Annual Report
2022

FRANCE
ENERGIES
MARINES

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INTERSECTING PERSPECTIVES BETWEEN...

Herveline Gaborieau *Executive Director of France Energies Marines*

Jean-Philippe Pagot *President of France Energies Marines*

What are your top takeaways from 2022?

Herveline Gaborieau: In 2022, the Institute installed several measurement devices at sea near to offshore wind farms, for instance acoustic telemetry receivers to monitor fish and crustacean movements, and a profiling lidar on Planier Island to build the very first Mediterranean database for wind and associated turbulence with data acquired at sea over a 12-month period. Additional systems have since been deployed, demonstrating our core focus on positioning ourselves at the heart of our field. This was also a driving force behind the creation in 2022 of an office in Le Havre for the Channel and North Sea coast. I would also like to highlight our continued growth: in 2022 we passed the milestone of 75 employees, and three major new members joined us: RWE, TotalEnergies and the Occitanie region.

Jean-Philippe Pagot: In addition to the introduction of these new members which contributes to the Institute's momentum, one key feature of 2022 for me is that it marked the organisation's 10-year milestone and illustrated the corresponding maturity in terms of the Institute' capacity to drive dynamic, collaborative research. After a controlled and somewhat limited initial phase, the Institute has taken advantage of its status as an Institute for the Energy Transition (ITE) and its conversion to a simplified joint-stock company (SAS) to speed up its development to best serve the sector. The year 2022 truly confirmed the legitimacy of this new status and new form of entity. 2022 was also marked by the departure of Yann-Hervé De Roeck and the appointment of Herveline Gaborieau as Executive Director. This internal handover guarantees continuity while introducing a new perspective: building on the work that has been accomplished over the past decade while looking to the future.

What are the Institute's objectives for the coming years?

Herveline Gaborieau: In 2023, the projects we have set up represent a budget well in excess of one million euros. This shows that the scale of our projects is evolving towards larger and more structural programmes, which is one of our objectives. To consolidate its growth and take a leading role, the Institute needs to acquire onshore and offshore infrastructures to roll out its R&D programme, carry out testing on technological components, collect data, etc. We need to assert our presence at sea, even although operating and maintaining this type of infrastructure is a real challenge. We must also initiate various major actions to strengthen our international involvement: an institute like France Energies Marines must be more visible on the European stage.

Jean-Philippe Pagot: We are in a context of continuity. We must consolidate our core focus—collaborative R&D projects—with greater ambitions in terms of their scale and our capacity to work offshore, as illustrated by our recent acquisition of a met mast off Fécamp. To achieve this goal, we must develop partnerships with French regions and work together with international partners. Working with like-minded institutes on European projects can only enhance our credibility and impact. This is how we intend to set up the structural programmes we are planning in order to boost the sector's development.

In the long term, how do you see the Institute evolving to continue to support the sector's development?

Herveline Gaborieau: Today, over 80% of our work focuses on three-year collaborative projects set up during our annual R&D consolidation. Looking to the future, we will need to accommodate other types of projects. The Institute's work will need to be organised in a way that enables us to support the sector in validating technological building blocks through alternative approaches to three-year R&D projects. In the future, these projects should account for no more than one third of our activities, so that we can work on larger-scale programmes and assert our expertise, particularly through shorter, specific research services.

Jean-Philippe Pagot: This is not an easy shift to make, given the various obstacles in both the public and private sectors. Yet, it is essential for us to assert the expertise we have acquired through collaborative R&D projects, and to be capable of delivering this expertise in the form of additional services, whether through the use of our infrastructures or by promoting our researchers' expertise.

Herveline Gaborieau: France Energies Marines must gain recognition for what it brings to the industry, but also be identified as a tool to support public policies, a tool that is as yet underused for this purpose by the French State. Our one-of-a-kind team has much to offer in this regard.

Jean-Philippe Pagot: This is in fact our underlying purpose, our *raison d'être*, the destination for which we have been headed ever since we embarked upon this adventure: to be at the interface between academic and industrial sector, in order to support the development of offshore renewable energies.

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01

IDENTITY

FRANCE
ENERGIES
MARINES

is the Institute for the Energy Transition for offshore wind and ocean energies.

75+
staff

140+ partners
WORLDWIDE

A **public-private partnership**
supported by the France 2030 investment plan

4 sites
along the French coastline

Involvement in over
70 R&D projects
since 2012

€**8** million
annual budget

27 public and private members

Strategy

Vision

France Energies Marines is a centre of pooled expertise that has gained recognition for its valuable achievements for the European industrial sector. To accomplish this, it draws upon its in-house talents and its network of academic experts.

Mission

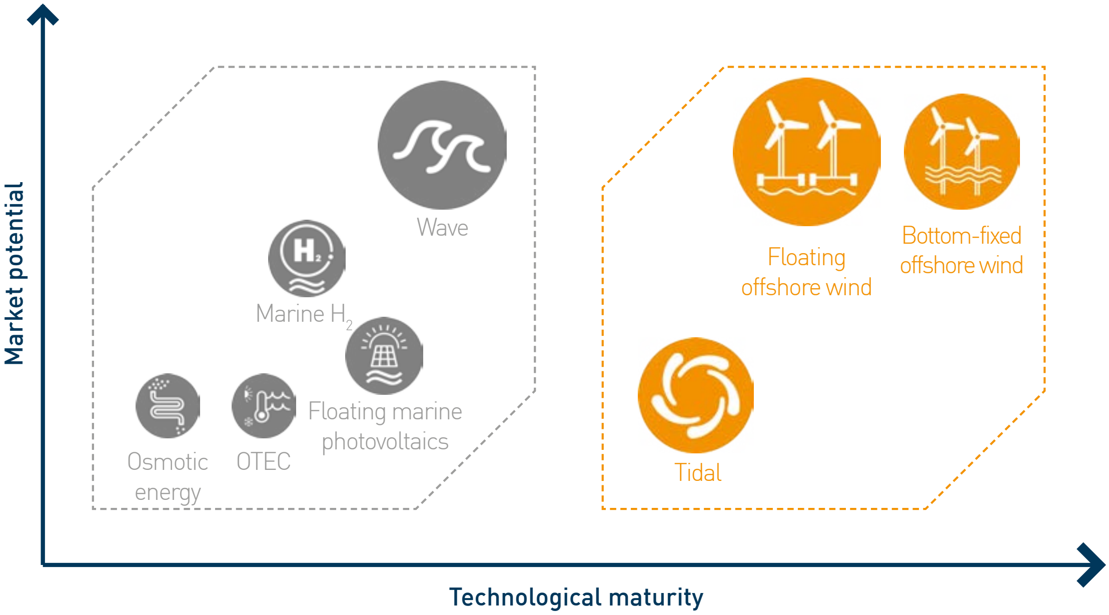
To define, set up and apply the scientific and technical environment required to overcome the obstacles related to the development of offshore renewable energy technologies while ensuring optimal environmental integration.

Position

The Institute supports the sector's development through R&D, so as to reduce overall investments and operating costs. It sets itself apart with its cross-cutting approach through which it is able to provide the entire sector with tried-and-tested tools for:

- Global optimisation by taking into account site conditions and adapting technologies,
- Development of standards tailored to offshore wind and ocean energy,
- Reduction of farm construction times by providing consultation methods and recommendations relating to environmental integration.

France Energies Marines provides services across the full range of technologies: bottom-fixed and floating offshore wind energy, tidal and wave energy, ocean thermal energy conversion, and osmotic energy.

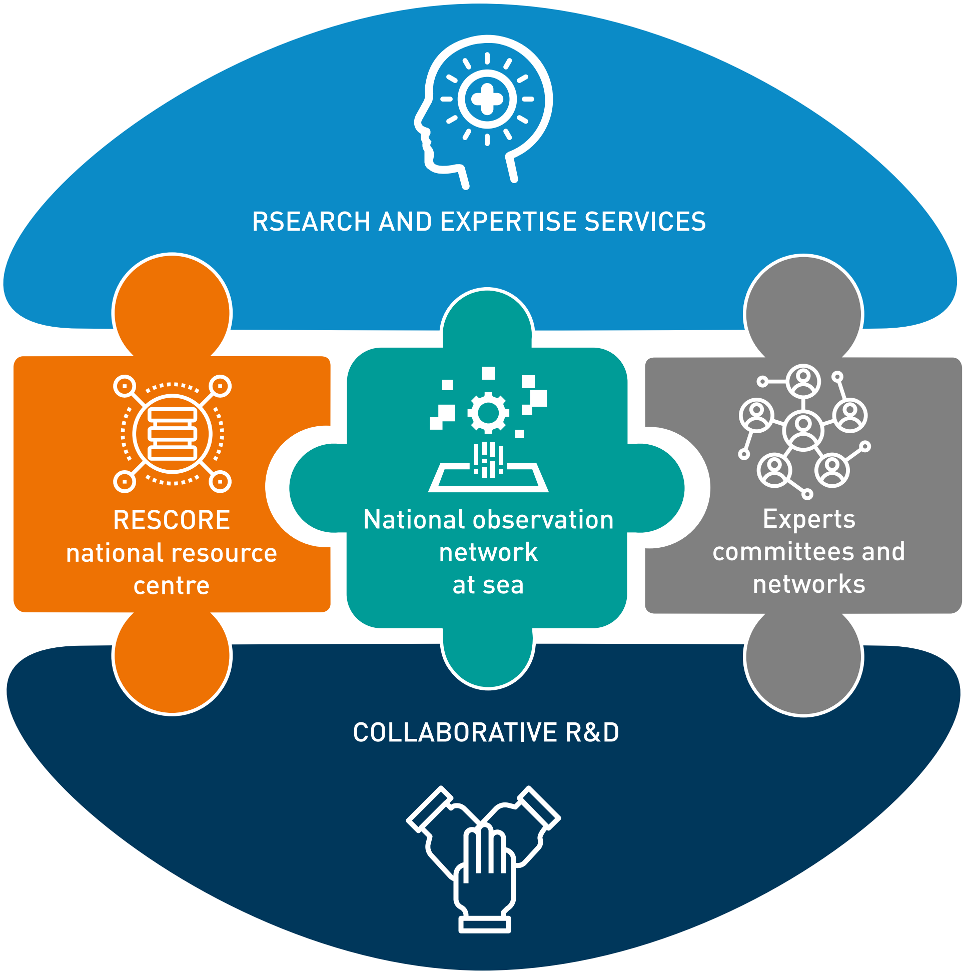

Market potential
Wave
Marine H_2
Floating marine photovoltaics
Osmotic energy
OTEC
Floating offshore wind
Bottom-fixed offshore wind
Tidal
Technological maturity

© FEM

Activities

R&D is firmly rooted at the heart of our work, which is organised into five focus areas:

- Setting up, coordinating and contributing to the scientific content of collaborative R&D projects
- Delivery of research and expertise services,
- Running of the national resource centre RESCORE,
- Creation of a national offshore observation network,
- Participation in expert panels and networks.


RSEARCH AND EXPERTISE SERVICES
RESCORE national resource centre
National observation network at sea
Experts committees and networks
COLLABORATIVE R&D

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Topics

Four complementary, cross-cutting research programmes have been defined in our scientific and technical roadmap: site characterisation, systems design and monitoring, farm optimisation and environmental integration. The collaborative R&D conducted by the Institute across these four programmes focuses on the main issues -whether technological, environmental, economic or societal- related to the development of offshore renewable energies.

Site characterisation

This programme aims to provide precise knowledge on the spatial and temporal variability of wind, waves and tidal currents, the extreme conditions that can occur, the ocean-atmosphere coupling, and certain seabed dynamics. By characterising the variability of the resource and offering insight into the physical processes at work, our research provides valuable data for selecting the best sites for farms, designing the machines and optimising operations at sea.

Systems design and monitoring

It is essential to have a detailed understanding of the interactions between the marine environment and the components of an ORE system in order to optimise the technology in terms of performance, reliability and competitiveness. This is the challenge this programme aims to tackle. It involves developing methodologies, and numerical and experimental tools that are able to simulate the behaviour of systems in wind, waves and current, as well as the impact of biofouling. At the end of the process, the aim is to provide industry players with realistic, robust solutions to improve the design of their systems and ensure their reliability and integrity throughout their operational lifetime.

Farm optimisation

An ORE farm is by no means simply an aggregation of production units; rather it should be considered as a whole entity, whose architecture can be optimised to obtain the best cost-performance compromise. With this as a backdrop, this programme aims to provide stakeholders in the sector with tools to help them strike this optimal technico-economic balance. Another key element in this programme consists in tackling grid integration challenges by considering potential innovative solutions such as floating substations or Power-to-X.

Environmental integration

Setting up an ORE farm is liable to trigger environmental impacts and lead to socio-economic repercussions. By focusing on certain key compartments of the ecosystem, such as birdlife, marine mammals, fish and benthos, while in parallel developing a global approach that reintegrates human beings into the ecosystem, this programme aims to develop tools and methods to preserve ecosystems and uses of the sea.

4 cross-cutting & complementary R&D programmes

1 SITE CHARACTERISATION

- Spatialisation of observations
- Characterisation of sea states
- Characterisation of wind at sea
- Climate change
- Hydro-sedimentary processes

2 SYSTEMS DESIGN AND MONITORING

- Structure, mooring and power cable
- Hydrodynamic and structural coupling
- Digital twins and in-service monitoring
- Technological innovation

3 ENVIRONMENTAL INTEGRATION

- Effects on ecosystem compartments
- Change of scale
- Environmental integration tools

4 FARM OPTIMISATION

- Farm architecture
- Grid integration
- Installation, operation and maintenance

© Halynea

Governance

The Institute is built around a broad public-private partnership that brings together 18 shareholder members and 9 contributor members—all key French ORE sector participants—from industry, academic and scientific establishments, local government and competitive clusters. France Energies Marines is governed by decision-making bodies and consultation bodies which ensure that its orientations continue to be aligned with the needs of the sector.

In terms of decision-making, three bodies have been defined:

- The **General Assembly**, composed of all shareholder members, appoints the Institute's President and guides its strategy and functioning,
- The **Board of Directors**, made up of 10 members elected among the Institute's shareholders, prompts and oversees the strategy's operational implementation,
- The **Executive Management**, appointed by the Board of Directors, which implements the strategy, submits proposals to the Board of Directors, oversees the implementation of the decisions made by the General Assembly and the Board of Directors, while handling the operational running of France Energies Marines.

In addition, two consultative bodies have been set up:

- The **Research & Development Committee**, which brings together all the Institute's members, examines the scientific merits of collaborative R&D projects set up by France Energies Marines and assesses them before they are submitted to the Board of Directors for funding,
- The **Science & Technology Committee**, composed of 8 independent international experts, issues an opinion on the Institute's scientific and technological programme and its materialisation via R&D projects. It also makes forward-looking recommendations on desired developments.

BOARD OF DIRECTORS - FULL MEMBERS

5 PUBLIC MEMBERS

ENSTA BRETAGNE
Represented by
Bruno Gruselle

Ifremer
Represented by
Jean-Marc Daniel

Nantes Université
Represented by
Franck Schoefs

Région BRETAGNE
Represented by
Daniel Cueff

UNICAEN UNIVERSITÉ CAEN NORMANDIE
Represented by
Lamri Adoui

5 PRIVATE MEMBERS

EDF
Represented by
Grégoire De Roux

EOLFI A member of the Shell Group
Represented by
Emmanuel Chanfreau

INNOSEA An ABL Group Company
Represented by
Hakim Mouslim

PÔLE MER BRETAGNE ATLANTIQUE
Represented by
Philippe Monbet

TotalEnergies
Represented by
Edmond Coche

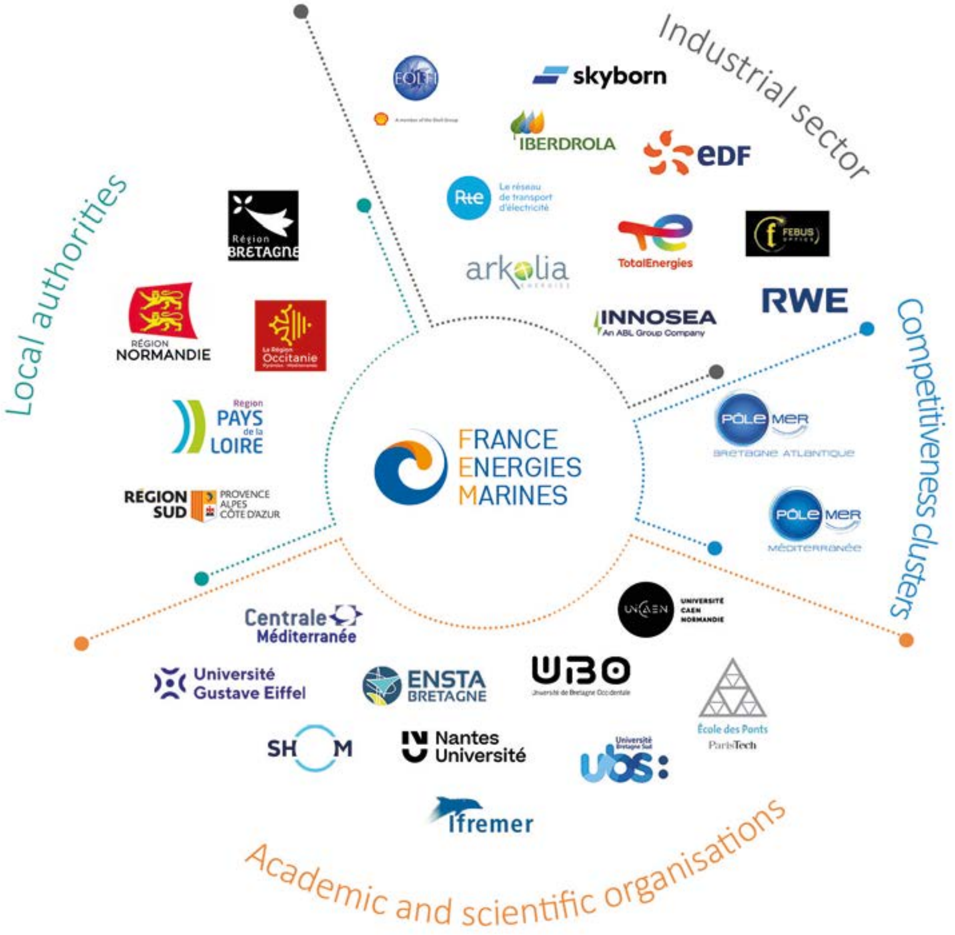
EXECUTIVE MANAGEMENT

Herveline Gaborieau
Executive Director
of France Energies Marines

PRESIDENCY

Jean-Philippe Pagot
President
of France Energies Marines

GENERAL ASSEMBLY - SHAREHOLDER AND CONTRIBUTOR MEMBERS


FRANCE ENERGIES MARINES
Industrial sector
EOLFI
A member of the Shell Group
skyborn
IBERDROLA
EDF
Rte Le réseau de transport d'électricité
arkolia ENERGIES
TotalEnergies
FEBUS OPTICS
INNOSEA An ABL Group Company
RWE
Local authorities
Région BRETAGNE
RÉGION NORMANDIE
La Région Occitanie Pyrénées - Méditerranée
Région PAYS de la LOIRE
RÉGION SUD PROVENCE ALPES CÔTE D'AZUR
Competitiveness clusters
PÔLE MER BRETAGNE ATLANTIQUE
PÔLE MER MÉDITERRANÉE
Academic and scientific organisations
Centrale Méditerranée
UNICAEN UNIVERSITÉ CAEN NORMANDIE
Université Gustave Eiffel
ENSTA BRETAGNE
UBO Université de Bretagne Occidentale
École des Ponts ParisTech
SHOM
Nantes Université
Université Bretagne Sud UBS
Ifremer

© Halynea

Team

With over 75 employees, the Institute boasts France's largest team dedicated to offshore renewable energy R&D. Thanks to this multi-disciplinary team, harbouring diverse profiles from both academic and industrial backgrounds, the Institute is able to support the sector via a cross-cutting approach on a range of topics.

Site characterisation

Expertise: observation and modelling of atmospheric and ocean turbulence, extreme sea states, hydrosedimentary dynamics

ORE systems and farms

Expertise: structural calculations, hydrodynamics, mooring system engineering, machine learning, offshore monitoring, electrical architecture, operation and maintenance

Environmental integration

Expertise: benthic ecology, ornithology, marine mammals, ichthyofauna, trophic modelling, ecosystem and socio-ecosystem modelling, sociology

Support services

Expertise: administration and finance, legal affairs, human resources, project management, IT, communication, development, valorisation

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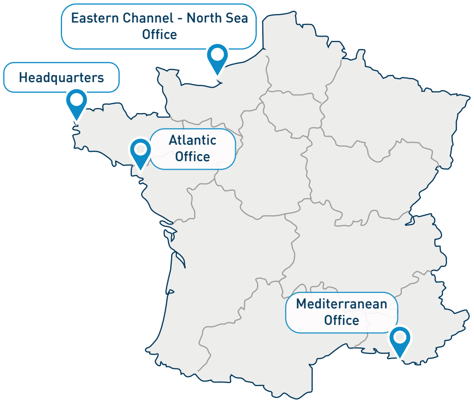
Locations

Given its national vocation, France Energies Marines has always taken into consideration the specific characteristics of the different French coasts and the local stakeholders. Our proximity, which is therefore a major asset, is reflected in our strategic locations, with each site broadening its reach as the Institute expands. France Energies Marines is particularly eager to support the development of bottom-fixed and floating offshore wind farms, working closely with pilot and commercial projects.



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Head office at the tip of Brittany

Ever since the creation of France Energies Marines in 2012, its headquarters have been based in Plouzané, near Brest. Shortly after, it moved to join the maritime cluster Pôle Mer Bretagne Atlantique and Technopôle Brest-Iroise in the Cap Océan building, the showcase building of Campus mondial de la mer. The proximity with these organisations and initiatives at the crossroads of collaboration between research and the marine and maritime industry reinforces synergies with the local ecosystem.

Atlantic office

France Energies Marines has had an Atlantic office since 2017. This office is located in Nantes, on the campus of the Ecole Centrale, which fosters collaboration between researchers and businesses through complementary initiatives. Several PhD and post-doctoral students are also hosted by the Institute's partner laboratories in the Loire Valley.

Mediterranean office

The Mediterranean office was set up in 2019 and is being developed by a multidisciplinary team based in Marseille, on the premises of the Ecole Centrale. PhD and post-doctoral students are also hosted and co-supervised by partner laboratories in the SUD Provence-Alpes-Côte d'Azur and Occitanie regions. The partnership with the maritime cluster Pôle Mer Méditerranée also strengthens collaboration between researchers and companies in the two regions.

Eastern Channel & North Sea office

The Eastern Channel & North Sea office opened at the end of 2022 and is located on the premises of the University of Le Havre Normandie. Its vocation is to support the development of wind energy off the Normandy coast. This local presence will also be valuable in 2023 for the launch of a structured research programme to study the interactions between offshore wind energy and the marine environment, through the instrumentation of a met mast located off Fécamp.

Sustainable development

As a driver in the energy transition, France Energies Marines is fully committed to a sustainable development approach that it applies within its team and its ecosystem, but also at a more global level. Our actions in this respect can be divided into five main focal areas: research and knowledge transfer, contributing to the local and socially responsible economy, continuously improving our quality and safety approach, developing well-being in the workplace, and reducing our carbon footprint.

Research and knowledge transfer

In 2012, France Energies Marines set up a research programme designed to study the environmental effects of offshore wind farms in order to provide the sector with the necessary knowledge to ensure that this energy production method is as clean and green as possible. The Institute is committed to sharing the knowledge acquired through the research carried out by its team, members and partners. For this purpose, it organises a public webinar to present the results at the end of each project. The data obtained through the various studies is also input into RESCORE, the national resource centre dedicated to the French ORE sector. The Institute also pays particular attention to communicating with the general public. In 2018, it launched the COME3T initiative, in which national ORE-sector stakeholders come together to put environmental questions to a panel of neutral and independent experts.

Contributing to the local and socially responsible economy

Proximity and solidarity are key values that France Energies Marines champions wherever possible. As a result, suppliers and service providers are not chosen solely on the basis of price: particular attention is paid to their experience and the occupational health and safety policy they apply. The Institute works mainly with French businesses, in some cases based locally, that are committed to the environment. The Institute is also building trusting relationships with a number of companies in the social economy.

Continuously improving our quality and safety approach

As part of our collaborative R&D, France Energies Marines has set up a selection process for new projects promoting excellence. These projects are also closely monitored in terms of scientific output and expenditure records. In terms of human resources, the Institute has established a detailed procedure to guarantee the quality of its recruitment process. It encompasses the entire process, from drafting the job offer to the induction of the new recruit.

Finally, all of the Institute's projects involving animals comply with a strict regulatory framework. All such projects have been submitted to an *ad hoc* ethics committee and have obtained authorisation, which must be renewed every five years, from the French ministry in charge of research. All staff involved with these aspects have attended and passed specific training courses on animal testing.

Developing well-being in the workplace

France Energies Marines strives on a daily basis to improve well-being in the workplace, which is a key factor in employee engagement and loyalty. The management team, aware that well-being is also dependent on long-term employment, opts for permanent contracts wherever possible. The possibility of working from home has been included in the company agreement since 2019. To date, 74% of employees have taken up this option.

France Energies Marines' pay policy aims to ensure that wages are appropriate and fair. The Institute is convinced that gender equality is a key performance driver and is fully committed to this issue. Our workplace gender equality index for 2022 is 90/100. This is a relatively good score and is well above the value of 75/100 below which companies are required to take corrective action.

