Talking Blue Sustainability

25 October 2022 – 9:00 to 10:30 CEST

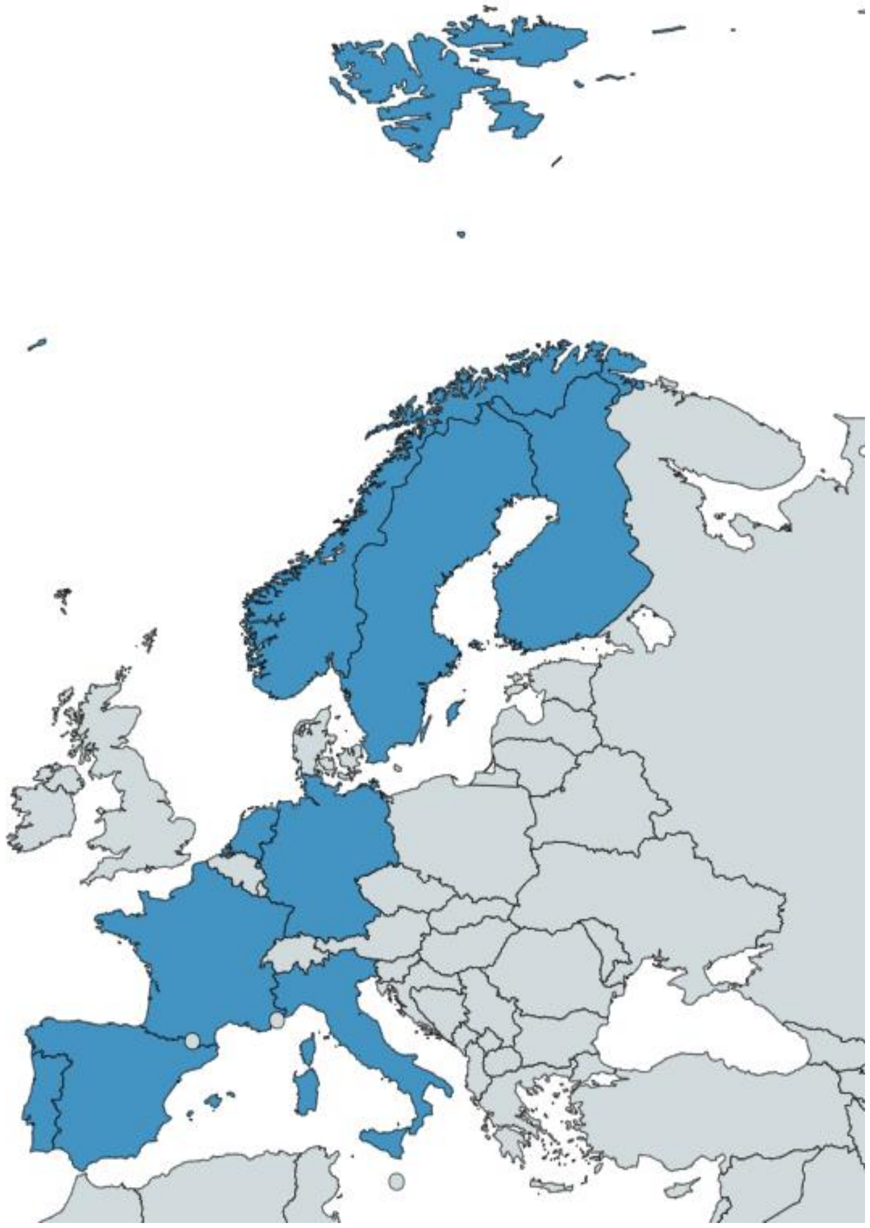
Transitioning to a sustainable blue economy: the role of material validation for marine applications

AGENDA

09:00	**Welcome and introduction by** Pierre Ingmarsson, Senior Project Manager, RISE Olivier Rod, Vice President Material & Production, RISE
09:20	**Setting the scene by MEP Pierre Karleskind** Patron of the webinar, Member of the European Parliament
09:30	**Expert presentation "Validating materials to ensure their sustainable use in our oceans"** Pablo Benguria, Materials for Extreme Conditions, Tecnalia Dr Dorothea Stübing, Antimicrobial coatings and biofouling control, Fraunhofer IFAM
10:10	**Discussion**
10:30	**End of event**

TALKING BLUE SUSTAINABILITY

Pierre Ingmarsson
Senior Project Manager
RISE Research Institutes of Sweden



Innovation Platform Sustainable Sea and Ocean Solutions ISSS

Intelligent Technologies for the Blue Economy

Ten European RTOs working together:

- SINTEF Ocean (Norway)
- VTT (Finland)
- RISE (Sweden)
- Fraunhofer (Germany)
- TNO (Netherlands)
- Ifremer (France)
- AZTI (Spain)
- TECNALIA (Spain)
- ENEA (Italy)
- CoLAB +ATLANTIC (Portugal)

Our Vision

A climate-neutral continent through a completely green-blue transformed economy and society in 2050

Our Mission

The responsible utilization of our oceans, to harness their potential to create additional value and future-proof jobs in the European marine and maritime sectors

Our work

We develop and master innovative technologies for a sustainable blue economy
We create shared infrastructures and data platforms
We closely integrate industry partners for rapid transfer into application

ISSS application areas – focus topics for our work

Living Marine Resources

Sustainable use of marine living resources, blue biotechnology

Ocean Cleaning

Prevention, monitoring, and removal of litter, pollution, and unexploded ordnance

Offshore Energy

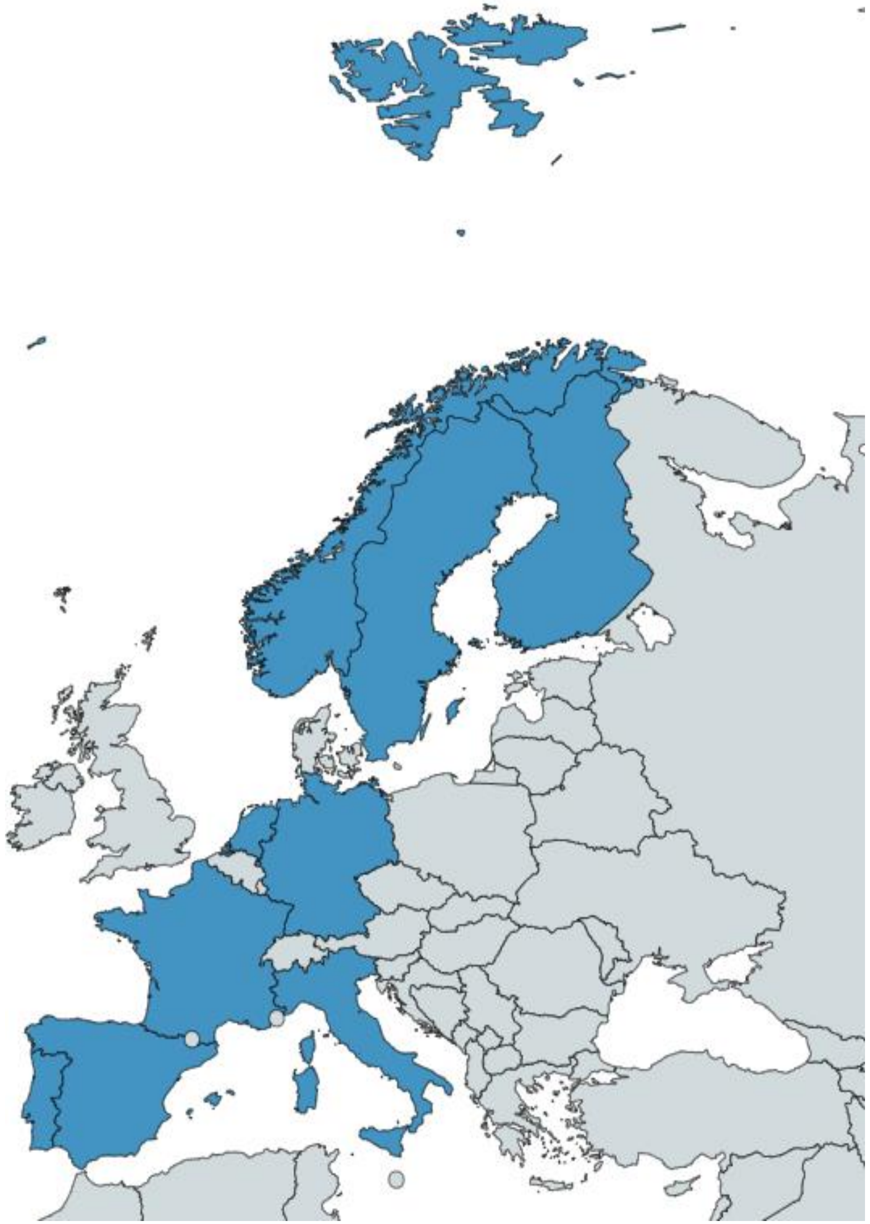
Increased and improved use of renewable energy (offshore wind, ocean energy)

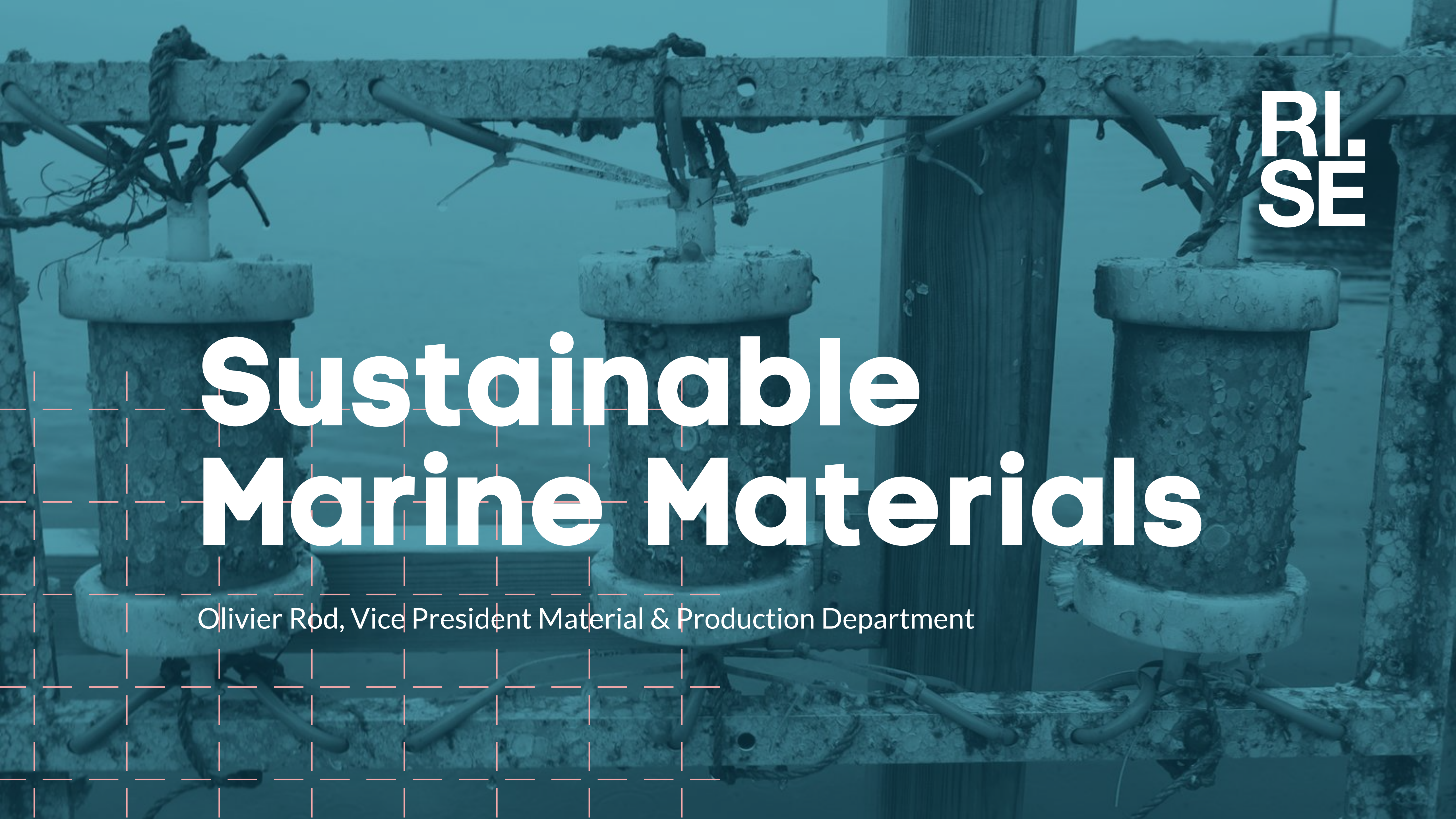
Waterborne Transport

Emission-free, efficient and sustainable waterborne transport

TALKING BLUE SUSTAINABILITY

Olivier Rod
Vice President Material & Production
RISE Research Institutes of Sweden





