
Annual Report
2025
FRANCE
ENERGIES
MARINES

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01 INTERSECTING PERSPECTIVES BETWEEN...

Herveline Gaborieau - *Executive Director of France Energies Marines*
Ronan Stephan - *Chairman of France Energies Marines*

How would you sum up 2025?

Herveline Gaborieau: I'd say it was a mixed bag. In France, market conditions have become less attractive, and the French Government's strategy on energy policy remained somewhat unclear. Several industrial firms have withdrawn from the French market, and hence from the Institute too. On the international scene, however, there are some very positive signals for France Energies Marines. We are now internationally recognised and are approached by leading European companies to set up projects. We are also building key international partnerships, particularly in Asia.

Ronan Stephan: Throughout 2025, which was predominantly marked by global geopolitical instability, our Institute continued to be a trusted resource for all stakeholders across the sector. Our strategic development choices, as well as the calibre of our teams and their scientific outputs, are fully acknowledged. Furthermore, this complex landscape has fostered stronger ties between the various institutes within the French Institutes of Technology (FIT) association and has laid the groundwork for a number of joint initiatives.

Herveline Gaborieau: Our industrial and academic members and partners have remained by our side throughout 2025. The regional authorities have also provided valuable support.

What lies ahead for the offshore wind sector?

Ronan Stephan: We had been awaiting France's third Multi-Annual Energy Programme (PPE 3). This new energy roadmap for the coming ten years was published on 13 February 2026. With a view to strengthening France's energy independence, this programme supports the development of offshore wind energy, with a target of 15 GW of installed capacity by 2035, in line with the French Government's previously defined ambitions.

Herveline Gaborieau: Yes, the publication of PPE 3 is a step in the right direction. The specifications for the call for tender AO10 should be published soon, with the winners expected to be announced in the first quarter of 2027. At European level, an important move came with the announcement, on 26 January 2026, of the Joint Offshore Wind Investment Pact for the North Seas, promoting the deployment of new offshore wind capacities between 2031 and 2040, with up to 15 GW installed per year. There is generally an increased awareness of the need for European energy independence. This is particularly true in the United Kingdom and Northern Europe, but also in the Mediterranean, where Spain and Portugal are moving forward. These very positive signs point to a welcome lift for the sector.

Ronan Stephan: Thanks to improving market conditions in various countries, the sector is set to become more competitive and new opportunities should emerge.

How do you see the Institute evolving in the medium-term?

Herveline Gaborieau: We are continuing on our gradual course towards greater internationalisation. In concrete terms, this means increased involvement in European projects. This is particularly the case for the Horizon Europe COMPASS project, for which we coordinated the set-up phase and are the scientific and administrative lead. This project aims to develop a decision support platform offering tools designed to improve the sustainability of offshore wind farms. In 2025, we submitted 10 applications for EU calls for proposals. Moving forward, the strategic partnerships we have begun to build with DHI – a leading Danish institute with a strong position in offshore wind – and FLOWRA – Japanese Floating Offshore Wind Technology Research Association – will be scaled up from 2026.

Ronan Stephan: The recognition our Institute has earned, highlighting the expertise and agility of our teams, has helped to promote our image internationally and has fostered favourable conditions for new development opportunities. I would add that we are clearly recognised and attractive to talented candidates, such as those from leading foreign institutions. This directly benefits the sector and the areas where we are based.

Herveline Gaborieau: Our strength is, and will always be, our people. Despite a very challenging context, our ever-dynamic team put up a united front. Through this resilience, we are well placed to tackle the challenges that lie ahead in the coming years.

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02

HIGHLIGHTS OF 2025

February

Meeting with the Director of the European Climate, Infrastructure and Environment Executive Agency (CINEA), during a visit organised by *Campus mondial de la mer*.

Filming of a video at our premises on how wind turbines and wind farms are designed. The film will be posted on *Le Blob*, the digital media platform of the *Cité des sciences et de l'industrie*.

April

Participation in an event organised by the French Secretary General for Investment (SGPI), following the meeting of the Interministerial Committee on Innovation chaired by the Prime Minister, aimed at illustrating the impact of the France 2030 plan on innovation to support French sovereignty.

April

Signing of a partnership agreement with *France Cyber Maritime* to strengthen cybersecurity in the offshore wind sector.

Strong involvement in FOWT 2025, with an oral presentation during a technical session, the organisation of a technical tour of our premises in Brest, and very active participation in the programme for the general public (serious games and conferences).

May

Participation in the Camargue Festival with a conference on the challenges of floating offshore wind in the Mediterranean, and the facilitation of sessions based on the serious game OUPS which explores how marine ecosystems work.

September |

Signing of an agreement with DHI, international software development and engineering consultant firm specialising in water.

Strong presence at the Conference on Wind energy and Wildlife impacts (CWW) in Montpellier, organised by *Biotope* and *France Renouvelables*, with scientific support from our Institute.


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Opening of an office in Pau, Nouvelle-Aquitaine, to develop the local network of offshore wind energy stakeholders and offer the Institute's support on priority issues for the sector, whilst keeping tabs on the development of wave energy.


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October

Participation in the *Fête de la Science* in Marseille, on the theme of digital technology and different forms of intelligence, illustrated through interactive workshops on the artificial intelligence models used to study marine mammals and seabirds.

Meeting in Brest with the French Secretary General for Investment (SGPI) and three of his team, accompanied by representatives of the regional prefecture, the regional council and *Brest Métropole*.

Strong involvement in the International Offshore Wind Technical Conference (IOWTC) in Toulon, an international scientific event in which the Institute is a partner.

Signing of an agreement with Japan's Floating Offshore Wind Technology Research Association (FLOWRA) and contribution to the creation of The Moonshot, an international alliance aimed at advancing the development and industrialisation of floating offshore wind power.

03

IDENTITY

FRANCE ENERGIES MARINES

is the Institute for Energy Transition for offshore wind.

90 staff

200+ partners **WORLDWIDE**

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

5 sites
along the French coastline

Involvement in over
100 R&D projects
since 2012

€**10** million
annual budget

27
public and private members

Position

France Energies Marines is the French research and innovation centre devoted to offshore wind energy. It develops tried-and-tested methodologies, software, tools and standards to de-risk the roll-out of offshore wind energy, boost the sector's competitiveness, enhance regional attractiveness and support decision-making by regional and national authorities in relation to offshore wind energy.

Mission

Our mission at France Energies Marines is to resolve bottlenecks to the development of offshore wind energy through research and innovation. Supported by the French State, the Institute, driven by a 90-strong multi-disciplinary team and a network of international experts, underpinned by one-of-a-kind infrastructures, conducts excellence-oriented multi-partner research projects.

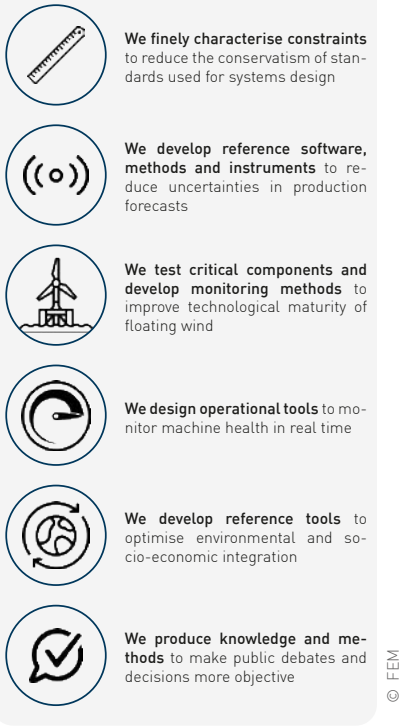
Through its actions, France Energies Marines is helping France to become a leader in renewable energies by 2030, one of the ten objectives set out by the French Government as part of the France 2030 investment plan.

Values

Underlying the identity of France Energies Marines are three founding values:

- **Innovation mindset**
  The innovation mindset is a cornerstone of our mission, driving us to design and put forward unique, relevant solutions with high added value.
- **Team spirit**
  Team spirit is deeply embedded in the culture of our team, members and partners, reflecting our core purpose: fast-tracking the development of offshore wind through collaborative R&D.
- **Excellence**
  We strive to cultivate excellence on a daily basis through high-quality work and discussions. This quest guides all our actions and strengthens our multidisciplinary, cutting-edge expertise.

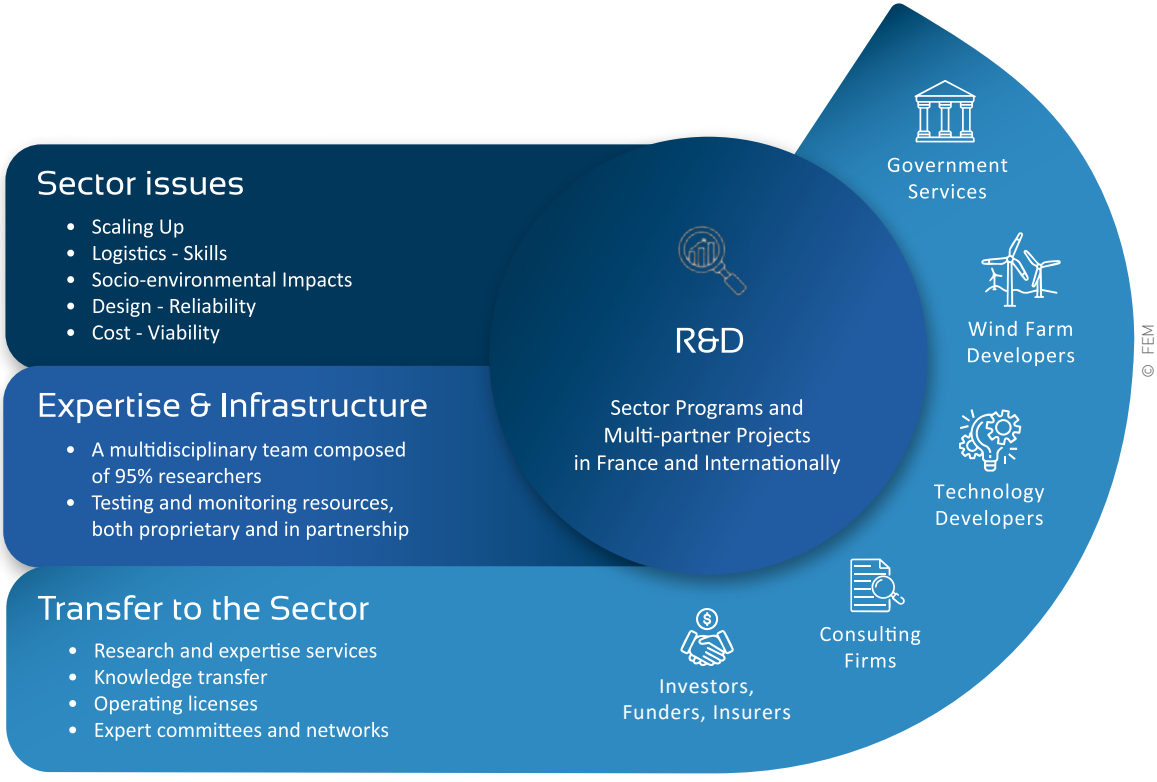
What we do



Activities

The Institute's activities are built on two cornerstones: a multidisciplinary team with invaluable expertise and high-level collaboration, and infrastructures, whether belonging to the Institute or to partner organisations, to carry out high added-value experimentation.

The R&D carried out by France Energies Marines takes the form of projects lasting between 18 and 48 months and long-term sector-focused programmes. The outputs are intended to be transferred to offshore wind sector stakeholders. This transfer currently takes the form of research and expertise services, operating licences, know-how transfer and participation in expert panels and networks.



Governance

The Institute is built around a broad public-private partnership that brings together 27 members – all key French offshore wind sector participants – from industry, academic and scientific establishments, local authorities 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 and impact on the sector of multi-partner projects set up by France Energies Marines,
- 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

6 PUBLIC MEMBERS

ENSTA IP PARIS	Ifremer	Nantes Université	Région Bretagne	UNICAEN Université Caen Normandie	Région Normandie
represented by **Raymond Levet**	represented by **Nabil Sultan**	represented by **Salvy Bourguet**	represented by **Daniel Cueff**	represented by **Loïc Le Pluart**	represented by **Julie Barenton Guillas**

4 PRIVATE MEMBERS

EDF	OWC An ABL Group Company	Pôle Mer Bretagne Atlantique	TotalEnergies
represented by **Eve Dufossé**	represented by **Hakim Mouslim**	represented by **Philippe Monbet**	represented by **Pierre-Olivier Lys**

EXECUTIVE MANAGEMENT

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Herveline Gaborieau
Executive Director
of France Energies Marines

PRESIDENCY

© Sylvain Coulaud

Ronan Stephan
Chairman
of France Energies Marines

SHAREHOLDER AND CONTRIBUTOR MEMBERS

© Haynea

Locations

To fulfil its missions at national scale, France Energies Marines has always sought to take into consideration the specificities of the different French coasts as well as the needs of local stakeholders. Through its proximity approach, with strategic locations along the Atlantic, Channel and Mediterranean coasts, the Institute supports the development of bottom-fixed and floating offshore wind energy within the vicinity of pilot and commercial projects.

Headquarters at the tip of Brittany | Brest

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 emblematic building of Campus mondial de la mer. The proximity with these organisations and initiatives at the crossroads of collaboration between research and industry reinforces synergies with the local ecosystem.

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Atlantic office | Nantes

Created in 2017, the Atlantic office is located in Nantes. All of the Institute's R&D programmes are represented at this office, which has a strong propensity to put forward interdisciplinary projects and to take part in the various events along the Atlantic coast. Several PhD and post-doctoral students, hosted by partner laboratories in the Loire area, strengthen our ties with research organisations and businesses.

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Manager:
Jérémy Bioud

Eastern Channel - North Sea office | Le Havre

The Eastern Channel - North Sea office opened at the end of 2022 and is located on the premises of the Université Le Havre Normandie. Its vocation is to support the development of wind energy off the Normandy coast. This local presence also supports the implementation of the DRACCAR sector programme on the interactions between offshore wind energy and the marine environment. This programme, launched in 2023, is built on the use of an instrumented met mast located off Fécamp as an offshore research platform. This location benefits from a 100 m² technical workshop, set up in 2025, dedicated to the preparation, storage and maintenance of equipment used during offshore operations, offering the office operational independence.

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Manager:
Cédric Bianchini

Mediterranean office | Marseille

Created in 2019, our Mediterranean office is being developed by a multidisciplinary team based in Marseille, on the premises of the Ecole centrale Méditerranée. 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 strengthens collaboration between researchers and companies in the two regions. This office is also involved in various organisations based along the Mediterranean coast, including the Sea Basin Maritime Council and the Sea Basin Scientific Council.

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Manager:
Georges Safi

South-Atlantic office

In September 2025, the Institute opened an office in Pau, based in the Hélioparc technology park, in the Nouvelle-Aquitaine region, which comprises the four coastal departments on the South-Atlantic coast. This new location bolsters our presence along the Atlantic coast and amplifies our commitment to supporting the development of offshore wind in close collaboration with local communities.

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Contact:
Cécile Bon

International impact

With each new year, France Energies Marines continues to consolidate its position in the international arena. The Institute plays an active role in numerous working groups and a broad array of scientific conferences. Articles based on the Institute's R&D projects are regularly published in leading journals, enhancing the visibility and credibility of our work.
This recognition helps to build strong bonds with key players in the field, including major global R&D institutes. It also supports the Institute's growing involvement in European projects, thereby confirming its strategic role within the offshore wind research ecosystem.

1 **international alliance** to accelerate the development and industrialisation of **floating wind energy**

7 **working groups** & **international networks of experts**

53 **publications** in peer-reviewed journals over the past three years

7 **European projects** currently underway, launched or completed in 2025

55 **presentations** at **international conferences, colloquia and symposia** in 2025

2 **strategic partnerships** relating to wind modelling, biodiversity and floating wind energy

4 **scientific and technical events co-organised** in 2025

600 **participants** from 24 countries attending the **Institute's R&D webinars** in 2025

04

EXPERTISE

France Energies Marines sets itself apart through its cutting-edge, multidisciplinary expertise in offshore wind energy. With a team of 70 researchers, engineers and technicians assisted by support roles, together with a capacity to mobilise leading partners in France and internationally, it provides support for the sector throughout the life cycle of an offshore wind farm, across the entire value chain. The Institute draws on numerical modelling, laboratory tests and offshore experimentation to develop sustainable, innovative solutions for offshore wind energy.

90 collaborators 100% dedicated to offshore wind energy research and innovation

81% of staff on permanent contracts to guarantee the continuity of our expertise

70 scientists from the research and industry sectors

4 complementary R&D departments

+200 partners in France and abroad

53 scientific publications over the last three years

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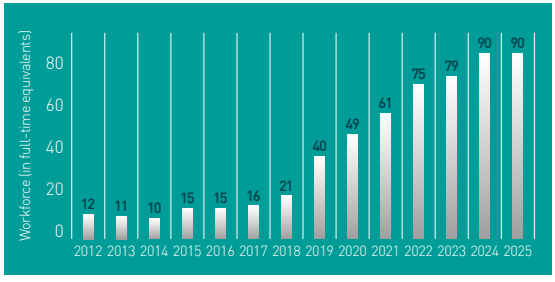
A multidisciplinary team

A team 100% dedicated to research and innovation

France Energies Marines boasts France's largest team of scientists entirely devoted to offshore wind energy research and innovation. Its multidisciplinary composition and cross-cutting approach are valuable assets thanks to which it is able to address R&D topics in a global and pragmatic manner. In 2025, the team comprised 90 employees. Scientific and technical profiles, whether researchers, engineers or technicians, still make up the vast majority of the staff, representing more than three-quarters of the workforce. They are divided into four R&D departments based on the following themes: wind and ocean dynamics, systems and performance, wildlife and interactions, ecosystem and society. With 81% of employees on permanent contracts, the Institute is guaranteeing the continuity of its expertise on advanced scientific topics.

A strong professional equality policy

In 2025, France Energies Marines had a professional equality index of 91/100, up one point on the previous year, while the national average sits at 88.5/100. This index is calculated out of 100 on the basis of four indicators: the pay gap, the gap in individual pay rises between women and men, the percentage of employees granted a pay rise upon return from maternity leave, and the distribution of women and men for the ten highest salaries. The Institute is pursuing its commitment towards closing the gender pay gap and ensuring equal treatment. Since the redressing of the gender balance in 2024, the mix of men and women has remained stable, with women representing 48% of the workforce.



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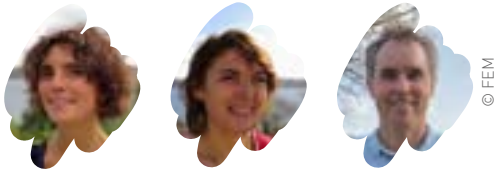
I Evolution of the number of employees

Executive Committee

The Executive Committee comprises representatives of Executive Management, Scientific Management and the Administration, Finance and Legal team. Composed of three members, this Committee is responsible for implementing the Institute's strategy and oversees its operational running.



