

Ocean Energy

Dr.ir. Henk Polinder

Overview

- Introduction
- Ocean wave energy
- Tidal / current energy

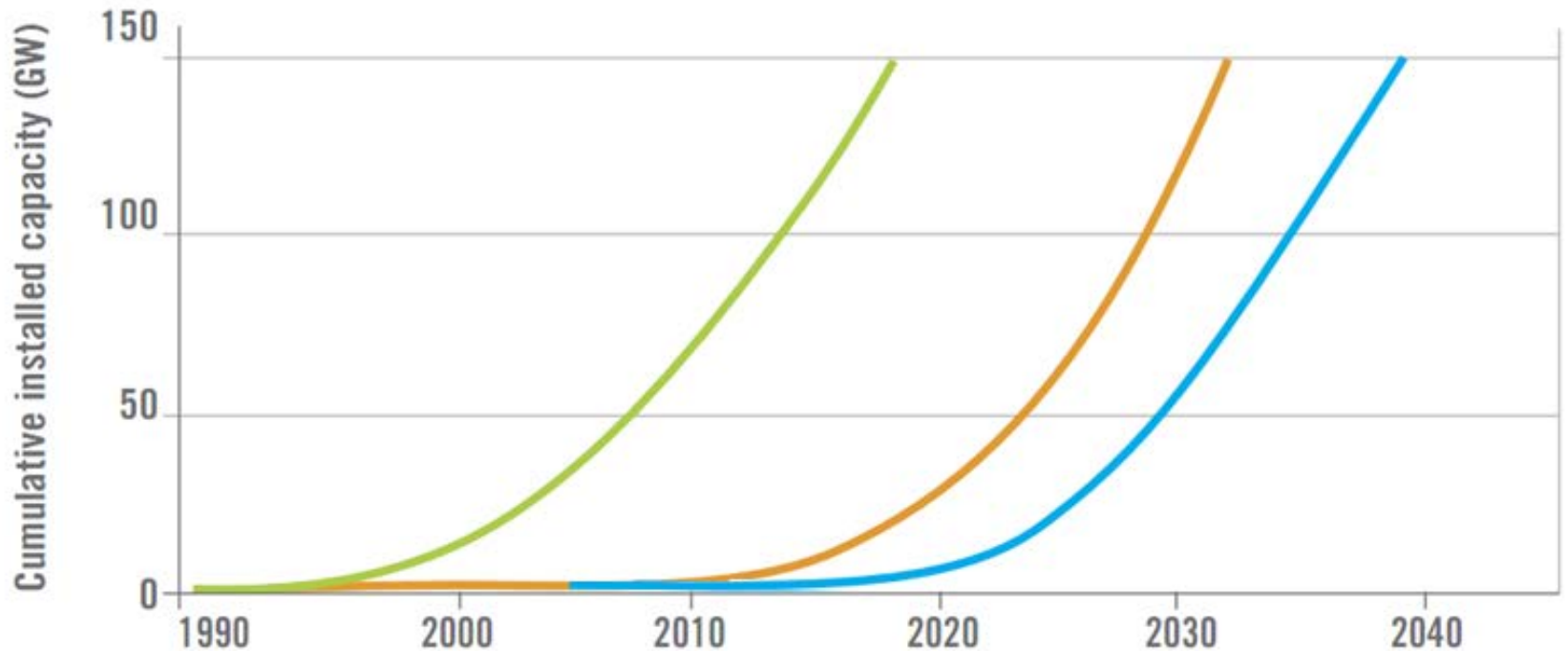
Context

- TU Delft is renowned in Water and Offshore Energy research (2nd position globally in Offshore Wind)
- TU Delft can build on an extensive network of knowledge partners and industry in the Water and Offshore field

Ocean Energy projected growth

In streamline of offshore wind

- Onshore wind
- Offshore wind
- Ocean energy



* Source: European Ocean Energy Association

2020: 3.5GW (€ 8.5 bn)
2050: 188GW (€ 450 bn)

Ocean Energy Platform

The Ocean Energy Platform is supported by the Delft Energy Initiative (DEI) and is officially created early this year



Henk Polinder
Wave Energy



Berend Jan Kleute
Thermal Gradient (OTEC)



