OPIN Webinar: OPIN & Ocean Energy Systems Technology Collaboration Programme (OES TCP)

15th of July 2021

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EUROPEAN UNION
North-West Europe
OPIN
European Regional Development Fund

Welcome

- Attendees’ microphones will be muted during the event.
- After the presentation there will be time for a Q&A Session.
- Questions can be formulated in the chat at any time, and they will be addressed during the Q&A session.
- The event will be recorded, and the slides will be shared on the OPIN website.

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Agenda

14:00 – 14:10	Welcome address and intro to OPIN by Patricia Comiskey, SEAI Programme manager
14:10 – 14:25	Intro to IEA-OES by Ana Brito e Melo, IEA-OES Executive Secretary
14:25 – 14:40	Jobs creation by Yann-Hervé De Roeck, IEA-OES Chairman
14:40 – 14:55	Performance Metrics by Jonathan Hodges, Senior Innovation Engineer
14:55- 15:10	OES Environmental by Anne Marie O'Hagan, Senior Research Fellow at UCC MaREI Centre for Energy, Climate and Marine
15:10 –15:25	Q&A session
15:25 –15:30	Close

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OPIN Introduction

Patricia Comiskey– SEAI

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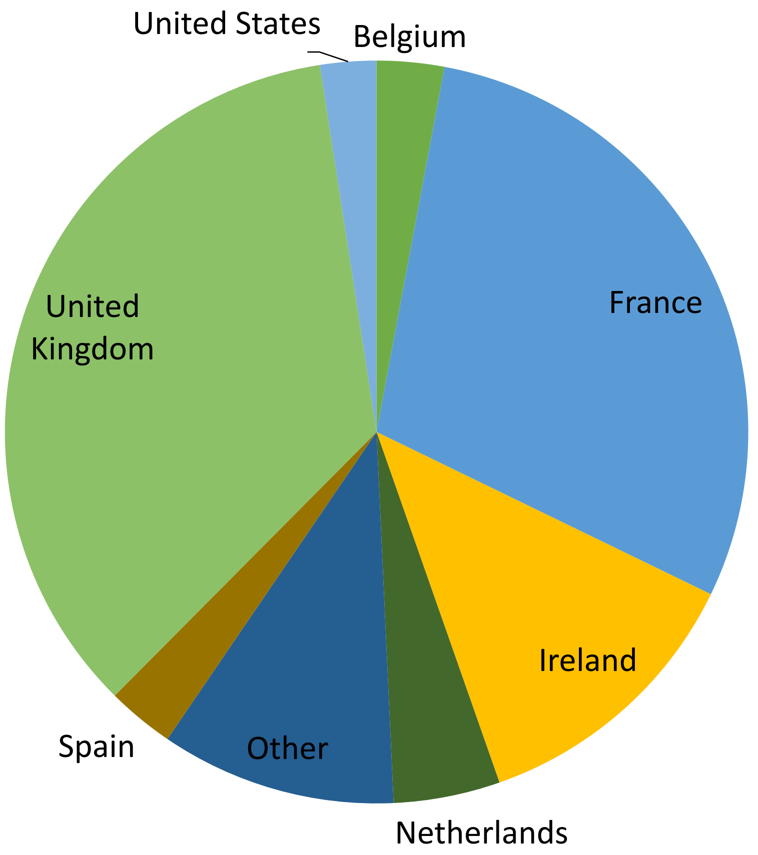
Who are OPIN ?

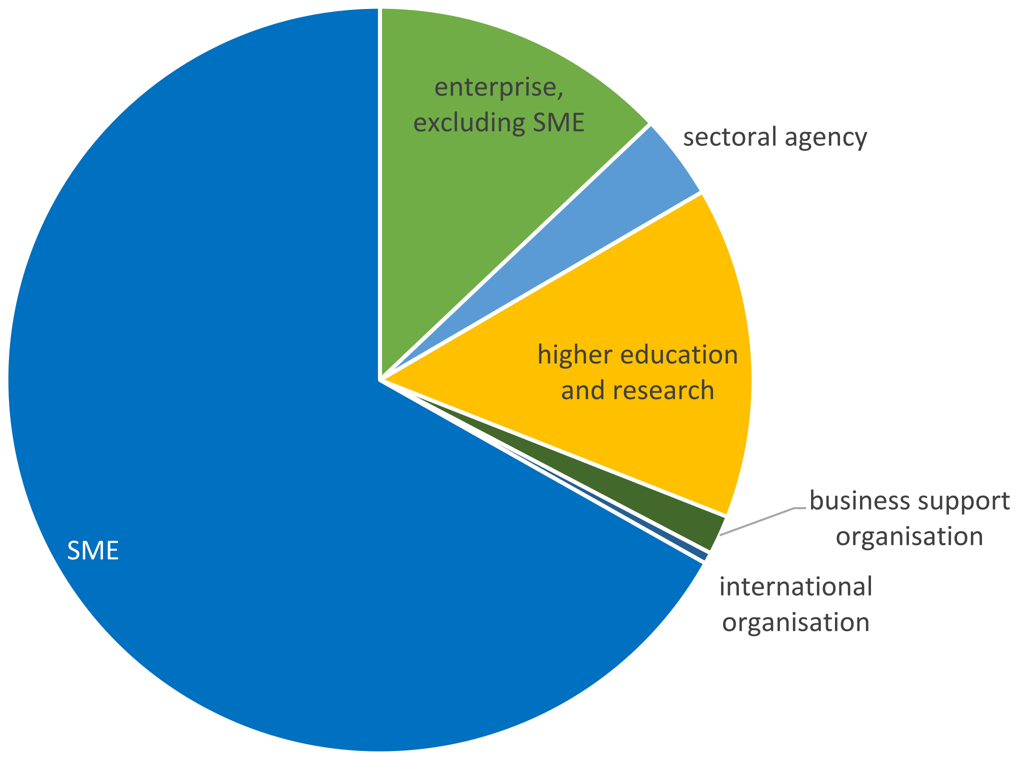
7 partners from Ireland, UK, Belgium, France, the Netherlands and Germany

Project Partners	Countries/Regions
Sustainable Energy Authority of Ireland (SEAI)	Ireland
Scottish Enterprise (SE)	Scotland
Offshore Renewable Energy Catapult (OREC)	United Kingdom
Sirris, het collectief centrum van de technologische industrie (SIRRIS)	Belgium
West Atlantic Marine Energy Community, École Centrale de Nantes (WEAMEC)	France Pays de la Loire
Dutch Marine Energy Centre (DMEC)	Netherlands
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (Fraunhofer IEE)	Germany

OPIN Members

435 members from
28 countries





Other countres (2 members or less):
Australia, Canada, Denmark, Finland, Germany, Hong Kong, India, Indonesia, Italy, Malaysia, Monaco, Norway, Russia, Sweden, Switzerland, Vietnam

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What can OPIN do for you (1/2)

Access **free events**: learning and networking opportunities

- **OPIN Annual Symposium 2021:** 23rd of September 2021
- **O&M in Emerging Ocean Energy Technologies –** *September tbc*
- **Financial Modelling for O&M in the Marine Energy Sector –** *September tbc*

Have a look at our Events page and register today !

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What can OPIN do for you (2/2)

Receive **travel support**

- ✓ Enabling Irish and Scottish Enterprise SMEs to travel abroad for OPIN events

Access **expert advice** on your technology (TAPs)

- ✓ Independent expert opinion – e.g. on the route to market, on reducing development risks and costs, etc.
- ✓ Advice on next steps, funding and collaboration opportunities

Support **collaborative projects** (CIGs)

- ✓ Preparatory step to National and EU research calls
- ✓ Find ways to solve technical or financial problems you are facing
- ✓ Expand your network nationally and internationally
- ✓ Benefit from the experience of those in other industries

OPIN Resources

OPIN Members list

OPIN Library:

- Workshops/masterclasses presentations
- Value chain study - summary report
- Ocean energy challenges and recommendations: Desktop analysis of studies and reports

OPIN Twitter **and** Linkedin **groups.** Join us for the latest updates!

Email us at: OPIN@seai.ie

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IEA OES Introduction

Ana Brito e Melo, IEA-OES Executive Secretary

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IEA Technology Collaboration Programme
OCEAN ENERGY SYSTEMS

Ana Brito e Melo
IEA-OES Executive Secretary

Technology Collaboration Programme by iea

Energy Security and Sustainability begins with Global Collaboration

Unique technology network

Essential forum for governments and industry

IEA Technology Collaboration Programmes

Over 40 groups of experts – Technology Collaboration Programmes (TCPs)

Working in the following areas:

Renewable Energies

- Efficient end-use Technologies
- Fossil Fuel
- Cross-cutting issues

IEA Ocean Energy Systems

IEA-OES embraces the full range of ocean energy technologies:

- Wave
- Tidal range
- Tidal and ocean currents
- Ocean thermal energy conversion
- Salinity gradients

Participation in OES builds connections between national governments and industries, creates networks of experts and expands national research capacities.

Diversified Representation Of Interests In The Exco

Members:

Vision for International Deployment of Ocean Energy

- Resources & Technologies
- Development themes
- Technology Development areas
- Cost reductions
- Challenges for uptake of ocean energy
- Technology Transfer
- Products & Markets
- Policies

Technology Development Areas

ENHANCED RELIABILITY

COST REDUCTION

PERFORMANCE IMPROVEMENT

Critical Themes

for the successful introduction of ocean energy into a very competitive energy supply market

- STRUCTURE & PRIME MOVERS
- FOUNDATION & MOORINGS
- POWER TAKE-OFFS & CONTROL SYSTEMS
- ARRAYS SYSTEMS AND SUBSEA CONNECTIONS
- INSTALLATION, MAINTENANCE & RECOVERY

IEA - OES Work Programme

Projects

- Environmental Effects and Monitoring Efforts
- Cost of Energy Assessment for Wave, Tidal, and OTEC
- International Evaluation Framework for Ocean Energy
- Assessment of Jobs Creation on Ocean Energy
- Alternative Markets on Ocean Energy

Working Groups

- Numerical Modelling on Wave Energy
- Numerical Modeling on Tidal Energy
- Assessment of OTEC Resource

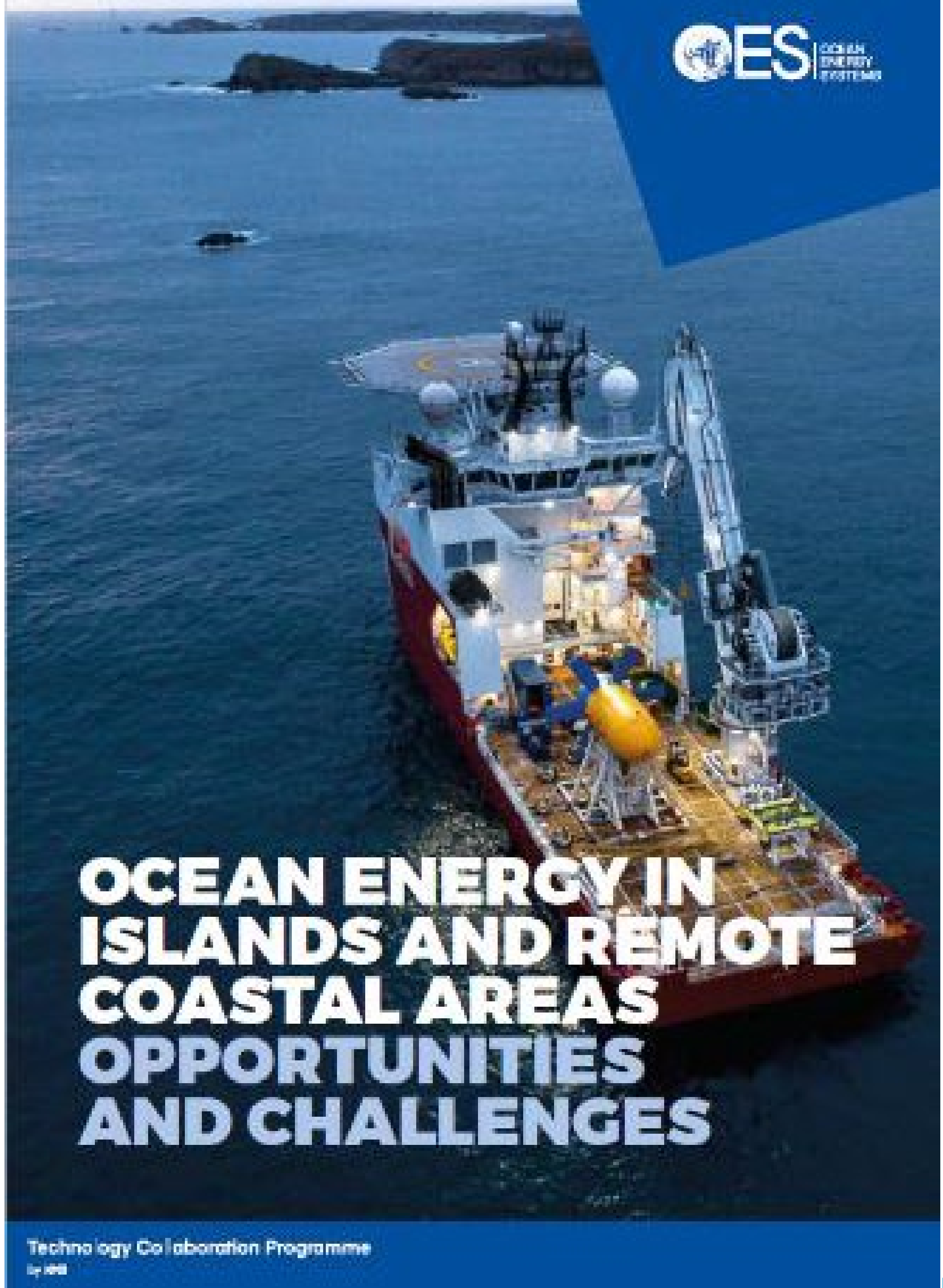
DataBases

- TETHYS – Environmental Data
- Worldwide Web GIS Database for Ocean Energy
- Consenting Processes for Ocean Energy