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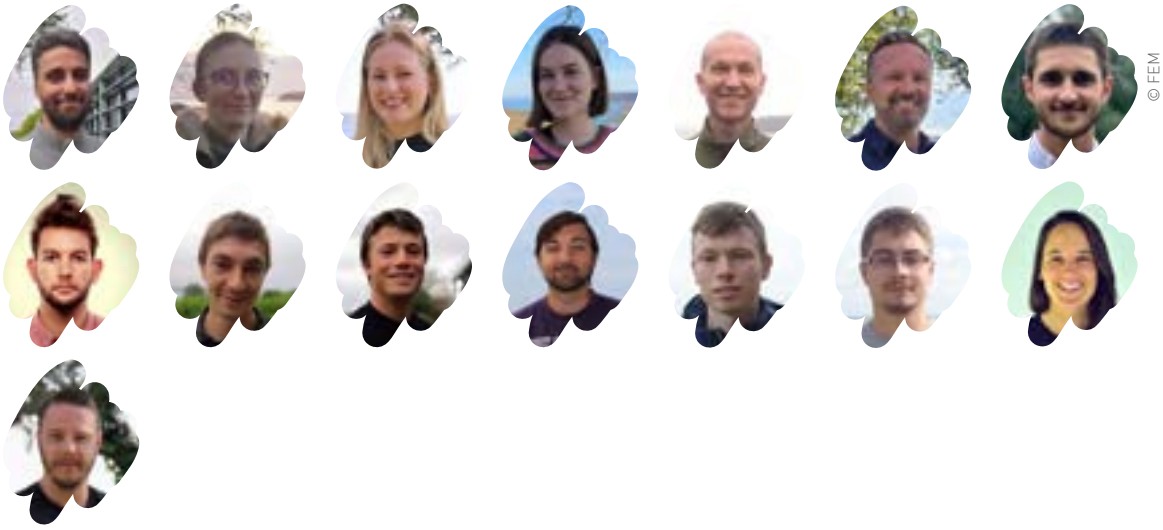
Wind and Ocean Dynamics

The Wind and Ocean Dynamics department comprises 15 people and is composed of 50% researchers, 29% engineers and 21% PhD students. Their main disciplines are meteorology, physical oceanography and geology. This department covers a vast spectrum of disciplines relating to the physics of the atmosphere and the ocean. It combines high-level numerical approaches with flume tank experiments and at-sea measurements. The team is particularly renowned for its work on the detailed assessment of atmospheric turbulence intensity, and the realistic evaluation of loadings on structures due to breaking waves. It is also focusing increasingly on current issues such as climate change, inter-farm wake effects and tropical cyclones.



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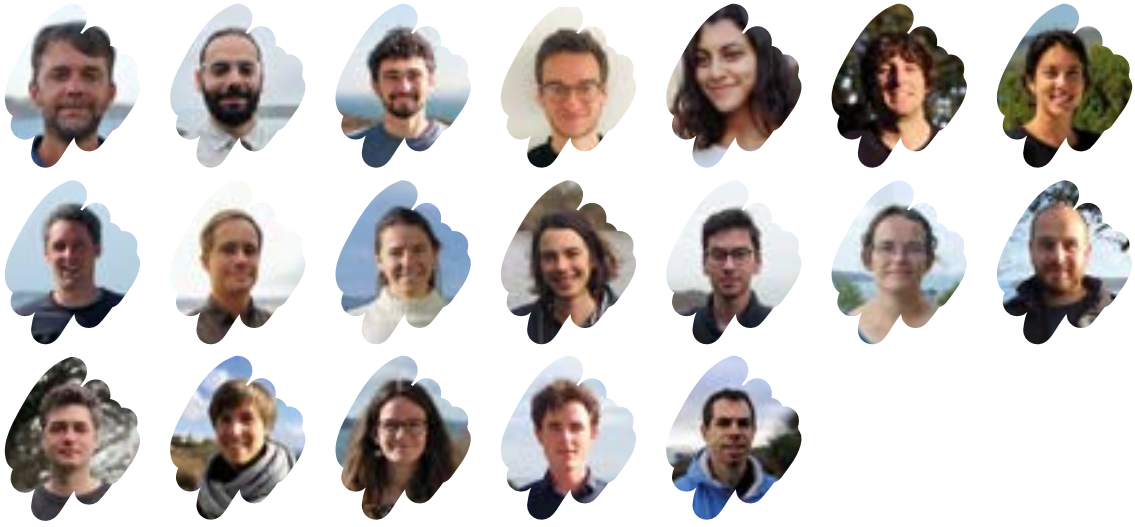
Systems and Performance

The Systems and Performance department comprises a team of 19 people, made up of 61% researchers, 28% engineers and 11% PhD students. It covers a broad range of disciplines: structural and fluid mechanics, applied mathematics, geotechnics, electrical engineering, etc. The work carried out combines numerical modelling, laboratory testing and offshore experimentation. Over time, this team has developed unique expertise in digital twins of floating wind turbines, in-service monitoring of dynamic subsea cables, and the behaviour of polyamide moorings. More recently, it has been working on emerging issues such as direct current floating electrical substations, heavy maintenance at sea, and hydrogen production from offshore wind turbines.



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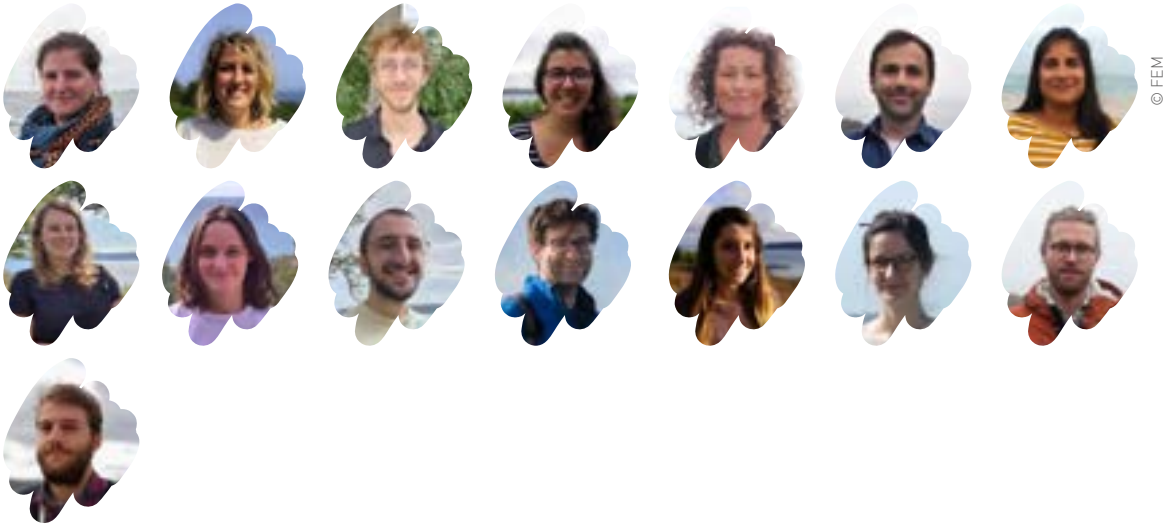
Wildlife and Interactions

The Wildlife and Interactions department comprises 15 people and is composed of 71% researchers, 22% engineers and 7% PhD students. The team comprises experts specialised in the study of the main compartments of the marine environment: birds, mammals, fish and benthos. Alongside these experts, specialists in monitoring tools and methods develop and apply advanced methods for data processing, the implementation of artificial intelligence algorithms, and complex data management pipelines to analyse large quantities of ecological data. The team models the interactions between species and infrastructures and develops high-performance, automated, energy-efficient monitoring tools for the sector. Given the topics it addresses, this team also carries out scientific outreach activities geared towards the general public.



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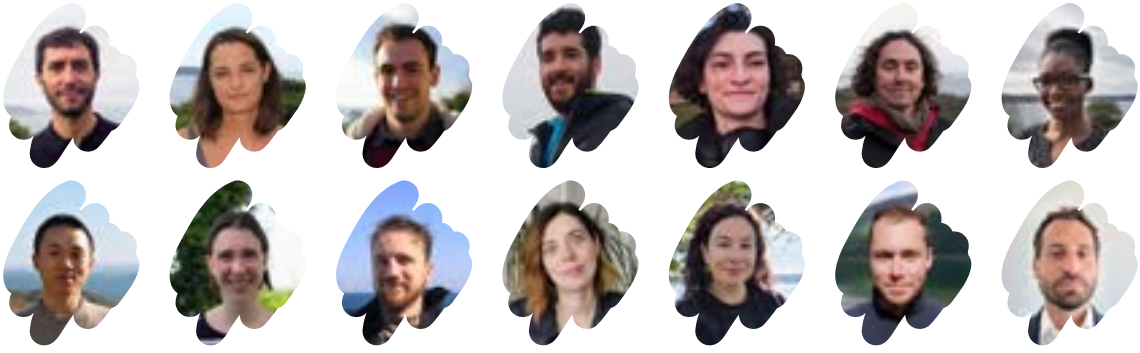
Ecosystem and Society

The Ecosystem and Society department comprises 14 people, including 84% researchers. It develops management tools for those working in the sector, to provide a global vision of the marine ecosystems in which offshore wind farms are set up. Expertise from various disciplines is combined within this department: ecology, oceanography, mathematics and IT, geography, sociology and political science. Thanks to this diversity, the team can tackle issues relating to offshore wind development from both environmental and socio-economic perspectives, drawing on specialists in trophic modelling, socio-ecosystem approaches and social perception.



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Business & Promotion

The Business & Promotion team is responsible for developing the Institute's service provision. Led by a business development manager, this team is composed of four development officers – one for each R&D area – a training project manager and a communications and marketing officer.

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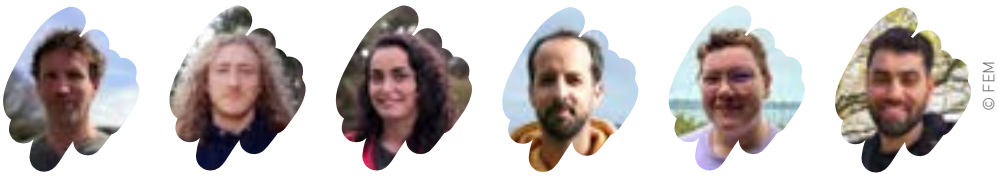
Instrumentation & Acquisition

The Instrumentation & Acquisition team is responsible for offshore operations and for developing offshore data collection equipment. It comprises a cross-functional, operational team of six people – engineers and technicians – dedicated to coordinating France Energies Marines' offshore activities. This team's role is to specify and integrate offshore measurement systems suited to deployment sites, manage offshore operations in compliance with HSE best practices, and monitor the Institute's offshore research infrastructures.



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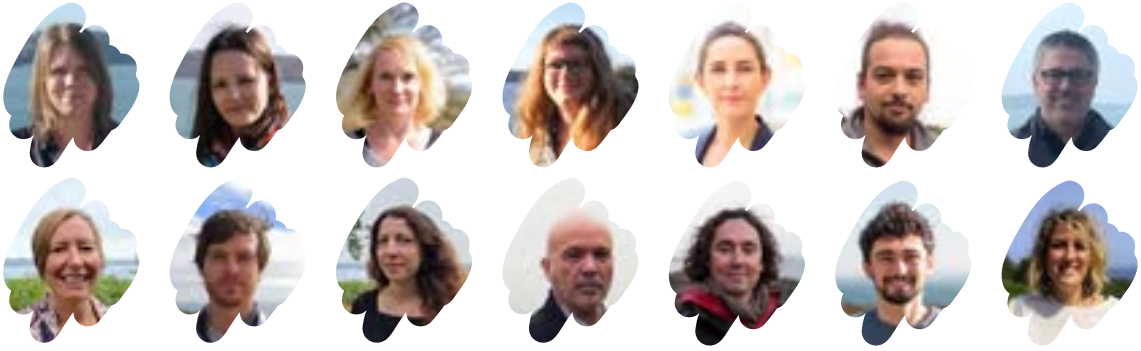
Support roles

Support roles are carried out at the Institute by 14 people with a wide range of profiles. This label covers very different components with a shared mission: to contribute to the smooth running and the development of the Institute, while supporting the scientific teams on a daily basis. The array of support roles is highly diverse: administrative support, communications, accounting, geomatics, IT, legal, office management, and human resources.



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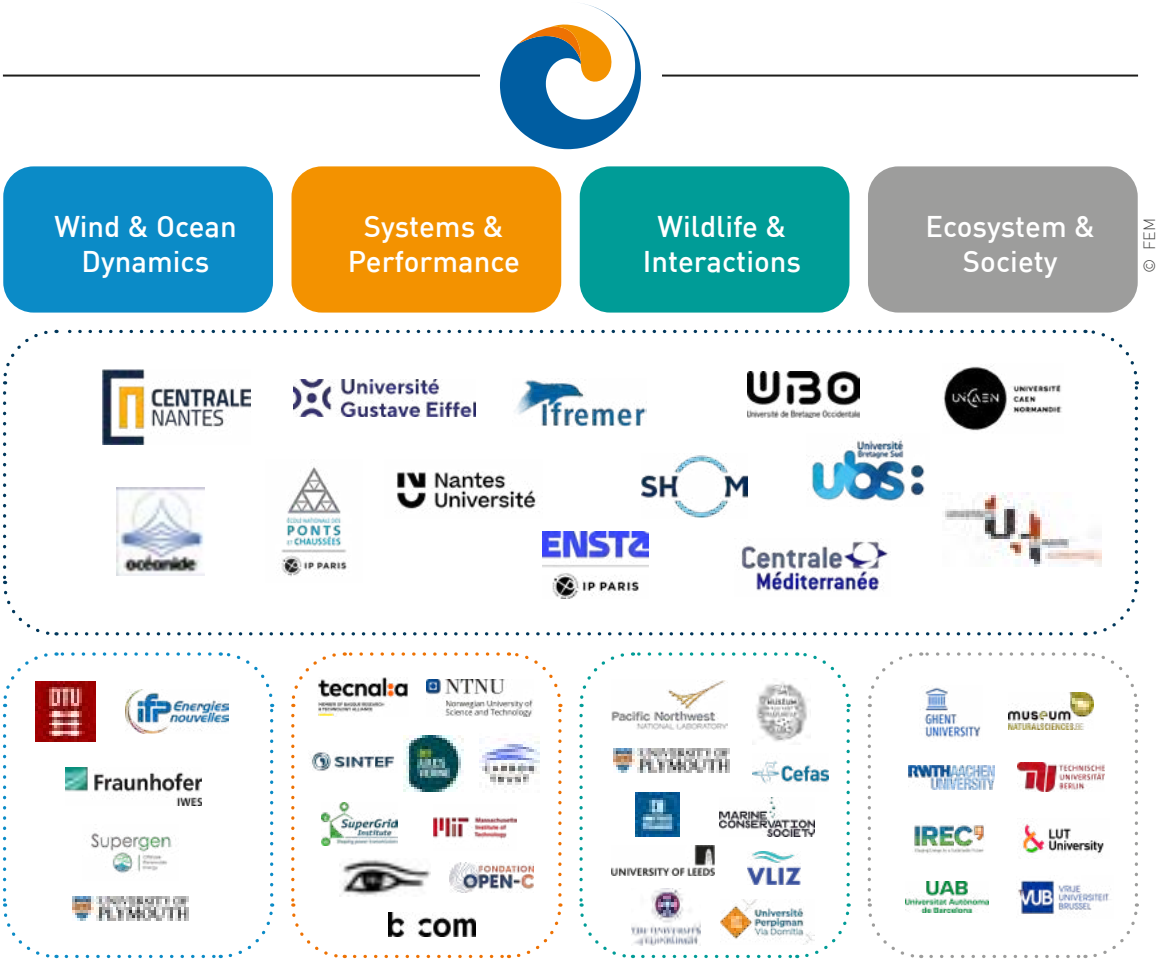
A network of experts and partners

The Science & Technology Committee

This Committee is made up of independent experts whose mission is to critically review the France Energies Marines roadmap and put forward recommendations to improve the R&D projects led by the Institute. The experts are chosen for their experience in the sector and/or in applied R&D projects. They work for prestigious institutes in different countries and are renowned in their field of expertise. They thus have good insight into how our work meets expectations within the offshore wind sector.

A network of key experts and partners

France Energies Marines brings together a national network of experts recognised by their peers. These scientists are part of research teams belonging to universities, engineering schools, public establishments and SMEs. The Institute also fosters fruitful collaboration with various key French and international R&D players.

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05

RESEARCH INFRASTRUCTURES

To carry out its research and innovation activities, France Energies Marines draws on a network of cutting-edge research infrastructures that belong to either the Institute or partner organisations. Thanks to our unique at-sea testing and monitoring facilities, long-term observations and experiments can be carried out in offshore environments. It is crucial for stakeholders in the sector to have access to data acquired in the field, under real-life conditions. Our infrastructures are complementary to those provided by our network of private and public partners. Together, they offer real added value for de-risking the development of offshore wind energy.

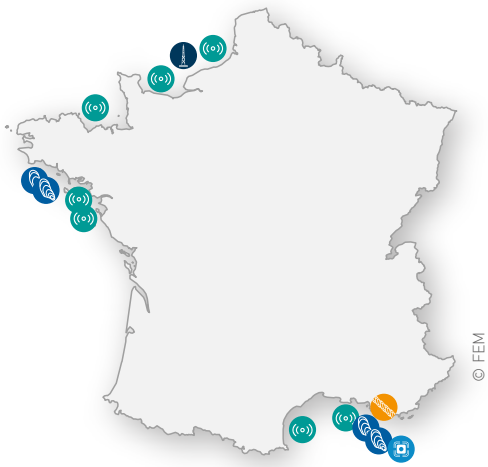
Multi-instrumented met mast
Wind, structure, megafauna monitoring

Profiling lidar
Wind, atmospheric turbulence

Mooring demonstrator
Innovative moorings

Biofouling observatory
4 instrumented buoys

Acoustic telemetry
Fish monitoring on 7 sites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Multi-instrumented met mast

Since 2023, France Energies Marines has been operating a met mast that is the foundation for the DRACCAR R&D programme devoted to France's first research platform for offshore wind. The mast is located 13 km from the coast on the southern edge of the Fécamp offshore wind farm. Installed on a gravity foundation and reaching a height of 60 metres above sea level, it is ideal for testing and validating innovative solutions, several of which are already operational.

The aerial part of the mast is equipped with acoustic recorders, 4K/360° cameras, camera traps and a Motus station. These instruments are used to detect and observe birds and bats. Underwater, hydrophones and acoustic receivers track tagged marine mammals, fish and crustaceans.

The instrumentation also includes equipment for studying atmospheric turbulence: a sonic anemometer, a profiling lidar and a weather station. A stereo-video system, pressure sensors and accelerometers have also been installed to monitor the structural behaviour of the mast during exposure to wind, waves and currents.

I Anemometers

I Pressure sensors

I Camera trap

Wind lidar in the Mediterranean

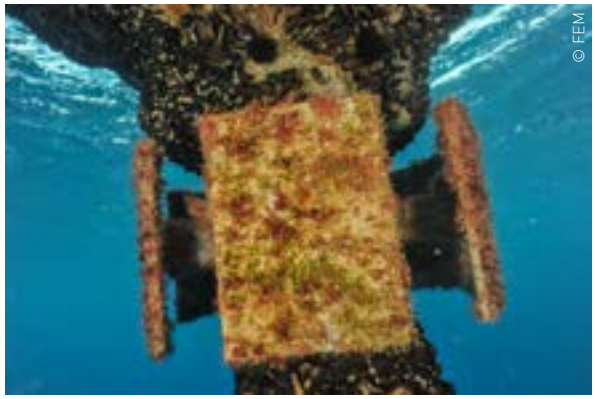
Since December 2022, France Energies Marines has been operating a Vaisala WindCube v2.1 (in compliance with the IEC 61400-12-1 standard) on Planier Island in the Gulf of Lion. This site, located 9 km off the coast, is used to record undisturbed atmospheric phenomena representative of the conditions encountered at floating wind farm sites in the Mediterranean. Through this data acquisition campaign, which is currently still ongoing, the Institute is able to compile a unique dataset.

