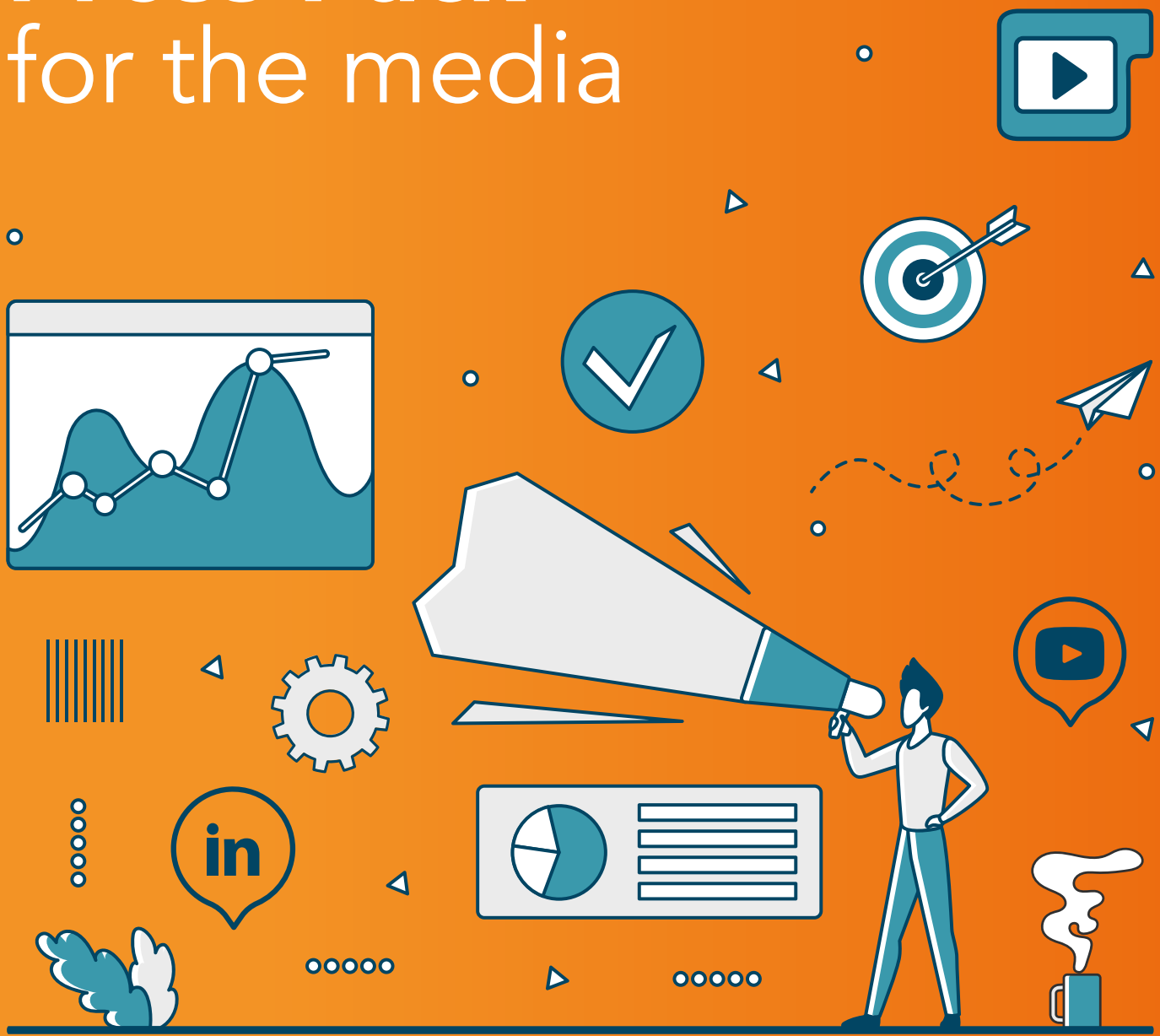
FLOATECH

THE FUTURE OF FLOATING WIND TURBINES

December 2023

Press Pack
for the media



The FLOATECH project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007142.