Reducing our carbon footprint

France Energies Marines conducts meetings remotely, either via video or telephone conferences wherever possible. The train is the recommended mode of transport for journeys of less than 500 km. The Institute's employees are environmentally conscious on an everyday basis, and the vast majority of them commute to work by bike, public transport or carpooling.

Digital waste is avoided as far as possible through regular maintenance of the IT equipment, with a view to extending the lifespan of computers, to reach a 5-year average for each machine. The Institute almost exclusively uses servers located in France. Since the best waste is waste that is never produced at all, our efforts focus primarily on waste reduction. Our paper consumption decreases each year. The volume of plastic waste from coffee breaks and meals is also dropping. Many of our employees eat home-cooked meals made from locally and sustainably produced food.

Nearly **1,000** views for the educational videos on the environmental challenges of offshore renewable energies

82% of the Institute's suppliers and service providers are based in France

43% are located less than 150 km from our premises

100% of test periods validated

90/100 Institute's gender equality index

59% of the Institute's employees use soft mobility for the majority of their home-to-work journeys

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02

HIGHLIGHTS OF 2022

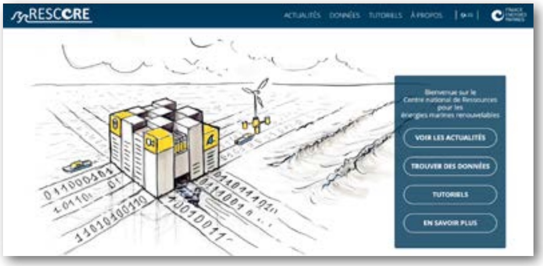
Systems design and monitoring | January

Retrieval of a structure submerged for 18 months in the Ria d'Etel and comprising mooring samples for a biofouling study.
ABIOP+ project

© FEM

Institute | February

Official launch of RESCORE, the national resource centre for the offshore renewable energy sector.



Bienvenue sur le Centre national de Ressources pour les énergies marines renouvelables

RESCORE
ACTUALITÉS
DONNÉES
TUTORIELS
À PROPOS
VOIR LES ACTUALITÉS
TROUVER DES DONNÉES
TUTORIELS
EN SAVOIR PLUS

© Appaloosa-FEM

Environmental integration | March

Public presentation of an innovative approach to measure the effects of wind farms,
at the crossroads between the natural sciences and social sciences.
APPEAL project

© FEM

Environmental integration |
April to November

Deployment of acoustic telemetry networks and tagging of fish and crustaceans in offshore wind farms.

FISH INTEL and FISHOWF projects

© FEM

Institute |
May

The Occitanie region, RWE and TotalEnergies became members of the Institute.

Farm optimisation |
September

Organisation of a session on offshore wind energy, hydrogen and maritime transport at the Sea Tech Week.

OPHARM project

© FEM

Institute I

September

Participation in European Researchers' Night on the theme of the unexpected and the installation of offshore renewable energy systems.

© FEM

Site characterisation I

October

End of a series of tests in a wave flume to measure the forces induced by breaking waves on a model of a floating wind turbine.
DIMPACT project

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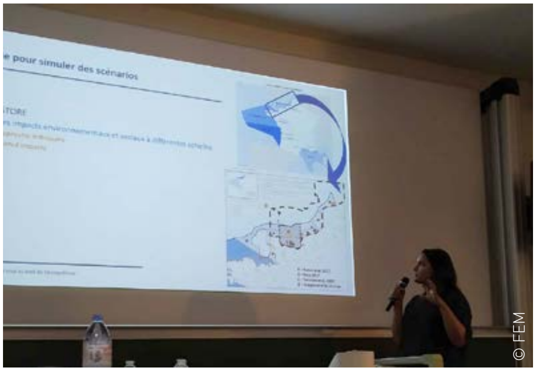
Environmental integration I

October

Public presentation of a conceptual model to characterise the relationship between the development of ORE farms and ecosystem services.
WINDSERV project



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Systems design & monitoring | October

Public meeting in Belz, Morbihan, to announce the deployment of an experimental tidal stream turbine in the Ria d'Etel.
ELEMENT project

© FEM

Institute | October and November

Our Science and Technology Tribune held in the form of a panel session in Brest and Marseille.

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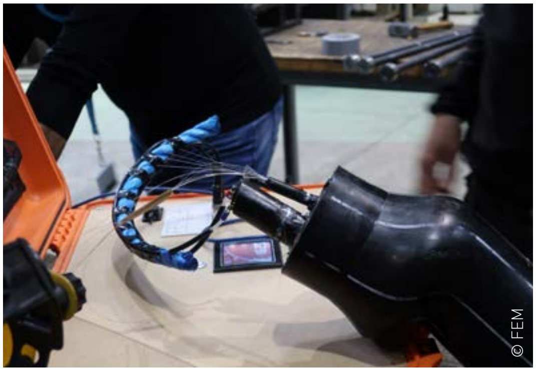
Systems design & monitoring | October to December

Bending, compression and tensile tests on sections of dynamic power cable.
DYNAMO project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Systems design & monitoring I

November to December

Assembly of a demonstrator composed of a 7-tonne buoy fitted with a hybrid chain and nylon mooring line and numerous sensors.

MONAMOOR project

© FEM

Site characterisation I

December

Deployment of a lidar on Planier Island in the Mediterranean to collect atmospheric turbulence data.

POWSEIDOM project

© FEM

2022 press review

8th February

RESCORE, a valuable tool for centralising, organising and disseminating data relating to offshore renewable energies.

4 articles |

ACTU ENVIRONNEMENT GreenUnivers la lettre api le marin

23rd February

Can shared mooring systems reduce the cost of floating wind farms?

2 articles |

le marin énergie Plus

16th May

The Occitanie region, RWE and TotalEnergies join France Energies Marines.

1 article |

le marin

12th September

A forum to discuss the results of the collaborative R&D carried out by France Energies Marines.

9th November

A great leap forward towards a 20 MW floating wind turbine: EOLINK is selected under the DEMO TASE call for projects launched by ADEME.

3 articles |

ENERGIES DE LA MER JDL GROUPE la lettre api

2nd December

Offshore renewable energy
45 partners working together on 6 new R&D projects led by France Energies Marines, representing a total budget of €9M.

6 articles |

LA LETTRE ÉCONOMIQUE DE BRETAGNE ENERGIES DE LA MER MARITIME JOURNAL la lettre api Mer et Marine reNEWS BIZ

As well as...

9 articles and a podcast in:

blue franceinfo: hit west L'USINE NOUVELLE Mer et Marine ouest france POC Reporterre

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03

COLLABORATIVE R&D PROJECTS

Collaborative R&D is the Institute's long-standing activity, inherent to its vocation as a pooled research facility serving the offshore wind and ocean energy sectors. As an interface between the public and private sectors, France Energies Marines pinpoints the R&D needs of ORE farm and technology developers, and responds to these needs by working with top-class academic, industrial and institutional experts. Since its creation, the Institute has provided scientific input to over 70 collaborative R&D projects, 85% of which were set up and managed by our team.

Types of collaborative projects conducted by the Institute

Projects led by France Energies Marines

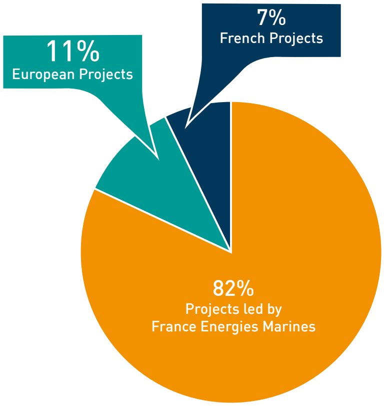
The R&D projects led by the Institute are initiated based on the needs expressed by its industrial members, then set up and carried out with constant vigilance as to the quality and applicability of the results obtained. Every year, five to seven new projects are launched following a tried-and-tested selection process promoting scientific excellence, as detailed in the following pages. The projects resulting from the Institute's annual R&D consolidation process can be carried out very openly, or in a more restricted manner requiring much greater confidentiality. They are supported by the France 2030 investment plan and various local authorities, as long as they secure funding from the industrial sector.

National projects

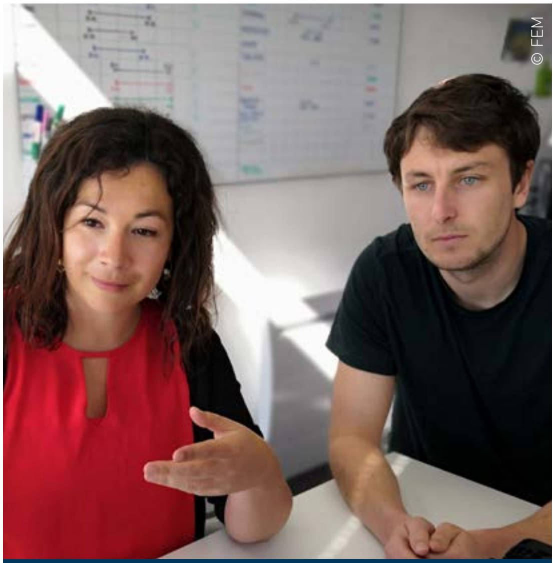
The Institute also takes part in collaborative projects mainly involving French stakeholders in the ORE sector, particularly innovative SMEs. These are relatively select consortia including both private and public sectors. This type of project receives financial support from national schemes such as ADEME's calls for research projects.

European projects

In order to extend its international reach, the Institute takes part in European projects that bring together a large number of public and private partners from different countries that are relatively advanced in the development of offshore renewable energies. These projects are funded by European Union programmes such as Interreg and Horizon 2020.



I Collaborative R&D in progress: breakdown by project type (% of the number of projects)



3 QUESTIONS for... Manon Joguet

Project Management Officer (PMO)
France Energies Marines

What are the different aspects of your role as PMO?

I support project managers throughout the life cycle of collaborative R&D projects, from initial set-up to final closure. This includes preparing document templates to lead working groups, assisting with budgeting, helping to explain how the Institute works, organising a risk identification workshop, supporting the management of deliverables and administrative documents during and at the end of the project, drawing up a meetings schedule and, in collaboration with Juliette Saunier, preparing a spreadsheet on industrial property protection.

My role also involves understanding the difficulties encountered by the project managers, flagging up critical points and communicating this information to the Institute's management team. They can then define a clear, common course of action to ensure an advanced, professional project management approach. I then provide support to ensure that the decisions made can be easily implemented by the team.

The last main aspect of my role consists in acting as the main contact for the French National Research Agency (ANR) in relation to the twenty or so collaborative projects currently in progress, led by the Institute and supported by the France 2030 investment plan.

What was your biggest challenge in the past year?

My biggest challenge was to roll out a company-wide project management tool. This project began with identifying and analysing the needs of the Institute's various components, which were then integrated into a software interface. Some twenty project managers then had to be trained in the use of the tool, then all France Energies Marines' staff were trained to enter timesheets for cost accounting purposes. The chosen tool initially appears complex, but will become increasingly relevant. It means changing practices, but the staff appear to be onboard and are getting to grips with it.

What are the main upcoming actions?

The priority will be to develop training course for project managers with a view to improve the professionalism of our project management. We have found that this type of training course provided by external organisations is often very generic and product-oriented. We therefore decided to construct an in-house training module tailored to the specific context of public-private collaborative R&D. It will involve the production of comprehensive support materials, together with checklists, document templates, procedures, etc. In 2023 five sessions will be run in sync with our project development timetable: one three-hour session on project set-up in May, one two-hour session on project closure in June, another two-hour session on project launch in September and two one-day sessions on project tracking in October and November.

Selection of the Institute's projects

As part of its collaborative R&D activity supported by the France 2030 investment plan, France Energies Marines has set up a selection process for new projects promoting excellence. Every year, projects are set up through a very open approach shared by all members of the Institute. It is also possible to propose more restricted projects. The selection process for both types of projects is composed of three main phases.

❶ Identification of priority industrial focal issues

- For **"open" projects**, the industrial members of France Energies Marines present the bottlenecks to be overcome and propose topics related to the Institute's roadmap. All of France Energies Marines' members and staff then work together in working groups to determine the priority focal issues.
- For **"restricted" projects,** the topics are directly defined with industrial members of France Energies Marines, with support from a restricted circle of partner teams.

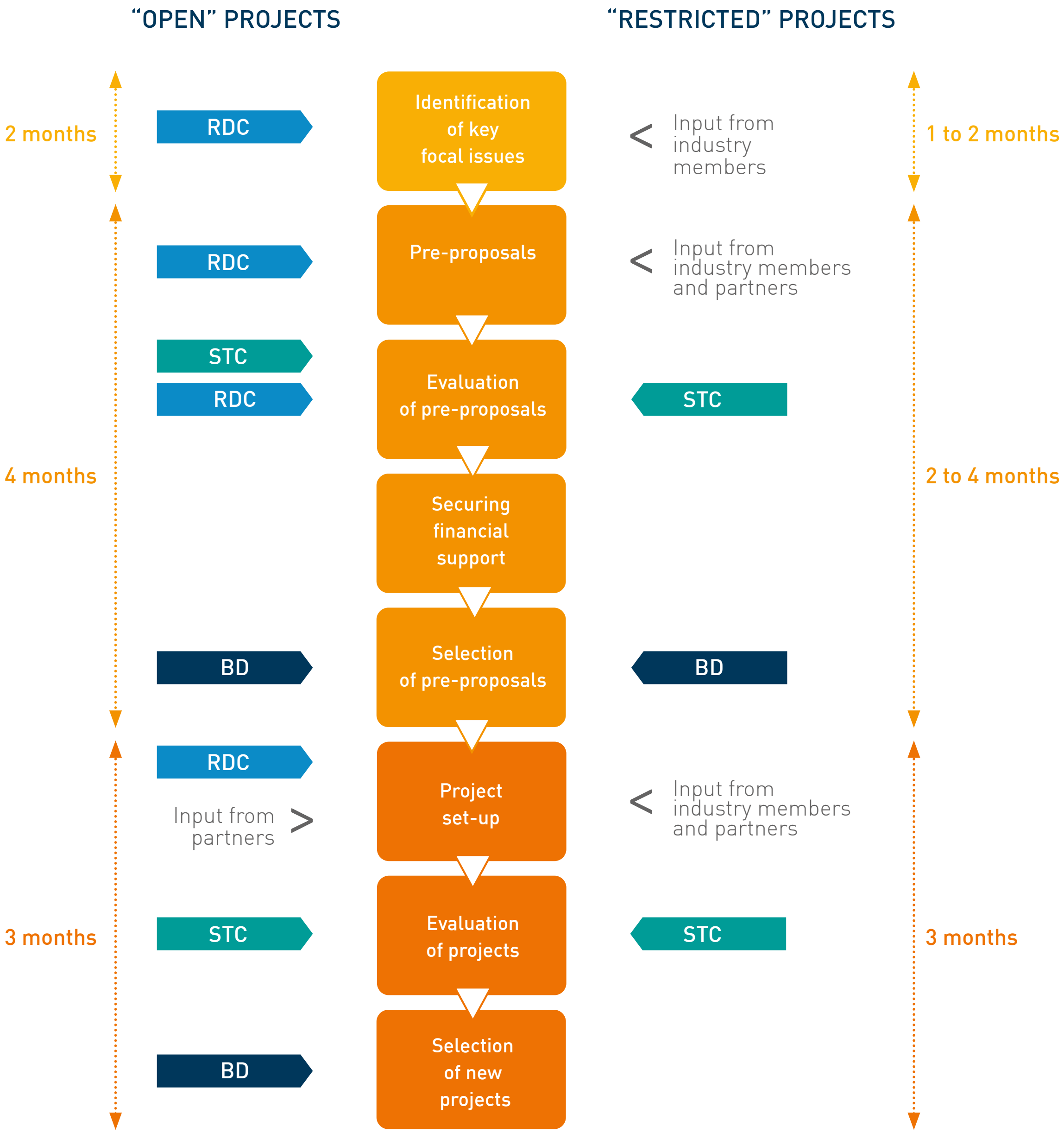
❷ Pre-proposals

On the basis of the selected topics, pre-proposals are drafted. At this stage, the scope of action of each member of the consortium is defined and an initial provisional budget is prepared.

- For **"open" projects**, these pre-proposals are reviewed by the members of France Energies Marines, the Science & Technology Committee composed of independent international experts, and the Institute's management team. Then, financial pledges from stakeholders are gathered. Building on these different elements, the Board of Directors selects the most promising pre-proposals.
- For **"restricted" projects**, the pre-proposals are evaluated by the Science & Technology Committee and the Institute's management team. The funding plan is drawn up by the project partners and France Energies Marines. The Board of Directors then selects the most relevant pre-proposals.

❸ Project set-up

Based on the evaluations received and funding obtained, each project is prepared in terms of its scientific, organisational, human resources and budgetary aspects. This phase results in a detailed document, around 40 pages long, which is then evaluated by the Institute's management team and the Science & Technology Committee. Taking into account the different appraisals, the Board of Directors validates the new projects to be launched.


"OPEN" PROJECTS
"RESTRICTED" PROJECTS
2 months
RDC
Identification of key focal issues
< Input from industry members
1 to 2 months
RDC
Pre-proposals
< Input from industry members and partners
STC
RDC
Evaluation of pre-proposals
STC
4 months
2 to 4 months
Securing financial support
BD
Selection of pre-proposals
BD
RDC
Input from partners >
Project set-up
< Input from industry members and partners
3 months
STC
Evaluation of projects
STC
3 months
BD
Selection of new projects

RDC
The **Research & Development Committee** which brings together all the Institute's members

BD
The **Board of Directors** made up of 10 members elected from the Institute's shareholders

STC
The **Science & Technology Committee** composed of 8 independent international experts

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Overview of achievements in 2022

The 30 collaborative projects in progress or completed in 2022 come under one or more of the Institute's four R&D programmes: site characterisation, systems design and monitoring, farm optimisation and environmental integration. 75% are led by France Energies Marines, 15% are supported by ADEME and 10% are funded by the European Union. They represent a total budget of €51.7 million and combined they involve nearly 130 partners.

7 projects

€10.9M
cumulative budget

52 different
partners

Topics studied: wind turbulence, air-atmosphere interface, winds and waves in cyclonic conditions, impact waves, underwater dunes, geophysics

SITE CHARACTERISATION

7 projects

€13.9M
cumulative budget

36 different
partners

Topics studied: biofouling, digital twins of moorings and floats, polyamide mooring lines, dynamic cables, tidal energy performance

SYSTEMS DESIGN AND MONITORING

ENVIRONMENTAL INTEGRATION

Themes studied: analysis of the life cycle of farms, socio-ecosystem approach, tools and methods for monitoring avifauna and marine megafauna, ecotoxicology

€20.4M
cumulative budget

69 different
partners

12 projects

FARM OPTIMISATION

Topics studied: floating electrical substations, coupling hydrogen and wind energy, isolated grids, mutualised anchors, O&M for floating wind energy

€7.3M
cumulative budget

35 different
partners

6 projects

COLLABORATIVE R&D PROJECTS

Site characterisation p.30
- CASSIOWPE
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- DUNES
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- OROWSHI
- POWSEIDOM

Design and monitoring p.44
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- OPHARM
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- ECOSYSM-EOF
- FISH INTEL
- FISHOWF
- LIF-OWI
- NESTORE
- ORNIT-EOF
- OWFSOMM
- SEMAFOR
- SEMMACAPE
- WINDSERV

CASSIOWPE

Characterisation of atmosphere-sea surface interactions for offshore wind energy in the Gulf of Lion

Technology |

Stages in the value chain |

Duration: 36 months | **Launched:** 2020

Objective:

- To provide a database of high resolution observations of wind, wave and current fields, as well as a new numerical tool to model metocean conditions in the Gulf of Lion.

Scientific and technical content:

- Collection of available observation data to describe the complexity of metocean conditions in the Gulf of Lion.
- Development of a new level 2 processing chain for synthetic aperture radar (SAR) images.
- Development of a coupled numerical system and incorporation of new physical parameterisations.
- Validation of the coupled model for the specific conditions.

2022 achievements:

- Finalisation of the surface wind field database and continuation of the assessment of the wave field characterisation potential using SAR imagery.
- Implementation of a coupled ocean-wave-atmosphere modelling chain and testing on five case studies.
- Cost-benefit analysis of the various model couplings and the corresponding resolutions to put forward an optimal configuration for a 25-year replay.
- Initial numerical simulations required to build and validate a database with one year of data for the coupled ocean-wave-atmosphere system.

Partners:

This project is led by the LOPS (Laboratoire d'Océanographie Physique et Spatiale) and France Energies Marines.

Total project budget: €1,290K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the SUD Provence-Alpes-Côte d'Azur region and from the maritime cluster Pôle Mer Méditerranée.
This project is approved by the maritime cluster Pôle Mer Méditerranée.

Characterisation of interactions between the atmosphere and the sea surface

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DIMPACT

Technologies |

Stages in the value chain |

Designing floating wind turbines taking into account the impacts of energetic steep and breaking waves

Duration: 42 months | **Launched:** 2020

Objective:

› To provide less conservative certification guidelines and an appropriate engineering tool taking into account the impact of energetic steep and breaking in terms of slamming, run-up, green water and vibration-induced effects.

Scientific and technical content:

› Numerical simulations of energetic steep and breaking waves interacting with a floating offshore wind turbine.

› Wave tank experiments in sea states of growing steepness up to the occurrence of large breaking waves.

› Field experiment from the full-scale floating offshore wind turbine *Unitech Zefyros* off Norway.

2022 achievements:

› Continuation of tests to validate the engineering formulas developed through the project.

› Development of new impact effort formulations.

› Implementation of an alternative measurement protocol to that initially developed for collecting measurements on the *Unitech Zefyros* floating wind turbine.

2022 dissemination:

› Publication:

- Battle Martin M., *et al.* (2022) Numerical investigation of slamming loads on floating offshore wind turbines. *Proceedings of the 32nd International Ocean and Polar Engineering Conference*, Vol. I, pp. 212-217

› Presentations:

- Leckler F. (2022) Table ronde Tempêtes et éolien en mer. Comment optimiser le dimensionnement des éoliennes flottantes pour faire face aux conditions extrêmes ? Tribune scientifique et technologiques de France Energies Marines, Brest, France, 07/10/2022
- Battle Martin M., *et al.* (2022) Numerical investigation of breaking focused wave-induced loads on floating offshore wind turbines. 18e Journées de l'hydrodynamique, Poitiers, France, 22/11/2022 -24/11/2022
- Hulin F., *et al.* (2022) Experimental investigation of the hydrodynamic loads induced by breaking wave impacts on a SPAR-type floating offshore wind turbine. 18e Journées de l'hydrodynamique, Poitiers, France, 22/11/2022 -24/11/2022

Partners:

This project is led by France Energies Marines.

Total project budget: €2,144K
This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Brittany and Réunion regions.
This project is approved by the maritime clusters Pôle Mer Bretagne-Atlantique and Pôle Mer Méditerranée.

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/ *Model for the wave tank tests to simulate sea states*

DUNES

Dynamics of underwater dunes and impact on ORE projects

Technologies |

Stages in the value chain |

Duration: 40 months | **Launched:** 2019 | **Completed:** 2022

Objectives:

› To understand the sediment and ecosystem dynamics of underwater dunes off the coast of Dunkirk.
› To offer ORE-sector technology developers and industrial firms knowledge and complementary approaches for working in environments with hydraulic dunes.

Scientific and technical content:

› Mapping of the dunes of French mainland coasts.
› Acquisition of high-resolution spatio-temporal data on Dunkirk dune dynamics.
› Understanding the short-term evolution of these underwater dunes.
› *In-situ* characterisation of the structure of dune ecosystems.
› Characterisation of ecosystem function by studying food webs through isotopic analyses.

Achievements throughout the project:

› Completion of 14 offshore campaigns by the end of the project (bathymetric surveys, hydrodynamic measurements and sampling of marine fauna), providing large quantities of data recorded in a database on the underwater dune morphodynamics and ecosystems.
› Preparation of two summary documents: a state of the art review on underwater dunes and their ecosystem and a recommendation report based on the project outcomes.

2022 dissemination:

› Presentation:
- Nexer M., *et al.* (2022) Compréhension de la dynamique des dunes sous-marines dans le cadre de la construction d'un parc éolien en mer à travers l'acquisition de données *in situ*, une analyse morphométrique, et leur modélisation numérique et physique. 18e Congrès français de Mécanique, Brest, France, 28/09/2022 - 30/09/2022

› Event:
- Organisation of a public meeting in Dunkirk in October to present the project results.

Partners:

This project is led by Shom and France Energies Marines.

Total project budget: €1,284K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.

It also receives funding from the Brittany and Normandy regions, and from the maritime cluster Pôle Mer Bretagne Atlantique.

During 14 campaigns at sea, large quantities of data have been collected on the morphodynamics and ecosystem of underwater dunes.

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GEOSISMEM

Geophysical surveys for the seabed characterisation of offshore renewable energy sites

Technology |

Stage in the value chain |

Duration: 52 months | **Launched:** 2018 | **Completed:** 2022

Objective:

- To develop a new seabed characterisation methodology based on a combination of geophysical and geotechnical data in order to make recommendations for use in the offshore wind sector.

Scientific and technical content:

- Development of new methodologies for processing existing geophysical data.
- Implementation of geophysical multitrace seismic and electromagnetic measurements.
- Development of an effective methodology for optimising geophysical and geotechnical surveys.
- Drafting of recommendations relating to the integration of geophysical data into site characterisation for project engineering purposes.