Antonio Larquin Laguna
Tidal/Current Energy



Peter Mooij
Aquatic Biomass



Kornelis Blok
Chairman



Elisabeth Insam
Student - Energy Club



Lily Li
Senior Project Manager DEI



Eveline Zeegers
Office Manager DEI

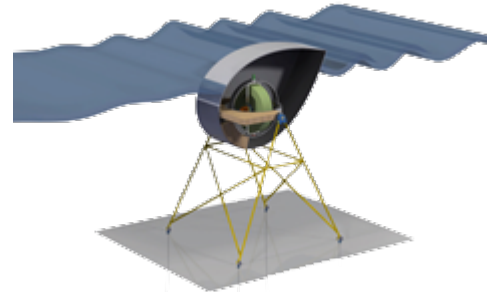
<http://oceanenergy.tudelft.nl/>

Different forms of ocean energy

Tidal / current



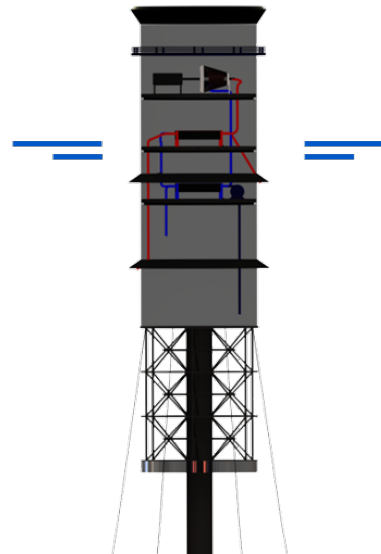
Wave



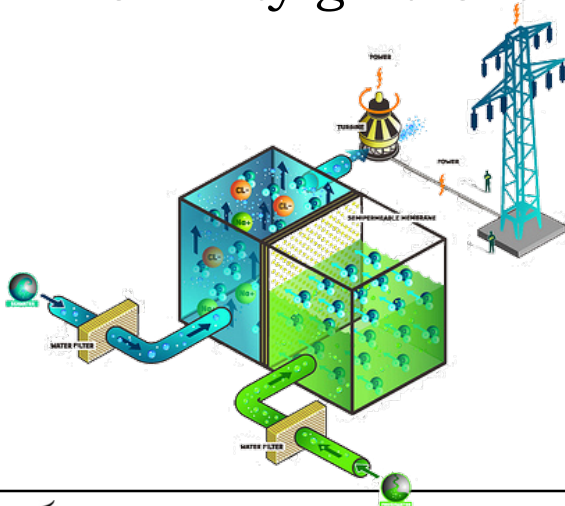
Aquatic biomass



Thermal gradient



Salinity gradient



Dutch industry momentum increases

Supported by Topsector Water



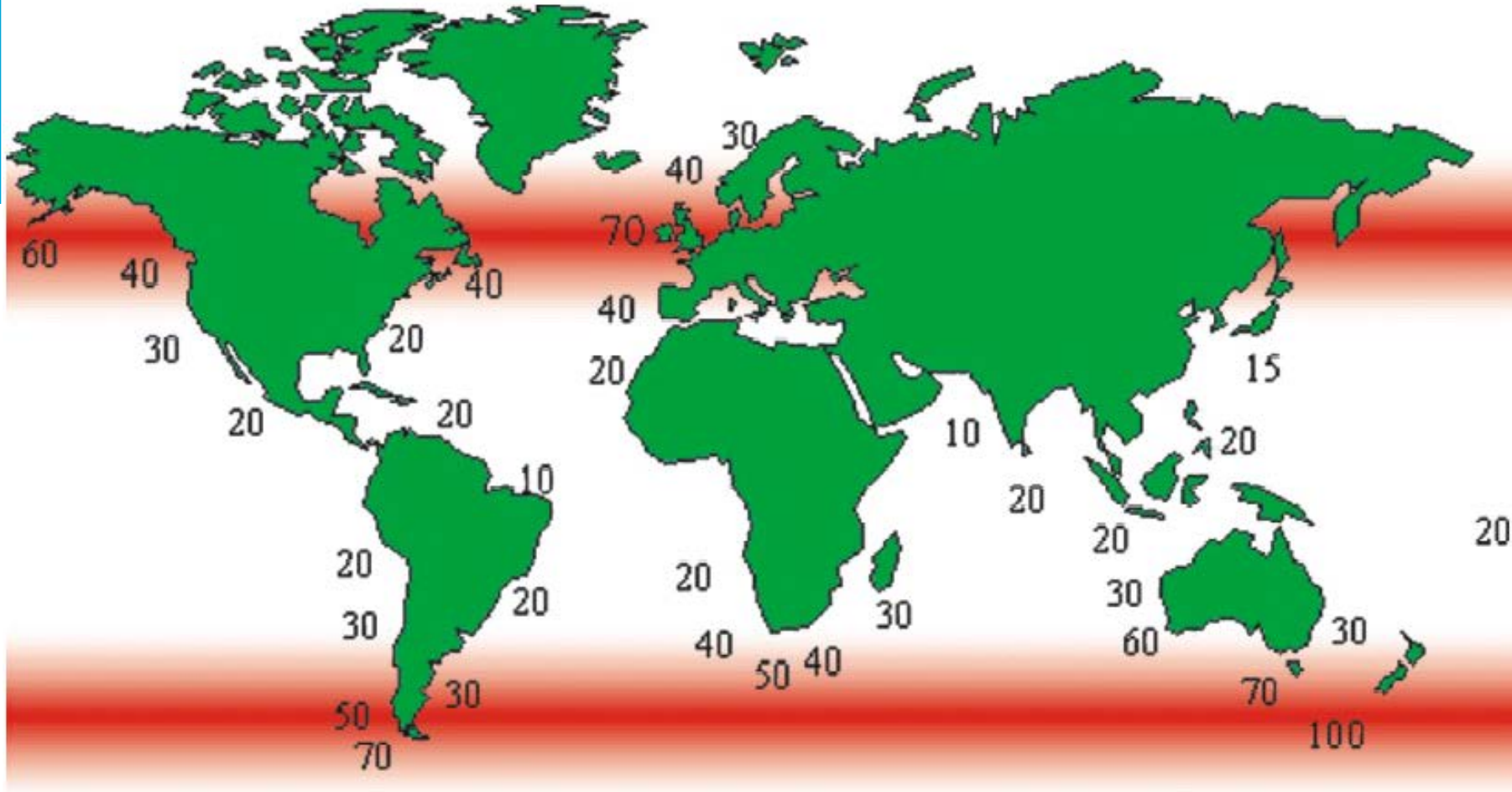
Dutch association for Energy from Water:



Overview

- Introduction
- Ocean wave energy
- Tidal / current energy

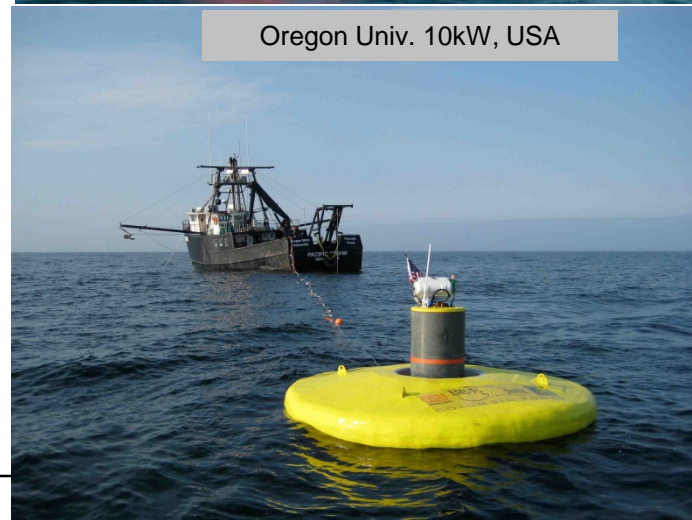
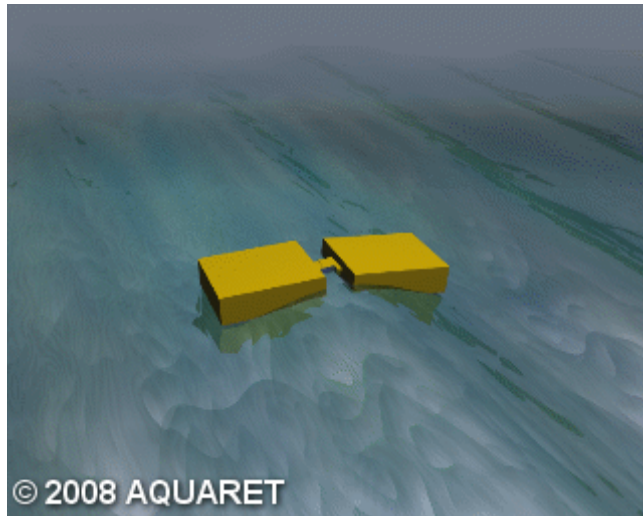
World Offshore Wave Resource



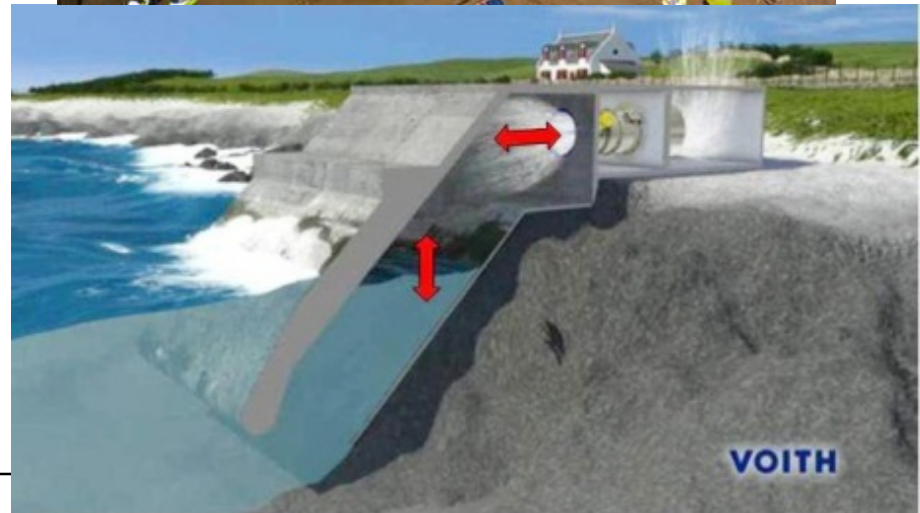
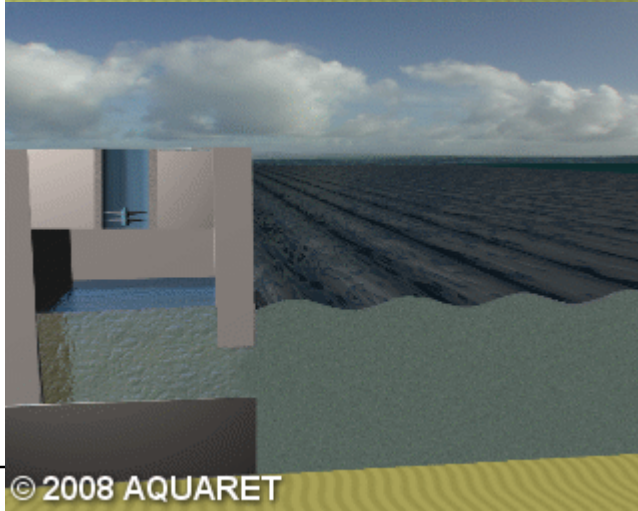
Source: "Wave Energy Utilization in Europe – Current Status and Perspectives", CRES , 2002 ; Kinsman, B., "Wind Waves", Prentice Hall, New Jersey, 1965

Figure 1: Global wave power distribution in kW/m of crest length

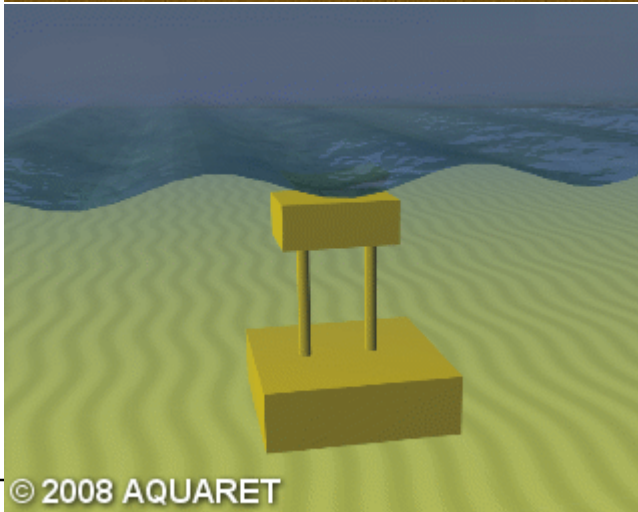
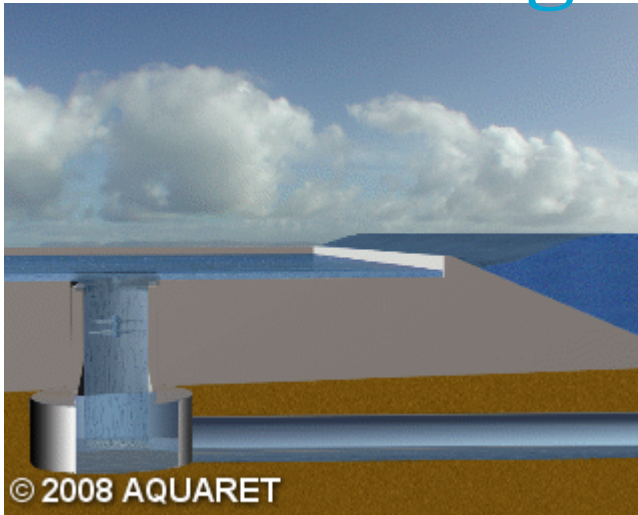
Attenuator / Point absorber