I Profiling lidar

Biofouling observatory

France Energies Marines has instrumented several buoys deployed in the Atlantic and the Mediterranean, as close as possible to the areas selected for future offshore wind farms. Equipped with biofouling monitoring systems (designed to insert samples of synthetic mooring lines or cables for instance), these buoys are used to study biofouling on underwater components. The data collected (dry weight, wet weight, volume, thickness, density, organism diversity, and degree of coverage) is used to characterise and quantify biofouling under various environmental conditions and at different depths (down to 70 m).

The results obtained provide valuable insights into the variability in biofouling and would be integrated into structural design models and trophic models. This data offers key information for the design and maintenance of floating wind farms.



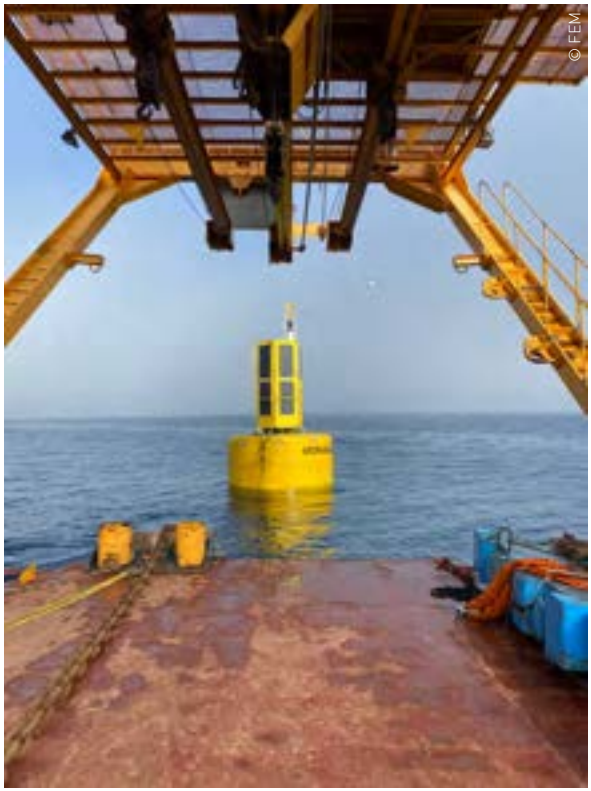
I System comprising polyvinyl chloride (PVC) plates to monitor biofouling over several years

I System comprising samples of high-density polyethylene (HDPE) and polyethylene terephthalate (PET) to monitor the biofouling of mooring lines and power cables and to quantify hydrodynamics

Mooring lines demonstrator

France Energies Marines has designed a demonstrator to study the behaviour of polyamide mooring lines under real conditions. It consists in a 7-tonne buoy with a diameter of 3.70 metres that is self-powered. The buoy's position, orientation and speed are calculated at high frequency by an inertial navigation system, and the data is transmitted in real-time via a 4G router.

The buoy can be fitted with between one and three mooring lines, composed of chains and synthetic ropes, which can be equipped with tension and elongation sensors. With this demonstrator, we are able to test the performance of synthetic mooring lines in offshore conditions over the medium and long term, as well as the robustness and reliability of in-service monitoring technologies. This system is a valuable asset for developing more efficient and sustainable solutions for floating wind energy.



I Mooring line demonstrator seen from the surface and from underwater

Acoustic telemetry network

France Energies Marines has deployed and maintains more than 80 acoustic telemetry receivers within seven French offshore wind farms, either in operation or under construction, located in the Channel, Atlantic and Mediterranean. These specialised hydrophones are capable of detecting the acoustic signals emitted by individual tags fitted to various species of fish and crustaceans. Based on these signals, the trajectories of the tracked animals can be reconstructed to gain a better understanding of their presence and behaviour within and between offshore wind farm development areas.

To date, more than 300 individuals – mainly rays, sharks, sea bass, sea bream and lobsters – have been tagged. The Institute's network is compatible with the equipment used by many other European initiatives, thereby contributing to the advancement of scientific knowledge across Europe.

I Deploying acoustic telemetry receivers

I Tag used for rays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06

RESEARCH & DEVELOPMENT

As an interface between the private sector and public bodies, France Energies Marines pinpoints the R&D needs of the offshore wind sector, 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 100 R&D projects, the majority of which were set up and managed by our team.

To increase its impact within the sector, France Energies Marines has been leading sector programmes drawing on offshore research infrastructures since 2023. The goal is to generate data and results in operational conditions that are crucial for all stakeholders in the value chain, in particular start-ups, SMEs and intermediate-sized enterprises. These programmes are designed to gather R&D projects under a shared banner, in order to address a given topic via a cross-disciplinary approach.

4 new projects launched by the Institute representing a budget of **€8M**

1 sector programme DRACCAR: interactions between offshore wind & the environment

over **45** industry partners in France and worldwide

2 PhD theses defended

R&D facts and figures for **2025**

32 R&D projects in progress or launched

70% of projects led by FRANCE ENERGIES MARINES

18 publications in peer-reviewed journals

55 presentations at international conferences

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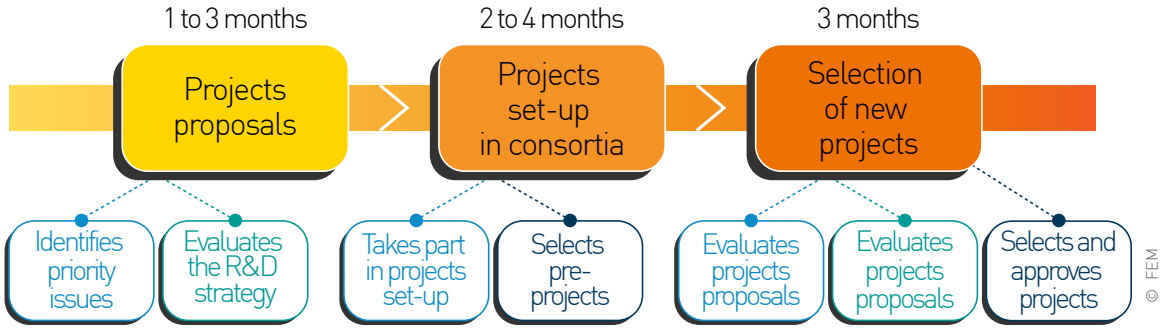
A project development process built on scientific excellence and the production of tangible results

The projects supported by the Institute are initiated according to the needs expressed by its industrial members, in order to overcome the technological, environmental and societal obstacles identified by the offshore wind energy sector. Each project is designed and implemented with an ongoing focus on the quality and applicability of the results obtained, in particular with regard to changes and developments in international standards and software production. Every year, four to six new projects are launched following a tried-and-tested selection process promoting scientific excellence, as detailed in the diagram below.

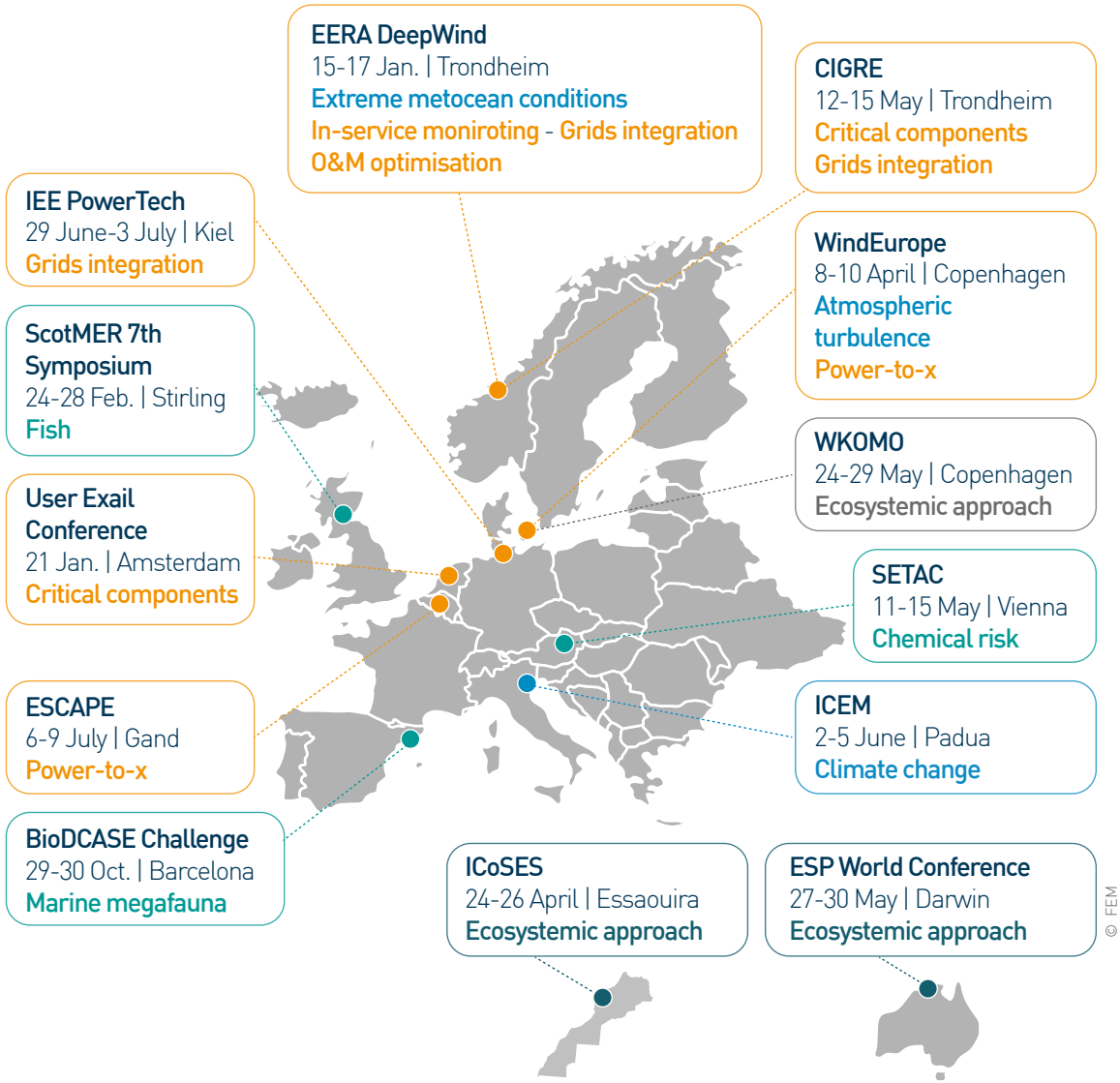


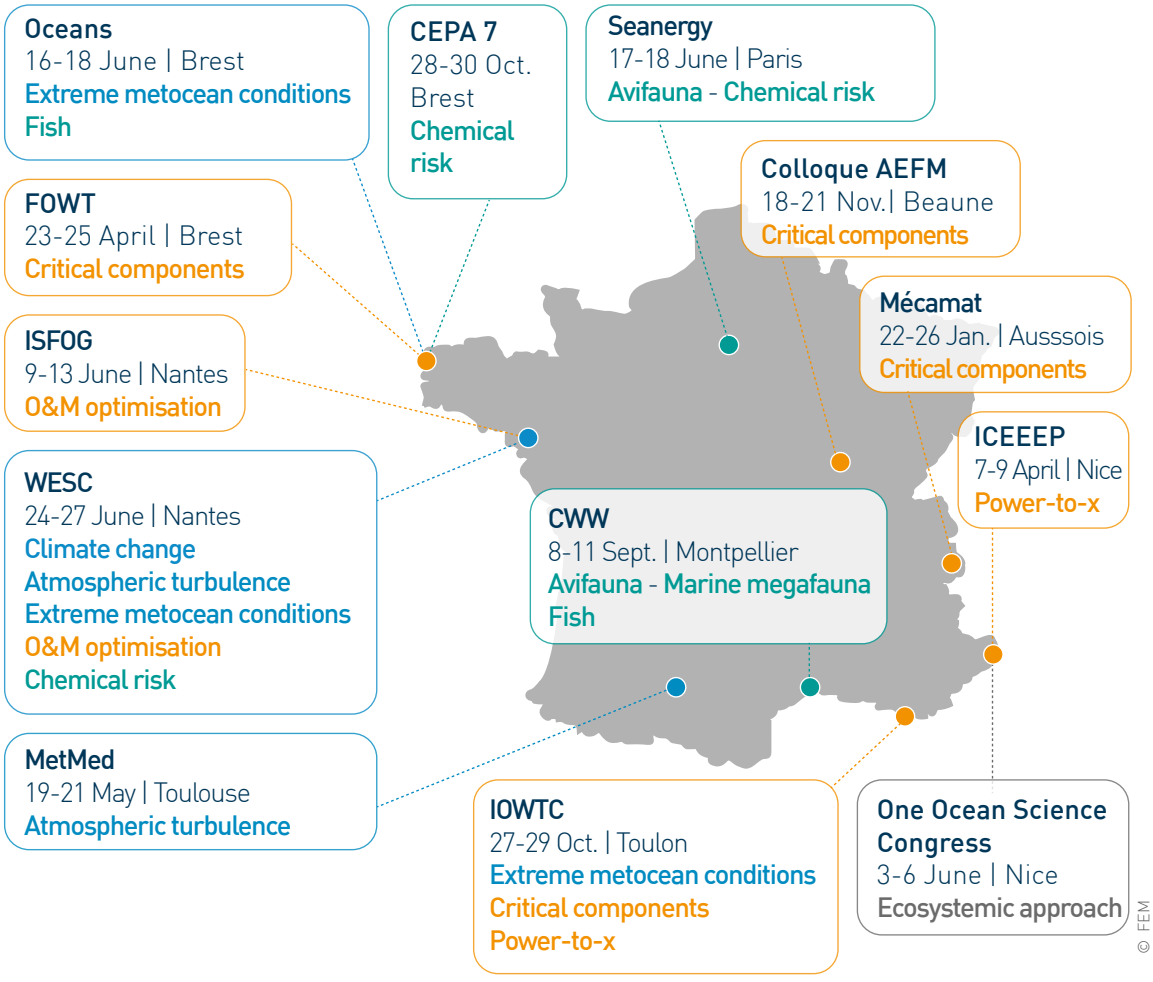
RDC - The Research & Development Committee brings together all the Institute's members

STC - The Science & Technology Committee composed of 8 independant international experts

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

Our participation in scientific conferences in 2025




Oceans
16-18 June | Brest
Extreme metocean conditions
Fish
CEPA 7
28-30 Oct.
Brest
Chemical risk
Seanergy
17-18 June | Paris
Avifauna - Chemical risk
Colloque AEFM
18-21 Nov.| Beaune
Critical components
FOWT
23-25 April | Brest
Critical components
Mécamat
22-26 Jan. | Ausssois
Critical components
ISFOG
9-13 June | Nantes
O&M optimisation
ICEEEP
7-9 April | Nice
Power-to-x
WESC
24-27 June | Nantes
Climate change
Atmospheric turbulence
Extreme metocean conditions
O&M optimisation
Chemical risk
CWW
8-11 Sept. | Montpellier
Avifauna - Marine megafauna
Fish
MetMed
19-21 May | Toulouse
Atmospheric turbulence
IOWTC
27-29 Oct. | Toulon
Extreme metocean conditions
Critical components
Power-to-x
One Ocean Science Congress
3-6 June | Nice
Ecosystemic approach
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6.1 | WIND AND OCEAN DYNAMICS

By combining observation and modelling, France Energies Marines accurately characterises the main offshore physical parameters: wind, waves and currents. Through these approaches, we can reduce uncertainties regarding generation and design calculations at an early stage. The Institute's work takes into account the effects of climate change, the increasing density of wind farms and the increasing size of wind turbines. Based on this fine-grained data, developers can draw up realistic business plans, securing the profitability of their wind farm projects.

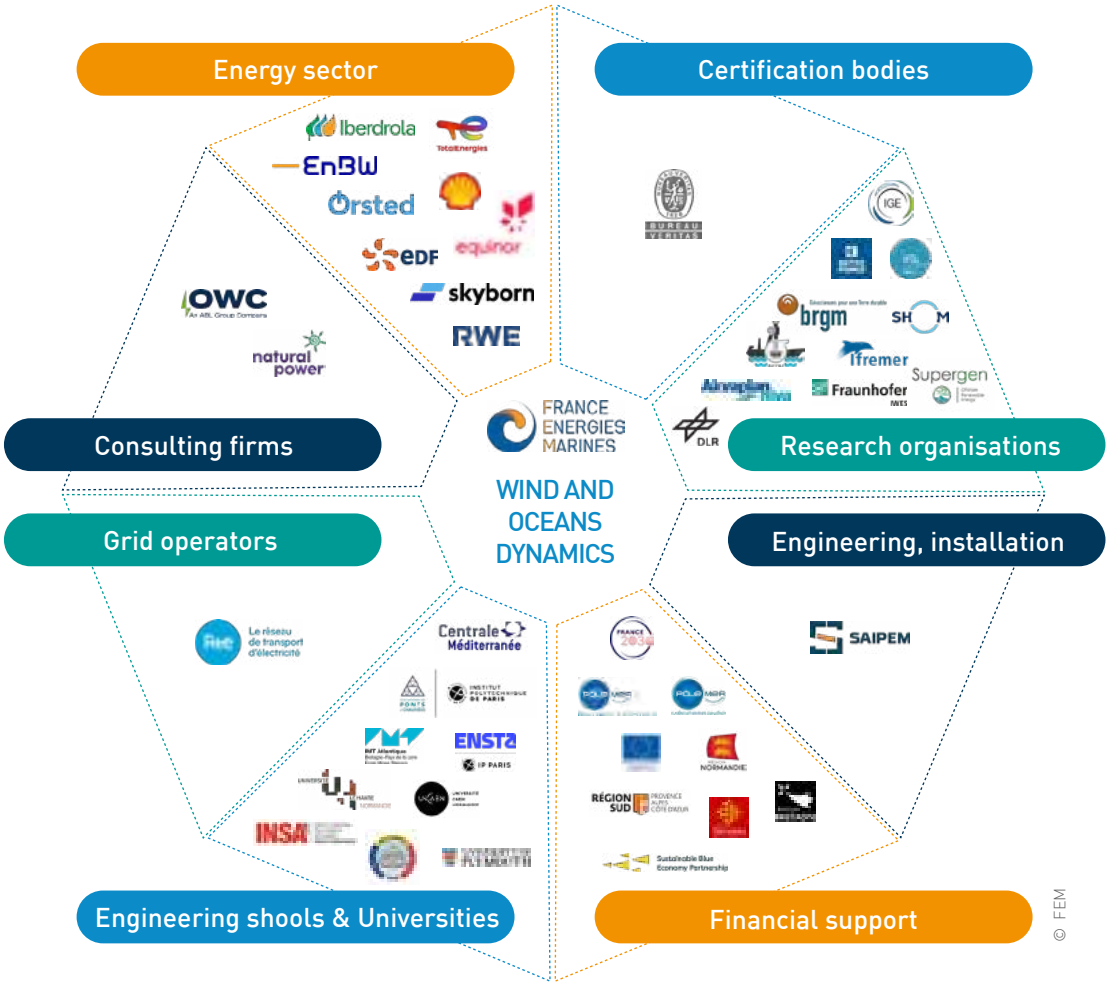
Topics currently studied

- Climate change
- Far wakes
- Atmospheric turbulence
- Extreme weather conditions
- Hydro-sedimentary processes

Scientific papers published

- Filipot J.-F., *et al.* (2025) Estimation of Extreme Wind and Wave Statistics Under Tropical Cyclones for the Design of Offshore Wind Turbines. *Proceedings of the Oceans 2025 Conference*, 5 p.
- Gilletta A., *et al.* (2025) Assessment of hybrid RANS/LES models for the prediction of the flow and scour around a wall-mounted cylinder. *Advances in Water Resources*, Vol. 199, 104934
- Hulin F., *et al.* (2025) Breaking onset and breaking strength of focused wave packets: Linear prediction model and nonlinear numerical simulations. *Ocean Engineering*, Vol. 197, 104660
- Michelet N., *et al.* (2025) Numerical estimation of ORE export cables burial depth in a marine dune environment; the Dunkirk offshore wind farm study case. *Proceedings of 5th International Symposium on Frontiers in Offshore Geotechnics*, 8 p.
- Prata A., *et al.* (2025) Evaluation of ERA5, COSMO-REA6 and CERRA in simulating wind speed along the French coastline for wind energy applications. *Advances in Science and Research*, Vol. 22, pp. 69–85
- Thiébaut M., et al. (2025) Evaluating the enhanced sampling rate for turbulence measurement with a wind lidar profiler. *Wind Energy Science*, Vol. 10, pp. 1869–1885

Our network of members and partners



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↘ Climate change

2C NOW

Climate change impact on offshore wind

Duration: 1.5 years (2023-2025) | **Total budget:** €725K

Objectives:

› To provide French offshore wind sector stakeholders with different appropriate indicators to assess the expected evolution over the next few decades of wind resources, associated production and design conditions.
› To assess uncertainties of current approaches and reduce the risk of conservatism, leading to reduced costs for renewable energies and better business plans for developers.