Achievements throughout the project:

- New methodologies for processing existing geophysical data.
- Geophysical multitrace seismic and electromagnetic measurement campaigns.
- Pile size calculations using geophysical and geotechnical data.
- Recommendations relating to the integration of geophysical data into site characterisation for project engineering purposes.

Partners:

This project is led by the Université de Bretagne Occidentale and France Energies Marines.

Total project budget: €775K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.

It also receives funding from the Brittany region.

This project is approved by the maritime clusters Pôle Mer Bretagne-Atlantique and Pôle Mer Méditerranée.

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MODULLES

Modelling of underwater dunes: local and large-scale evolutions in an offshore wind context

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2021

Objectives:

› To predict the impact of dune movement on offshore wind farm components.
› To gain a better understanding of the resiliency of underwater dunes after the construction phase.

Scientific and technical content:

› Numerical modelling of scouring and sediment transport close to offshore wind farm components.
› Numerical modelling of several marine dune fields in an offshore wind farm context.
› Thermal studies of a cable buried in an underwater dune field.
› Physical modelling of underwater dunes subjected to complex hydrodynamic forcings.
› Pre-study of dune ecological resiliency.

2022 achievements:

› Drafting of a state of the art review on the simulation of scouring and a state of the art review on the numerical modelling of several underwater dunes.
› Summary of scenarios and configuration for numerical modelling of several underwater dunes.
› Parametrisation and coupling of wave and current models developed using CROCO and TELEMAC.
› Preparation and initial testing of physical modelling of underwater dunes in a flume tank.
› Drafting of a report on the integration of the resilience of underwater dunes in morphodynamic models.

2022 dissemination:

› Presentations:

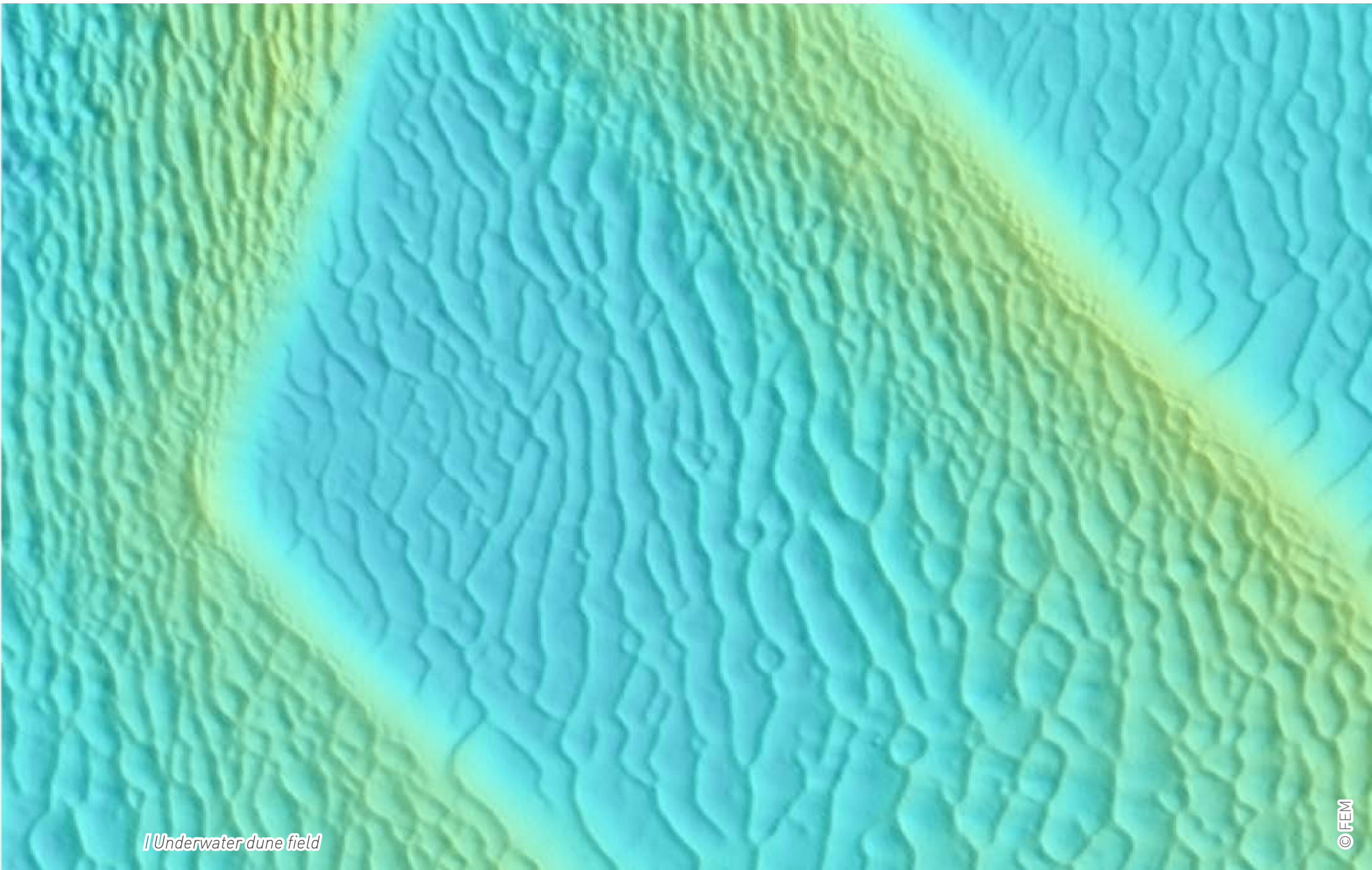
- Durand N., *et al.* (2022) Towards numerical modelling of marine dunes in a shallow shelf sea. 17th edition of the Journées Nationales Génie Côtier – Génie Civil, Chatou, France, 11/10/2022 - 13/10/2022
- Gilletta A., *et al.* (2022) Hydrodynamic simulations of flow around a wall-mounted cylinder using RANS, LES and hybrid RANS-LES turbulence models. 17th edition of the Journées Nationales Génie Côtier – Génie Civil, Chatou, France, 11/10/2022 - 13/10/2022
- Michelet N., *et al.* (2022) Estimation de l'influence des conditions hydrodynamiques sur les flux sédimentaires associés à la migration des dunes au large de Dunkerque. 17th edition of the Journées Nationales Génie Côtier – Génie Civil, Chatou, France, 11/10/2022 - 13/10/2022
- Nexer M., *et al.* (2022) Compréhension de la dynamique des dunes sous-marines dans le cadre de la construction d'un parc éolien en mer à travers l'acquisition de données in situ, une analyse morphométrique, et leur modélisation numérique et physique. 18e Congrès français de Mécanique, Brest, France, 28/09/2022 - 30/09/2022
- Gilletta A., *et al.* (2022) Hydrodynamic simulations of flow around a wall-mounted cylinder using RANS, LES and hybrid RANS-LES turbulence models. 10th OpenFOAM® users conference, Chambéry, France, 08/11/2022
- Gilletta A., *et al.* (2022), Towards turbulence-resolving two-fluid simulation of scour process. THESIS-2022 Symposium, Les Houches, France, 06/06/2022 - 10/06/2022
- Durand N., *et al.* (2002) Numerical modelling of marine dunes: Large-scale evolutions in an OWF context. European Geoscience Union Assembly 2022, Vienne, Autriche, 23/05/2022 – 27/05/2022

Partners:

This project is led by Shom, Marum and France Energies Marines.

Total project budget: €3,339K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Normandy region.



/ Underwater dune field

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OROWSHI

Offshore wind turbine design including joint wind-wave information in standard for hurricane-exposed sites

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2022

Objective:

› To better characterise extreme wind and waves during tropical cyclones to optimise the design of offshore wind turbines exposed to hurricane risks.

Scientific and technical content:

› Creation of a database of existing information on winds and waves associated with tropical cyclones.
› Validation and improvement of parametric surface wind models, then extrapolation to hub height.
› Validation, improvement and extension towards coastal waters of the parametric wave model from Kudryavtsev *et al.*
› Development of a method for estimating wind and wave joint extremes.
› Application of the new method to two sites of interest and comparison to standard practices.

2022 achievements:

› Project launch in November and initiation of various scheduled activities.

Partners:

This project is led by France Energies Marines.

Total project budget: €1,266K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the maritime cluster Pôle Mer Bretagne Atlantique.

| Hurricane over South-East Asia

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POWSEIDOM

Deployment of wind and turbulence observations in the Mediterranean

Technology |

Stages in the value chain |

Duration: 30 months | **Launched:** 2021

Objectives:

› To overcome the lack of wind and turbulence data from *in-situ* measurements in the Gulf of Lion.
› To propose specific recommendations for the design of offshore wind turbines in this region.

Scientific and technical content:

› Deployment of a WindCube v2 lidar operating at 4 Hz, i.e. with an acquisition frequency four times higher than a commercial lidar of the same type.
› Preliminary study of the lidar's capacity to measure turbulence by comparison with a met mast equipped with anemometers.
› Characterisation of turbulence in the Gulf of Lion by measuring the lidar deployed on Planier Island.
› Testing of the lidar on board a mobile platform reproducing the movements of a buoy deployed in the Gulf of Lion.
› Development of a motion compensation algorithm.

2022 achievements:

› Implementation of a campaign to compare measurements from a fixed lidar with those from a mobile lidar positioned on a hexapod, providing a concomitant dataset between the two instruments with a view to reproducing the movements of a lidar installed on a buoy.
› Installation of a profiling lidar on Planier Island in the Mediterranean to record wind measurements, particularly turbulence, representative of conditions at sea, over at least one year.

2022 dissemination:

› Presentation:
  - Thiébaut M. (2022) Table ronde Tempêtes et éolien en mer. Comment optimiser le dimensionnement des éoliennes flottantes pour faire face aux conditions extrêmes ? Tribune scientifique et technologiques de France Energies Marines, Brest, France, 07/10/2022

Partners:

This project is led by France Energies Marines.

FRANCE ENERGIES MARINES · Centrale Méditerranée · EOLFI · Ifremer · OW OCEAN WINDS · EDF · VAISALA · RÉGION SUD PROVENCE ALPES CÔTE D'AZUR · PÔLE MER BRETAGNE ATLANTIQUE · PÔLE MER MÉDITERRANÉE

Total project budget: €834K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
This project is approved by the maritime cluster Pôle Mer Méditerranée.

FRANCE 2030

WINDCUBE
LEOSPHERE
A VAISALA COMPANY

Testing the profiling lidar on the coast of Brittany before deployment on Planier Island

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ABIOP+

Accounting for biofouling through established protocols of quantification for engineering

Technologies |

Stages in the value chain |

Duration: 40 months | **Launched:** 2019 | **Completed:** 2022

Objective:

- To characterise biofouling qualitatively and quantitatively by site and component through innovative, low-cost, globally applicable protocols based on robust data analysis.

Scientific and technical content:

- Multi-scale characterisation at different ORE sites with biofouling.
- Improvement of biofouling characterisation protocols in terms of standardisation, operability and cost.
- Development of a quantitative image analysis method.
- Assessment of existing biofouling management solutions.

Achievements throughout the project:

- Detailed characterisation over 30 months of biofouling at five offshore renewable energy sites in the Atlantic and Mediterranean.
- Development of a new biofouling characterisation protocol including an adaptation to synthetic mooring lines, helping to move standards forward.
- Development of an image analysis method for species group recognition based on deep learning, classification and segmentation.
- Development of a protocol, an experimental set-up and a numerical model to quantify the thermal resistance of biofouling.
- Selection of an *in-situ* proven biofouling management solution.
- Identification of material biodegradation modes.

2022 dissemination:

- Publication:
  - Portas A., *et al.* (2022) Eukaryotic diversity of marine biofouling from coastal to offshore areas. *Frontiers in Marine Science*. Vol. 9, 971939
- Poster:
  - Signor J., *et al.* (2022) Automatic classification of biofouling images on marine renewable energy structures using deep learning. Seanergy, Le Havre, France, 15/06/2022 -17/06/2022

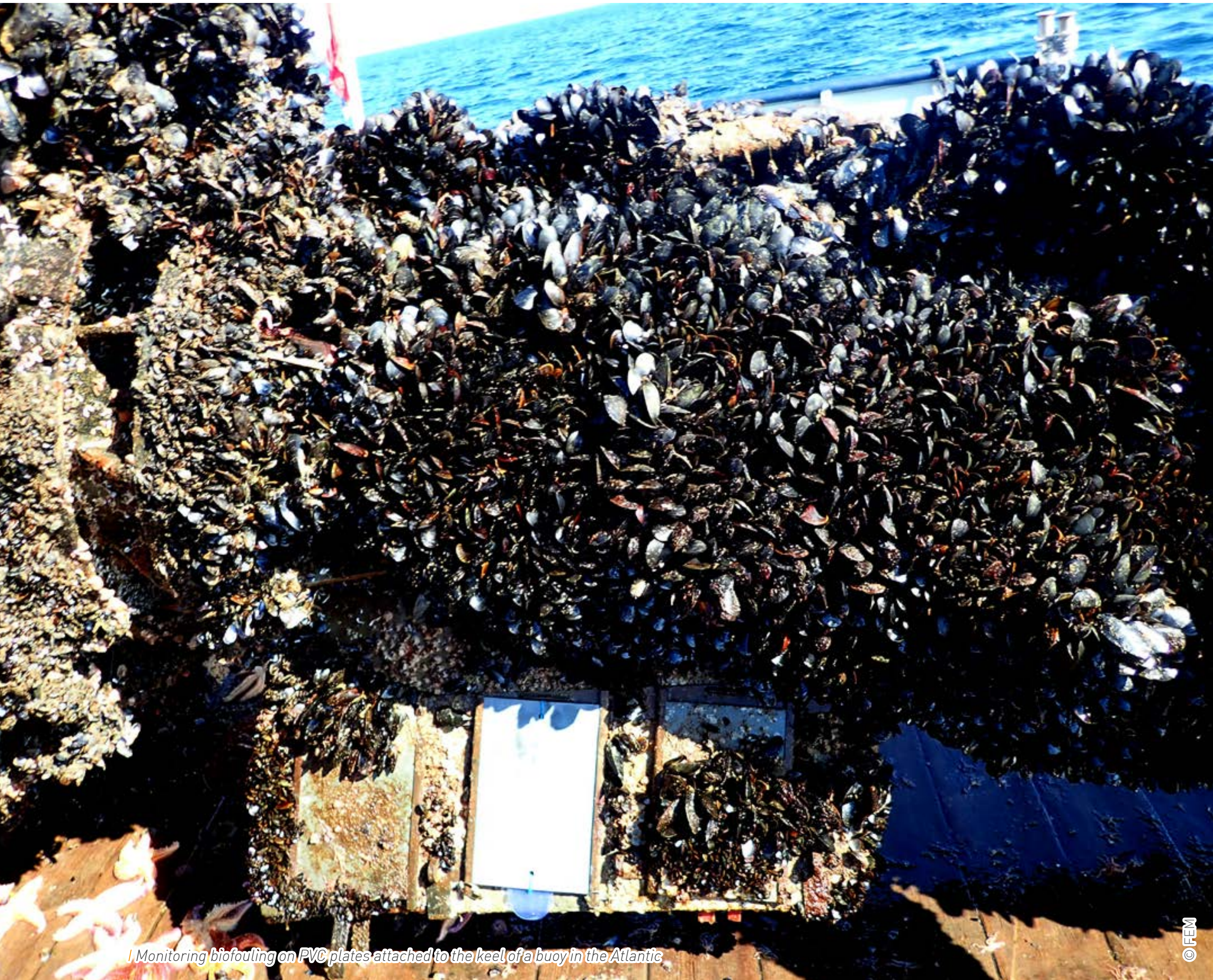
Partners:

This project is led by the Université de Nantes and France Energies Marines.

Nantes Université · FRANCE ENERGIES MARINES · corrodys · EDF · OW OCEAN WINDS · Rte Le réseau de transport d'électricité · NAVAL ENERGIES · EDF renouvelables · BEXCO · Ifremer · Université Bretagne Sud · UNIVERSITÉ DE TOULON

Total project budget: €1,990K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Brittany, Normandy, Pays de la Loire, SUD Provence-Alpes-Côte d'Azur and Réunion regions and from the maritime cluster Pôle Mer Méditerranée.
This project is approved by the maritime cluster Pôle Mer Méditerranée.



| Monitoring biofouling on PVC plates attached to the keel of a buoy in the Atlantic

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BIODHYL

Biofouling integrative characterisation and description of hydrodynamic loadings

Technologies |

Stages in the value chain |

Duration: 40 months | **Launched:** 2022

Objectives:

- To better understand the structural and environmental impacts of the development of biofouling on floating systems.
- To identify the most reliable and robust techniques to accurately characterise biofouling in an automated manner.

Scientific and technical content:

- *In-situ* characterisation of biofouling and study of the influence of parameters such as immersion time, depth, physico-chemical conditions, and site hydrodynamics.
- Development of methodologies to combine a morphological approach and metabarcoding to better characterise biofouling.
- Definition and characterisation of hydromechanical biofouling groups based on the different fluid-structure behaviours presented in the scientific literature and refined by mechanical tests.
- Building of a generic full-scale numerical model of a floating wind system including moorings and dynamic cable.
- State of the art review of technologies to automate the recognition and metrology of biofouling, then benchmark qualification.

2022 achievements:

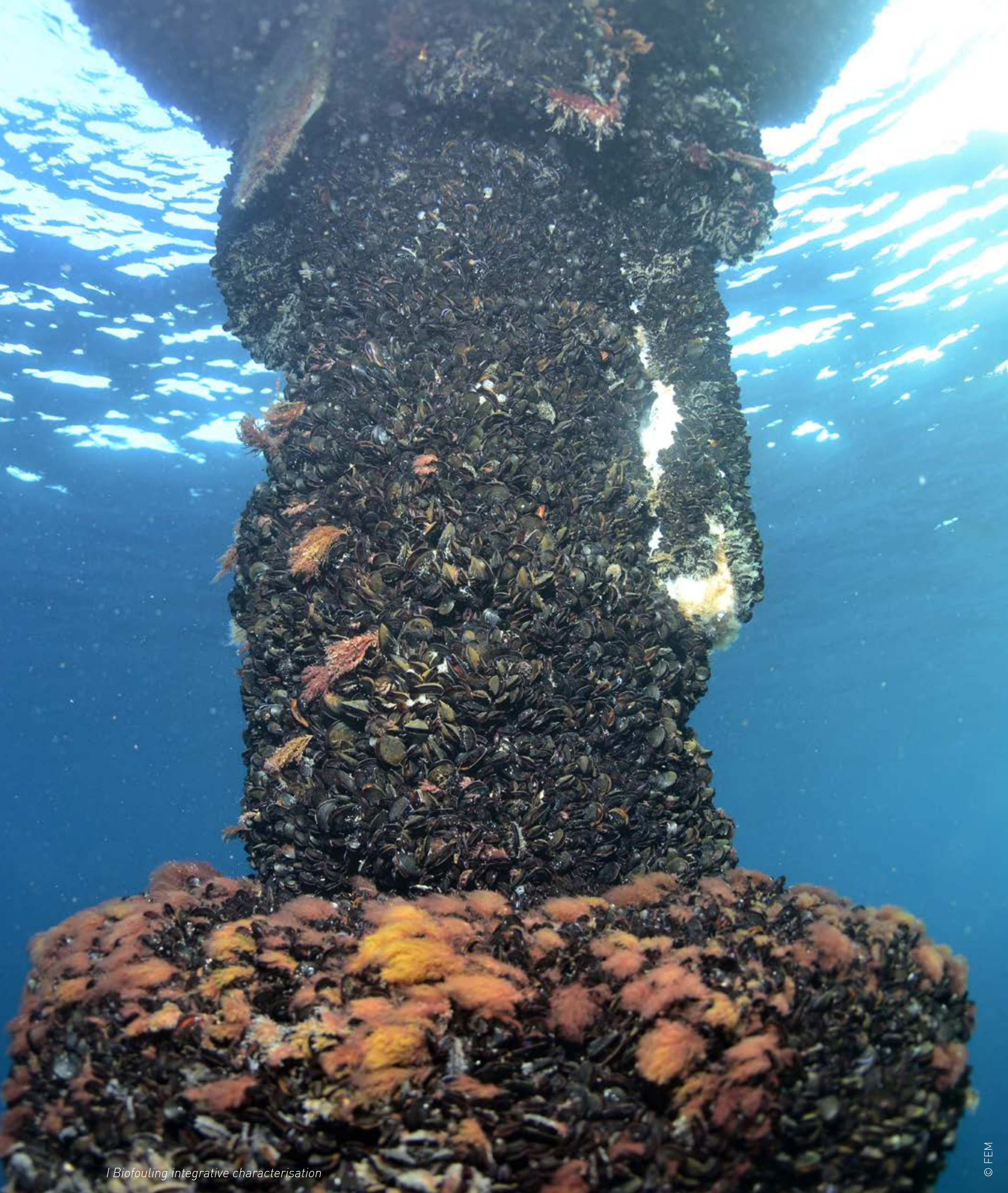
- Project launch in December and initiation of various scheduled activities.

Partners:

This project is led by France Energies Marines.

Total project budget: €1,607K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Brittany, Occitanie, Pays de la Loire and SUD Provence-Alpes-Côte d'Azur regions.
This project is approved by the maritime cluster Pôle Mer Méditerranée



I Biofouling integrative characterisation

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DIONYSOS

Digital intelligent operational network using hybrid sensors/simulations approach

Technology |

Stages in the value chain |

Duration: 36 months | **Launched:** 2021

Objective:

› To develop and test a fatigue monitoring system for floaters and mooring lines of a floating wind turbine.

Scientific and technical content:

› Review of the structural health methodology useful for the fatigue life of floater parts.

› At-sea testing of functionalities thanks to the deployment of sensors on the *Unitech Zefyros* offshore wind turbine located off the coast of Norway.

› Assimilation of data from field observations on the floating wind turbine digital twin with a machine learning methodology to improve integration between sensors (wave, wind, motions, structural health monitoring) and numerical models of the floating wind turbine.

› Web platform development.

› Construction of the digital twin: sensor calibration and deployment, numerical tool development, default detection, analysis of outputs, meta-model learning assessment, multi-level analysis.

2022 achievements:

› Finalisation of the numerical model of the *Unitech Zefyros* floating wind turbine and training in anomaly recognition.

› Deployment of NEURON® sensors and an inertial measurement unit on this offshore wind turbine and finalisation of the data repatriation process.

› Completion of an initial analysis of the data, revealing a good correlation at low frequencies between the global model and the measurements.

2022 and 2023 dissemination:

› Posters:

- Mezon C., *et al.* (2023) Détection d'anomalies et de comportements pathologiques d'une éolienne offshore flottante basée sur des capteurs inertiels et des réseaux de neurones pré-entrainés sur des données synthétiques, Colloque Jumeaux Numériques, Paris, France, 09/02/2023
- Ribault R., *et al.* (2023) Anomaly and pathological behavior detection of floating offshore wind turbine based on neuron sensors and simulation models, WindEurope Annual Event, Copenhague, Danemark, 25/04/2023 - 27/04/2023
- Dridi N., *et al.* (2023) Estimation de l'incertitude pour les réseaux de neurones : application pour la prédiction de mouvement d'éolienne en mer, GRETSI'23, Grenoble, France, 28/08/2023 - 01/09/2023

› Presentation:

- Ribault R. (2022) Maintenance prédictive des fermes EMR flottantes : Quelles perspectives pour l'utilisation de modèles de suivi hybrides intégrant simulations et capteurs ? Tribune scientifique et technologiques de France Energies Marines, Brest, France, 07/10/2022

Partners:

This project is led by France Energies Marines.

Total project budget: €1,302K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the maritime cluster Pôle Mer Bretagne Atlantique.

/ *Deployment of NEURON® sensors on the Unitech Zefyros floating wind turbine*

© Morphosense

DYNAMO

In-service monitoring of dynamic cables

Technologies |

Stages in the value chain |

Duration: 26 months | **Launched:** 2020

Objectives:

- To prepare guidelines for the farm-scale deployment of in-service monitoring solutions for subsea cables.
- To propose a roadmap for the development of in-service monitoring technologies.

Scientific and technical content:

- Compilation of feedback and experimental data on local failure modes (electrical, mechanical, thermal) of dynamic cables.
- Identification of parameters reflecting the emergence of failure modes.
- Identification of sensor technologies available or under development capable of detecting several of the failure modes.
- Study of the best technological and economic strategies for the deployment of sensors to monitor the electrical cable network of a farm.

2022 achievements:

- Completion of mechanical tensile, compression and bending tests, which gave relevant results on the selected in-service monitoring technologies and cable failure modes.
- Finalisation of the state of the art review of in-service monitoring technologies and offshore sensors.
- Drafting of recommendations and a roadmap for the development of instrumentation solutions tailored to the in-service monitoring of the dynamic power cable network of an offshore wind farm.

