from the “right” development pathways, which can help us develop added value to societies, and transition older industries.

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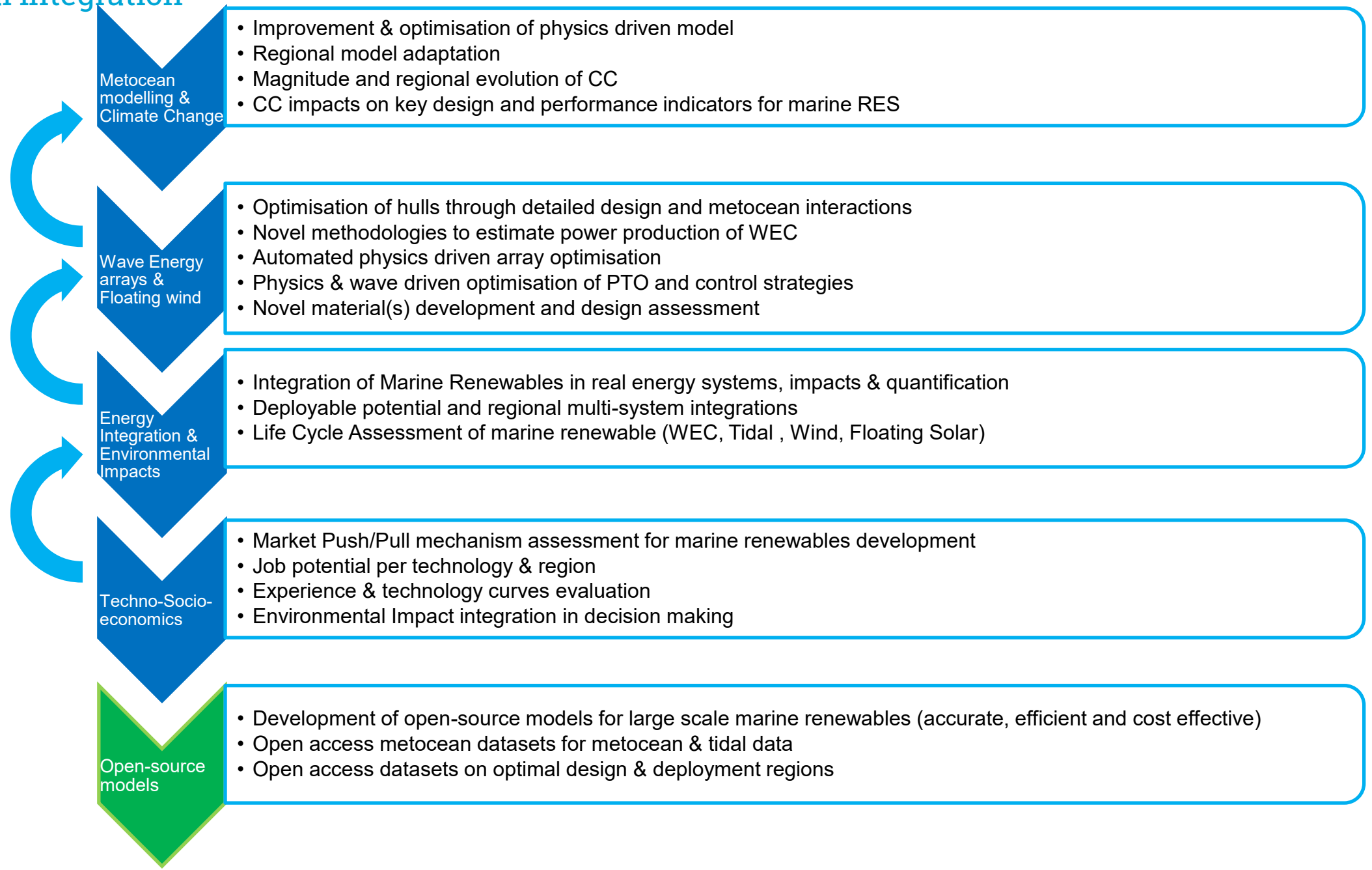
Accelerate the renewable energy transition, through innovative research in marine energies

MREL is a vertical integrated research group that provides comprehensive solutions for marine renewables, through breakthroughs in SotA via a holistic iterative loop of decisions.

Our focus is **on marine renewables**, offshore floating wind, wave energy, tidal energy.

MREL vertical integration



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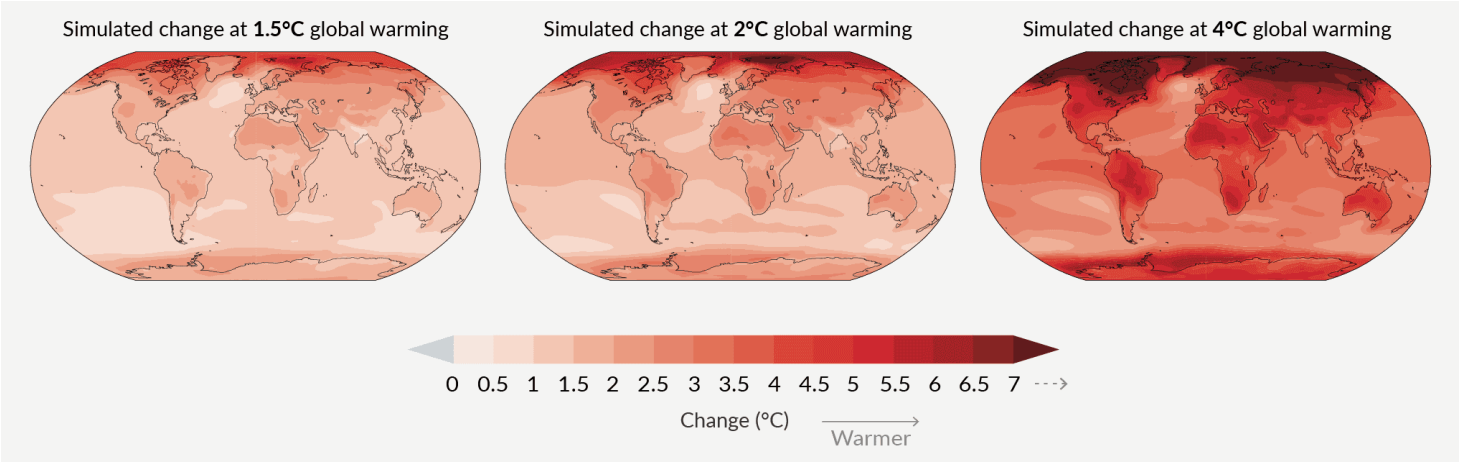
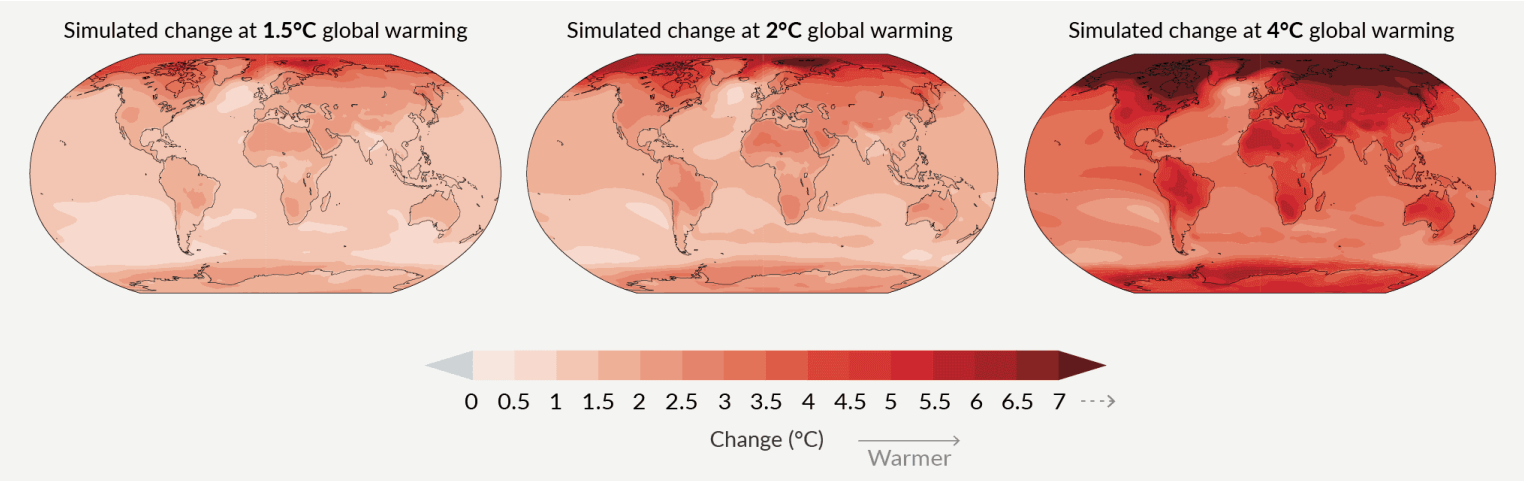
The future