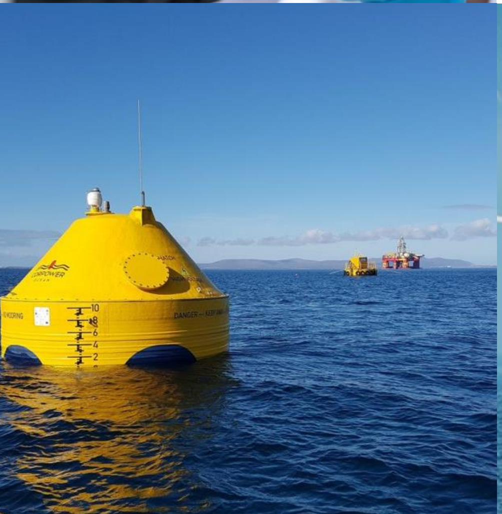
Sustainable Marine Materials

Olivier Rod, Vice President Material & Production Department

A tremendous increase of materials used in our oceans

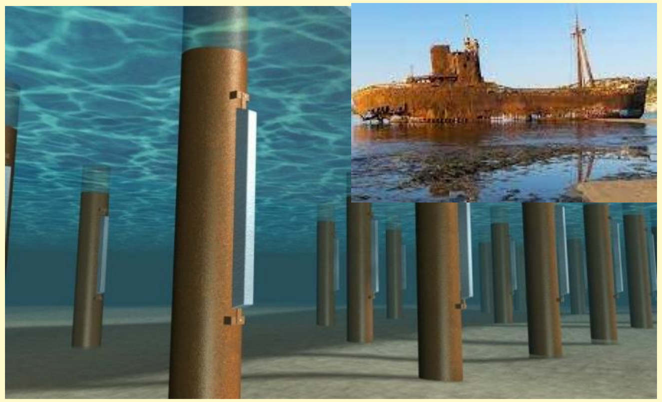



- Offshore Renewable Energy
- Seafood & Marine Production
- Offshore Engineering




From a material to an environmental perspective

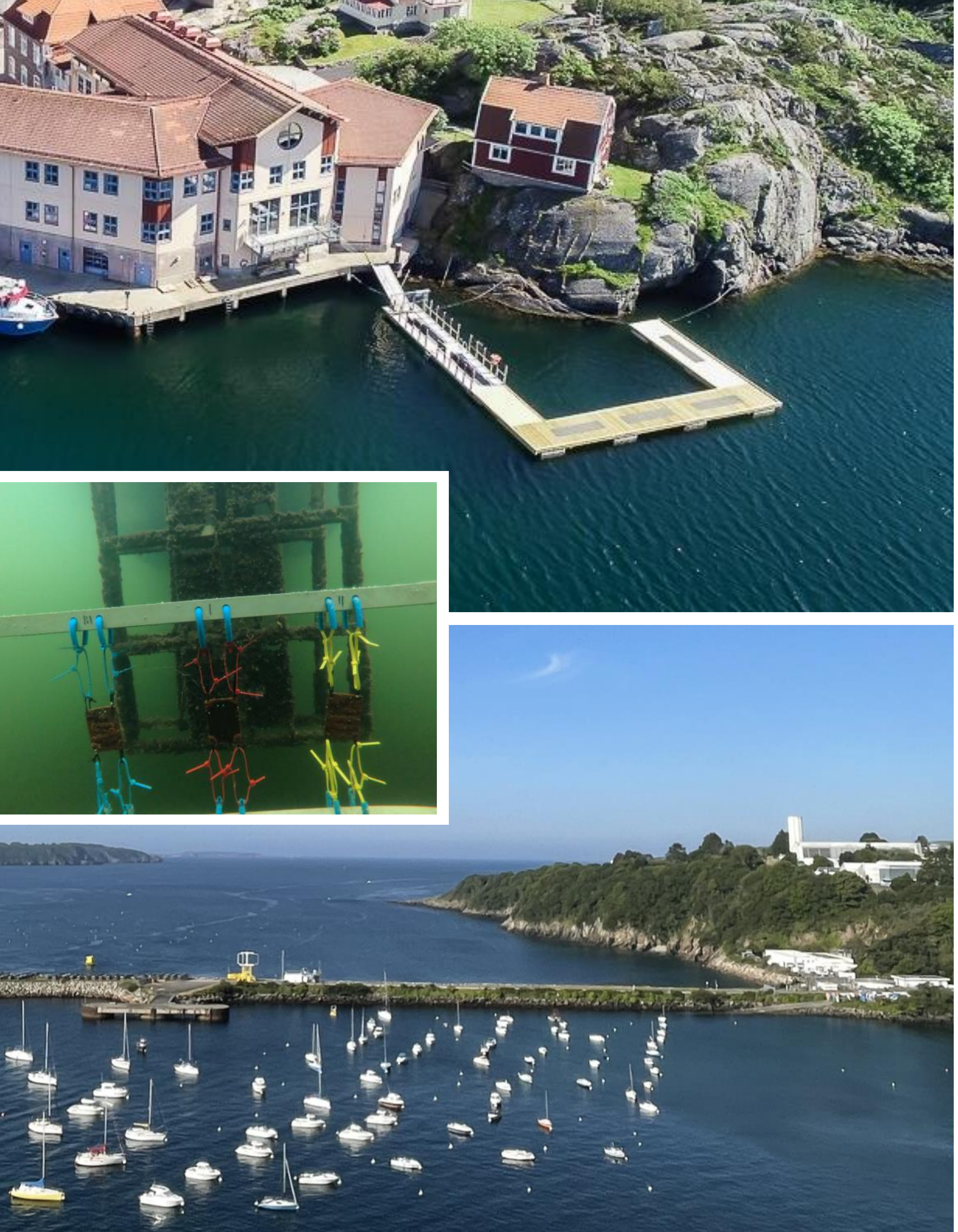
Materials ← Marine Environment



Materials ↔ Marine Environment

Design by circularity

RI. SE



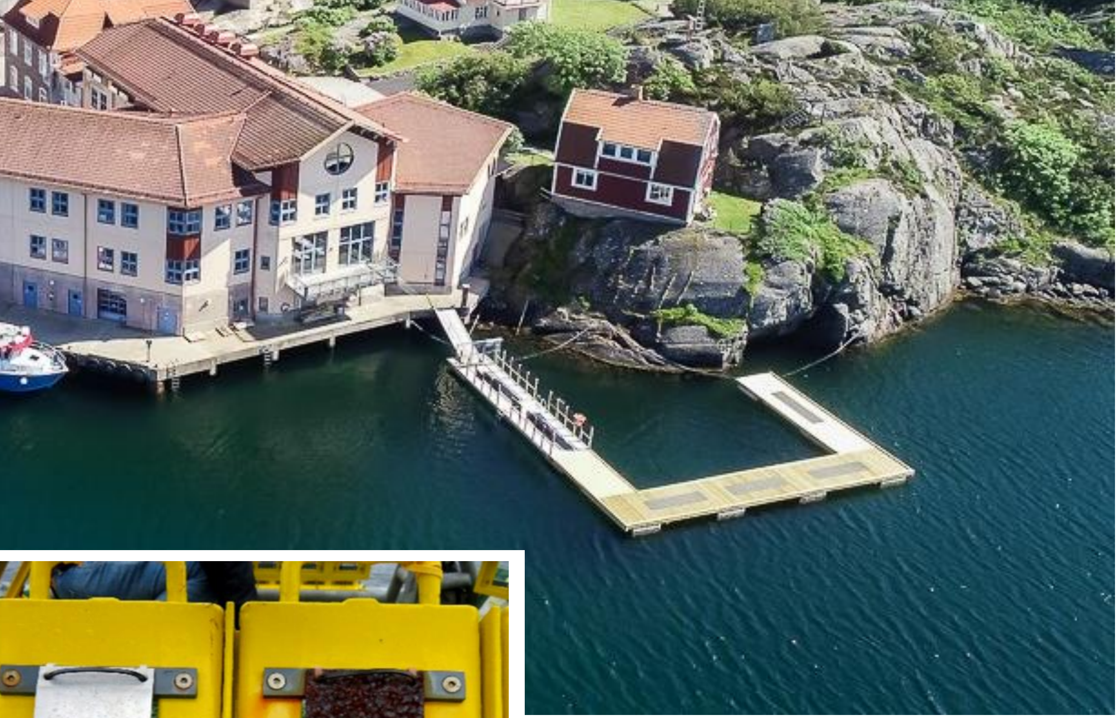
Ocean exposure and accelerated lab testing is key for material assessment

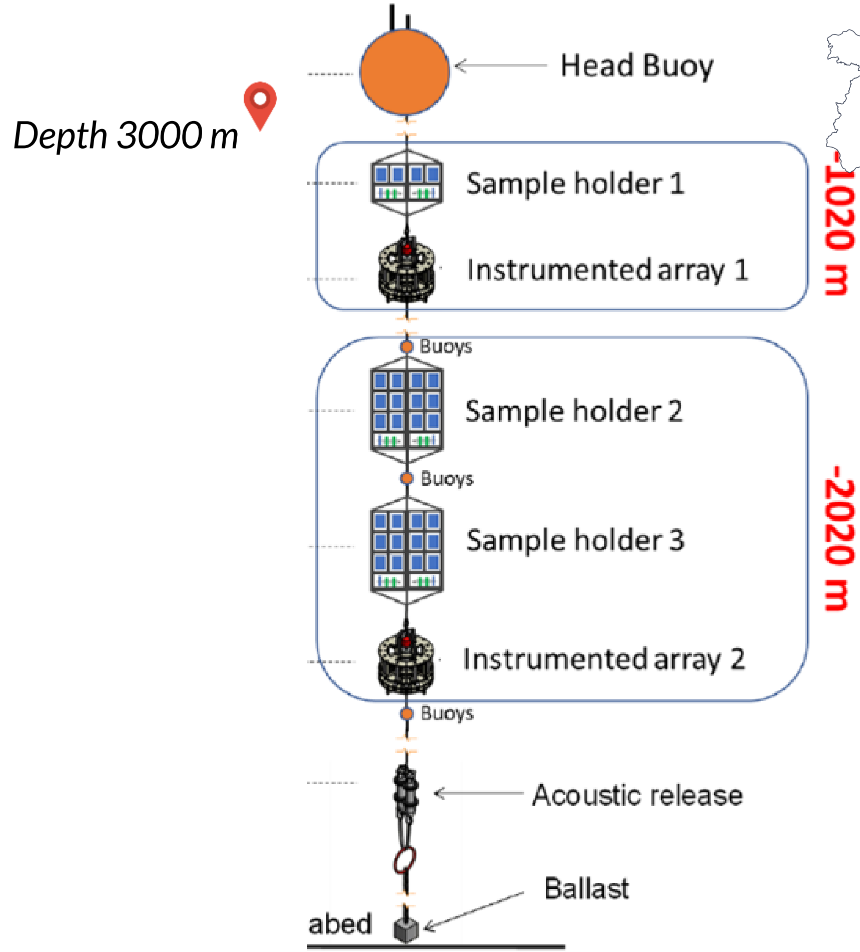
Depth 3000 m

- Kristineberg Center for marine research and material testing on the West Coast of Sweden
- Marine station for material testing in Brest, France
- Deep sea testing, Atlantic Ocean

RI. SE

Ocean exposure and accelerated lab testing is key for material assessment





European & International networks of testing sites

- Integrated network of marine material testing facilities
- Integrated European Ocean Governance on materials
- New policies leading to new standards and sustainable materials

European & International networks of testing sites

- Integrated network of marine material testing facilities
- Integrated European Ocean Governance on materials
- New policies leading to new standards and sustainable materials

Collected Field Corrosion Data

Olivier Rod

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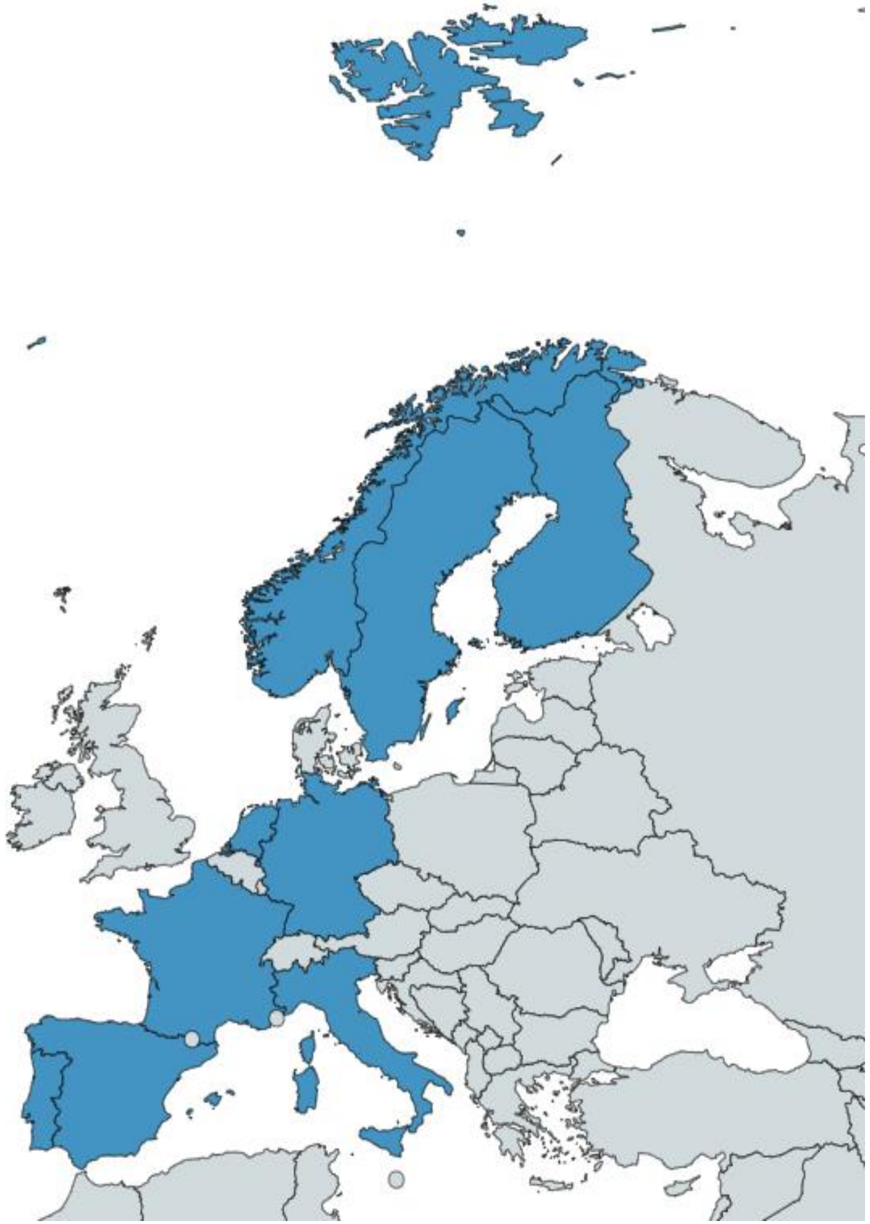
Pierre Karleskind
Member of the European Parliament
Patron of this webinar



