BLUE MISSION BANOS

1st MISSION ARENA
14-16 November 2023 | Gothenburg, SE

Ecosystem & Circular design for our oceans

#MissionArenaBANOS1

EU MISSIONS
RESTORE OUR OCEAN & WATERS

Funded by the European Union

Workshop Objective

The workshop objective is to formulate recommendations that supports policy development to implement circularity by design principles in the R&D Process and Business models for technologies intended for the marine environment that is durable and at the same time protects and restores marine ecosystem services.

Agenda

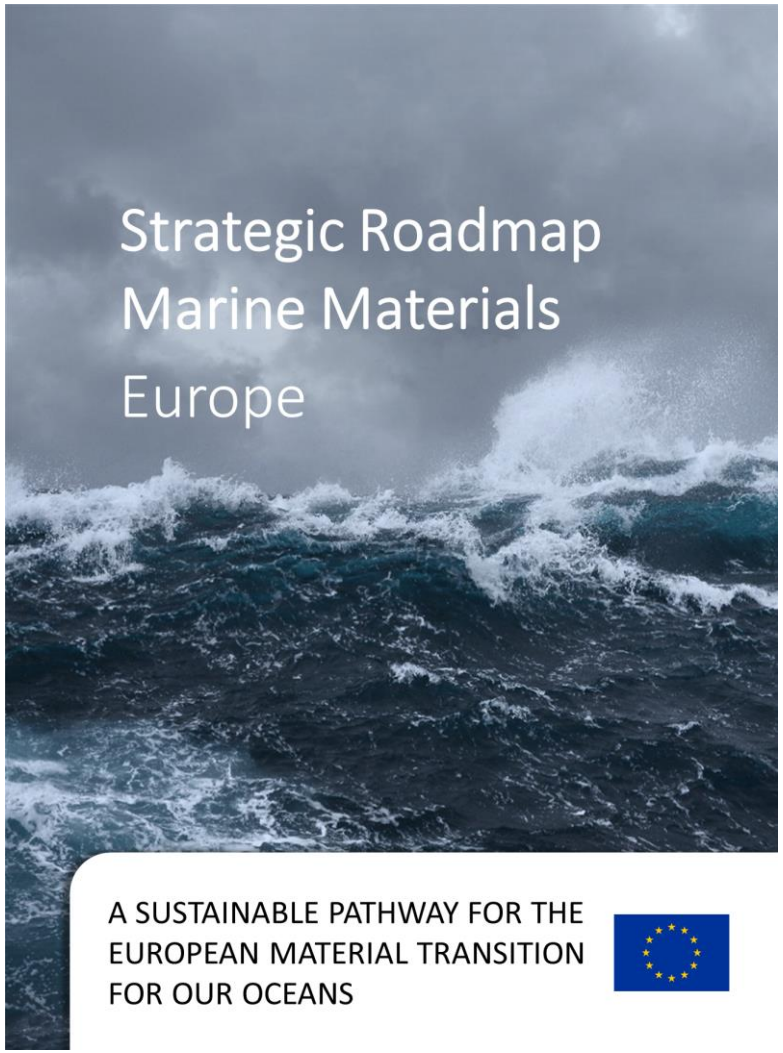
11.00 – 11.05	**Introduction and Welcome** Pierre Ingmarsson, Senior Project Manager, RISE Research Institutes of Sweden
11.05 – 11.20	**Nature-based solutions and mitigation of plastic pollution** Geraldine Thomas, Institute for circular economy & Nature based solutions
11.20 – 11.35	**Circularity by design principles** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
11.35 – 11.50	**Circular Design Case in Wave Energy – InfinityWEC** Mikael Sidenmark, CEO, Ocean Harvesting Technologies
Regroup into discussions groups (2 min)	
11.50 – 12.20	**Work Group 1 – Integration of Circularity by design methodologies in the R&D process and company business model** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
	Work Group 2 – Validation in the marine environment Konrad Tarka, Director Durability, RISE Research Institutes of Sweden
	Work Group 3 – Ecosystem based design Geraldine Thomas, Institute for circular economy & Nature based solutions
	Work Group 4 – LCA and Environmental Impact Johanna Berlin, Director Research, NILU
12.20 – 12.30	**Summary and Final Discussions**

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

European Roadmap Marine Material



BLUE MISSION BANOS

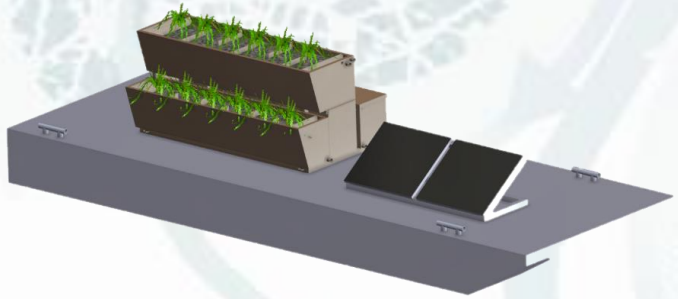
EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

alchemia nova
circular by nature

Nature-based solutions and mitigation of plastic pollution

Three projects



VertECO® raft – a floating wetland system

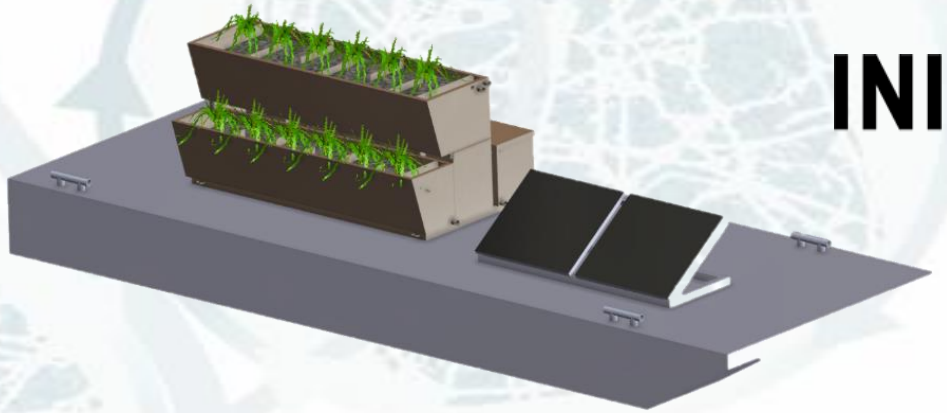
REMEDIES
MEDITERRANEAN SEA BASIN LIGHTHOUSE

INSPIRE
Innovative Solutions for Plastic Free European Rivers

1st Mission Arena BANOS

16 November 2023 | Gothenburg, Sweden

Speaker: Geraldine Thomas



vertECO® raft

lab-scale and prototype testing and development of a floating wetland system to mitigate eutrophication in the baltic sea

1st Mission Arena BANOS
16 November 2023 | Gothenburg, Sweden

M. Hartl[1,*], E. Kendir Cakmak[2,*], Z. Cetecioglu[2], R. Cederlund[3], T. Hjelm[3], J. Kisser[1]

[1]Institute for circular economy & nature-based solutions, alchemia-nova GmbH, 1140 Vienna, Austria

[2]Department of Industrial Biotechnology, KTH, AlbaNova University Center, SE-11421 Stockholm, Sweden

[3]Initiativ Utö, Alléviken 1, S-13056 Utö, Sweden.

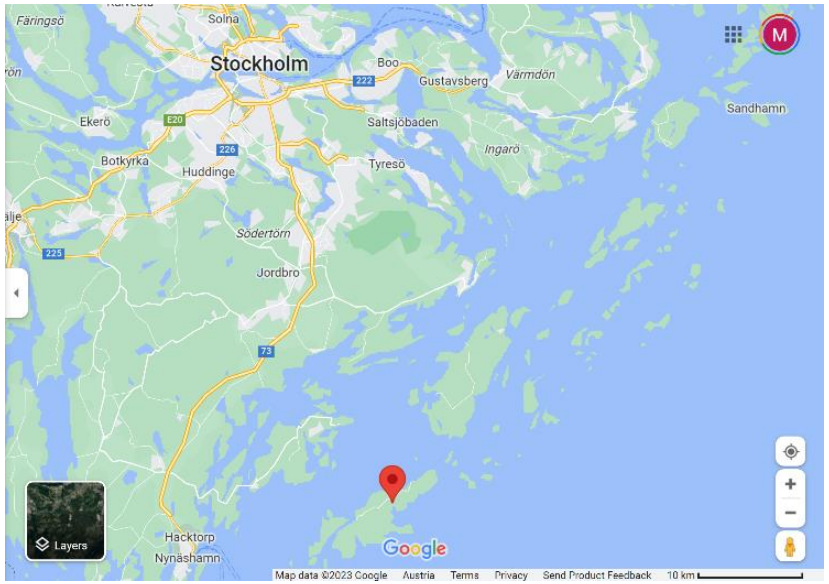
(E-Mail: ece2@kth.se or marco.hartl@alchemia-nova.net) * Co-first authors

- Background
  - Excess nutrients and resulting high level of eutrophication in Baltic Sea
  - Main sources; internal phosphorus release from anoxic sediment together with wastewater and agricultural runoff
  - Besides mitigating sources, also existing sink i.e., Baltic sea and sediments nutrients need to be removed

vertECO© raft – Scheme

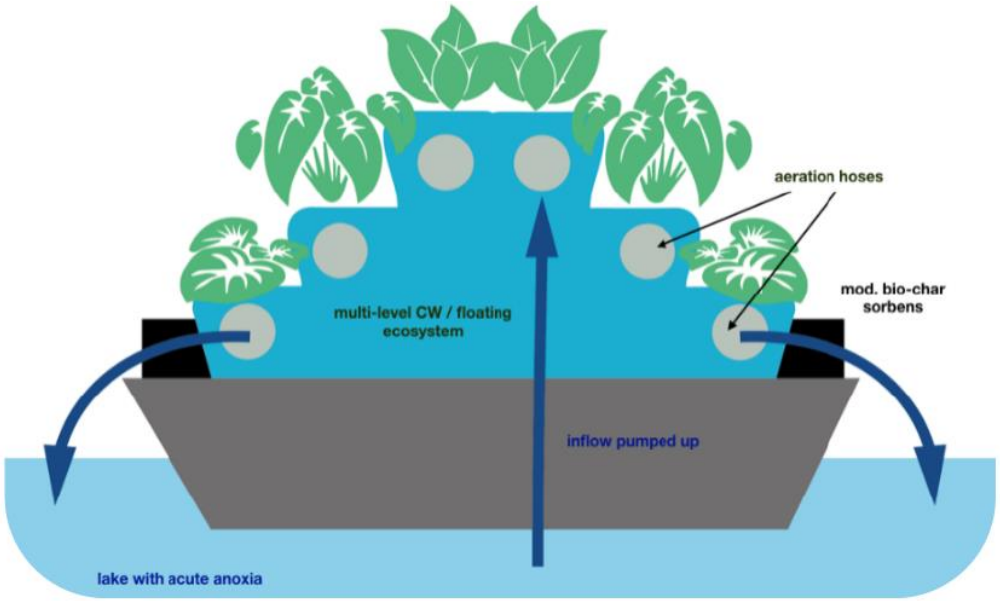
Objectives

- Develop and test an engineered raft floating wetland system
- Potentially create a role model for similar applications around the Nordic region / world



© google maps

vertECO© raft – Scheme



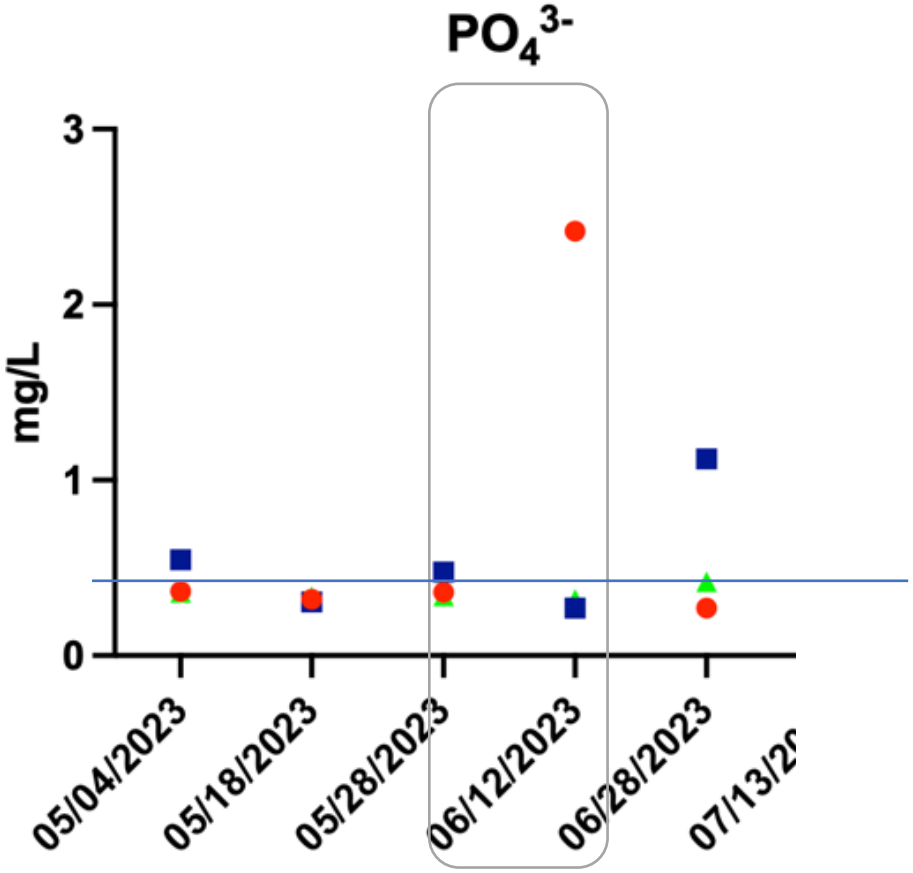
vertECO® - raft vision

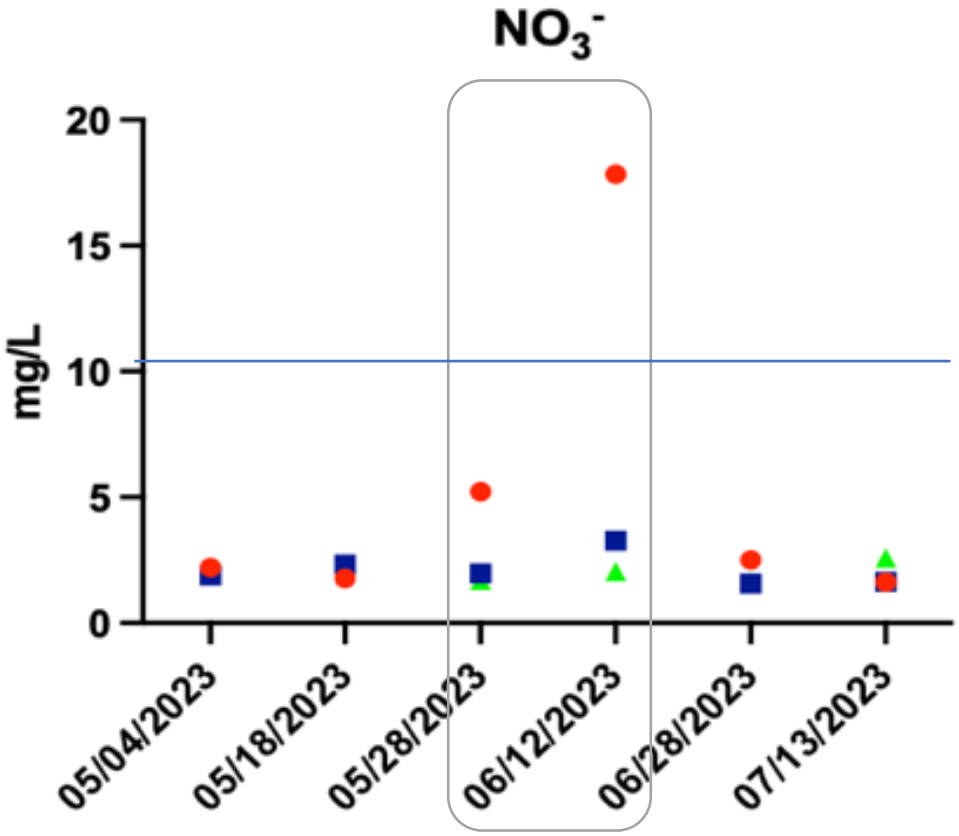
- Vertically aligned constructed wetland system
- Water pump powered by Photovoltaics
- Gravimetric downflow from stage to stage
- Each stage horizontal subsurface flow