Alternative markets on Ocean Energy

→ ISLANDS AND REMOTE COASTAL AREAS

- Energy systems in islands and remote locations face challenges: security of supply and access to modern, clean, and affordable energy.
- Ocean energy can provide predictable and *low-carbon energy* and *socio-economic benefits*
- There are *opportunities (i.e., potential markets)* for ocean energy in the short, medium and long-term
- Nonetheless, *technical, socio-environmental, legal* and *financial* challenges remain



Alternative markets on Ocean Energy

→ OFFSHORE AQUACULTURE

- Ongoing study on the energy requirements
- Sustainability
- Potential synergistic opportunities
- Outline of case studies
- Challenges and recomendations

→ DESALINATION

- Study to be commissioned
- Understanding the potential
- Assessing the technology
- Suitable hybrid combinations & key factors
- The way forward

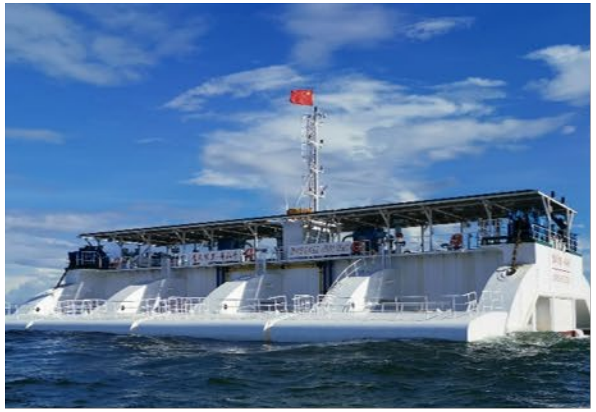
2021

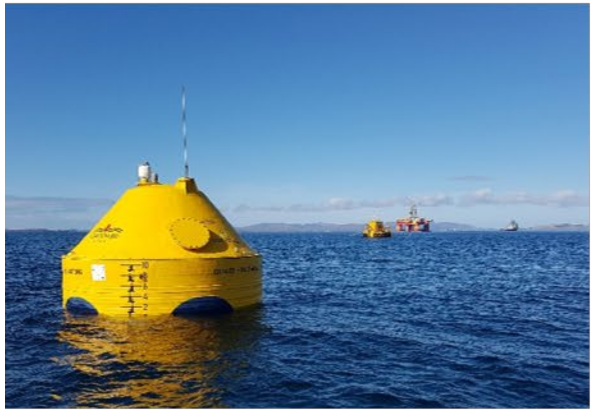
WAVE ENERGY DEVELOPMENTS HIGHLIGHTS

Successful deployments have taken place

OES OCEAN ENERGY SYSTEMS

- Several **full-scale devices** in the manufacturing phase or preparing for deployment
- **Continuous evolution** along the TRL scale and first farms are being designed
- A number of **potential breakthroughs** have been developed
- A **wide variety** of wave energy technologies
- **Extensive testing** programmes are still required





2021

TIDAL CURRENT ENERGY DEVELOPMENTS
HIGHLIGHTS

Progress in recent years

- Approaching design **convergence**
- **Approaching commercialisation**, with deployment of full-scale devices and first arrays
- **Progress demonstrated** by operating hours accumulated and electricity generated
- **Need for further technology investigation** and demonstration for long periods of time

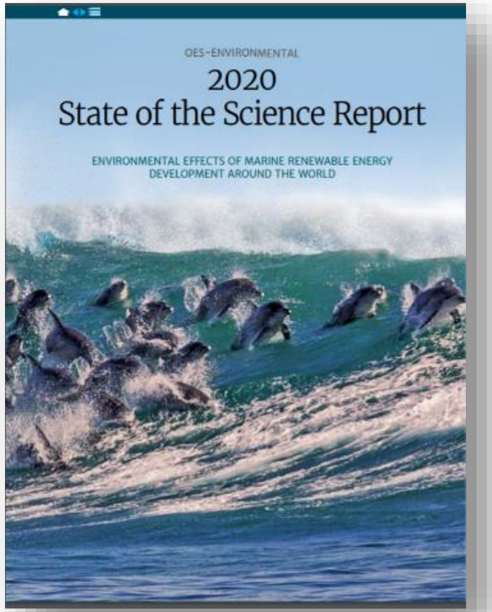


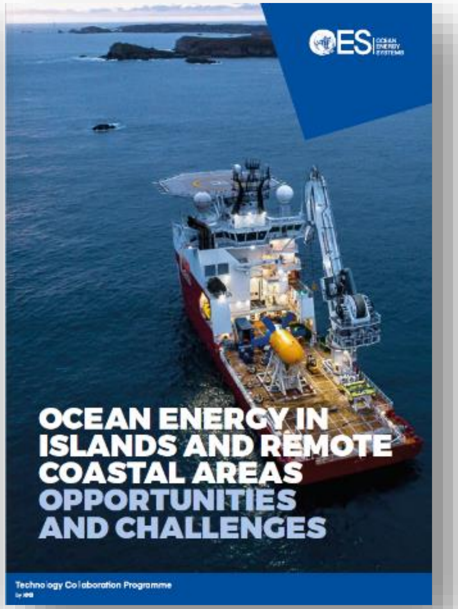


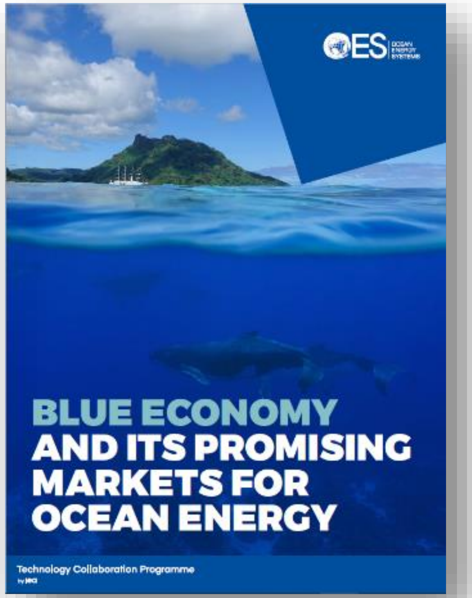


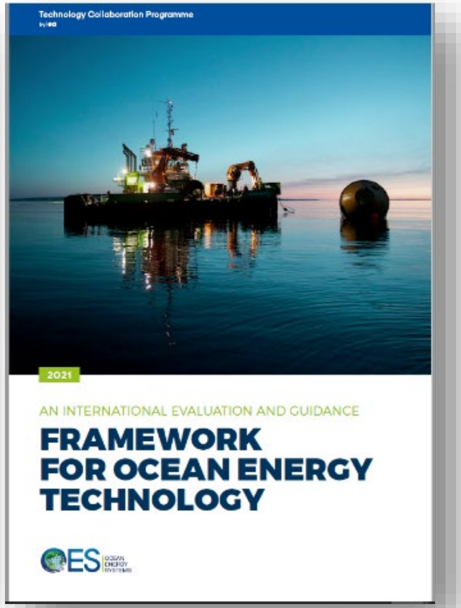


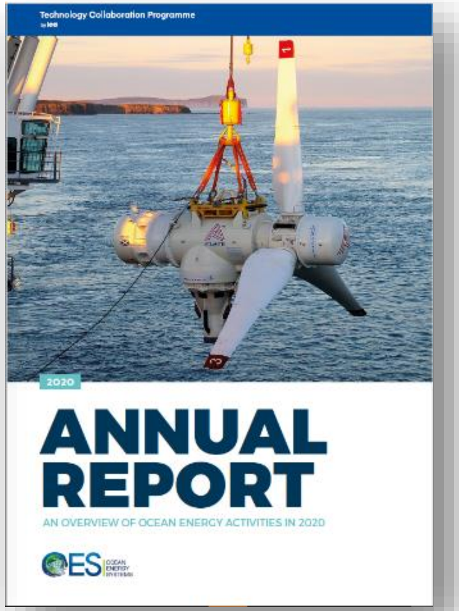
OES Publications

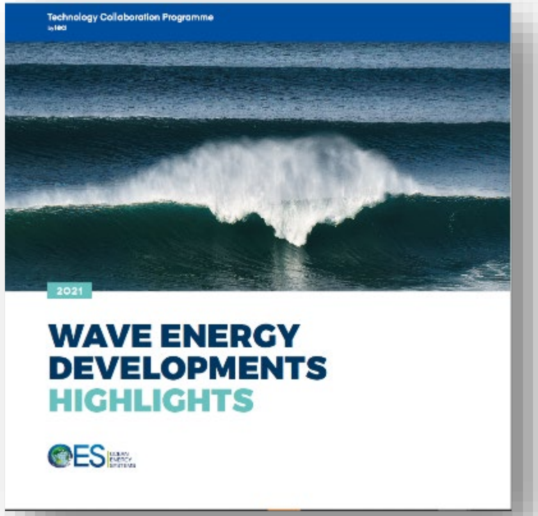


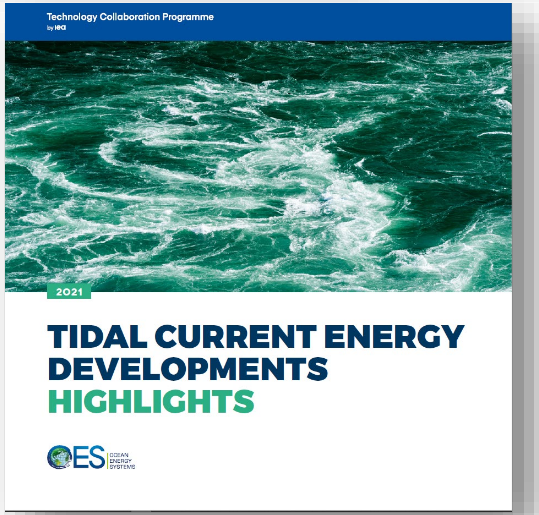












Next Publications:

- Alternative Markets: Interview (October 2021)
- OTEC White Paper
- Jobs Creation

www.ocean-energy-systems.org

THANK YOU

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EXECUTIVE COMMITTEE

Yann-Hervé De Roeck
Chair
France Energies Marines, FRANCE
yhdr@france-energies-marines.org

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Vice-Chair
European Commission
Matthijs.SOEDE@ec.europa.eu

Purnima Jalihal
Vice-Chair
NIOT, INDIA
purnima@niot.res.in

Ana Brito e Melo
Secretary
WavEC, PORTUGAL
ana@wavec.org

How many jobs in Europe in the OES sector: Horizon 2050

Yann-Hervé De Roeck, IEA-OES Chairman

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TOPIC of the OES study:
OCEAN ENERGY JOBS CREATION: METHODOLOGICAL STUDY AND FIRST GLOBAL ASSESSMENT

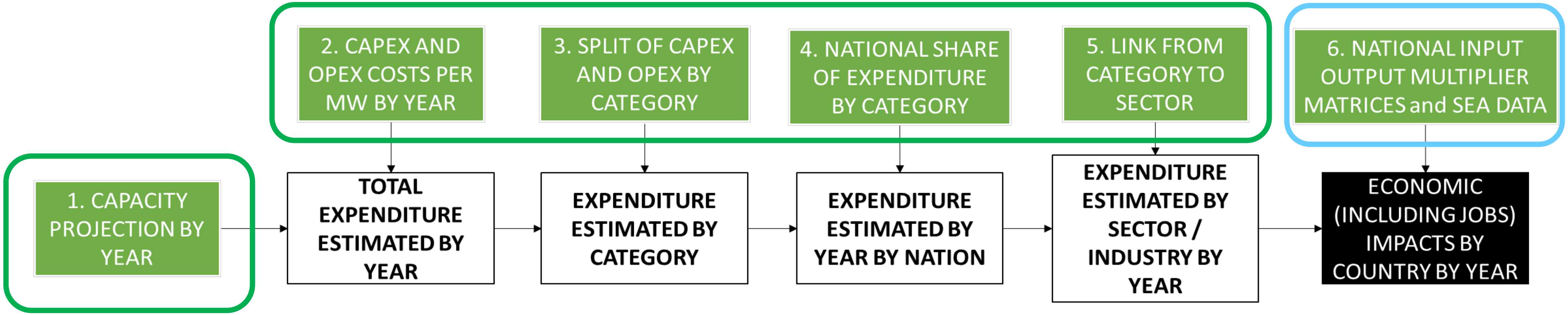
- **Team in charge of delivery**

Claire BARON	INNOSEA
Florian CASTILLO	INNOSEA
Félix GORINTIN	INNOSEA
Yann-Hervé DE ROECK	France Energies Marines
Grant ALLAN	Univ. Strathclyde

- **Today's summary**

1. Methodology summary
2. Inputs for European jobs assessment
3. Results of European jobs assessments
    1. Total employments, Output and Gross Value Added
    2. Direct, indirect and induced employments

Methodology summary



From the ExCo members

Economic inputs

Green boxes: inputs data

White boxes: intermediate results

Black box: final result

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COUNTRIES INCLUDED IN THE STUDY

8 countries are included:
- Canada
- Denmark
- France
- Ireland
- Portugal
- Spain
- United Kingdom
- United States of America

NB: The countries included are limited to the ones which have provided detailed enough input to run the model.