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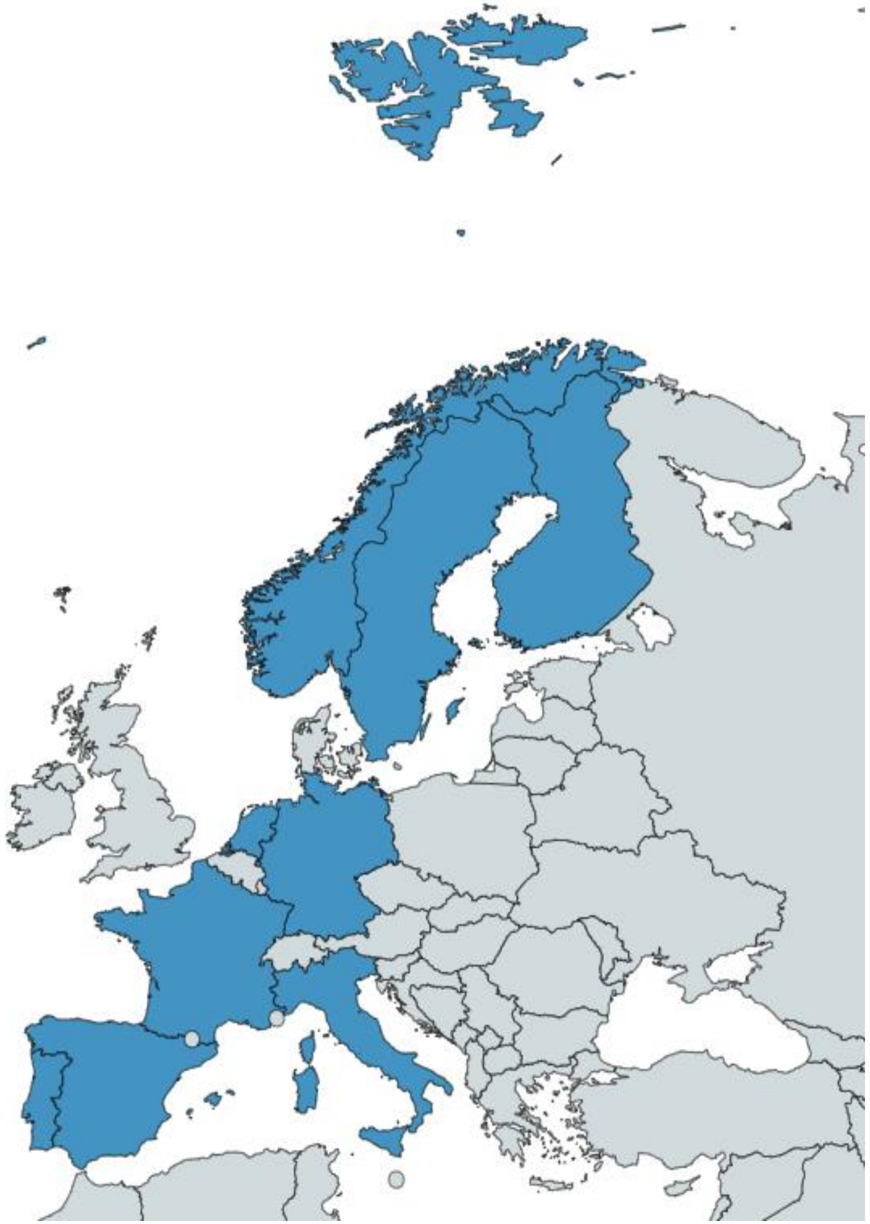
TALKING BLUE SUSTAINABILITY

Pablo Benguria
Manager Harshlab Offshore Materials and Component labs
Tecnalia



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The need for a network of test facilities to validate materials for offshore applications

Pablo Benguria

October 25^{th} 2022

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02 Main challenges in the ocean. Storms? Not only

03 The need of a network of test sites: the MARINUS initiative

04 Examples of offshore testing sites around the world

05 Conclusions

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The Blue Economy

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The Blue Economy

- Blue Economy is comprised by both established and emerging sectors:
  - ✓ Marine living resources
  - ✓ Marine non-living resources
  - ✓ Marine Renewable Energy
  - ✓ Port activities
  - ✓ Shipbuilding and repair
  - ✓ Maritime transport
  - ✓ Coastal tourism

- In 2018, costal tourism had the highest contribution to the Blue Economy's GVA (45%), followed by maritime transport (17%) and port activities (21%).

- MRE encompasses both offshore wind energy and ocean energy, including e.g., offshore wind, floating wind, tidal energy, wave energy and floating PV.

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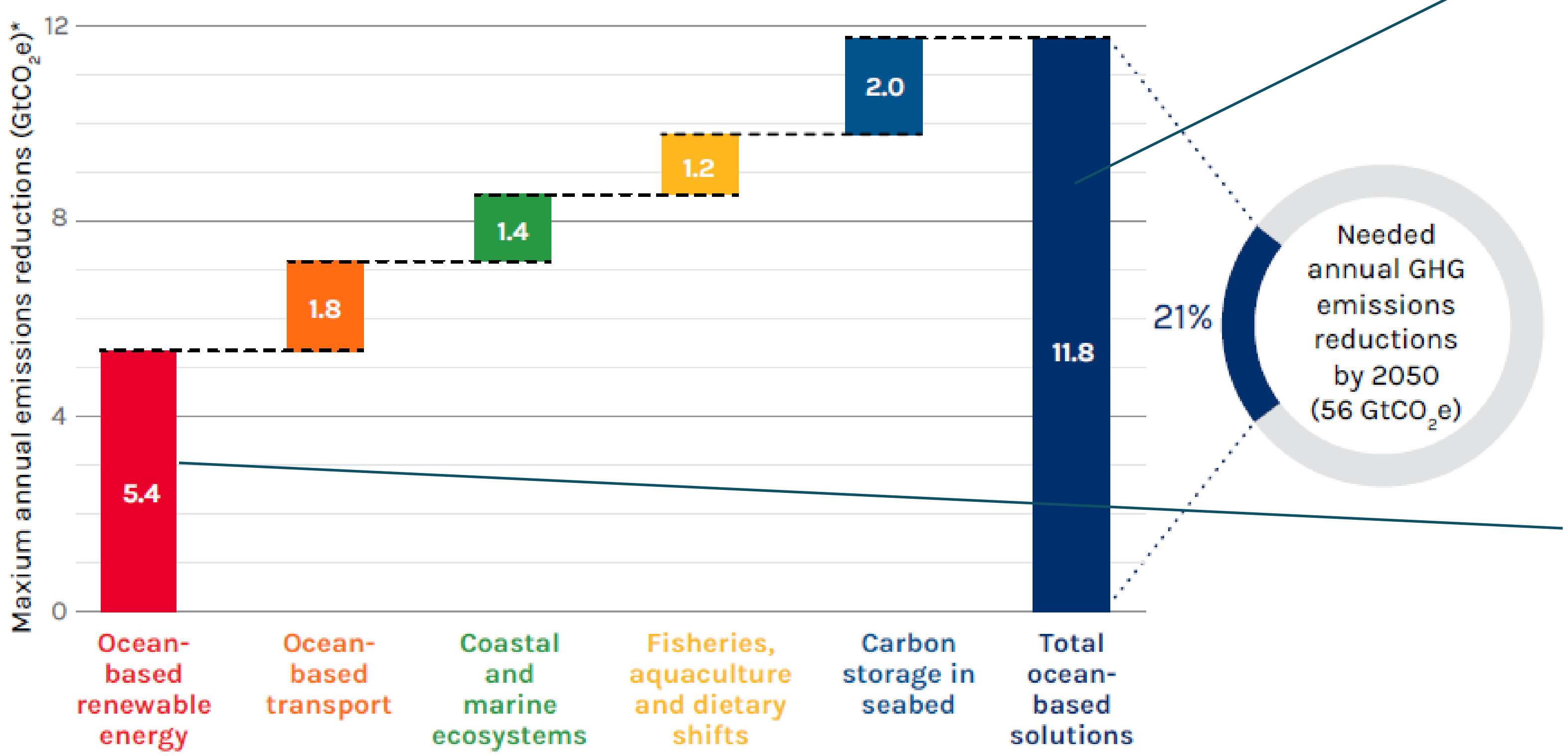
The Ocean as a Solution to climate Change

Commissioned by

HIGH LEVEL PANEL for A SUSTAINABLE OCEAN ECONOMY

WORLD RESOURCES INSTITUTE

Figure ES-4. Contribution of Five Ocean-based Climate Action Areas to Mitigating Climate Change in 2050 (Maximum $GtCO_2e$)



21% needed emissions reduction actions should come from oceans

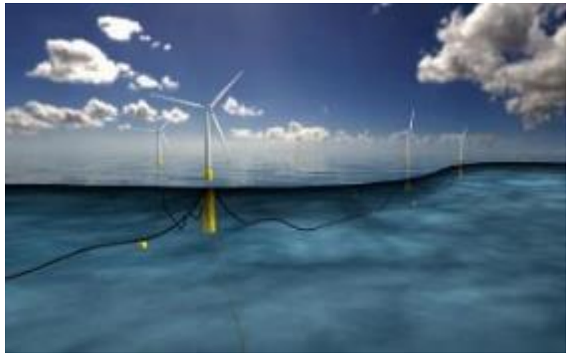
About half of these actions are related to offshore renewable energy

Offshore Renewable Energy
Several resources

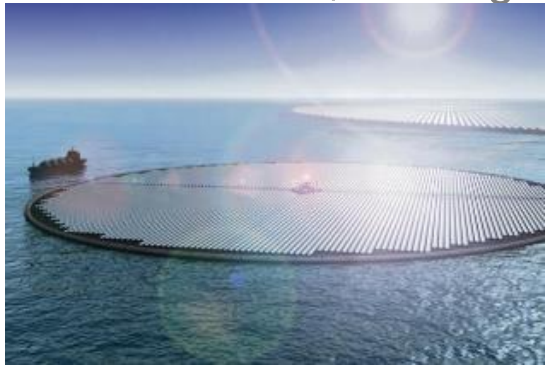
Ocean Energy: Wave, Tidal Currents, Tide rise & fall, Ocean thermal gradient and Salinity gradient

Other renewables in the marine environment: Offshore wind, marine biomass, floating PV

Fixed Offshore Wind



Floating Offshore Wind



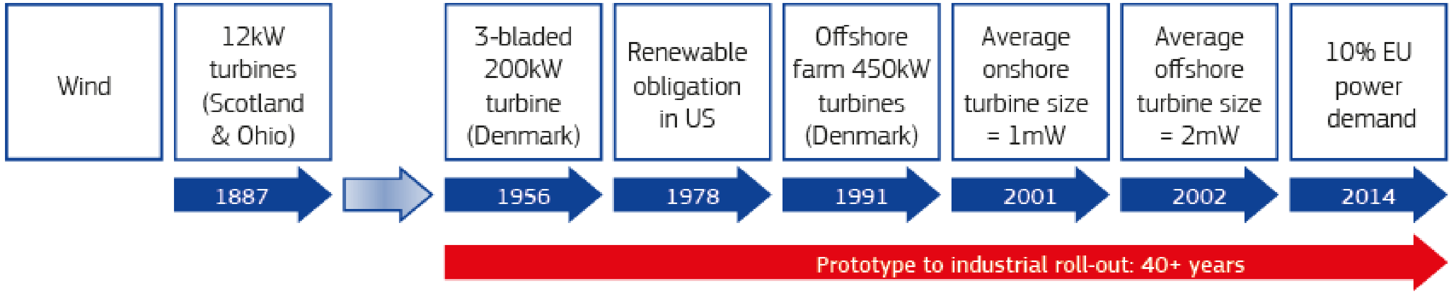
Floating PV

Wave Energy

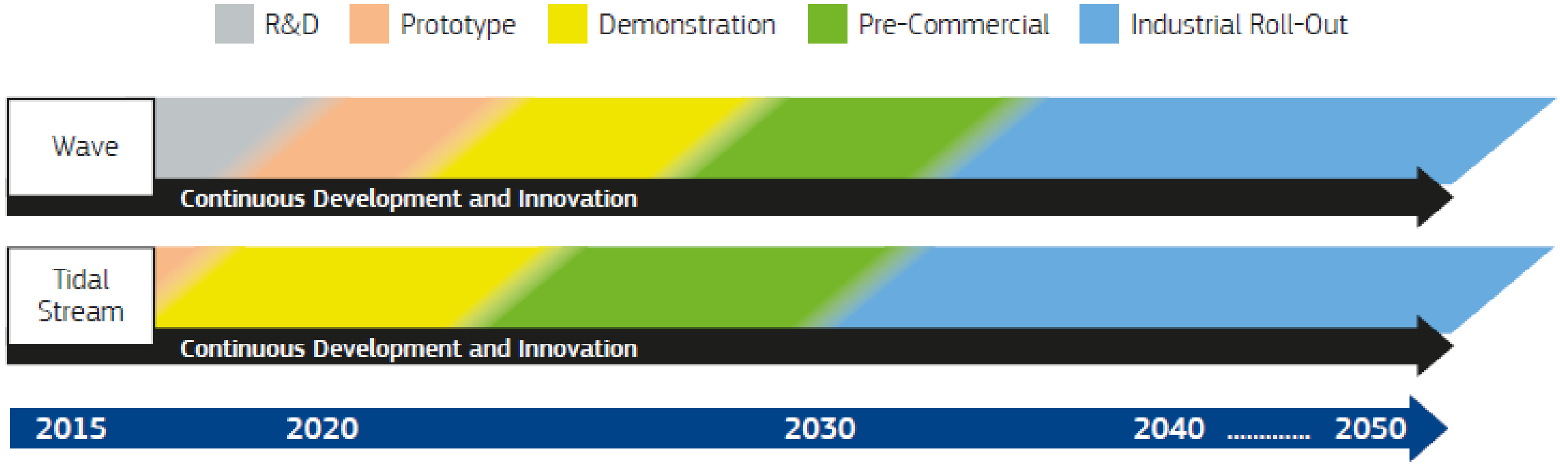
Tidal currents

Ocean Energy Outlook

Figure 2. Development of wind turbines, from early experiments to industrial roll-out

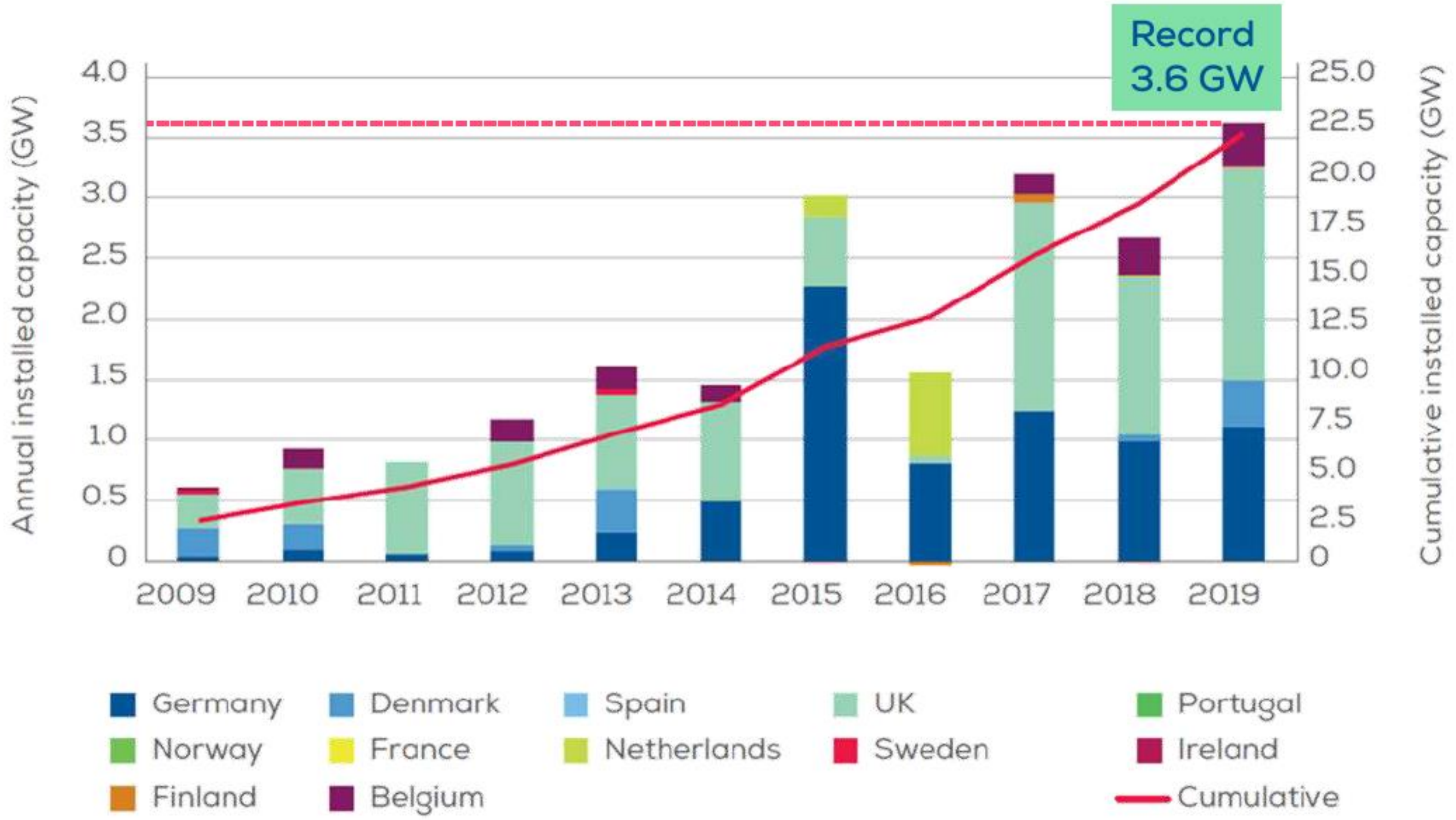


Source: Ocean Energy Europe, adapted from European Wind Energy Association, Danish Wind Industry Association, US Office of Energy Efficiency and Renewables.