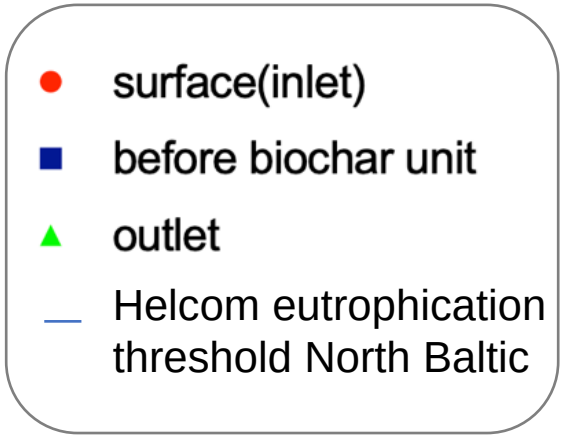
- Nutrient removal through
  - Specific substrate and microbially mediated processes (biofilm)
  - Selected plants adapted to local conditions (native halophytes)
  - Modified biochar for enhanced adsorption of Phosphorus and Nitrogen → nutrient recovery

Prototype - Installation

Prototype – Selected IC results







- NH_4^+ and NO_2^- concentrations were detected as 0 mg/L at all sampling points
- Algae bloom from around <u>end of May to beginning of June</u>

https://helcom.fi/wp-content/uploads/2023/06/HELCOM-Thematic-assessment-of-eutrophication-2016-2021.pdf

Summary

- Satisfactory nutrient (P/N) removal during algae bloom
- As known, CW systems also works well with fluctuating loads
- Still relatively short period plant establishment & observation
- Plants survived but slow development (few nutrients)

Outlook

- Biochar to be analysed
- Continued water sampling (with increased loading from spring)
  - Initiativ Utö willing to continue O&M, KTH monthly sampling
  - next year more frequent sampling during algae bloom (increased nutrients)
- Stockholm Water Utility showed interest in testing for ponds
- In future move raft to more polluted sites (port, tourist hot-spots, inflow etc.)

REMEDIES

MEDITERRANEAN SEA BASIN LIGHTHOUSE

Innovative Solutions For Plastic-litter Free waters and Beaches for future generations in the Mediterranean and other Seas

Funded by the European Union

alchemia nova

circular by nature

REMEDIES – at a glance

HORIZON Mission Ocean - Prevent and eliminate pollution of our ocean, seas and waters

- Duration 4 years
- Coordinator: National Institute of Chemistry (NIC-SL)
- € 9.000.000

Objectives

- Collect 400 tonnes of plastic litter
- Prevent the deposition of 61 tonnes of plastic
- Distribute 500k € in funding for the development of zero-waste solutions
- Engage +250.000 citizens
- Organise 115 coast clean-ups
- Explore +33 replication locations

Funded by the European Union

REMEDIES - main pillars of activities

alchemia nova
circular by nature

- **Monitoring** & detection of plastics in the Mediterranean
- Building on existing knowledge
- Creating better understanding of the plastic flows and movement

- **Collection** of plastic litter and microplastics
- Empowerment of local communities to collect and recycle plastic litter

- **Prevention** of single-use and non-biodedgradable plastics
- Biobased/biodegradable fishing gear
- Delivery of zero-waste solutions for the tourism industry and beyond

REMEDIES
MEDITERRANEAN SEA BASIN LIGHTHOUSE

Funded by the European Union

REMEDIES - main pillars of activities

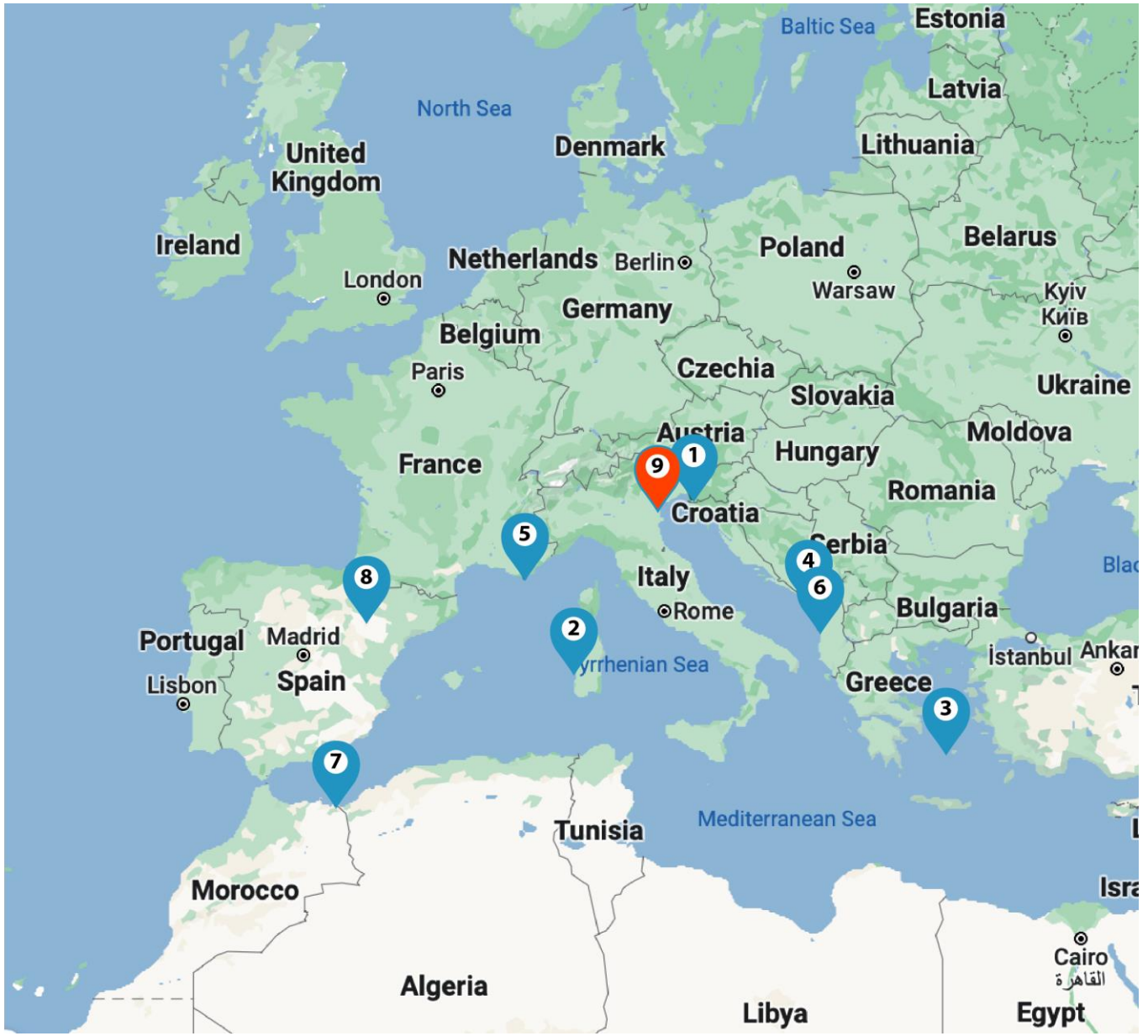
alchemia nova
circular by nature

Demo sites

1. Koper, Slovenia (UM)
2. Sinis Peninsula, Sardinia, Italy (CNR)
3. Cyclades, Greece (NTUA)
4. Sea Dance Festival, Budva, Montenegro (EXIT)
5. Island of Porquerolles, France (SMILO)
6. Durrës & Tirana, Albania (ETMI)
7. Saïdia, Morocco (MOH)
8. Zaragoza, Spain (AITIIP)

Lighthouse

9. Venice Lighhouse, Italy (VLPF)



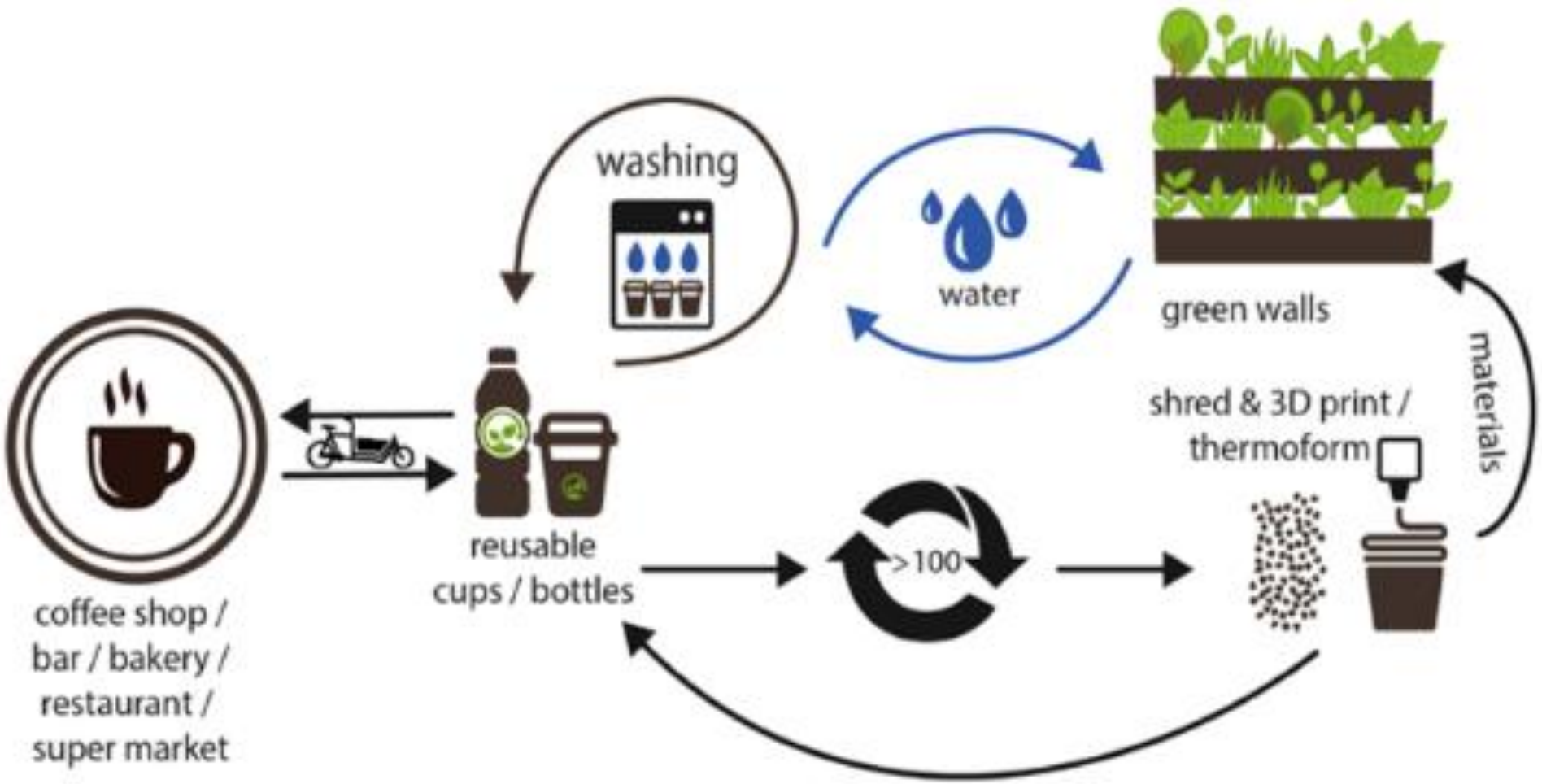
REMEDIES
MEDITERRANEAN SEA BASIN LIGHTHOUSE

Funded by the European Union

REMEDIES - main pillars of activities

alchemia nova
circular by nature

REMEDIES
MEDITERRANEAN SEA BASIN LIGHTHOUSE



Funded by the European Union

INSPIRE

Innovative Solutions for Plastic Free European Rivers

Innovative Solutions for Plastic Free European Rivers

1st Mission Arena BANOS

16 November 2023 | Gothenburg, Sweden

Funded by the European Union

alchemia nova
circular by nature

INSPIRE

alchemia nova
circular by nature

- 4-year project funded under the call HORIZON-MISS-2022-OCEAN-01
- Goal: drastic reduction of **litter**, **macro** and **microplastics in European rivers**
- Coordinators: **VLIZ** – Vlaams Instituut voor de Zee
- It contributes to the Mission "**Restore our Ocean and Waters by 2030**".