Achievements throughout the project:

› Development of a calculation methodology for wave, wind and water level statistics based on climate model forecasts.
› Determination of mean and extreme statistics for waves, wind and water levels at representative geographical points along the French coasts, and for various IPCC scenarios.
› Statistical description of impacts on wind energy potential along the French coasts and on wind turbine structure design.
› Development of a methodology to predict sand accumulation at power cable landing zones.

2C MORE

Climate change impacts on offshore wind energy

Duration: 3 years (2025-2028) | **Total budget:** €2,400K

Objective:

› To assess the impacts of climate change on the offshore wind sector, focusing on the evolution of wind energy potential and design criteria, with an evaluation of associated uncertainties.

2025 achievements:

› Project kick-off on 23 September 2025.
› Downloading of atmospheric climate datasets.

In the spotlight

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Laurent Dubus

Scientific manager of the 2C NOW and 2C MORE projects, meteorology and climate researcher with RTE

"In terms of results, the 2C NOW project has revealed a slight potential decrease in electricity generation by wind farms off the French coast. There is, however, considerable uncertainty over this downward trend, mainly due to the outputs of climate projection models. Some models show an increase, while others point to a decrease. On average, the projected result is a slight decline, but there is considerable uncertainty over these projected trends. Furthermore, the potential drops in electricity generation are much greater in scenarios with high greenhouse gas emissions, and are more moderate in low-emission scenarios.
A gap in the datasets available for conducting this type of study has also been identified, particularly in relation to sea states. Indeed, there are no entirely satisfactory projections covering the entire 21st century for waves and how they might evolve in the future, particularly in terms of extreme waves. Yet this is very important for structure design."

Watch the video

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DIVE

Digital twin for innovation in oceanic visualization and exploration

Duration: 3 years (2025-2028) | **Total budget:** €1,050K

Objectives:

› To facilitate integration, visualisation and scenario prediction based on data from ocean biophysical observations, digital simulations and remote sensing.
› To support decision-making for the management of sensitive marine communities and ecosystems in the face of climate change.
› To improve the accuracy of the decision systems tools for offshore wind farm operation.
› To develop tools for advanced space-based remote sensing observations.

France Energies Marines' contribution to the project:

› Development of a module designed to improve the forecasting of wind cells by combining data from rain radars with satellite measurements using synthetic aperture radar (SAR).

2025 achievements:

› Project kick-off on 8 September 2025.
› Beginning of specification development for the three functions that will make up the digital twin: a "what if" explorer, a "causal" explorer and an "ocean visualiser".

↘ Far wakes

FARWAKES

Models and tools for inter-farm wake characterisation and estimation of energy production losses

Duration: 2 years (2025-2027) | **Total budget:** €840K

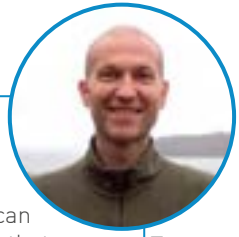
Objectives:

› To study the reliability of tools for modelling far wakes.
› To provide recommendations for assessing the effects of the widespread roll-out of offshore wind in Europe on wind resources and associated energy yields.

2025 achievements:

› Project kick-off on 19 February 2025.
› Literature review of existing tools.
› Initial work to compare two approaches to modelling wakes in the North Sea region: the use of engineering models (open-source PyWake suite) and the application of two mesoscale models (Meso-NH and WRF).
› Beginning of assessment work on atmospheric stability indicators to study the effects of this parameter on the wind farm wake effect.

In the spotlight



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Jean Dubranna
R&D engineer and offshore wind project manager at France Energies Marines

"Given France's ambitions regarding the roll-out of offshore wind energy, we can expect to see larger, more densely packed wind farms in the future. So much so that a farm is likely to disturb the wind flow for another farm located downwind: this is known as the inter-farm wake effect. This phenomenon is being studied under the FARWAKES project. There are many tools available for the numerical simulation of inter-farm wakes. Some are very accurate, but are also computationally intensive and require technical expertise. Others are much simpler to use, but their results are less accurate. The initial focus will be on identifying the areas of use and validity of these different tools so that they can be used appropriately.
We will then examine the atmospheric conditions that influence the development of the wake of a wind farm. We know, for example, that under certain fairly common atmospheric conditions, the wake of a wind farm can extend over 50 or even 100 km.
Finally, we will apply this knowledge to quantify the effects of inter-farm wakes on the electricity generation of offshore wind turbines, in realistic deployment scenarios, particularly looking ahead to 2050."

Watch the pitch

↘ Atmospheric turbulence

DRACCAR-NEMO

New methods for turbulence measurements and models in offshore wind

Duration: 2.5 years (2023-2026) | **Total budget:** €1,400K

Objective:

› To provide methodologies and tools for a comprehensive assessment of turbulence at prospective offshore wind sites.

2025 achievements:

› Detailed comparison between the variance method and the traditional method for reconstructing turbulence intensity from data co-located with a sonic anemometer on the Fécamp met mast: significant improvement in turbulence estimations, particularly for the longitudinal component, and enhanced robustness with regard to atmospheric stability.
› Multifractal analysis of offshore wind turbulence based on universal multifractals.
› Characterisation of wind intermittency and multi-scale variability, assessment of the sensitivity of conventional turbulence indicators to temporal resolution, and analysis of the influence of instrumental biases introduced by the lidars, particularly intra- and inter-beam effects.
› Exploration of the role of the land–sea transition, topography and the atmospheric stability regime in the organisation of turbulence.
› Improvement in the representation of turbulence in mesoscale models through the development of a new estimation of turbulence kinetic energy that takes better account of organised structures in the atmospheric boundary layer.
› Development of an innovative methodology for reconstructing offshore wind conditions using a data-driven approach comb ining coastal data, numerical weather prediction model outputs and observations from an offshore lidar.

In the spotlight

Characterising turbulence for wind turbine optimisation

Sites with a strong potential for the development of floating wind projects can pose major challenges in terms of the detailed characterisation of wind resources and atmospheric turbulence. Atmospheric turbulence refers to rapid changes in the speed and direction of air particles, which generate vortex structures that exert significant loads on structures and affect wind turbine wakes. Offshore measurements are required to validate the numerical models used to assess wind and associated turbulence at sea. How can these measurements be taken offshore? This is the question addressed by the POWSEIDOM R&D project which preceded DRACCAR-NEMO. The final webinar presenting the main results was attended by 74 participants from 13 different countries.

Watch the webinar

↘ Extreme weather

OROWSHI

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

Duration: 3 years (2022-2025) | **Total budget:** €1,700K

Objective:

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

Achievements throughout the project:

› Compilation of a dataset on wind and wave observation during cyclones.
› Comparison of different wave propagation models for wave prediction in cyclonic conditions.
› Development of a tool for estimating extreme winds, based on the method recommended by the International Electrotechnical Commission (IEC) and published by T. Ishihara and A. Yamaguchi in 2015, to test different statistical laws so as to identify the best match with the site data.
› Parameterisation of surface wind fields with parameters learned from satellite-measured wind fields.
› Parameterisation of the vertical extrapolation of surface winds at hub height.
› Validation of the OpenFOAM code to qualify the effect of the coast on winds in offshore wind farms exposed to cyclones.
› Definition of a methodology for estimating joint wave and wind statistics under cyclonic conditions.
› Development of a methodology for estimating wave and wind statistics for sites exposed to cyclonic conditions, taking into account the influence of extratropical cyclones.
› Development of the TAIFU-WindWaves© software, which incorporates all the methodologies developed through the project, to facilitate effective transfer to industry.

In the spotlight

Wind turbine design and tropical cyclones

In areas prone to cyclones, it is crucial to accurately determine extreme wind and wave values in order to design turbines capable of withstanding these metocean conditions. While wind estimations appear reliable, the standard recommendation regarding extreme wave statistics is not, as it is based on a method generally used for wind farms located at mid-latitudes. Such uncertainty over extreme waves could result in wind turbines being either oversized or undersized. The final webinar was attended by 52 participants from 9 different countries.

Watch the webinar

DIMPACT+

Design of offshore wind turbines and impact of extreme and breaking waves

Duration: 3 years (2024-2027) | **Total budget:** €2,900K

Objectives:

› To consolidate the definition of the design sea state and the methods for improved integration of slamming forces established during the DIMPACT project, then implemented in offshore wind turbine coupled models and in recommended practices by DNV.
› To test the DIMPACT method in shallow water with a constant bottom slope and develop numerical codes to simulate non-linear waves that will be used as input data for coupled models of offshore wind turbines.

2025 achievements:

› Initial prototype tests in the partners' different flume tanks.
› Continuation of numerical simulations of waves, in order to identify new phenomena and progress beyond the state of the art in the field of extreme hydrodynamic loads.
› Full instrumentation of the Fécamp met mast, resulting in the acquisition of the first *in situ* data.
› Creation of a Python library integrating the DIMPACT method.
› Coordination, by France Energies Marines, of the tasks devoted to integrating the loads induced by breaking waves on floating offshore wind turbines in numerical models, as part of IEA Wind Task 56.
› Official referencing of the DIMPACT method in the DNV-RP-C205 recommendation.

In the spotlight

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Neil Luxcey
Wind and Ocean Dynamics R&D department manager at France Energies Marines

"DIMPACT+ aims to develop a methodology to calculate the slamming forces of breaking waves. It must be accurate enough to prevent an overly conservative design. It must be simple enough to be implemented in existing engineering tools, such as OpenFast, for example. The key idea is to take the simplified waves presented in these tools (linear waves), identify whether they are breaking waves, determine the shape of the realistic (non-linear) wave, and calculate the corresponding slamming force.

To develop this methodology, the R&D tasks under the DIMPACT+ project include numerical studies using CFD tools, as well as experiments in wave flumes. The methodology will be applied to real measurements collected using our met mast off the coast of Fécamp, which we have equipped with stereo-video cameras, pressure sensors and accelerometers as part of the DRACCAR programme.

The methodology will be implemented in the engineering tools. The concluding elements of the methodology will also be documented in design standards, codes and recommendations."

Watch the pitch

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↘ Hydro-sedimentary processes

DRACCAR-COBHYS

Hydrosedimentary processes around an offshore mast

Duration: 5 years (2023-2028) | **Total budget:** €5,100K

Objective:

› To understand seabed dynamics around a wind turbine foundation.

2025 achievements:

› Deployment of instrumented seafloor stations revealing hydrodynamic contrasts associated with the presence of the mast.
› Installation of a reference station for waves located outside the direct influence of the mast.

6.2 | SYSTEMS AND PERFORMANCE

France Energies Marines develops robust solutions to optimise the performance of offshore wind turbines. Through our work, we strive to improve the design and reliability of wind farms throughout their operational life. To this end, model representativeness can be enhanced by applying an in-service monitoring approach combining digital twins with *in-situ* sensors. It is also crucial to characterise the behaviour of critical components to assess their performance levels. At farm level, optimising operations and maintenance is also a key driver towards achieving the best compromise between cost and availability. The other key focus is on grid integration for which we study solutions such as floating substations (HVAC/HVDC) and power-to-X.

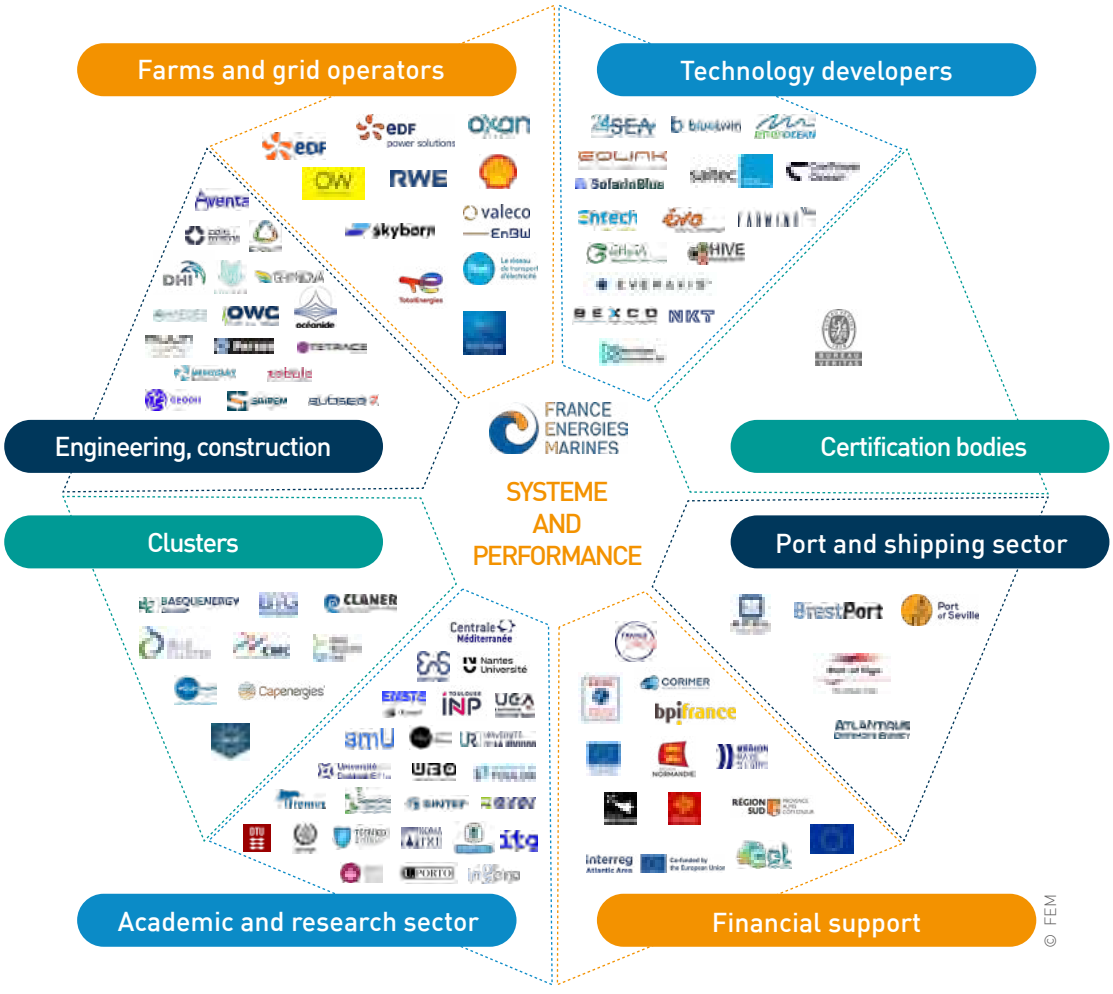
Topics currently studied

- Digital twins and in-service monitoring
- Behaviour and performance of critical components
- Optimisation of operation and maintenance phases
- Grids integration and power-to-X

Scientific papers published

- Bles G., *et al.* (2025) Transversely isotropic hyperelastoplastic constitutive model for large deformation analysis and simulation of fiber yarns and stranded ropes. *International Journal of Solids and Structures*, Vol. 321, 113532
- Cherrouk M., *et al.* (2025) Integrating offshore wind energy into the optimal deployment of a hydrogen supply chain: a case study in Occitanie. *Systems & Control Transactions*, Vol. 4, pp. 856-862
- Grangeat R., *et al.* (2025) Plastic optical fiber sensors for mooring lines monitoring in floating wind turbines: A reliability study of OTDR measurement. *Applied Ocean Research*, Vol. 158, 104541
- Hirvoas A., *et al.* (2025) *In situ* condition monitoring of floating offshore wind turbines using kurtosis and deep-learning-based approaches. *Wind Energy Science*, Vol. 10, pp. 2099–2115
- Lovera A., *et al.* (2025) Analysis of loads applied on floating wind turbines shared anchors. *Ocean Engineering*, Vol. 324, 120627

Our network of members and partners



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↘ Digital twins and in-service monitoring

I3FLOAT

Integrating an interregional value chain to consolidate European leadership in floating wind development

Duration: 3 years (2025-2028) | **Total budget:** €11,000K

Objective:

› To develop a southern interregional value chain to consolidate European leadership in floating wind and accelerate innovation time-to-market.

France Energies Marines' contribution to the project:

Implementation and validation of the digital twin solution developed by the Institute on the DemoSATH platform, in particular:

› Qualifying the accuracy of numerical simulations by comparing them with field measurements.
› Improving the understanding of Single Point Mooring (SPM) behaviour under complex environmental loads.
› Calibrating the aero-servo-hydro-elastic models using *in-situ* sensor data.
› Developing and validating the behavioural and health state forecasting model.

2025 achievements:

› Project launch on 8 October 2025 and initiation of scheduled initiatives.

↘ Behaviour and performance of critical components

HT-20MW

Electrical connection hub and application for a 20 MW wind turbine

Duration: 4 years (2023-2027) | **Total budget:** €6,200K

Objective:

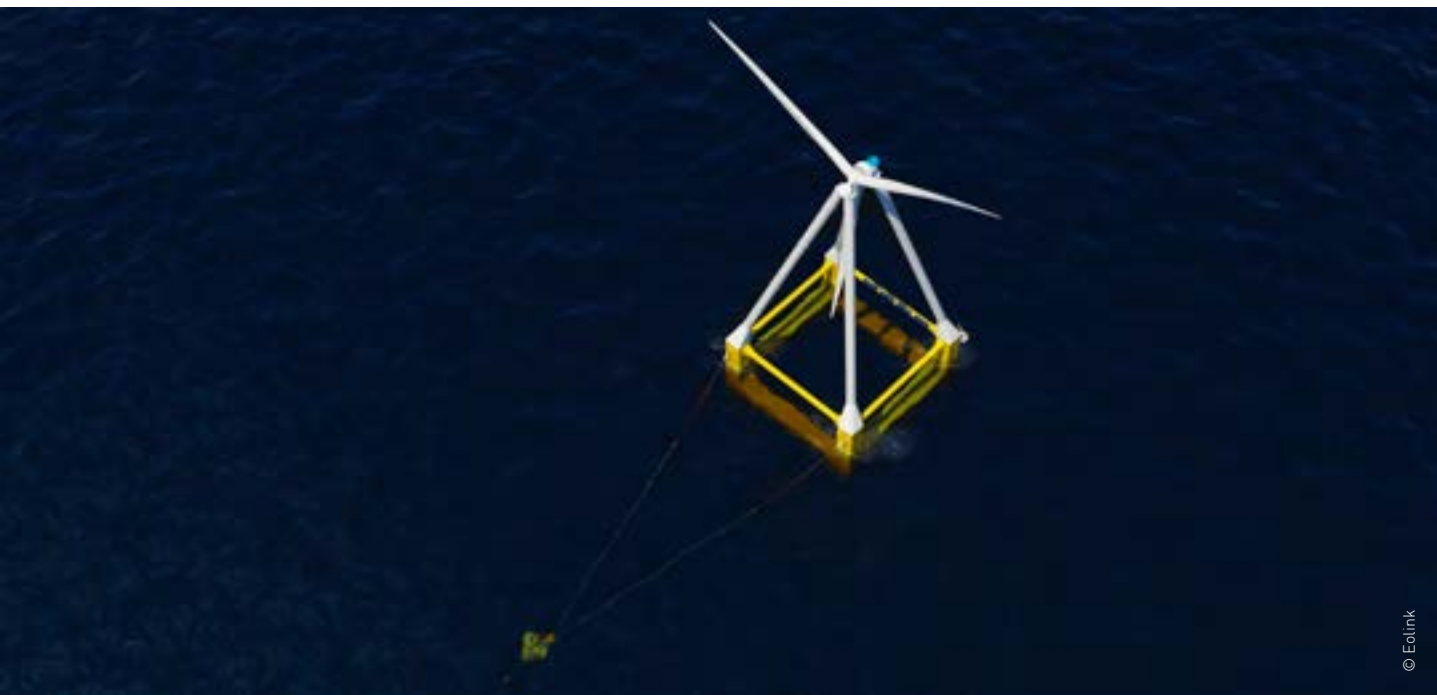
› To design, test and certify a high-voltage rotating mechanical and electrical connection that is watertight and maintenance-free for 10 years.