Offshore Wind

A growing sector



3,623 MW Gross installed capacity

502 Grid-connected turbines

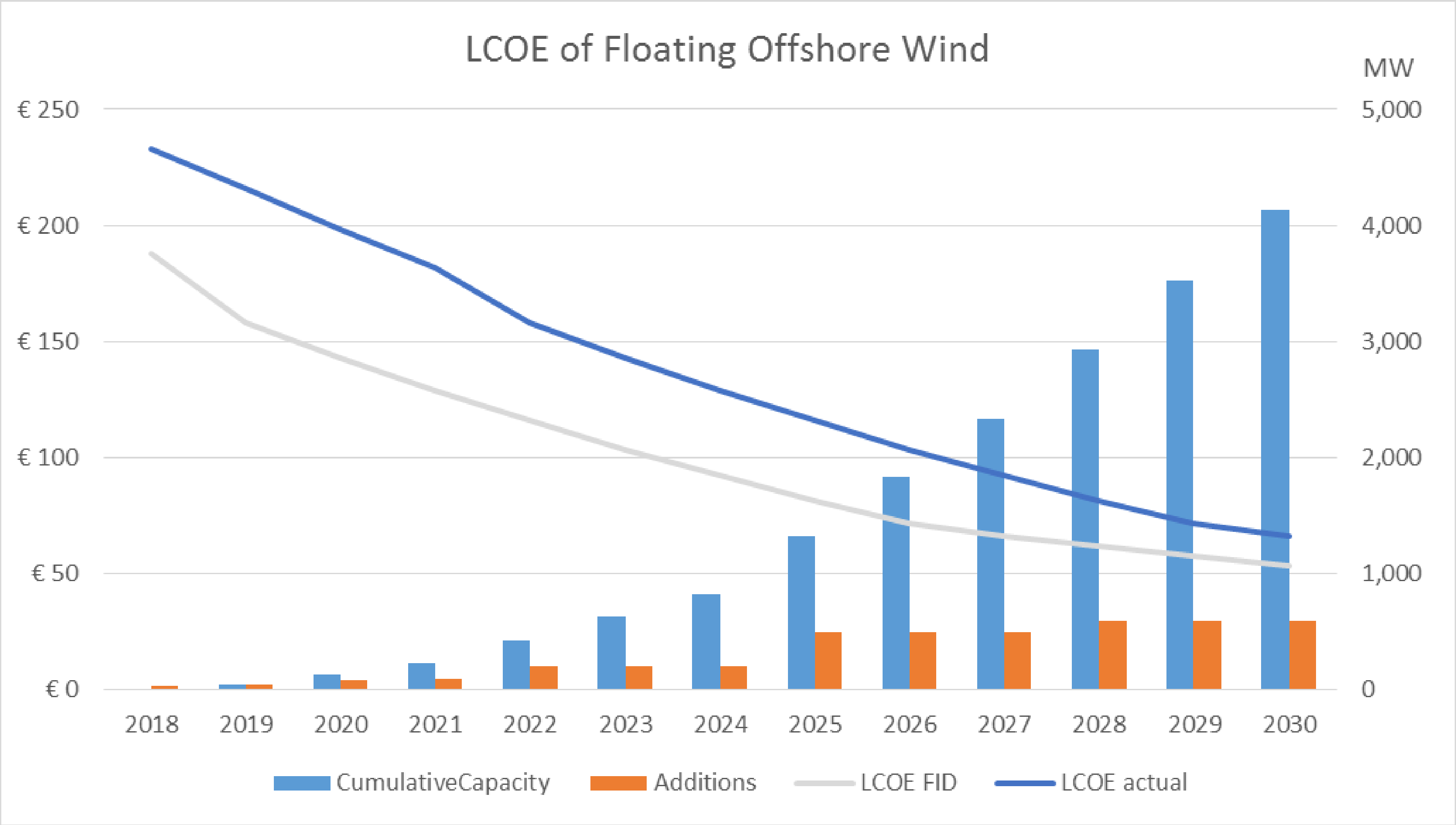
10 Wind farms grid-connected

5 Wind farms under construction

1 Wind farm fully decommissioned

Key trends and statistics **2019**

Floating offshore wind
Expected to continue growing & cost reduction



FLOATING OFFSHORE WIND ENERGY

A POLICY BLUEPRINT FOR EUROPE

WindFloat Atlantic" (WFA) 25 MW (8MW x 3) in the North of Portugal

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Main challenges in the ocean. Storms? Not only…

Relevance of testing in real offshore environment

- **Corrosion** is usually the main challenge related to ageing in offshore infrastructures
- The annual global cost of corrosion is estimated over **3% of the world's GDP**
- **25 to 30%** of annual corrosion costs **could be saved** with optimum corrosion management practices
- According to NACE, corrosion is the deterioration of a material (usually a metal) because of a **reaction with the environment**
- 3 basic elements are needed for corrosion: **a metal**, **oxygen** and a **electrolyte**.
- **Not a single form of corrosion**: general corrosion, pitting corrosion, crevice corrosion, galvanic corrosion, stress-corrosion cracking, corrosion fatigue and MIC.
- Current methods to prevent corrosion: **cathodic protection** and **protective paints/coatings**.
- Corrosion is a slow reaction, but can led to a **sudden failure with catastrophic consequences**

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Biofouling relevance

- According to Wikipedia:

Biofouling or biological fouling *is the accumulation of microorganisms, plants, algae, or small animals where it is not wanted on surfaces such as ship and submarine hulls, devices such as water inlets, pipework, grates, ponds, and rivers that cause degradation to the primary purpose of that item.*

- **Consequences of biofouling in the ocean**
  - ✓ In vessels, more drag with water and thus, increase in the oil consumption
  - ✓ In floating structures, additional weight and grad lead to a reduction in performance
  - ✓ In all cases, damage in the materials that boost the corrosion risk

- **Limitations of lab testing of biofouling:**
  - ✓ Only replicable in very precise cases
  - ✓ Real offshore conditions cannot be reproduced in the lab

Relevance of testing in real offshore environment

- **Ageing** is a **slow process** for industry standard where many parameters are involved: corrosion, fouling, decolouration, loss of mechanical properties, …

- Testing at the lab is relevant for a **quick screening through accelerated testing**, but real life is not always easy to simulate

- **Limitations of lab testing:**
  - ✓ Each test simulates a **limited number of parameters** (UV, salt spray, thermal shock,…)
  - ✓ Even long cycles (e.g. Norsok) have limitations to simulate real life conditions, such **fouling**
  - ✓ There are **no clear correlation** with real life

- **Limitations of real offshore environment testing:**
  - ✓ **Time** consuming
  - ✓ In practice, limited to understand **initial mechanisms of failure**: testing for 25 years is not realistic
  - ✓ Lack of **real offshore** infrastructures

Ideally, lab testing should be combined with real offshore testing

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03

The need of a network of test sites: the MARINUS initiative

The need of a network of test sites

- Main barrier that SMEs face for fast implementation of innovative products is the **lack of access to validation infrastructure**.
- The increase in market potential for innovative sustainable materials lies in **validation in different environments** and easy penetration in the European market instead of only national one.
- There is **no current standard for offshore testing** of marine materials.
- The ambition is to have a **common testing methodology** that can be applied in different test sites to ensure the safe deployment of innovative materials in the marine environment.
- The Blue Economy and the sustainable use and exploitation of the sea **can not be governed or managed by a single member state or at the regional level.**

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MARINUS
Marine Materials Infrastructure Network for Sustainable Use of our Seas

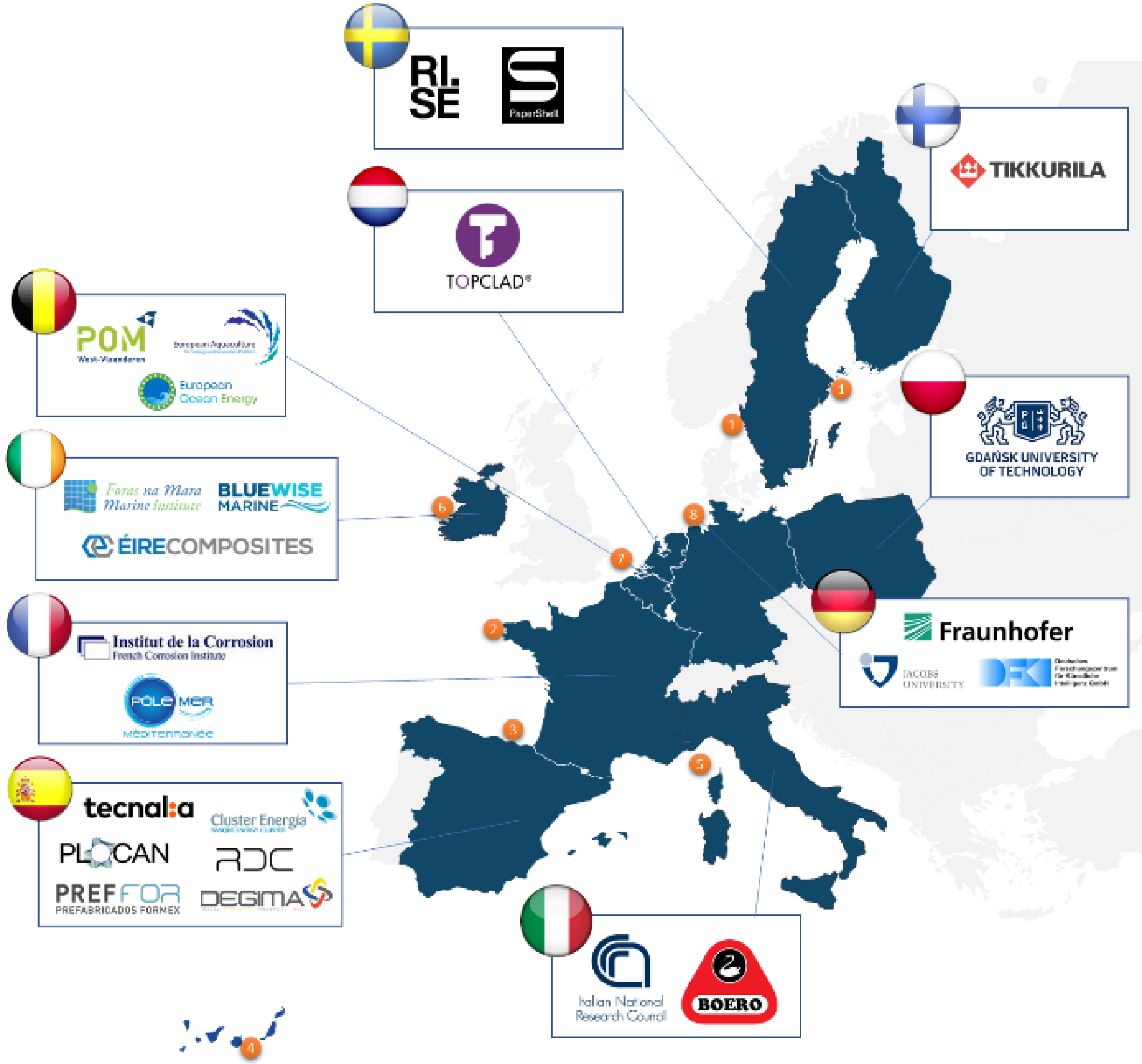
MARINUS initiative

MARINUS is the name of an unsuccessful proposal submitted in March 2022

The main objective of MARINUS was to fill the gaps and represent the European OITB for marine materials in the European seas, improving material reliability and costs; **environmental safety by design**; **homogeneity of testing** and **validation procedures**.

The project assimilates an infrastructure of **8 established marine test sites,** ranging from Baltic Sea to Mediterranean including Bay of Biscay and Canary Islands**:**

1. Tecnalia HarshLab,
2. PLOCAN harshlab,
3. RISE - Kristineberg Center and Baltic Sea,
4. Fraunhofer IFAM Heligoland,
5. SMARTBAY,
6. Institute de la Corrosion,
7. Blue Accelerator,
8. W1M3A observatory and experimental marine station CNR



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Marinus initiative

One of the main objectives of the project was to set up technical cross sectorial services/groups of the ecosystem to support all testing sites and innovative marine materials, including:

1. Prediction/process optimization (data-driven approaches)
2. Fast simulation and optimization (screening process) to the final material/product validated in the marine environment.