Foreword

Dr.-Ing. Christian Navid Nayeri
Technische Universität Berlin,
Faculty V Mechanical Engineering
and Transport Systems,
Chair of Fluid Mechanics

"The strength of the team is each individual member. The strength of each member is the team."

This principle, as articulated by the renowned basketball coach Phil Jackson, finds vivid confirmation in our FLOATECH project.

Without the expertise and dedication of each individual team member, the realization of FLOATECH would not have been possible, and the remarkable success achieved by FLOATECH would have remained beyond reach.

The core idea behind the FLOATECH project was to elevate the technical maturity and cost competitiveness of floating offshore wind (FOW) energy. This mission is of paramount importance, as the constraints on available onshore installation sites make offshore wind energy an indispensable component for the continued growth of the wind energy sector.

The FLOATECH consortium is a collective of five European research institutions, each boasting expertise in the field of offshore floating wind energy, along with four companies, two of which have played pivotal roles in the latest advancements in floating wind systems. The diverse range of scientific and technical facets tackled by our team members encompasses aerodynamics, control theory, hydrodynamics, numerical modeling, wave tank experiments, economics, maritime systems, radar technology, and much more. Amidst the intricacies of our undertaking, the team also had to contend with the challenges posed by the COVID-19 pandemic, which prevented in-person meetings during the project's first year in 2021.

FLOATECH's efforts have yielded three significant outcomes:

Firstly, we have we've succeeded in the development of two essential simulation tools. QBlade-Ocean integrates cutting-edge aerodynamics and structural capabilities with state-of-the-art hydrodynamic theory, reducing design uncertainties and enhancing turbine efficiency. Additionally, we've enhanced the open-source BEM code NEMOH, making the calculation of quadratic transfer functions accessible to the research community. These innovations are propelling wind energy technology and research forward, bringing us closer to a sustainable future.

Secondly, we've crafted two groundbreaking control techniques: Active Wave-based feed-forward Control and Active Wake Mixing, specifically tailored for floating wind turbines and floaters. These techniques fuse wave prediction with the anticipation of induced platform motions and have undergone rigorous testing in both numerical and experimental settings.

Thirdly, we've conducted an economic analysis of these innovations to qualitatively and quantitatively demonstrate their impact on the Levelized Cost of Energy (LCOE) for FOW technology. Notably, the Helix control strategy has significantly reduced wake losses, resulting in a 3% to 6% reduction in LCOE.

FLOATECH has not only achieved promising technological results but has also fostered a remarkable team. We look forward to continuing our collaborative efforts to further advance the technology of floating offshore wind and contribute to the future of sustainable energy.

Photo of Dr.-Ing. Christian Navid Nayeri

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The project in a nutshell

FLOATECH aims at increasing the technical maturity and the cost competitiveness of floating offshore wind energy.

This is achieved by two types of actions:

- The development, implementation and validation of user-friendly and efficient **design engineering tools** (i.e. QBlade-Ocean, Nemoh) performing simulations of floating offshore wind turbines with unseen aerodynamic and hydrodynamic fidelity. The more advanced modelling theories contribute to reduce the uncertainties in the design process and to increase the turbine efficiency.

- The development of **two innovative control techniques** (i.e. Active Wave-based feed-forward Control and the Active Wake Mixing) for Floating Wind Turbines and floaters, combining wave prediction and anticipation of induced platform motions. This is expected to reduce the wake effects in floating wind farms, leading to a net increase in the annual energy production of the farm.

CONSORTIUM
9 partners
4 countries

DURATION
3 years

START-END DATE
01.01.2021 - 31.12.2023

BUDGET
4 M€

TECHNOLOGY
Floating Offshore Wind (FOW)

A collaborative EU-funded project

FLOATECH has been supported by the European Union's Horizon 2020 research and innovation programme. The project was funded by the "SOCIETAL CHALLENGES - Secure, clean and efficient energy" programme, under the specific topic "Offshore wind basic science and balance of plant" (H2020_LC-SC3-RES-31-2020).