PREVENT AND ELIMINATE POLLUTION OF OUR OCEANS, SEAS AND WATERS

- Reduce by at least 50% plastic litter
- Reduce by at least 30% microplastics
- Reduce by at least 50% nutrient losses, chemical pesticides

Funded by the European Union

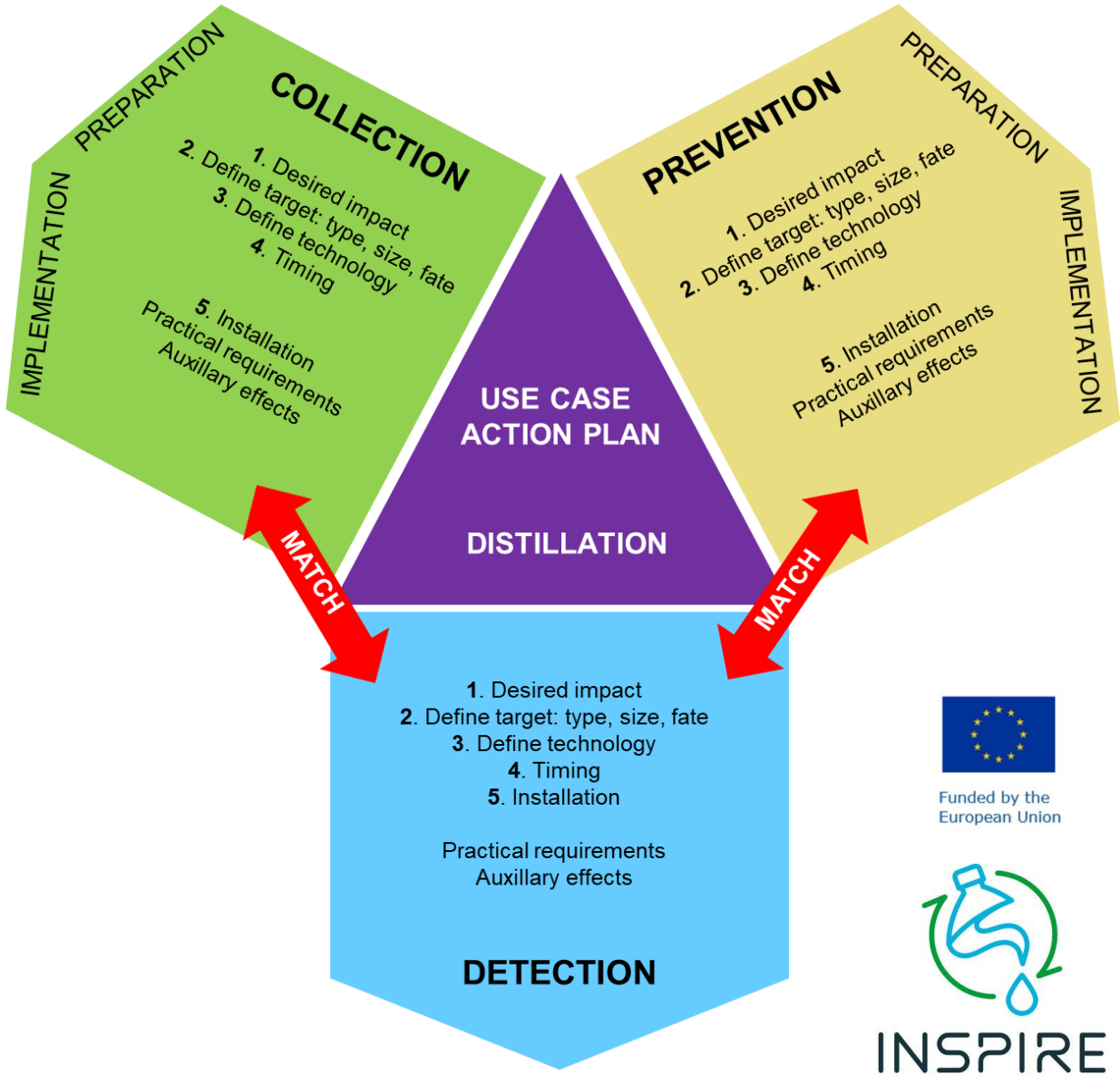
INSPIRE
Innovative Solutions for Plastic Free European Rivers

alchemia nova
circular by nature

Holistic DCP concept

The holistic approach of INSPIRE is summed up in the DCP concept:

1. **DETECTION**
   of the pollution located in the river and on the riverbanks
2. **COLLECTION**
   of litter and macroplastics on the riverbank;
   of litter, macro- and micro plastics in the river
3. **PREVENTION**
   of litter, macro- and microplastics before entering the rivers
   - stopping it in its waste stream
   - developing biodegradable alternatives

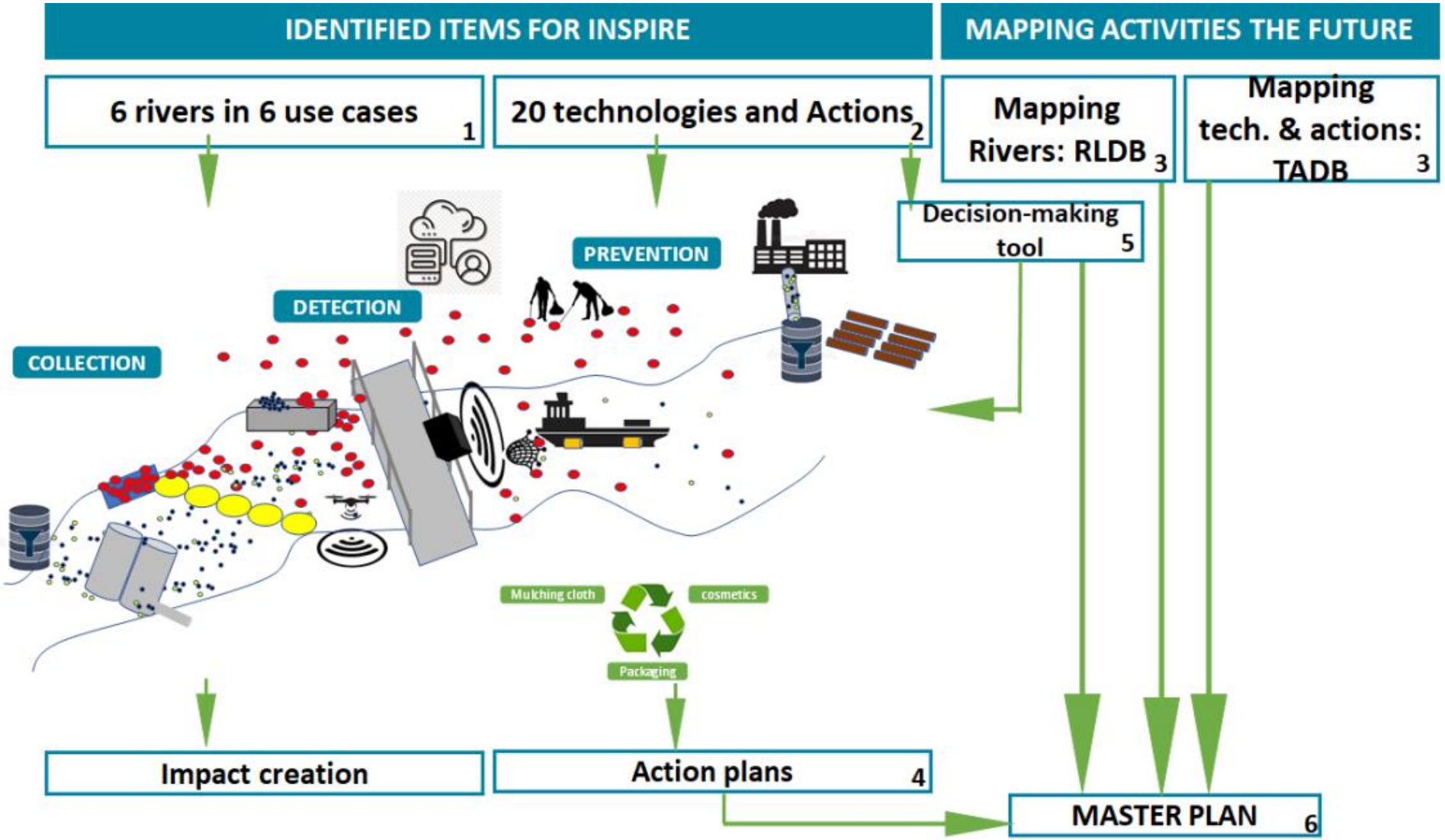


Funded by the European Union

INSPIRE
Innovative Solutions for Plastic Free European Rivers

alchemia nova
circular by nature

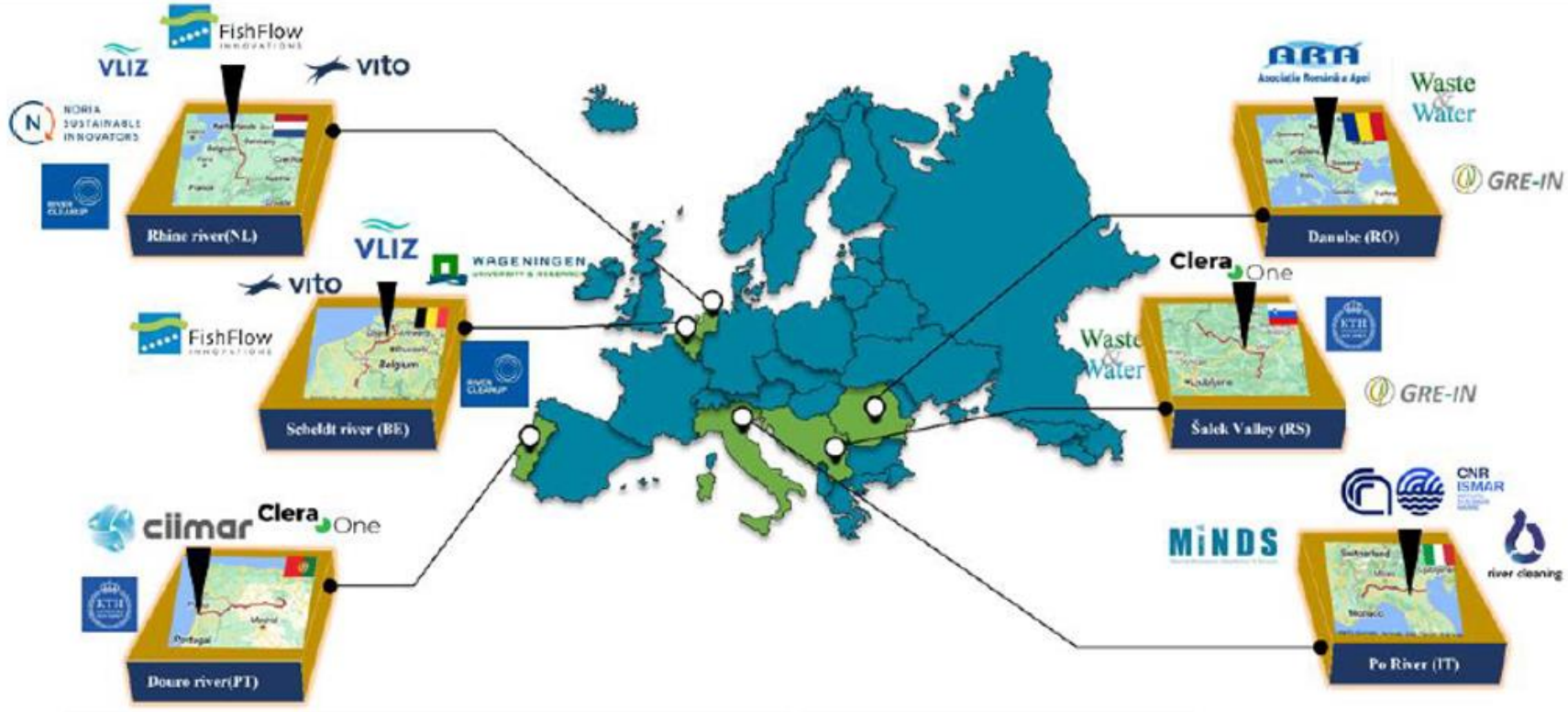
Overview of activities in INSPIRE



Funded by the European Union

INSPIRE
Innovative Solutions for Plastic Free European Rivers

Overview of activities in INSPIRE



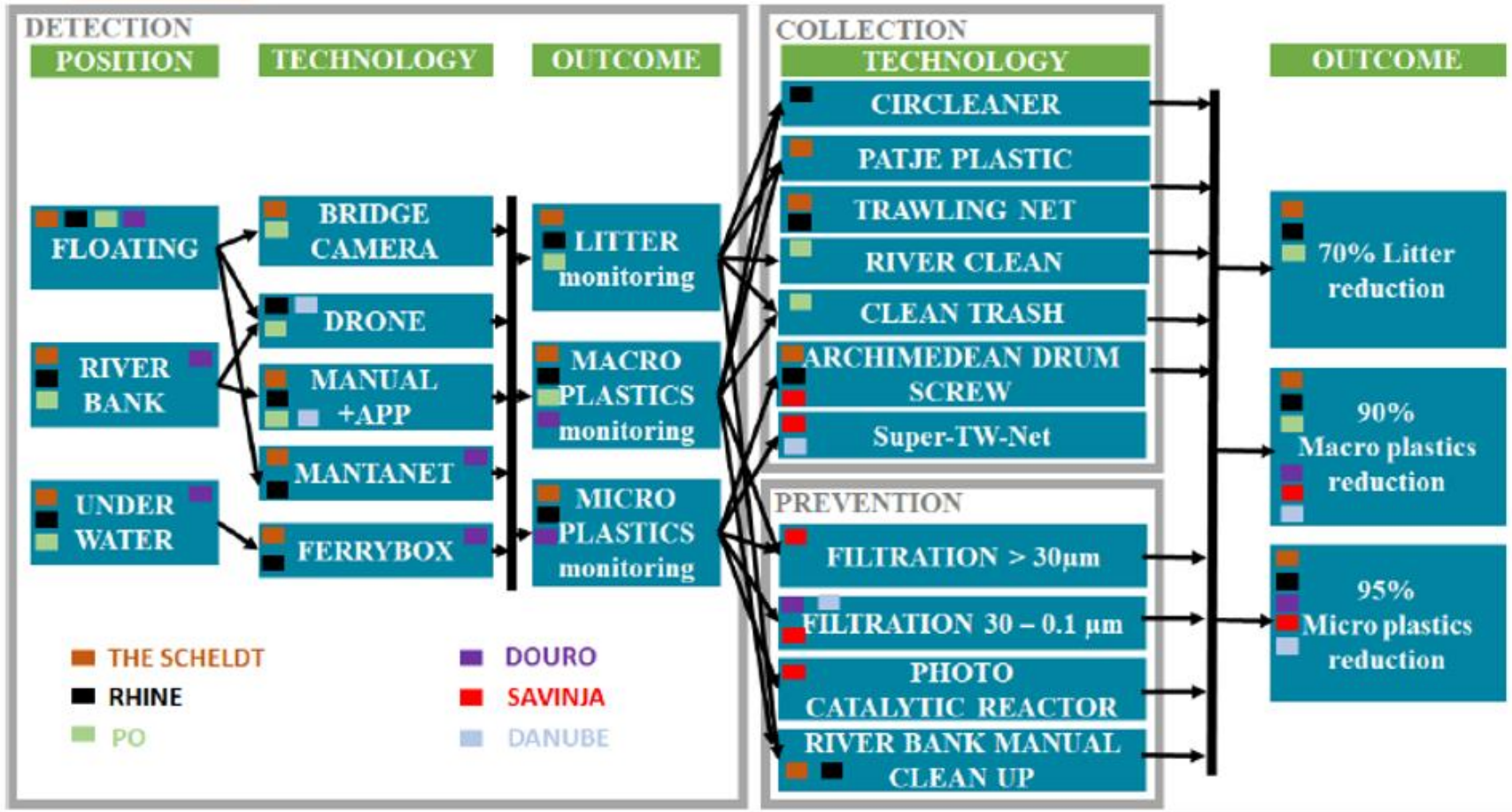
6 rivers

- **Scheldt** (Belgium)
- **Rhine** (Netherlands)
- **Po** (Italy)
- **Douro** (Portugal)
- **Savinja** (Serbia)
- **Danube** (Romania)

Funded by the European Union

INSPIRE
Innovative Solutions for Plastic Free European Rivers

Overview of activities in INSPIRE



Funded by the European Union

INSPIRE
Innovative Solutions for Plastic Free European Rivers

alchemia nova
circular by nature

The Po River case study

Collection

Hybrid system of **River Cleaning barriers** (modular, self-powered, automatic) and **Clean Trash collection cage** with AI-powered litter identification