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INPUTS for JOBS ASSESSMENT

Needed inputs are the following:

- Capacity outlook
- CAPEX and OPEX
- Split of CAPEX and OPEX by sector, allocation of these sectors to SIC codes
- National share in spending of national and international projects

To ease the process of data collecting, some inputs are assumed to be the same regardless of the country

Inputs required from each country are:

- Capacity outlook
- National share in spending of national and international projects

Constant inputs (regardless of the country) are:

- CAPEX and OPEX
- Split of CAPEX and OPEX by sector, allocation of these sectors to SIC codes

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INPUTS for JOBS ASSESSMENT

CAPEX and OPEX: assumed to be the same for all countries

CAPEX and OPEX per ocean technology		Units	Costs per MW (per year) in 2015*	Annual cost reduction (%, p.a., 2020-2050)
Wave	CAPEX	€/kW	7675	4%
	OPEX	€/kW/year	263	4%
Tidal	CAPEX	€/kW	5475	4%
	OPEX	€/kW/year	293	4%
OTEC	CAPEX	€/kW	13325	4%
	OPEX	€/kW/year	598	4%

*Source: International levelised cost of energy for ocean energy technologies. IEA-OES. 2015.

INPUTS for JOBS ASSESSMENT

Split of CAPEX and OPEX by sector: assumed to be the same for all countries

		Spending by category by technology % of total		
		Wave	Tidal	OTEC
CAPEX	Construction	32%	32%	32%
	Turbines / generators	9%	9%	9%
	Electrical equipment	5%	5%	5%
	Metal equipment	14%	14%	14%
	Civil construction	9%	9%	9%
	Consulting and engineering services	14%	14%	14%
	Financial services	15%	15%	15%
	Energy sector	1%	1%	1%
	Total	**100%**	**100%**	**100%**

		Spending by category by technology % of total		
		Wave	Tidal	OTEC
OPEX	Construction	25%	25%	25%
	Energy sector	25%	25%	25%
	Components and maintenance	50%	50%	50%
	Total	**100%**	**100%**	**100%**

Source: Eur'Observer report (2017)

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INPUTS for JOBS ASSESSMENT

CAPEX and OPEX: allocation of sectors to NACE codes

	Category	Allocation to NACE codes (Nomenclature statistique des activités économiques dans la Communauté européenne) for each category	
CAPEX	Construction	**C33**	Repair and installation of machinery and equipment
	Turbines/generators	**C28**	Manufacture of machinery and equipment n.e.c.
	Electrical equipment	**C27**	Manufacture of electrical equipment
	Metal equipment	**C25**	Manufacture of fabricated metal products, except machinery and equipment
	Civil construction	**F**	Construction
	Consulting and engineering services	**M71**	Architectural and engineering activities; technical testing and analysis
	Financial services	**K64**	Financial service activities, except insurance and pension funding
	Energy sector	**D35**	Electricity, gas, steam and air conditioning supply
OPEX	Construction	**C33**	Repair and installation of machinery and equipment
	Energy sector	**D35**	Electricity, gas, steam and air conditioning supply
	Components and maintenance	**C33**	Repair and installation of machinery and equipment

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INPUTS for JOBS ASSESSMENT

Code	Description	Origin	A01 Crop and animal production, hunting and related service activities	A02 Forestry and logging	A03 Fishing and aquaculture	B Mining and quarrying
A01	Crop and animal production, hunting and related service activities	Domestic	31 105	787	234	25
A02	Forestry and logging	Domestic	6 696	2 890	860	13
A03	Fishing and aquaculture	Domestic	1 980	855	254	4
B	Mining and quarrying	Domestic	974	25	7	14 922
A01	Crop and animal production, hunting and related service activities	Imports	1 500	94	28	10
A02	Forestry and logging	Imports	1 684	723	215	5
A03	Fishing and aquaculture	Imports	517	222	66	1
B	Mining and quarrying	Imports	339	3	1	7 441

A good read to understand the input-output and multipliers methodology to assess the employments:

INPUT-OUTPUT MULTIPLIERS SPECIFICATION SHEET AND SUPPORTING MATERIAL

D'Hernoncourt, J., Cordier, M., and Hadley, D.

Université Libre de Bruxelles – CEESE, Brussels

University of East Anglia CSERGE, Norwich

[Specification sheet I_O_final.pdf (coastal-saf.eu)]

The **National Input Output table** used in our methodology presents inter-industrial flows of goods and services (produced domestically and imported) in current prices during one year (data used are from 2014).

Multiplier matrix is then calculated and aims at evaluating the economical consequences (output) of the demand in one sector on other sectors.

The assumption is made that this distribution stay the same over time.

SEA (Socio Enconomic Account) data are then used to translate output in employment and GVA. These data are giving (per year), the numbers of employees, related to an amount of output, for a sector. We use the ratio employees/output to assess the number of employments with the output calculated by multiplier matrix.

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Inputs for jobs assessment
National share in spending

Share of national spending by category		National share in spending on national projects	National share in spending on international projects
C33	Repair and installation of machinery and equipment	90%	30%
C28	Manufacture of machinery and equipment n.e.c.	85%	30%
C27	Manufacture of electrical equipment	85%	30%
C25	Manufacture of fabricated metal products, except machinery and equipment	90%	30%
F	Construction	90%	30%
M71	Architectural and engineering activities; technical testing and analysis	95%	30%
K64	Financial service activities, except insurance and pension funding	95%	30%
D35	Electricity, gas, steam and air conditioning supply	90%	30%

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European results
Summary of inputs and final results

	CAPACITY OUTLOOK AT THE END OF :					
	2025	2030	2035	2040	2045	2050
EU 28	250	830	3500	10980	25710	60000
SUM OF 6 EUROPEAN COUNTRIES STUDIED PREVIOUSLY	170	580	2490	7900	18600	44560

	DIRECT JOBS ASSESSMENT AT THE BEGINNING OF :					
	2025	2030	2035	2040	2045	2050
EU 28	2500	6300	31400	57200	125200	286200
SUM OF 6 EUROPEAN COUNTRIES STUDIED PREVIOUSLY	2900	6300	29900	50900	116400	288400

	DIRECT, INDIRECT AND INDUCED JOBS ASSESSMENT AT THE BEGINNING OF :					
	2025	2030	2035	2040	2045	2050
EU 28	8900	22900	112800	205800	450100	1029000
SUM OF 6 EUROPEAN COUNTRIES STUDIED PREVIOUSLY	8300	17700	84400	144800	331000	815800

These values seem inconsistent for 2 reasons : the limitations of our SEA data and the fact that the participation on international project was higher for single countries.

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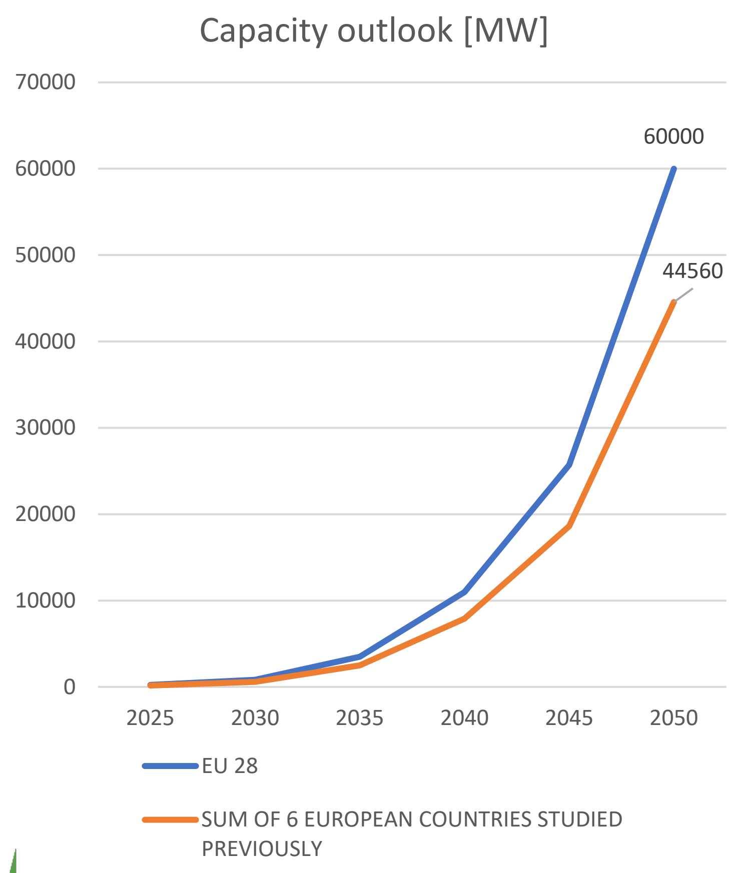
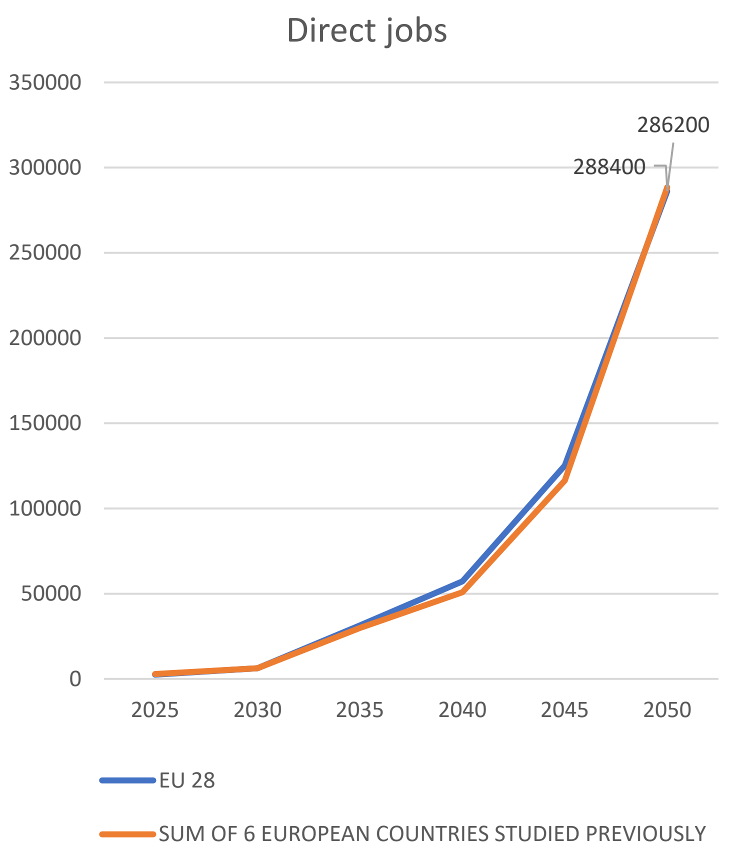
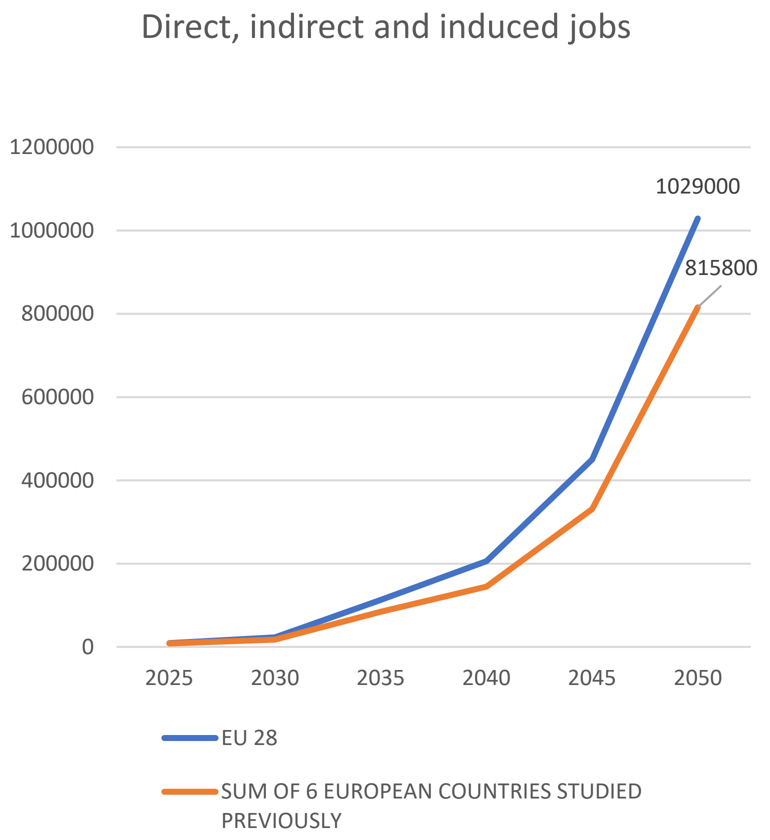
European results
Summary of inputs and final results







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European results
Summary of inputs and final results

- **Others indicators in 2050 :**
    - **3 jobs/MW (direct) :** comparable to what we had
    - **10 jobs/MW (direct, indirect and induced)**: more than the countries we studied before, due to the induced and indirect effects (agriculture for example creates more jobs in Romania than in France for the same spending in the sector : this is the ratio jobs/GO that we take from SEA data).
    - **11 jobs/GVA in USD millions (direct) :** comparable to what we had

	Jobs/MW D + I + In	Jobs/MW Direct	Jobs/m$GVA Direct
Canada	5	2	10
Denmark	4	2	7
France	7	2	8
Ireland	5	3	9
Portugal	17	6	21
Spain	18	5	11
UK	5	2	9
USA	13	4	12