2022 dissemination:

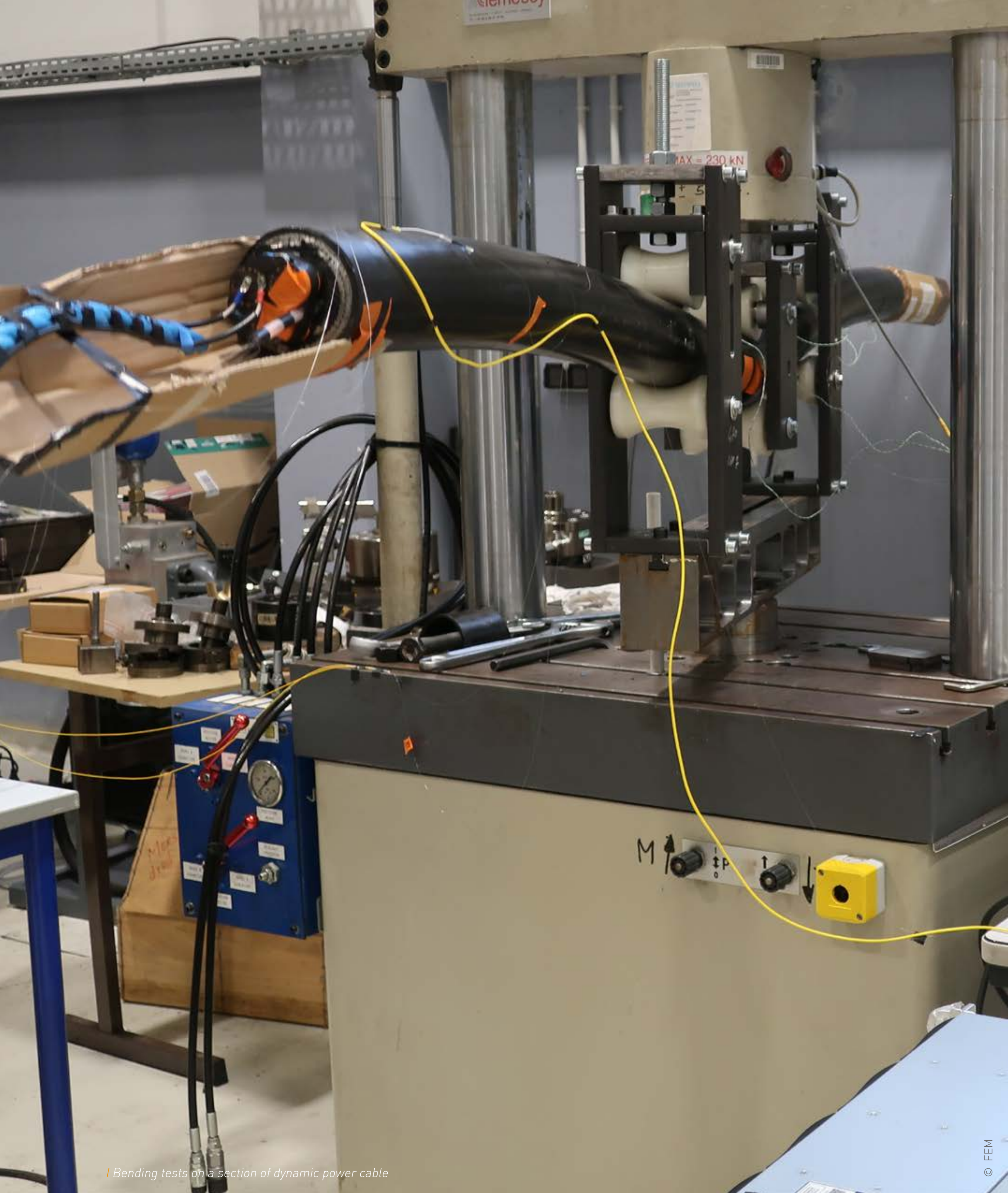
- Presentation:
  - Maison A. (2022) Maintenance prédictive des fermes EMR flottantes : Quelles perspectives pour l'utilisation de modèles de suivi hybrides intégrant simulations et capteurs ? Tribune scientifique et technologiques de France Energies Marines, Brest, France, 07/10/2022

Partners:

This project is led by EDF and France Energies Marines.

Total project budget: €1,304K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Brittany region.



Bending tests on a section of dynamic power cable

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ELEMENT

Effective lifetime extension in the marine environment for tidal energy

Technology |

Stages in the value chain |

Duration: 48 months | **Launched:** 2019

Objective:

- To use artificial intelligence to develop a control system to optimise the performance of a tidal turbine in turbulent flow, maximise energy yield, increase reliability and extend the lifetime of the turbine.

Scientific and technical content:

- Environmental characterisation of deployment sites, and assessment and modelling of the potential environmental impacts of tidal turbines.
- Design of a control system based on artificial intelligence.
- Onshore testing in a controlled environment, followed by tests in an estuary and at sea.
- Production of the control system and design of a tidal turbine based on the results of these tests.
- Socio-economic assessment of tidal turbine energy at regional, national and European levels.

2022 achievements:

- Finalisation of the study on the socio-economic impacts of tidal power in Europe.
- Design and construction of the gravity-based foundation for the tidal turbine for the estuary tests.
- Finalisation of the data analysis from the physical and environmental characterisation of the Ria d'Etel, which reveals that hydrodynamics influence biofouling.
- Completion of the development of a new feature in the DTOcean+ software suite to assess the collision risk for marine mammals and birds.

2021 dissemination:

- Publications:
  - IDETA (2022) European Tidal Energy Impact Analysis Report. ELEMENT Deliverable D12.4, 38 p.
  - Thiébaut M., *et al.* (2022) Investigating the flow dynamics and turbulence at a tidal-stream energy site in a highly energetic estuary. *Renewable Energy*. Vol. 195, pp. 252-262
- Event:
  - Organisation of a public information meeting on 24 October in Belz, attended by 75 people.

Partners:

This project is coordinated by Nova Innovation.

Total project budget: €4,895K
This project receives funding from the Horizon 2020 European research and innovation programme (grant agreement no. 815180).

| Building the tidal turbine foundation prior to deployment in the Ria d'Etel

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MONAMOOR

Monitoring of polyamide mooring lines

Technologies |

Stages in the value chain |

Duration: 42 months | **Launched:** 2020

Objective:

› To develop modelling tools for the mechanical behaviour of nylon fiber rope and the appropriate long-term monitoring instruments based on a deep understanding of material degradation mechanisms.

Scientific and technical content:

› Dedicated model based on the rheological hypothesis of a visco-elasto-plastic material.
› Development of sensors providing information on the interactions between global constraints and sub-constraints.
› Development of an approach comprising long-term sensors and a technique for high cycle fatigue prediction.
› Validation of sensors and models through at-sea testing.

2022 achievements:

› Performance of numerous creep tests on nylon fibres, characterisation of a long-term elongation behaviour law and initiation of the set-up of a mesoscale model.
› Assembly of the various components of a 7-tonne buoy forming the base of a demonstrator for at-sea trials.
› Finalisation of the development of the internal pressure sensors, integration of pressure, tension and elongation sensors into the nylon mooring lines, finalisation of the design of the mooring demonstrator.
› Preparation and validation of the installation procedure for the demonstrator, obtaining of all the necessary authorisations for its deployment in the Gulf of Fos.

2022 dissemination:

› Publications:
- Bain C., *et al.* (2022) Experimental evaluation of the main parameters influencing friction between polyamide fibers and influence of friction on the abrasion resistance. *The Journal of The Textile Institute*
- Civier L., *et al.* (2022) Short and long term creep behaviour of polyamide ropes for mooring applications. *Ocean Engineering*. Vol. 259, 111800

Partners:

This project is led by Ifremer and France Energies Marines.

Total project budget: €2,000K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.

It also receives funding from the Brittany, Pays de la Loire and SUD Provence-Alpes-Côte d'Azur regions.

This project is approved by the maritime clusters Pôle Mer Bretagne-Atlantique and Pôle Mer Méditerranée.

Preparing the demonstrator for deployment in the Mediterranean

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SUBSEE 4D

Development of a digital twin to facilitate the operation of floating wind farms

Technologies |

Stages in the value chain |

Duration: 24 months | **Launched:** 2020 | **Completed:** 2022

Objective:

- To optimise and plan maintenance operations, but also to improve the reliability of submerged systems, by developing a digital twin solution comprising two sub-modules:
  one for in-service monitoring of mooring lines and one for automated processing for the recognition and improvement of underwater vision.

Scientific and technical content:

- Detection of anomalies on mooring systems and calculation of remaining fatigue lifetime for mooring components using time domain simulations coupled with state-of-the-art numerical techniques.
- Development of a methodology for identifying the critical parameters of a mooring system and definition of a sensor deployment strategy.
- Development of an algorithm for image analysis based on texture recognition in degraded visual conditions.
- Laboratory image testing in controlled visual conditions.
- At-sea image analysis testing on a static device in real conditions, including biofouling aspects.

Achievements throughout the project:

- Development and deployment of software for in-service monitoring of mooring lines.
- Development and validation using real data, in conjunction with the DIONYSOS project, of supervised or unsupervised machine learning tools to detect and classify potential anomalies in the floating wind farm.
- Validation, in conjunction with the DIONYSOS project, of a convolutional neural network model to replace the system's slower numerical model, using real data from sensors positioned on the *Unitech Zefyros* floating wind turbine.

2022 and 2023 dissemination:

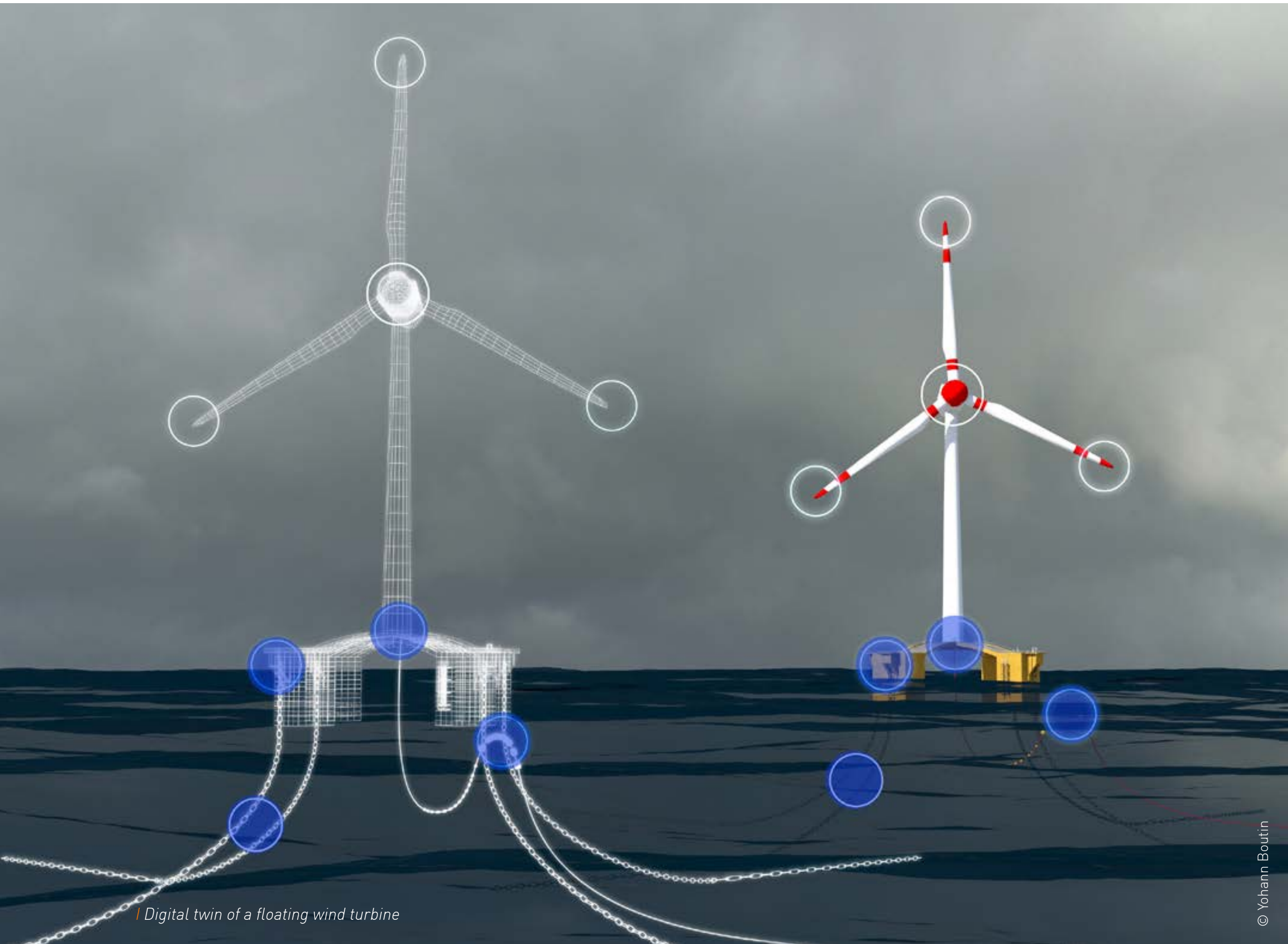
- Posters:
  - Mezon C., *et al.* (2023) Détection d'anomalies et de comportements pathologiques d'une éolienne offshore flottante basée sur des capteurs inertiels et des réseaux de neurones pré-entrainés sur des données synthétiques, Colloque Jumeaux Numériques, Paris, France, 09/02/2023
  - Ribault R., *et al.* (2023) Anomaly and pathological behavior detection of floating offshore wind turbine based on neuron sensors and simulation models, WindEurope Annual Event, Copenhague, Danemark, 25/04/2023 - 27/04/2023
  - Dridi N., *et al.* (2023) Estimation de l'incertitude pour les réseaux de neurones : application pour la prédiction de mouvement d'éolienne en mer, GRETSI'23, Grenoble, France, 28/08/2023 - 01/09/2023
- Presentation:
  - Ribault R. (2022) Maintenance prédictive des fermes EMR flottantes : Quelles perspectives pour l'utilisation de modèles de suivi hybrides intégrant simulations et capteurs ? Tribune scientifique et technologiques de France Energies Marines, Brest, France, 07/10/2022

Partners:

This project is led by Cervval.

Total project budget: €730K

This project receives financial support from the Brittany region.
the European Regional Development Fund and Brest Métropole.
This project is approved by the maritime cluster Pôle Mer Bretagne-Atlantique and competitiveness cluster Images & Réseaux.
It also receives support from Corimer.



/ *Digital twin of a floating wind turbine*

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AFOSS-DC

Architecture and design of a floating offshore substation for direct current applications

Technology |

Stages in the value chain |

Duration: 36 months | **Launched:** 2022

Objective:

- To study the HVDC floating offshore substation as an integrated system through analyses of functional requirements, integration constraints, risk and reliability.

Scientific and technical content:

- **Design basis:** global market analysis, definition of geographic sites and collection of metocean data, definition of farm and grid connection scenarios.
- **Electrical systems and topside:** functional analysis, electrical components list, electrical architecture definition, topside arrangement, calculation of the movements of the whole.
- **Semi-submersible platform:** design, motion and vibration analysis.
- **TLP platform:** advanced and comparative design, motion and vibration analysis, basin testing.
- **Dynamic cables:** design of a cross-section, definition of their arrangement and connection.
- **Cybersecurity:** architecture and mapping, risk analysis, mitigation measures.
- **System integration:** risk and reliability analysis, maintenance optimisation, OPEX calculation.
- **Qualification:** validation and qualification strategy, rules and regulation gap analysis, recommendations.

2022 achievements:

- Project launch in November and initiation of various scheduled activities.

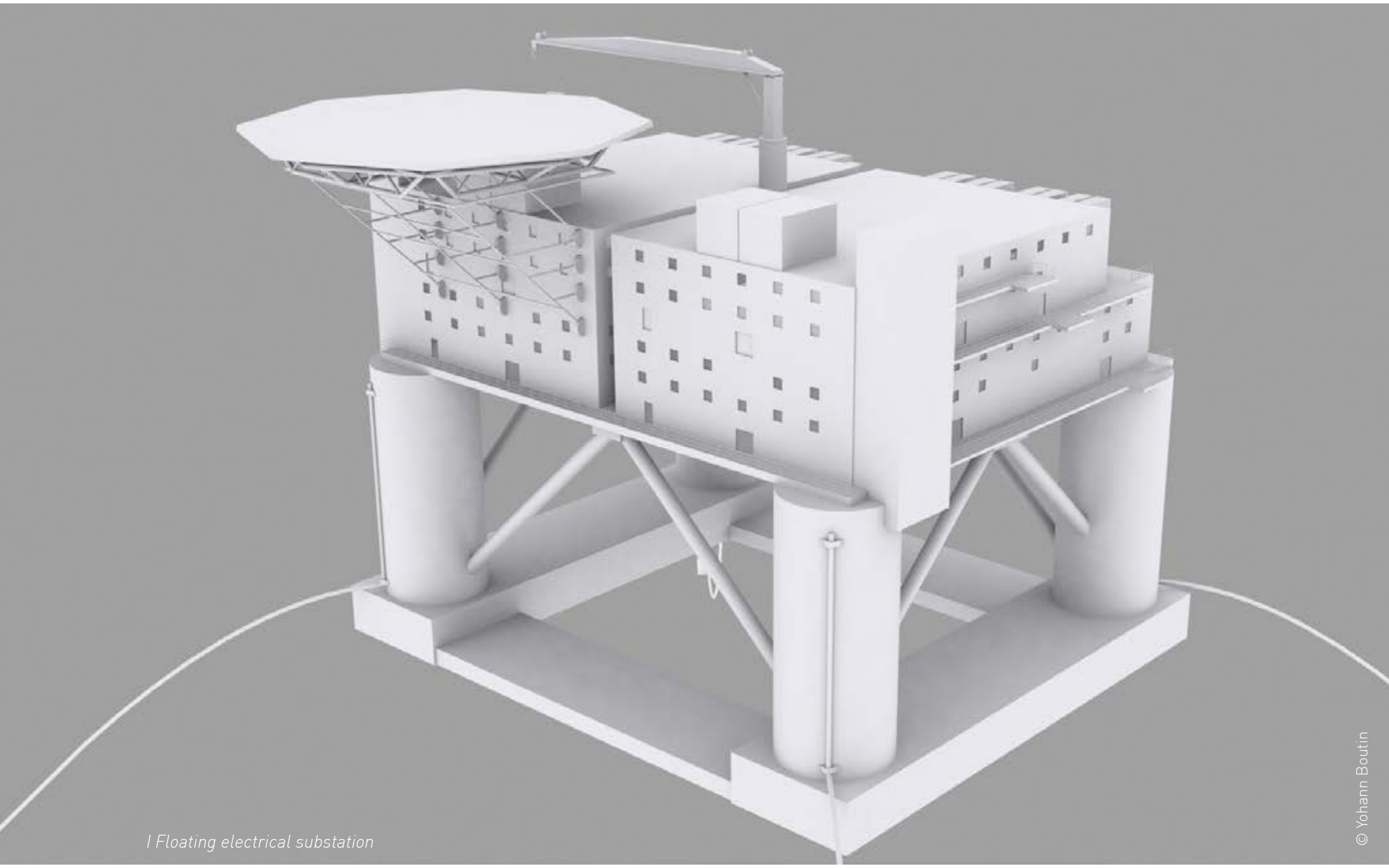
Partners:

This project is led by France Energies Marines.

Total project budget: €1,491K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.

It also receives funding from the Occitanie, Pays de la Loire and SUD Provence-Alpes-Côte d'Azur regions.



I Floating electrical substation

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FLOWTOM

Floating offshore wind turbines operation and maintenance

Technology |

Stages in the value chain |

Duration: 36 months | **Launched:** 2021

Objectives:

› To contribute to the development of heavy lift solutions for the offshore maintenance of floating wind turbines.
› To provide high resolution short term metocean forecasts for the Gulf of Lion for maintenance operations.

Scientific and technical content:

› **Offshore heavy lift maintenance methods:**
- Investigation of methods and technologies for offshore heavy lift operations at floating wind farms through stakeholder workshops.
- Assessment of a selected heavy lift solution through numerical simulations using different turbine and floater designs.
- Validation of the method statement through tank tests.

› **High resolution probabilistic forecasts:**
- Construction of the dataset, including implementation of *in-situ* surveys.
- Development of wind and wave learning-based model: end-to-end architecture, tuning and testing at test site, transfer learning.
- Implementation of an online forecasting system with scoring: iterative design with end-user feedback.

2022 achievements:

› Drawing up of initial user specifications based on weather forecasting work carried out.
› Production of a state of the art review of offshore heavy maintenance based on literature data and 12 bilateral interviews with companies specialising in this sector.
› Organisation of exchange workshops with technology developers with a view to selection for the subsequent stages of the project.

2022 dissemination:

› Poster:
- Marcille R., *et al.* (2022) Optimal sensors siting for offshore wind reconstruction using Gaussian mixture models. Seanergy, Le Havre, France, 15/06/2022 - 17/06/2022

Partners:

This project is led by France Energies Marines.

Total project budget: €1,600K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Brittany region.

Operation and maintenance of floating offshore wind turbines

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MOSISS

Monitoring strategies for innovative substations

Technology |

Stages in the value chain |

Duration: 29 months | **Launched:** 2020

Objective:

- To develop and demonstrate a comprehensive methodology for in-service electrical and structural health monitoring (including mooring) of floating offshore substations with currently available solutions and identify challenges for future technologies.

Scientific and technical content:

- Review of feedback from past experience and definition of specific needs related to floating offshore substations.
- Development of a maintenance optimisation approach: identification of the risks for offshore substations, identification of degradation processes and development of simplified models, determination of system reliability taking into account in-service electrical and structural health monitoring.
- Specification of in-service electrical and structural health monitoring: performance, redundancy.

2022 achievements:

- Drafting of a report on the maintenance specifications for a floating substation.
- Finalisation of the specifications for systems reliability modelling.
- Implementation of a method for formalising the modelling of floating electrical substation reliability and the impact of repairs, inspections and sensor-based monitoring, then generalisation of this method so that it can be used on a set of systems without affecting the quality or calculation time.

2022 dissemination:

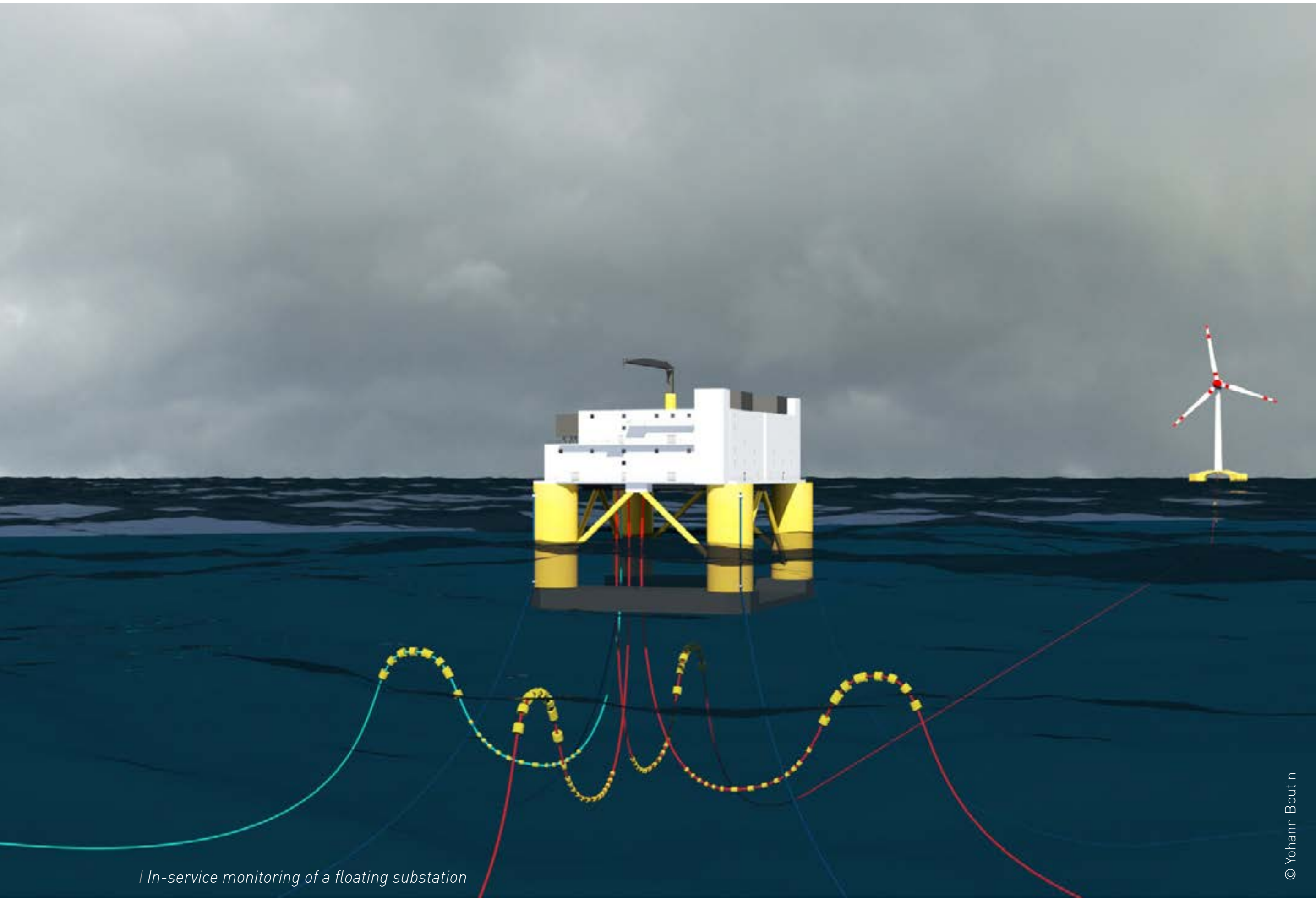
- Poster:
  - Ahmadivala M., *et al.* (2021) Time-dependent system reliability of Innovative concepts for floating offshore substation: first results. Seanergy, Le Havre, France, 15/06/2022 - 17/06/2022

Partners:

This project is led by Nantes University and France Energies Marines.