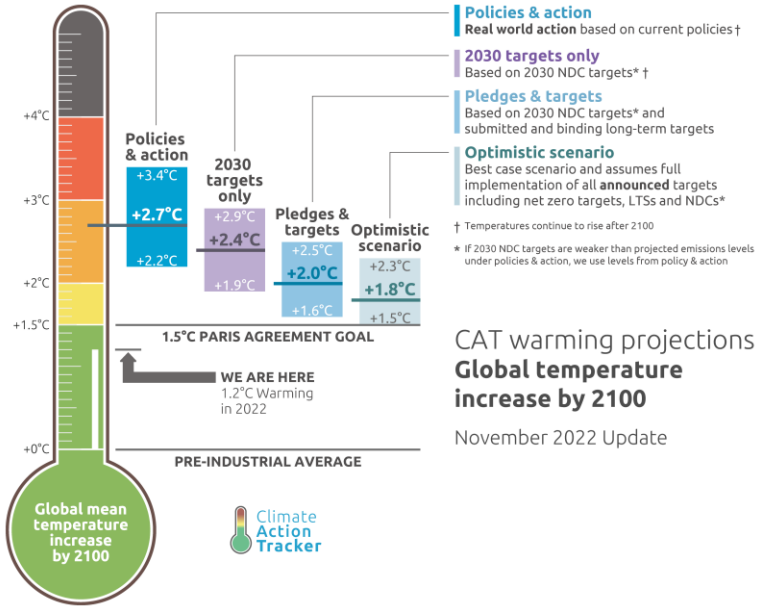
Scenario	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