For comparison, in offshore wind today, studies give:
- from 2 to 6 jobs/MW (direct jobs)
- from 4 to about 25 jobs/MW (direct, indirect and induced jobs)

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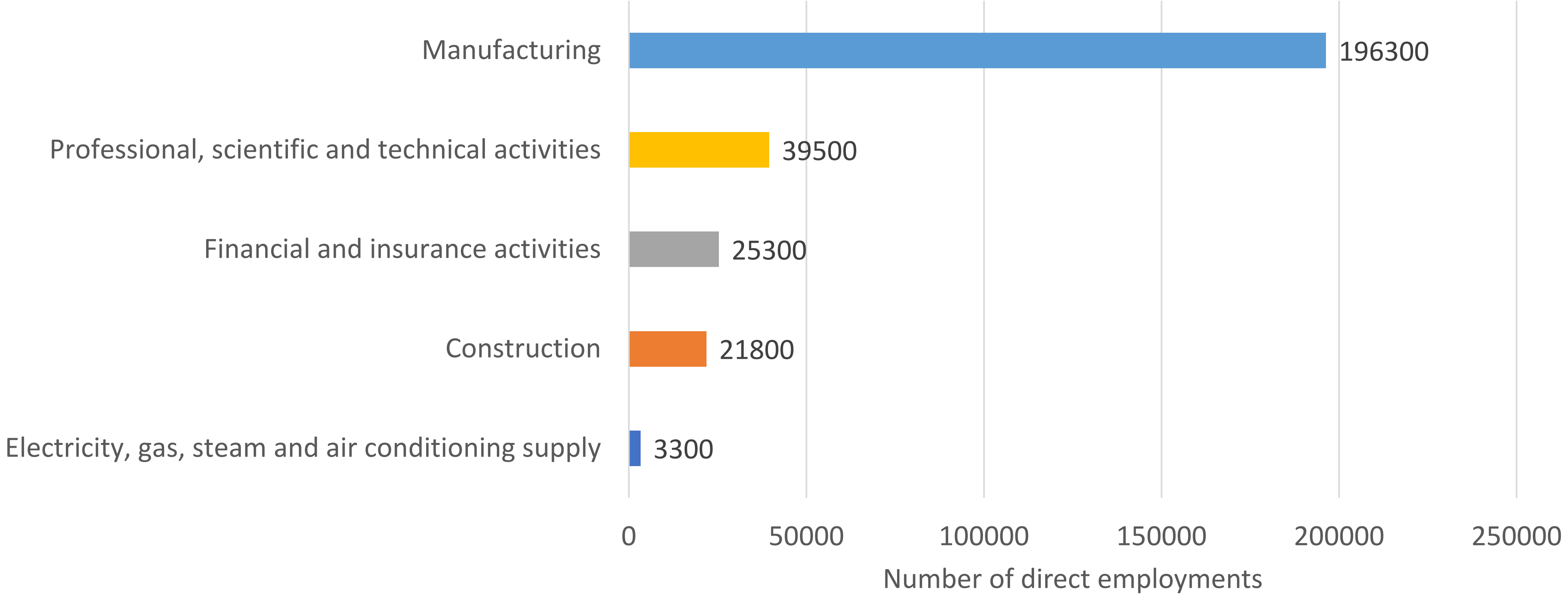
European results
Number of direct employments by sector



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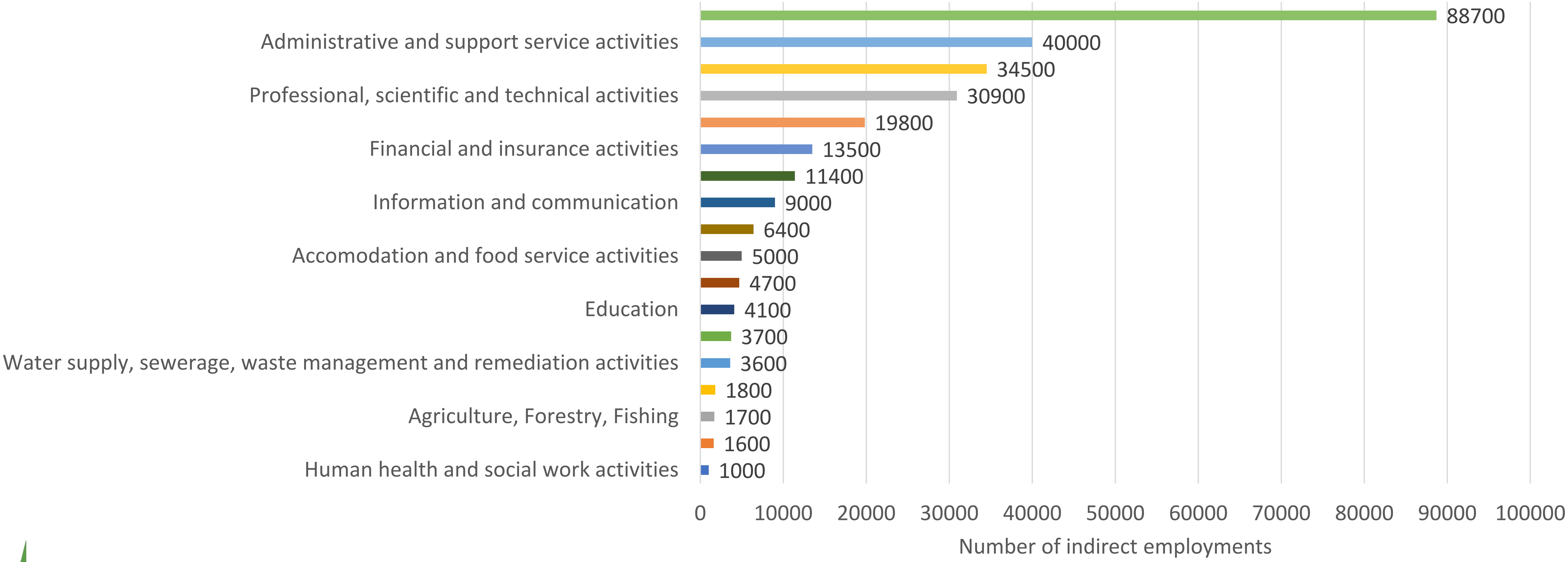
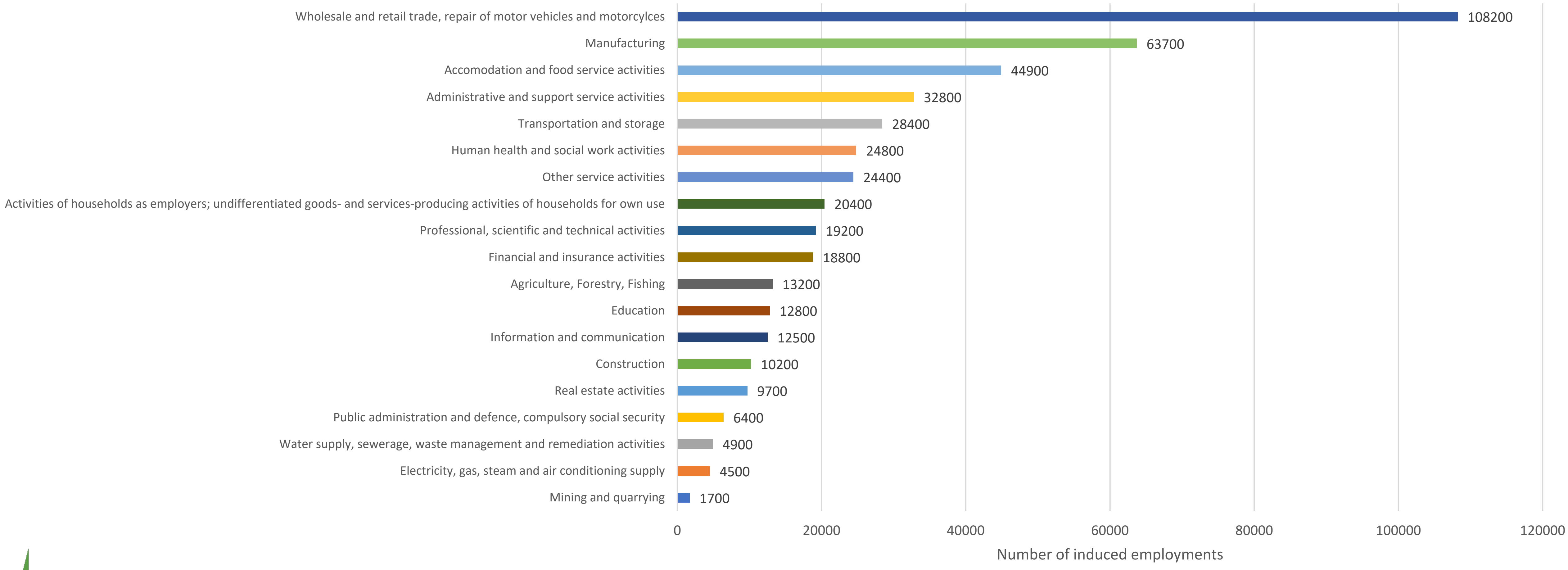
European results
Number of indirect employments by sector



European results
Number of induced employments by sector



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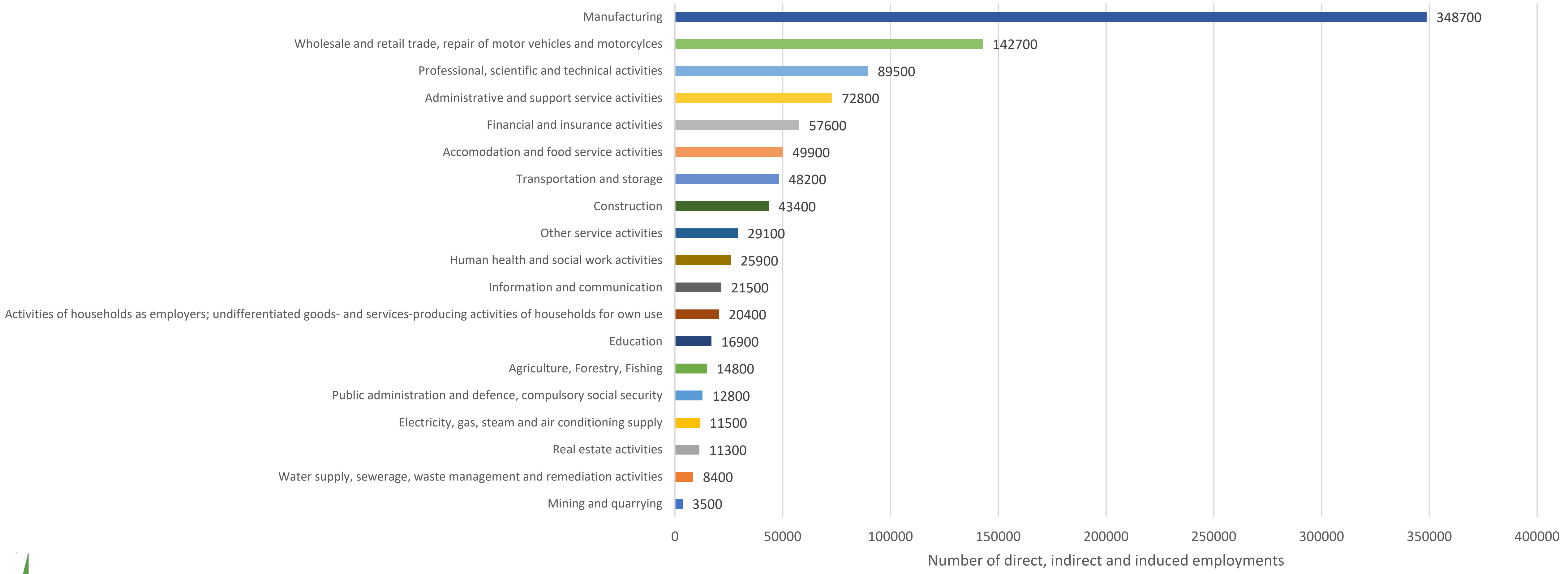
European results
Number of total employments by sector



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Limitations

SEA data : the approach used for the calculation of european SEA data is leading to uncertainties in the results : it is leading to results that do not depend on the location of installed MW within Europe (in UK or in Romania for example), as we used a single value of the ratio jobs/GO for the entire Europe and

The only approach that would not have lead to this limitation is to make separate study for each European country.

National share in spending : assumptions has been made on national share in spending on non-European projects, but this value of 30% does not depend on the industrial sectors, and is applied on the overall spending. No available public data.

CAPEX and OPEX values : values used for costs are from countries already involved in OE energy. These values would probably be higher for some of the countries in the UE.