- MARINUS aims to define and standardize **common environmental risk assessment protocols** to ascertain the environmental safety of innovative materials.
- The OITB will also support the development of **coherent testing and certification standards creation** for new materials testing in marine environment.
- By establishing a comprehensive database and know-how, MARINUS will help bridge the gaps in the existing and upcoming standards and provide a dedicated testbed for **reliable assessment of new sustainable marine materials**

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Main outcomes of the MARINUS initiative

- ✓ Outcome 2 – **Reduce the technological risk** of innovative materials and products, thus attracting more investors, and cut the time to market
- ✓ Outcome 3 – Support companies, especially SMEs, to become **world leaders in clean products and technologies** by setting up a new generation of Open Innovation test Beds focused on the creation of Business Opportunities and Sustainability
- ✓ Outcome 5 – **Translation of industrial needs into scientific problems** and tailor made solutions, increased awareness and uptake by industry, and effective access of relevant stakeholders to know-how and advanced tools/infrastructure

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04

Examples of offshore testing sites around the world

Some examples of offshore testing included in Marinus initiative

RISE’s Marine Material Test Sites (Sweden)

- Marine Material Test Sites is composed by two different locations:
  - Kristineberg Marine Research and Innovation Centre (West) is in the “Baltic Transition Zone”
  - Stockholm site is in the “Baltic Zone”.
- The test bed consists of laboratory resources for material production and paint formulation, lab resources for chemical, physical and mechanical characterization of material and surface treatment, High Accelerated Life Test (HALT) in corrosion chamber using natural seawater, field testing for both marine corrosion and marine fouling.
- Validation of marine materials and coatings for resistance to marine biofouling represents a challenge for lab scale testing, making field testing a more realistic option.
- Corrosion tests in the field can be performed in various exposure zones, near sea, air, splash zone, and submerged in the sea.

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Some examples of offshore testing included in Marinus initiative

Institute de la Corosion (France)

- Exposures can be performed in open sea and in large basins continuously supplied with natural sea water.
- The seawater comes from the bay of Brest (France),
- The SOMLIT station (Coastal Observation Service operated by the CNRS) continuously measures the main physic-chemical parameters of the seawater that supplies the basins.
- In the test basins, the temperature of the seawater can be controlled from 5°C-90°C. Seawater can also be treated (deaeration, chlorination).
- More than 300 samples can be continuously monitored at the same time.
- Bespoke flow loops can be adapted to test materials in flowing conditions up to 6m/s to simulate high flow rates.
- Samples can also be tested in tidal conditions and in seabed. Various testing can be performed at the open circuit potential or under polarization, in natural or synthetic seawater.

Some examples of offshore testing included in Marinus initiative

TECNALIA's HarshLab (Bay of Biscay, Spain)

- HarshLab is a unique offshore floating laboratory moored in 2018 in the Biscay Marine Platform (BiMEP), 1.6 miles away from the Basque coast in the Bay of Biscay (Spain).
- It is moored in a 65 m depth unsheltered, open sea area, receiving the heaviest swells from the Atlantic.
- It was upgraded in 2022 to a larger version allowing the validation of larger probes, equipment and sensor solutions.
- HarshLab will be connected to Bimep's submarine grid in 2023
- The new HarshLab can host more than 2000 samples in atmospheric, splash and immersion zones.
- Anticorrosion, antifouling, ageing testing of materials and equipment in real offshore environment is possible.
- Tecnalia's onshore facilities include a fully equipped corrosion and characterization labs,

https://harshlab.eu/

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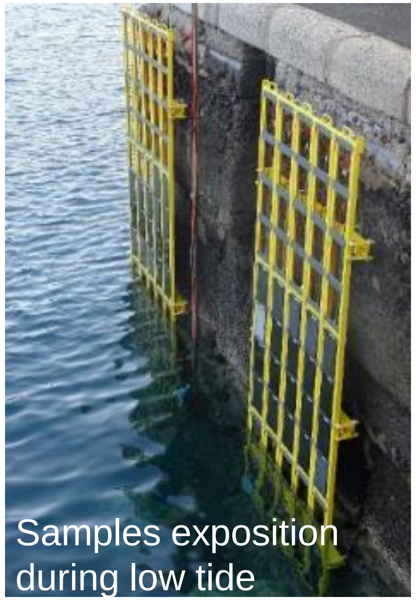
Some examples of offshore testing included in Marinus initiative

PLOCAN’s HarshLab0.5 (Canary Islands, Spain)

- The lab consists of two panels attached to the dock wall of the port of Taliarte (Gran Canaria, Spain), capable of housing 140 standardised probes, that may be multiplied threefold.
- Each panel has three different parts: atmospheric, splash, and submersed.
- All the probes can be easily extracted from the dock without need of auxiliary resources and in any type of weather conditions, aiming for exhaustive monitoring of the experiments.
- Apart from the two panels installed in the Port of Taliarte, Harshlab 0.5 has a mobile module, capable of hosting 44 probes, which can be installed in different atmospheric conditions depending on the purpose of the test.


Samples exposition during high tide


Samples exposition during low tide

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Some examples of offshore testing included in Marinus initiative

CNR’s Experimental Marine Station and Multi-Sensor Array (Mediterranean Sea, France)

Experimental Marine Station (EMS)

- Is an infrastructure of CNR IAS Genova located in Genoa Harbour
- An outdoor surface is available for both atmospheric exposures and immersion trials.
- A laboratory with a flow through system is available for the set-up of experimental mesocosms with natural seawater circuit.
- A floating wharf anchored in the harbour area in front of the marine station is available for static immersion trials in an “high pressure fouling area” enabling several tests for material degradation and antifouling technologies performance.

Western 1 - Mediterranean Moored Multi-Sensor Array (W1M3A):

- The W1M3A is moored at the centre of the North-western Mediterranean Sea, on a deep-sea bed of 1200 m at about 80 km from the coast, in the Pelagos Sanctuary.
- W1M3A consists of a moored spar buoy, collecting atmospheric and upper ocean measurements and a sub-surface mooring, hosting instruments for collecting physical ocean measurements.
- The observatory can host racks for material exposure on the upper trellis, near the meteorological sensors, as well as on the submerged part -from the sea surface down to 40 m depth.

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Some examples of offshore testing included in Marinus initiative

BlueWise Marine's SMARTBAY (Ireland)

- Located off the north shore of Galway Bay on the West Coast of Ireland.
- The test site is 37 hectares, with water depths of 21-24 m and forms an intrinsic part of the Irish Government's Marine technology and ocean energy programme.
- The test site allows the deployment and testing of prototype marine renewable energy devices, innovative marine technologies and novel sensors in a harsh marine environment.
- The test site provides researchers and ocean energy device developers with an area to safely test and demonstrate quarter-scale prototype marine energy converters and related technologies.
- Access to the SmartBay Cabled Observatory, a test and demonstration facility on the seafloor to catalyse and facilitate the commercial development of cutting-edge marine ICT products and services, is also provided.
- Several spare electro-optic ports facilitate connection of third-party equipment.

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Some examples of offshore testing included in Marinus initiative

POM’s Blue Accelerator (Belgium)

- Blue Accelerator is an advanced offshore platform off the Belgium coast.
- It is a maritime test and demonstration platform for a wide range of offshore energy and Blue Economy research & innovation projects – including materials tests in the atmospheric, splash, and submersed zones.
- The platform is open for industry, SMEs, developers, project consortia, and knowledge centres.
- It is focused on mid-to-later stage tests and demo’s (TRLs 4-9).
- The Blue Accelerator focuses on
  - a) floating solar PV and multi-use applications and multi-source energy solutions,
  - b) new materials development, corrosion & biofouling tests, sensor testing in the atmospheric, splash, submersed zones, and
  - c) drone solutions (air, surface, submerged) within the test exclusion zone around the platform.

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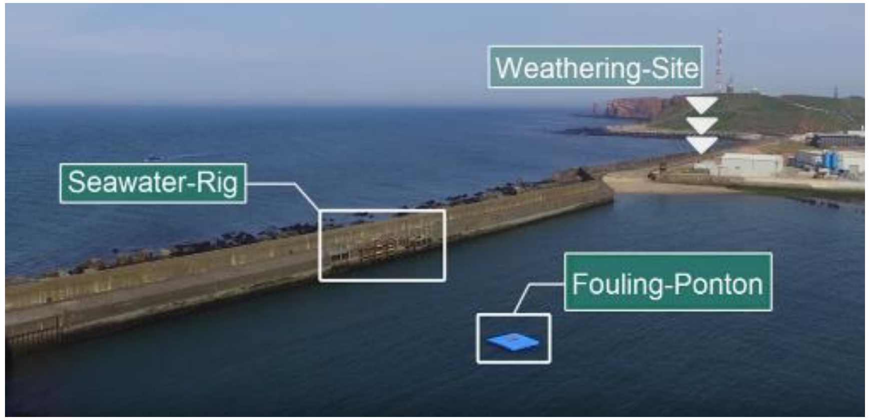
Some examples of offshore testing included in Marinus initiative

FRAUNHOFER's Heligoland (North Sea, Germany)

- Fraunhofer IFAM has many years of practical experience with the immersion of material samples in seawater or in the vicinity of the sea on Heligoland and at other maritime IFAM test sites such as the Alte Weser lighthouse and List on Sylt.
- Material development can be carried out at IFAM from the early phase through to final application validation.
- Modern laboratory testing methods are available at Bremen, which can be used synergistically with the field test stands.
- The institute has accredited corrosion and coating test laboratories.
- Tests such as climate change test, determination of scratch resistance, bend test (cylindrical mandrel), cross-cut test, determination of gloss value, measurement of coating thickness, pull-off test for adhesion are carried out.
- IFAM has numerous methods for characterizing materials and coatings, such as electrochemistry and (electron) microscopy.



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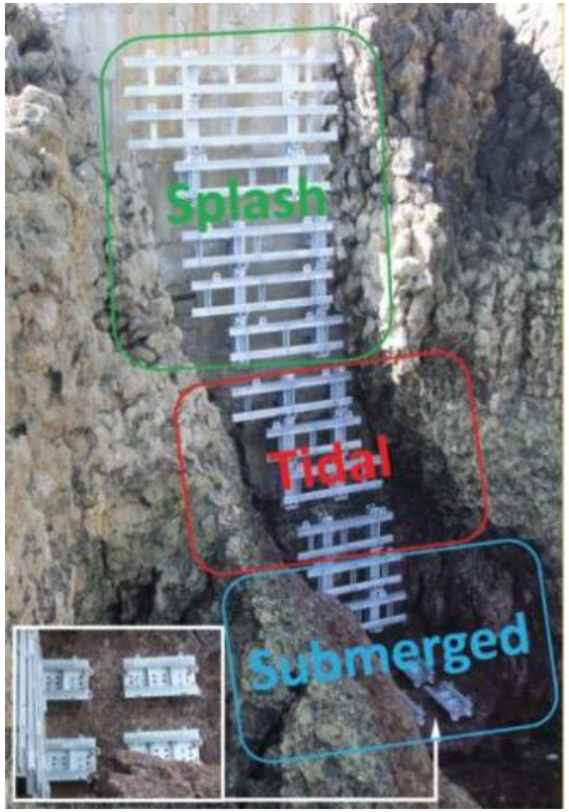
Some other examples of offshore testing around the world

CTC El Bocal (Cantabria, Spain)

- **Splash, tidal** and **immersion zones**
- **Bay of Biscay**



IPT - Instituto de Pesquisas Tecnológicas (Sao Paulo, Brazil)

- **Offshore floating laboratory** at the São Sebastião canal (South Atlantic Ocean).
- **Atmosphere**, **splash** and **immersion** zones.

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Some other examples of offshore testing around the world

NASA Corrosion Testing Laboratory (Kennedy Space Center, Florida, EEUU)

Seawater Immersion System

- **Two immersion tanks** with a continuous once-through, filtered supply of seawater.
- Temperature, salinity, dissolved oxygen, conductivity and pH are closely monitored.

Makai Ocean Engineering Marine Corrosion Lab (Hawaii, EEUU)

- Pipelines supply **deep & shallow seawater**:
  - *Ocean Intake Depths*: 25m to 915m (80ft to 3,000ft)
  - *Natural Seawater Temperatures*: 4°C to 27°C (39°F to 81°F)

Intake pipes reach depths of 25m to 915m (80ft to 3,000ft) with seawater temperatures ranging from 4°C to 27°C (39°F to 81°F).

.... and some others testing sites around the world....

...but not too many!

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05

Conclusions

- ✓ There are some testing sites around Europe, but **no formal relation** between most of them
- ✓ Each testing site produce its **own procedures and methodologies**, making difficult to compare results among them
- ✓ Common methodologies and standards are required to obtain comparable and valuable results
- ✓ Most of the actions included in Marinus project are **still needed** and should be somehow built
- ✓ **A collaboration strategy** is needed to boost the market uptake of materials for offshore applications

Ideas?

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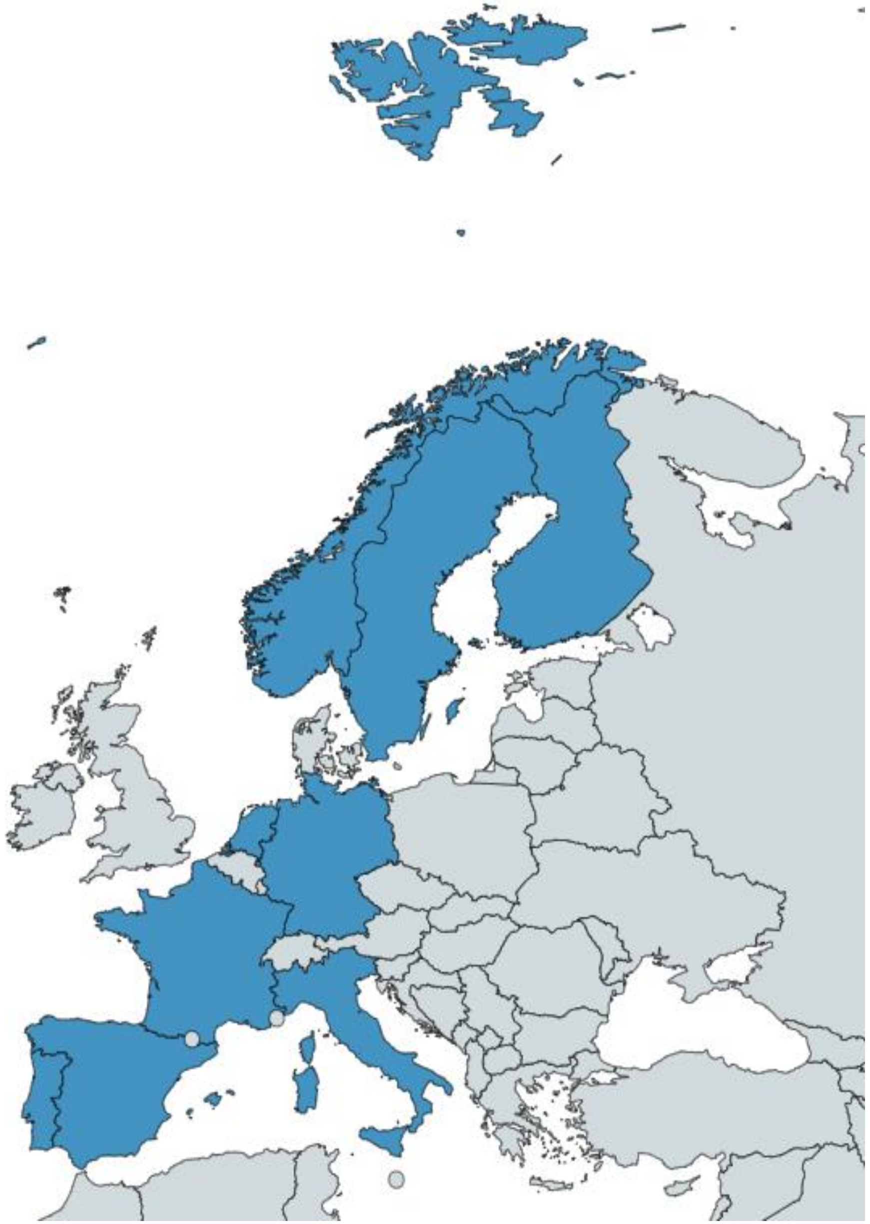
AGENDA