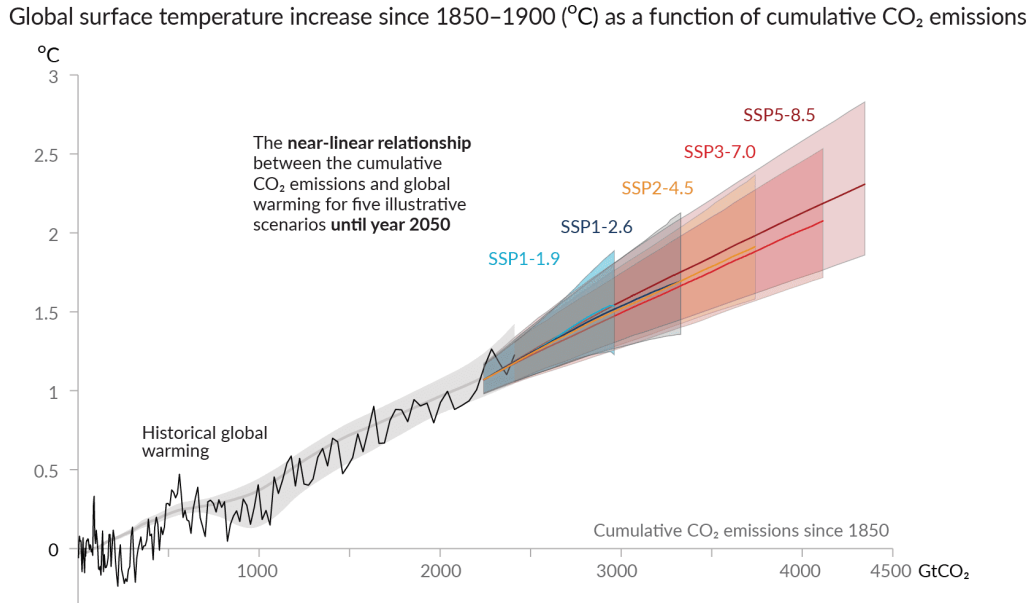


IPCC, 2021

Scenarios Impact

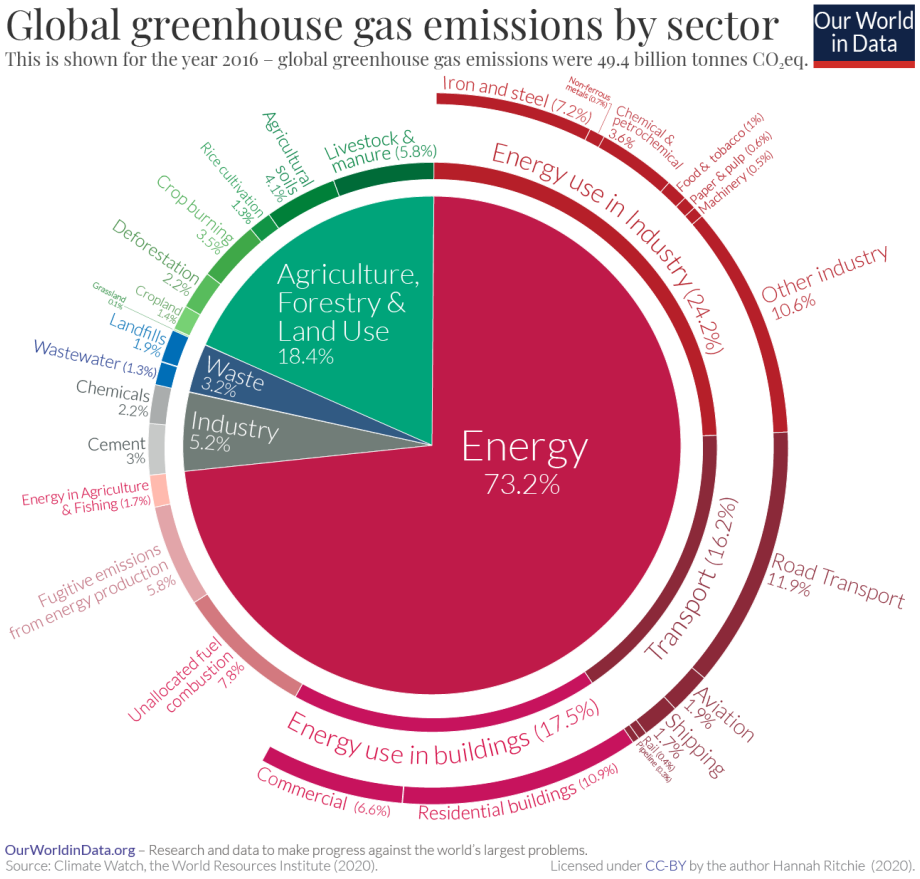






IPCC, 2021
Climate Action Tracker 2023

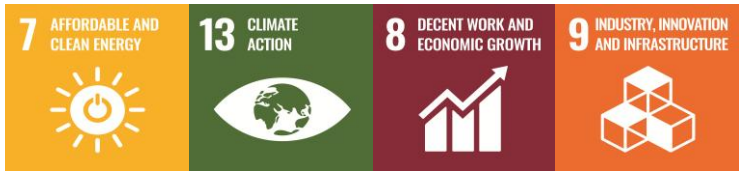
Mitigation



Our world in data 2023
EEA 2023
IEA 2023

Mitigation & Marine Renewables

United Nations: Sustainable Development Goals



European Commission: Offshore Energy Strategy

≥ 300 GW offshore wind

≥ 40 GW wave & tidal

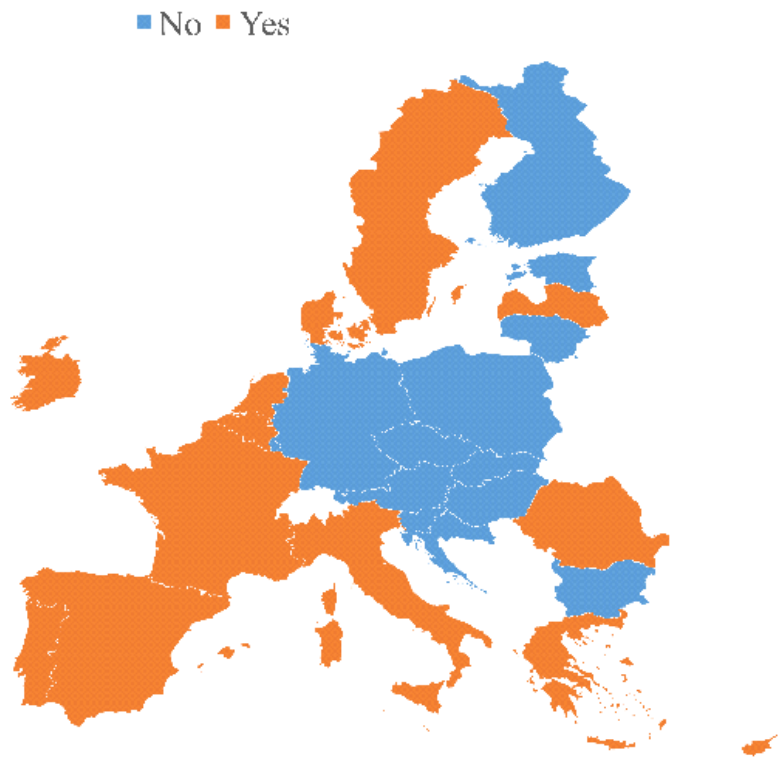
European Commission

Conference of Parties (COP): Country commitments for reduction of emissions

United Nations Climate Change

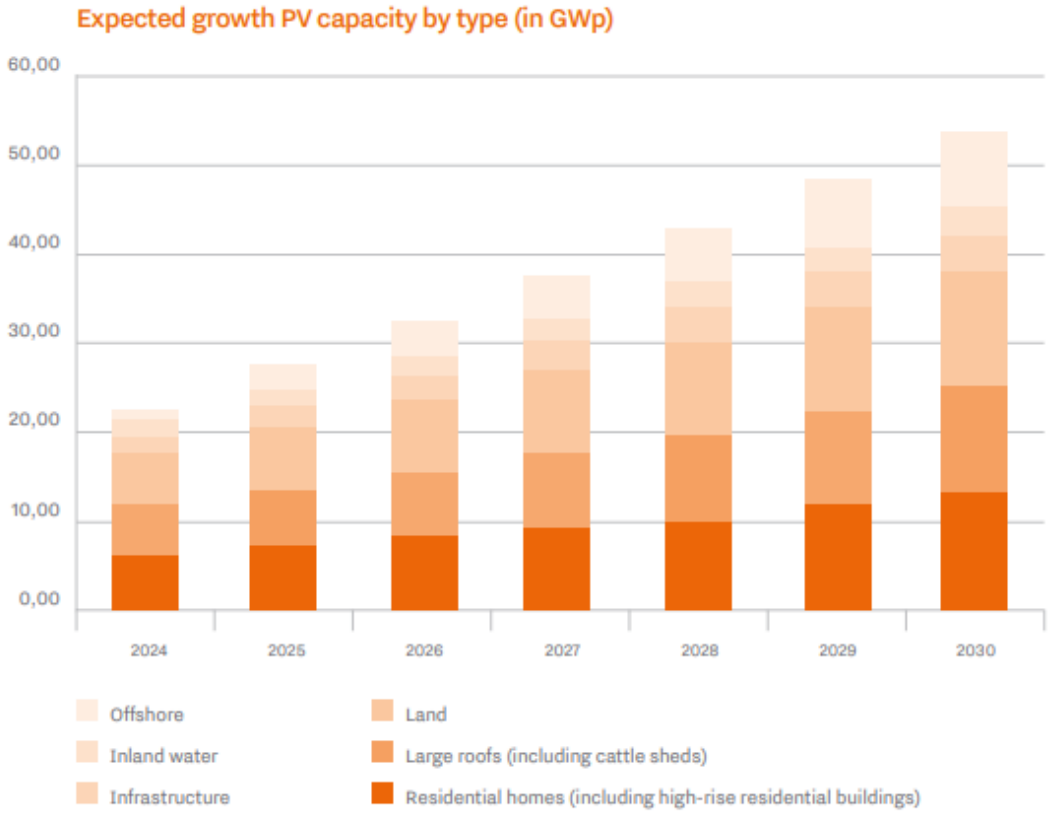
PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

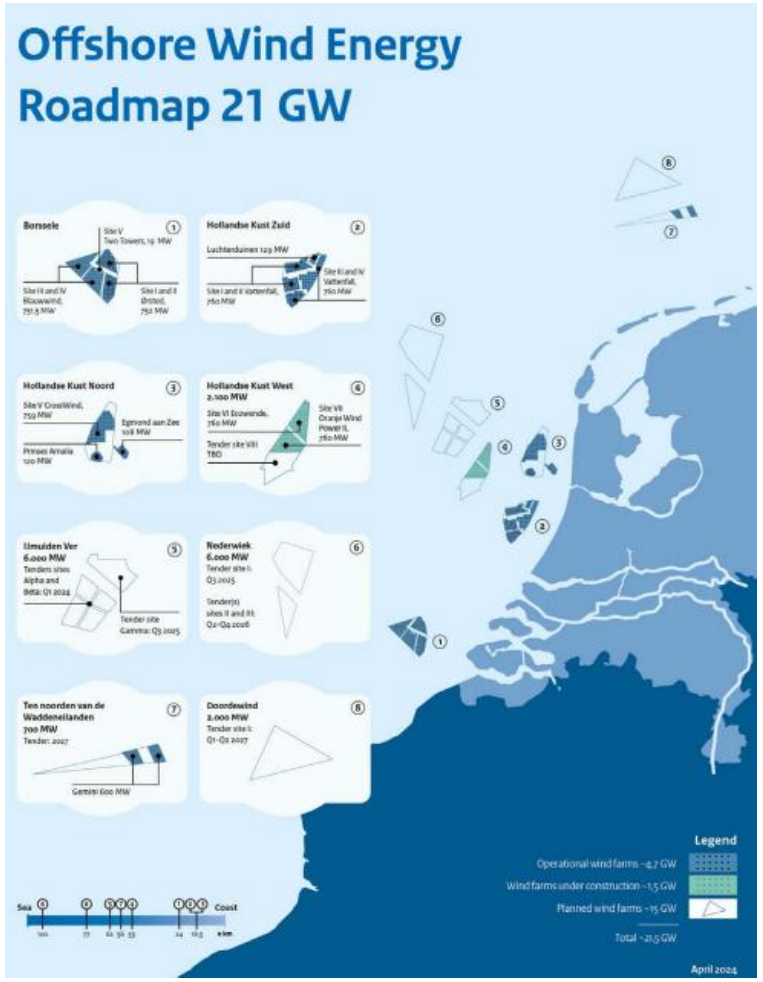
Marine Renewables NECP



- European Commission, Blue Growth, Ocean Energy, 2020
- European Commission, European Green Deal, Clean Energy priorities, 2020
- JRC, Ocean Energy Market report, 2019

The Netherlands (short-term) 2030 goal

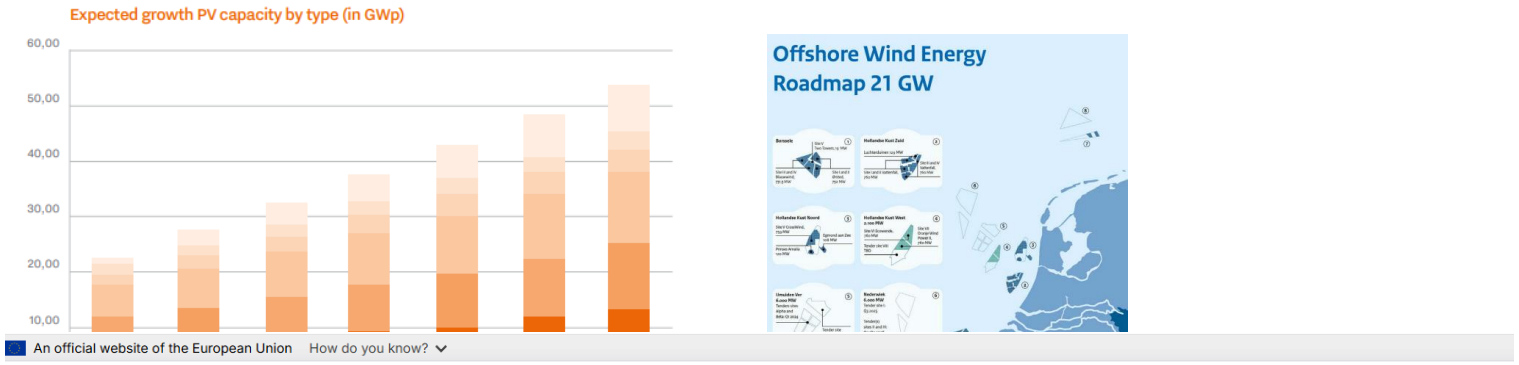




Solar: ≈50 GW
Offshore wind: 21 GW
Onshore wind: 7 GW
Total: ≈78 GW

Development Framework for Offshore Wind Energy Ministry of Economic Affairs and Climate Policy Directorate-General for Climate and Energy, 2024
RVO, Solar and storage synergies for a sustainable future Dutch PV and energy storage technology, 2024

The Netherlands (short-term) 2030 goal



European Commission

EN

Energy, Climate change, Environment

Energy

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GENERAL PUBLICATIONS

Communication on innovative technologies and forms of renewable energy deployment