Oscillating wave surge converter / oscillating water column

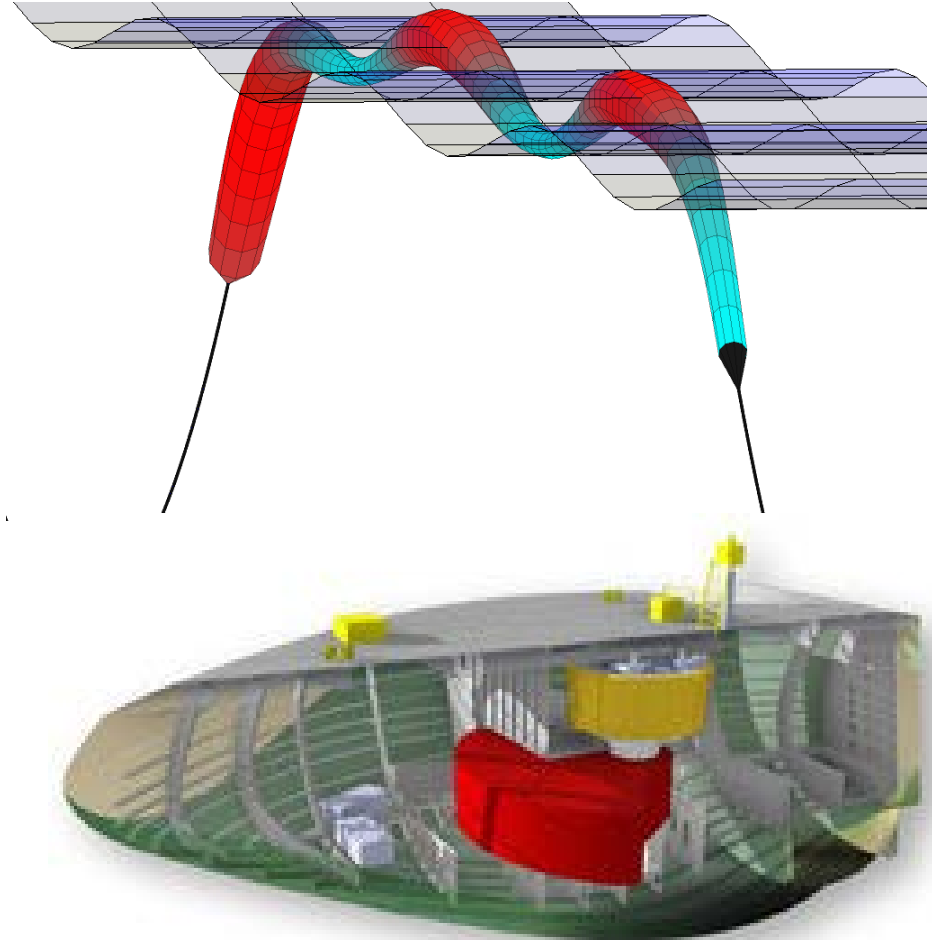
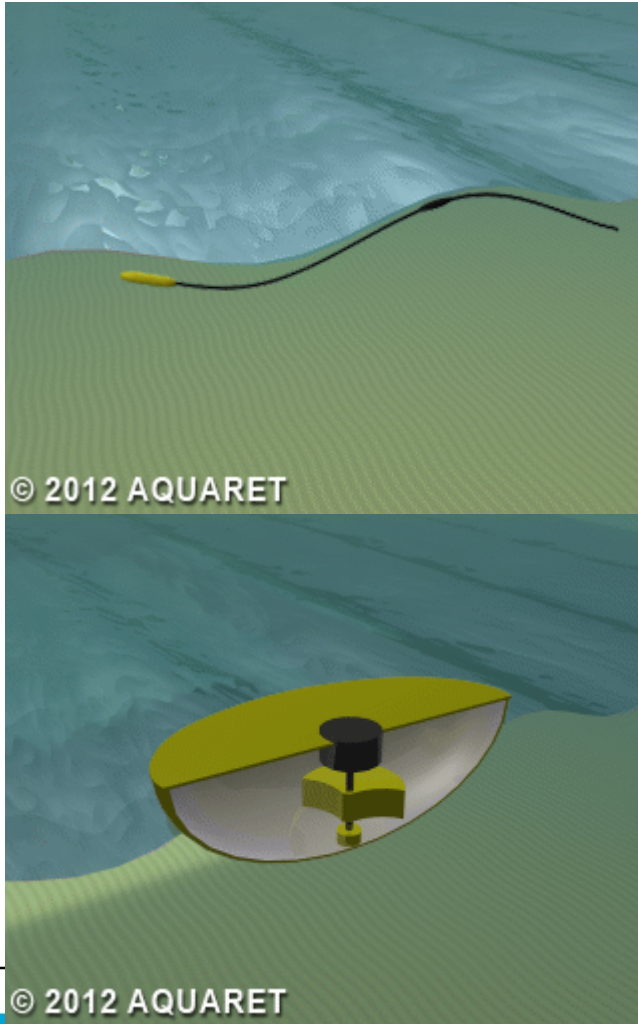