Total project budget: €892K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from EDF Renouvelables and the Pays de la Loire region.



| In-service monitoring of a floating substation

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MUTANC

Mutualised anchors for offshore wind farms

Technology |

Stages in the value chain |

Duration: 36 months | **Launched:** 2021

Objective:

- To study the potential of mutualised anchors to reduce the levelised cost of energy of floating offshore wind farms.

Scientific and technical content:

- Mooring system design and shared anchor load analysis.
- Geotechnical modelling with 3D finite element numerical method.
- Centrifuge tests on small-scale models to study multidirectional loadings and cyclic loadings.
- Cost estimation of mooring systems through expert consultation and existing cost models.

2022 achievements:

- Establishment of a coupled numerical model of the NREL 15 MW floating wind turbine on a semi-submersible float.
- Design and analysis of an anchoring system for several water depths and with shared anchors.
- In-depth comparison of two numerical models developed with two different software packages, with good results.
- Completion of the numerical geotechnical analysis of shared anchor piles.

Partners:

This project is led by France Energies Marines.

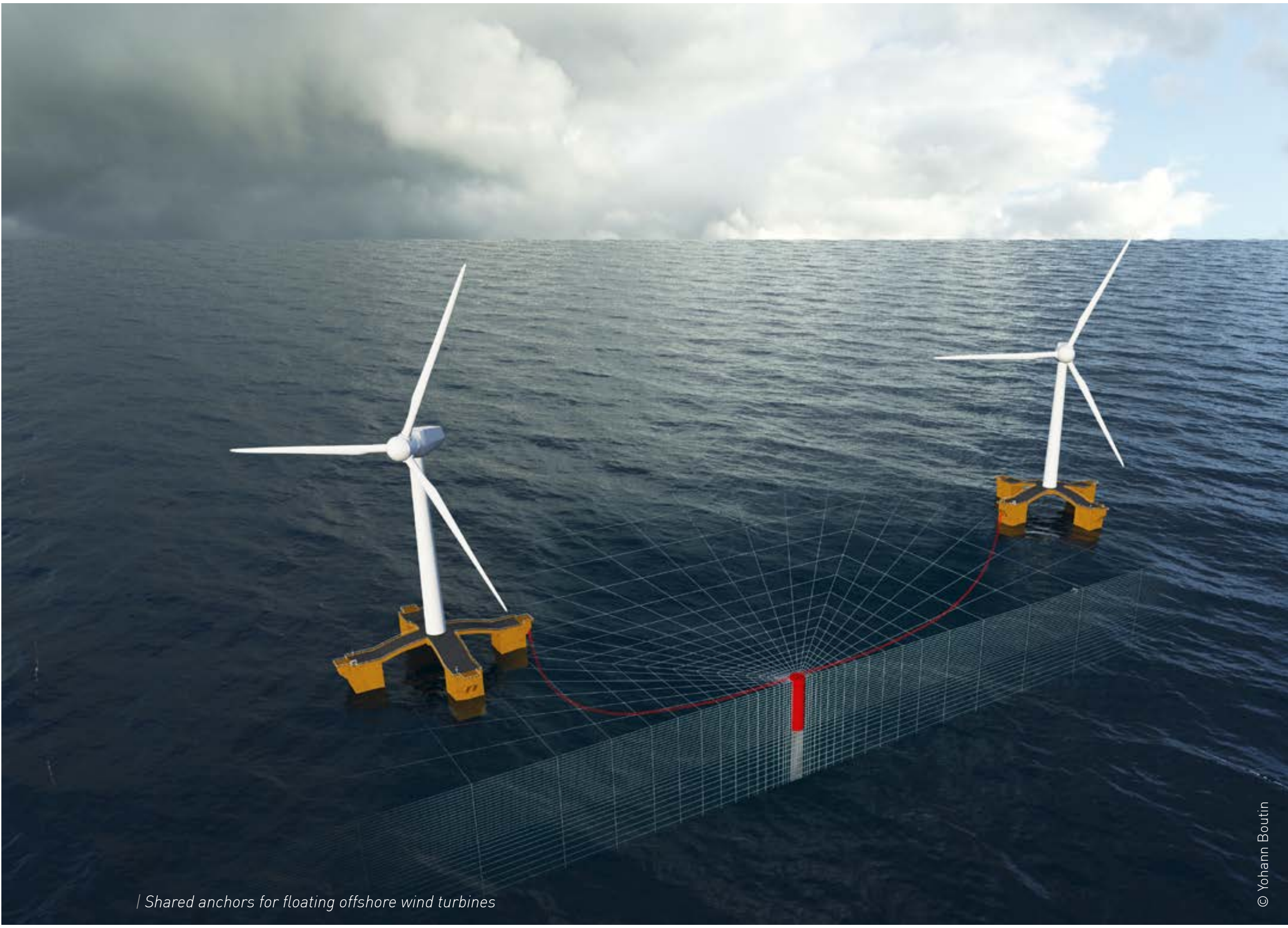
FRANCE ENERGIES MARINES
Nantes Université
Université Gustave Eiffel
UGA Université Grenoble Alpes
EDF
EOLFI
INNOSEA AqualisBraemar LOC Group
SAIPEM
TEN TECHNIP ENERGIES
TotalEnergies
skyborn

Total project budget: €1,343K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.

FRANCE 2030

It also receives funding from the Pays de la Loire region and from the maritime cluster Pôle Mer Bretagne Atlantique.



| *Shared anchors for floating offshore wind turbines*

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OPHARM

Offshore production of hydrogen analysis and roadmap

Technologies |

Stage in the value chain |

Duration: 24 months | **Launched:** 2021

Objective:

› To produce a roadmap and decision-making tools for the future players of the offshore renewable hydrogen market, with a focus on wind farms.

Scientific and technical content:

› Sector analysis.
› Identification of solutions and risks for offshore hydrogen production.
› Development of tools for offshore hydrogen production analysis.
› Preparation of a hydrogen roadmap for the offshore wind industry.

2022 achievements:

› Organisation of technology workshops to discuss hydrogen production equipment: electrolysis and desalination, storage and transport.
› Organisation of regional workshops to build scenarios for the joint deployment of offshore wind power and hydrogen production systems in Normandy, Pays de la Loire, SUD Provence-Alpes-Côte d'Azur and Occitanie regions.
› Development of the methodology for assessing the different configurations considered for hydrogen production.
› Production of an initial version of the numerical tool for assessing these configurations.

2022 dissemination:

› Poster:
  - Robert M., *et al.* (2022) Analysis of scenarios for hydrogen production combined with offshore wind. Seanergy, Le Havre, France, 15/06/2022 - 17/06/2022.

› Event:
  - Organisation on 22 September, during Sea Tech Week in Brest, of a panel session on offshore wind energy, hydrogen production and maritime transport, bringing together the MEET 2030 Institute, the Institut des Matériaux de Nantes, Sofresid Engineering, RWE and France Energies Marines.

Partners:

This project is led by France Energies Marines.

Total project budget: €544K
This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Normandy, Occitanie, Pays de la Loire and SUD Provence-Alpes-Côte d'Azur regions.
This project is approved by the maritime cluster Pôle Mer Méditerranée.

/ Roadmap for offshore hydrogen production from wind power

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OPTILE

Multi-criteria optimisation for offgrid marine renewable electrical production

Technologies |

Stage in the value chain |

Duration: 36 months | **Launched:** 2022

Objective:

› To propose economic and environmental solutions for the supply of isolated electrical grids

Scientific and technical content:

› Bibliography on offshore renewable energy sources and storage: price, maintenance, reliability, lifetime, system life cycle, CO_2 impact, implantation.
› Calculation of key performance indicators for a multi-criteria approach: failure, machine position, cost, optimised electricity price.
› Development and implementation of a multifactor joint optimisation method.
› Real-time simulation of an electrical network taking into account cybersecurity aspects.
› Application cases: island, aquaculture and oil & gas infrastructures.

2022 achievements:

› Project launch in October and initiation of various scheduled actions.

Partners:

This project is led by France Energies Marines.

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Total project budget: €1,546K
This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Brittany and Normandy regions.

FRANCE 2030

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APPEAL

Socio-ecosystem approach to the impact of floating wind farms

Technology |

Stages in the value chain |

Duration: 48 months | **Launched:** 2018 | **Completed:** 2022

Objective:

› To develop an integrated approach to measure the effects of floating wind farms on the functioning of coastal socio-ecosystems.

Scientific and technical content:

› Acquisition of environmental data from sites near Groix & Belle-Île and Leucate.
› Description of the structure and functioning of the benthic compartment of these sites.
› Characterisation of benthic food webs down to fish living near the seabed, although they may not permanently dwell there.
› Development of a spatial knowledge base on human activities at sea.
› Construction of a methodological approach to measure infrastructures' social acceptability.
› Modelling and scenario-building for 2030 and 2050.
› Study on the legal impacts and professional fishing activities, analysis of the stakeholder network.
› Modelling of the socio-ecological system.

Achievements throughout the project:

› Characterisation of benthic biological communities at sites near Groix and Leucate.
› Production of a set of data to characterise and spatialise human activities off Groix & Belle-Île.
› Analysis of stakeholders' perceptions and representations of their local area, and of the expected changes as a result of the construction of floating offshore wind farm infrastructures, in order to develop social acceptability indicators.
› Production of a set of ecological models (trophic model, ecological niche model, systemic conservation planning) and anthropogenic models (use interaction model, economic model for fishing fleets, etc.).
› Development of scenario-based and forward-looking approaches to simulate the evolution of interactions between floating offshore wind farm infrastructures, marine ecosystems and human activities, in a context of climate change, via a spatialised multi-criteria model.
› Completion of a legal analysis of the environmental assessment required for floating wind turbine electricity generation projects.
› Integration of models and scenarios to set up a socio-ecosystem model of interactions between coastal ecosystems and users to provide decision support.

2022 dissemination:

› Publication:
- Le Marchand M., *et al.* (2022) Potential combined impacts of climate change and non-indigenous species arrivals on Bay of Biscay trophic network structure and functioning. *Journal of Marine Systems.* Vol. 228, 103704.

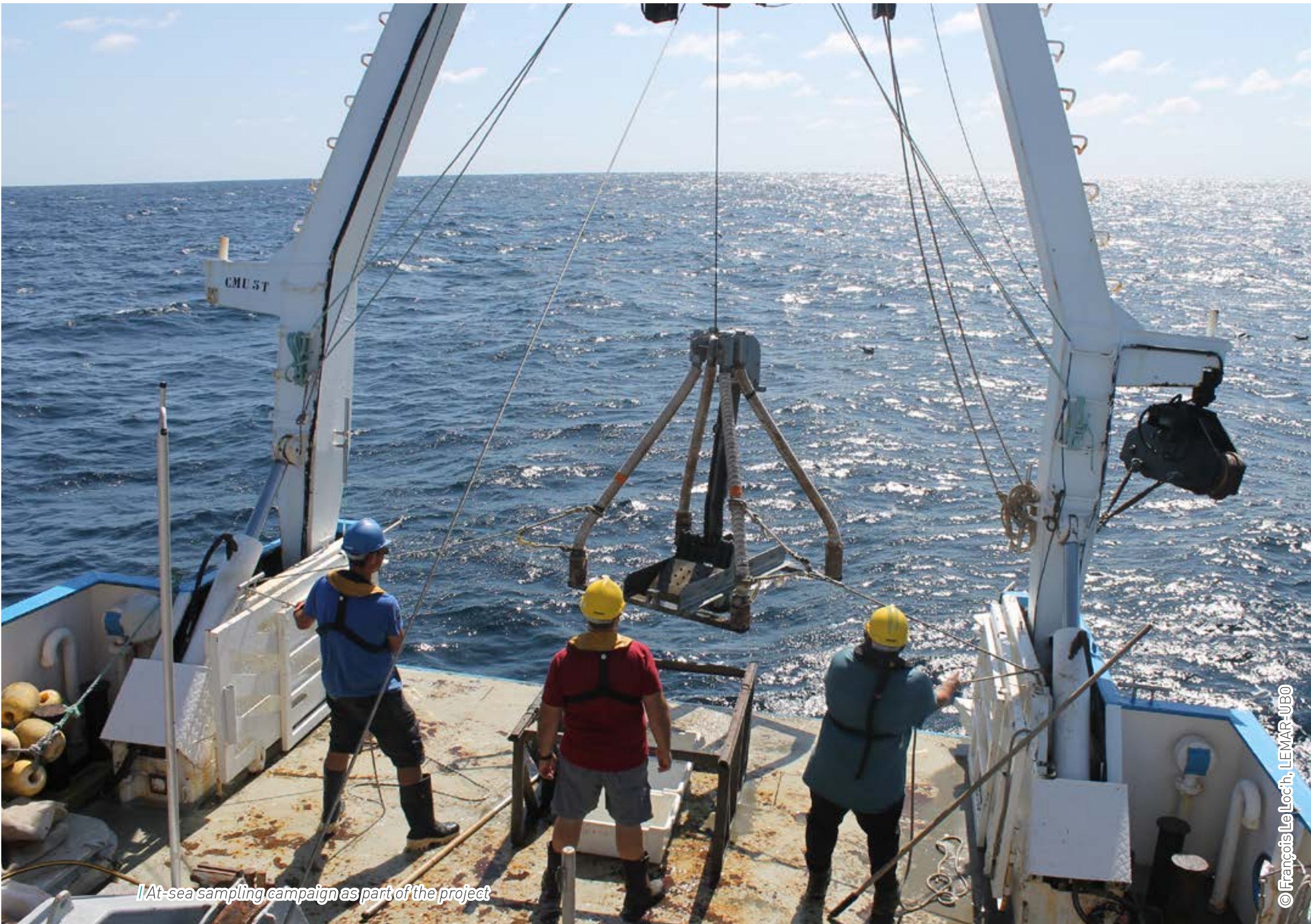
› Event:
- Organisation of a public meeting in Lorient in March to present the project results.

Partners:

This project is led by the Université de Bretagne Occidentale and France Energies Marines.

Total project budget: €2,036K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives public funding from the Brittany and Normandy regions.
This project is approved by the maritime clusters Pôle Mer Bretagne-Atlantique and Pôle Mer Méditerranée.



/ At-sea sampling campaign as part of the project

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ECOCAP

Ecotoxicology analysis of cathodic protections to assess the chemical risk of elements released from galvanic anode and impressed current on the marine environment and its food webs

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2021

Objective:

› To produce a knowledge base of the potential environmental impacts of anticorrosion protections commonly used in the offshore renewable energy industry, including galvanic anode cathodic protection (GACP), impressed current cathodic protection (ICCP) and anticorrosion coatings.

Scientific and technical content:

› A literature review and an audit of current practices in terms of cathodic protections and anticorrosion coatings.

› Laboratory study to assess the impact of the cocktails of elements released by cathodic protection systems on marine organisms.

› Laboratory characterisation of all elements, including (chloro)brominated compounds, released by impressed current cathodic protection, and study of their stability in seawater.

› Upgrading and development of models to simulate the elements' dispersion and investigate the trophic transfer of elements from cathodic protection systems.

› Publication of a report comprising recommendations for offshore renewable energy stakeholders.

2022 achievements:

› Deployment of passive samplers to measure metals in the marine environment:

- in May at the Mistral test site in the Mediterranean, for which the concession is held by Valeco - EnBW
- in October at the Courseulles-sur-mer offshore wind farm in the Bay of Seine

› Set-up of an experimental device to study the chemical elements released by impressed current cathodic protection systems and initiation of analyses.

› Conducting of tests to determine the toxicity of aluminium and chemical elements released by a galvanic anode on Rockpool prawns (*Palaemon elegans*), Artemia larvae (*Artemia salina*) and three species of marine microalgae (*Tetraselmis suecica, Chaetoceros calcitrans* and *Isochrysis galbana*).

› Conducting of tests to determine the toxicity of aluminium on the common cuttlefish (*Sepia officinalis*) and the purple sea urchin (*Paracentrotus lividus*).

2022 dissemination:

› Presentation:

- Dussauze M., *et al.* (2022) Ecotoxicology analysis of cathodic protections to assess the chemical risk of elements released from galvanic anode and impressed current on the marine environment and its food web. Workshop Biofouling Marin, Lorient, France, 8/11/2022 - 10/11/2022.

Partners:

This project is led by the Université de Caen Normandie and France Energies Marines.

Total project budget: €2,189K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.

It also receives public funding from the SUD Provence-Alpes-Côte d’Azur, Brittany and Normandy regions.

Toxicity tests on Rockpool prawns (Palaemon elegans)

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Environmental integration

ECOSYSM-EOF

Prefiguration of an observatory of marine ecosystems in interaction with floating offshore wind farms in the Gulf of Lion

Technology |

Stages in the value chain |

Duration: 24 months | **Launched:** 2020 | **Completed:** 2022

Objective:

- To put forward a high-frequency observatory architecture relying on the subsea cable network of the Gulf of Lion to determine the state and evolution of marine ecosystems in interaction with high-power floating wind farms.

Scientific and technical content:

- State of the art of knowledge and available means of observation concerning the functioning of Mediterranean marine ecosystems (fish, cetaceans…).
- Evaluation of the instrumentation currently used and/or developed by academic research and the private sector.
- Summary of the measurement needs for the observation of marine ecosystems and the associated technical and environmental constraints.
- Drafting of specifications for potential architectures of observation networks.

Achievements throughout the project:

- Summary of knowledge and observation methods of the Gulf of Lion ecosystem.
- Inventory of sensors and instruments currently used and/or developed by academic research and the private sector.
- Definition of two potential observation network architectures for one or more offshore wind farms.

Partners:

This project is led by the maritime cluster Pôle Mer Méditerranée.

Total project budget: €470K

This project receives funding from French Agency for Ecological Transition (ADEME) under the call for sustainable energy research projects (2018-2019).
This project is approved by the maritime cluster Pôle Mer Méditerranée.

The Gulf of Lion seen from the calanques of Marseille

© Anne Valdambrini, Pixabay

FISH INTEL

Monitoring the movements and favoured habitats of several important marine species through a cross-Channel acoustic telemetry network

Technologies |

Stages in the value chain |

Duration: 24 months | **Launched:** 2021

Objectives:

› To deploy an acoustic telemetry network and monitor the movements and favoured habitats of important marine species at seven pilot sites in the Channel, including two ORE areas.
› To share the data obtained with key project stakeholders, managers and policy makers to facilitate the implementation of ecosystem-based fisheries management programmes in the Channel.

Scientific and technical content:

› Roll-out of an acoustic telemetry network, tagging of different target species and habitat characterisation of seven pilot sites.
› Analysis of individual movement data and identification of critical fish habitats.
› Use of project data to operationalise the ecosystem approach to fisheries at local and regional scales.

2022 achievements:

› Deployment of acoustic telemetry receivers at seven pilot sites in France, England and Belgium. In France, deployment of more than 60 receivers in the Iroise Sea, off Côtes d'Armor and in the Bay of Seine.
› Acoustic tagging of various fish species and of crawfish. Tagging of more than 300 individuals in France during three campaigns carried out between May and June.
› Receiver reading campaigns and downloading of the first tracking data.
› Conducting of a survey among recreational fishermen in the Channel, focusing mainly on their well-being, their fishing activity and their opinion of current management measures.
› Awareness-raising among local stakeholders.

2022 dissemination:

› Presentation:
- Couturier L. (2022) Monitoring the habitat use and movements of fish communities within offshore wind-farms, 6th Conference on Wind energy and Wildlife impacts, Egmond aan Zee, Netherlands, 04/04/2022 - 08/04/2022
- Couturier L. (2022) Stratégies de suivi pour identifier et évaluer les effets des parcs éoliens offshore et leur raccordement sur les peuplements de poissons, Séminaire sur les habitats rocheux intertidaux et subtidaux des façades Manche - Mer du Nord - Atlantique, Brest, France, 16/11/2022 - 18/11/2022

Partners:

This project is led by the University of Plymouth.

Total project budget: €4,100K
This project receives funding from the European Regional Development Fund through the Interreg France (Channel) England programme.

/ *Shoal of European sea bass, one of the species monitored in the project*

© Keith Hiscock

FISHOWF

Effective monitoring strategies to identify and evaluate effects of offshore wind farms and their export cables on fish communities

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2021

Objective:

› To develop a long-term monitoring approach capable of detecting effects of both bottom-fixed and floating offshore wind farms and their export cables, on fish communities.

Scientific and technical content:

› Monitoring of occupancy patterns, habitat use and individual movements of fish using acoustic telemetry to identify effects of offshore wind farms at different spatial scales.

› Proposal of methodological guidelines using acoustic telemetry to update regulatory environmental impact assessment methods.

› Development of an effective combined approach using complementary innovative methodologies to investigate the effects of offshore wind farms and export cables on fish communities.

2022 achievements:

› Deployment of 42 acoustic telemetry receivers in offshore wind farms at Saint-Brieuc, Courseulles-sur-mer and Saint-Nazaire, in association with the FISH INTEL project.

› Acoustic tagging of almost 190 fish and crustaceans of nine different species (rays and sharks, European sea bass, lobsters) in the Channel, Atlantic and Mediterranean.

› Receiver reading campaigns and downloading of the first tracking data.

2022 dissemination:

› Poster:
- Couturier L. (2022) Stratégies efficaces de suivi pour identifier et évaluer les effets des parcs éoliens offshore et leur raccordement sur les peuplements de poissons et de grands crustacés, Printemps de la Recherche, Nantes, France, 15/09/2022.

› Presentations:
- Couturier L. (2022) Monitoring the habitat use and movements of fish communities within offshore windfarms, 6th Conference on Wind energy and Wildlife impacts, Egmond aan Zee, Netherlands, 04/04/2022 - 08/04/2022.
- Couturier L. (2022) Stratégies de suivi pour identifier et évaluer les effets des parcs éoliens offshore et leur raccordement sur les peuplements de poissons, Séminaire sur les habitats rocheux intertidaux et subtidaux des façades Manche - Mer du Nord - Atlantique, Brest, France, 16/11/2022 - 18/11/2022.

Partners:

This project is led by France Energies Marines.

Total project budget: €2,363K
This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Université de Bretagne Occidentale as well as from the SUD Provence-Alpes-Côte d'Azur and Brittany regions.
This project is approved by the maritime cluster Pôle Mer Méditerranée.

/ *Releasing a spotted dogfish after acoustic tagging to track its movements in the Saint-Nazaire offshore wind farm*

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LIF-OWI

Tackling environmental, socio-economic and technological challenges for life cycle assessments of offshore wind farms

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2020

Objectives:

› To develop a comprehensive methodological framework for environmental and social life cycle assessment, then validate it by applying it to a selection of offshore wind farms (pilot and commercial, floating and bottom-fixed).
› To identify ways to improve the environmental and societal sustainability of offshore wind farms using the results of their life cycle assessments.

Scientific and technical content:

› Development of detailed guidelines and reference materials for environmental and social analysis of the life cycle of offshore wind energy projects.
› Identification of specific indicators (not existing or identified today) for biodiversity and socio-economic aspects for integration in the life cycle assessment.
› Case studies based on data from several offshore wind farms: life cycle analysis of the environmental and then societal aspects and preliminary identification of the crucial points for the eco-design of offshore wind projects.
› Transfer of the methodology and best practices to the sector via an online platform and workshops.

2022 achievements:

› Delivery and testing of a social life cycle assessment model for assessing the socio-economic impacts of bottom-fixed and floating offshore wind farms.
› Production of the first full version of a parameterised life cycle assessment model to describe the environmental performance of bottom-fixed and floating offshore wind farms.
› Drafting of specifications for the deployment of an online platform to conduct environmental and social life cycle assessments of offshore wind projects.

2022 dissemination:

› Poster:
  - Sansa M., *et al.* (2022) A parameterized model for the evaluation of marine operations' impacts during the installation stage of offshore wind farms, SETAC Europe 32nd annual conference, Copenhagen, Denmark, 15/05/2022 - 19/05/2022.

› Presentations:
  - Baulaz Y., *et al.* (2022) A methodological framework to consider ecosystem impacts in the life cycle impact assessment of offshore wind farms, SETAC Europe 32nd annual conference, Copenhagen, Denmark, 15/05/2022 - 19/05/2022.
  - Lehmann J., *et al.* (2022) Hierarchy of social impacts: towards a consolidated method for a representative social impact prioritization. Social Life Cycle Assessment 8th edition, Aachen, Germany, 5/09/2023 - 8/09/2022.
  - Fofack-Garcia R., *et al.* (2022), Éolien offshore : L'Analyse du Cycle de Vie au bénéfice des projets, Printemps de la Recherche, Nantes, France, 15/09/2022.
  - Fofack-Garcia R., *et al.* (2022), Projet LIF-OWI : Vers une évaluation intégrée de la durabilité des projets éoliens en mer, Journées scientifiques de l'éolien, Paris, France, 11/10/2022.

- Fofack-Garcia R. & Pérez-López P. (2022) Table ronde Éolien en mer, écosystème et société. Comment concilier la préservation des écosystèmes et les usages socio-économiques ? Tribune scientifique et technologiques de France Energies Marines, Marseille, France, 24/11/2022.

Partners:

This project is led by MINES Paris - PSL and France Energies Marines.