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Publication date 2 July 2025

Author Directorate-General for Energy

Solar: ≈50 GW
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Total: ≈78 GW

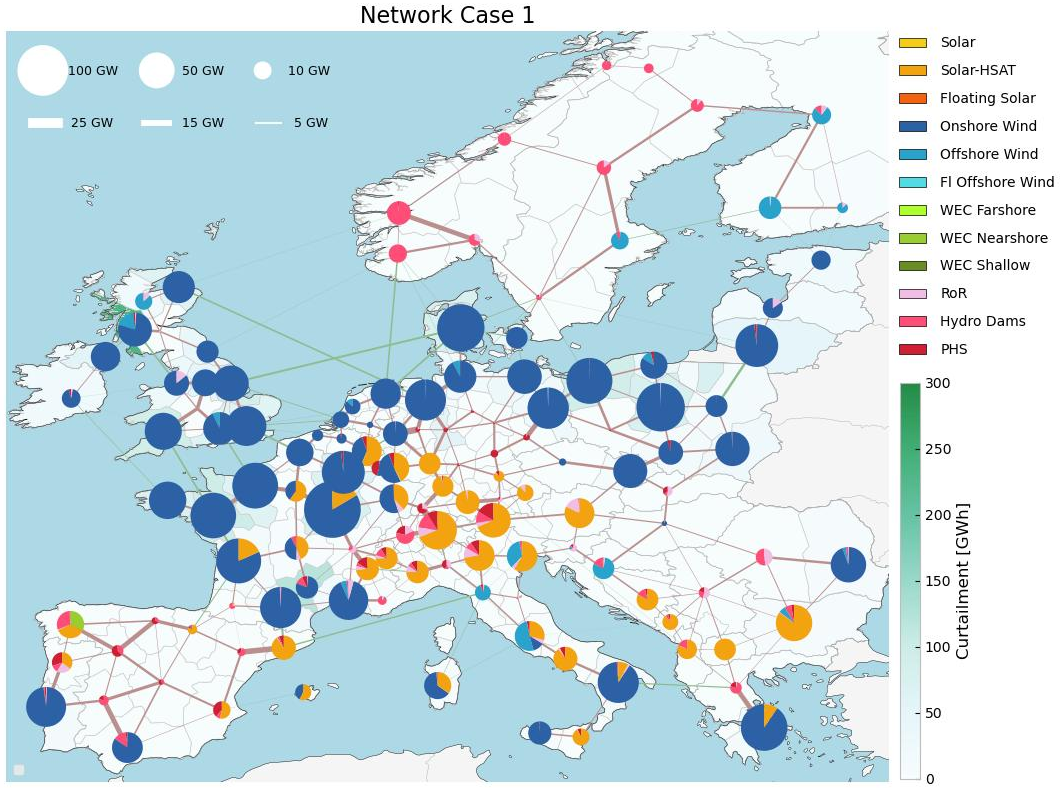
5% (minima) need to be wave, tidal, floating wind

Wave energy expected ≈3-4GW

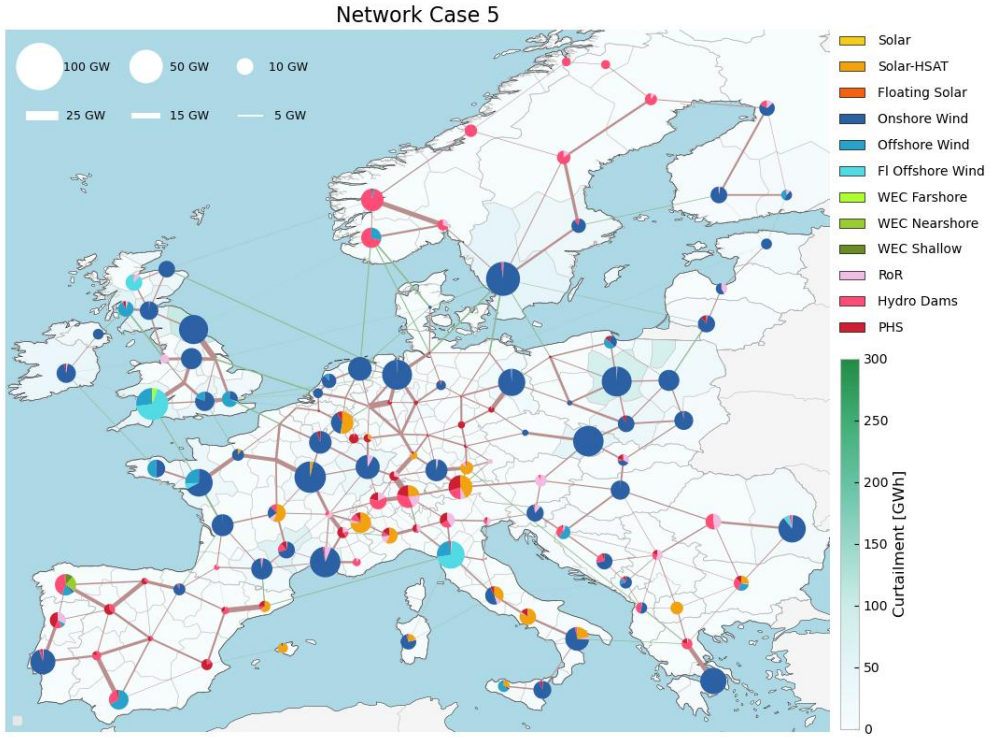
Development Framework for Offshore Wind Energy Ministry of Economic Affairs and Climate Policy Directorate-General for Climate and Energy, 2024
RVO, Solar and storage synergies for a sustainable future Dutch PV and energy storage technology, 2024