The FLOATECH consortium led by the Technical University of Berlin (Germany) brings together partners that have been selected and integrated based on their specific know-how, experience, track record by which they form the frontier in technology and scientific excellence in the wind energy sector.

The project involves a consortium composed of 3 Higher Education Institution (Ecole Centrale de Nantes, Technische Universiteit Delft and Università degli Studi di Firenze), 1 non-profit research organization (SEAPOWER scrl), 3 SMEs (BWIDEOL, NEXT OCEAN and EURONOVIA) and 1 company (SAIPEM).

MORE INFO
Visit www.cordis.europa.eu

Timeline

JAN. 2021

2021

JUNE
Coupling of NEMOH

DECEMBER
Development of hydrodynamic solver

2022

MARCH
Aero-hydro-elastic model database

JULY
Release of QBlade-Ocean

NOVEMBER
Development of Feed-forward wave control

DECEMBER
- Uncertainty quantification through QBlade-Ocean
- FOWT design for Active Wake Mixing (AWM)

2023

MAY
Feed-forward Controller validation

OCTOBER
Wave tank validation Active Wave-based Control (AWC)

NOVEMBER
Potential for LCOE improvement

DEC. 2023

Results & achievements

SOFTWARE

The development of the **open-source software package QBlade-Ocean** for the design and simulation of floating turbines was released publicly in July 2022. A workshop was held in June 2022 where members of both academia and industry took part in an induction for the use of the software, accompanied by the release of an extensive **user guide [PDF]**.

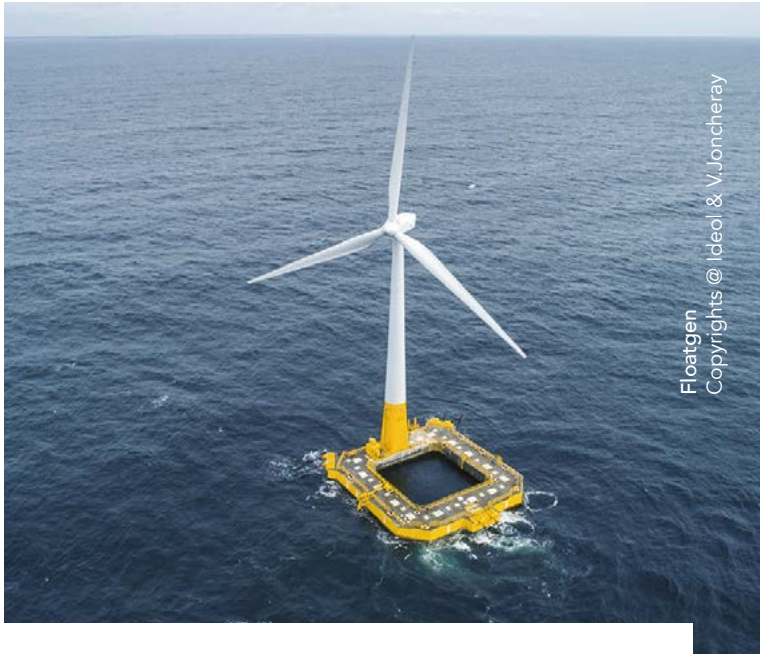
QBlade Ocean was validated and verified by three aero-hydro-elastic models, each representing a different approach of FOWT technology, to ensure that the software can be used for all types of FOWTs. These three models were then thoroughly validated against experimental results and other state-of-the-art aero-servo-hydro-elastic simulation codes with complex load cases. A detailed **validation report [PDF]** is available.

The **NEMOH v3.0.0 software** was publicly released in December 2022. This new version of the NEMOH Boundary Element Methods (BEM) code includes the treatment of irregular frequencies and 2nd order (QTF). NEMOH v3.0.0 is available at **https://gitlab.com/lheea/Nemoh**.