France Energies Marines' contribution to the project:

› Implementation of trials at sea for the in-service monitoring of dynamic power cables.

2025 achievements:

› Finalisation of post-processing and analysis of the results obtained for the in-service monitoring solutions deployed during trials at sea, involving monitoring of the deformation of the dynamic cable in time and space, the local radius of curvature, and load peaks.



BAMOS

Behaviour and ageing of synthetic rope mooring lines

Duration: 4 years (2023-2027) | **Total budget:** €2,200K

Objective:

› To improve the modelling of short- and long-term behaviour of nylon ropes and expand knowledge of fatigue and degradation mechanisms.

2025 achievements:

› Validation, through numerical simulations, of the relevance of a new identification method based on long-term creep tests.
› Continuation of work to improve the rheological model (also referred to as the POLYAMOOR law) by integrating this method.
› Definition of experimental protocols and implementation of multi-relaxation and cyclic testing campaigns.
› Implementation of the first tests to characterise worn ropes from the dismantling of the MONABIOP moorings demonstrator.
› Definition of study cases for mooring line behaviour simulations.

In the spotlight

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"My Thesis in 180 Seconds" by Juliette Laurent

How can we gain better insight into the short- and long-term behaviour of synthetic fibre ropes used for floating mooring systems? This question lies at the heart of Juliette Laurent's PhD thesis, which focuses on the work she is conducting as part of the BAMOS research project. Indeed, synthetic ropes offer a promising solution, as they are lightweight and have a reduced footprint on the seabed, however their behaviour remains complex.

ESOMOOR

Enhancing shared mooring system design for floating offshore wind farms

Duration: 3 years (2023-2027) | **Total budget:** €2,200K

Objective:

› To significantly advance the mooring technologies for large-scale floating offshore wind farms

France Energies Marines' contribution to the project:

› Joint supervision of PhD research conducted at ENSTA on the behaviour, testing and modelling of synthetic fibres (polyamide and polyester).

2025 achievements for the work conducted by the Institute**:**

› Comparison of the POLYAMOOR and SYROPE laws.
› Development and implementation of the POLYAMOOR law in MooDyn, the module dedicated to moorings in the OpenFAST software tool.

BIODHYL

Biofouling characterisation and description of hydrodynamic loadings

Duration: 3.5 years (2022-2026) | **Total budget:** €1,900K

Objectives:

› To gain a better understanding of biofouling, the characteristics of the organisms present, its evolution over time and the environmental parameters that influence it.
› To identify the most reliable and robust techniques and protocols to accurately characterise biofouling in an automated manner in order to model its effects.

2025 achievements:

› Development of a methodology to combine taxonomic approaches based on morphological and molecular criteria in order to improve the identification of biofouling communities.
› Sampling at various locations along the Atlantic and Mediterranean coasts of France, followed by taxonomic analysis.
› Characterisation of variables – measured *in situ* and resulting from modelling – that could affect biofouling; identification of the most appropriate timescale for each of these variables; definition of a method to correlate these variables with the samples collected.
› Definition of specifications for qualifying observation equipment that could be used to measure variables influencing biofouling. Analysis of the initial samples collected, taxonomic classification based on morphological criteria, analysis of *in situ* variables and physical characteristics will continue until the end of the project.

DRACCAR-COBHYS

Study and monitoring of benthos and biofouling around a wind turbine foundation

Duration: 5 years (2023-2028) | **Total budget:** €5,100K

Objective:

› To assess the role of an underwater structure in the creation of the reef effect.

2025 achievements:

› Completion of two full biological sampling campaigns and significant progress in data processing.
› Launch of the study into biofouling dynamics.

In the spotlight

Recap of BIODHYL advances in a newsletter

As this project is being carried out across various sites and using different experimental systems, a newsletter is sent out each year summarising the operations conducted at sea and the progress of sample analysis.

See the April 2025 newsletter

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↘ Optimisation of operation and maintenance phases

MUTANC2

Shared anchors and mooring lines for floating offshore wind farms

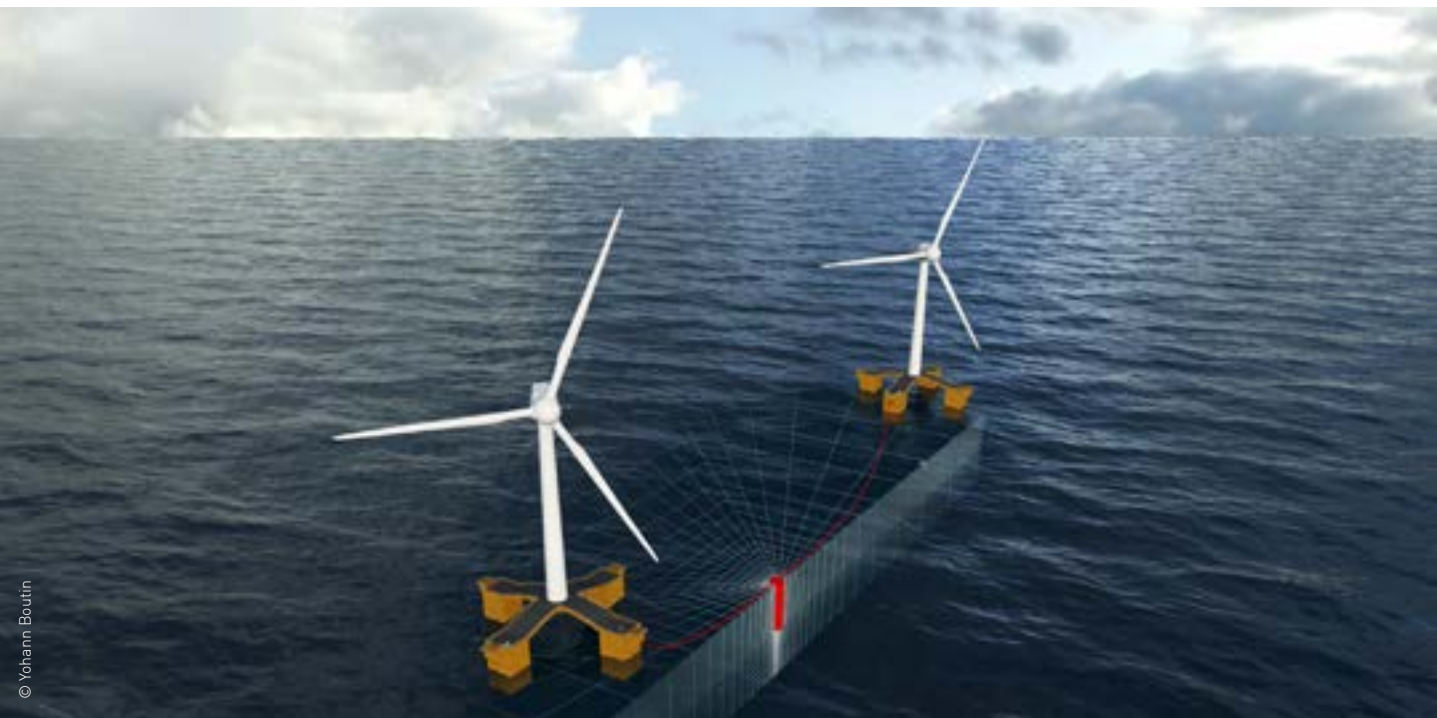
Duration: 3 years (2025-2028) | **Total budget:** €2,000K

Objectives:

› To provide an engineering methodology and design tools for industry practice, based on a thorough understanding of pile behaviour in sand under horizontal cyclic and multidirectional loading.
› To explore the use of shared mooring line systems to ensure their integrity and prevent the potential impact of failure on production.
› To improve the cost model developed in the MUTANC project with installation and maintenance specificities impacting the cost and the operational availability.

2025 achievements:

› Project launch on 20 October 2025 and initiation of scheduled initiatives.



STORM

Strategies and Tool for Offshore Reliability and Maintenance

Duration: 2 years (2024-2026) | **Total budget:** €1,350K

Objective:

› To develop an integrated tool for quantifying and optimising the availability and maintenance costs of floating offshore wind farms in relation to a given architecture and geographical location.

2025 achievements:

› Design of the tool's structure, development of a reliability database, and benchmarking of existing wind farm maintenance management tools.
› Development of a methodology for calculating mean downtime, taking into account inspection, supply, access and repair times.
› Development of numerical hydrodynamic simulation models to study the accessibility of offshore systems.
› Beginning of work to define the final study cases and indicators that will be the tool's outputs and on which the optimisation work will focus.

In the spotlight

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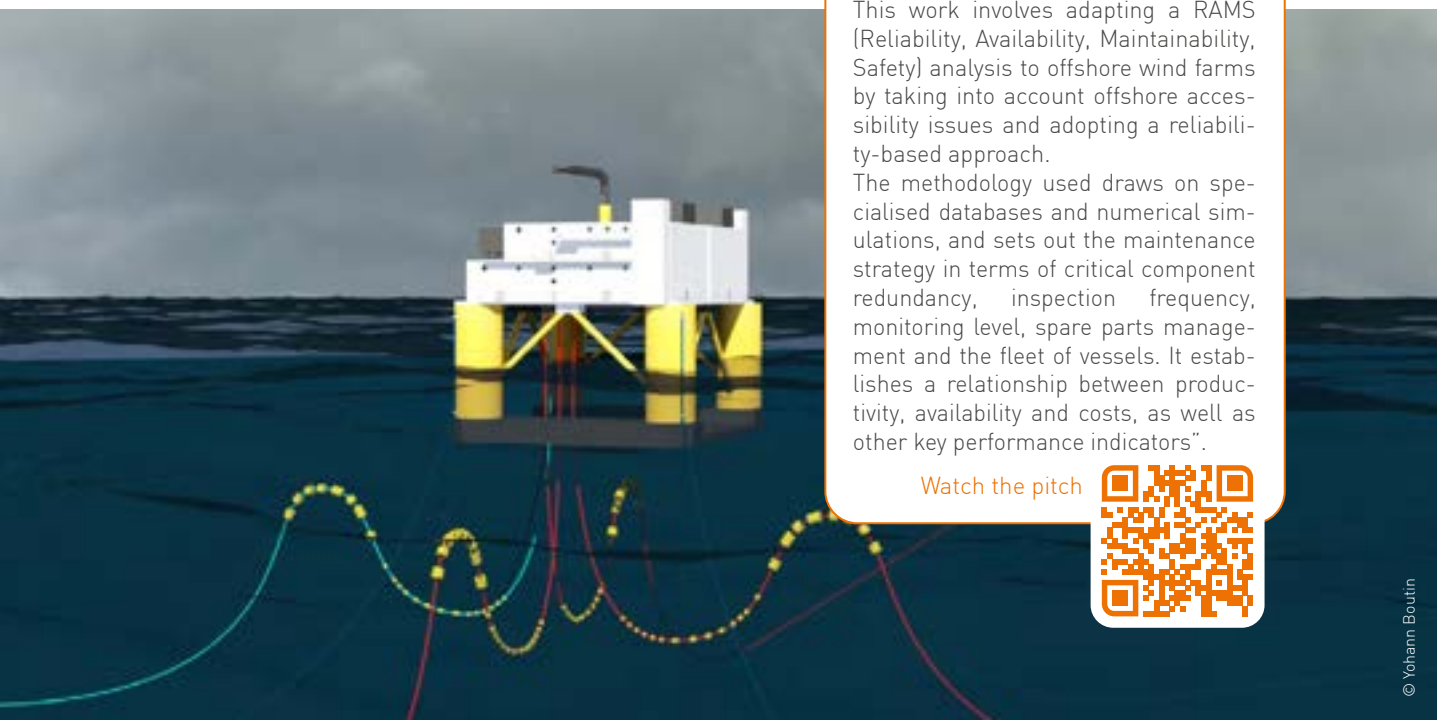
Laure Cossalter
offshore wind project manager at France Energies Marines

"Offshore wind farms are exposed to harsher environmental conditions than their onshore counterparts, which results in repercussions in terms of their failure rate and availability. In these environments, maintenance and operational activities are also more complex, as accessibility and operability are heavily dependent on the weather conditions. To accurately calculate the share of costs associated with the operation and maintenance of a wind farm and its production, accessibility must be factored into reliability calculations and the overall maintenance strategy must be taken into account in maintainability calculations.
The STORM project aims to develop a decision support system for defining the optimal maintenance strategy. This work involves adapting a RAMS (Reliability, Availability, Maintainability, Safety) analysis to offshore wind farms by taking into account offshore accessibility issues and adopting a reliability-based approach.
The methodology used draws on specialised databases and numerical simulations, and sets out the maintenance strategy in terms of critical component redundancy, inspection frequency, monitoring level, spare parts management and the fleet of vessels. It establishes a relationship between productivity, availability and costs, as well as other key performance indicators".

Watch the pitch



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↘ Grids integration and power-to-X

AFOSS-DC

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

Duration: 3 years (2022-2025) | **Total budget:** €1,500K

Objective:

› To study the high-voltage direct current floating offshore substation as an integrated system through analyses of functional requirements, integration constraints, risk and reliability.

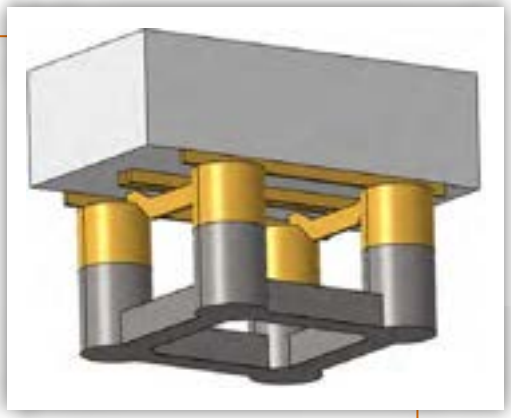
Achievements throughout the project:

› Definition of case studies in France and Europe.
› Determination of the electrical architecture and topside layout.
› Modelling of two floating platform technologies: a semi-submersible platform and a tension-leg platform (TLP).
› Implementation of wave tank tests on a 1:50 scale model of the substation on a TLP substructure to validate the hydrodynamic behaviour and quantify the non-linear resonance effects that could occur with this type of technology.
› Simulation of dynamic inter-array and export cable configurations.
› Implementation of a RAMS study based on the developed inspection and maintenance scenarios; definition of tests on non-linear absorbers for sensitive electrical components.

In the spotlight

Designing the electrical substations of the future

With future offshore wind farms being located increasingly further from the coast, and given the inherent energy losses with this type of facility, high voltage direct current (HVDC) is a competitive alternative. The design of floating electrical substations operating with HVDC raises a number of issues that call for further R&D. The AFOSS-DC project has provided some initial insights which were shared during the project's final webinar attended by 65 participants from 11 different countries.



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Watch the webinar

OPTILE

Multi-criteria optimisation for offgrid marine renewable electrical production

Duration: 3 years (2022-2025) | **Total budget:** €1,500K

Objective:

› To put forward an operational solution to design, simulate and optimise isolated electricity grids powered by different offshore renewable energy sources.

Achievements throughout the project:

› Compilation of an exhaustive catalogue of offshore renewable energy technologies and storage systems.
› Development of a spatiotemporal database calibrated on different application cases.
› Development of a simulation code for physical and energy interactions and a multi-objective stochastic optimisation methodology.
› Study of three practical application cases to validate the transferability and robustness of the methodology and tool developed: Réunion Island, an aquaculture farm and an offshore platform.

In the spotlight

PhD defence on the optimisation of an isolated grid

© Haje Ebnou

On 21 November 2025, Haje Ebnou successfully defended her PhD thesis on a methodology for the optimal design of an isolated microgrid powered by offshore renewable energy sources, while accounting for uncertainties in electricity demand and production. She carried out her research at the Nantes Atlantique Electrical Energy Research Institute, IREENA, in Saint-Nazaire, as part of the OPTILE project, under the supervision of Salvy Bourguet (Nantes University), with co-supervision by Anne Blavette (ENS Rennes) and Florian Dupriez-Robin (France Energies Marines).

Watch the PhD defence

© Yohann Boutin

OPHARM2

Advanced analysis for offshore production of hydrogen from offshore wind

Duration: 3 years (2023-2026) | **Total budget:** €2,500K

Objective:

› To address a series of complementary aspects of renewable hydrogen production from offshore wind farms to support its progress towards operational deployment, including the integration in energy networks, technological aspects and environmental impacts.

2025 achievements:

› Definition of case studies in the Fos-Marseille harbour basin.
› Definition and implementation of performance tests on a PEM (proton exchange membrane) electrolyser exposed to the movements of a floating structure, simulated with a hexapod simulator.
› Numerical simulations of the impact of plumes of production water discharged following offshore electrolysis in the Channel and the Mediterranean.
› Ecotoxicological experiments on model species to study the impact of these pressures on the entire food web.

HYDEA

Boosting the hydrogen transition in the Atlantic Area ports

Duration: 3 years (2023-2026) | **Total budget:** €3,400K

Objective:

› To assess, develop and promote the use of technologies based on green hydrogen from renewable energies in Atlantic Area ports.

2025 achievements:

› Identification of potential barriers to the use of hydrogen in ports along France's Atlantic coast and listing of possible solutions to overcome these barriers.
› Definition of the scope of the case studies and initial work to provide details on these cases
› Publication of recommendations for developing hydrogen action plans in ports
› Organisation of a webinar on the development of a roadmap for hydrogen transport, storage and commercial applications in ports
› Organisation of two calls for applicants to provide technology developers with access to the experimental facilities and expertise of the project partners.

In the spotlight

© ITG

Interview with Victoria León

scientific lead for the HYDEA project

Victoria León is a chemical engineer and holds an Msc in Renewable Energy, Fuel Cells and Hydrogen Production. She is a researcher with the ITG Technology Center and is a firm believer in integrating gender equality into European projects and beyond. In this interview, she reflects on her professional experience and explains how it contributes to the HYDEA project in relation to both practical and technical aspects.

Watch the interview

© Port of Seville

6.3 | WILDLIFE & INTERACTIONS

France Energies Marines studies the potential impacts of offshore wind energy on the marine environment, focusing on key ecosystem compartments: birds and bats, marine mammals, fish and benthos. The scientific protocols and tools developed help to improve impact assessment and enable us to put forward solutions to anticipate, prevent and mitigate these impacts. The Institute supports farm developers, government departments and other stakeholders in the sector by providing recommendations aimed at raising the standards of environmental impact assessments and setting up monitoring programmes focusing on the most sensitive or least known impacts.