The Energy Transition pathways

Without significant marine renewables 2030



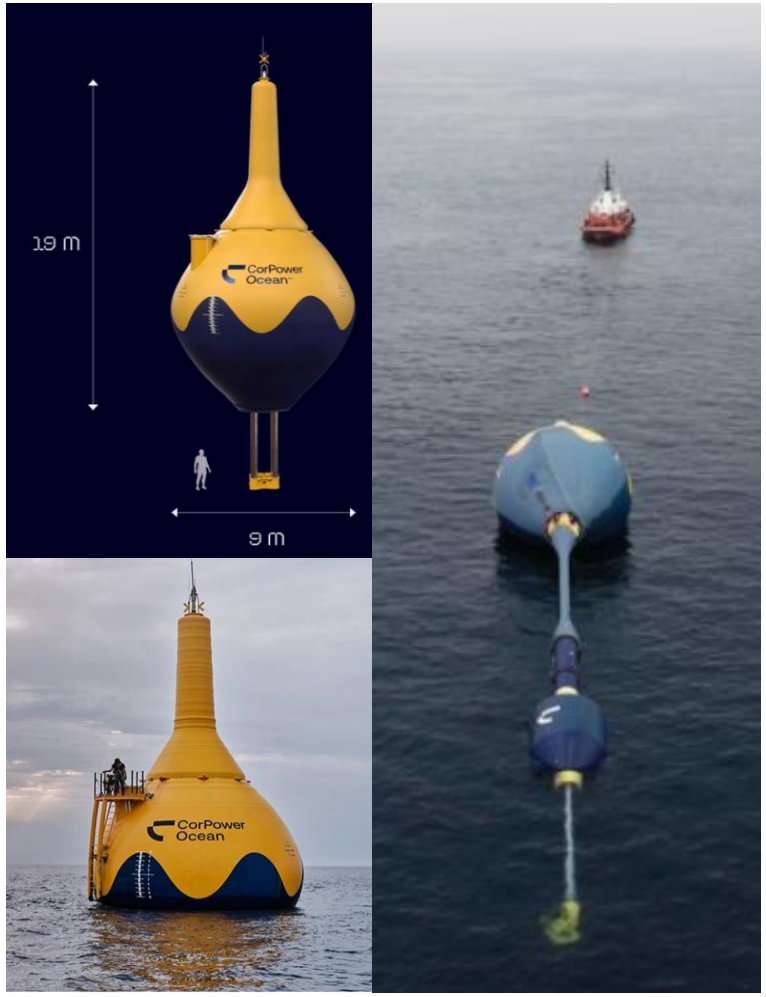
With the OES marine renewables 2030



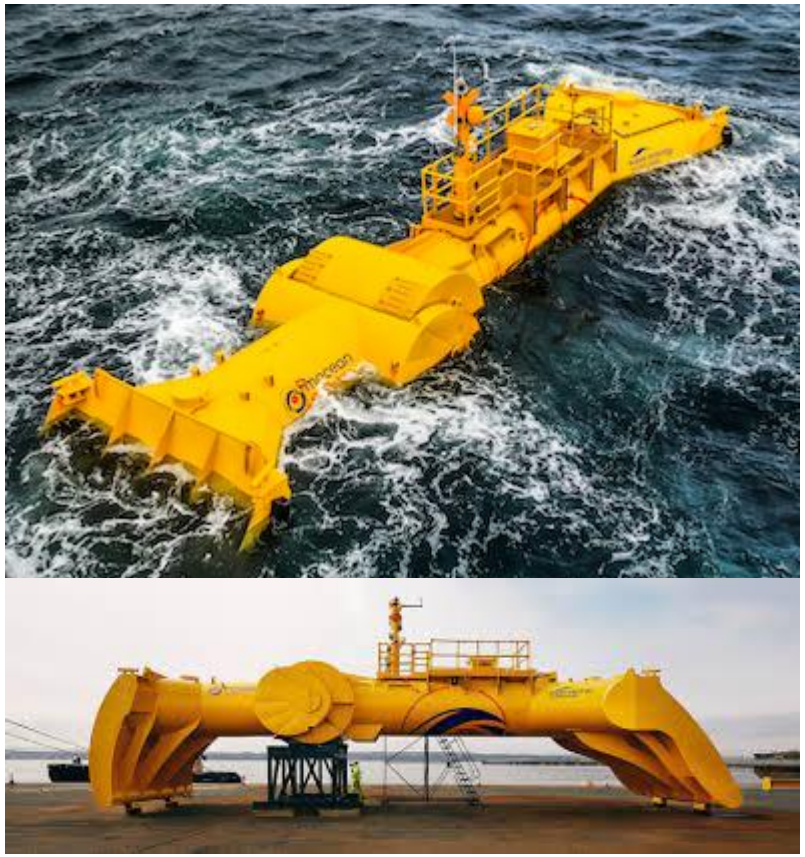
Wave energy converters (WECs)

There are different types of WECs with different operating principles, different extraction capabilities, deployment depths etc