09:00	Welcome and introduction by Pierre Ingmarsson, Senior Project Manager, RISE Olivier Rod, Vice President Material & Production, RISE
09:20	Setting the scene by MEP Pierre Karleskind Patron of the webinar, Member of the European Parliament
09:30	Expert presentation “Validating materials to ensure their sustainable use in our oceans” Pablo Benguria, Materials for Extreme Conditions, Tecnalia Dr Dorothea Stübing, Antimicrobial coatings and biofouling control, Fraunhofer IFAM
10:10	Discussion
10:30	End of event

TALKING BLUE SUSTAINABILITY

Dr Dorothea Stübing,
Antimicrobial coatings and biofouling
Control
Fraunhofer IFAM



Inspired by nature – approaches for optmizing hydrodynamic efficiency of ship hulls

Dorothea Stübing, Paint Technology. dorothea.stuebing@ifam.fraunhofer.de

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Energy efficiency of ship hulls – a key towards zero emission shipping

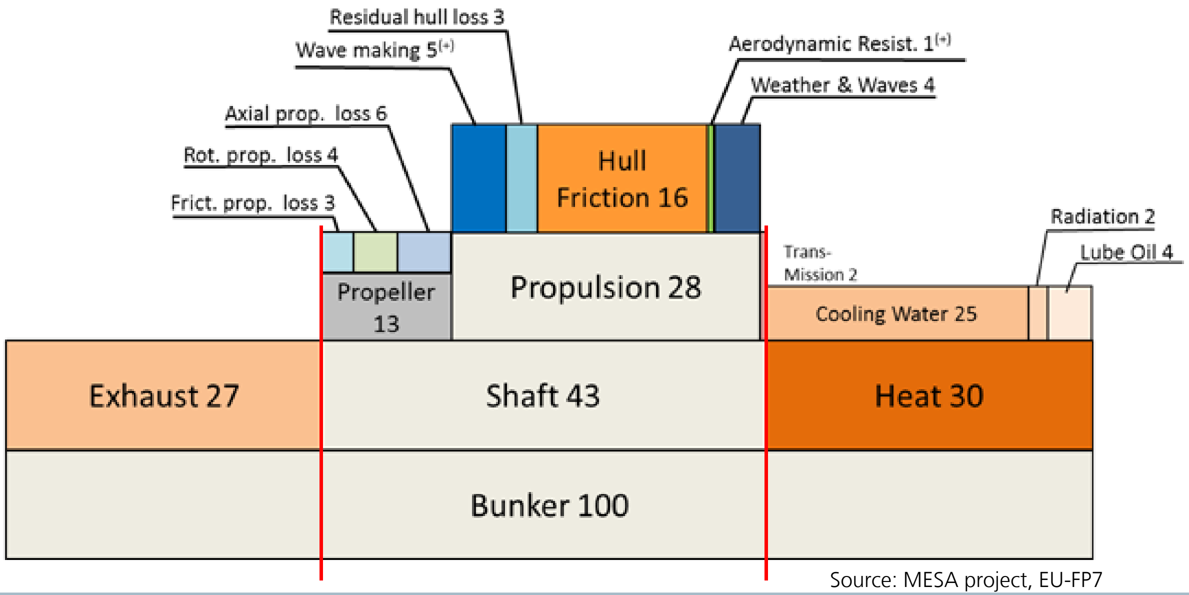
Rationale

- IMO regulations for reduction of emissions ➡ a set of measures to comply with the targets
- Alternative fuels indispensable to reach these goals

➢ What is there to be done in the meantime?

- Over 90% of the “useful“ energy of conventional cargo vessels are used for propulsion
- 37% are lost due to hull friction ➡ single largest source of energy consumption
- Design optimization largely exhausted ➡ is there anything to be done about viscous resistance?
- Each ton of fuel saved means 3.7 tons of CO_2 not emitted (plus SO_x and NO_x)

Example: Cargo Vessel (“simple”) (Averages)



Source: MESA project, EU-FP7

Hydrodynamic champions in nature

Different strategies for hydrodynamic optimization

Sharks – microtextured skin
➢ Reduction of turbulent skin friction

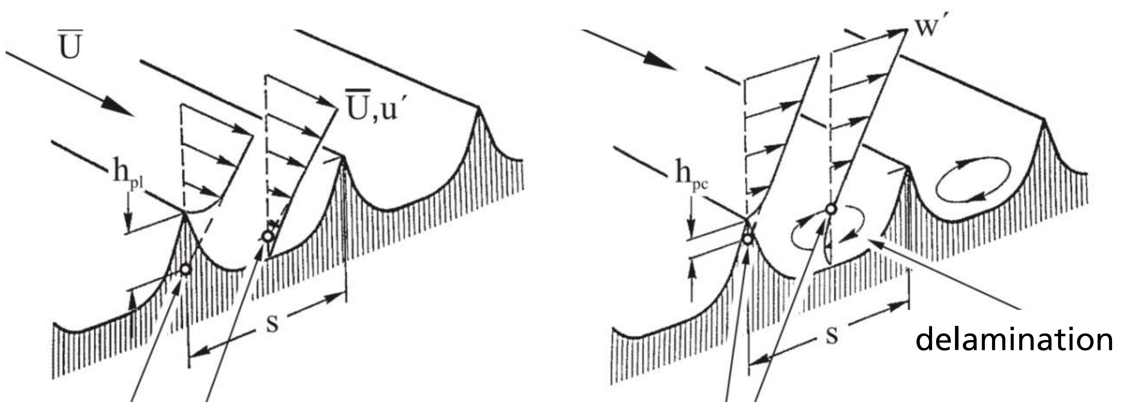
Penguins – air lubrication
➢ Reduction of turbulent skin friction

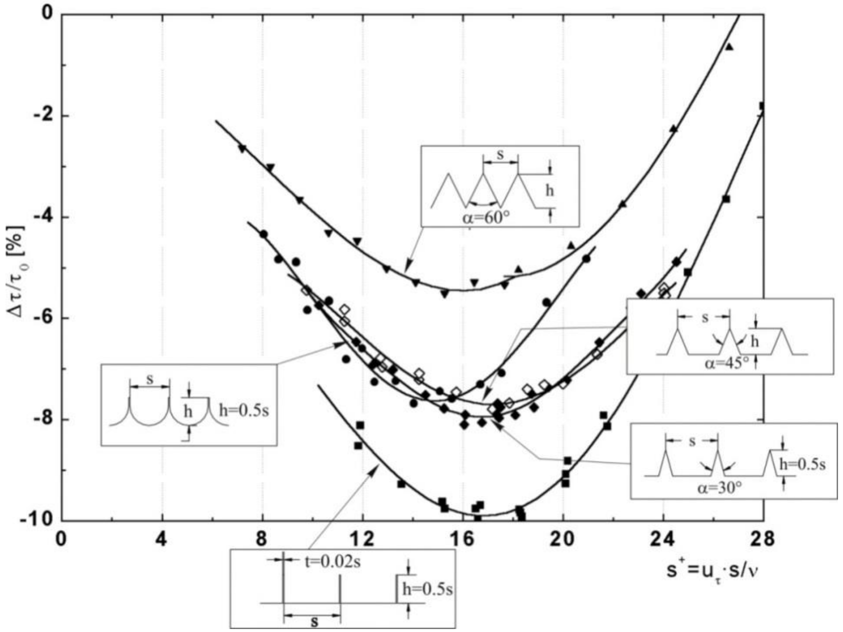
Dolphins – compliant skin
➢ Retention of laminar flow