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Example of the limitation of our approach for SEA data

- **Country A :**
  - 10 jobs/m€GO (from SEA data)
  - 10 MW to install (capacity outlook)
  - 1.5 m€GO/MW (CAPEX and OPEX)
  - **Leads to 150 jobs created**
- **Country B :**
  - 20 jobs/m€GO (from SEA data)
  - 20 MW to install (capacity outlook)
  - 1.5 m€GO/MW (CAPEX and OPEX)
  - **Leads to 600 jobs created**
- **Countries A+B :**
  - **If we sum the previous results : 750 created jobs**
  - **If we take the approach we used for global and european studies :**
    - 15 jobs/m€GO (sum of jobs/sum of GO accross countries from SEA data): this is one the biggest bias of the approach
    - 30 MW to install
    - 1.5 m€GO/MW
    - **Leads to 675 jobs created**

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An Evaluation and Guidance Framework for Ocean Energy Technology

Jonathan Hodges, Senior Innovation Engineer

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OPIN & OES WEBINAR

An Evaluation and Guidance Framework for Ocean Energy Technology

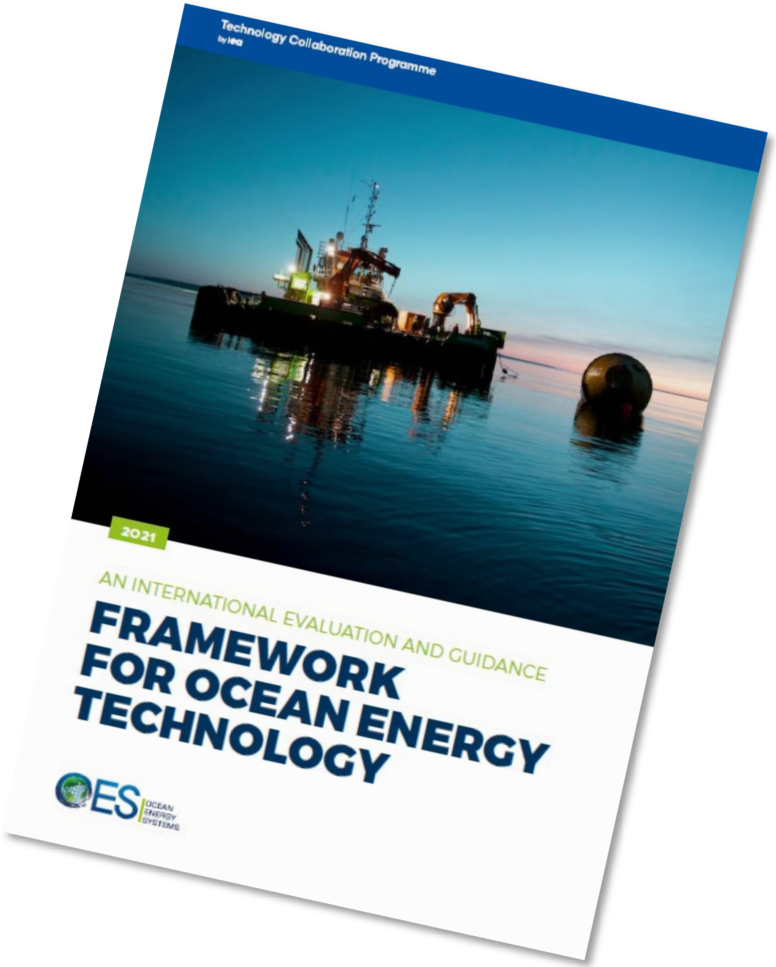
15th July 2021

Technology Collaboration Programme

by iea

Overview

- Introduction to the framework
  - Objectives and benefits
  - Route to consensus
  - Scope
  - Content of framework
- Use cases
  - Benefit example
  - Context for funders and developers
- Next steps



Task 12 Objectives

Support decision making

Guide appropriate and robust activities

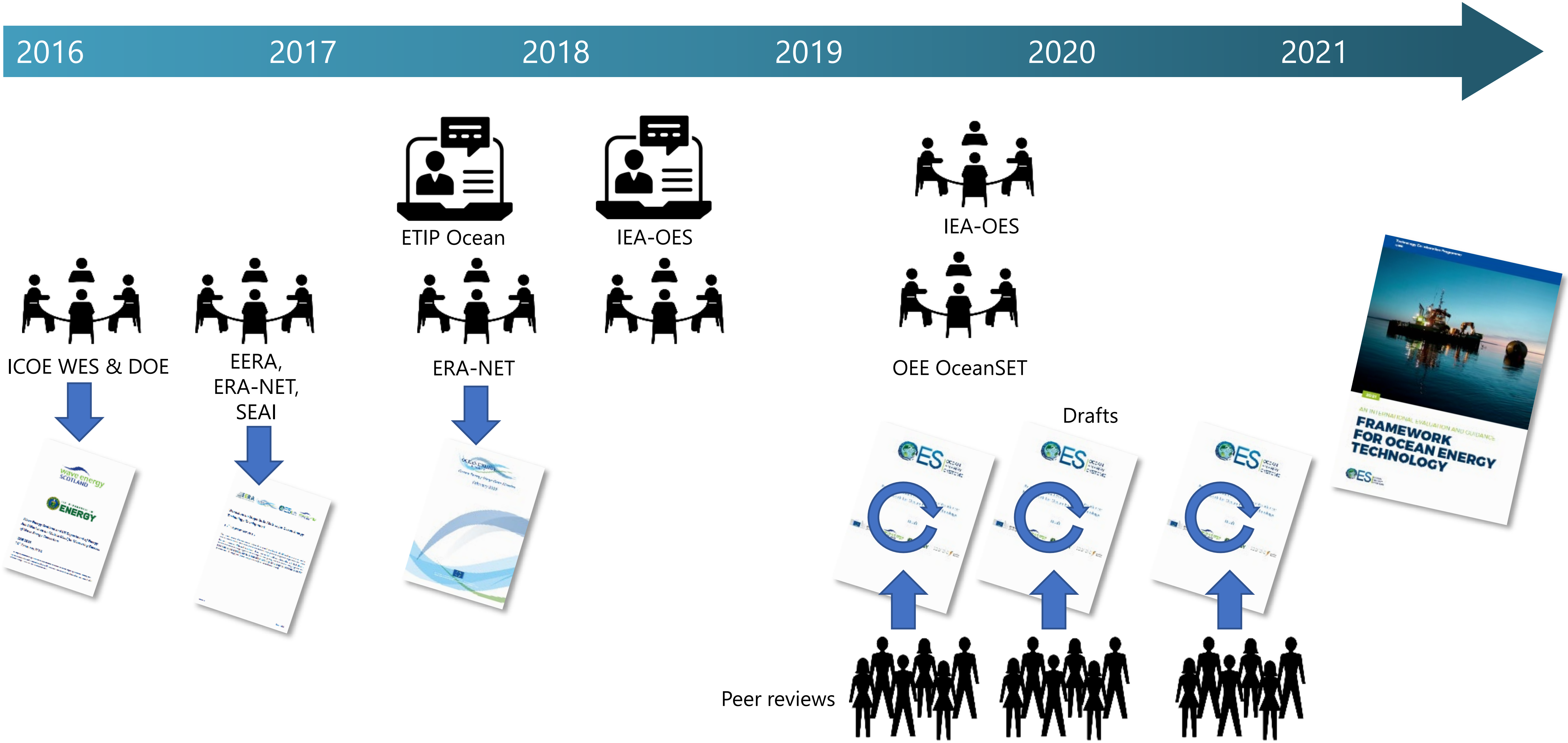
Share knowledge and promote collaboration

Build international consensus

Benefits

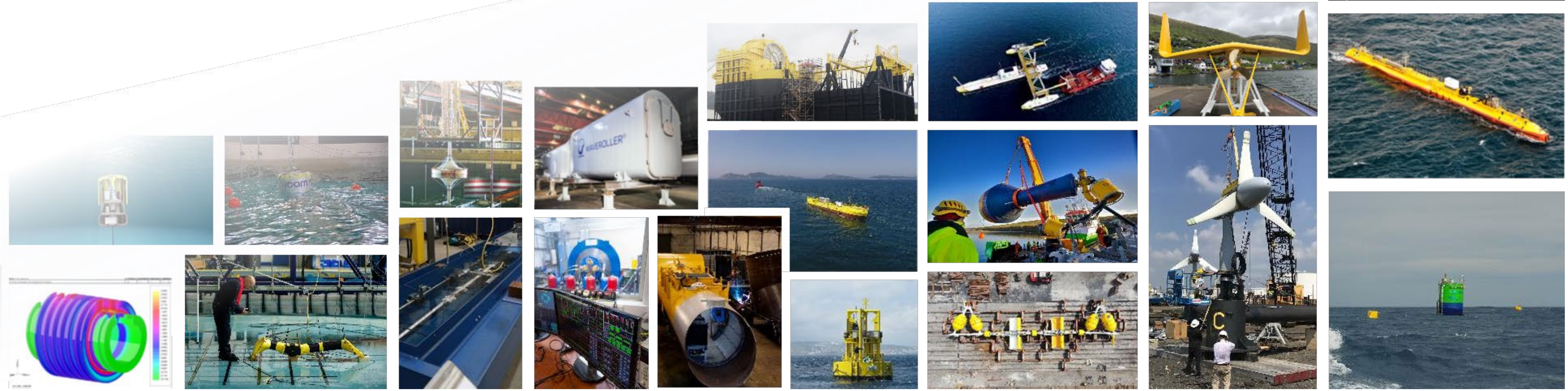
- Clarity of stakeholder expectations
- Efficient decision-making processes
  - Funding to the technologies with highest chances of commercial success
- Technology development process consistent across the world
  - More international collaboration
  - More globally transferrable technology
  - 'Technology passport' concept

Route to consensus



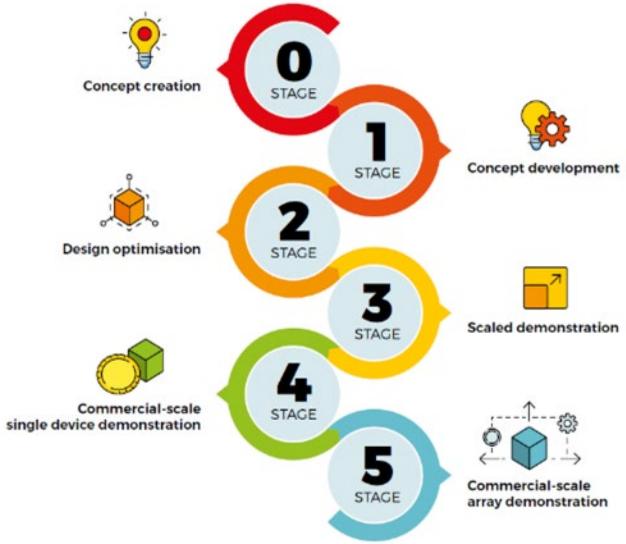
Scope

- Grid-scale electricity generation (although more widely applicable)
- Ocean waves and tidal stream
- Concept creation to commercial readiness
  - TRL 1-9
- Subsystems, devices, arrays of devices



Evaluation and Guidance Framework

- Stages



- Evaluation Areas

- Stage Activities

Stage	Stage Activities

Stage 0
Concept creation
	• Definition of technology requirements and challenges associated with Power Conversion (the problem statement)
	• Concept definition and identification of physical/ functional characteristics and fundamental operating principles of PTO, including:
	  • suitability of the PTO to the fundamental operating principle and force of damping requirements of existing devices
	  • suitability for implementation of control systems to maximise performance
	  • potential benefits of control systems
	  • degree of reliance on control systems to achieve functionality
	• Energy transformation behaviour and efficiency expectations defined based on (or derived from) existing, more mature technologies

Stage 1
Concept development
	• Development of a numerical model to estimate commercial-scale Power Conversion efficiency and validation against test data
	• Physical, laboratory or bench testing of main components or subsystems at an appropriate scale to represent the functional behaviour of the PTO and provide proof-of-concept of the technology, covering:
	  • a representative range of PTO input conditions
	  • representation of inertia and other device-related phenomena

- Evaluation Criteria

Evaluation Criteria	Units	Format
Range of acceptable environmental conditions Wave height – H_{m0} and H_{max} Wave period – T_e Wind speed – U_{10} Tidal current Tidal range or tidal water depth	m s m/s m/s or kt m	Numerical values, upper and lower limits or combinations of conditions
Mean Time to Repair (MTTR, or to maintain) Measure of the time from the start of maintenance - when all resources are available and environmental conditions are within limits - until the system is returned to operation. Mobilisation and transit to site are excluded to remain site independent.	Hours	Numerical values (with **minimum and maximum** to quantify variance and its impact on availability)
Cost to Repair (or maintain) Includes all costs of maintenance and re-commissioning e.g. vessels to access a device, tow a device to maintenance location (if required), labour and specialist staff or equipment	£, € or $	Numerical values (**minimum and maximum** to quantify variance and its impact on cost)

Benefit example – CorPower Ocean

- Early stage development
- WES PTO call – 3 stages – increasing value
    - Stage 1 - Concept Characterisation
    - Stage 2 - Concept Optimisation & Demonstration
    - Stage 3 – Small Prototype Development
- Array deployment
- Commercial arrays