Shallow

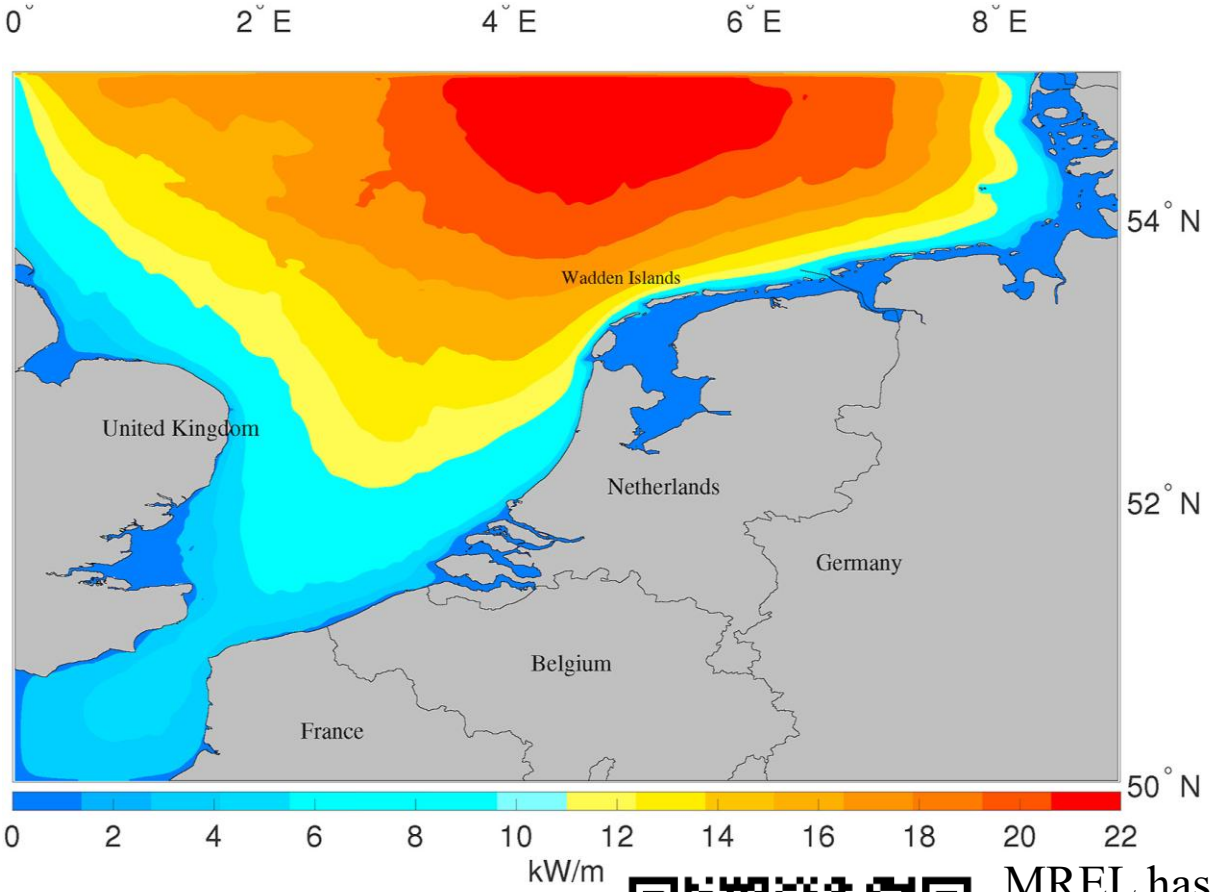


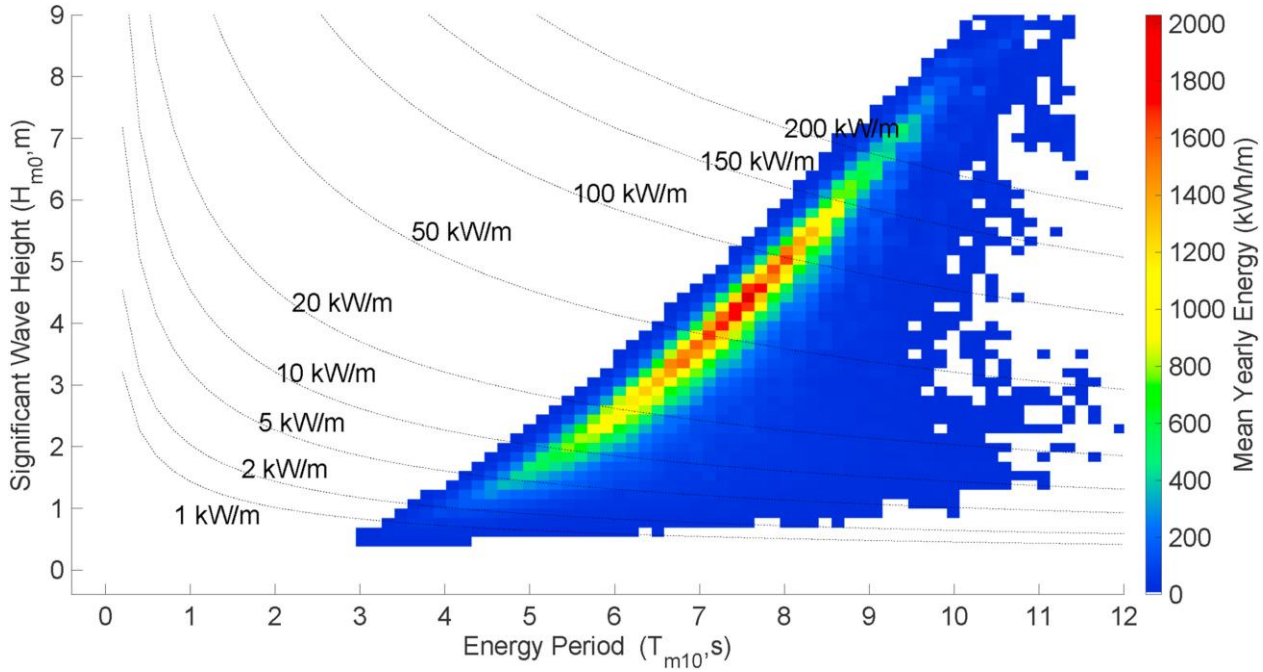
Nearshore



Farshore

Wave Energy Converters

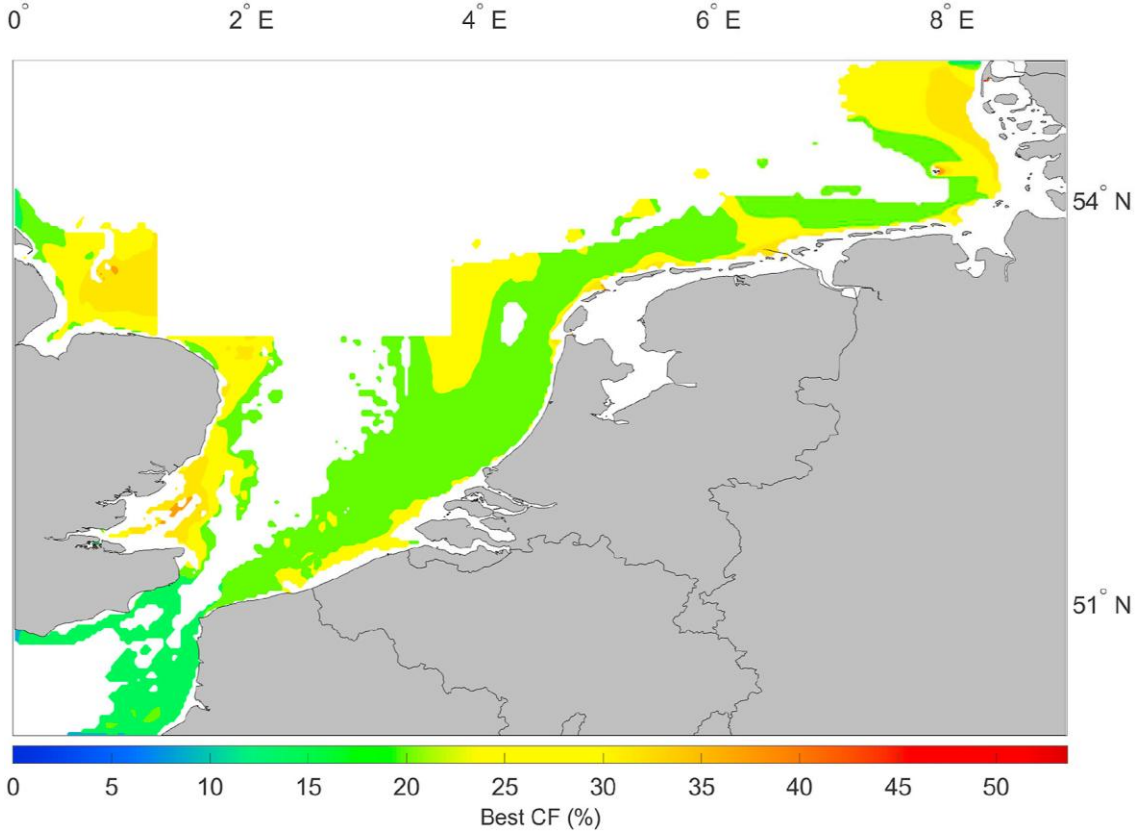


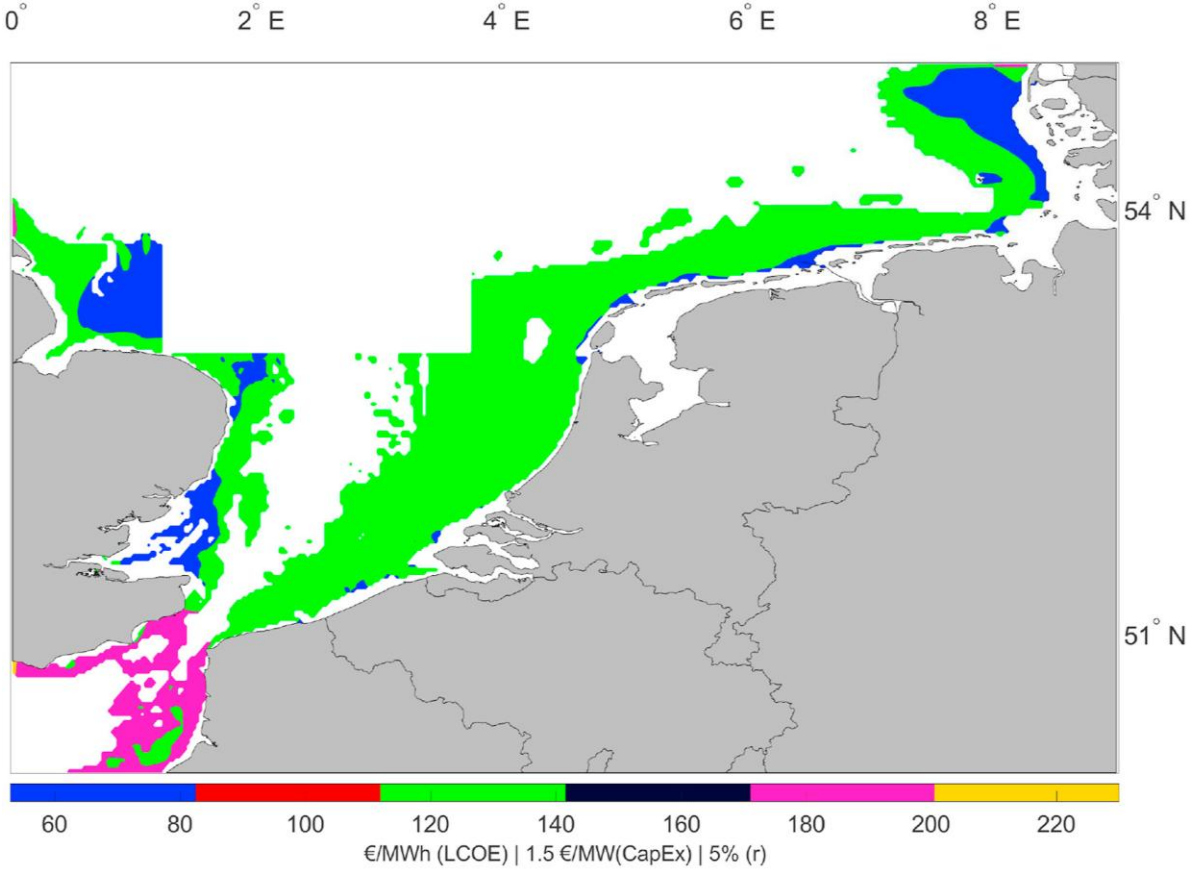


MREL has free open source
High-resolution 30-year datasets with wave conditions

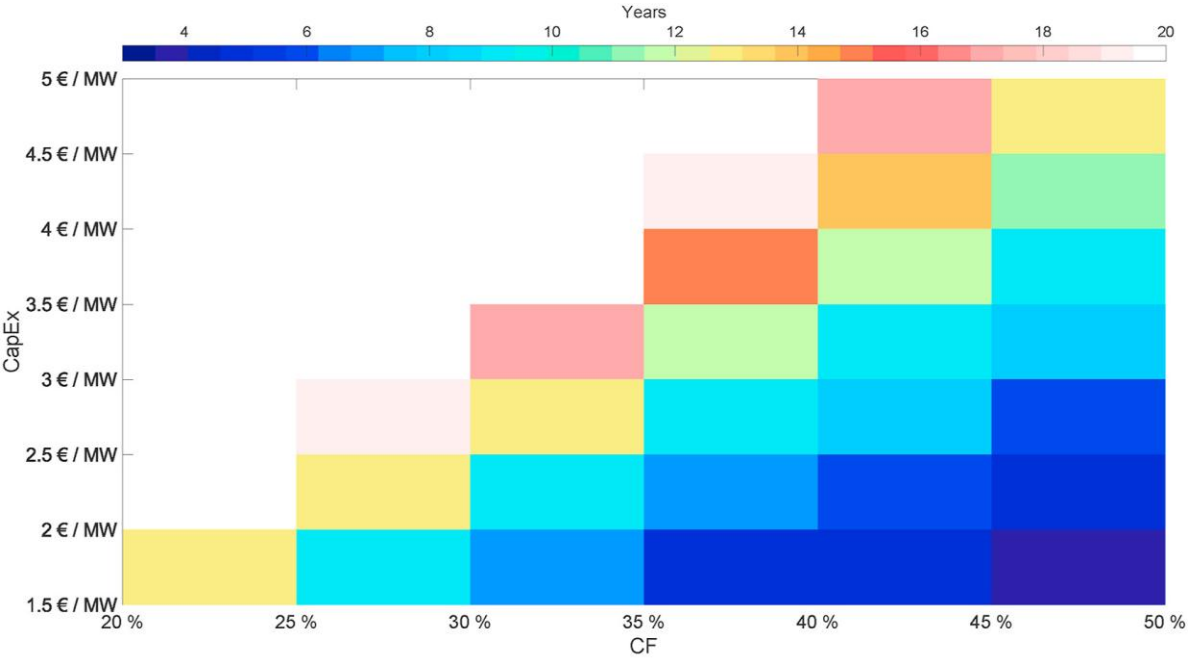
ECHOWAVE (**E**uropean **CO**asts **H**igh Resolution **O**cean **WAVE**s Hindcast)