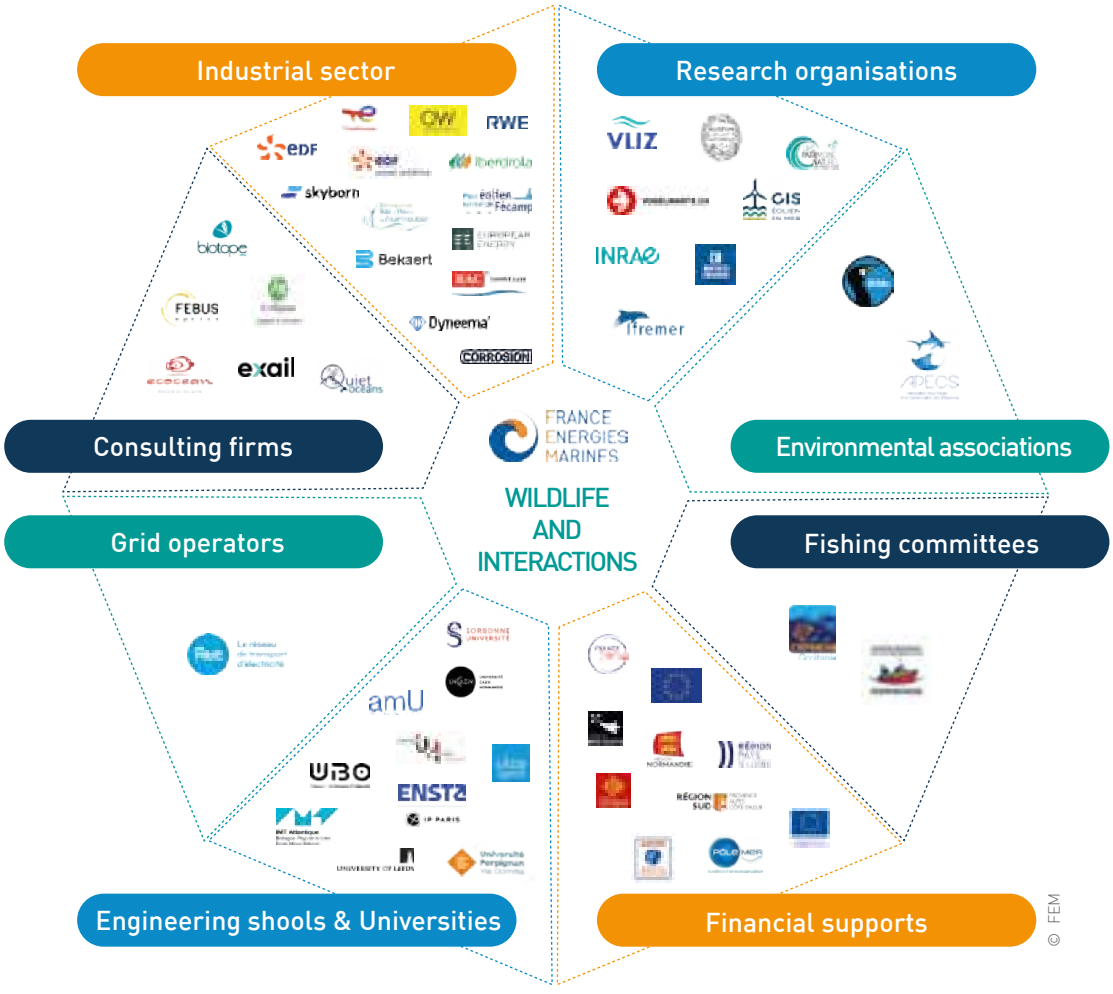
Topics currently studied

- Monitoring marine megafauna
- Monitoring seabirds
- Monitoring fish and crustaceans
- Chemical risk assessment

Scientific papers published

- Couturier L., *et al.* (2025) Investigating Interactions Between Fish and Offshore Wind Farms Using Acoustic Telemetry. *OCEANS 2025 Proceedings*, pp 1-7
- Hall A.E., *et al.*, (2025) A collaborative approach to marine species tracking: Insights from the Fish Intel Acoustic Telemetry Network. *Ecological Solutions and Evidence*, Vol. 6, e70148
- Michelet N., *et al.* (2025) Numerical modelling of dissolved aluminium dispersion from floating wind farm cathodic protection in the gulf of lion. *Ocean Dynamics*, Vol. 75, 83
- Roy A., *et al.*, (2025) Enhanced forecasting of bird nocturnal migration intensity in relation to previous days and synoptic weather patterns. *International Journal of Biometeorology*, Vol. 69, pp. 1617–1630

Our network of members and partners



↘ Monitoring marine megafauna

DRACCAR-MMERMAID

Monitoring marine megafauna through an integrated approach towards an observatory network

Duration: 4 years (2023-2027) | **Total budget:** €6,400K

Objective:

› To provide an integrative framework of advanced monitoring methods for efficient and relevant environmental impact assessments, using cutting-edge technologies and methodological developments.

2025 achievements:

› Deployment of a broadband hydrophone near the Fécamp met mast and recording of two sets of data.
› GPS tagging of 10 new seagulls in Le Havre, bringing the total number of tagged birds to 20.
› Organisation of two new participatory annotation campaigns for images and videos recorded by the devices installed on the mast.
› Development of shared data processing pipelines.
› Training of automatic detection algorithms for marine megafauna using annotated data.
› Continued development of local and regional ecosystem models to study the cumulative impacts of human activities and climate change on the environment.
› Organisation of a workshop to jointly develop a roadmap for the establishment of offshore observatories.

In the spotlight

A Blue Challenge nominee

The DRACCAR-MMERMAID project has been nominated for the Blue Challenge 2026 award, organised by the maritime cluster Pôle Mer Bretagne Atlantique. Every year, this maritime innovation competition rewards a particularly innovative blue economy initiative. It showcases projects that offer strategic solutions for the future of the maritime sector. A video (English subtitles available) was produced to present the project and can be accessed by flashing the QR code.

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Watch the project presentation video

© FEM

I MOTUS station installed on the Fécamp met mast and used to track radio-tagged migratory birds and bats

↘ Monitoring avifauna

SEMAFOR

Observation and prediction of bird migration from weather radars

Duration: 3 years (2022-2025) | **Total budget:** €840K

Objective:

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

2025 achievements:

› Improvement in the calibration of the real-time detection algorithm for migratory flows at night.
› Finalisation of the spatial interpolation tools developed for 3D migration mapping across the whole of mainland France and its coasts.
› Development of various models for forecasting migration flows and assessment of their performance compared to state-of-the-art models.
› Development and implementation of an initial web interface, hosted by Météo-France, to visualise and forecast these flows.

AVOCET

Migratory avifauna and offshore wind farms: improving the assessment of collision risks using observations from weather radars

Duration: 3 years (2025-2028) | **Total budget:** €1,900K

Objectives:

› To map migratory bird flows by developing innovative and transferable methods, using the European weather radar network.
› To assess the feasibility of extrapolating these bird flows to marine areas and estimate the associated uncertainties.
› To enhance the robustness of CRMs for offshore wind farms by integrating site-specific flight parameters and quantifying the propagation of uncertainties.

2025 achievements:

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

I Avocets in flight

↘ Monitoring fish and crustaceans

FISHOWF+

Investigating interactions between fish and offshore wind farms

Duration: 3 years (2024-2027) | **Total budget:** €4,050K

Objectives:

› To characterise the interactions between fish and offshore wind farms and their export cables at multiple spatial scales through an *in situ* monitoring approach based on acoustic telemetry.
› To promote and facilitate the integration of acoustic telemetry into national marine environment monitoring strategies.
› To integrate France's monitoring efforts and results into European collaborations to assess the effects of offshore wind farm development on fish movements in the North-East Atlantic.

2025 achievements:

› Obtainment of all the administrative authorisations required to launch operations to deploy the receivers and tag individuals.
› Deployment of acoustic telemetry receivers at two new offshore wind farms off the coast of Fos-sur-Mer (Provence Grand Large) and Dieppe (Dieppe-Le Tréport), bringing the total number of wind farms monitored to six.
› Tagging of 178 new individuals in the Channel, Atlantic and Mediterranean, including 111 as part of the fisheries resource monitoring campaign (CGFS) led by Ifremer.

| Deploying acoustic telemetry receivers at the Provence Grand Large offshore wind farm

In the spotlight

Pan-European monitoring

While FISHOWF+ focuses its efforts along the French coasts, it also falls within a broader initiative, associated with the European Tracking Network, for the continent-wide tracking of certain species to gain a better understanding of their ecological connectivity. Within this context, the FISHOWF+ team contributes to the NorTrack project, which aim to monitor the movements of aquatic species critical to the Northeast Atlantic, and to the DTOTrack project, which aims to create a digital twin of the North Sea to support decision-making.

↘ Chemical risk assessment

PEARL

Chemical risks associated with elements released by offshore wind farm components

Duration: 3 years (2025-2028) | **Total budget:** €2,200K

Objectives:

› To enhance the assessment of environmental risks associated with emissions of chemical elements from offshore wind farms.

› To provide a more precise definition of environmental pressures associated with galvanic anode cathodic protection (GACP) and impressed current cathodic protection (ICCP), along with an initial characterisation of pressures associated with synthetic mooring lines.

2025 achievements:

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

I Biofouling of a galvanic anode

6.4 | ECOSYSTEM AND SOCIETY

It is crucial to be able to anticipate the direct and indirect environmental and socio-economic effects of offshore wind farms in order to ensure their smooth integration into the environment. For this, France Energies Marines develops predictive models for the structure and functioning of marine ecosystems in which different human activities co-exist. Based on this so-called socio-ecosystem approach, we can describe how human activities at sea – including shipping traffic, commercial fisheries, the extraction of raw materials, as well as the development of offshore wind energy – could affect the overall functioning of a socio-ecosystem. The tools developed are used to simulate various offshore wind farm siting scenarios, in order to predict cumulative impacts and support decision-making.

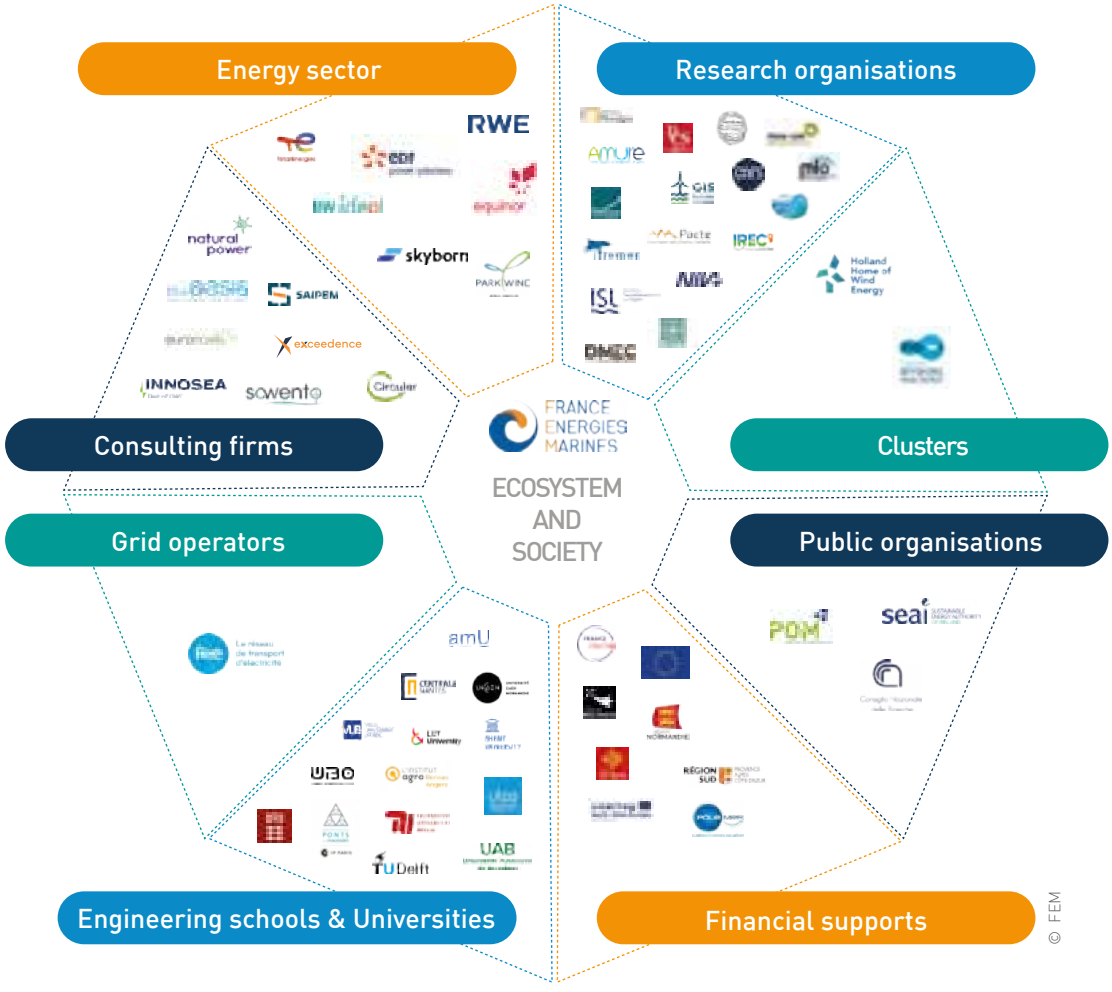
Topics currently studied

- Ecosystem approach
- Socio-economic impacts
- Sustainability and transfer to the sector

Scientific papers published

- Huang Y., *et al.* (2025) An ecosystem modelling approach to assess potential impacts of offshore wind farms. *ICES Journal of Marine Science*, Vol. 82, fsaf153
- Le Marchand M., *et al.* (2025) Towards an ecosystem approach to a simulated floating wind farm combined with climate change in the Bay of Biscay (France). *Regional Studies in Marine Science*, Vol. 87, 104218

Our network of members and partners



↘ Ecosystem approach

NESTORE

Nested modelling approach to offshore renewable energy development and cumulative impact assessment considering local to regional environmental and socio-economic issues

Duration: 3 years (2022-2025) | **Total budget:** €3,350K

Objective:

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

2025 achievements:

› Development of a nested modelling approach to support offshore wind farm development.
› Study and calibration of three regional socio-ecosystem models: Eastern Channel - North Sea, Southern Brittany and Gulf of Lion.
› Assessment of cumulative impacts, taking into account environmental and socio-economic issues, from a local to a regional scale.
› Simulation of scenarios comprising multiple pressures (offshore wind, commercial fisheries, shipping, climate change).
› Correlation of modelling work with local governance of maritime activities, through French strategic coastal planning documents.
› Analysis of structural uncertainty in ecosystem models.
› Mapping of ecosystem services, providing a cross-cutting view of environmental and socio-economic issues.

FLOATFARM

Advancing floating offshore wind to the next level of technological readiness to develop the next generation of environmentally-friendly floating wind farms

Duration: 3 years (2024-2027) | **Total budget:** €3,000K

Objectives:

› To significantly advance the maturity of floating offshore wind technology by achieving important cost reductions at all levels within the design and implementation phases.
› To contribute to decreasing the negative environmental impacts on marine life and to enhancing the public acceptability of floating offshore wind farms.

2025 achievements for the work conducted by France Energies Marines**:**

› Mapping of the acoustic impacts of co-existing offshore activities, with a particular focus on future floating wind farms.
› Launch of a literature review on the impact of noise levels on animal species, particularly marine mammals.

I Saint-Nazaire offshore wind farm

↘ Socio-economic impacts

EOLENMER

Monitoring the development of the first offshore wind farms and analysis of environmental and socio-economic issues

Duration: 4 years (2023-2027) | **Total budget:** €4,500K

Objective:

› To understand how offshore wind farms interact with the marine environment and local communities.

2025 achievements:

› Completion of 51 semi-structured interviews with tourism service providers at three sites (Saint-Nazaire, Saint-Brieuc and Leucate).
› Development of an analysis framework for recreational boaters' perceptions and representations of wind farms using an artificial intelligence tool.
› Creation of a database of around 27,000 online news articles, spanning 70 years of media coverage of the impacts of offshore wind in France.

FISHOREMAN

Towards an improvement in the representation of fisheries in the ecosystem approach through social, economic and cultural dynamics

Duration: 3 years (2024-2027) | **Total budget:** €1,400K

Objectives:

› To enhance our understanding of fishing fleets by analysing the cultural and socio-economic drivers influencing their activity and quantifying their vulnerability to offshore wind farms.
› To build a flexible fleet dynamic modelling tool to simulate cumulative impacts associated with offshore wind farms under multiple co-constructed scenarios with a better representation of the fishing fleets.

2025 achievements:

› Development of a methodology for the selection of a representative panel of fishing fleets in the Eastern Channel and the Gulf of Lion, based primarily on socio-economic and cultural criteria.

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In the spotlight

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Pierre Bourdaud
Researcher in ecosystem modelling at France Energies Marines

"The FISHOREMAN project is a collaborative research project involving various partners: academic and industrial partners, as well as fishing industry representatives. This project aims to gain a better understanding of how fishing activities will react to the deployment of offshore wind farms, so as to more accurately model the cumulative impacts on the marine environment and the social sphere."

Watch the pitch

I Fishing boat near an offshore wind farm

↘ Sustainability and transfer to the sector

ORESA

Offshore Renewable Energy Sustainability Alliance

Duration: 4 years (2025-2029) | **Total budget:** €5,600K

Objectives:

› To develop an accelerator strategy to help innovators address the growing demand for sustainability in their roll-out.
› To pilot the sustainability accelerator for 25 SMEs, to improve their competitive innovation capacity.
› To leverage ORESA's expertise in 30 capacity-building activities (training, staff exchange programmes, videos) to reach relevant stakeholders and engage the future work force in offshore sustainability.

2025 achievements:

› Preparation of the first versions of the different training courses for the ORESA accelerator.
› Provision, by France Energies Marines, of expert content on wind farm life-cycle assessment, circularity, nature-inclusive design, and European offshore wind development policies.
› Launch of the first Innovation Call for Dutch SMEs for training.

COMPASS

Comprehensive Offshore Management Platform for Assessing Sustainability

Duration: 4 years (2025-2029) | **Total budget:** €5,000K

Objective:

› To develop a decision-support platform combining tools and recommendations designed to improve the sustainability of offshore wind farms.

2025 achievements:

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

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In the spotlight

First European project coordinated by the Institute!

COMPASS is a four-year European project launched on 1st November 2025 and aims to develop a decision support platform offering tools and recommendations designed to improve the sustainability of offshore wind farms. France Energies Marines is coordinating this €5 million project which brings together 14 partners from 8 countries, a first for the Institute which is already a partner in several European consortia.

Read the press release

I Distant view of the Provence Grand Large wind farm in the Gulf of Lion.