Detection

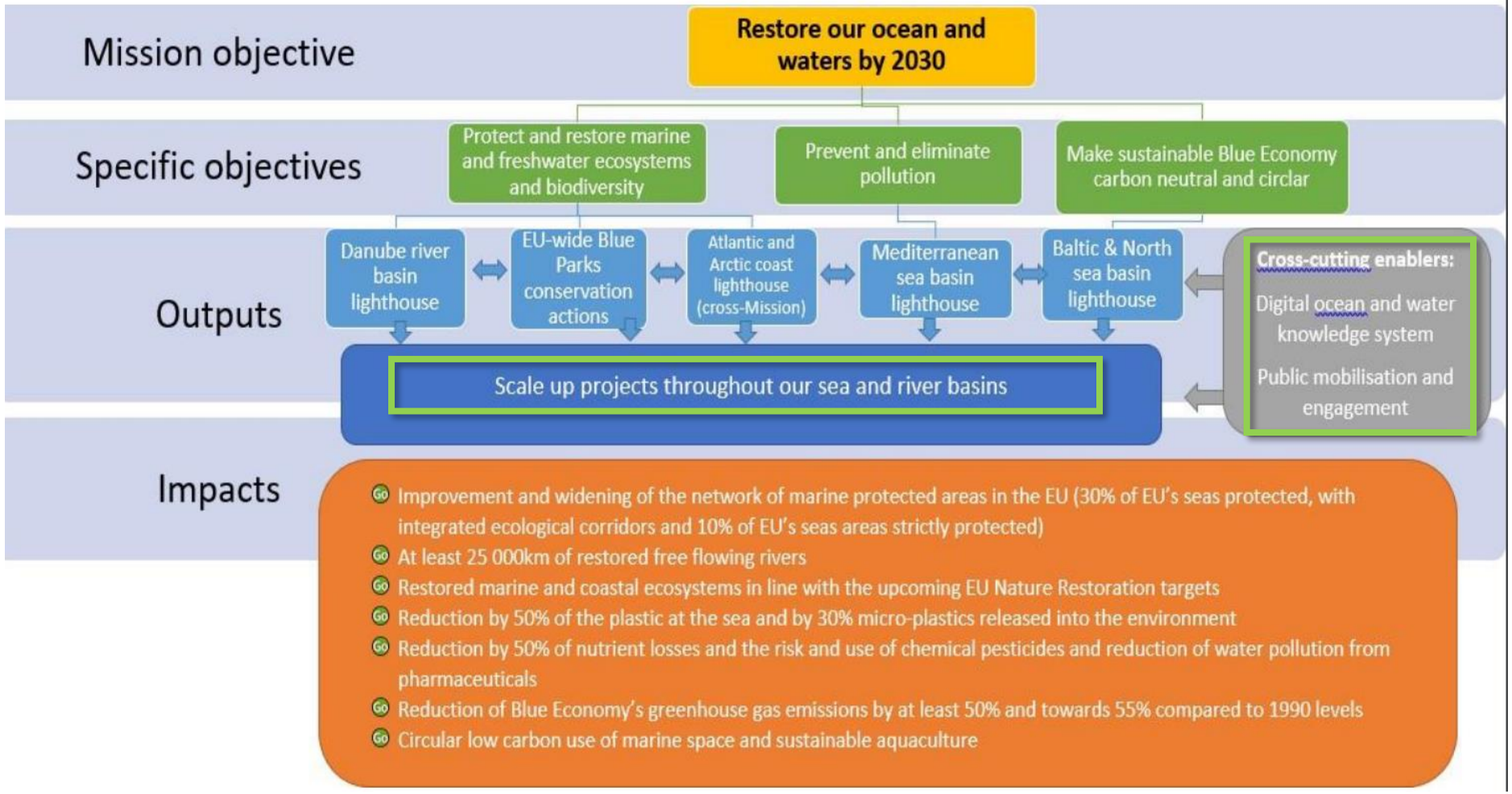
Monitoring and **detection** of plastics and litter using bridge-mounted **RGB cameras with multispectral systems (VNIR)** and **AI-mounted CCTV** systems

Funded by the European Union

INSPIRE
Innovative Solutions for Plastic Free European Rivers

alchemia nova
circular by nature

INSPIRE and the targets of the Mission Ocean



In line with the **EU Towards Zero Pollution Action Plan for Air, Water and Soil**, INSPIRE demonstrates **scalable breakthrough innovations** (technological, business, social and governance) to prevent and minimize pollution from litter, plastics and microplastics in European rivers.

Funded by the European Union

INSPIRE
Innovative Solutions for Plastic Free European Rivers

INSPIRE

alchemia nova
circular by nature

INSPIRE

Innovative Solutions for Plastic Free European Rivers

https://inspire-europe.org/ / Inspire Europe (LinkedIn) / Inspire Europe (Facebook) / inspire_eu (Instagram) / INSPIRE_EUROPE (twitter)

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them. This project has received funding under grant agreement No 101112879 (INSPIRE).

Dream - Plan – Implement - Celebrate

alchemia nova

alchemia nova

institute for circular economy & nature based solutions

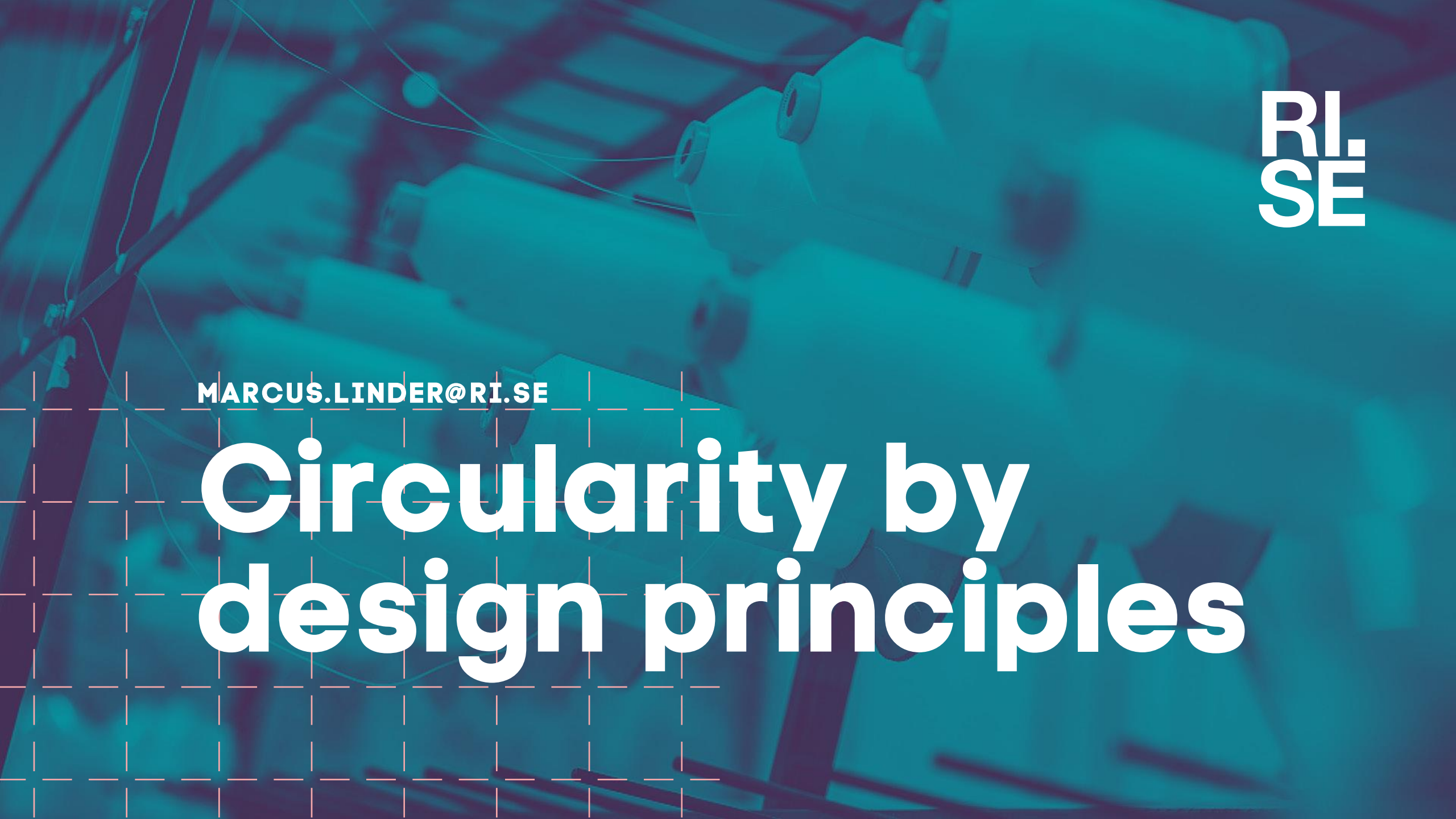
Thank you!

circular by nature

www.alchemia-nova.net

Agenda

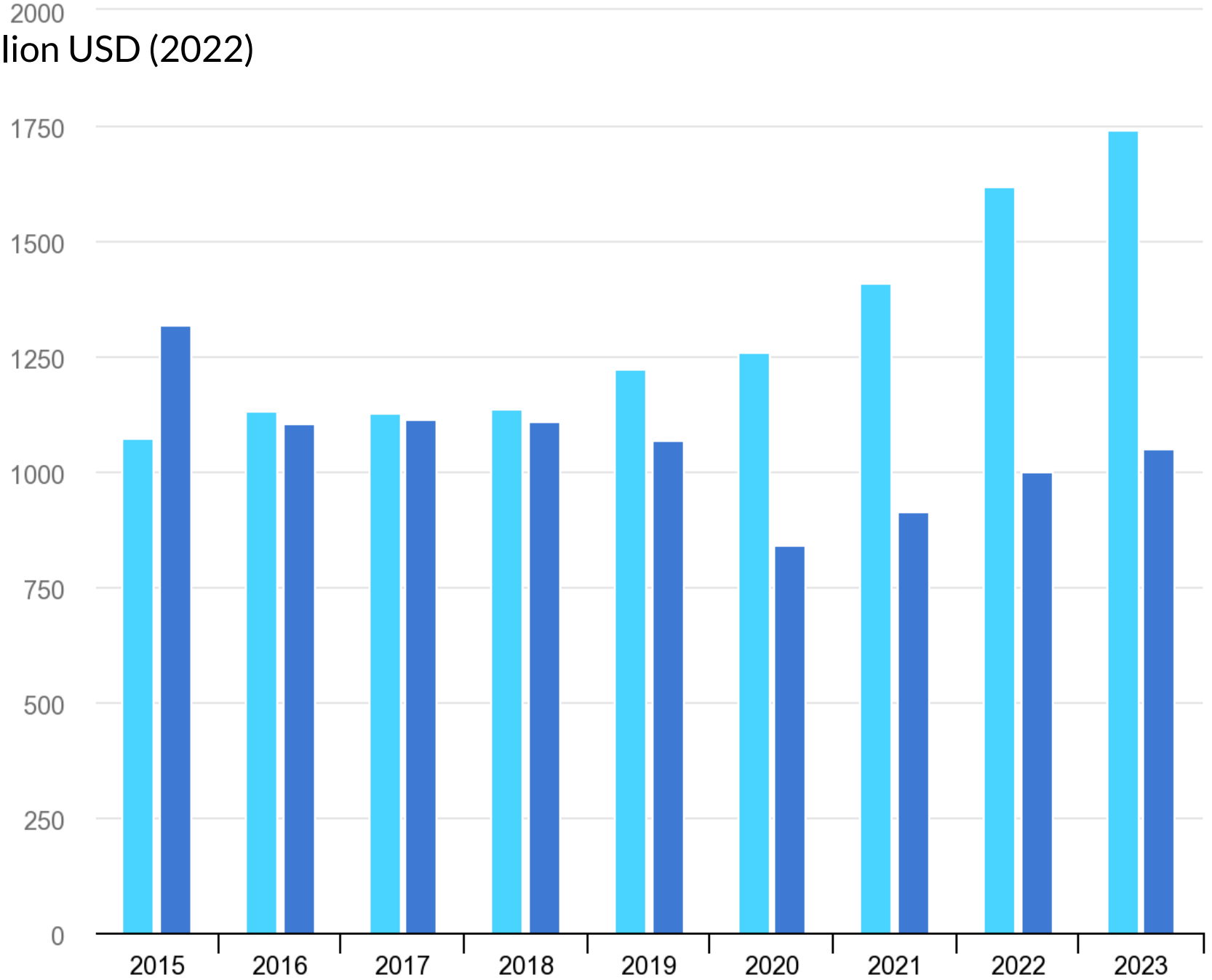
11.00 – 11.05	**Introduction and Welcome** Pierre Ingmarsson, Senior Project Manager, RISE Research Institutes of Sweden
11.05 – 11.20	**Nature-based solutions and mitigation of plastic pollution** Geraldine Thomas, Institute for circular economy & Nature based solutions
11.20 – 11.35	**Circularity by design principles** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
11.35 – 11.50	**Circular Design Case in Wave Energy – InfinityWEC** Mikael Sidenmark, CEO, Ocean Harvesting Technologies
Regroup into discussions groups (2 min)	
11.50 – 12.20	**Work Group 1 – Integration of Circularity by design methodologies in the R&D process and company business model** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
	Work Group 2 – Validation in the marine environment Konrad Tarka, Director Durability, RISE Research Institutes of Sweden
	Work Group 3 – Ecosystem based design Geraldine Thomas, Institute for circular economy & Nature based solutions
	Work Group 4 – LCA and Environmental Impact Johanna Berlin, Director Research, NILU
12.20 – 12.30	**Summary and Final Discussions**



MARCUS.LINDER@RI.SE

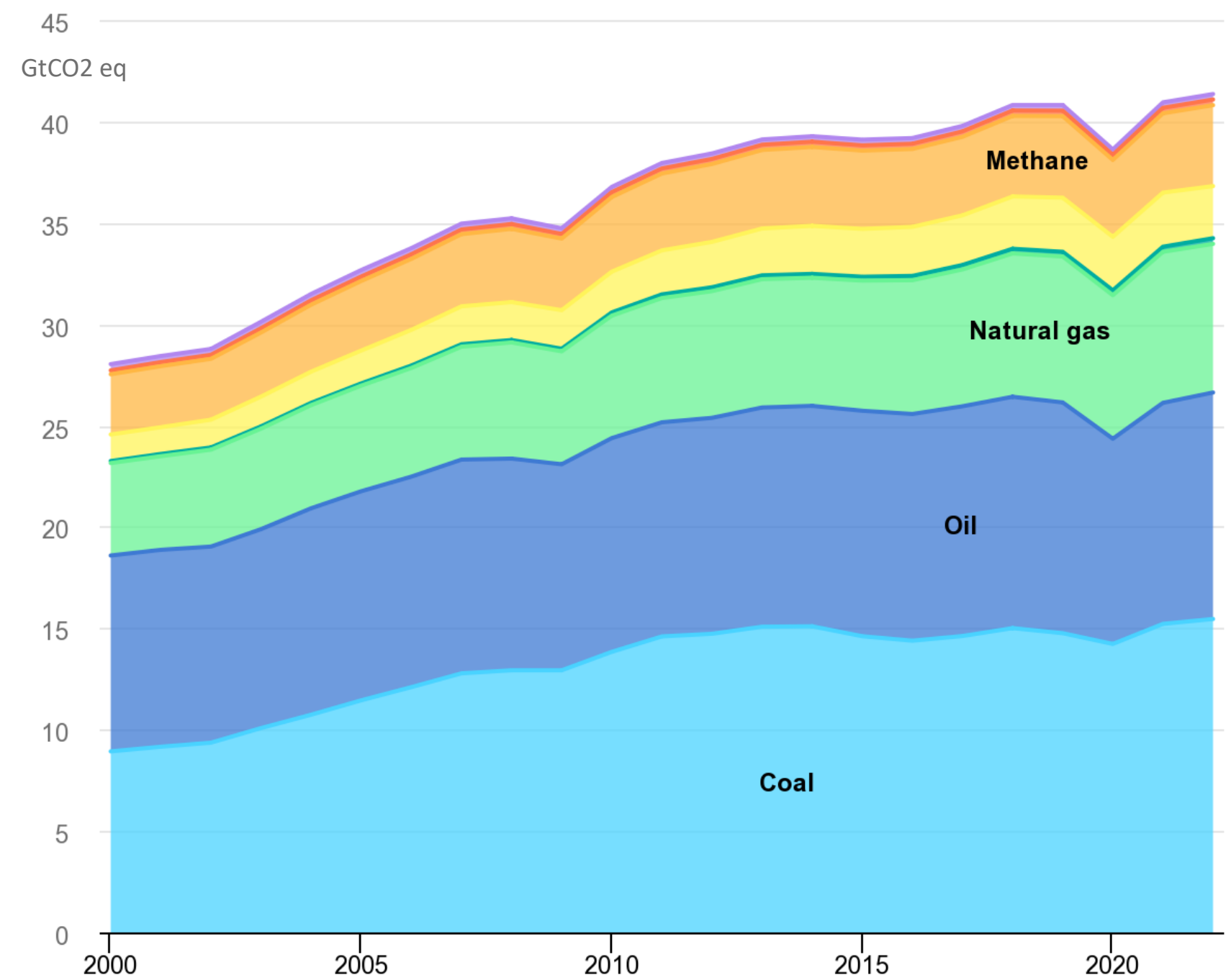
Circularity by design principles

billion USD (2022)



IEA, Global energy investment in clean energy and in fossil fuels, 2015-2023, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-energy-investment-in-clean-energy-and-in-fossil-fuels-2015-2023, IEA. Licence: CC BY 4.0

RI. SE



IEA, Global energy-related greenhouse gas emissions, 2000-2022, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-energy-related-greenhouse-gas-emissions-2000-2022, IEA.