FOWT CONTROL STRATEGIES

A **new feed-forward wave-based control system** was developed with the objective of mitigating wave disturbances effects on the FOWT. The idea of avoiding the wave disturbances basically depends on the possibility to predict the loads caused by the incoming waves through the determination of their elevation. Having predicted the incoming waves, the gathered information can be provided to a controller that makes use of this input in order to be able to take a proper control action before the waves hit the FOWT. Consequently, the wave disturbance effects are avoided, reducing fatigue loads on the structure of a floating turbine. This technology was thoroughly validated in a controlled experimental environment in the wave basin at LHEEA. The LHEEA (Laboratoire de recherche en Hydrodynamique, Énergétique et Environnement Atmosphérique) at Centrale Nantes is a joint unit associated with the CNRS).

A wave predictor radar was installed on the FLOATGEN Floating Offshore Wind Turbine located near Saint Nazaire (France) in July 2022 with the aim of validating the wave prediction system in real environment.



We additionally applied **two distinct wake mixing technologies** to floating wind turbines with the aim to analyse the possible gain by this technology on a wind turbine pair/cluster level. Moreover, an innovative approach to optimize floater design that passively enhances wake mixing was taken. Thereby, the mitigation of negative turbine-to-turbine interactions could be enhanced. Wake mixing techniques allows for re-energization of the wake, thus increasing the wind speed downstream and resulting in higher power production.

OTHER RESULTS

- LCOE evaluation tool taking into account control technologies developed within the project / LCOE evaluation tool using relations for FOW components dimensioning enhanced compared to the scaling laws currently used in most cost evaluation tools.

- Economic assessment to prove the effectiveness of FOWs embedding the control technologies developed within the project and their positioning into the energy mix system.

- Creation of scientific data:
  - Experimental measurements of responses of a scaled floating wind turbine test bench
  - Full scale experimental measurements of wave fields

Work plan & deliverables

WP1

High order open-source aero-hydro-servo-elastic simulation tool, focused on the development of the modelling framework QBlade-Ocean which contains all necessary tools for high order analysis and design of FWTs and the enhancement of the open-source software NEMOH making it capable of calculating quadratic transfer functions.

DELIVERABLES

- Technical Report: Hybrid Eulerian-Lagrangian Aerodynamic Model [PDF]
- Technical Report: Higher Order Hydroelastic Module [PDF]
- Training Manual, Project Partner Workshop and Public Dissemination [PDF]

WP2

Quantification of uncertainty reduction gained through QBlade-Ocean, a systematic and isolated module-based methodology was applied for differentiation of important physical aspects and model strengths and limitations in identifying the capture of higher order physical processes.

DELIVERABLES

- Database including the full aero-hydro-elastic model definition for OC4 DeepCWind, SOFTWIND and Hexafloat test cases in QBlade-Ocean [PDF]
- Validation report of the new integrated aero-hydro-servo-elastic simulation framework QBlade-Ocean [PDF]
- Complete post-processed DLC database from the simulations with QBlade-Ocean (loaded on a publicly accessible webserver) [PDF]
- Full report on the estimated reduction of uncertainty in comparison to the state-of-the-art codes OpenFast and DeepLines Wind™ [PDF]

WP3

Feed forward wave-based control, dedicated to the development and experimental validation of a new technology named AWC for floating wind turbines.

DELIVERABLES

- An advanced open-source wind turbine controller for power generation and load mitigation using real-time feedforward wave information [PDF]
- Controller development, findings and validation against numerical simulations [PDF]
- Experimental wave tank validation database [PDF]
- Experimental offshore validation database [PDF]

WP4

Active Wake Mixing for floating wind farm, included the development of the fundamental knowledge, technology and control algorithms for AWM in floating offshore wind farms.

DELIVERABLES

- Study on the physics underlying the active wake mixing concept [PDF]
- Initial design report: wind turbine teether hinge, compliant turbine floater, and wind turbine controllers (baseline and IPC) [PDF]
- Final design report: integrated design optimization [PDF]
- Validation report: numerical and experimental [To be available soon]

WP5

LCOE and market value evaluation of proposed technologies and scale up, was dedicated to the evaluation of the economic impact of the developed technologies.