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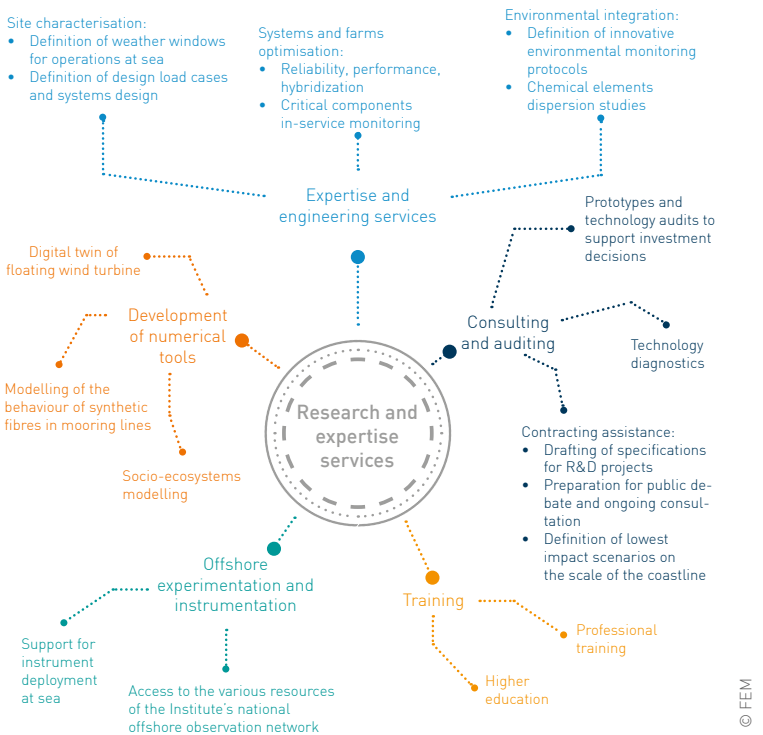
07

TRANSFER TO THE SECTOR

France Energies Marines offers a unique range of services, built on an in-depth understanding of the market and on expertise developed through its R&D work. These services are underpinned by a firm commitment towards scientific excellence and innovation in the development of tried-and-tested software, standards and methodologies apart to help the offshore wind sector tackle environmental, societal, economic and technological challenges. France Energies Marines boosts the sector's competitiveness, enhances regional attractiveness and supports the work of regional and national authorities.

The services offered by the Institute cover five areas: consulting and auditing, expertise and engineering services, development of digital tools, training, experimentation at sea and instrumentation. Through this organisation, the Institute is able to provide solutions tailored to each stage of a wind farm project. Through varied collaboration methods and the upscaling of its tender bidding expertise, the Institute meets the diverse sector-wide stakeholder needs.



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7.1 FARM DEVELOPERS AND OPERATORS

France Energies Marines supports offshore wind farm developers and operators at every stage in their project's lifecycle. The Institute provides project management assistance, acting as a technical interface on specialised issues, whether for drafting specifications, providing scientific support to prepare public debates and ongoing consultation, or offering support for maritime planning at the scale of the coastline.

Design phase

From the conceptual design stage onwards, France Energies Marines helps to reduce technical uncertainties and optimise key design choices. The TwinDAR© tool developed by the Institute is capable of **calculating refined turbulence values** from lidar measurements and generating realistic aerodynamic load scenarios. By improving the characterisation of wind conditions, TwinDAR© helps to design optimally sized turbines, towers and transition parts, thereby reducing CAPEX. Furthermore, France Energies Marines is a prime ally for the **characterisation of breaking and impact waves**, thanks to the development of methods for rationally defining the sea states to be considered for designing floating wind turbines.

The Institute also offers **cumulative impact assessments** at each phase in the development of an offshore wind farm, from tender proposals right through to decommissioning. This service is designed to quantitatively meet the regulatory requirement for the calculation of cumulative impacts based on socio-ecosystem modelling.

The Institute supports developers and their consultancy firms in defining the methodology for calculating cumulative impacts when preparing tender applications. France Energies Marines then uses trophic models specific to the area of interest, taking into account the impacts of the farm, climate change or any other anthropogenic activity, to define ecosystem indicators. Our teams also carry out specific evaluations, for instance an environmental impact assessment of water discharge from offshore hydrogen production.

The Institute contributes to consultation processes through **science communication initiatives** aimed at the general public and local stakeholders. These actions, based on quantitative and scientific data, are intended to enhance public perceptions of the projects. France Energies Marines also supports project developers in identifying the specific challenges associated with a wind farm by monitoring public perception trends. This analysis is based on the automated processing of online press articles, using a tool specially developed by France Energies Marines.

Engineering phase

During the project engineering phase, the Institute carries out **synthetic mooring line studies** based on the POLYAMOOR law. This law defines the visco-elasto-plastic behaviour of materials in order to accurately determine their response under real conditions and is used to characterise the short- and long-term behaviour of synthetic mooring lines.

At France Energies Marines, we conduct **feasibility studies and technical and economic comparisons** between different floating foundation solutions, in particular semi-submersible foundations and tension-leg platforms, taking into account site-specific conditions and installation and maintenance constraints. The Institute also develops technical and economic optimisation strategies based on the floating wind farm architecture by incorporating shared mooring solutions. This approach reduces installation costs while improving the overall efficiency of the system.

Construction phase

From the construction phase onwards, France Energies Marines offers the **definition of site-specific, innovative environmental monitoring protocols**. The Institute supports the application of "Avoid, Reduce, Compensate" measures and assesses their effectiveness using advanced modelling tools, particularly trophic models. Through this quantitative approach, the environmental performance of the measures implemented can be demonstrated and compliance with regulatory commitments is ensured.

Operational phase

During the operational phase, the Institute carries out studies on **hydrodynamic conditions and the dispersion of chemical elements** such as metals released by corrosion protection systems. In parallel, France Energies Marines deploys instrumented devices designed to study biofouling. The data collected is used to refine engineering parameters, improve the consideration of the additional weight, and more accurately plan maintenance throughout systems' service life.

Additionally, the Institute is involved in the **in-service monitoring of critical components**, such as turbines, foundations and dynamic cables, and in the development of digital twins to predict failures, optimise maintenance strategies and extend the service life of systems.

Completed in 2025

Data management support for the DemoSATH demonstrator developed by Saitec Offshore Technologies


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DemoSATH is a 2 MW floating wind turbine demonstrator deployed at the BIMEP test site in the Bay of Biscay. Saitec Offshore Technologies tasked France Energies Marines with providing data management support during the operational phase. Given the large volume and high complexity of the data collected at sea, the Institute brought its expertise to the project to help organise and promote structured, reliable information. The work involved assimilating and organising the datasets obtained during the operation of the demonstrator, implementing quality control procedures to guarantee data integrity and consistency, and making the processed data and analyses available to external stakeholders. France Energies Marines also contributed to the early detection of anomalies and potential malfunctions in data flows, thereby contributing to the reliable operational monitoring and optimised performance of the demonstrator.


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7.2 | CONSULTANCY FIRMS

France Energies Marines supports consultancy firms in developing tender bids that will set them apart, both in France and internationally. The Institute offers various approaches: joint bids, studies for developers or French Government departments via co-contracting or subcontracting, and strategic partnerships. Through these collaborative options, a comprehensive proposal can be developed covering all the identified areas.

The Institute offers its services as an outsourcing provider to metocean and environmental consultancy firms. France Energies Marines brings added value, particularly for initial and baseline assessments, by mobilising its scientific skills, through literature reviews and critical deliverables reviews, as well as in-depth methodological expertise, guaranteeing robust analyses tailored to the sector's requirements.

Baseline assessment and environmental monitoring

France Energies Marines offers **innovative environmental monitoring protocols** tailored to the specific characteristics of each project and the scientific issue at stake, covering all ecosystem components. These protocols may relate to biofouling, ecotoxicology or other site-specific environmental issues.

France Energies Marines also offers **support in the modelling of the dynamic baseline**, in relation to the calculation of cumulative effects. The Institute assists consultancy firms with the assessments required as part of environmental impact studies, using trophic ecosystem modelling. This approach produces differentiating, robust scientific analyses that meet regulatory requirements. In addition, France Energies Marines offers training on cumulative impact modelling tools, designed to meet the specific needs of project teams. These initiatives are intended to boost their autonomy and enhance the quality of deliverables produced as part of tenders.

Drawing on three years of analysed acoustic data and images collected from the Fécamp met mast, France Energies Marines supports consultancy firms in the implementation of automated models for processing *in situ* data as part of **environmental wind farm monitoring**. These tools optimise the volume of data to be processed, improve reliability and ensure better detection of marine mammals and birds.

The Institute also offers turnkey solutions for **measuring the effectiveness of "avoid, reduce, compensate" measures**, by defining a monitoring protocol, training an *ad-hoc* algorithm, integrating data to monitor the effectiveness of measures, and calculating cumulative effects. During engineering studies, our services include cumulative effect calculations for environmental impact assessments, as well as system design optimisation with regard to biofouling.

Dispersion of chemical elements

France Energies Marines supports consultancy firms for the **analysis of the dispersion of chemical-based pollutants** such as anti-corrosion coatings, discharges from hydrogen production, microplastics and lubricants. This assistance complies with the European REACH regulation and involves providing an inventory of substances released into the environment, assessing exposure and hazard levels, and characterising risks.

The Institute also offers solutions for **system optimisation** (reliability, output, hybridisation), operation and maintenance, and real-time monitoring of critical components. Finally, France Energies Marines works on innovative mooring technologies and the in-service monitoring of dynamic cables for floating wind turbines.

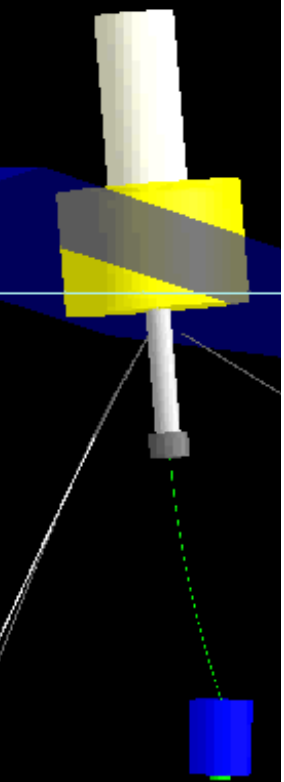
Completed in 2025

Reviewing a wave energy system demonstrator project

As part of its work in French Polynesia with Ys Energies Marines Developpement, Meteolien commissioned France Energies Marines to carry out a critical review of the investigations and preliminary studies conducted for a wave energy system demonstrator. This task involved conducting an in-depth analysis of all deliverables produced by the contractors, including wave resource modelling, ADCP and *in situ* measurement campaign reports, geotechnical investigations, as well as bathymetric, topographical and environmental studies. The purpose of this review was to identify any methodological inconsistencies, limitations or inaccuracies, to assess the residual risks for the project's development, and to make recommendations for further investigations to ensure the reliability of subsequent phases. France Energies Marines also examined the preliminary design developed by Meteolien on the basis of these studies and issued several technical and methodological recommendations aimed at consolidating the project's feasibility demonstration.

7.3 | TECHNOLOGY DEVELOPERS

France Energies Marines supports technology developers in fast-tracking the technology readiness of their solutions. The services offered by the Institute aim to secure each project stage in terms of technological maturity and to enhance performance reliability, from tank tests through to sea trials.



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During the development phases

In the intermediate stages of development (TRL 5 to 7), France Energies Marines supports project developers in defining a study framework tailored to the degree of maturity of their project. The Institute provides technical support in **drafting proposals in response to calls for projects and grant applications**, particularly to Bpifrance, ADEME or under Horizon Europe, and then assists in conducting studies after funding has been obtained.

The Institute also offers **specialised test methodologies** geared towards pinpointed technological bottlenecks. For dynamic cables, this includes defining thermomechanical laboratory protocols, developing behaviour monitoring methods, and setting up tests to validate sensor solutions, including in representative marine environments. For synthetic mooring lines, France Energies Marines develops fatigue testing methodologies for predicting service life, multi-relaxation tests to characterise short-term visco-elastoplastic behaviour, as well as long-term creep and relaxation tests.

During the demonstration phases

During at-sea demonstration phases (TRL 7 to 9), **France Energies Marines provides its offshore infrastructures**, in particular its met mast and multi-instrumented buoys, to test, develop and validate technology demonstrators in real conditions. The support provided covers the definition of needs, project management, functional qualification, deployment and maintenance, as well as data acquisition, post-processing and analysis. Building on its expertise and tools, the Institute supports technology developers in equipping their systems with smart sensors for real-time monitoring, defining relevant performance indicators and integrating data into digital twins.

For new market entrants

The Institute also offers R&D support to help achieve a technological readiness level of 6 or higher, drawing on the infrastructures of its partner network.

Finally, France Energies Marines offers **sector integration training courses** designed to offer a deeper understanding of the technical, environmental and societal challenges of offshore wind power for companies entering the offshore wind market.

Completed in 2025

Drone testing at Fécamp met mast

France Energies Marines provided support to Aentec Altitude for the testing of its drone solution around the Fécamp mast, a unique facility for validating offshore technologies, including drones, ROVs, strain and vibration sensors, and data collection devices. The images recorded were used to create an enhanced virtual tour, including detailed photos, technical documents, 360° panoramas and interactive points of interest. This immersive interface offers users an overview of the mast's condition and preparations for work and contributes to technical information sharing and knowledge capitalisation.

The Fécamp met mast offers a unique environment for testing new technologies without the constraints of an operational farm. France Energies Marines draws on its multidisciplinary expertise in engineering, the environment and offshore operations to support companies at every stage in their projects.

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7.4 | GOVERNMENT DEPARTMENTS

France Energies Marines offers French Government departments an integrated range of scientific expertise and decision support systems geared towards planning, environmental assessment and project acceptability.

Identification of regional challenges

Using a tool developed by France Energies Marines, the Institute supports French Government departments in **identifying and understanding local issues** associated with an offshore wind project, so as to pre-empt potential barriers by monitoring trends in the public perception of offshore wind farms. This tool is designed to collect, analyse and visualise a large volume of data from the local, regional and national press, powered by artificial intelligence and natural language processing (NLP) techniques. This raw information can then be converted into actionable indicators. The tool monitors spatial and temporal trends in perceptions, highlighting changes in public discourse and local opinions at different stages in the project development. It provides spatial analyses, time-series graphs and matrices of relationships between stakeholders and key themes, enabling the identification of socio-environmental issues and potential obstacles. This tool is therefore designed to help French Government departments to foresee the risks of opposition, prepare stakeholders consultations, and foster strategic decision-making and offshore wind project planning.

Assessment of cumulative impacts

This tool thus serves as a decision support system to develop informed regional hydrogen production strategies, by providing objective, comparable and scientifically robust data on the economic and environmental performance of the scenarios studied.

The Institute also offers **cumulative impact assessments** by developing an initial dynamic ecosystem model to improve decision-making on aspects relating to the planning, authorisation and monitoring of offshore wind projects. This service is designed to quantitatively meet the regulatory requirement for the environmental impact studies, through socio-ecosystem modelling. The Institute supports French Government departments in defining and validating the cumulative impact calculation methodology, drawing on trophic models specific to the study area. These models incorporate the effects of the wind farm, climate change and other human activities to produce reliable indicators of the state of the ecosystem and the intensity of cumulative pressures.

Acoustic telemetry monitoring

One of France Energies Marines' strategic R&D priorities lies in assessing the environmental impacts of offshore renewable energy, with recognised expertise in passive **acoustic telemetry**. This innovative technology is used to track the movements and behaviour of marine fauna, particularly fish, using acoustic tags detected by underwater hydrophone networks.

The deployment of acoustic telemetry receivers from the baseline assess-

ment stage is essential to gain a detailed, robust understanding of the interactions between offshore wind farms and fish populations. Through this approach, we are able to fill gaps in existing protocols, accurately characterise the impacts of offshore wind farms on fish, and facilitate stakeholder consultation and project acceptability.

France Energies Marines offers support for the deployment of a telemetry network combined with tagging of individuals within a wind farm, providing additional information to that produced through existing protocols, through a specialised approach, to highlight the effects of a wind farm on ichthyofauna and crustaceans and to address the specific challenges of environmental impact assessments.

Configuration of hydrogen production

France Energies Marines supports French Government departments in the **assessment of hydrogen production configurations** combined with offshore wind using a digital tool developed in-house. This tool is designed to analyse the different technical and economic options in a given area, detailing costs for each link in the value chain, as well as key indicators such as LCOE, LCOH and life cycle assessment results.

Completed in 2025

General public activities and educational games


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France Energies Marines organised various activities for the general public as part of the "La mer, quelle énergie !" event organised by Brest Métropole from 22 to 25 April 2025. Two educational games were on offer to around 50 visitors and over 100 secondary school pupils: OUPS (Ocean Under Pressures), designed to teach participants about food webs and the ecosystem approach, and an "avoid-reduce-compensate" workshop to present the environmental and socio-economic challenges of offshore renewable energy. During this event, organised in conjunction with the FOWT international conference, members of the Institute also gave presentations at two conferences on floating wind energy.

In progress in 2025

Assessing the effects of inter-farm wakes

The increasing number and density of offshore wind farms to meet the 2050 deployment targets could result in interactions between farms. This includes a reduction in the available wind speed for a wind farm located downwind of another, a phenomenon known as the wake effect. In this context, France Energies Marines is conducting a study for the French Directorate General for Energy and Climate to assess the production losses caused by inter-farm wake effects.


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7.5 | INVESTORS, FUNDERS AND INSURERS

France Energies Marines supports investors, funders and insurers through an integrated offer combining scientific expertise, audits and decision support tools, ensuring more reliable technical and economic assessments, effective risk management and safe investment portfolios.

Tropical cyclones

The Institute has distinguished itself in particular through its **combined estimation of extreme winds and waves caused by tropical cyclones for the design of offshore structures**. If the potential impact of tropical cyclones is not properly taken into account, investors, funders and insurers may be exposed to major risks. The lack of combined wind and wave statistics and the high uncertainties in current methods can lead to under-design or, conversely, to costly over-design. These pitfalls increase the risk of failure under extreme conditions, lead to higher CAPEX and OPEX, and could jeopardise a project's bankability. For insurers and investors, under- and over-design can distort the assessment of potential maximum losses and reduce the reliability of internal models. A robust approach is therefore essential to ensure sound investment decisions, financing strategies and insurance coverage policies.

France Energies Marines supports insurance companies throughout the entire lifecycle of projects exposed to tropical cyclones. During the development phase, our experts assist insurers and investors with risk assessment using TAIFU-WindWaves©, a unique tool that uses Monte Carlo simulations to calculate combined extreme wind and wave conditions, in order to pinpoint factors liable to influence the systems' design and performance.

During the operational phase, TAIFU-WindWaves© is able to recreate the environmental conditions generated by a real cyclone, to provide input for fatigue analyses and in the case of damage investigations. This support provides insurers with a robust scientific basis to refine their internal models, enhance the reliability of their claims assessments and optimise their cyclone cover strategies.

Breaking waves

France Energies Marines has developed new tools to **improve the design of floating offshore wind turbines by better integrating loads due to wave breaking.** Precise characterisation of breaking waves is essential for correctly designing offshore foundations, as these waves generate high-amplitude slamming forces that can contribute to ultimate limit states, excite structural modes and produce significant moments at the base of the foundation. Inaccurate estimates of these loads – a common occurrence in current practices due to significant simplifications and inadequate non-linear modelling – expose investors and funders to risks of under-design or excessive costs, thereby affecting a project's bankability and economic viability. For insurers, this increases uncertainty over potential maximum losses and complicates claims assessments.

France Energies Marines therefore offers specialised support built on the

DIMPACT method, which enables the detection of breaking waves, the estimation of their severity using equivalent linear waves, and the calculation of slamming forces and structural response by combining the method with the numerical tools used for system design. This expertise provides funders and insurers with a reliable scientific basis for assessing the risks, making informed decisions and optimising foundation design.

Climate change

The Institute is developing its expertise in the **analysis of climate change impacts on wind and wave statistics, which are essential for estimating energy yield and designing offshore structures**. Investors, funders and insurers may be exposed to major risks if the potential impact of these changes is not properly taken into account: gradual changes in wind conditions at hub height, variations in waves and extreme waves, seasonal shifts, and increasing uncertainties over design conditions up to 2100, according to IPCC scenarios. These pitfalls can lead to an underestimation or overestimation of energy yields, over- or under-sized foundations, increased CAPEX and OPEX, and lower bankability. For insurers and investors, they can distort the assessment of potential maximum losses and reduce the reliability of internal climate risk exposure models. A robust approach is therefore crucial to ensure sound investment decisions, financing strategies and insurance coverage policies.