RI. SE

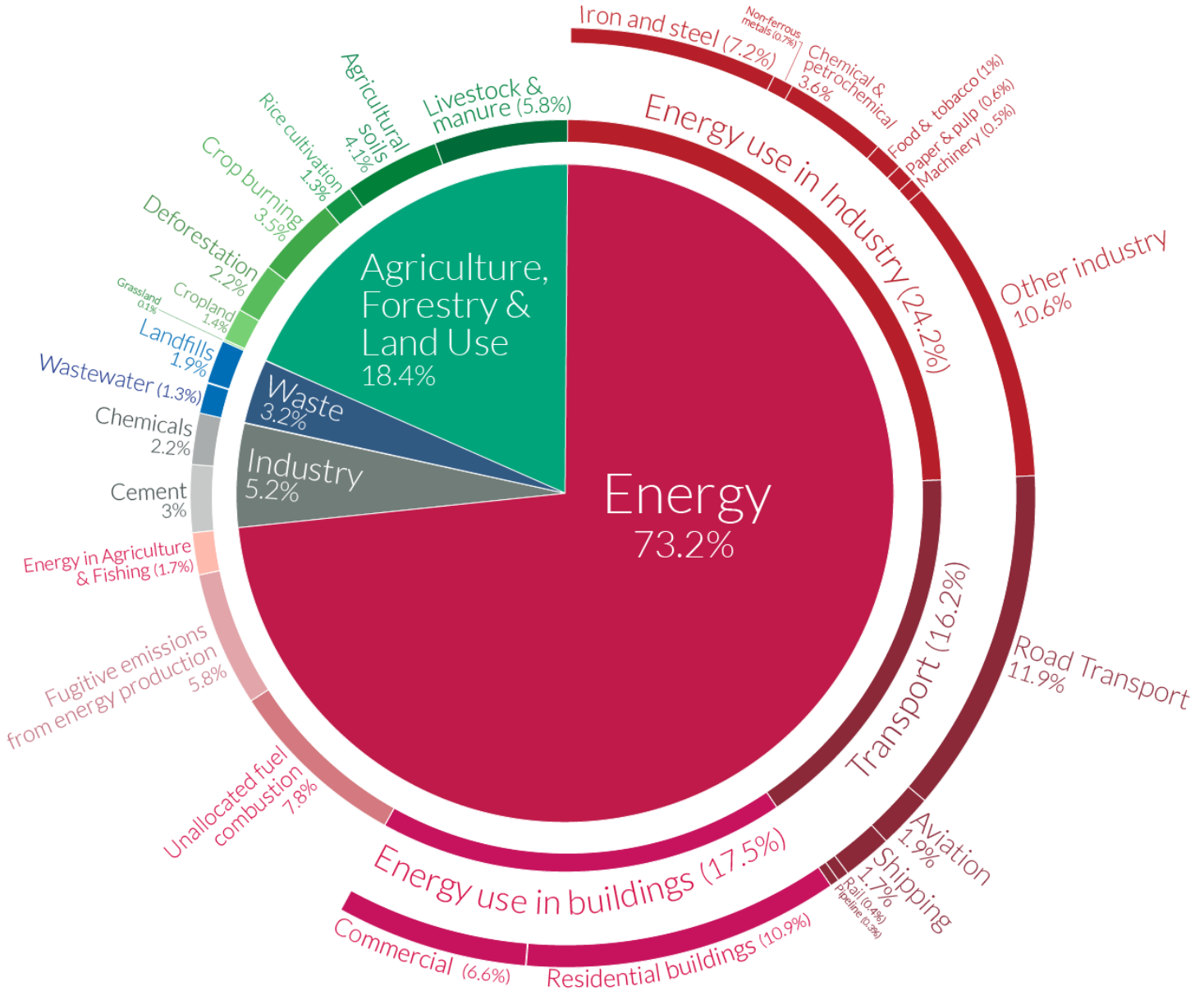
“In my kingdom,” as the Red Queen tells Alice in Wonderland, “you have to run as fast as you can just to stay in the same place.”

“Specifically,” the Red Queen continued, “you have to run at 1750 BUSD invested annually, just to keep GHG emissions steady.”

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

Our World in Data

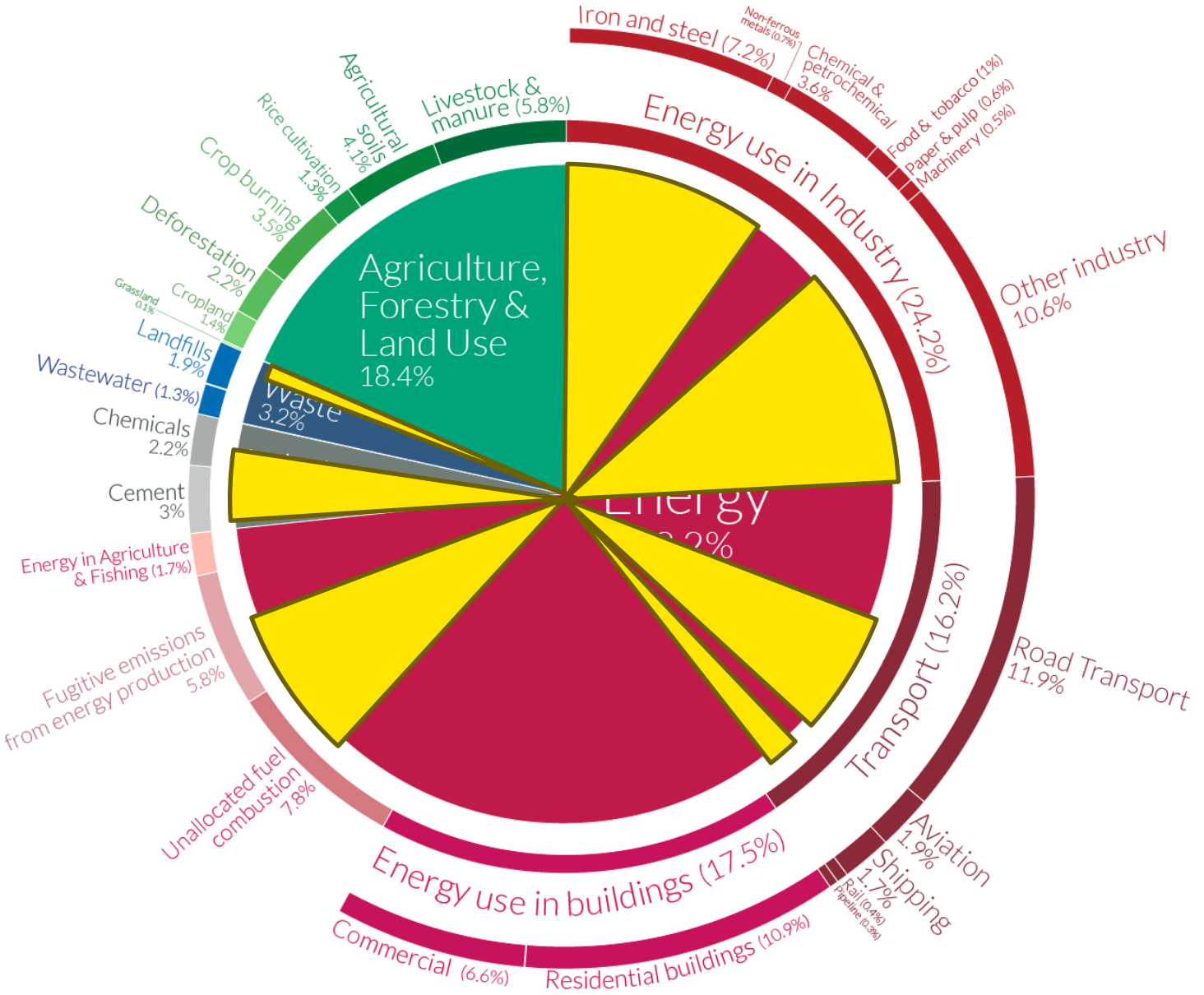


RI. SE

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

Our World in Data



Half is energy embedded in physical artifacts = **products**

Source: Climate Watch, the World Resources Institute (2020).

RI. SE

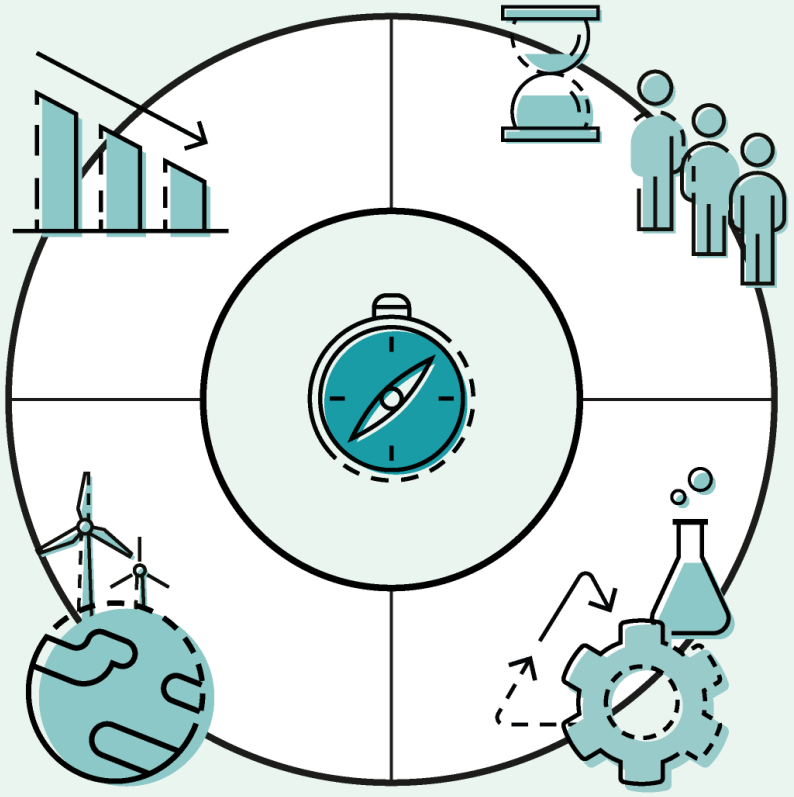
Four principles for circular design

Contribute to reduced flows by:

USING MATERIALS & RESOURCES EFFICIENTLY

Contribute to renewed flows by:

REGENERATING & PRESERVING ECOSYSTEM VALUES



Contribute to slow flows by:

USING PRODUCTS MORE & FOR LONGER

Contribute to closed flows by:

CIRCULATING OBSOLETE MATERIALS & RESOURCES

RISE , Sustainable Business
Anneli Selvefors & Thomas Nyström 2021
Adapted from: Konietzko et al., (2020)
Bocken et al., (2016);

RI.
SE

2x product life
2x utilization
1/2x primary material
1/2x waste

- 50% reduced need for replacement production = 50% of emissions
- Times 50% reduced need for replacement production = 25% of emissions
- Times 50% reduced need for replacment production = 12,5% of emissions
- Times 50% reduced need for original production = 6% of emissions

6% emissions!

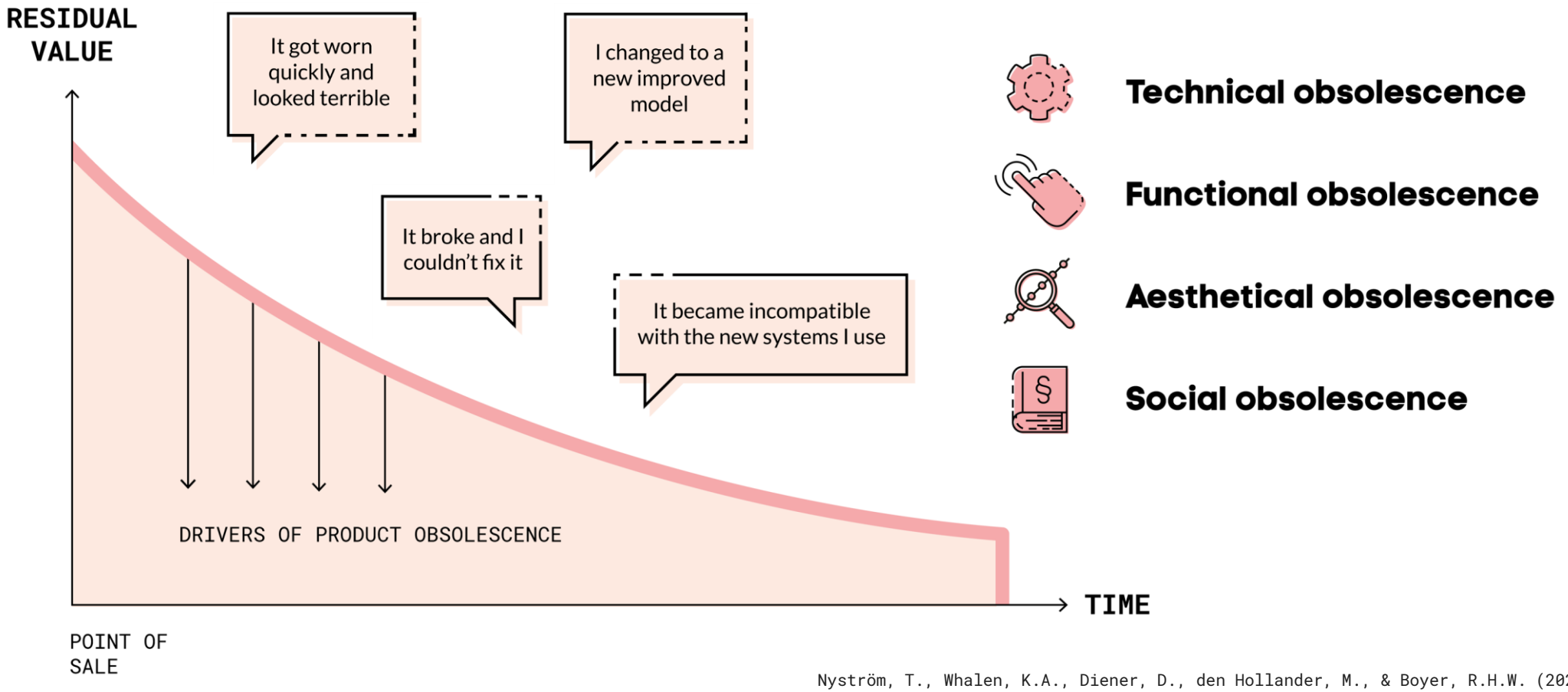
RI.
SE

RI.
SE

A tale of two Volvos


NISHIKI
SCHWALBE
KOJAK

Value lost over time due to premature obsolescence



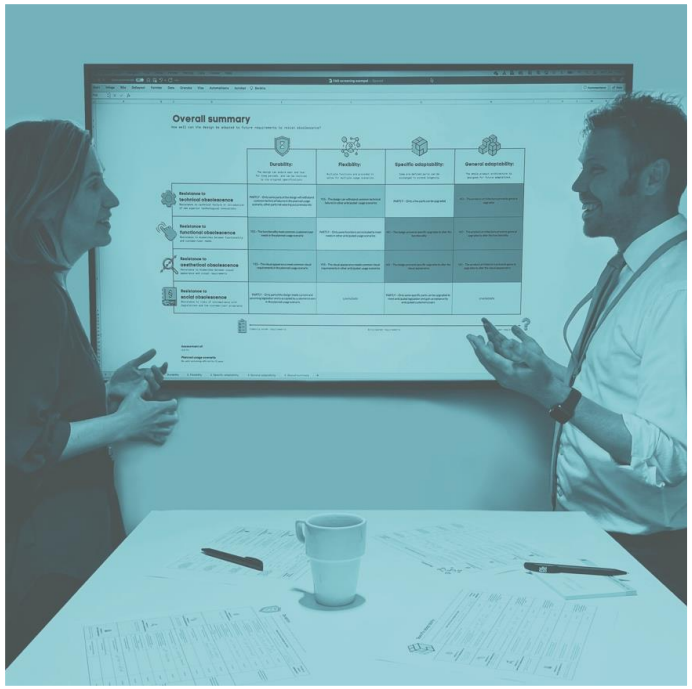
Nyström, T., Whalen, K.A., Diener, D., den Hollander, M., & Boyer, R.H.W. (2021)