Context for funders and developers

Design funding schemes

Evaluate and select technologies

Prioritise innovation support areas

Funders and Investors

Technology developers

Identify improvement areas

Identify funding programmes

Demonstrate progress

Plan activities

Develop technology

Context for funders and developers

Design funding schemes

Evaluate and select technologies

Prioritise innovation support areas

Funders and Investors

Technology developers

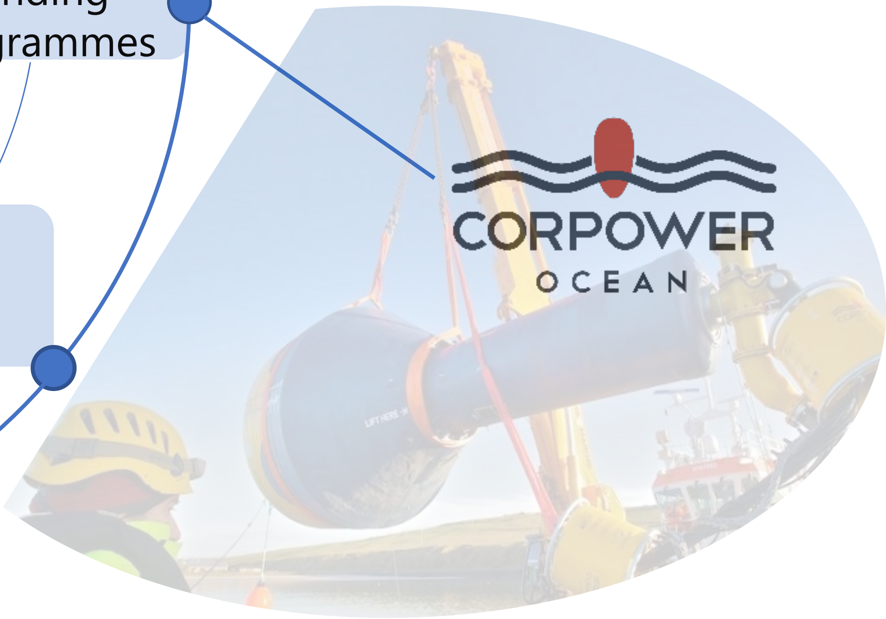
Identify improvement areas

Identify funding programmes

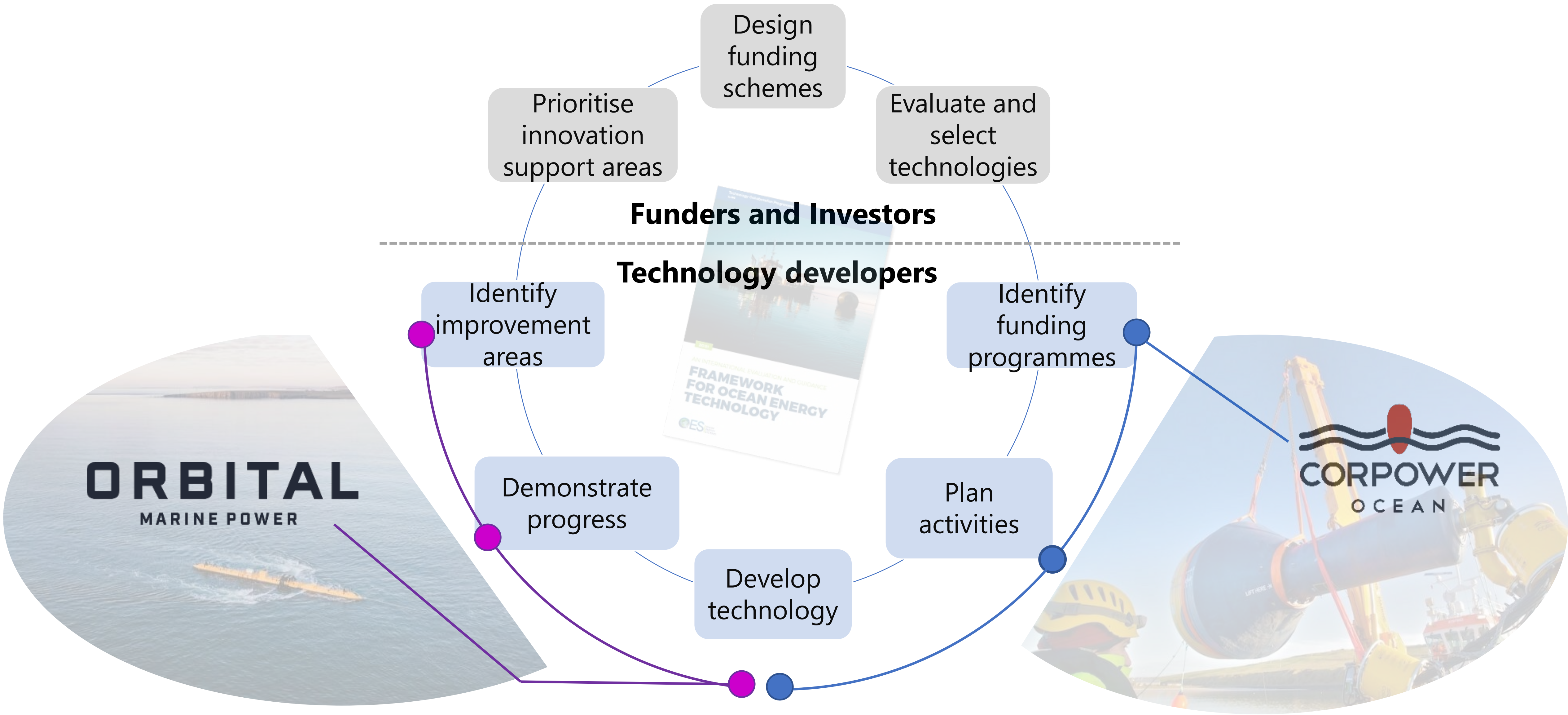
Demonstrate progress

Plan activities

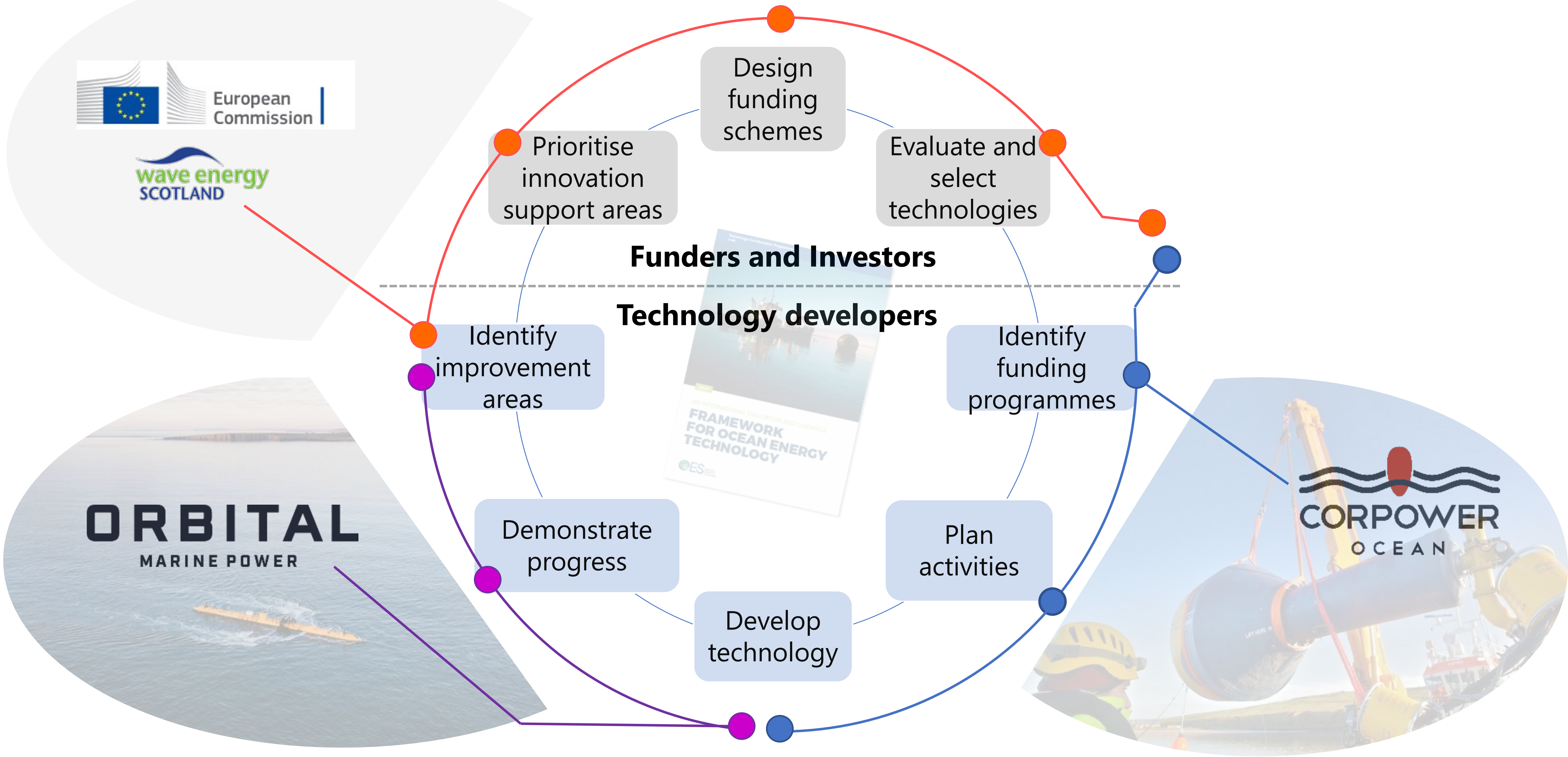
Develop technology



Context for funders and developers

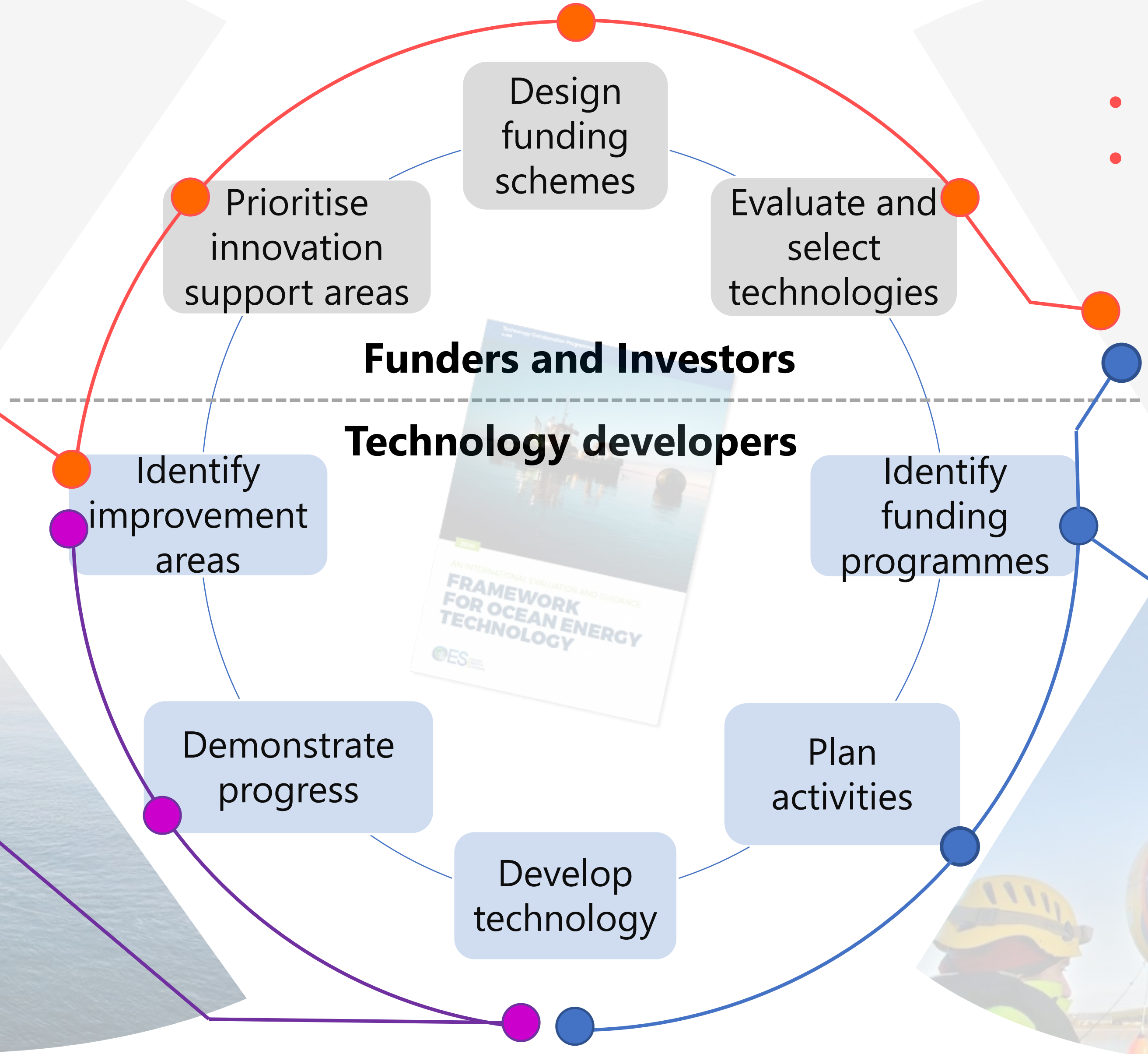


Context for funders and developers



Context for funders and developers

- Common expectations
- Consensus on technology development path



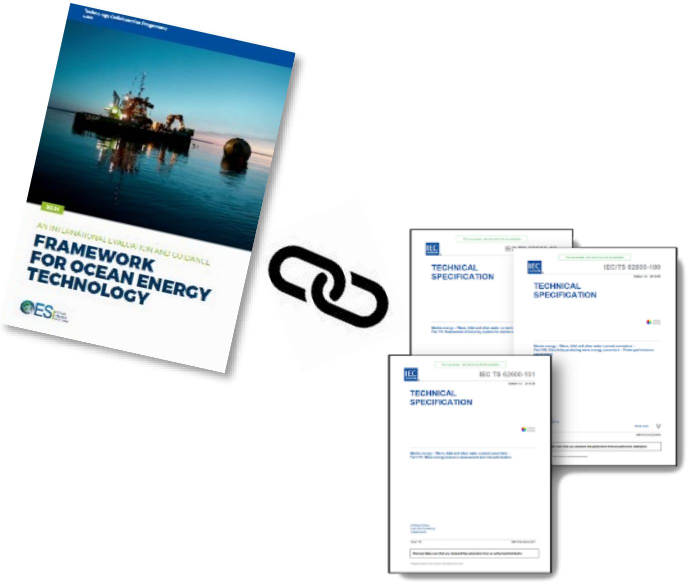
Next steps

1. Promote uptake of framework among funders

2. Extend the framework

- Environmental considerations?