France Energies Marines therefore supports funders, investors and insurers through the 2C NOW initiative. This involves selecting the best reanalysis for the site, applying bias correction methods (such as CDF-t) to climate models, and then generating projections of future hub-height wind and wave statistics up to 2100, for different IPCC scenarios. Based on the Institute's analyses, it is possible to assess not only the sensitivity of the energy yield, but also the sensitivity of foundation design using non-stationary extreme value models.

The support provided therefore provides a solid scientific basis for predicting the impact of climate change on the performance, sustainability and resilience of offshore wind energy projects, while improving the reliability of internal models and the soundness of capital allocation decisions.

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7.6 | DATA

France Energies Marines holds data collected through over a decade of research projects in the field of offshore wind. This data is accessible via a dedicated access framework, in order to ensure its appropriate usage and the long-term sustainability of the Institute's research activities. It covers a wide range of topics and is centralised within the RESCORE platform.

Biofouling

Thanks to the biofouling data collected along the Mediterranean and Atlantic coasts near offshore wind projects, uncertainties regarding system design and maintenance operations can be mitigated thanks to a deeper understanding of local biofouling processes.

- Physical characteristics: mass in air and water, thickness, volume, density.
- Taxonomy based on physical and genetic criteria: composition of biofouling communities, percentage cover (based on physical criteria only), abundance, species richness.

Wind

Wind data measured by the met mast off Fécamp and in the Mediterranean provide a more accurate estimation of loads and finer modelling of wake effects, as well as a more accurate prediction of potential energy yield.

- 1 year hindcast of metocean variables derived from combined ocean-wave-atmosphere simulations in the Gulf of Lion.
- Wind and turbulence intensity data off Fécamp, obtained using 2D and 3D sonic anemometers and a WindCube lidar mounted on an offshore mast.
- Wind data from the WindCube lidar on Planier Island, collected continuously since 2022.

Hydrodynamics & Bathymetry

Hydrodynamic and bathymetric data on the Raz Blanchard and Dunkirk areas provide a better understanding of hydro-sedimentary processes, which is channelled into the design and maintenance of these systems.

Synthetic mooring lines

Synthetic mooring line characterisation data provide a better short- and long-term understanding of mooring lines for design studies.

- Laboratory test results: short- and long-term creep tests, multi-relaxation tests on 4T and 7T nylon ropes.

Offshore wildlife

Offshore wildlife data, collected over several years, can be used to train machine learning models. The detection of flying wildlife, marine mammals and fish, using associated algorithms, enhances our understanding of their ecology and how they use the area, particularly in the vicinity of an operational wind farm.

- Annotated data from camera traps and videos of seabirds, annotated acoustic data for dolphins and porpoises (Fécamp met mast).
- Detection of the location and movements of fish using an acoustic telemetry network (wind farms).

Chemical elements

Chemical element concentration data is useful for producing hydrodynamic models, simulating the dispersion of elements released from galvanic anode cathodic protection (GACP) and impressed current cathodic protection (ICCP) systems, taking into account different sources of pollutants, and gaining a better understanding of the effects of galvanic anodes on biodiversity.

- Measurements of metals and organohalogen compounds in the water column.
- Ecotoxicology data: effects of GACP on shrimp, fish and microalgae.
- Hydrodynamic model outputs for the Gulf of Lion, the Bay of Seine and the northern Bay of Biscay, taking into account wind farms equipped with GACP.

Climate change

Wind, wave and water level data that integrates climate change offer a more accurate estimation of loads for optimised design, as well as a more realistic assessment of wind resources in business plans.

- Climate model time series with bias correction via numerical reanalysis across all French tender areas.
- Time series of wind speeds from 1985 to 2100, for 4 climate scenarios and 13 CMIP6 models.
- Significant wave height time series from 1985 to 2014 and from 2071 to 2100, for 2 climate scenarios and 8 CMIP6 models.
- Water level time series from 1985 to 2050, for 1 climate scenario and 5 CMIP6 models.

Dynamic cables

Based on dynamic cable in-service monitoring data, cable reconstruction models can be produced to generate alerts on their operational condition.

- Measurements of variations in the physical parameters of a dynamic cable (load, 3D position, impedance, curvature) using various sensor technologies (fibre optic communication, distributed Bragg reflector, multibeam echosounder, pinger, reflectometry), in partnership with sensor suppliers.


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7.7 | TRAINING

France Energies Marines offers training tailored to a growing and diversified demand in order to prepare for the sector's increasing need for relevant skills and to meet wider demand. The Institute therefore offers bespoke training courses, delivered either online or in person, to develop key skills for professionals in the sector. As part of the second round of the CMA call for expressions of interest, France Energies Marines also plays a key role in preparing offshore wind proposals, through projects such as FORTEIM.

Our training courses are built on more than ten years of scientific and technological research. Drawing on the expertise of the Institute's four research departments, they cover all the technical, environmental and societal issues relating to offshore wind energy. This close coordination with R&D projects ensures that the training content is continually updated and directly linked to the latest scientific advances.

Our training programmes are targeted towards a wide range of stakeholders: consultancy firms, developers, industrial operators, specialised financial institutions, government departments and any organisation involved in the development, installation or operation of offshore wind farms. Two complementary formats are on offer:

- **Bespoke intra-company courses**, designed in close collaboration with organisations to meet their specific operational objectives;
- **Inter-company online masterclasses**, for fast, specialised skills development, led by the Institute's experts.

The training courses are organised around five main themes:

1. **Science outreach**
   Seeks to promote awareness among diverse audiences, particularly through educational games.
2. **Wind, wave, current and seabed characterisation**
   Aims to improve physical environment modelling and wind farm design optimisation.
3. **Optimising systems and their operation**
   Covers digitalisation, digital twins, system design and in-service monitoring, particularly for floating technologies.
4. **Innovative protocols and trophic modelling**
   Focuses on wildlife monitoring methods, AI-powered data analysis, and ecological and socio-economic impact assessment.
5. **Use of the Institute's digital tools**
   Specialised modules, with personalised support.

Involvement in national and international projects for training

France Energies Marines' involvement in AMI-CMA projects (calls for expressions of interest on skills and jobs of the future) enhances the quality of proposals and helps to widely disseminate skills that are essential to the energy transition. As part of the CINav-led **FORTEIM** project, launched in September 2024, the Institute is the scientific and educational engineering lead on the themes of offshore renewable energy and offshore wind, for both introductory and advanced levels. It also contributes to other key areas such as Earth system physics, natural resources, biodiversity and marine ecosystems.

At European level, the Institute is also stepping up its activities through its involvement in the **ORESA** project, led by the Dutch Marine Energy Centre. This programme brings together five European countries and aims to support innovators in placing sustainability issues at the centre of their projects. As part of ORESA, 25 SMEs will receive structured support, while some 30 capacity-building initiatives will be rolled out, including training, staff exchanges and audiovisual educational resources.

Through these initiatives, France Energies Marines is confirming its role as a catalyst in upskilling the sector and is actively contributing to the development of a sustainable, innovative and competitive offshore wind sector.

Completed in 2025

Contributions to the IFP School's Masters course in Offshore Wind Project Development (OWPD)

France Energies Marines contributed to the IFP School's Master's course in Offshore Wind Project Development (OWPD) on 22, 23, 24 and 27 October 2025 to provide insights into the environmental issues associated with offshore wind energy. Two of our environmental experts led sessions and interactive activities on marine ecosystems, interactions between offshore wind systems and wildlife, the pressures exerted by such projects, and mitigation strategies. The OUPS game was used to illustrate how food webs work. These sessions helped to consolidate the students' knowledge and strengthened the links between research and education.


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7.8 | GENERAL PUBLIC

France Energies Marines is actively involved in various cross-cutting activities geared towards supporting the development of offshore wind energy through research, both in France and internationally. As a scientific and technical reference organisation, the Institute offers its expertise to industry, regional authorities, public institutions and the general public.

National support for the sector's development

France Energies Marines regularly works with regional authorities and their maritime organisations, providing technical input during public or strategic consultations. Its active participation in various panels, devoted to the orientations of the sector, the development of future international standards or environmental issues, reinforces its role as a trusted third party.

Through its contribution to ongoing consultation, France Energies Marines seeks to provide access to often complex research results, thereby helping to improve understanding of the issues involved related to the development of offshore wind. It is also involved in networks dedicated to facilitating and coordinating research, development and innovation.

Support for regional authorities

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

Participation in expert committees

Working groups: EMR et biodiversité de l'UICN, Biodiversité du SER, Environnement de France Renouvelables, Comité Hydrogène maritime d'Evolen

Steering committees for scientific interest groups: Eolien en mer, Eoliennes en mer de Yeu et de Noirmoutier

Involvement in stakeholder networks

Comités Stratégiques de Filières Industries des Nouveaux Systèmes Energétiques et Industries de la Mer, Fondation Open-C, Association FIT, Campus Mondial de la Mer, Pôles Mer, Journées scientifiques du Labex ORACLE et GDR EOL-EMR, Pôles Universitaires d'Innovation Blue Box et Povence

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The COME3T initiative

France Energies Marines coordinates the COME3T initiative, whose purpose is to put environmental and societal questions to a panel of neutral and independent experts. The questions addressed are based on issues identified by the sector as well as public queries. A steering committee, comprising a broad range of public and private stakeholders, selects the scientific topics to be addressed and ensures the neutrality of the expert panels. The experts explore the issue in depth and rank the topic according to how much of a challenge it represents. All the information gathered is summarised in informative bulletins and videos.

In 2025, two bulletins were published on the topics of the life cycle assessment of offshore wind farms and turbidity. Four explanatory videos were also produced. Meanwhile, three expert committee meetings were organised to prepare the next bulletins, which are to focus on the coordination of uses within wind farms and on offshore compensation schemes.

I Covers of two of the COME3T bulletins published in 2025

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Science outreach actions and tools

France Energies Marines carries out numerous science outreach actions to share the knowledge gained from its research and innovation projects with a broad audience. These initiatives aim to raise awareness of the environmental and societal issues associated with the development of offshore wind energy. For this, the Institute offers a range of science communication and outreach resources, designed to present knowledge in a clear and educational manner. These resources include thematic bulletins, science communication videos and educational tools, in order to facilitate the understanding of scientific knowledge for different audiences: the general public, students, professionals and local stakeholders involved in or affected by offshore wind projects.

France Energies Marines is actively involved in science outreach events aimed at the general public, such as European Researchers' Night and the Fête de la Science. These events provide the opportunity to present the Institute's work, answer questions from the public and foster discussions on the challenges of the energy transition.

France Energies Marines also contributes to the development of scientific content for science outreach centres and is involved with schools.

To support these outreach activities, France Energies Marines designs original educational resources, based on input from its scientific experts. Through these tools, complex concepts can be tackled in an accessible and engaging way.

The resources developed by the Institute include:

OUPS© - Ocean Under Pressures

This educational game helps players understand how a **marine food web** works and to explore the effects of different pressures exerted on ecosystems. The players learn how a source of pressure can have direct and indirect consequences on the entire food web, illustrating the importance of a holistic, ecosystem-based approach to studying environmental impacts.

Offshore wind farm impacts: Avoid, Reduce, Compensate

This educational tool aims to explain the **Avoid, Reduce, Compensate** sequence, the core principle in the environmental assessment of projects liable to have an impact on the environment. Through an interactive approach, participants learn about the regulatory framework governing the development of offshore wind farms, as well as the measures in place to minimise their environmental and socio-economic impacts.

"Où est Fernande ?" game

This game raises participants' awareness of the importance of **scientific monitoring in the development of offshore wind farms, particularly with regard to seabirds**. It helps them understand how researchers use numerical tools to process and analyse the large volumes of data collected during these environmental monitoring programmes.

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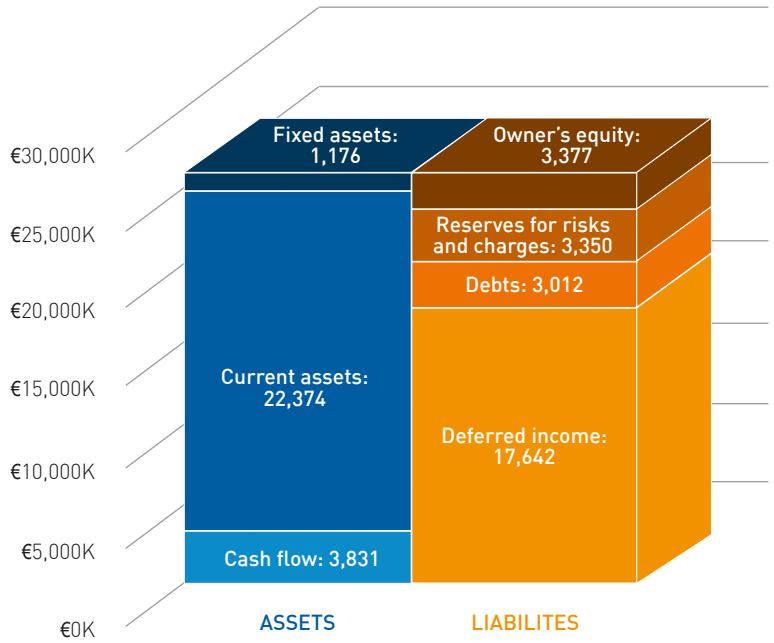
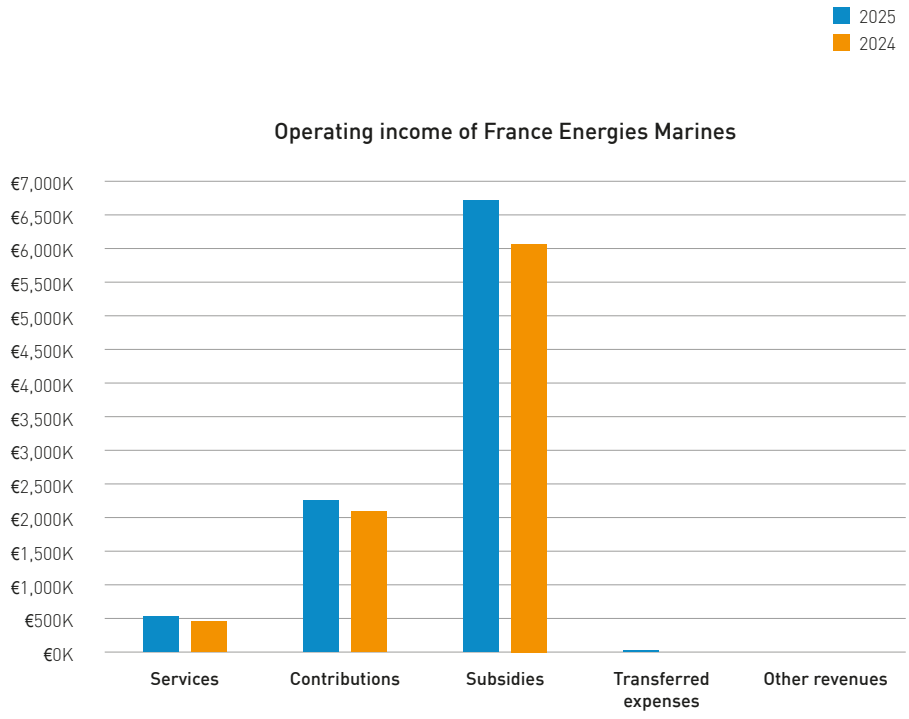
FINANCIAL SUMMARY

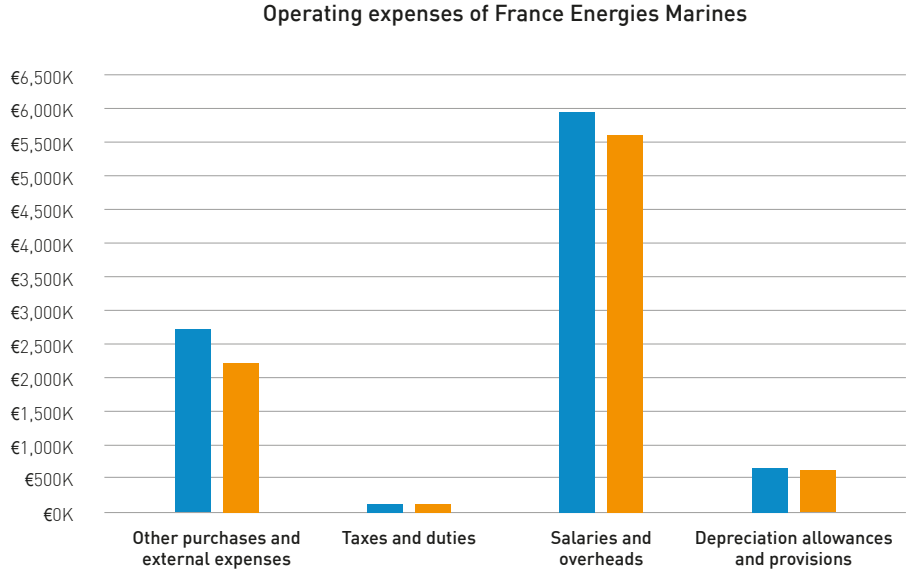
In 2025, France Energies Marines' activity was slightly higher than in 2024. Ten new research projects were launched, six of which come under the Institute's annual R&D consolidation process and represent a €9M budget. In total, France Energies Marines committed €10 M in 2025.

In 2025, despite a challenging context, the Institute managed to reach its operating break-even point and achieve a net profit of over €650 k. Operating income was €9,527K (compared to €8,666K in 2024) and operating expenses represented €9,478K (compared to €8,563K in 2024). The balance sheet total remains stable compared to 2024 and stands at €27,381K.



I France Energies Marines balance sheet for 2025





I France Energies Marines income statement for 2025 against 2024

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OUTLOOK

After several years of strong growth, the offshore wind sector is slumping across Europe and United States. This leads to reorganisation and a drop in investments in research, development and innovation projects. Despite this challenging context, France Energies Marine is holding its course by fostering its long-standing partnerships in France, while continuing to expand its reach across Europe and the rest of the world. The expertise of our team and the quality of our work are our most valuable assets in continuing to effectively and pragmatically support offshore wind stakeholders.

Setting up and carrying out R&D projects, in response to the needs expressed by the sector, are and will remain the cornerstone of the Institute's work. These projects lead to the development of software tools that can be used directly by industry and to the evolution of international standards relating to system design and wind farm in-service and environmental monitoring. In 2026, six projects will reach completion and 27 will be continued. Four to six projects are expected to be launched as part of the annual R&D consolidation process. Ten proposals have been drawn up and submitted in response to European calls, for which we are hopeful of a positive outcome.

The DRACCAR sector programme, based on the instrumentation of the met mast off Fécamp, is set to continue. Data acquisition, processing algorithm development and modelling work are currently underway. A database and software tools, transferable to the industry, will be delivered in 2027. Three further sector programmes are under preparation and are expected to come to fruition in the coming years.

The Institute's service provision is gaining increasing visibility. In the coming years, it will be crucial to strengthen relations with teams within government departments and agencies, while maintaining the close ties established with several farm developers. Training is set to gain strong momentum. Furthermore, the tools and software aspect, currently under development, will be gradually ramped up as we embark on the marketing roadmap set out in 2025.

The Institute will continue to implement actions to further extend its international reach by fostering its key partnerships, contributing to expert panels, jointly organising scientific conferences, publishing in peer-reviewed journals, and presenting its R&D work through webinars attended by participants across the world.

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