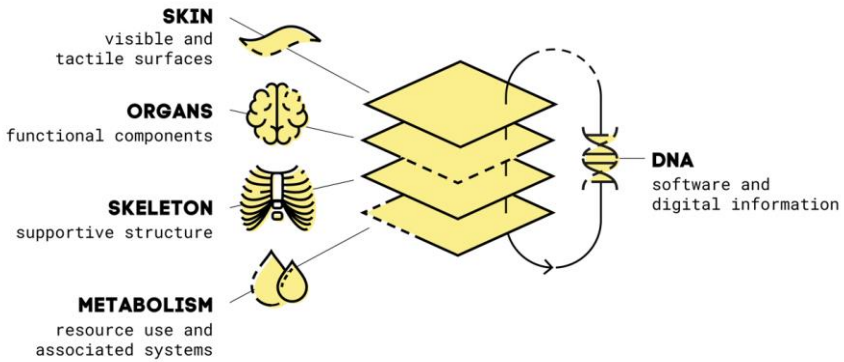
Technical obsolescence

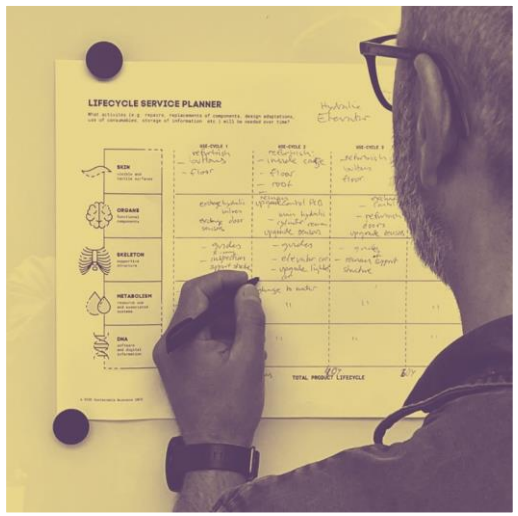
Functional obsolescence

Aesthetical obsolescence

Social obsolescence




SKIN
visible and
tactile surfaces
ORGANS
functional components
SKELETON
supportive structure
METABOLISM
resource use and
associated systems
DNA
software and
digital information


LIFECYCLE SERVICE PLANNER
SKIN
ORGANS
SKELETON
METABOLISM
DNA
TOTAL PRODUCT LIFECYCLE

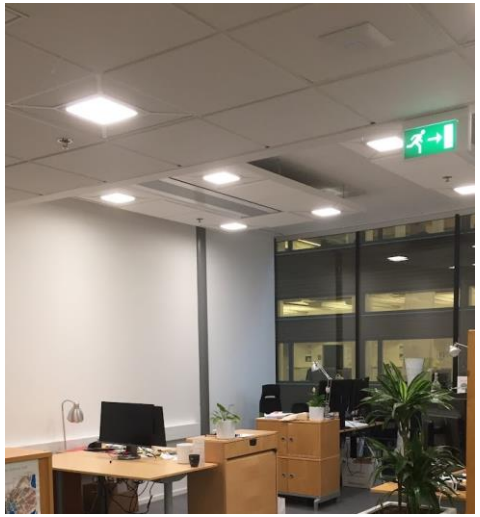
Future adaptive design – How to make products profitably last longer

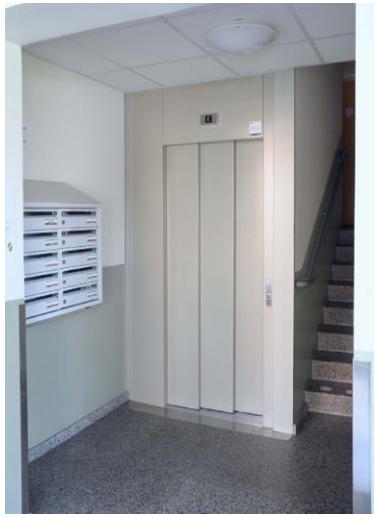

VIDDE


NEW OFFER
PAY PER KM


SCANIA


re:sign
by accus






BLIZ


Volvo Truck Center
ELECTRIC

Accessing the guide and toolbox

- Selvefors, A. & Nyström, T. (Eds.). (2023). Future Adaptive Design – How to create longer-lasting products for circular offerings. RISE. RISE report 2023:74. ISBN 978-91-89821-51-4.
- Freely available on the expertise page Future adaptive design at www.ri.se
- https://www.ri.se/sv/vad-vi-gor/expertiser/framtidsadaptiv-design-for-en-cirkular-e

Research

Thomas.Nystrom@ri.se

Circular Business Lab

Pernilla.Dahlman@ri.se

Marcus.Linder@ri.se

RI.
SE

Agenda

11.00 – 11.05	**Introduction and Welcome** Pierre Ingmarsson, Senior Project Manager, RISE Research Institutes of Sweden
11.05 – 11.20	**Nature-based solutions and mitigation of plastic pollution** Geraldine Thomas, Institute for circular economy & Nature based solutions
11.20 – 11.35	**Circularity by design principles** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
11.35 – 11.50	**Circular Design Case in Wave Energy – InfinityWEC** Mikael Sidenmark, CEO, Ocean Harvesting Technologies

Regroup into discussions groups (2 min)

11.50 – 12.20	**Work Group 1 – Integration of Circularity by design methodologies in the R&D process and company business model** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
	Work Group 2 – Validation in the marine environment Konrad Tarka, Director Durability, RISE Research Institutes of Sweden
	Work Group 3 – Ecosystem based design Geraldine Thomas, Institute for circular economy & Nature based solutions
	Work Group 4 – LCA and Environmental Impact Johanna Berlin, Director Research, NILU
12.20 – 12.30	**Summary and Final Discussions**

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

OCEAN HARVESTING

Generating electricity, one wave at a time

Circular Design Case in Wave Energy – InfinityWEC

1st mission arena Gothenburg, 16 Nov 2023

Mikael Sidenmark, CEO
mikael.sidenmark@oceanharvesting.com
+46 70 955 6166
www.oceanharvesting.com

Circular Design Considerations

- The transition to renewable energy is critical to tackle climate change
- Massive amounts of material is needed to build renewable power plants with limited lifetime
- New materials is needed to reduce cost and environmental impact.
- Opportunity to introduce new materials in early-stage technology, much more difficult at later stage.
- But challenging task that requires support with material development and testing.

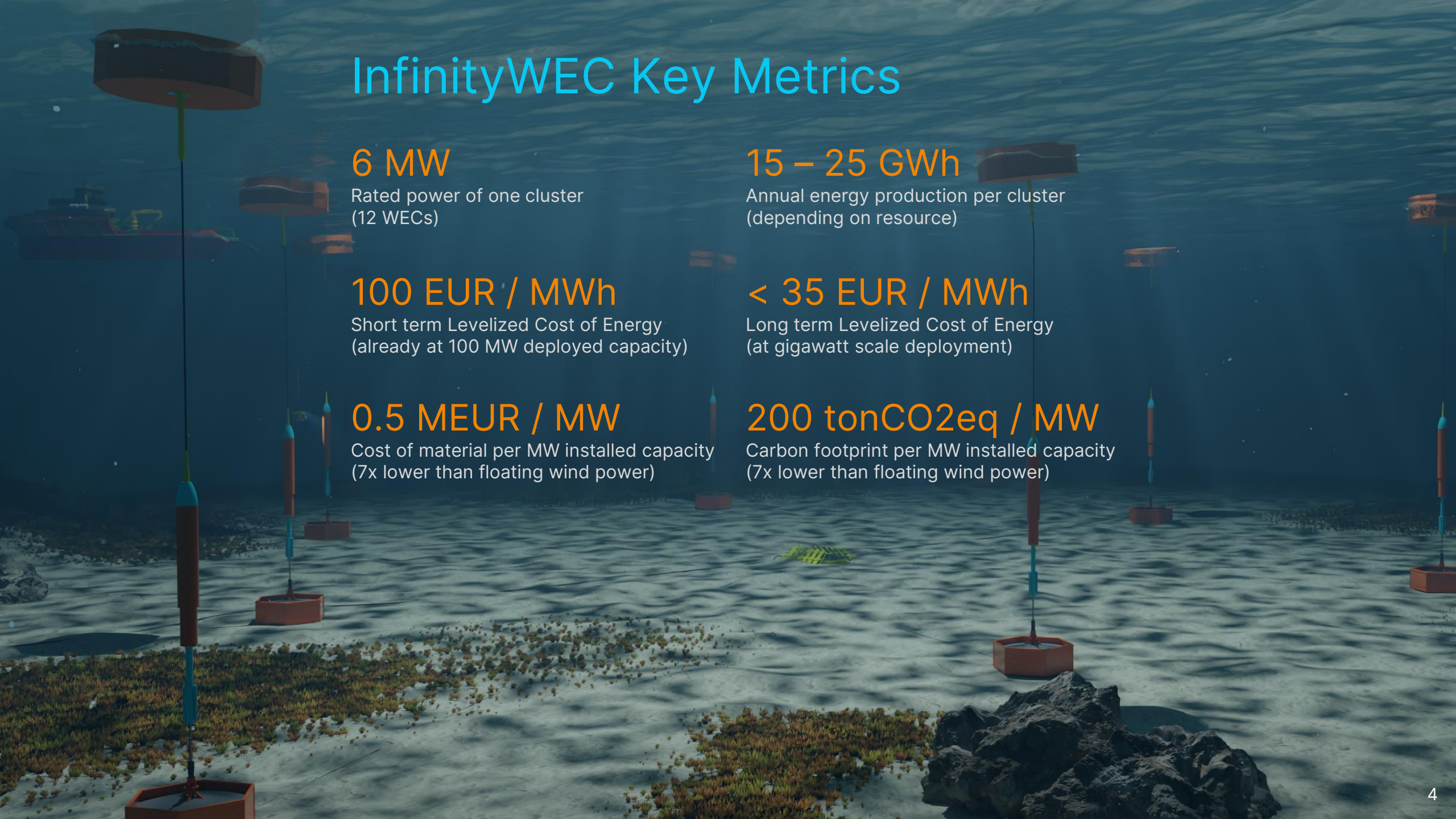
The Wave Power Opportunity

Easily accessible wave energy resources are estimated to 500 GW, 10% of global demand of electricity

Wave energy produces electricity more consistently and at different times than wind and solar, increasing the value of produced electricity by improving the grid balance and reducing the need for energy storage

The InfinityWEC Solution

- Breakthrough technology making wave energy competitive by maximizing the energy output from every individual wave
- High material efficiency and use of low-carbon materials, lead to low-cost electricity with low CO_2 footprint
- Wave farms have low visibility from shore, are area efficient and environmentally friendly



InfinityWEC Key Metrics

6 MW
Rated power of one cluster
(12 WECs)

15 – 25 GWh
Annual energy production per cluster
(depending on resource)

100 EUR / MWh
Short term Levelized Cost of Energy
(already at 100 MW deployed capacity)

< 35 EUR / MWh
Long term Levelized Cost of Energy
(at gigawatt scale deployment)

0.5 MEUR / MW
Cost of material per MW installed capacity
(7x lower than floating wind power)

200 tonCO2eq / MW
Carbon footprint per MW installed capacity
(7x lower than floating wind power)

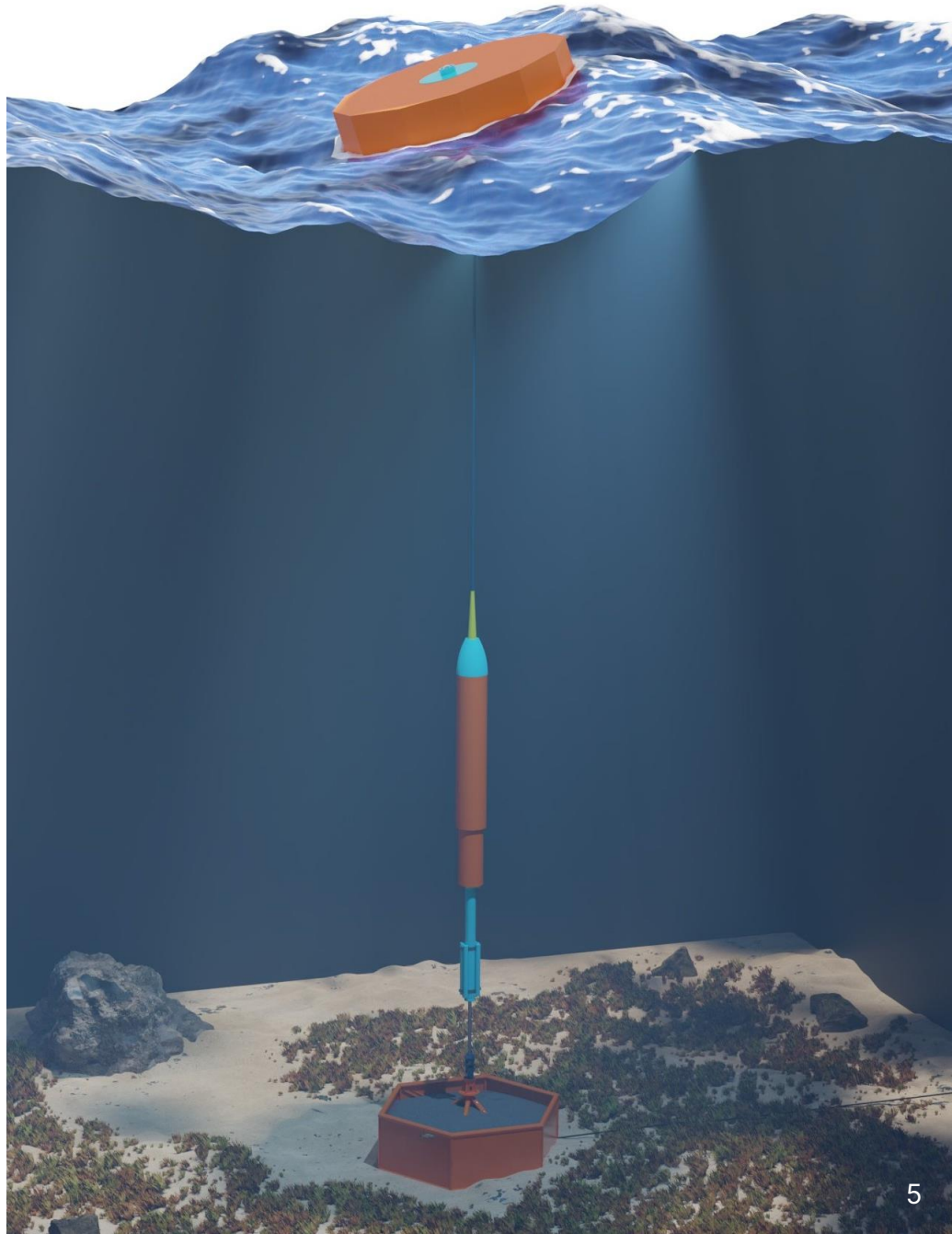
Introduction

Ocean Harvesting Technologies AB, based in Karlskrona/ Gothenburg, Sweden, develops novel technology to transform ocean waves into clean, reliable and cost-efficient electricity.