3. Link to Standards and Certification



Thank you

jonathan.hodges@waveenergyscotland.co.uk

Environmental Effects of Marine Renewable Energy

Dr. Anne Marie O'Hagan, MaREI Centre, ERI,
University College Cork

Interreg
EUROPEAN UNION
North-West Europe
OPIN
European Regional Development Fund

OES ENVIRONMENTAL

Environmental Effects of Marine Renewable Energy

OPIN Webinar 15th July 2021

MaREI
Energy · Climate · Marine

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Dr. Anne Marie O’Hagan

MaREI Centre, ERI,

University College Cork, IRELAND

OES-Environmental

- Ocean Energy Systems – Environmental

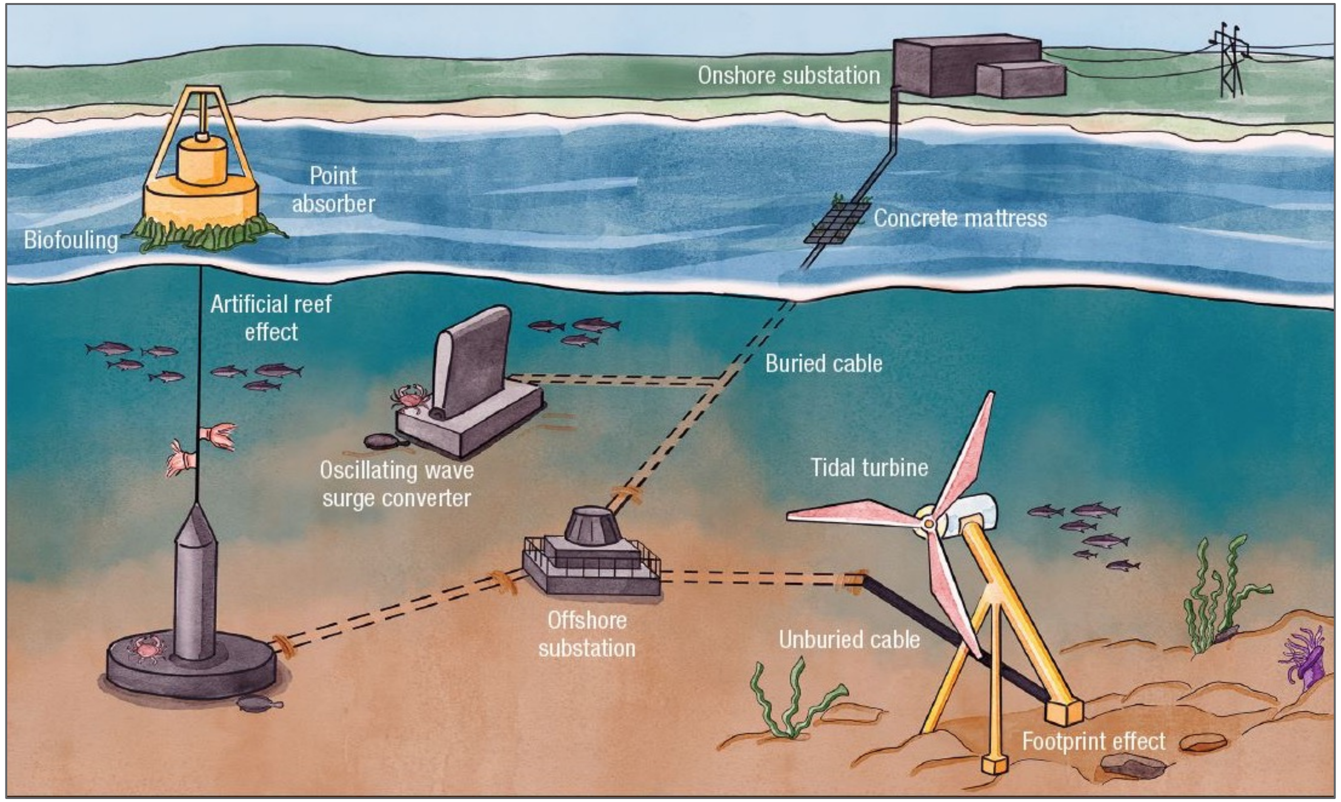


Figure 6.1 in the *2020 State of the Science Report*

- International initiative aimed at coordinating research and information to progress the MRE industry in an environmentally responsible manner

- 15 OES nations currently participating
  - Australia, Canada, China, Denmark, France, India, Ireland, Japan, Mexico, Monaco, Portugal, Singapore, Spain, United Kingdom, United States, with several others in the process of joining

Why study environmental effects of offshore renewable energy (ORE)?

- Drivers for ORE are clear, but
  - Stakeholders and regulators have concerns
  - Regulatory processes not always well established

- These concerns are driven by:
  - New, unknown technologies, unknown potential for harm
  - New use of ocean space and many other uses
  - Insufficient knowledge of environment in high energy areas
  - Concerns about marine species already under stress

- Improved information can:
  - Simplify/shorten time to consent and deploy devices, arrays
  - Decrease scientific uncertainty
  - Share information internationally

Environmental Effects of MRE: Stressors and Receptors

Collision Risk

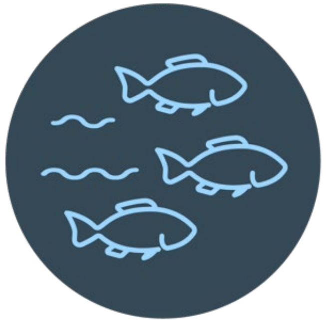
Underwater Noise

Electromagnetic Fields

Habitat Change

Oceanographic Systems

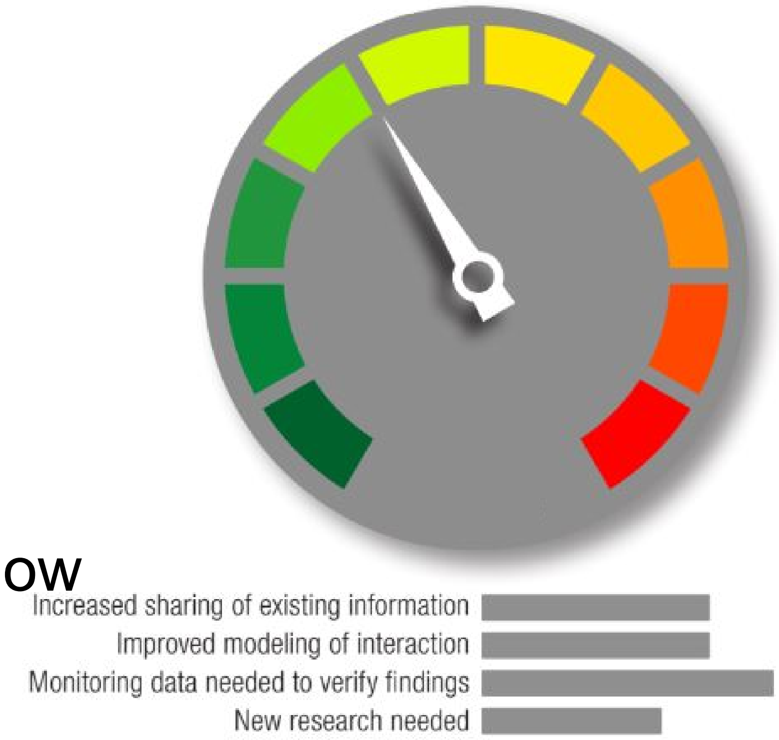
Entanglement



Displacement

Risk from Underwater Noise

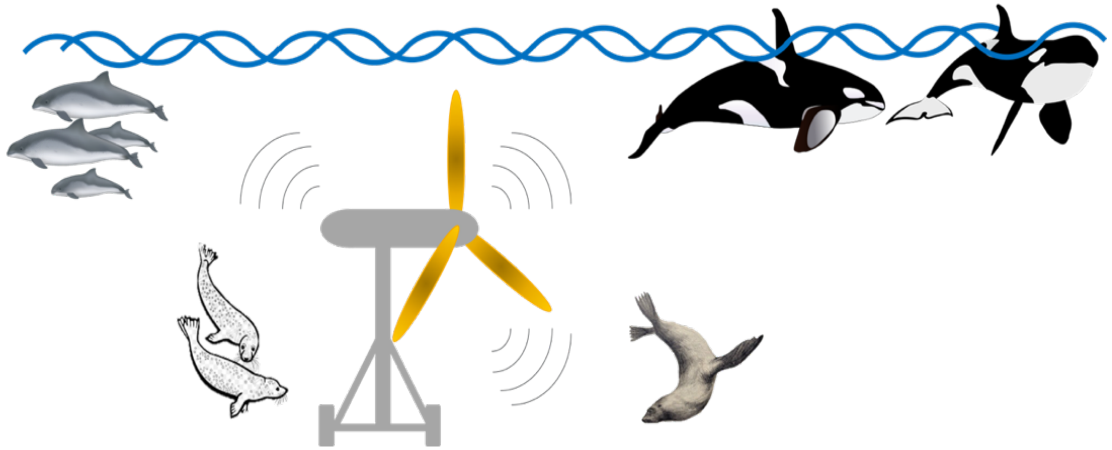
- Regulatory consideration under EU Marine Strategy Framework Directive (MSFD)
- Marine animals use sound in water to communicate and navigate
- Behavioural effects most likely but difficult and costly to investigate
- Important tools:
  - International standard (TC114)
  - US regulatory action thresholds:
    - NOAA marine mammal underwater sound thresholds
    - BOEM fish guidance
- Measurements of some turbines and WECs, below these guidelines



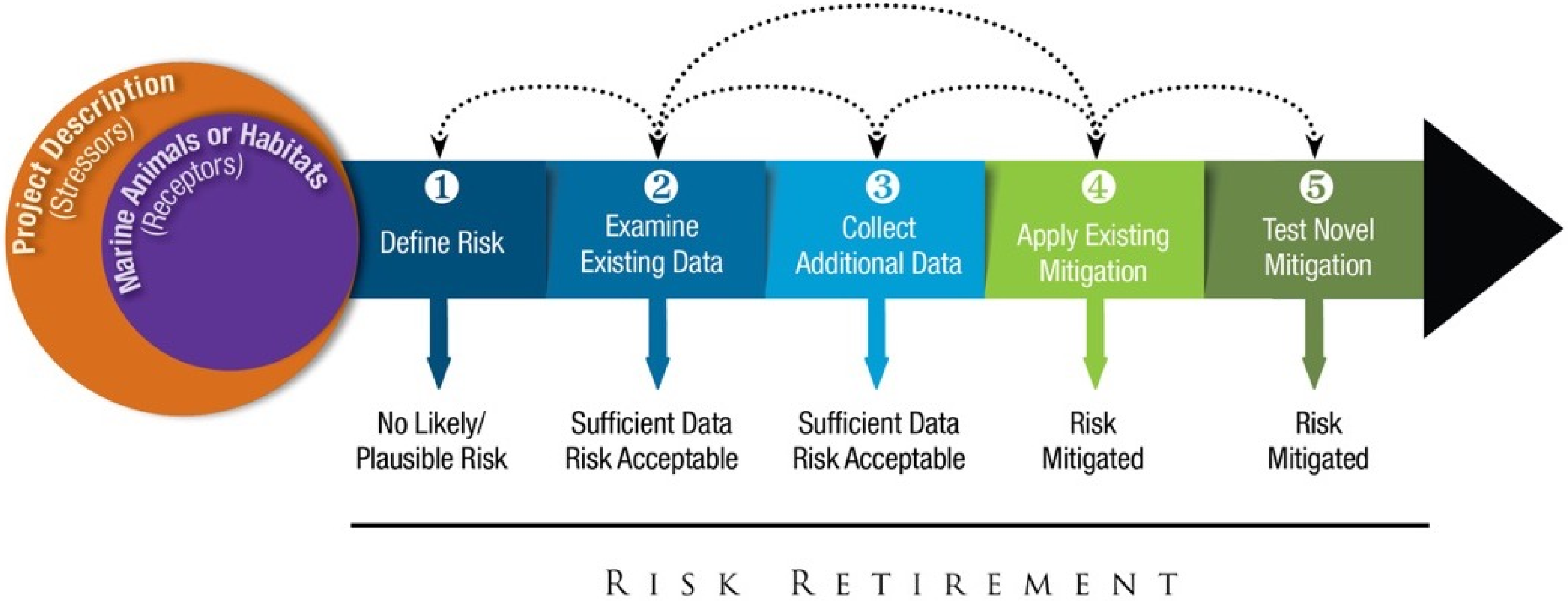
Bottom Line and Path Forward

On the whole, it appears that the likely risk to marine animals is small (except possibly for collision risk), for small numbers of MRE devices.