Shark skin – and its technical realization

The principle

The hydrodynamic theory:
reduction of lateral stream by riblet structure



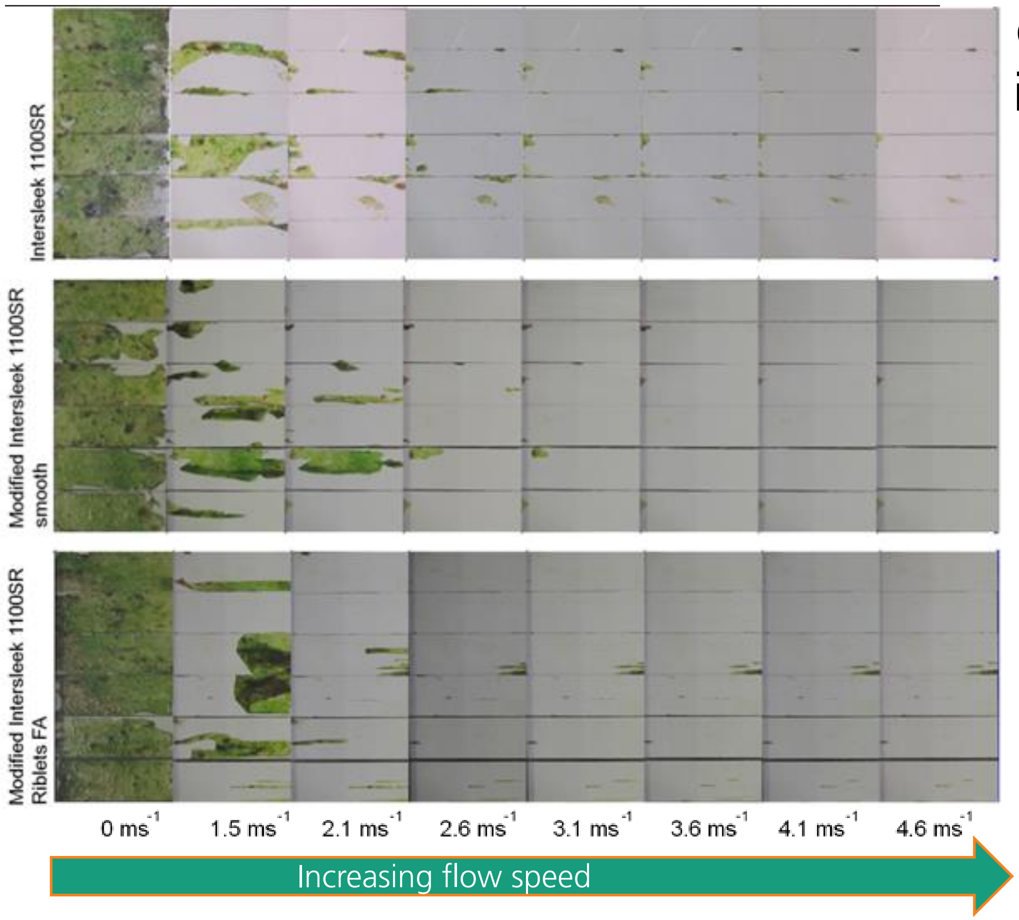


favoured structure

Experimental identification of ideal riblet structure

Shark skin – and its technical realization

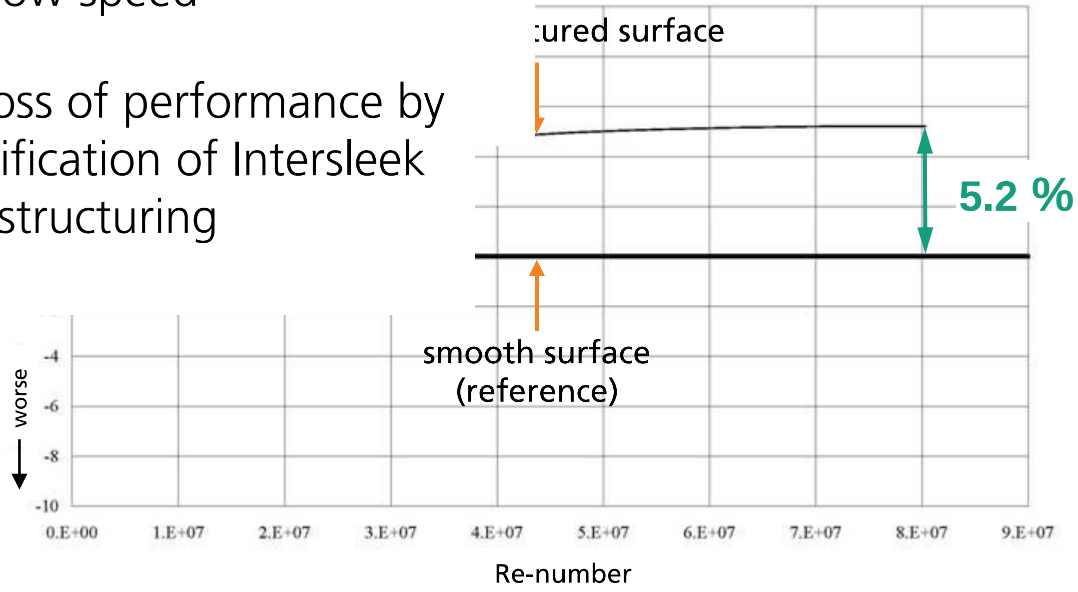
State of the art



Lab testing:
Biofilm removal with increasing water flow speed

- ➢ No loss of performance by modification of Intersleek and structuring

he experimental verification:
. yield 5.2% drag reduction



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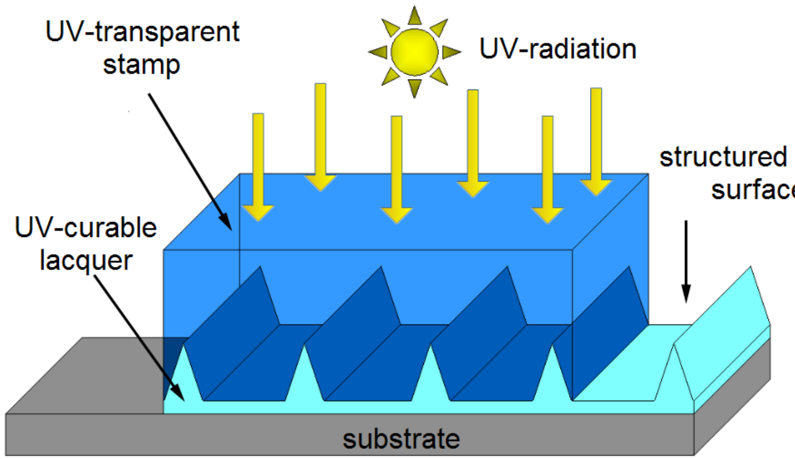
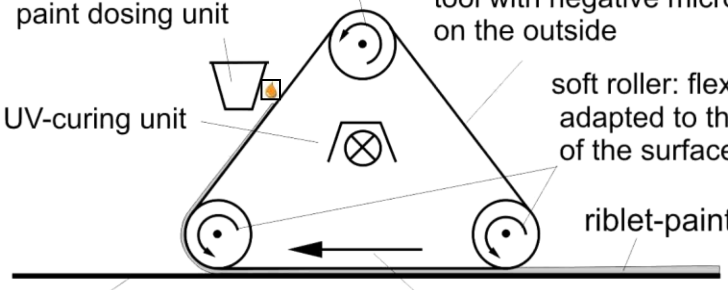
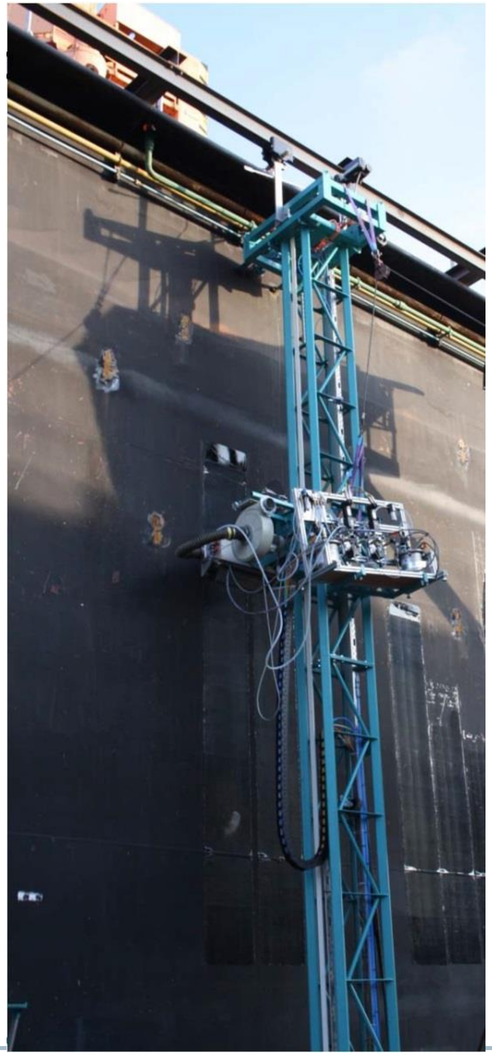
Shark skin – and its technical realization

State of the art, challenges

- Automated application technology (for aerodynamic applications)







Challenges

- Large-scale industrial application technology for fouling control riblets
- In-service demonstration

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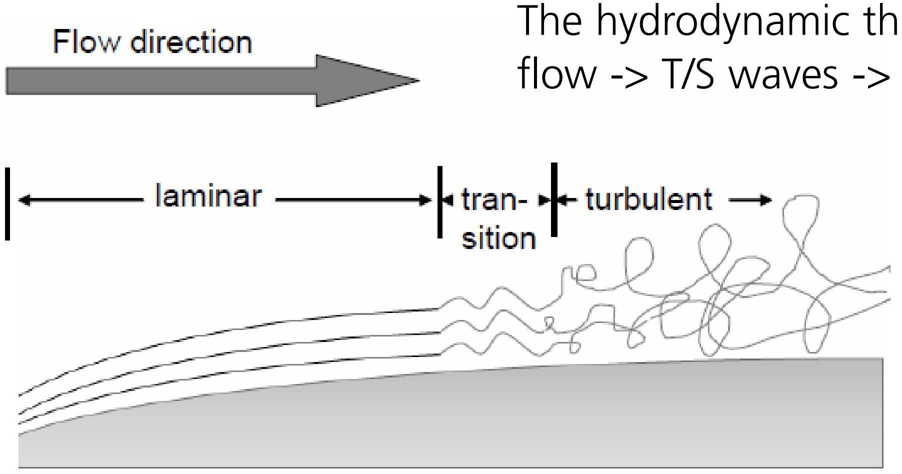
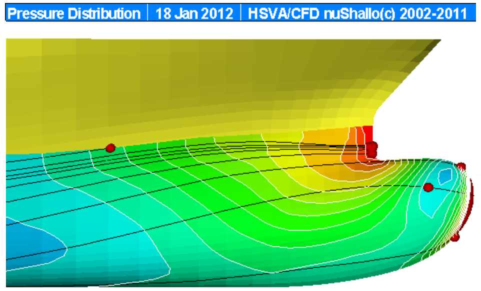
Dolphin skin – and its technical realization

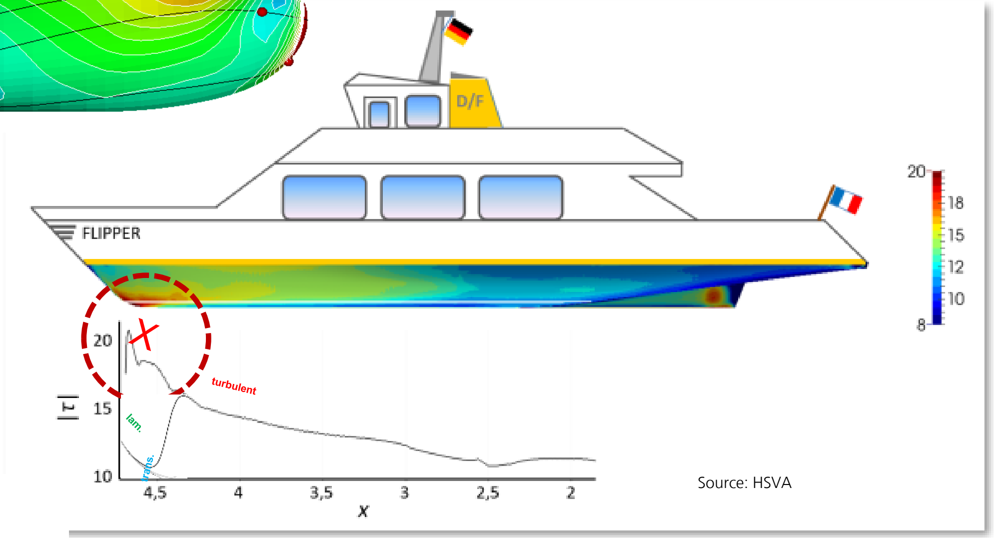
Principle



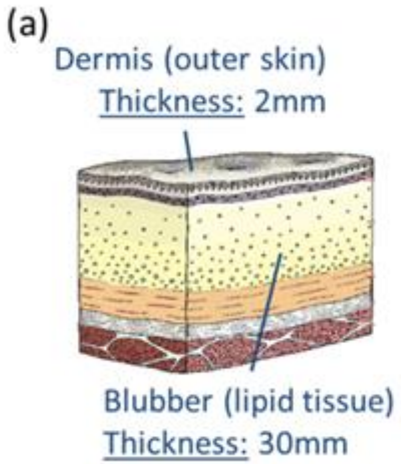
The hydrodynamic theory: Laminar flow -> T/S waves -> transition

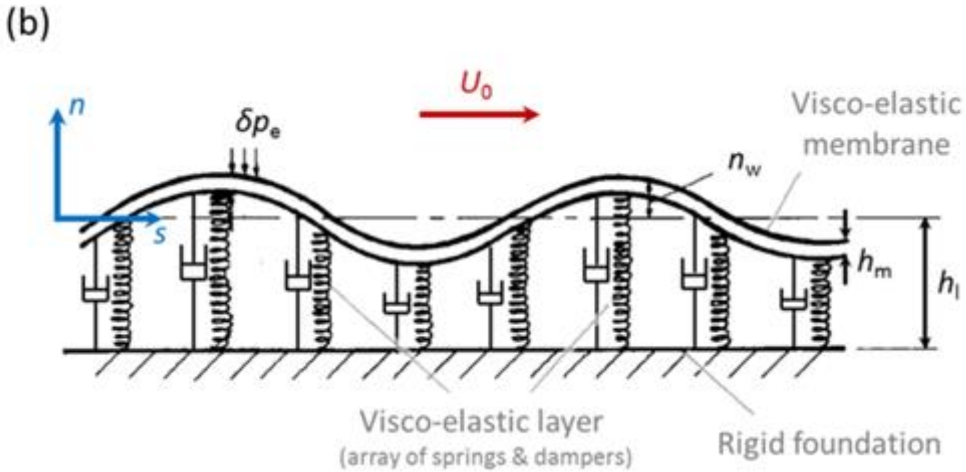


Transition along the streamlines, close to the bow



Delay of transition -> large effect on frictional resistance





reproduced after Carpenter & Garrad, J. Fluid Mech. 155, 1985

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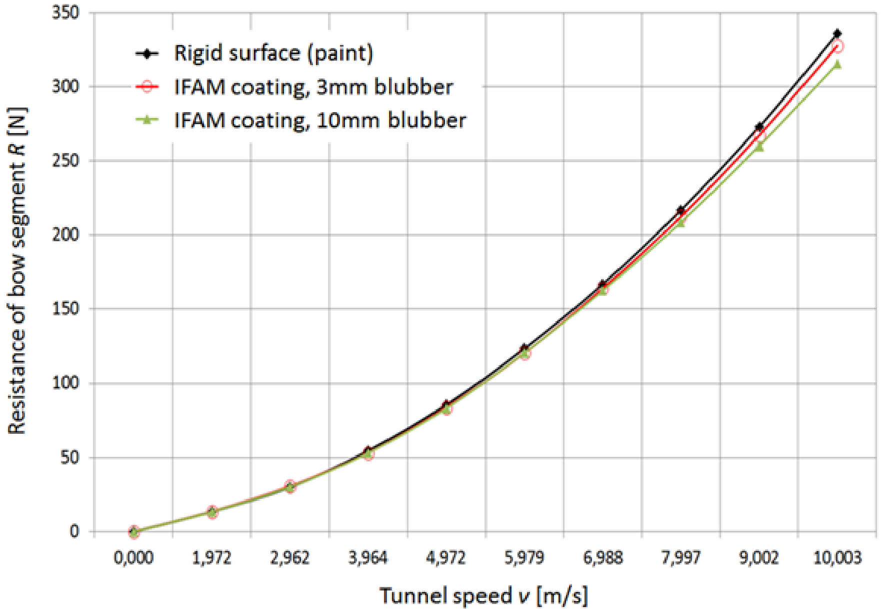
Dolphin skin – and its technical realization

State of the art, challenges

- State of the art:
  - Numerical simulation of required material parameters
  - Artificial dolphin skin reconstructed as a 2-layer system
  - Feasibility of technical realization demonstrated
  - Cavitation tunnel experiment: up to 6% less hydrodynamic resistance
- Challenges:
  - Appropriate scalable application technology
  - Transfer to large commercial vessels

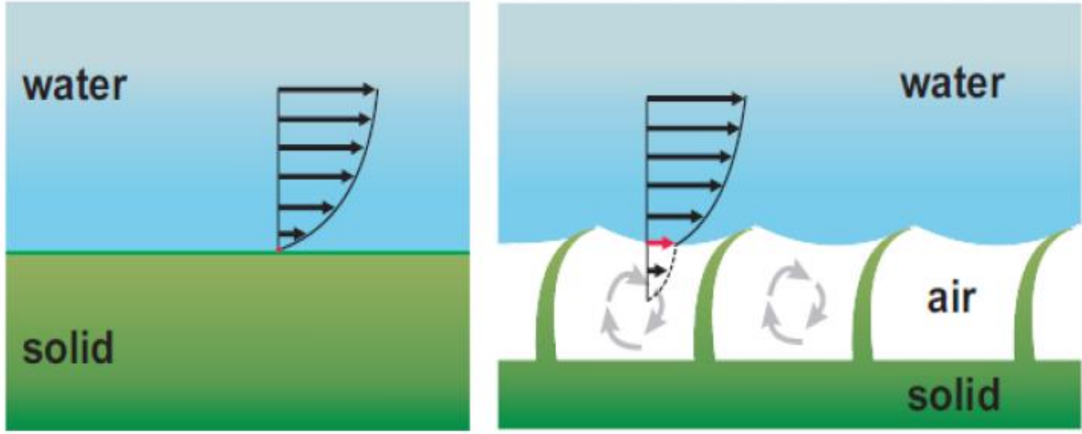


v [m/s]	ΔR [%] 3mm blubber	ΔR [%] 10mm blubber
2	+1.04	+0.04
3	+2.25	+0.78
4	-2.46	-2.66
5	-2.08	-2.80
6	-2.39	-2.24
7	-1.68	-2.60
8	-2.03	-3.75
9	-2.07	-4.71
10	-2.41	-6.03

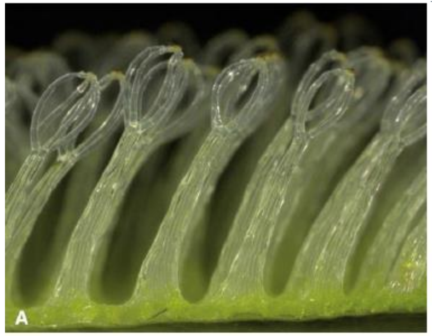
Air lubrication – and its technical realization

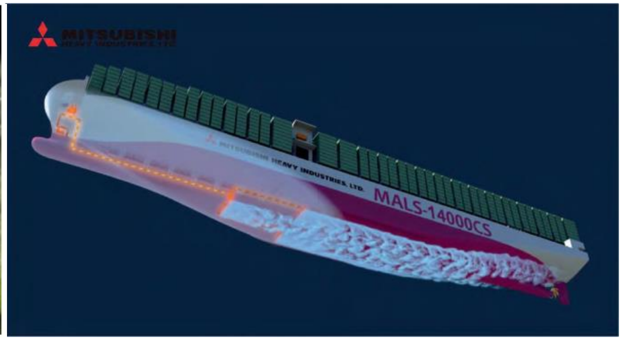
State of the art, challenges

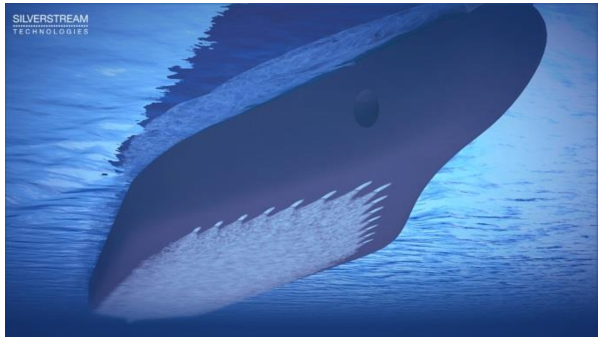
The hydrodynamic theory: Laminar flow -> T/S waves -> transition



- State of the art:
  - Passive systems: AirCoat (*Salvinia*)
  - Active systems:
    - MALS
    - Silverstream
    - IFAM's Premium coating