InfinityWEC is a wave energy converter with an **advanced power take-off system**, which tunes to every individual wave to efficiently extract energy in all sea states. An innovative **end-stop function** protects the system from high forces and ensures reliable power production even in the harshest wave conditions.

The **buoy is made with high strength concrete**, with similar weight as a conventional steel hull, but at a quarter of the cost, a third of the CO_2 footprint and one tenth of the manufacturing time.

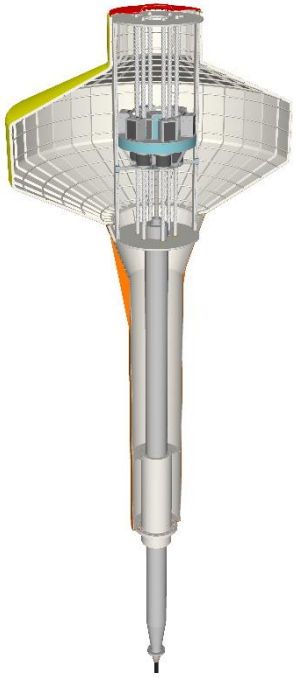
The excellent power production and reliability, combined with a modular design, where all critical parts are easily manufactured, transported, installed and maintained, make InfinityWEC a **highly competitive solution** for the future global energy market.



InfinityWEC Development

G1: 2017

- Mechanical flywheel based KERS and collection gear to ball screw actuators.
- Providing instant force control with reactive power.
- Enabling optimal predictive force control (MPC).



G2: 2018

- Electrical KERS with electric flywheel energy storage to provide reactive power.
- Mechanical gear system removed.
- Complexity reduced and efficiency and reliability improved.

G3: 2019

- Modular buoy with buoyancy blocks, separated from PTO.
- Pneumatic Pre-tension integrated with roller screw tidal adjustment.
- Improved efficiency, and flywheels no longer necessary to provide reactive power.

G4: 2020

- Honeycomb buoy with thin walls of high-performance concrete and EPS core.
- Reduced cost and CO2 footprint, fast and easy on-site manufacturing.

G5: 2021

- Two-stage submerge end stop provided with pneumatic spring in the tidal cylinder.
- Pre-tension and tidal adjustment separated into two hydraulic cylinders.
- Passive survival, manufacturability improved.

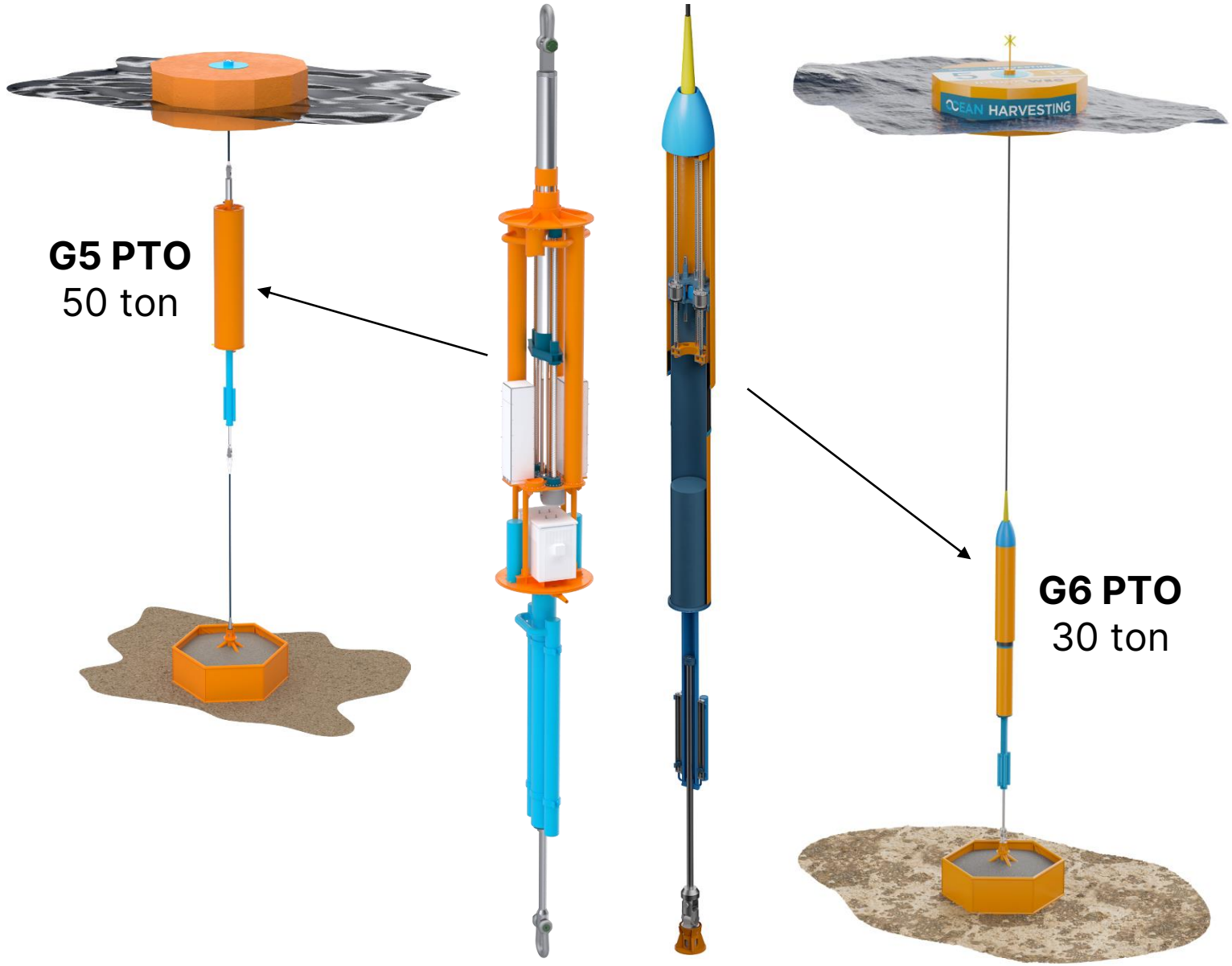
G6: 2022

- Hydraulic Pre-tension system replaced with a hydrostatic spring, PTO moved to seabed, (40% lower weight, reduced complexity).
- Rubber membrane instead of piston rod.
- Reduced cost, reliability improved.

Power Take-Off (PTO) Generation G5 vs G6

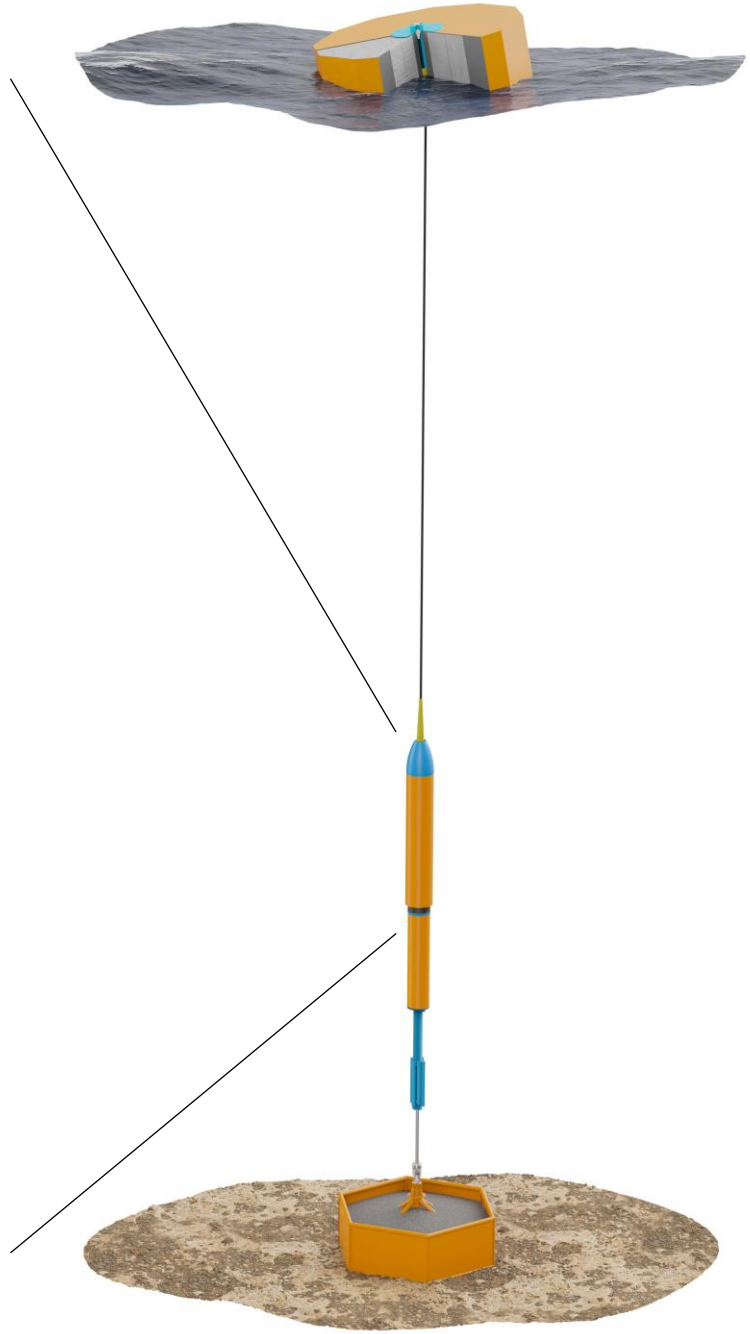
In G6, the hydraulic cylinder and gas accumulators used in G5 have been replaced by a hydrostatic pre-tension system.

- The PTO hull is split in two halves, being pushed together by the surrounding water pressure. This way half of the PTO control force (100 ton) is provided "for free" in the G6 design.
- The diameter of the PTO is reduced from 2.4 m to 1.6 m, and its weight by 40%, without compromising performance.
- G6 includes a flexible rubber membrane between the two halves to provide the sealing. This replaces the cylinder seal, thus eliminating the most critical point of failure in the G5 design, the wear and corrosion on the pre-tension cylinder extending upward through the PTO hull.



InfinityWEC Specification

- **Performance:**
  - 500 kW maximum average power
  - 2 GWh Annual Energy Production (medium-strong resource)
  - 80 – 200 m installation depth
- **Concrete buoy:**
  - 12 m width, 3.5 m height, 400 m^3 volume
  - 112 ton mass (100 ton concrete, 10 ton EPS, 2 ton steel)
- **Power Take-off:**
  - 2.25 MN PTO force capacity with model predictive control
  - 5.5 m heave stroke
  - 4 m tidal adjustment
  - 18 m height (fully contracted), 1.6 m diameter
  - 30 ton weight
- **Anchor:**
  - 30 ton cage (concrete / steel)
  - 500 ton ballast



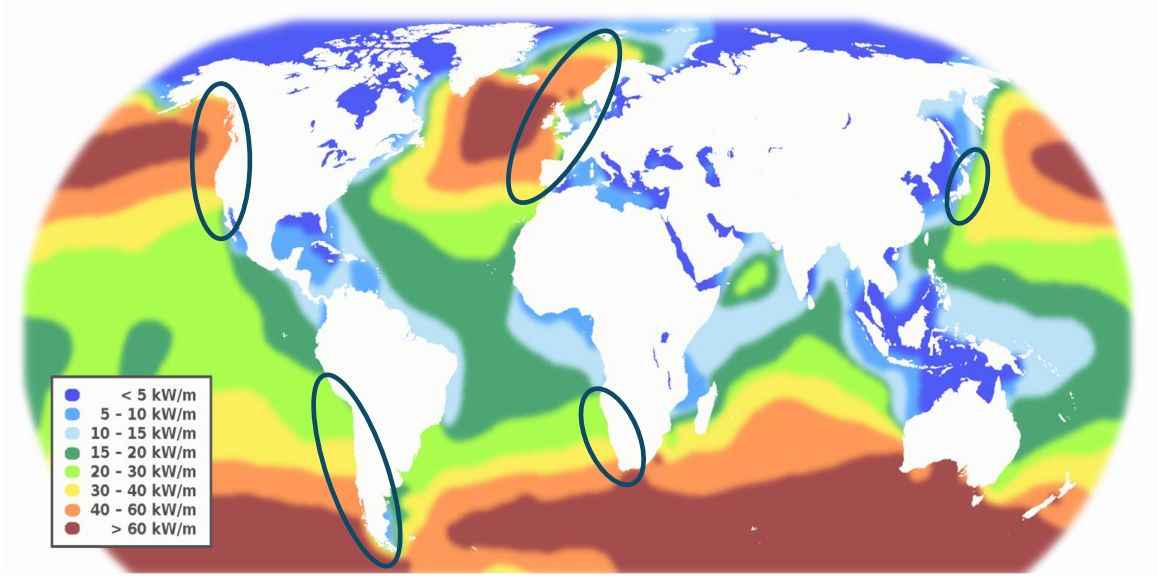
InfinityWEC Target Markets

Target markets are utility scale wave farms connected to onshore grids, off-grid power supply to Island communities, oil & gas platforms, aqua culture and green hydrogen and ammonia production.