Total project budget: €1,466K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Normandy region.

/ Life cycle assessment of offshore wind farms

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NESTORE

Nested modelling approach for ORE development and cumulative impact assessment considering local to regional environmental and socio-economic stakes

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2022

Objective:

› To develop appropriate tools to study the cumulative impacts of ORE farms and other human activities on marine ecosystems

Scientific and technical content:

› A comprehensive analysis of the French strategic coastal planning documents for marine ecosystem management and nested mapping of the associated local and regional challenges.

› Development of a set of nested trophic modelling tools at different spatial scales to assess the cumulative impact of OREs and other human activities.

› Improvement of the consideration of uncertainty in models' predictions by coupling different model approaches and data availability.

› Production of different management scenarios comprising local and regional challenges, including mapping showing the evolution of ecosystem services related to ORE development.

2022 achievements:

› Project launch in December and initiation of scheduled activities.

Partners:

This project is led by the Université de Caen Normandie and France Energies Marines.

Total project budget: €3,344K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the SUD Provence-Alpes-Côte d'Azur, Brittany and Normandy regions.

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ORNIT-EOF

Prefiguration of an observatory of birdlife in the Gulf of Lion interacting with offshore floating wind farms

Technology |

Stage in the value chain |

Duration: 37 months | **Launched:** 2019 | **Completed:** 2023

Objective:

- To propose a high-frequency observatory architecture in the Gulf of Lion to study the condition and evolution of birdlife interacting with high-power floating wind farms.

Scientific and technical content:

- Review of available knowledge and data, as well as of data currently being gathered, on Mediterranean birdlife.
- Study and specifications of birdlife observation systems.
- Detailed 3D mapping of Scopoli's shearwater activity in the Gulf of Lion.
- Birdlife migration monitoring by land-based radar.
- Specification of the observation network architecture.
- Test of the repercussions of a series of future Gulf of Lion wind farm installation scenarios on the energy landscape of Scopoli's shearwaters, as a model species.

Achievements throughout the project:

- Review of knowledge of birdlife in the Gulf of Lion and its interaction with floating wind energy projects under development.
- Inventory of birdlife monitoring campaigns.
- Acquisition and use of radar data for an initial characterisation of coastal migratory movements in the Gulf of Lion.
- Acquisition and analysis of data on the flight behaviour of Scopoli's shearwaters.

Partners:

This project is led by the maritime cluster Pôle Mer Méditerranée.

PÔLE MER MÉDITERRANÉE

CENTRE D'ÉCOLOGIE FONCTIONNELLE & ÉVOLUTIVE

biotope

FRANCE ENERGIES MARINES

LPO

Total project budget: €450K

This project receives funding from French Agency for Ecological Transition (ADEME) under the call for sustainable energy research projects (2018-2019).
This project is approved by the maritime cluster Pôle Mer Méditerranée.

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

Prefiguration of a birdlife observatory in the Gulf of Lion

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OWFSOMM

Offshore wind farm surveys of marine megafauna: standardisation of tools and methods for monitoring at farm scales

Technologies |

Stages in the value chain |

Duration: 36 months | **Launched:** 2020

Objectives:

- To provide an operational roadmap for conducting a robust inter-calibration of marine megafauna aerial surveys at offshore wind farm scale using different technologies.
- To improve the efficiency of multiple sensors in detecting, identifying and characterising marine megafauna by using an AI tool.

Scientific and technical content:

- Development of an inter-calibration methodology between digital and human-based aerial surveys.
- Development of AI solutions coupling multimodal data (radar, acoustic) to enhance the identification and estimation of targets (birds, marine mammals).
- Drafting of technical recommendations for marine megafauna monitoring in relation to offshore wind projects to ensure inter-operability of datasets.
- Implementation of a cost-effectiveness analysis of sampling strategies using different acquisition methods.

2022 achievements:

- Marine megafauna aerial monitoring campaigns with visual and digital data acquisition at different altitudes at offshore wind farm sites off Normandy and Southern Brittany.
- Definition and distribution of a data format for processing digital images.
- Analysis of data from aerial campaigns for the intercalibration of marine megafauna monitoring methods.
- Provision of an open source R package to simulate datasets for the distribution and abundance of seabirds and marine mammals.
- Continued development of an algorithm for the passive acoustic detection and identification of marine mammals.
- Preparations to deploy a network of sensors on a met mast off Fécamp to record continuous and synchronous observation data relating to seabirds and marine mammals.

Partners:

This project is led by Université de Bretagne Sud’s laboratory IRISA, CEFE and France Energies Marines.

Total project budget: €1,447K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Normandy region, the French Biodiversity Agency (OFB) and the French Directorate General for Energy and Climate (DGEC).

Group of dolphins photographed during an aerial survey of marine megafauna

© Pelagis Hytech imaging STORMM

SEMAFOR

Observation and prediction of bird migration from weather radars

Technologies |

Stage in the value chain |

Duration: 36 months | **Launched:** 2022

Objective:

› To develop a real-time monitoring tool for bird flights and migration via the Météo-France weather radar network.

Scientific and technical content:

› Analysis of the state of the art, feedback and framing of the study.
› Development and validation of an algorithm for the detection of bird echoes on radar echoes.
› Field calibration/validation protocol.
› Construction of a predictive model of bird flows on the maritime facades.

2022 achievements:

› Project launch in November and initiation of scheduled activities.

Partners:

This project is coordinated by France Energies Marines.

FRANCE ENERGIES MARINES   METEO FRANCE   biotope   vogelwarte.ch

Total project budget: €840K

This project receives funding from French Agency for Ecological Transition (ADEME).

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

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SEMMACAPE

Monitoring and study of marine megafauna in wind farms by automatic characterisation

Technologies |

Stage in the value chain |

Duration: 36 months | **Launched:** 2019

Objective:

- To demonstrate the ability of aerial photography processing and analysis software to automatically inventory marine megafauna.

Scientific and technical content:

- Implementation of an aerial megafauna observation campaign (standard visual method and VHR digital photography system), integrating the seasonal variability of species and environmental conditions.
- Development and qualification of 2 types of automatic aerial photography processing algorithms for animal identification and classification.
  - Detection using a deep neural (end-to-end) network, moving directly from the global image to bounding boxes.
  - Anomaly detection by unsupervised deep learning.
- Assessment of the performance of each detection method tested based on indicators classed by species or group of species, as well as according to environmental conditions.

2022 achievements:

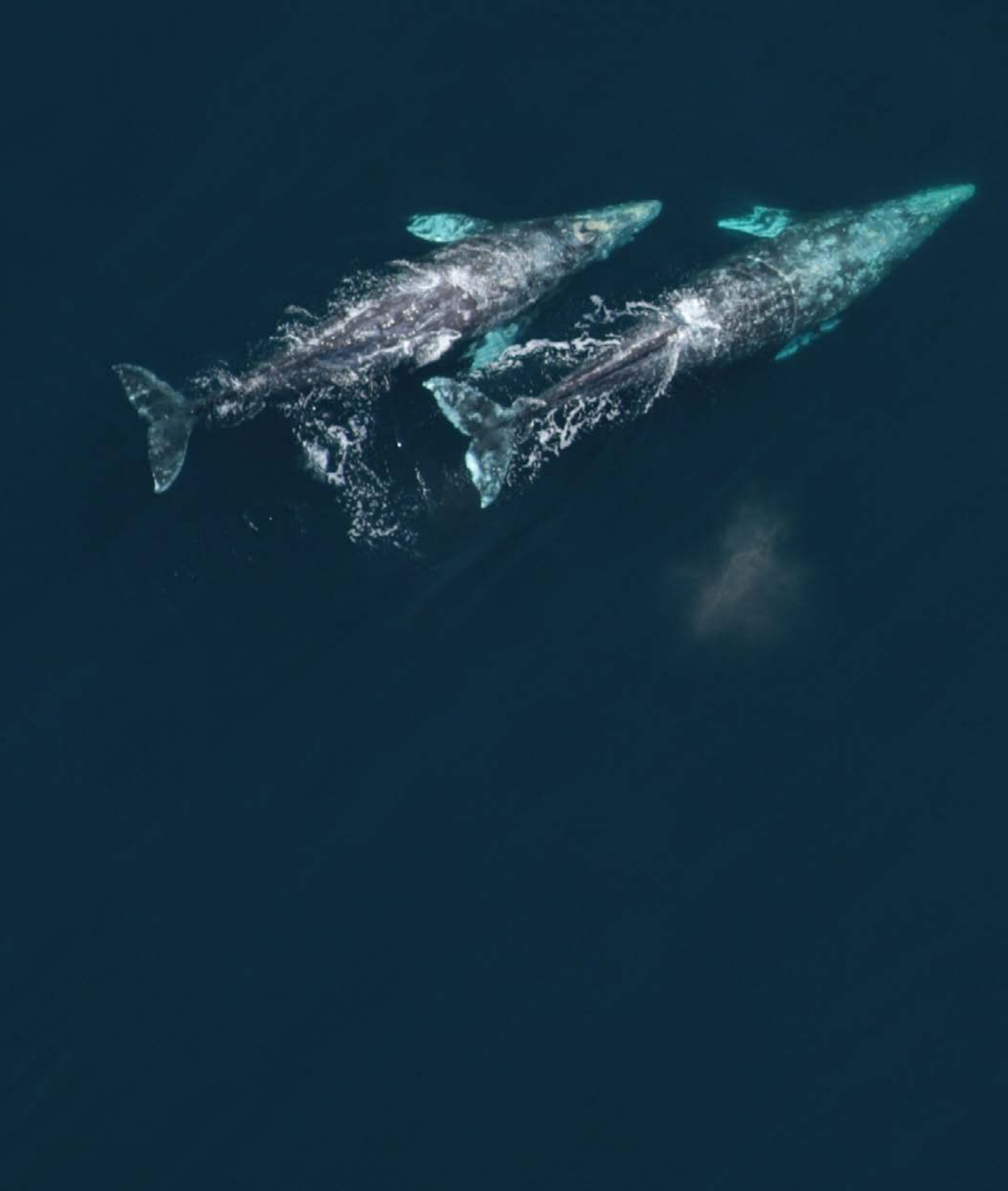
- Continued development of algorithms for the automatic detection and identification of marine megafauna from imagery.
- Preparation of a video for the general public explaining the project results.

Partners:

This project is coordinated by Université de Bretagne Sud's laboratory IRISA.

Total project budget: €600K

This project receives funding from French Agency for Ecological Transition (ADEME) under the call for sustainable energy research projects (2018-2019).
This project is approved by the maritime clusters Pôle Mer Bretagne-Atlantique and Pôle Mer Méditerranée.



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WINDSERV

Towards a multi-model approach to indicators of ecosystem services

Technology |

Stage in the value chain |

Duration: 24 months | **Launched:** 2020 | **Completed:** 2022

Objectives:

› To develop a multi-model approach to predict offshore wind farm impacts on ecosystems and the resulting services.

› To guide a win-win strategy between offshore wind farm developments and biodiversity conservation strategies.

Scientific and technical content:

› Development of an end-to-end model consisting of a trophic and spatial model forced by ecological niche models outputs and a biogeochemical model for the areas of future wind farms in the Eastern English Channel and the Gulf of Lion and their related ecosystem indicators.

› Development of novel ecosystem service indicators specific to offshore wind energy, building on ecosystem model outputs.

Achievements throughout the project:

› Development of an innovative end-to-end model consisting of a trophic and spatial model (Ecospace) forced by ecological niche model outputs and a biogeochemical model output (ERSEM).

› Proposal for new spatialisable ecosystem service indicators in relation to offshore wind energy.

2022 dissemination:

› Publication:
- Baulaz Y., *et al.* (2023) An integrated conceptual model to characterize the effects of offshore wind farms on ecosystem services. *Ecosystem services*, Vol. 60, 101513.

› Event:
- Organisation of a public meeting in Boulogne-sur-Mer in October to present the project results.

Partners:

This project is led by the Université du Littoral Côte d'Opale and France Energies Marines.

Total project budget: €1,076K

This project receives funding from France Energies Marines and its members and partners, as well as French State funding managed by the French National Research Agency under the France 2030 investment plan.
It also receives funding from the Normandy and SUD Provence-Alpes-Côte d'Azur regions.
This project is approved by the maritime clusters Pôle Mer Bretagne-Atlantique and Pôle Mer Méditerranée.

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3 QUESTIONS for...

Florian Dupriez-Robin

Research project leader in risk analysis
and reliability of ORE systems
France Energies Marines

What conclusions have been drawn from the work on floating substation reliability?

The aim of the work conducted under the MOSISS project is to optimise the OPEX of a floating electrical substation by adding in-service monitoring. Initially, we focused on how to perform this in-service monitoring by improving a method initially developed by Université de Nantes. We then assessed the impact of an on-site inspection and/or in-service monitoring.

We carried out an assessment of the system as a whole and then of the components of a floating wind turbine, in particular the dynamic cable and the mooring lines. Based on this assessment, we estimated the level of reliability, and the same exercise was carried out with the addition of in-service monitoring of certain failure modes. We note that a poor assessment may be due to the quality of the sensor.

We therefore need to standardise the information it provides, and assess its lifespan and failure rate. We are currently drafting recommendations on sensor industrialisation, as well as an economic evaluation.

Why focus on isolated electricity grids?

An isolated grid is complex to maintain. Electricity is very expensive in such grids because fuel often has to be transported, and in small quantities. There are no economies of scale either when it comes to maintaining the infrastructure. On islands, offshore renewable energy can be a good way of generating electricity (up to 50% of the mix). The impact is more direct with medium to low usage, and this can avoid the need for a generator. This is decarbonised redundancy!

What is multi-criteria optimisation?

Through the OPTILE project, we are optimising the electrical system based on a number of criteria: the investment cost, the operating cost over 20 years, the reliability and the associated tolerance, the proportion of renewables in the mix, seeking the optimum to avoid having to install excessive storage facilities, and the quantity of CO_2 emitted per kW of electricity per kg of H_2 over the entire life cycle. After six months of data collection, we began to define scenarios with different production means and to use the methodology developed through the MOSISS project. Two islands are to be taken as case studies: Réunion and Ushant Islands (Brittany).

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3 QUESTIONS for…
Maud Quéroué

Postdoctoral research fellow working on the development of intercalibration tools for aerial surveillance of marine megafauna
France Energies Marines / Centre d'Ecologie Fonctionnelle et Evolutive

What is the OWFSOMM project about and what is your role?

One of the project's work packages—the one on which I'm working—aims to standardise different methods and techniques that will be used to assess the impact of offshore wind farms on marine megafauna, including birds, turtles and marine mammals, sharks, and large fish such as tuna. As part of my postdoctoral fellowship, I'm focusing on aerial monitoring of this megafauna. Two methods currently exist: visual monitoring carried out by observers onboard an aircraft, and digital monitoring using a high-definition imagery or video system. Visual monitoring is carried out at an altitude that is incompatible with the safety rules in force in ORE farms. Digital monitoring will therefore be used to monitor the megafauna from a higher altitude. My role involves checking the comparability of the two methods. In other words, do we obtain the same monitoring results when we simultaneously use a plane with observers and a plane with cameras?

How do you go about answering this question?

We are working at three offshore wind farm sites (Fécamp, Courseulles-sur-mer and Dieppe - Le Tréport) and two prospective sites (French Calls for Tender AO4 and AO5). For each site, several aerial campaigns were carried out with two planes flying simultaneously for visual and digital monitoring. As digital monitoring is relatively new, there was no clear protocol on how to organise the collected data. The first stage of the project therefore consisted in reaching a consensus with all the partners on the data format required to meet our needs, which was a challenge in itself! Now that this has been achieved, I can analyse the visual and digital monitoring datasets, estimate the abundance of individuals and their distribution within the study area for each method and compare the results obtained. It is crucial to question the impact of this change in method on monitoring so that reliable trends can then be observed.

What are the advantages and drawbacks of the digital monitoring systems that will be used on ORE farms?

They provide precise information on the positions of individuals and the number of animals within each group. This approach also means that species can be identified at a later stage. However, image analysis is very time-consuming and each aerial campaign produces thousands of images. In this respect, visual observations are more efficient because the data is available and can be used immediately. However, in the future, it is entirely conceivable that advances in artificial intelligence and improvements in photo quality will allow for automatic image analysis, saving us an enormous amount of processing time. This is the focus of the SEMMACAPE project.

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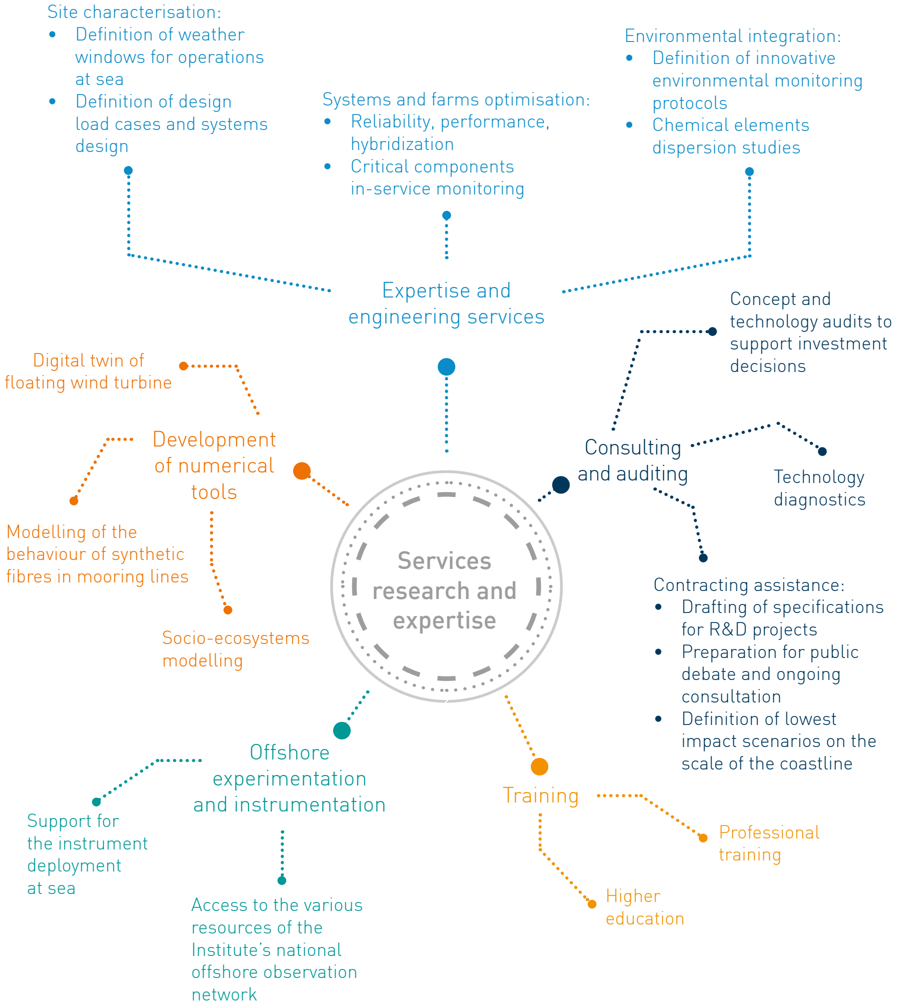
04

RESEARCH AND EXPERTISE SERVICES

With a 75-strong multi-disciplinary team and experience based on over 70 R&D projects, France Energies Marines offers research and expertise services in line with the needs of private and public sector stakeholders. The Institute provides support at each stage in the design and life of an offshore renewable energy project. We take a holistic approach, thanks to which we are able to implement relevant actions to optimise costs, reduce lead times and foster a positive perception of the sector.



Services research and expertise

Expertise and engineering services

Site characterisation:
- Definition of weather windows for operations at sea
- Definition of design load cases and systems design

Systems and farms optimisation:
- Reliability, performance, hybridization
- Critical components in-service monitoring

Environmental integration:
- Definition of innovative environmental monitoring protocols
- Chemical elements dispersion studies

Consulting and auditing

Concept and technology audits to support investment decisions

Technology diagnostics

Contracting assistance:
- Drafting of specifications for R&D projects
- Preparation for public debate and ongoing consultation
- Definition of lowest impact scenarios on the scale of the coastline

Development of numerical tools

Digital twin of floating wind turbine

Modelling of the behaviour of synthetic fibres in mooring lines

Socio-ecosystems modelling

Offshore experimentation and instrumentation

Support for the instrument deployment at sea

Access to the various resources of the Institute's national offshore observation network

Training

Professional training

Higher education

Consulting and auditing

The Institute supports investors in their decision-making process by offering concept and technology audits. We can also carry out technological diagnostics for wind farms developers and wind, wave and tidal energy technologies developers. In addition, France Energies Marines provides support to government departments and farm developers, acting as a technical interface on specialised issues such as drafting specifications for R&D projects, scientific support in preparation for public debate and ongoing consultation, as well as support for offshore planning at the scale of the coastline by defining the lowest impact scenarios.

Expertise and engineering services

France Energies Marines provides expertise and engineering services for the various aspects of its R&D programmes. In terms of site characterisation, we can implement coupled wind, wave and current modelling to determine the optimal weather windows for offshore operations, as well as to characterise breaking and impact waves in order to define load cases and system design. Our team is also highly competent in terms of system optimisation (reliability, yield, hybridisation), operation and maintenance, and in-service monitoring of critical components (real-time health status, anticipation of maintenance, reassessment of service life). The Institute also focuses on the environmental and societal integration of ORE, defining innovative monitoring protocols for wind farm developers and consultancy firms, as well as characterising hydrodynamic conditions and studying the dispersion of chemical elements.

COMPLETED IN 2022

Study of the Atlantic offshore energy potential

The consortium formed by France Energies Marines, Tecnalia, University College Cork and EDP NEW was selected to conduct a study commissioned by the European Commission's Directorate-General for Energy. This study aimed to analyse the technical potential of offshore energy production in the Atlantic and to examine the need and potential for developing a meshed offshore electricity grid, in order to help Member States in the area to increase renewable energy production and reach their decarbonisation targets in a more cost-effective way.

IN PROGRESS IN 2022

Hydrogen potential in Brittany and Pays de la Loire

France Energies Marines, in association with the consultancy firm Hinicio, carried out a study dubbed PROSPECTHYVE on behalf of the Brittany and Pays de la Loire regions. The aim of this study was to build a forward-looking vision of the potential for the production and use of renewable hydrogen, both onshore and offshore, in these two regions, looking ahead to 2030, 2040 and 2050. The Institute assessed the resource, built scenarios for ORE-based hydrogen production, and quantified the resulting hydrogen.

IN PROGRESS IN 2022

Monitoring of birds and bats in the Gulf of Lion

The French Biodiversity Agency (OFB) chose France Energies Marines to be responsible for overall coordination and management of the various work packages of the MIGRALION programme. With a budget of €4.2M and 14 partners, the project aims to gain a better understanding of the offshore migratory flows of birds and bats in the Gulf of Lion, as well as the use of the marine area by the birds that are dependent on it. In addition to routine programme management, the Institute is carrying out various communication campaigns for the general public and is helping to develop a combined modelling method for the data collected.

I *Pied avocets in flight*

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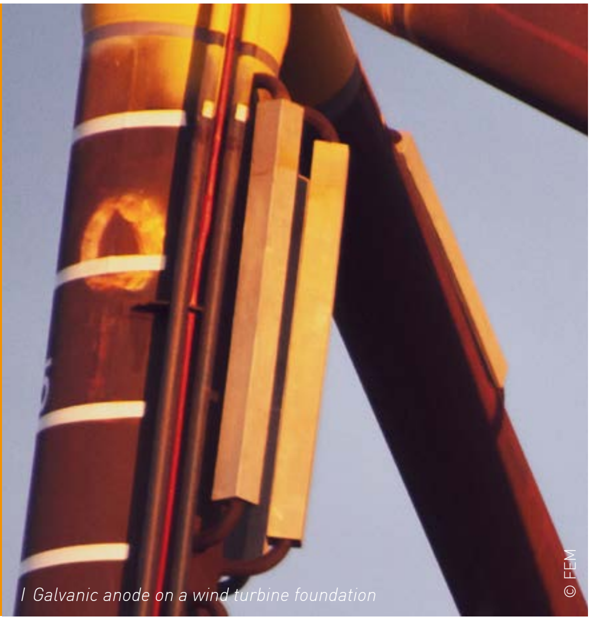
IN PROGRESS IN 2022

Anti-corrosion systems and dispersion modelling

As part of a project named POLLU-ECUME, the Water & Biodiversity Directorate under the French Ministry for Ecological Transition and Territorial Cohesion, working in joint leadership alongside the Directorate-General for Energy and Climate, commissioned INERIS, in partnership with Ifremer and France Energies Marines, to define a risk-based methodology for assessing cumulative effects or risks. This work is based on test modelling of the cumulative dispersion of chemical elements from anti-corrosion systems within the Courseulles-sur-mer and Fécamp wind farms.



I *Galvanic anode on a wind turbine foundation*

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Development of numerical tools

France Energies Marines develops digital tools tailored to its clients' needs, based on a foundation built and tested during the many collaborative R&D projects it has clocked up. We are thus capable of building the digital twin of a floating wind turbine, i.e. a smart digital network with input data from sensors coupled with digital simulations, with a view to reducing uncertainties over the fatigue life of components and thus facilitating the operation of commercial wind farms. The team has also been working for several years on the non-linear behaviour of synthetic fibres used in mooring lines, in particular nylon, for which a visco-elasto-plastic rheological model has been developed. Finally, thanks to its expertise and strong academic partnerships, the Institute is able to assess the influence of ORE projects on the socio-ecosystem using ecosystem modelling approaches.