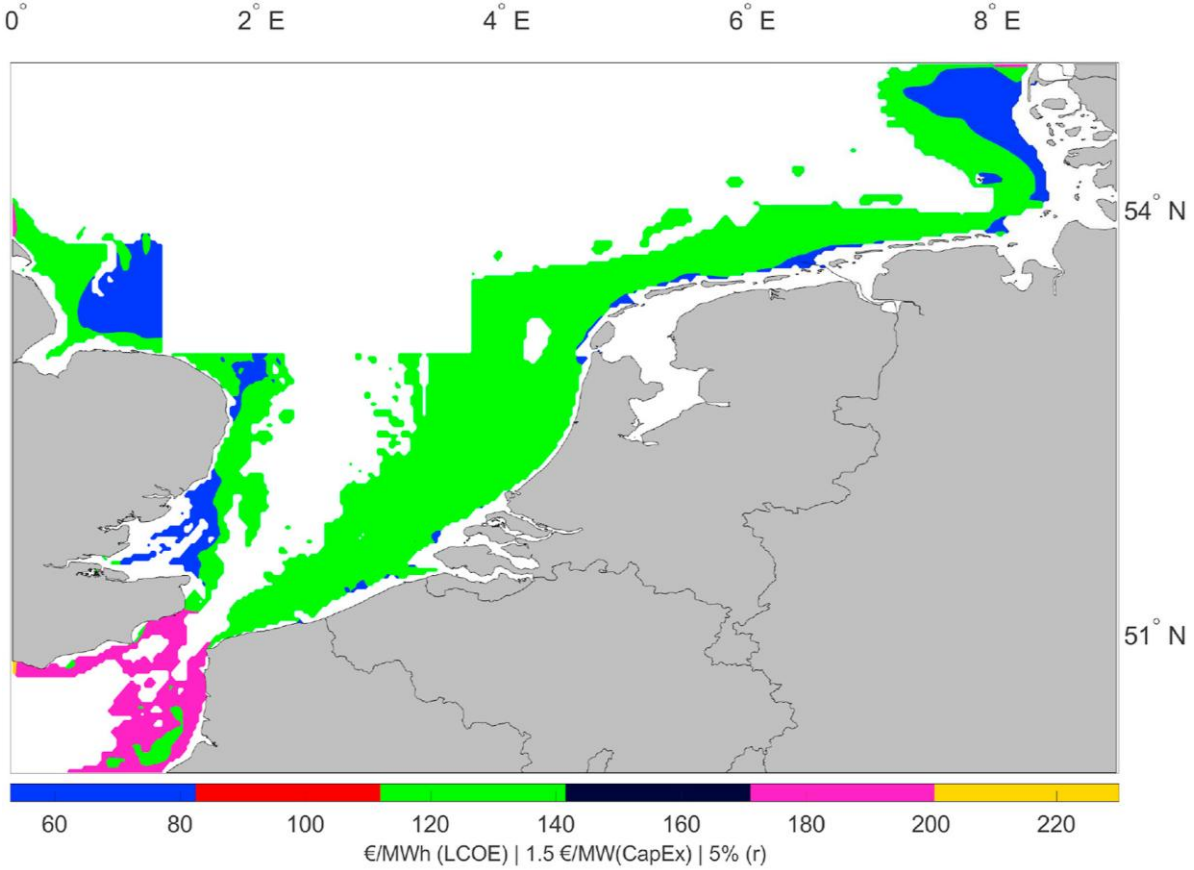
Opportunities and feasibility



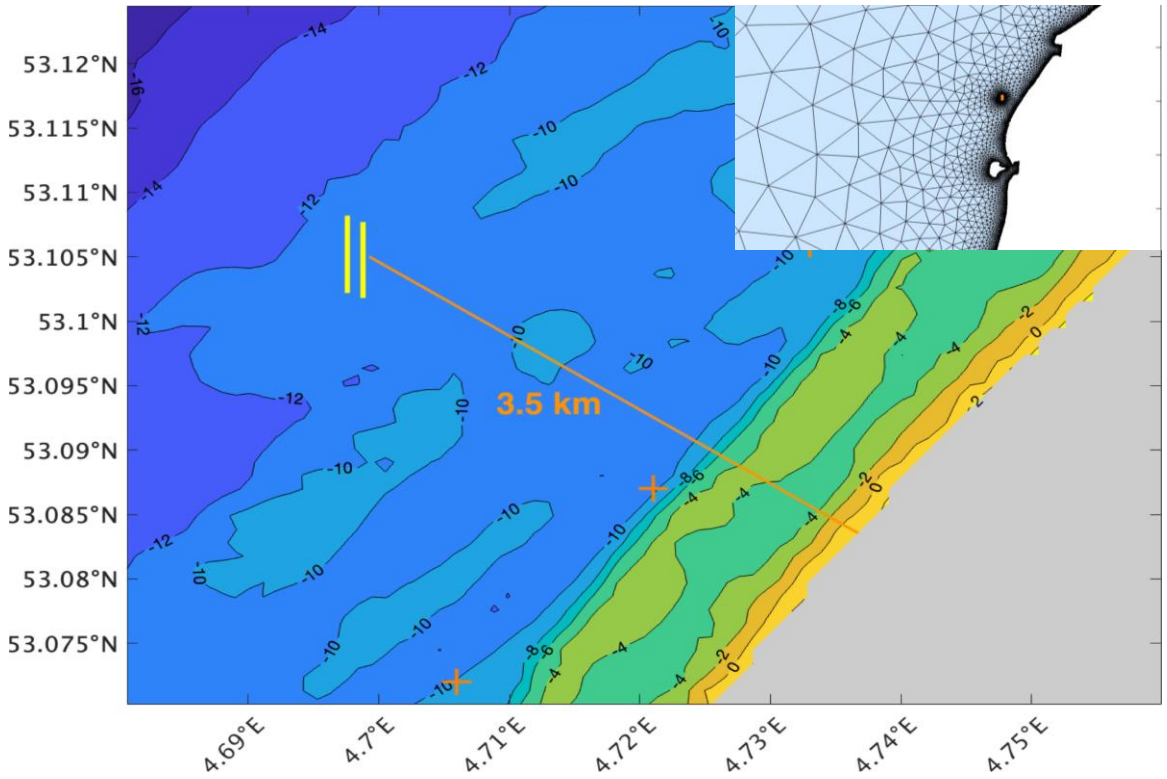


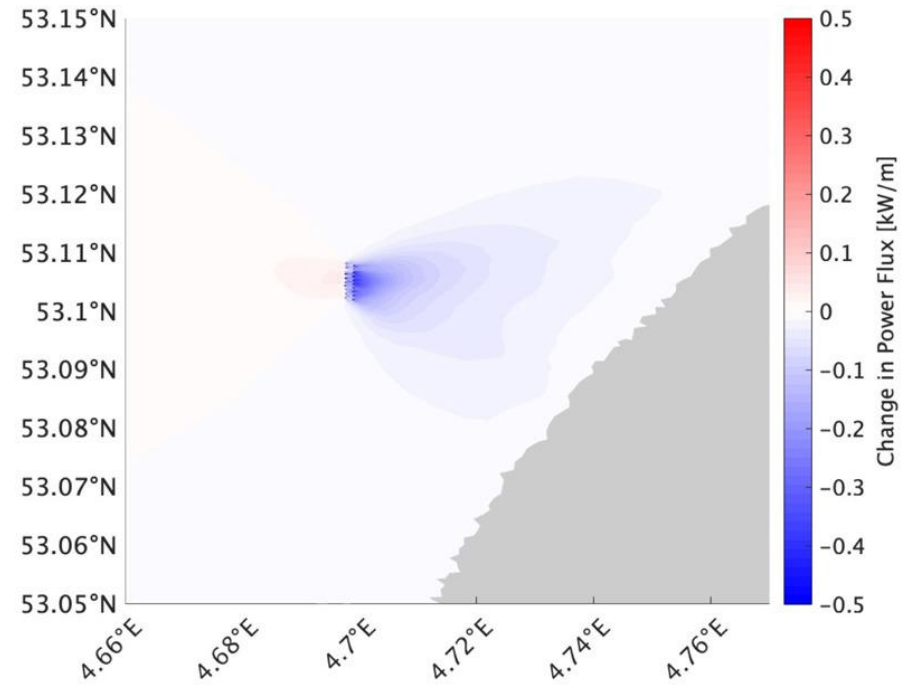
Wave energy in the Netherlands

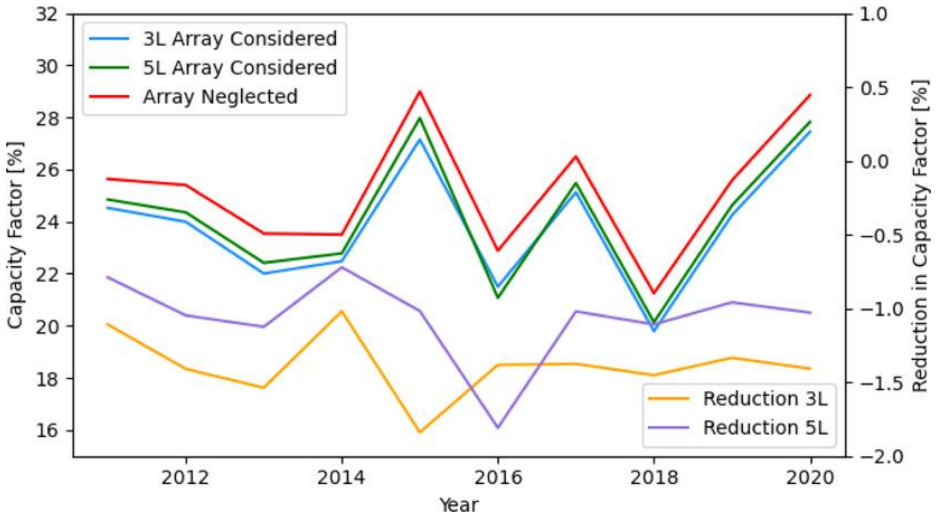




WECs & marine renewables as additional influences







Wake effects influence the power production BUT will also reduce the incoming waves for coastal structures.

Our preliminary research shows potential for reduction of loading and potential cost savings.

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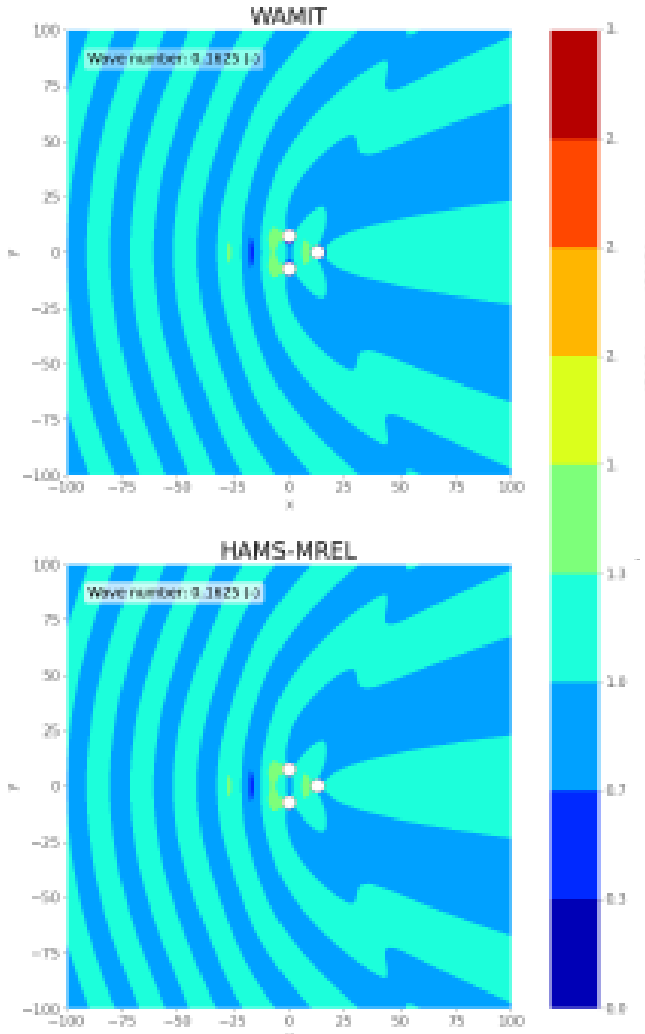
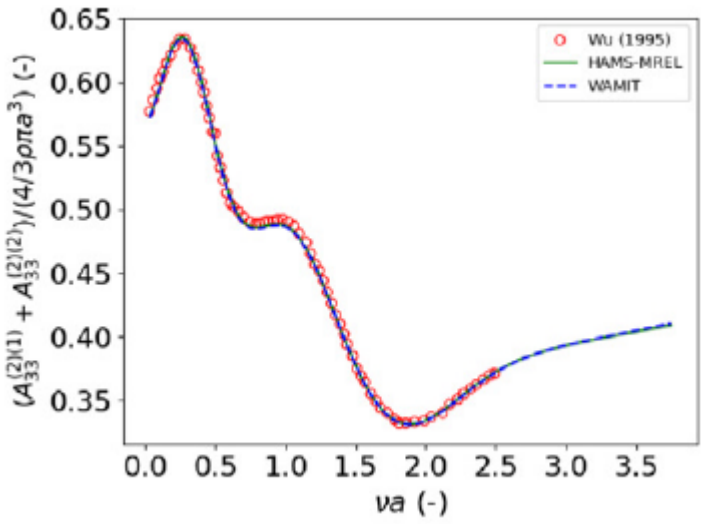
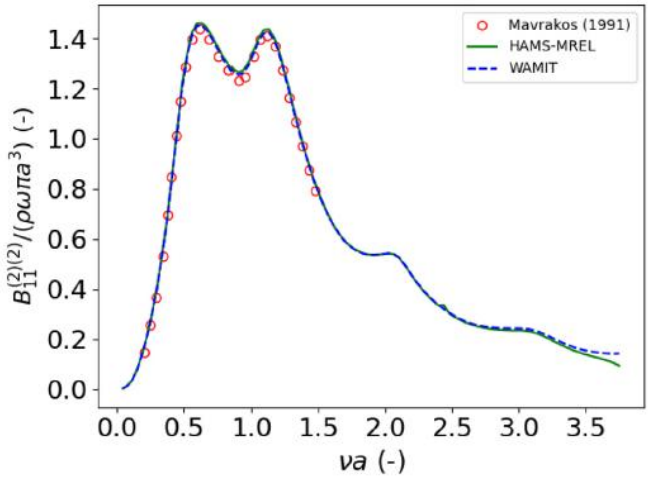