Overtopping device / Submerged pressure differential

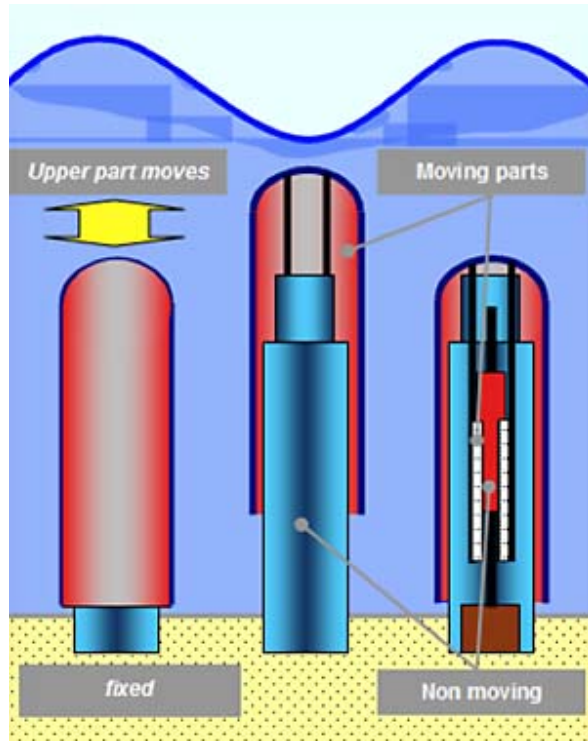


Bulged wave

Rotating mass

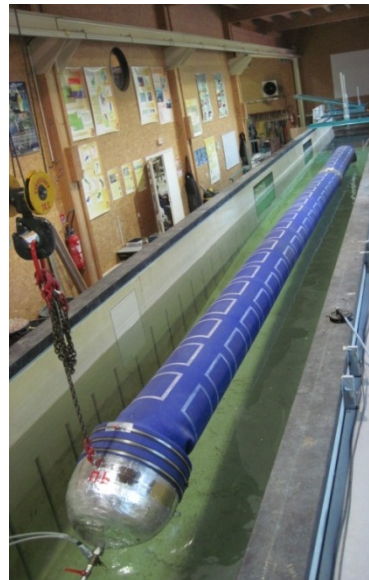


Archimedes Wave Swing

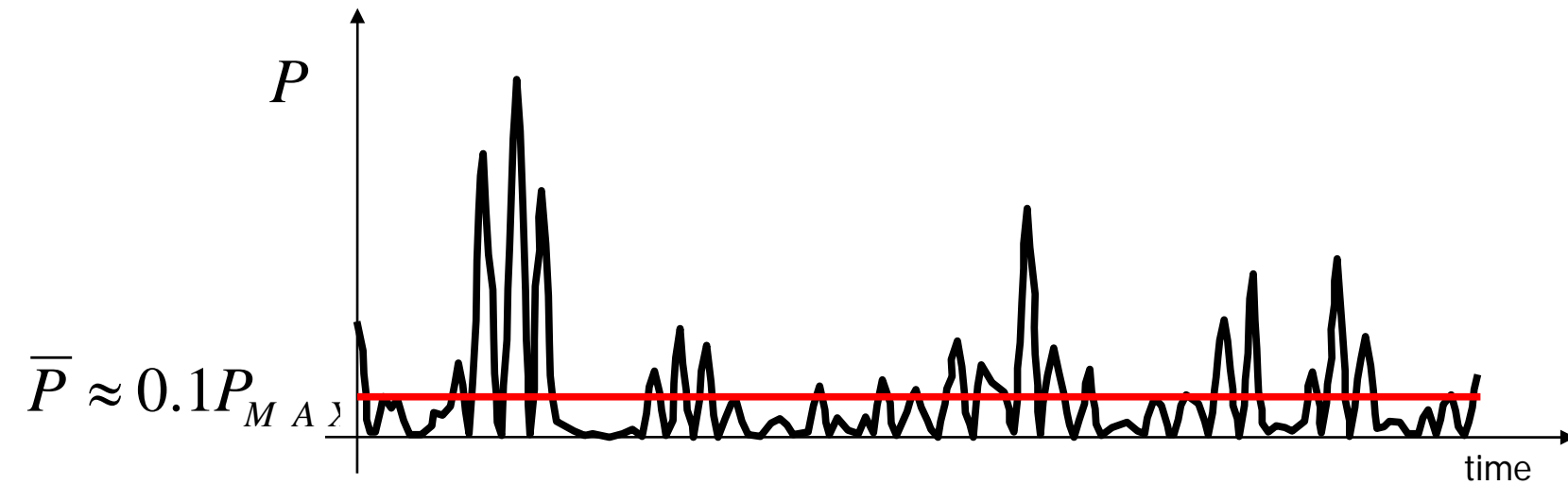
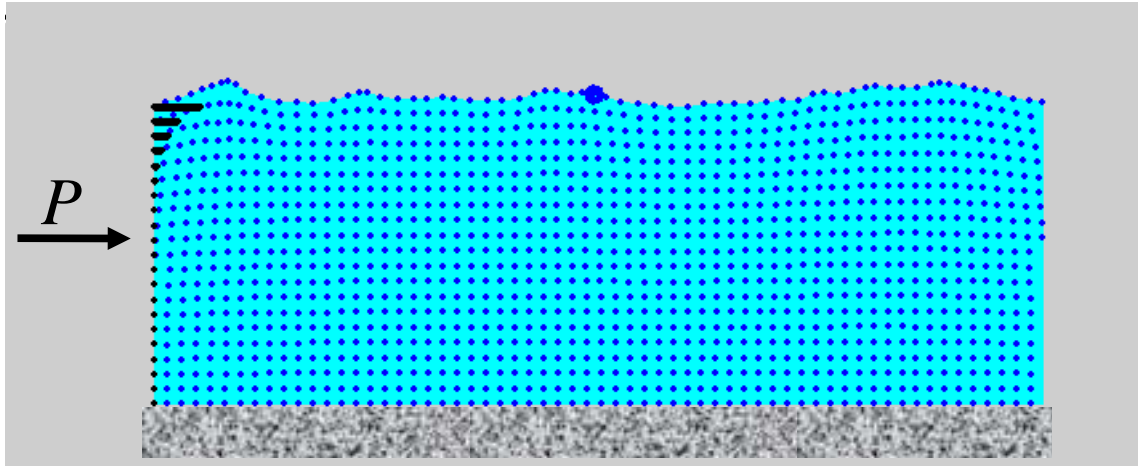