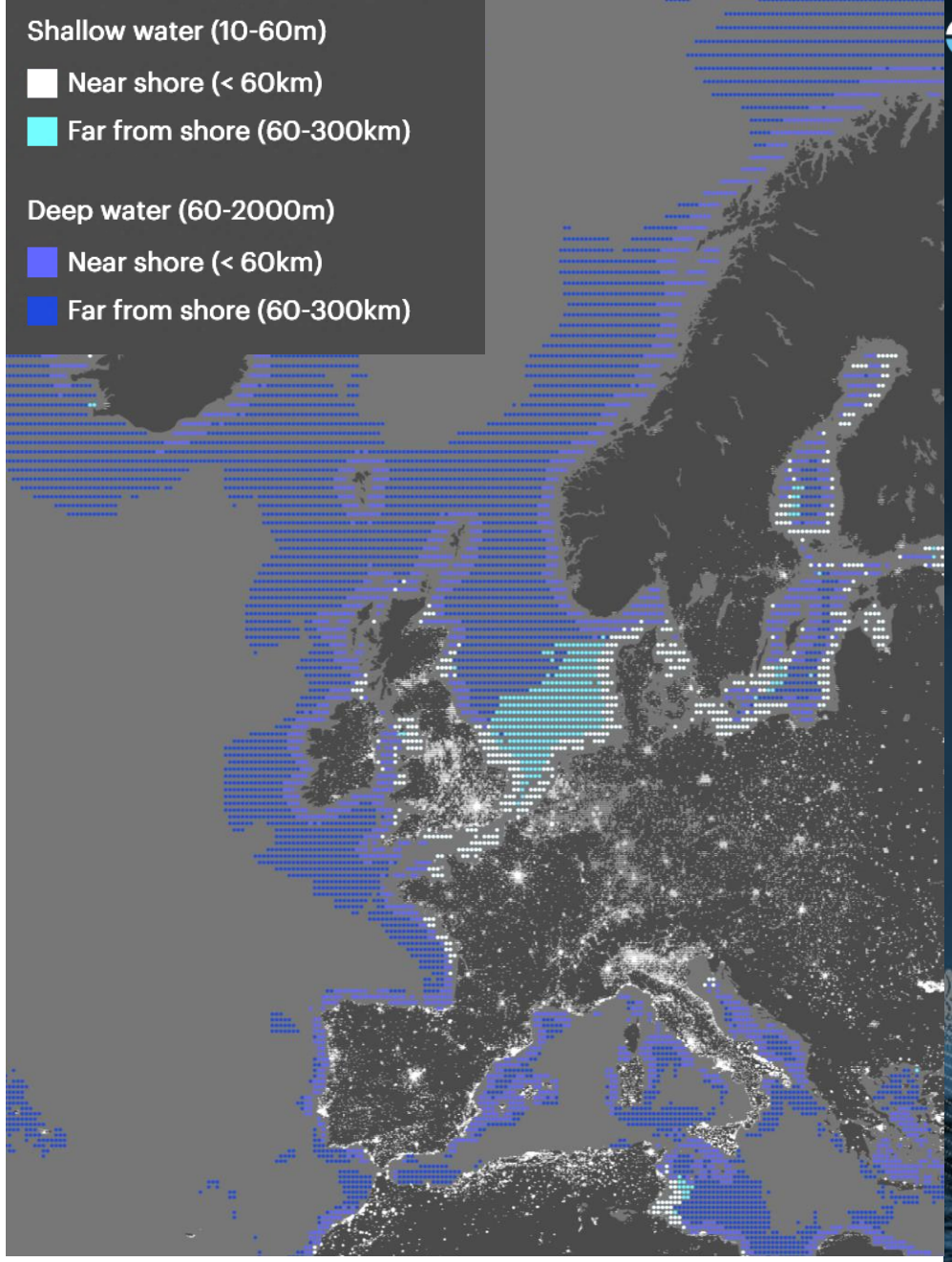
Attractive locations for InfinityWEC wave farm installations are ocean areas characterized by 80 – 200 meters depth and wave resources > 25 kW/m.

Most of the west coast of Europe has deep water close to shore and very good wave resources in the range of 40 – 60 kW/m, and >60 kW/m outside British Isles.

Norway, a major producer of oil and gas as well as hydropower, plans to commission up to 30 GW of offshore wind capacity by 2040.



Suitable areas for InfinityWEC indicated on a World Wave Energy Resource Map (ref. Wikimedia Commons)



iea – Offshore Wind Geospatial Analysis

Material Efficiency

InfinityWEC vs Floating Wind Power

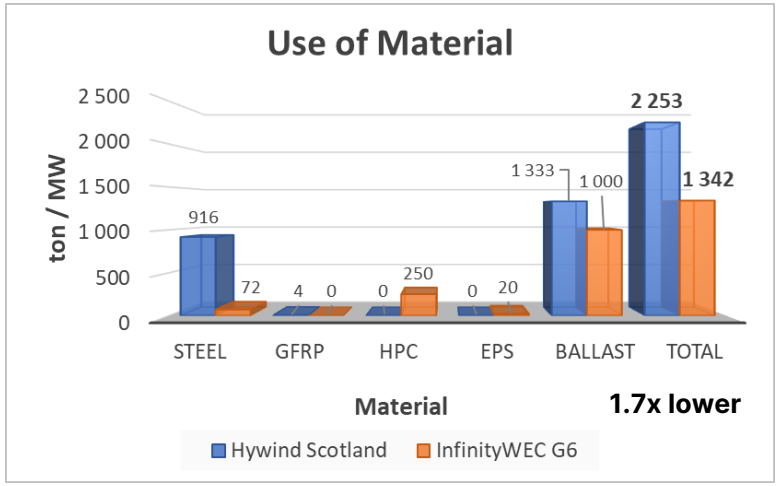
- Material efficiency is a valuable complementary metric to LCOE, to compare the economic potential and environmental impact of different technologies based on the materials used.
- Measured as total mass, cost and CO2 footprint per MW installed capacity.

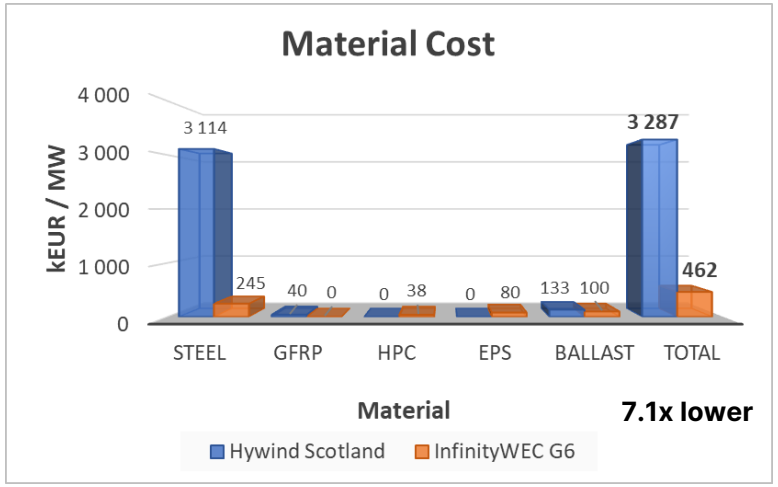
Compared to floating wind power (Hywind Scotland), InfinityWEC uses:

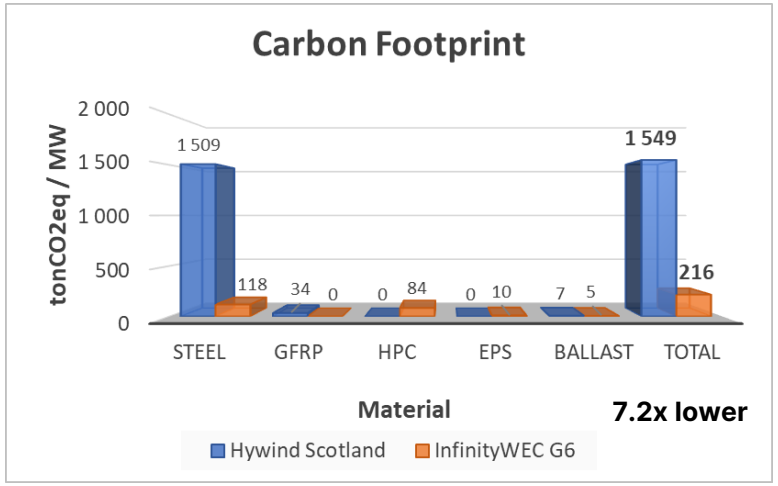
- Low cost, low carbon materials to a larger extent, leading to 7x lower cost and 7x lower CO2 footprint.
- Buoy made of concrete and EPS, leading to 13x less use of steel.
- No GFRP.

Material Cost	**EUR/ton**
Steel	3400
High Performance Concrete (HPC)	150
Low Carbon Cellular Plastic (EPS)	4000
Glassfibre Reinforced Plastic (GFRP)	9500
Ballast (Magnadense)	100

Carbon Footprint	**kgCO2eq/kg**
Steel	1,640
High Performance Concrete (HPC)	0,335
Low Carbon Cellular Plastic (EPS)	0,480
GFRP (wind turbine blades)	8,100
Ballast (Magnadense)	0,005







Ref: Hywind Scotland - Environmental Statement
Ref: Hywind Scotland - Brochure

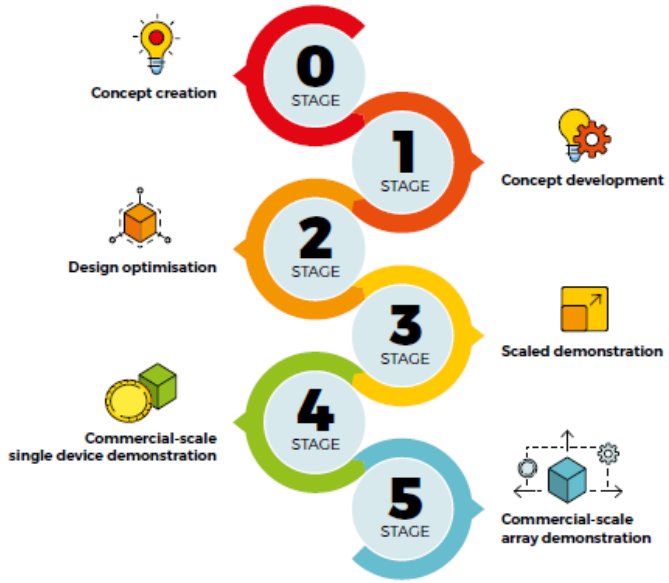
Staged Development Road Map

2021	2022	2023	2024	2025	2026	2027	2028 →
Stage 2 (TRL 5) - COMPLETED **Design Optimization** **Scale 1:10 Test Rig** **Oil&Gas Case Study** 8 persons		Stage 3 (TRL 6) **Scaled Demonstration** Sea Trials in scale 1:3 5 MEUR (public + private) 15-20 persons			Stage 4 (TRL 7-8) **Commercial-scale Single WEC Demonstration** ~16 MEUR (public + private) 30-40 persons		Stage 5 (TRL 9) **Commercial Array Demo** ~20 MEUR (customers, public + private) >50 persons

InfinityWEC is developed in a staged approach in line with Ocean Energy Systems framework for ocean energy technology.

Next stage 3 is Scaled Demonstration (sea trial) Jan2024 - Dec2025. Preparing for this, OHT is during 2023 optimizing the control system and updating system design.

The scaled demonstration will be followed by full-scale demonstration, arrays demonstration and commercialization



From: Ocean Energy Systems An International Evaluation and Guidance Framework for Ocean Energy Technology

Team

Mikael Sidenmark, CEO, founder, board member: 15 years experience in wave power technology development, author of 20 approved / pending patent application.

Markus Wallentin, CTO: with 25 years' experience of product development and project execution for marine renewables, subsea oil & gas, automotive, train and industry applications.

Johan Grönkvist, Head of Supply Chain: with 15 years' broad experience in product development from geotechnical drill rigs to subsea components used in the oil & gas industry.

Johannes Palm, Head of Simulation and Control, Sigma E&M : PhD in numerical simulation of wave energy, with deep knowledge of hydrodynamics and Computational Fluid Dynamics.

Andreas Berg, Lead Engineer, Sigma E&M: Extensive experience from product development, specialist within subsea equipment and marine renewable solutions.

External Engineering Expertise

Control Strategy
Experts in modelling and control including system simulations, control algorithm and implementation on real time systems.

Control System
Specialist with internationally recognized knowledge in implementation of Beckhoff control systems. Experienced in wave power development.

Mechatronics
Expert in implementation and installation of automated equipment.

Ocean Energy
15-year experience in the wave energy sector with combined technical and financial background.

Partners

SIGMA Energy & Marine

MOTION & CONTROL NSK

COMBINE

RI. SE

Swedish Energy Agency

COER Centre for Ocean Energy Research

Maynooth University National University of Ireland Maynooth

BLEKINGE TEKNISKA HÖGSKOLA · BTH ·

CHALMERS UNIVERSITY OF TECHNOLOGY

AALBORG UNIVERSITY DENMARK

For more information, contact:

Mikael Sidenmark, CEO
mikael.sidenmark@oceanharvesting.com
+46 70 955 6166
www.oceanharvesting.com

Agenda

11.00 – 11.05	**Introduction and Welcome** Pierre Ingmarsson, Senior Project Manager, RISE Research Institutes of Sweden
11.05 – 11.20	**Nature-based solutions and mitigation of plastic pollution** Geraldine Thomas, Institute for circular economy & Nature based solutions
11.20 – 11.35	**Circularity by design principles** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
11.35 – 11.50	**Circular Design Case in Wave Energy – InfinityWEC** Mikael Sidenmark, CEO, Ocean Harvesting Technologies

Regroup into discussions groups (2 min)

11.50 – 12.20	**Work Group 1 – Integration of Circularity by design methodologies in the R&D process and company business model** Marcus Linder, Director Sustainable Business, RISE Research Institutes of Sweden
	Work Group 2 – Validation in the marine environment Konrad Tarka, Director Durability, RISE Research Institutes of Sweden
	Work Group 3 – Ecosystem based design Geraldine Thomas, Institute for circular economy & Nature based solutions
	Work Group 4 – LCA and Environmental Impact Johanna Berlin, Director Research, NILU
12.20 – 12.30	**Summary and Final Discussions**

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

Work Group 1 – Integration of Circularity by design methodologies in the R&D process and company business model

1. Which dimension of circular design is the best established already in your industry? Which is the least established?

2. Which department in your firm will champion more circular design? Which department is skeptical?

3. Which businesses would benefit the most from a move towards increased circularity (e.g. longevity, material circulation, increased utilisation) in your industry? Who would lose?

4. If you had a magic wand that could change anything in your job, what would you use it for in order to promote the transition to a circular economy in your work?

5. What would you recommend for actions in Europe to support the integration of circularity by design principles?

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

Work Group 2 – Validation in the marine environment

1. How comfortable/confident are you with the current state of validations protocols (standards/regulations)
2. How does your organization work with validating the environmental impact of your materials on the aquatic environment.
3. What is the acceptable trade of acceleration/accuracy for validation within your field?
4. How much time do you allocate for validation before implementing a new material/component/product?
5. Are the challenges and needs to validate materials in the marine environment?
6. What would you recommend for actions in Europe to support validation products in the marine environment and makes sure “do no harm” is fulfilled?

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

Work Group 3 – Ecosystem based design

1. Have you heard about ecosystem-based design/solutions in the maritime environment? Give some examples.

2. Which opportunities and synergies can arise from the application of ecosystem-based design?

3. Which challenges and conflicts do you see for the implementation of ecosystem-based design?

4. What do we need to do to accelerate the application of ecosystem-based design in the EU? Research, storytelling, incentives, regulations?

5. How should we proceed to integrate ecosystem-based design more in maritime environments?

6. What would you recommend for actions in Europe to support include ecobased design in our installation in the marine environment?

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union

Work Group 4 – LCA and Environmental Impact

1. Do you have the LCA knowledge in house?
2. When do you perform your LCA?
3. How do you use the result of the LCA in your company?
4. Which environmental impact categories are most interesting for your organisation?
5. What would you recommend for actions in Europe to support the assessment of marine technologies?

Pierre Ingmarsson
RISE Research Institutes of Sweden
pierre.ingmarsson@ri.se

Mikael Sidenmark
Ocean Harvesting Technologies
mikael.sidenmark@oceanharvesting.com

Geraldine Thomas
Institute for circular economy & Nature based solutions
geraldine.thomas@alchemia-nova.net

Johanna Berlin
The Climate and Environmental Research Institute
jber@nilu-research.se

Marcus Linder
RISE Research Institutes of Sweden
marcus.linder@ri.se

Konrad Tarka
RISE Research Institutes of Sweden
konrad.tarka@ri.se

BLUE MISSION BANOS

EU MISSIONS RESTORE OUR OCEAN & WATERS

Funded by the European Union