- Challenges:
  - Energy efficiency optmization
  - Retention of air bubbles
  - May affect propeller performance

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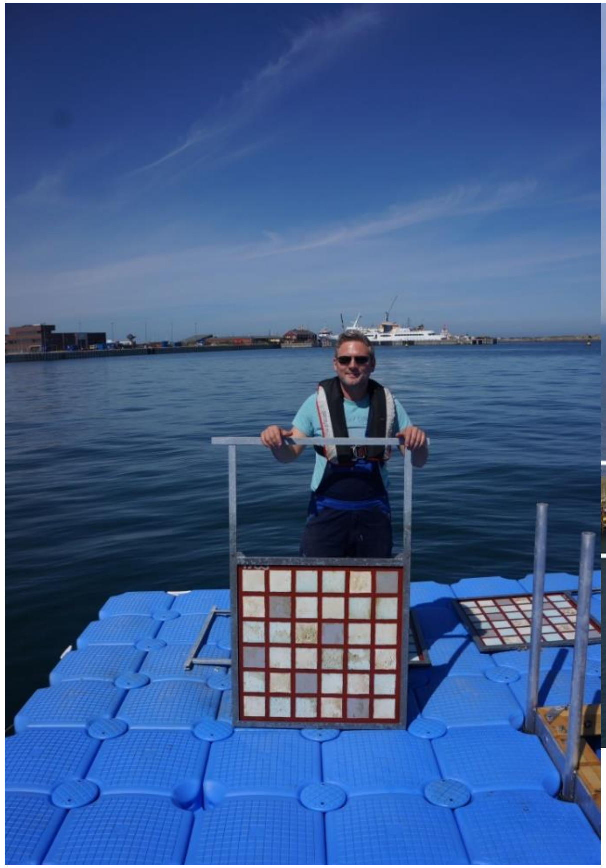
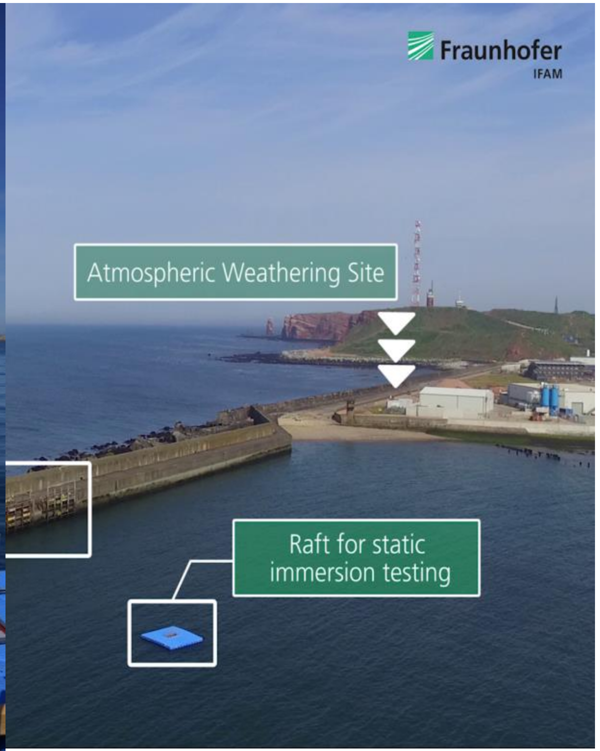
Testing – a key requisite for performance verification

Fraunhofer IFAM's infrastructure on the island of Helgoland, German Bight, North Sea

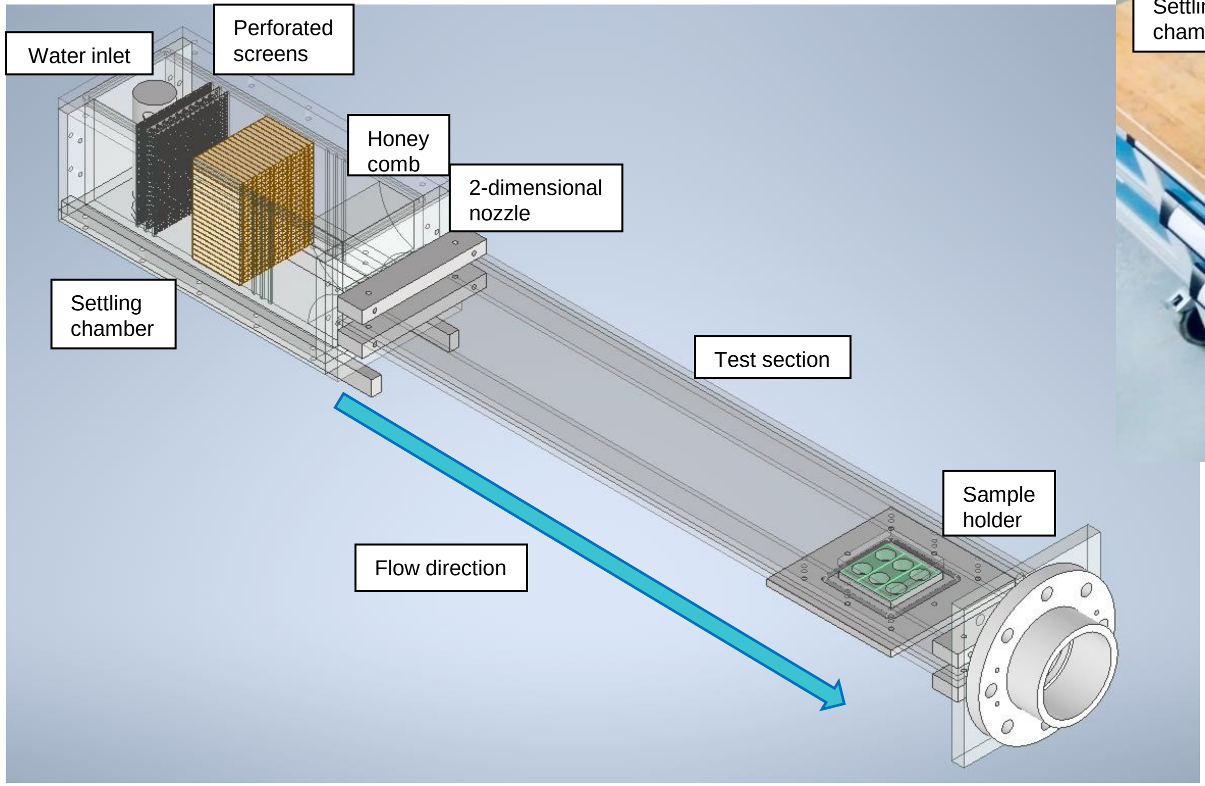
- Static immersion testing (ASTM D6990-20)
  - Floating raft
  - Test plates 80 x 80 cm
  - 6 test areas per coating type, 10 x 10 cm
  - Statistical distribution (bias of margin and depth effects)
  - Sensors for environmental monitoring (flow, turbidity, temperature, salinity, pH)
  - Fouling coverage, detailed biological evaluation
  - Cleaning behavior (brushes, water jet, laser)
- 2023: Dynamic immersion testing (ASTM D4939-89 (reapproved 2020))

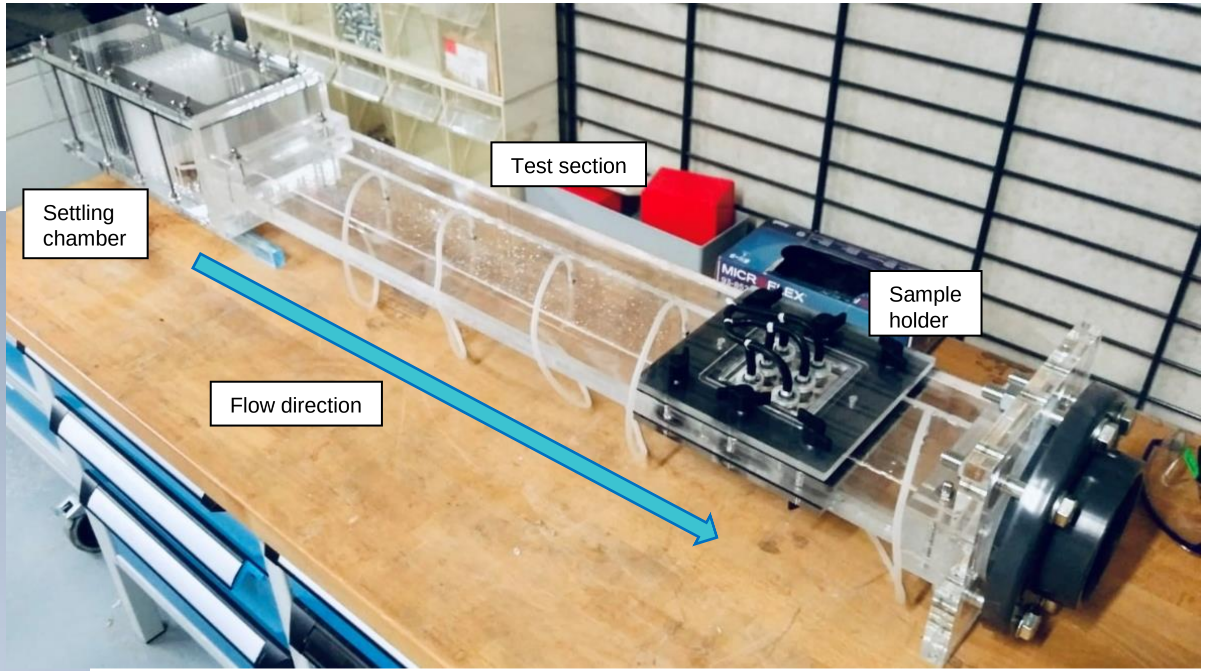




Testing – a key requisite for performance verification

Flow cell – fouling release performance under dynamic flow conditions





Further tests:
- Barnacle adhesion (ASTM D5618-20)
- Mussel test
- Microbial testing

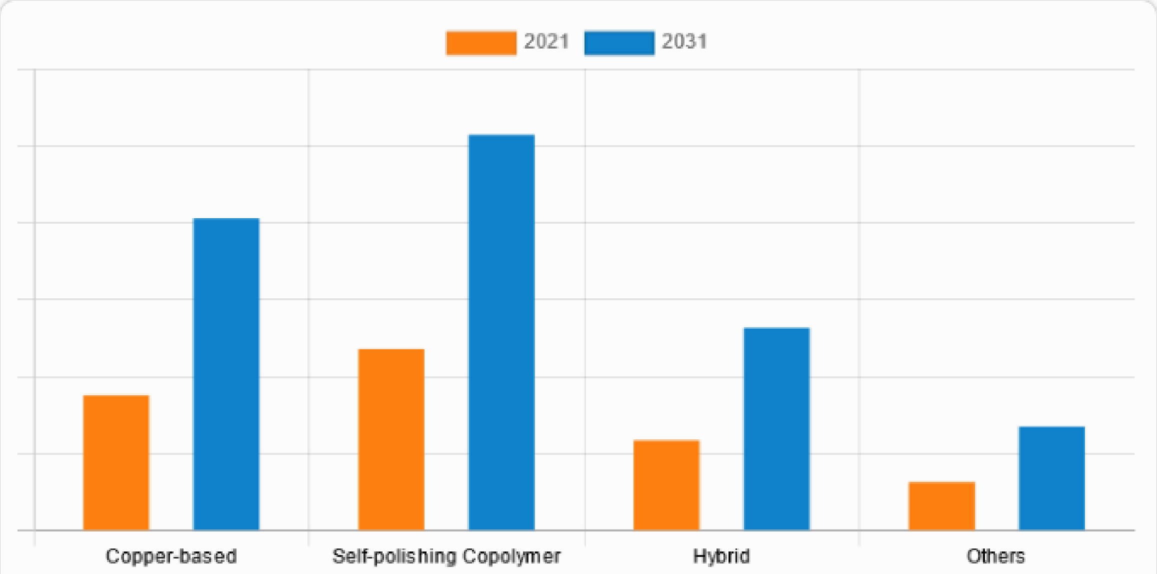
Materials for enhanced sustainability – sustainable materials

Understanding material-environment interactions and the role of regulations

- Biocidal coatings dominate the market of antifouling coatings

Global Antifouling Paints and Coatings Market

By Type

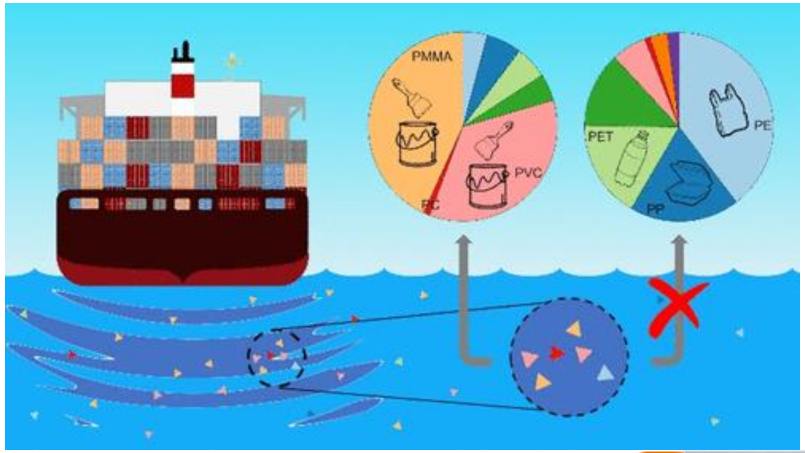


Selg-polishing copolymer is projected as the most lucrative segment

Materials for enhanced sustainability – sustainable materials

Understanding material-environment interactions and the role of regulations

- Biocidal coatings dominate the market of antifouling coatings
- Self-polishing copolymers -> hydrolysis and continuous release of polymeric and biocidal compounds into the environment
- Accumulation in sediments / bioaccumulation
- Entrance into food chain
- Development of non-biocidal or less toxic fouling control coatings
- Regulations should no put the breaks on innovations but pave their way



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Marine Pollution Bulletin
Volume 184, November 2022, 114102

Are silicone foul-release coatings a viable and environmentally sustainable alternative to biocidal antifouling coatings in the Baltic Sea region?

Maria Lagerström [a], Anna-Lisa Wrange [b], Dinis Reis Oliveira [a], Lena Granhag [a], Ann I. Larsson [c], Erik Ytreberg [a]

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Microplastic Mass Concentrations and Distribution in German Bight Waters by Pyrolysis–Gas Chromatography–Mass Spectrometry/Thermochemolysis Reveal Potential Impact of Marine Coatings: Do Ships Leave Skid Marks?

Christopher Dibke, Marten Fischer, and Barbara M. Scholz-Böttcher*

Cite this: *Environ. Sci. Technol.* 2021, 55, 4, 2285–2295
Publication Date: February 1, 2021
https://doi.org/10.1021/acs.est.0c04522

Environmental Science & Technology

Thank you

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TALKING BLUE SUSTAINABILITY
Discussion





Thank you for your attention!

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