SBM Offshore EAP WEC Concept

- Fully flexible tube filled with water, closed at both ends
- Energy conversion system = Electro-Active Polymers



Real Seas (Polychromatic)



Research aspects

- Resource assessment
- Devices and technology
 - Primary energy conversion – hydrodynamics
 - Secondary energy conversion – power take off systems
 - Control
 - Structural materials, moorings and foundations (fatigue)
- Deployment and operations
 - Reliability, condition monitoring, maintenance
 - Farm arrays and shared infrastructure
 - Electrical infrastructure
- Environment
- Socio-economic impact

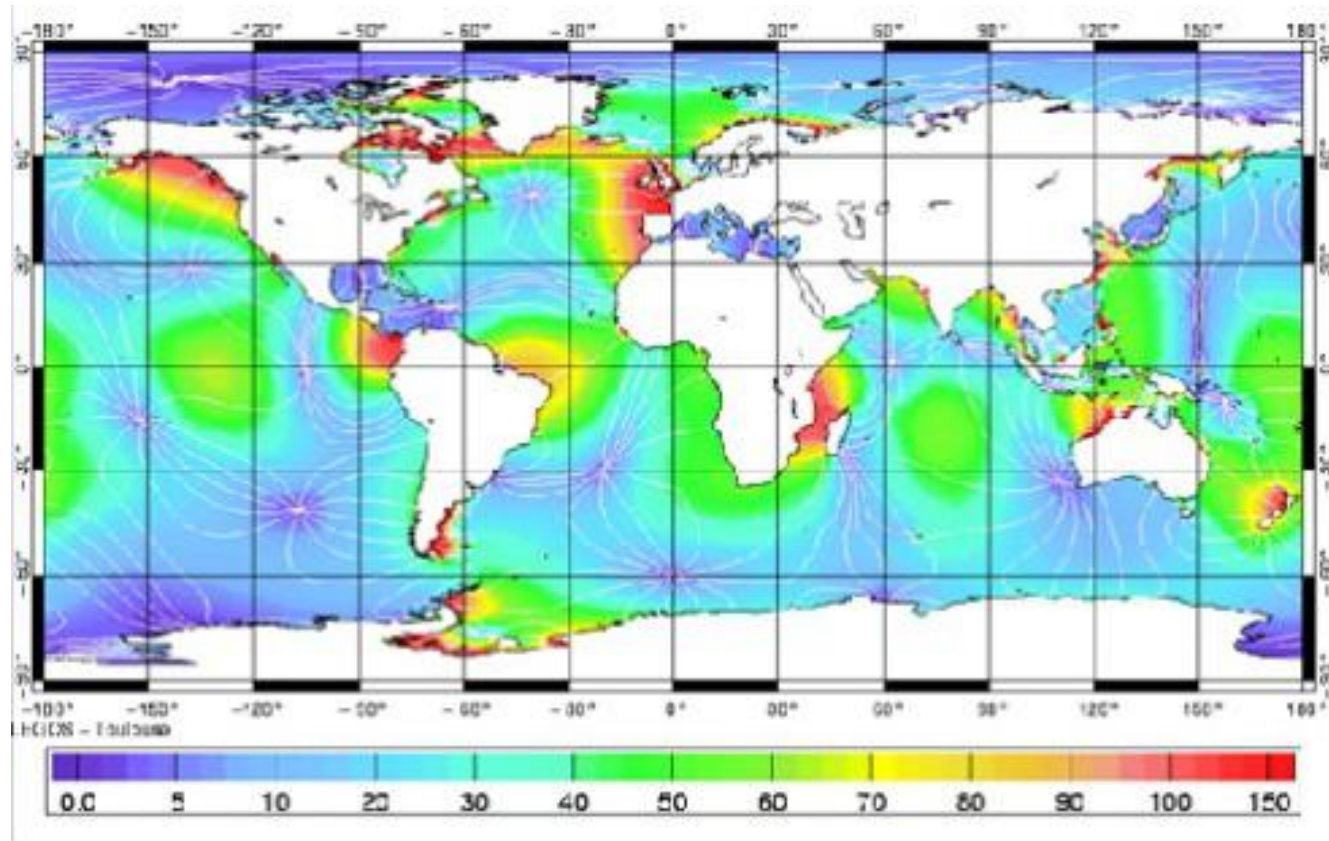
Key research questions

- Large variety of devices (>80), no convergence
 - Is there a way to converge?
- Aggressive environment - devices should be sensitive to waves to harvest energy, but not when there is too much energy
 - How to design devices that capture energy, but are robust enough to withstand storms in the offshore environment?
- Cost of Energy
 - Can the potential Cost of Energy be made acceptable?