1. Data collection for consenting needs to be proportionate to risk
2. Need sufficient evidence of risk or likely risk for regulators to rely on
3. Transfer of data and information from consented projects and other studies
4. Move to retire risks that are not significant, revisit for larger arrays

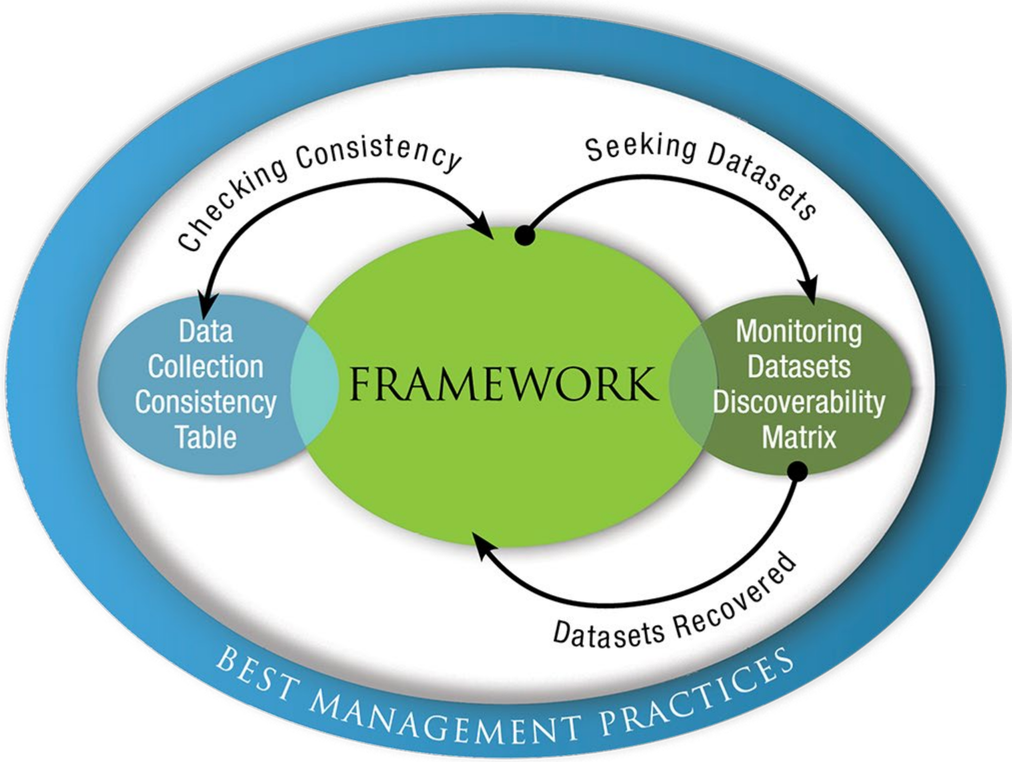


Risk Retirement



- Determine which interactions of MRE devices and the marine environment are low risk and may be "retired"
- Which need further data collection and research, or new mitigation measures

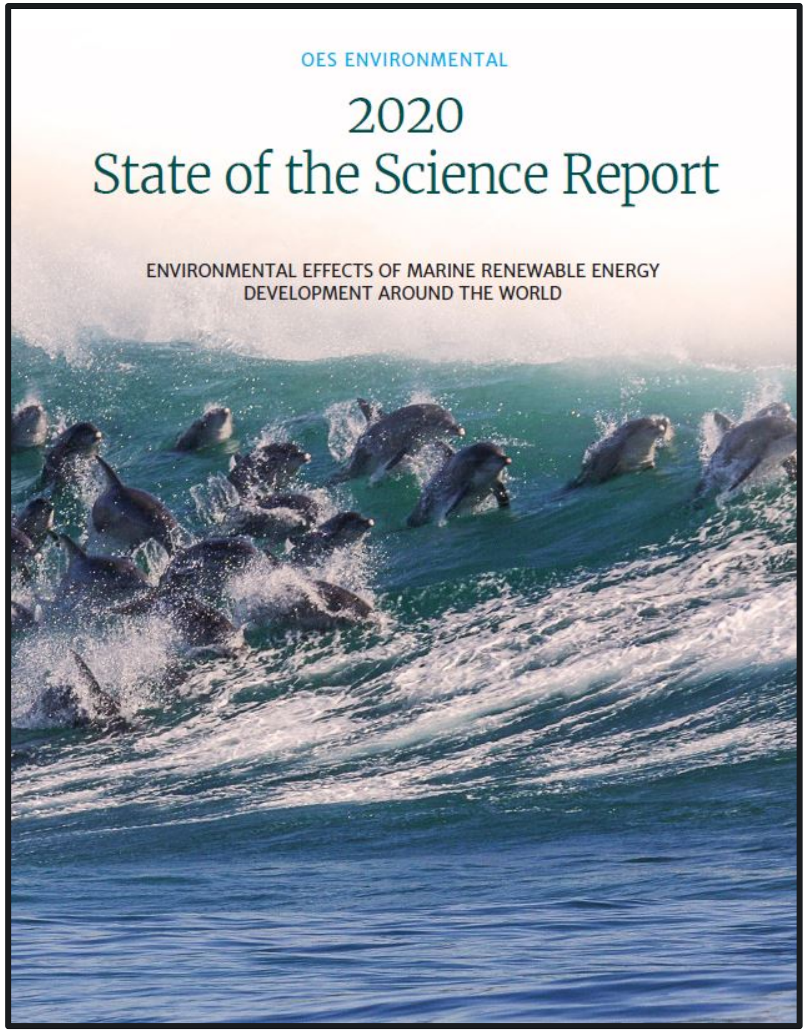
Data Transferability



- Information from one MRE project or similar industry should inform new MRE projects
- Reduce site-specific data collection needs
- Monitoring datasets discoverability matrix (matrix):
  - Interactive tool that classifies monitoring datasets from already consented/permitted projects and research studies for six key environmental stressors.

Environmental Effects of MRE:
The OES-Environmental *2020 State of the Science Report*

- The most up-to-date compilation of scientific research and evidence associated with environmental effects of MRE
- 300+ pages; 14 chapters
- Extensive reviewing process
- 40 authors & contributors
  - Key device interactions with the marine environment
  - Environmental monitoring technologies
  - Strategies for accelerating consenting
  - Summary & path forward

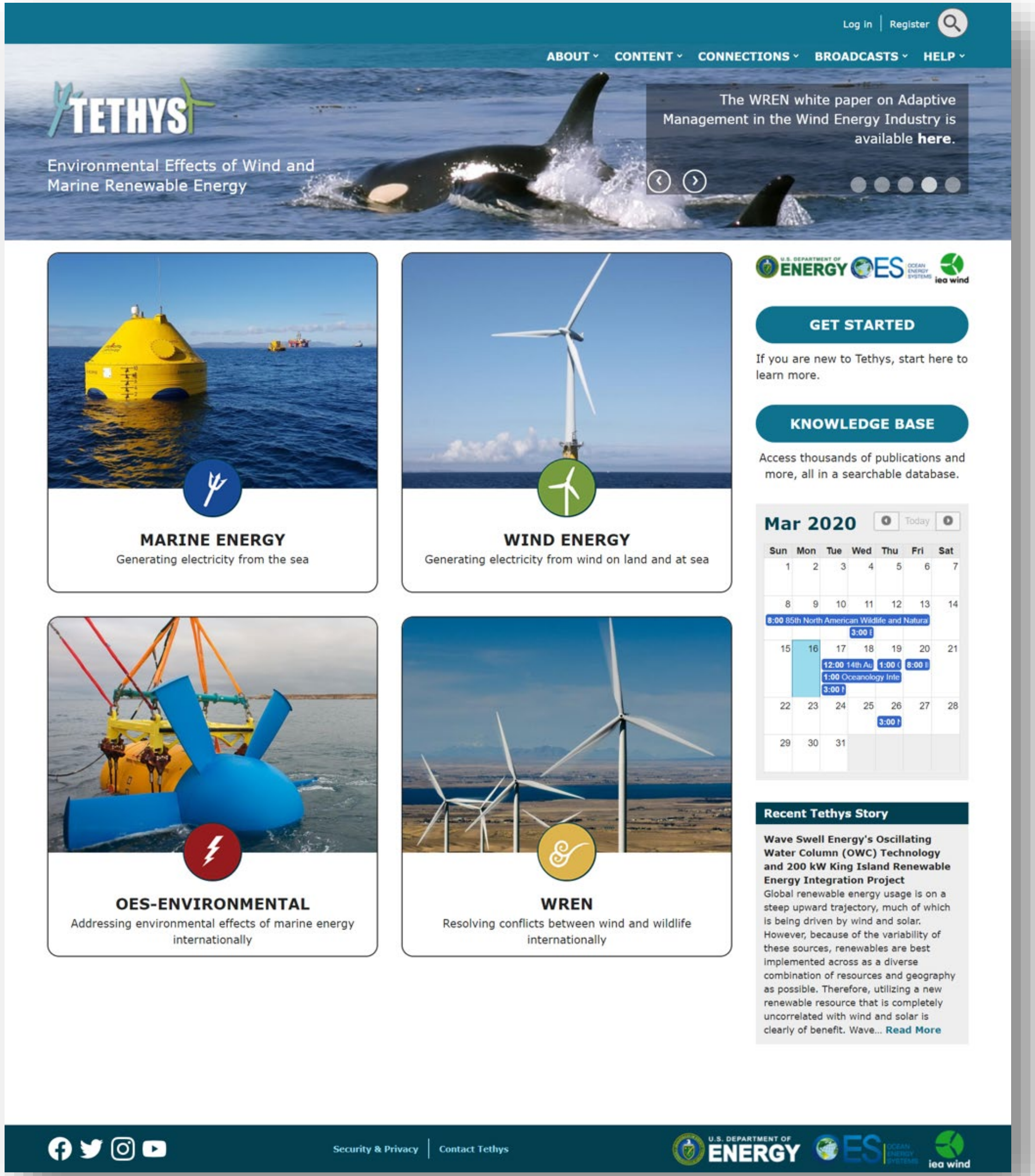


https://tethys.pnnl.gov/publications/state-of-the-science-2020

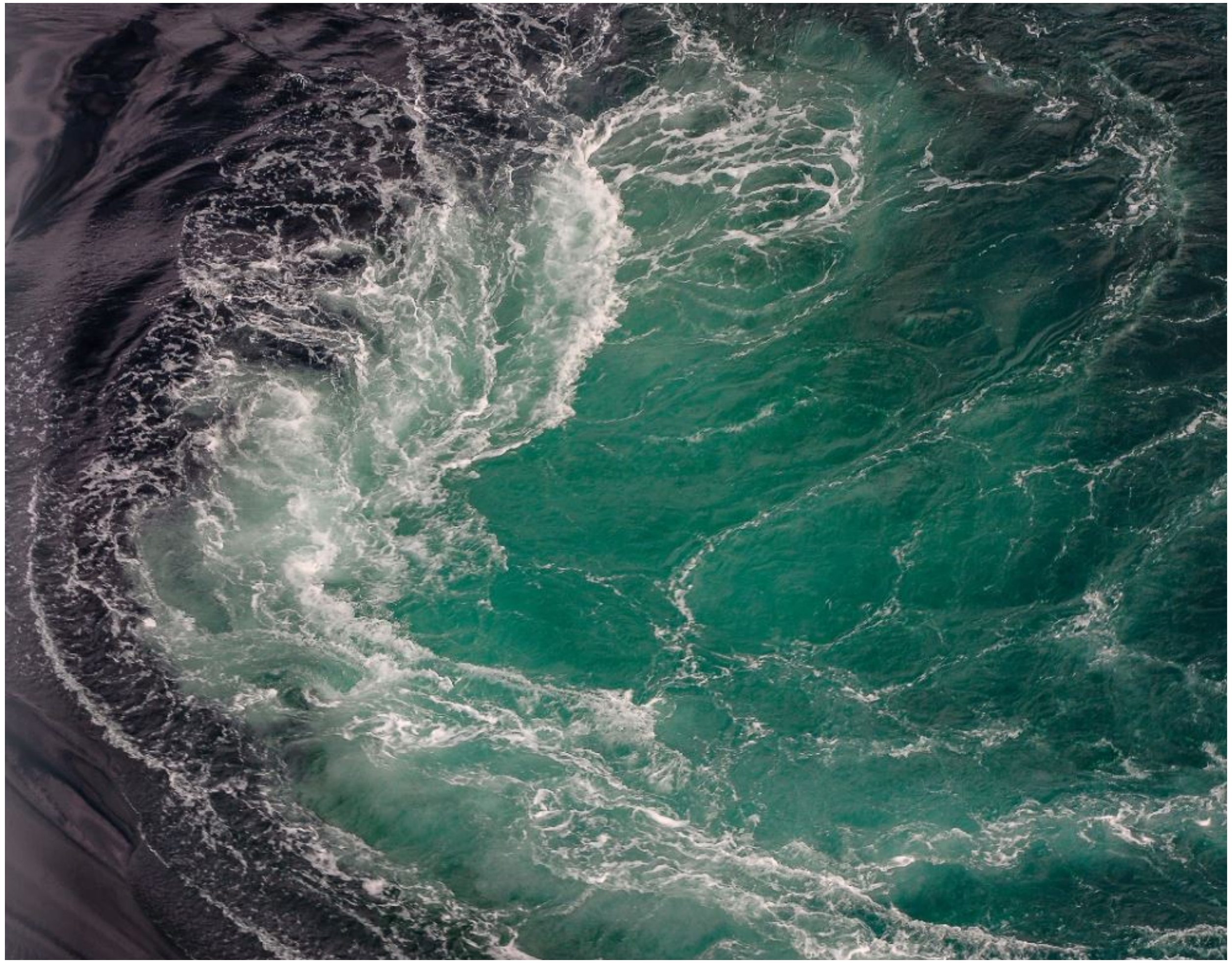
Tethys

- Online Knowledge Base
- Hosts over 6,600 scientific papers, grey literature reports, and other documents
- Map Viewer
- *Tethys* Blasts
- *Tethys* Stories
- Events Calendar
- OES-Environmental Metadata

https://tethys.pnnl.gov/



Phase 4 of OES-Environmental



- Continued international outreach, engagement, sharing of data & information for research gaps
- Workshops, conferences
- *2020 State of the Science* outreach
- Extend more into tropical areas, southern hemisphere
- Inform regulators involved with regulatory processes
- 2024 State of the Science Report

ES ENVIRONMENTAL

Thank You!

Dr. Anne Marie O’Hagan

a.ohagan@ucc.ie

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Q&A Session

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