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/ *Python language used to develop digital tools*

Offshore experimentation and instrumentation

Offshore data acquisition remains crucial in the field of ORE, as there is still very limited feedback from experience. This explains why France Energies Marines has always been committed to including experimental components in the R&D projects it leads. The Institute therefore offers support for the deployment of offshore instrumentation such as lidar, current profilers and biofouling monitoring systems. It can also provide access to the various resources that make up its national offshore observation network: a met mast off Fécamp, a multi-instrumented lighthouse off the Ushant Island to study breaking waves, and several buoys in Brittany, the North Atlantic and the Mediterranean to monitor biofouling.

Coastal risk assessment

COMPLETED IN 2022

As part of the European MARLIT project, the SUEZ group's Rivages Pro Tech research centre called on France Energies Marines to conduct measurement campaigns geared towards studying waves and marine flooding on the the central beach ("Grande Plage") in Biarritz. The stereoscopic video system and associated know-how developed during the DIME project were used to produce 3D reconstructions of the wave field near the coastline.

Training

The Institute is involved in various training programmes on offshore renewable energy. A wide range of topics are covered: metocean, environmental integration, marine environment design, in-service monitoring and array architecture. In 2022, most of the training courses delivered by France Energies Marines took place at higher education establishments. Lecturers were selected from our multidisciplinary team according to their expertise and experience in the topics covered. The course materials prepared by our lecturers are richly illustrated with diagrams and videos. Their content is based on past experience of various R&D projects carried out over the last ten years.

Bachelor's degree in marine environment engineering	le cnam Intechmer
Specialised Masters in marine engineering and offshore wind energy	Centrale Méditerranée
Masters in risks and the environment - Environmental expertise and processing	ulco Université
Masters in hydraulics, structures and environment	Grenoble INP Ense3 UGA
2nd year of the Naval Officer training	École Navale
Masters in offshore renewable energies	ENSTA Bretagne
Final year of the Hydrography & Oceanography programme	ENSTA Bretagne
International Network on Offshore Renewable Energy INORE	Training in the use of the DTOcean+ design tool for tidal and wave farms
Saint-Malo IUT	DUT technical diploma in industrial engineering and maintenance Offshore renewable energy module
Océanopolis Brest SciencesPo Rennes	Young Reporters in the Arts, Sciences and Environment Initiative
SciencesPo Rennes	Masters in the governance of metropolitan areas, public affairs and the maritime dimension
UBO Université de Bretagne Occidentale	Masters in marine and coastal sciences - Environmental management speciality
Université de Rouen Normandie	Masters in environmental management, sustainable resource management and environmental risks
WEAMEC	Module on electricity generation by wind turbines and grid integration Module on offshore technologies - State of the art of ORE

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3 QUESTIONS for...
Juliette Saunier

ORE Technical and Business Developer
France Energies Marines

Why is the Institute developing a research services offering?

We need to provide research services in order to ensure the long-term viability of France Energies Marines' development model. Through this activity, we are able to meet the specific, highly targeted needs of private and public sector clients requiring a high level of confidentiality and expertise. It perfectly complements our collaborative R&D work, which addresses the global challenges faced by the ORE sector. Through research services, the Institute is also able to disseminate its project-based know-how to the fast-evolving offshore wind and ocean energy sectors.

Demand in the floating offshore wind sector is growing thanks to the strong commitments made by France and the European Union in this field. The research services provided by France Energies Marines tackle the new issues inherent to the development of this sector, such as environmental integration and engineering relating to the reliability of new components.

What added value does France Energies Marines offer in this respect?

Our strength lies in our multidisciplinary team, with more than 70 engineers and researchers working transversally. In this way, we are able to take a holistic approach to issues, combining effective problem-solving with a detailed view of the various aspects to be addressed. The annual pattern for setting up R&D projects means that we are constantly updating our knowledge and keeping up to speed with current and future issues in the highly dynamic field of ORE. The very high quality of our applied research work is recognised by clients such as the French Biodiversity Agency. Thanks to our neutral position, we are able to work with wind farm developers, the government, consultancy firms, insurers, etc.

What are the short- and medium-term objectives for this activity?

We will continue to structure our offer, as this is still a relatively recent activity for the Institute. Following the delivery of each service, we outline the lessons learned with a view to continuous improvement. Our aim is to expand our client base to include all stakeholders in the ORE sector, in France in the short term and in Europe in the medium term. We seek to work hand-in-hand with consultancy firms, rather than in competition with them, to offer high added-value services.

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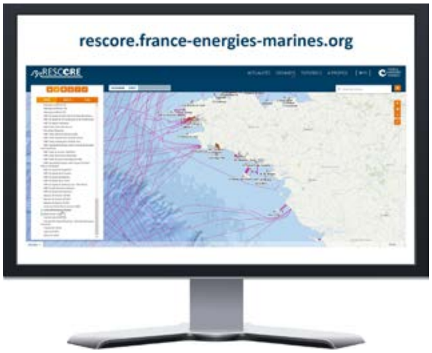
05

RESCORE, THE FRENCH RESOURCE CENTRE

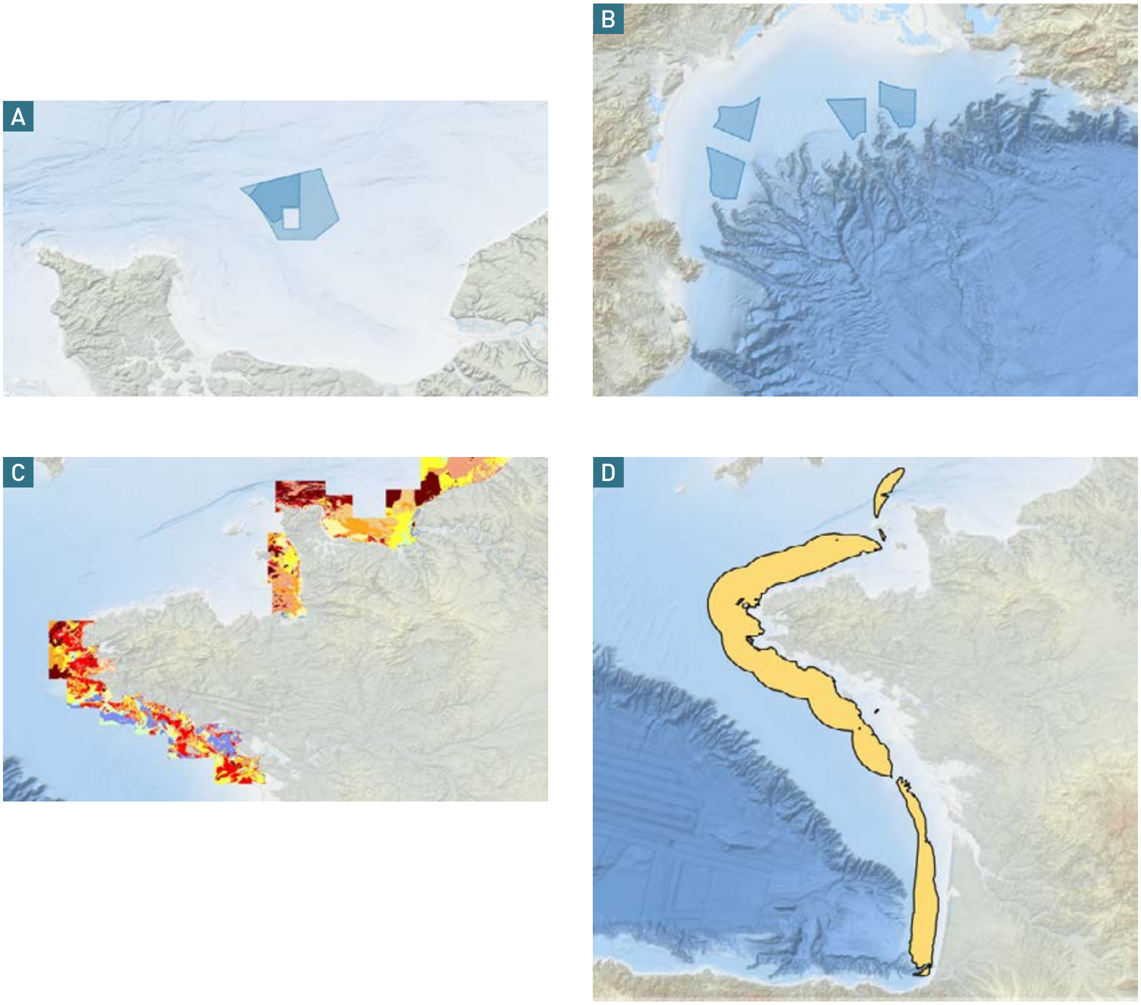
Launched in February, RESCORE is an online resource centre offering pooled access to useful information for the development of the offshore renewable energy sector in France. While it currently focuses on the results obtained from R&D projects conducted by France Energies Marines, RESCORE is gradually expanding to include data from various stakeholders in the sector so as to become a one-stop shop. By complying with international data formatting standards, it has the advantage of being interoperable and hence compatible with the main French and foreign resource centres.

A web portal comprising an ergonomic mapping tool

RESCORE takes the form of a web portal via which data searches can be performed applying many different criteria, such as the type of technology involved or the specific coastline, and results are displayed via an ergonomic mapping tool. Several tutorials have been produced to help new users, whether they wish to access the data catalogue or use the interactive map.



I View of the RESCORE map interface



/ *Example of data displayed in RESCORE, obtained from external sources.*
A: Call for tender area no. 4 off Normandy
B: Call for tender area no. 6 in the Mediterranean
C: Surface sediment data collected by Shom
D: Technical potential for the development of wave energy, developed by Cerema

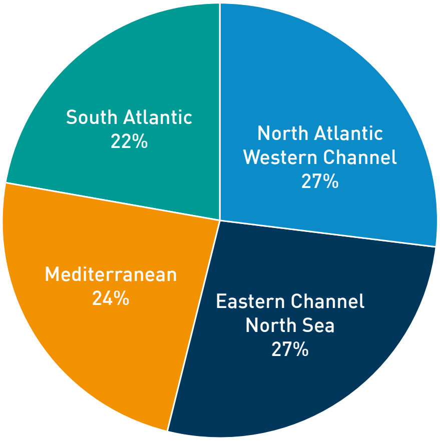
Over 200 metadata entries available

The basic function of RESCORE is to display metadata relating to a document, map, time series or spatial measurements. The existence of these data and the identity of their owner are thus made public. Their availability depends on the confidence level or usage rights defined by their holder. More than 200 metadata sheets are already available: site characterisation, environmental parameters, component and system characteristics, reports, recommendations, methodologies, literature reviews, links to additional external resources, etc.

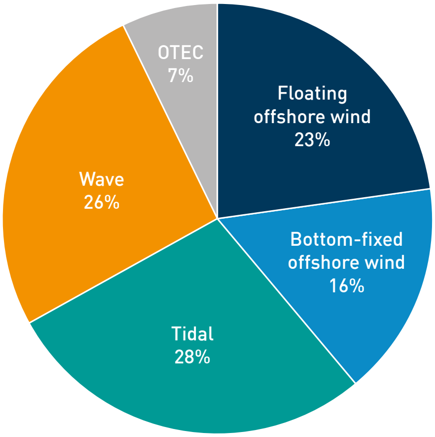
Consulting & contributing

RESCORE is targeted towards all ORE sector players: developers, operators and owners of pilot and commercial farms, technology developers, consultancy firms, decision-makers at national and regional levels, and academic researchers. It is possible to interact with RESCORE in two ways:

- **Consulting:** Given its vocation to centralise data, RESCORE is the primary gateway to data specific to offshore renewable energy in France. It ensures that its users can efficiently consult the currently available data related to the chosen search criteria.
- **Contributing:** By depositing data or inputting metadata to RESCORE, the information is given high visibility and may generate financial revenue for the owner. Contributors earn financial compensation, making for a win-win relationship.



I *Breakdown of France Energies Marines data featured in RESCORE by coast*



I *Breakdown of France Energies Marines data featured in RESCORE by technology*

© RTE

3 QUESTIONS for...
Sabine Ostermann

Leader for Connections - R&D Cyber-physical and eco-designed futures for grid infrastructures, RTE

How did RTE contribute to the development of RESCORE?

RESCORE is a web platform with a cartographic interface providing access to large share of the data obtained through the R&D work carried out by France Energies Marines to support the development of offshore renewable energies. Within this context, RTE, which develops the French onshore and offshore grid, contributes to this platform by providing the elements generated by the collaborative research projects in which it is involved. During the construction phase of this resource centre, I was on the steering committee that oversaw the key stages in the genesis of RESCORE.

What information available via RESCORE do you find most interesting?

RESCORE offers a large quantity of R&D data: reports, summaries, fact sheets, different datasets, etc. Take the ABIOP+ project, for example, which focuses on the characterisation of biofouling. For two study sites off Groix and Belle-Île, the platform features: the sampling plan, the physical characteristics of the sampling stations, video footage and sediment profiles, maps of the taxonomic, functional and phylogenetic diversity of the species present, an analysis of the economic effects and of public policies, etc. RESCORE is gradually being expanded with data from the different stakeholders in the sector, with a view to becoming a one-stop shop.

What types of data is RTE likely to input into RESCORE?

RTE's own data can be consulted by the general public on our website. For collaborative R&D projects led by France Energies Marines, RTE contributes its data, which is combined with that of the other partners. The corresponding metadata records are steadily being indexed in RESCORE. This is the case, for instance, for the projects called ABIOP+ (characterisation of biofouling), APPEAL (socio-ecosystemic approach to the impacts of floating wind farms), DUNES (dynamics of underwater dunes) and DYNAMO (in-service monitoring of dynamic cables) projects.

© FEM

06

NATIONAL OFFSHORE OBSERVATION NETWORK

France Energies Marines is building, brick by brick, a permanent offshore observation network to support the development of offshore wind energy. This initiative is fully in line with the national strategy to improve planning and risk knowledge.

This observation network has several objectives:

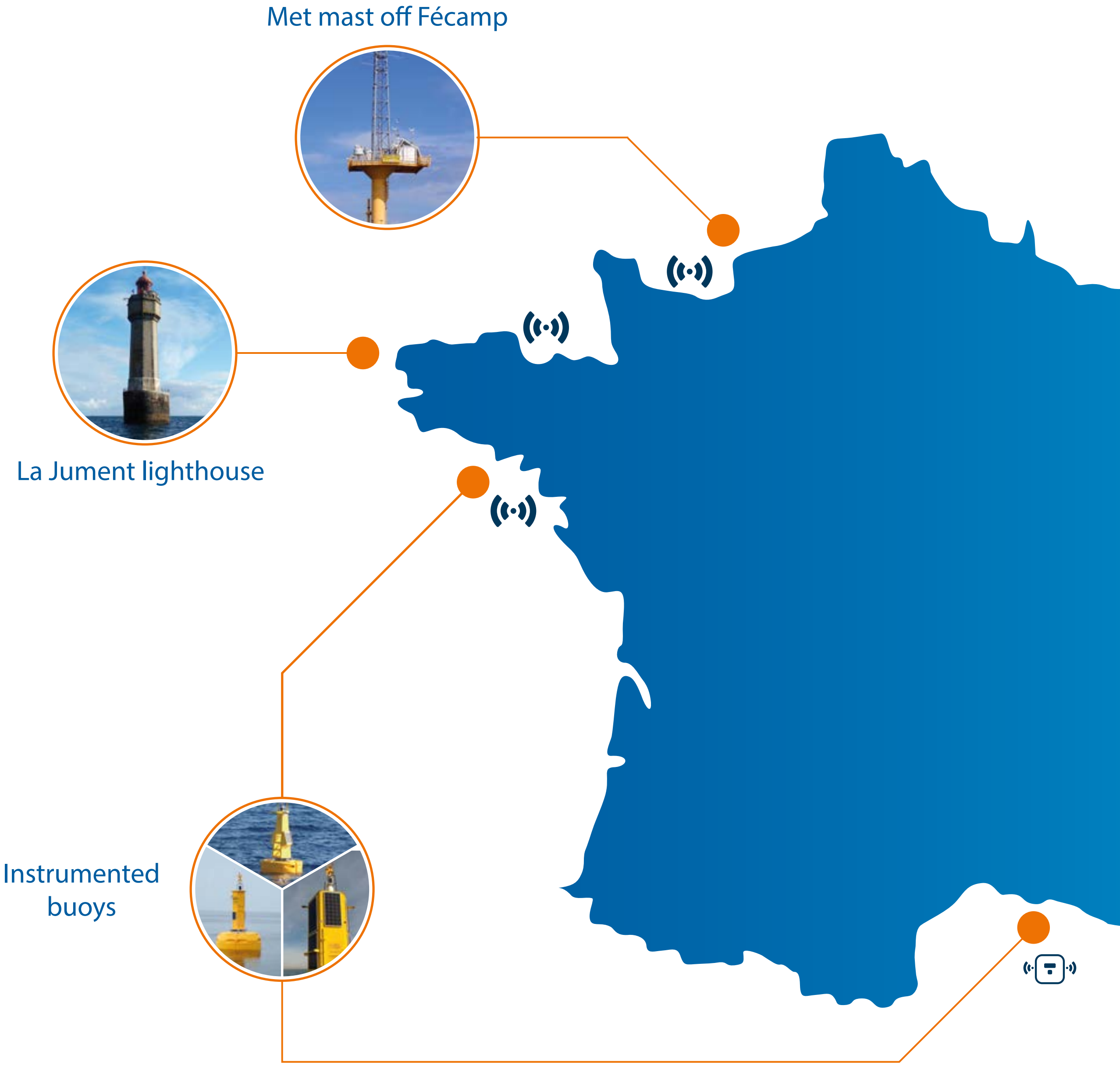
- To develop reliable real-time monitoring solutions and protocols adapted to the offshore environment.
- To observe interactions between offshore wind power and the environment at the scale of the coastline, in order to assess the effects on ecosystems, quantify the physical parameters and their spatio-temporal variations, optimise system design and adapt monitoring protocols.
- To provide qualified data and processing tools.
- To support decision-making about the deployment of future farms.

A met mast, the network's cornerstone

In 2022, France Energies Marines initiated procedures with a view to purchasing the met mast located in the vicinity of the Fécamp offshore wind farm. This mast will be a major building block in the national offshore observation network developed by the Institute. Installed on a gravity foundation and reaching a height of 40 metres above sea level, this tower will be used to roll out a major programme dubbed DRACCAR, financially supported by the Normandy region and the European Regional Development Fund. This programme aims to study the interactions between offshore wind farms and the marine environment, focusing on six complementary aspects. As soon as the mast has been purchased, a series of cutting-edge instruments will be installed on the mast to study various biological and physical aspects of the environment. At the end of 2022, the sale agreement for the mast, currently owned by Eoliennes Offshores des Hautes Falaises, was being finalised and the maritime authorisation application had been submitted. The transfer of ownership is scheduled for 2023.

© FEM

I The met mast off Fécamp is an ideal platform for monitoring and better understanding interactions between offshore wind farms and the environment.


Met mast off Fécamp
La Jument lighthouse
Instrumented buoys

((•)) Acoustic telemetry network deployed on 3 offshore wind farm sites

(·▣·) Profiling lidar deployed on the Planier Island

A sentinel lighthouse for giant waves

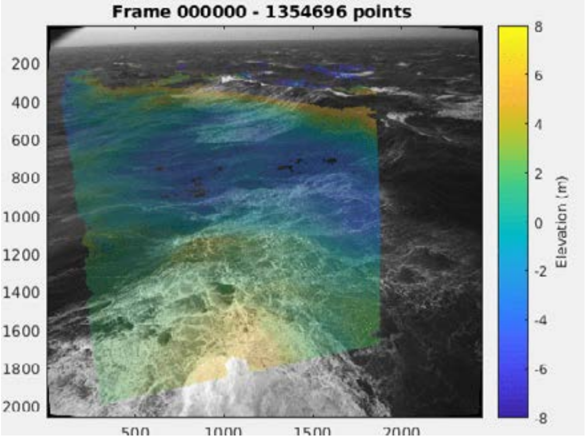
The Jument lighthouse is located off the coast of Ushant Island in an area that is representative of the bathymetry of floating wind farm sites. Since 2017, it has been used as a full-scale experimental device to carry out measurements directly in the field. Equipped with a stereo-video camera system, an X-band radar, pressure sensors and accelerometers, it records data on the breaking and impact of extreme waves. With this device, a giant breaking wave more than 24 m high was observed and its impact measured. This information is essential in order to optimise the design, and therefore the cost, of future offshore wind turbines, while guaranteeing their storm-resistance.

© Ifremer, Mickael Accensi

Jument lighthouse, off Ushant Island in the Iroise Sea

© FEM

Left-hand camera of the stereo-video system installed at the top of the lighthouse

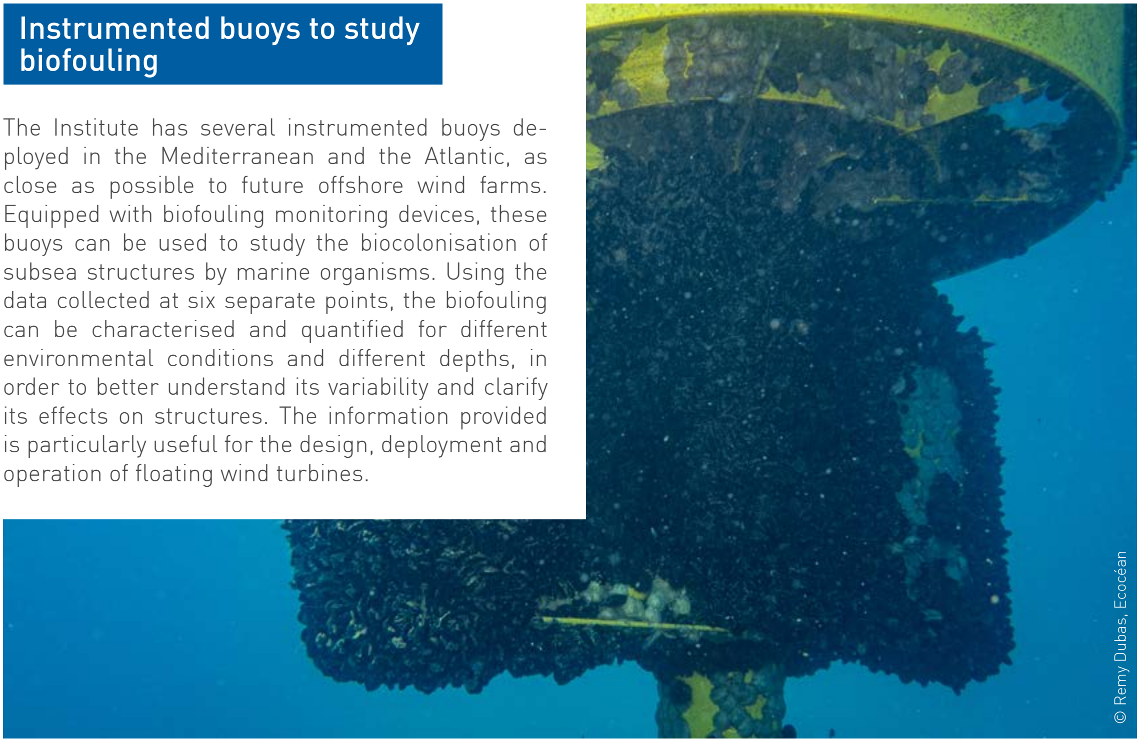


© DIME

3D reconstruction of wave fields

Instrumented buoys to study biofouling

The Institute has several instrumented buoys deployed in the Mediterranean and the Atlantic, as close as possible to future offshore wind farms. Equipped with biofouling monitoring devices, these buoys can be used to study the biocolonisation of subsea structures by marine organisms. Using the data collected at six separate points, the biofouling can be characterised and quantified for different environmental conditions and different depths, in order to better understand its variability and clarify its effects on structures. The information provided is particularly useful for the design, deployment and operation of floating wind turbines.

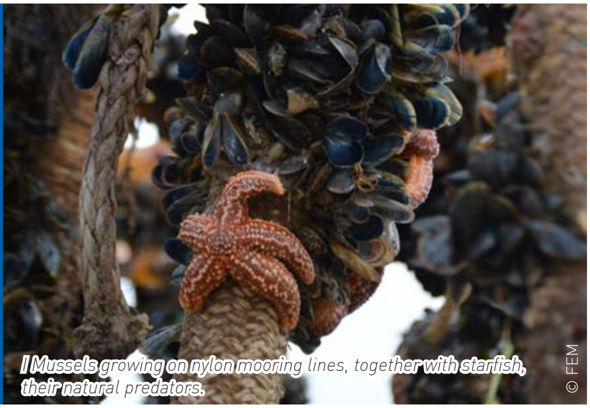


© Remy Dubas, Ecocéan

I Biofouling can significantly increase the mass and volume of structures

Moorings and biofouling in the Ria d'Etel

After 18 months of immersion in the Ria d'Etel, a fixed structure comprising samples of different types of mooring lines was retrieved in January 2022. The aim was to determine whether the geometry of the moorings and the materials used affected biofouling.



I Mussels growing on nylon mooring lines, together with starfish, their natural predators.

© FEM

Complementary instruments

The Institute has a range of technological equipment at its disposal for offshore data acquisition: current profilers, lidars, acoustic telemetry receivers, video camera systems, etc.