Overview

- Introduction
- Ocean wave energy
- Tidal / current energy

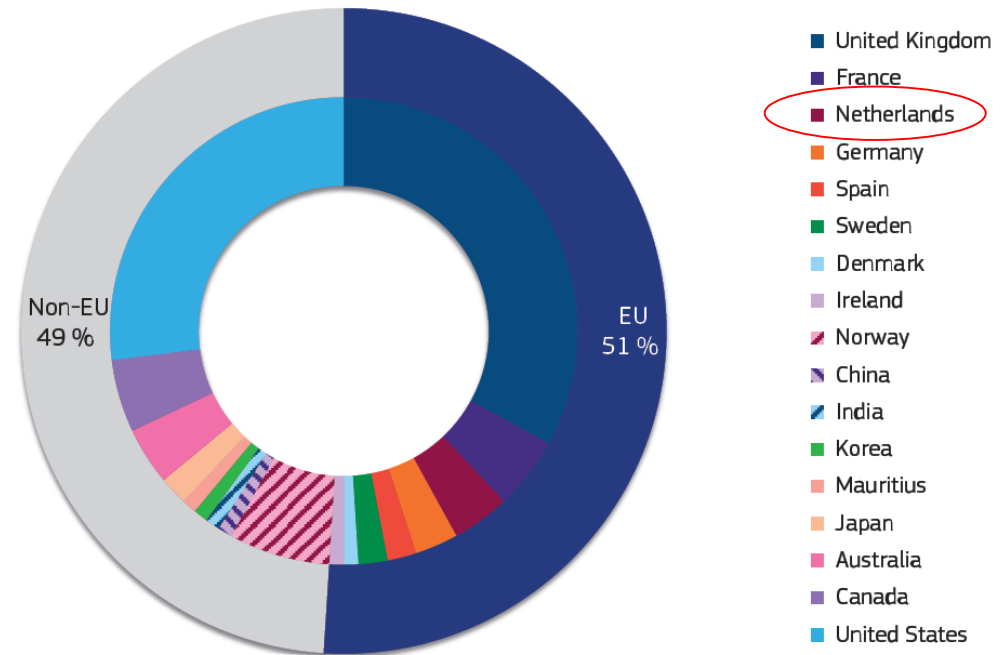
Global potential of tidal currents



150 TWh/year or **90 GW** of generating capacity
20 billion EUR electricity sales

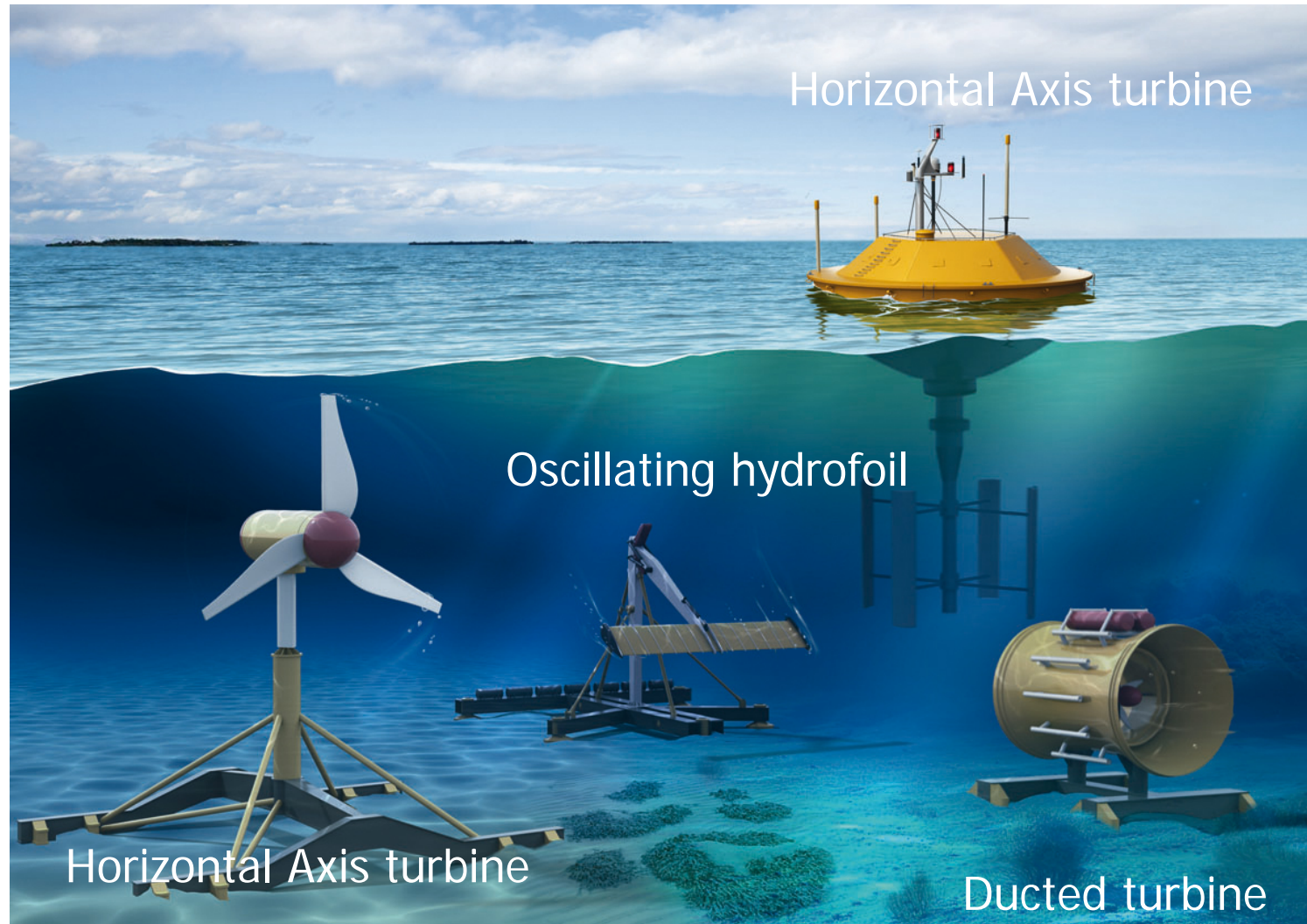
Current status

- ~7MW installed capacity globally
- 20- 130 MW tidal energy potential in the NL
- Need for pre-commercial projects and first farm arrays