HAMS-MREL: fast & effective BIEM solver for Marine renewables





(a) Added mass in surge

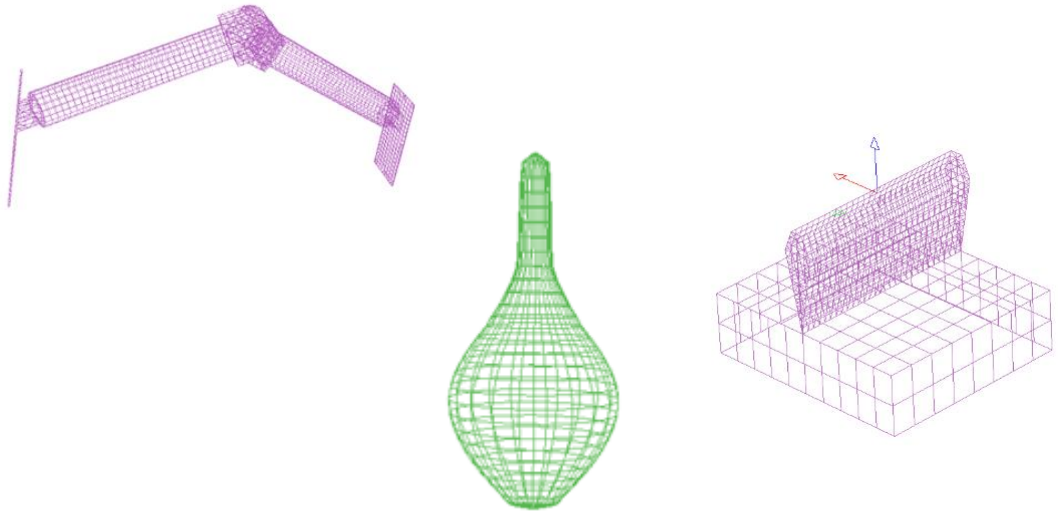


(b) Radiation damping in surge

Fully validated with analytical, semi-analytical and inter-model comparison.

WEC	Solver	No. of panels	DOF	Time (s)
PA(HULL)	WAMIT	2448	6	72
	NEMOH	2448	6	765
	HAMS	2448	6	36
PA(HULL +WATER)	WAMIT	2448 + 1584	6	176
	NEMOH	2448	6	765
	HAMS	2448 + 1584	6	175
OSWEC (HULL)	WAMIT	716	1	39
	NEMOH	716	1	210
	HAMS	716	6*	11

* HAMS always calculates for all 6 DOFs



More can be see on our website
www.tudelft/nl/ceg/mrel

Questions welcome !

Marine Renewable Energies Lab

Thank you for your attention

TU Delft