Wind and turbulence

In 2022, a profiling lidar was deployed on Planier Island for 12 months to fill the gaps in wind and turbulence measurements in the Gulf of Lion. This completely flat island offers conditions that are representative of the offshore environment, similar to those of the future pilot farm sites in the Mediterranean.

I *Vaisala WindCube v2.1 profiling lidar deployed on Planier Island*

Monitoring fish and crustaceans

To study the effects of offshore wind farms on fish populations, some forty acoustic telemetry receivers have been deployed at offshore wind farm sites in the Channel, Atlantic and Mediterranean. Meanwhile, several hundred fish and crustaceans were fitted with acoustic transmitters. With this technology, the movements of these marine organisms are recorded, providing information on their presence within the farms.

I *Deploying acoustic telemetry receivers*

© FEM

3 QUESTIONS for...
Fabrice Leroy

Head of the Eastern Channel and North Sea Office
France Energies Marines

Why did France Energies Marines decide to purchase the Fécamp offshore met mast?

Since its installation in 2015, this mast has been used by the company Eoliennes Offshores des Hautes Falaises as a measuring device in the vicinity of the Fécamp offshore wind farm, equipped in particular with a radar to monitor migratory flows of birds and bats. The Institute sought to purchase the mast, located around 13 km off Fécamp, to make it into a full-blown offshore research platform for an ambitious research programme on the interactions between offshore wind turbines and the marine environment. This programme, dubbed DRACCAR, benefits from funding from the Normandy region and the European Regional Development Fund and is run in partnership with the universities of Caen and Le Havre Normandie and INSA Rouen Normandie. In the longer term, the Institute aims to develop a network of offshore observatories based on the electrical substations of future offshore wind farms. With this objective in mind, the acquisition of the mast is the first building block to test the deployment of different types of instrumentation and to set up the data acquisition chain.

What exactly does the Institute intend to do with the mast?

Various instruments will be deployed to gain a better understanding of the effects of wind farms on the marine environment, and vice versa. Pressure sensors and accelerometers will be fitted to the mast to analyse the forces exerted on the structure by wave action. Anemometers and lidars will be used to study wind profiles. Underwater, current profilers and special hydrophones will be deployed to characterise the influence of wind turbines on sediment hydrodynamics. Finally, various technologies will be used to study interactions with marine megafauna, migratory birds and bats: acoustic recorders, hydrophones and a 360° synchronised camera system.

When will the first instruments be fitted?

We are currently finalising the technical specifications for the research platform and defining the sensor installation schedule. The first operations at sea will be to install the marine megafauna monitoring instruments and are scheduled for early summer 2023.

© Photo Mix

07

EXPERT PANELS AND NETWORKS

France Energies Marines is greatly involved in various cross-cutting initiatives with a common goal of supporting ORE development through research.

National support for the sector's development

France Energies Marines works with regional authorities and their development agencies as the sector's technical advisor during consultations, and takes part in various panels relating to strategic orientations, future international standards and the environment.

The Institute contributes to public debates by providing insight and presenting research results. It is also involved in national networks dedicated to facilitating and coordinating research, development and innovation.

Support for regional authorities

Conférence Régionale Mer Littoral, Assemblée Régionale Mer Littoral, Agence de développement économique de la Région Occitanie, Assemblée Maritime pour la Croissance Régionale et l'Environnement

Participation in national expert committees

Mirror groups formed by the certification bodies on resource characterisation, floating wind turbine moorings and ORE infrastructure, ORE and biodiversity working group, Dieppe-Le Tréport and Yeu-Noirmoutier wind farm project steering committees

Contribution to public debates

Call for Tender n°4 Normandy, Call for Tender n°5 South Britany, Call for Tender n°6 Mediterranean

Involvement in national stakeholder networks

Campus Mondial de la Mer, Conseil maritime de façade de la Méditerranée, Alliance Nationale de Coordination de la Recherche en Energie, GDR EOL-EMR, Comités Stratégiques de Filières, Association FIT

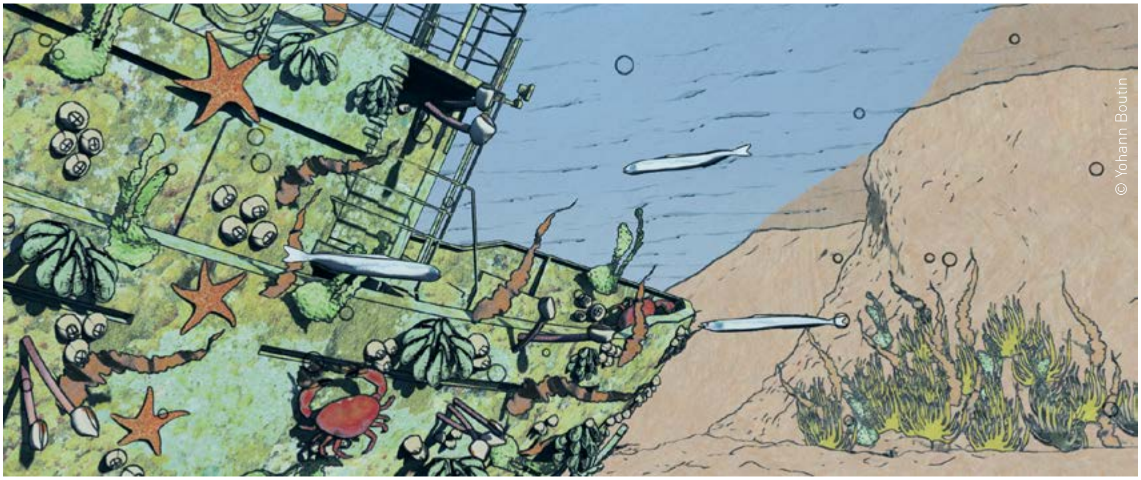
© FEM

Coordination of expert panels: COME3T

France Energies Marines has been coordinating the COME3T initiative since 2018. This project, which brings together national ORE stakeholders, aims to put environmental questions to a panel of neutral and independent experts. The questions addressed are based on challenges identified by the sector as well as public queries relating to the development of offshore renewable energies in France. France Energies Marines acts as the interface between the steering committee, which ranks the issued to be tackled, and the panel of experts, who provide scientific insight.

The steering committee comprises a wide range of public and private stakeholders: clusters and consultancy firms, grid developers, NGOs, State and government institutions, regional and local authorities, universities, farm developers. It jointly selects the scientific topics to be addressed and ensures that the experts are independent and neutral. Each expert panel aims to examine the question posed in depth and to classify the topic according to the associated environmental issue. Information bulletins are prepared for each topic addressed. They are richly illustrated and present the scientific information justifying the issue's classification. These documents are then used as a basis for the development of short videos.

Launched in late 2020, the second phase of COME3T continued throughout 2022. It is organised into various sessions addressing different topics. In 2022, four bulletins were published on the following subjects: the reef effect, the monitoring of marine mammals, the effects of noise emissions and the coastline dynamics. Two further bulletins on the effects of electromagnetic fields and metals released by galvanic anodes have been initiated, with a view to publication in 2023. Four explanatory videos have been released, dealing with the dangerous waves that may or may not be generated by wind farms, the relay effect and the impact of ballast water on colonisation by invasive species.


© Yohann Boutin

/ *Extract from a video for the general public on the reef effect*

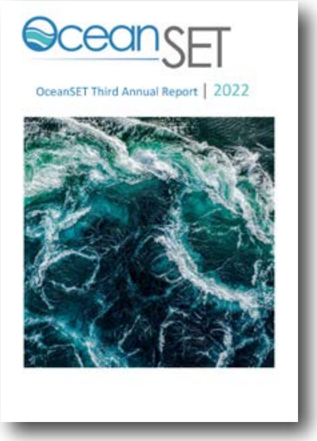
Participation in European networks

OCEAN ENERGY EUROPE - OEE

OEE is a network of ocean energy professionals, representing more than 120 European organisations. France Energies Marines is a member of this pivotal network.

OCEANSET

The European H2020 OCEANSET project was launched in March 2019 to support the roll-out of the European Strategic Energy Technology Plan (SET Plan). Completed in 2022, it was coordinated by the Sustainable Energy Authority of Ireland and brought together nine partners, including France Energies Marines. The project had three key objectives: to facilitate and support technology development; to promote knowledge sharing among stakeholders in the ocean energy sector; and to investigate mechanisms for pooled funding between Member States and Regions. In March 2022, the third and final annual report analysing the progress made in the ocean energy sector was published and a public webinar was organised to present the project results.



OceanSET Third Annual Report | 2022

© OCEANSET

I Latest OCEANSET project report

SEETIP Ocean

In the wake of the OCEANSET project, the Horizon Europe SEETIP Ocean project was launched at the end of 2022. This project supports the activities of the SET Plan Ocean Energy Implementation Working Group (OE-IWG) and the European Technology and Innovation Platform for Ocean Energy (ETIP Ocean). Coordinated by OEE and bringing together the same partners as OCEANSET, SEETIP Ocean project aims to strengthen cooperation and collaboration between the key players in the European ocean energy sector. The project aims to achieve its objectives through coordination actions, webinars and knowledge-sharing workshops. Based on these discussions, SEETIP Ocean will publish studies and reports that will be widely disseminated within the ocean energy sector.

Joint Programme on Ocean Energy of the European Energy Research Alliance - JPOE-EERA

France Energies Marines contributes to the JPOE-EERA, as the French delegate for this group, under the auspices of the French Alternative Energies and Atomic Energy Commission (CEA). This programme plays an important role in influencing the direction of European R&D objectives.

Common Environmental Assessment Framework - CEAF

France Energies Marines pursued its action as the French representative for the CEAF, a stakeholder network that meets several times a year to work on marine environments and wind energy in the Channel and North Sea alongside participants from the Netherlands, Germany, Denmark, Belgium, Scotland, England and France. The objective of this network is to support the definition of maritime planning objectives by making recommendations on implementing a common environmental assessment framework.

International reach

The International Energy Agency's Ocean Energy Systems Technological Collaboration Programme - IEA-OES

France Energies Marines is involved in IEA-OES under a mandate from the French Directorate-General for Energy and Climate, with financial support from ADEME. The Institute plays a significant role in the operational management of the Programme, and has been chairing it since 1st January 2021 for a period of 2 years. In addition to overseeing the Executive Committee, this involves acting as editor of the Programme publications as well as representing Programme at many events. IEA-OES is one of the organisers of the International Conference on Ocean Energies (ICOE), which, in 2022, was held in San Sebastián, in the Spanish Basque Country. The Programme Chair was in great demand at this event for various presentations. France Energies Marines also leads a French mirror group which improves the dissemination of initiatives and makes it easier to share information of international interest, thereby raising the profile of the French sector and its successes.

Technology Collaboration Programme
ANNUAL REPORT
AN OVERVIEW OF OCEAN ENERGY ACTIVITIES IN 2021
OES

© IEA-OES

/ IEA-OES Annual Report 2021

The Institute continued its participation in OES-Environmental, one of the IEA-OES' flagship projects, involved in examining the environmental effects of ORE development. This programme brings together 16 nations from all five continents. France Energies Marines staff members participate in the organisation's quarterly analyst meetings, most often held by videoconference.

MARINE RENEWABLE ENERGY

Benefits and Effects

Technologies that harvest energy from the movement of water in oceans and large rivers are under development around the world. Marine renewable energy (MRE) devices are designed to take advantage of tidal currents, fast flowing rivers, and waves, as well as ocean currents and natural gradients of temperature and salinity in ocean waters. The potential benefits that MRE can bring to nations and stakeholders are driving research studies, development of engineering systems, and experimental deployments of wave energy converters, as well as tidal and river turbines, in coastal areas. These studies, trials, and experiments are the leading edge of the development of an international MRE industry that is adding to the renewable energy portfolio of many nations. As this development occurs, it is essential that MRE projects not harm valuable and often fragile marine populations, habitats, and systems in the oceans. The responsible development of the MRE industry is informed by science-based understanding of the potential effects of MRE installations worldwide.

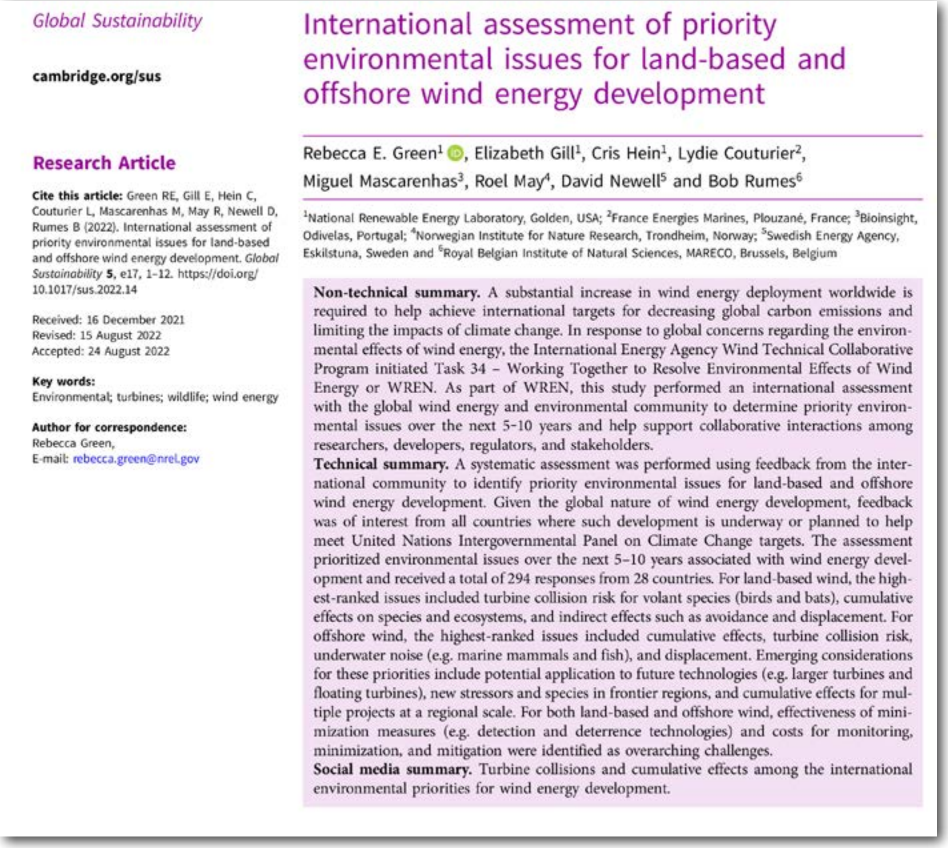
OES-Environmental | **2020 State of the Science** | Short Science Summary - Chapters 1, 2

© OES-Environmental

/ Example of a Short Science Summary designed and distributed by OES-Environmental

International Energy Agency's Wind Technological Collaboration Program - IEA Wind TCP

Within this programme, France Energies Marines is one of the ambassadors for the WREN project, which focuses on the environmental effects of onshore and offshore wind power. Launched in October 2012, WREN represents 13 European and North American nations. The Institute acts as the French representative among the other project ambassadors, communicating on national progress in wind energy and biodiversity. Within this context, it participates in drafting reports and takes part in plenary sessions aimed at establishing an inventory of scientific knowledge and techniques in the field. In September, the Institute contributed to the publication of a study assessing the priority environmental issues for land-based and offshore wind energy development for the coming 5 to 10 years.



Global Sustainability

cambridge.org/sus

Research Article

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Environmental; turbines; wildlife; wind energy

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International assessment of priority environmental issues for land-based and offshore wind energy development

Rebecca E. Green[1], Elizabeth Gill[1], Cris Hein[1], Lydie Couturier[2], Miguel Mascarenhas[3], Roel May[4], David Newell[5] and Bob Rumes[6]

[1]National Renewable Energy Laboratory, Golden, USA; [2]France Energies Marines, Plouzané, France; [3]Bioinsight, Odivelas, Portugal; [4]Norwegian Institute for Nature Research, Trondheim, Norway; [5]Swedish Energy Agency, Eskilstuna, Sweden and [6]Royal Belgian Institute of Natural Sciences, MARECO, Brussels, Belgium

Non-technical summary. A substantial increase in wind energy deployment worldwide is required to help achieve international targets for decreasing global carbon emissions and limiting the impacts of climate change. In response to global concerns regarding the environmental effects of wind energy, the International Energy Agency Wind Technical Collaborative Program initiated Task 34 – Working Together to Resolve Environmental Effects of Wind Energy or WREN. As part of WREN, this study performed an international assessment with the global wind energy and environmental community to determine priority environmental issues over the next 5–10 years and help support collaborative interactions among researchers, developers, regulators, and stakeholders.

Technical summary. A systematic assessment was performed using feedback from the international community to identify priority environmental issues for land-based and offshore wind energy development. Given the global nature of wind energy development, feedback was of interest from all countries where such development is underway or planned to help meet United Nations Intergovernmental Panel on Climate Change targets. The assessment prioritized environmental issues over the next 5–10 years associated with wind energy development and received a total of 294 responses from 28 countries. For land-based wind, the highest-ranked issues included turbine collision risk for volant species (birds and bats), cumulative effects on species and ecosystems, and indirect effects such as avoidance and displacement. For offshore wind, the highest-ranked issues included cumulative effects, turbine collision risk, underwater noise (e.g. marine mammals and fish), and displacement. Emerging considerations for these priorities include potential application to future technologies (e.g. larger turbines and floating turbines), new stressors and species in frontier regions, and cumulative effects for multiple projects at a regional scale. For both land-based and offshore wind, effectiveness of minimization measures (e.g. detection and deterrence technologies) and costs for monitoring, minimization, and mitigation were identified as overarching challenges.

Social media summary. Turbine collisions and cumulative effects among the international environmental priorities for wind energy development.

I *Front cover of a joint scientific publication on the international assessment of the environmental issues relating to wind energy development*

© FEM

3 QUESTIONS for...
Sybill Henry

Research & Scientific Mediation Officer
France Energies Marines

What is the COME3T project about?

It is a scientific mediation project on the environmental issues related to the development of offshore renewable energies. The aim is to provide stakeholders and the general public with access to the knowledge of scientific experts on various ORE-related environmental issues, such as the effects generated by noise emissions or the introduction of anthropogenic structures in the marine environment. For the 2023-2024 cycle of the project, we also intend to include the socio-economic issues raised by the development of offshore wind farms, such as maritime spatial planning and the reconciliation of different demands on the maritime space.

How are the topics selected and what role do you play in the project?

A steering committee, composed of a broad range of public and private stakeholders involved in the ORE sector, propose priority issues to be addressed. Most of these relate to questions raised by civil society. A call for experts is then organised to bring together neutral and independent scientists who are specialists in the subject. This is one of the linchpins of the project. Within this context, I organise the different project phases, coordinate the steering committee, liaise between the various stakeholders and facilitate the expert committee workshops in order to identify and summarise the scientific content to be disseminated.

How is this work presented?

We disseminate the experts' knowledge in bulletins, around fifteen pages long, that explain the subject and provide information to answer the questions raised, based on the current state of knowledge. Some subjects are difficult to summarise and explain to non-experts in a few pages without distorting the scientific message. The difficulty lies in bridging the gap between highly specialised scientific expertise and the steering committee's expectations in terms of popularisation. The richly illustrated bulletins are scientific mediation documents based on which we produce short videos aimed at a wider audience with less awareness of ORE-related environmental issues.

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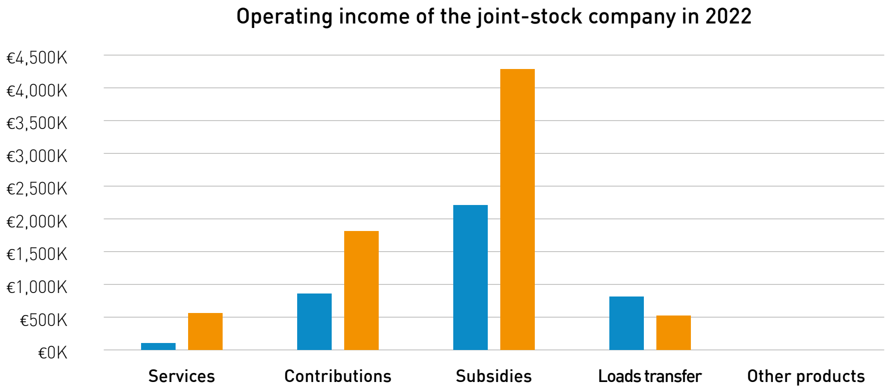
08

FINANCIAL SUMMARY

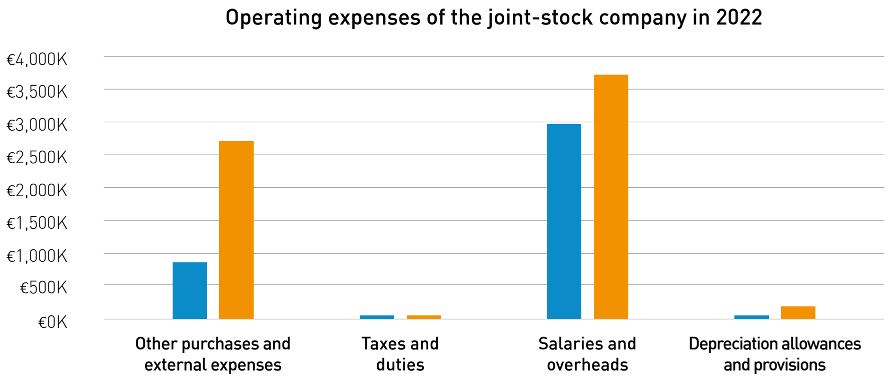
2022 was another year of strong growth for the Institute, linked to the development of the offshore wind energy sector. Eight new projects were launched—six led by France Energies Marines, one funded by ADEME and another funded by the Horizon Europe programme—representing a total budget of €11M, and are set to strengthen the team's expertise across its different R&D programmes. Additionally, 2022 saw €800K of research service commitments. Several projects have involved the deployment of measurement equipment at sea, thus contributing to the development of a national network for observing interactions between offshore wind farms and the environment. The share capital of the SAS was increased by €200K. The R&D agreements between France Energies Marines and its members have been renewed for a three-year period, with a major step-up in financial contributions. Three new members have joined the Institute: the Occitanie region, RWE and TotalEnergies.

Two organisations co-exist in the 2022 financial report: the Association created at the inception of France Energies Marines, and the joint-stock company (SAS) responsible for the Institute's activities since 1st January 2019. The Association no longer initiates projects and all personnel are gradually being transferred to the joint-stock company. The goal is to close down the Association in 2023.

The joint-stock company's operating result for 2022 is €508K, a 535% increase from 2021. Operating income was €7,190K (compared to €4,008K in 2021) and operating expenses represented €6,681K (compared to €3,928K in 2021). The balance sheet total stands at €16,327K, up almost 30% from 2021.

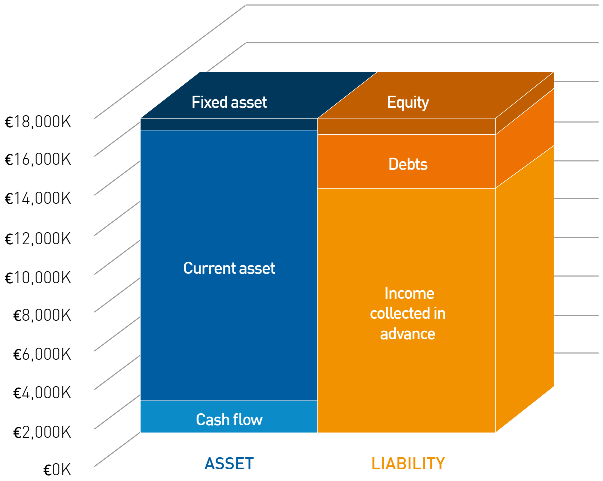


Operating income of the joint-stock company in 2022



Operating expenses of the joint-stock company in 2022

/ Joint-stock company income statement for 2022 against 2021



/ Joint-stock company balance sheet for 2022

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09

OUTLOOK

The tense geopolitical context, the hike in energy prices, the increasingly visible effects of climate change and the move to reduce dependence on imports all contribute to the perception that electricity generation by offshore wind farms is now one of the main keys to ensuring France's energy independence. In his speech in Belfort on 10 February 2022, the French President announced a target of 40 GW of offshore wind power connected to the grid by 2050, i.e. around 50 offshore wind farms. At European and international levels, the targets are equally ambitious, with 300 GW in Europe and 2,000 GW worldwide. Strong market growth can therefore be expected.

With wind farms being built further and further from the coast and in increasingly deep waters, floating wind technology could account for around half of the offshore wind market by 2050. This technology, which is currently still at the demonstration stage, will require considerable R&D to fulfil the sector's economic objectives. The Institute's longstanding positioning with regard to this technology is a major asset.

2023 looks set to be another year of growth for the Institute, which will be defining the framework required to implement emblematic programmes to help the sector achieve its national ambitions. The start of the year will be marked by DRACCAR, France's first offshore research platform dedicated to offshore wind energy, coupled with a major multidisciplinary R&D programme.

Work on collaborative projects, aimed at strengthening France Energies Marines' expertise, will remain its main activity. Five new open collaborative projects led by the Institute are expected to be put to its members. Restricted collaborative projects of a more confidential nature are also expected. Proposals in response to a number of French and European calls are currently under preparation.

Research and expertise services will continue to grow. France Energies Marines is poised to launch its 18-month training development project. The aim is to consolidate the Institute's training offering, while enhancing existing training courses geared towards the offshore renewable energy sector.

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