Tidal companies in the world
2014 JRC Ocean Energy Status Report

Current technologies

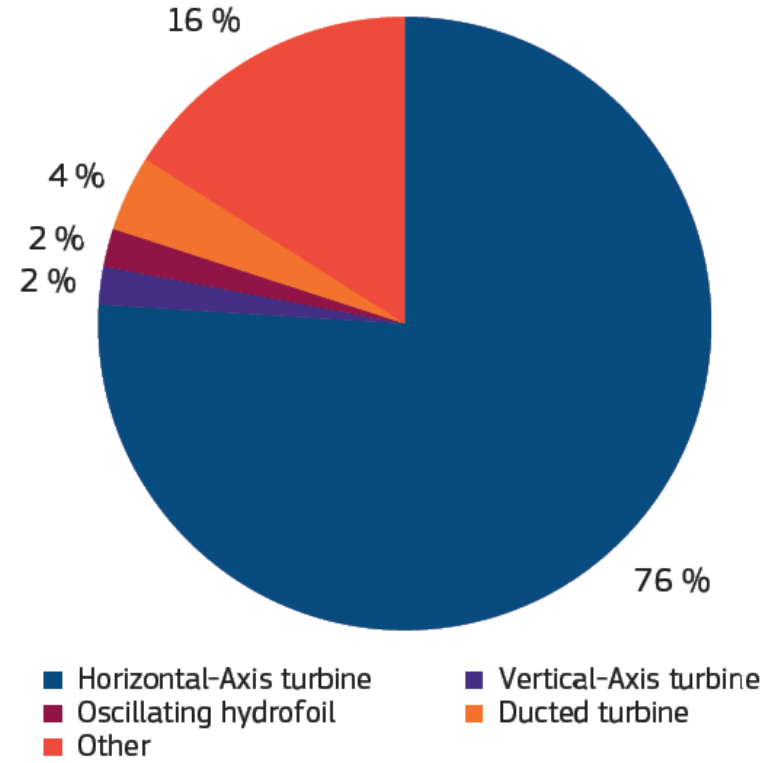


Full-scale demonstration projects



Full-scale demonstration projects

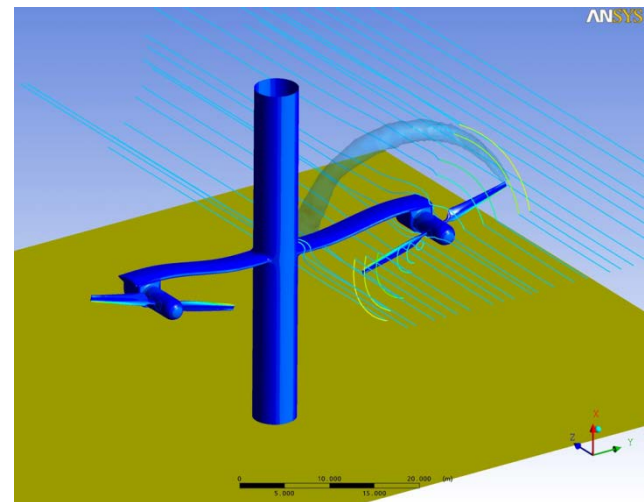
TIDAL SITE			
Developer	Device	Rated capacity	Location
TGL (a wholly owned Alstom Company)	DeepGen	1 MW	EMEC
ANDRITZ HYDRO Hammerfest	HS1000	1 MW	EMEC
OpenHydro	Open Centre Turbine	0.25 MW	EMEC
Scotrenewables Tidal Power Ltd	SR250	0.25 MW	EMEC
Voith	Hy-Tide	1 MW	EMEC
Nautricity	Cormat	Non grid connected	EMEC
Magallanes	ATIR	Non grid connected	EMEC



Operational projects in the UK
 Ocean Energy Systems- Annual Report 2014

Main research challenges

- **Wave and current resource**
 - Impact of turbulence?
 - Wave-current interaction?
- **Devices and technology**
 - Water-to-wire numerical models
 - Performance validation
 - Moorings and foundations
- **Deployment and operations**
 - How to increase the reliability?
 - New offshore materials
 - Farm array aspects
- **Environmental impact**



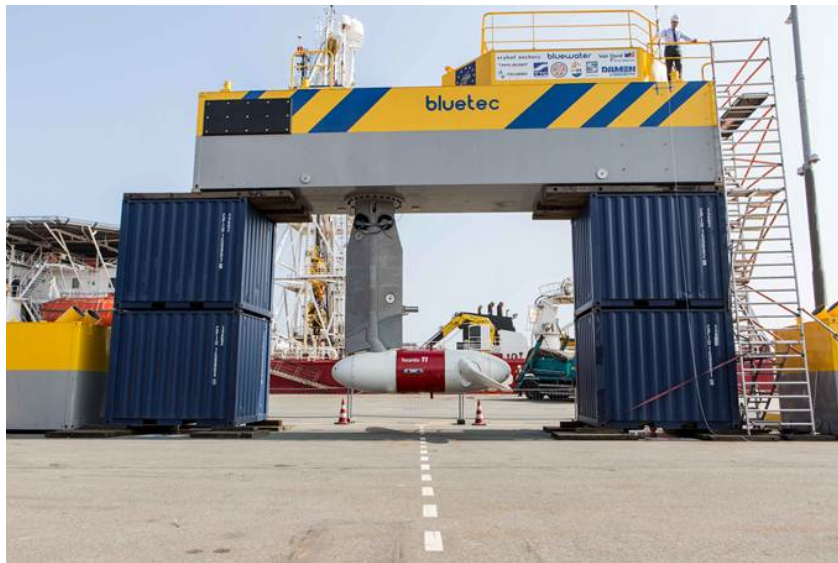
Some future prospects

- The World's first Tidal Array Scheme
7 MW tidal array project in the Pentland Firth in Scotland.
- The Swansea Bay Lagoon
320 MW tidal lagoon project in Swansea Bay, UK
- Dutch Tidal Test Center in den Oever
High tidal flow site for intermediate scale testing



(Dutch) key players

Tidal / current



Netherlands	Tocado	Developer	Producer of tidal energy turbines
	Bluewater Energy Services	Engineering	Generic floating structure for tidal current turbines
	Schottel Hydro	Developer	Producer of tidal current turbines
	Dutch Expansion Capital	Investor	Project management and investments for tidal turbine system
	Nijhuis pompen	Developer	Producer of low head hydropower turbines
	Blue motion energy	Developer	Producer of free flow technologies

Role of the TUDelft

- High expertise from researchers with a connection to Ocean Energy
- Opportunity for new research projects and new ideas
- Education