DELIVERABLES

- Report on the LCOE improvement of AWC controlled floating wind farms [PDF]
- Report on the LCOE improvement of AWM controlled floating wind farms [PDF]
- Report on the LCOE parameterization for AWC & AWM controlled wind turbines [To be available soon]
- Data management plan [PDF]

WP6

Dissemination, Communication & Exploitation, was dedicated to provide maximum visibility to the project, to disseminate its results and to ensure they are exploited, in order to maximize the post-project impact on a wide range of stakeholders.

DELIVERABLES

- Plan for exploitation and dissemination of the project results [PDF]
- Mid-term report on dissemination and communication activities [PDF]
- Final report on the project exploitation initiatives and related impacts on innovation, including dissemination and communication activities [To be available soon]

WP7

Project management, focused to guarantee the completion of the project planned outcomes within budget and time schedule.

DELIVERABLES

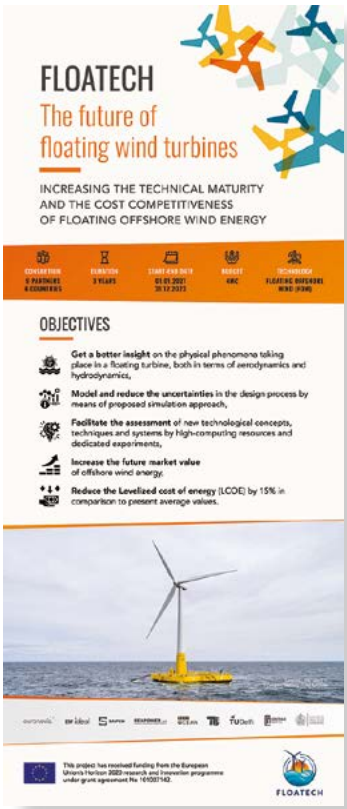
- Quality Management Plan [PDF]
- Mid-term project report [PDF]
- Final project report [To be available soon]

Communication & dissemination material

PRINTED MATERIALS

Flyer

Factsheet



Roll-up

Final brochure

VIDEOS

FLOATECH Motion design video

Partner interviews

EVENTS ORGANISED BY THE PROJECT

CONFERENCES AND WORKSHOPS

April 6, 2022
FLOATECH Side Event to WindEurope

January 25, 2023
Floating offshore wind Workshop

June 22-24, 2022
Training Workshop on QBlade-Ocean

November 9-10, 2023
Technical Workshop on NEMOH 3.0

EXHIBITION BOOTHS

November 23-25, 2021
WindEurope Electric City 2021

September 27-30, 2022
WindEnergy 2022

September 12-15, 2023
Husum Wind 2023

May 10-11, 2023
FOWT 2023

WEBINARS

Women4Wind:
How to encourage women to pursue careers in the wind energy sector

Databases4Wind:
Are the FLOATECH databases your research's missing piece?

Scientific publications & conference proceedings

JOURNAL ARTICLES

- Real-time phase-resolved ocean wave prediction in directional wave fields: Enhanced algorithm and experimental validation [PDF] - 2023
- The Dynamic Coupling Between the Pulse Wake Mixing Strategy and Floating Wind Turbines [PDF] - 2023
- A Code-to-Code Comparison for Floating Offshore Wind Turbine Simulation in Realistic Environmental Conditions: Quantifying the Impact of Modeling Fidelity on Different Substructure Concepts [PDF] - 2023
- Verifying QBlade-Ocean: A Hydrodynamic Extension to the Wind Turbine Simulation Tool QBlade [PDF] - 2023
- NEMOH: Open-source boundary element solver for computation of first- and second-order hydrodynamic loads in the frequency domain [PDF] - 2023
- A real-time wave prediction in directional wave fields: Strategies for accurate continuous prediction in time [PDF] - 2023
- Numerical and experimental investigation on deterministic prediction of ocean surface wave and wave excitation force [PDF] - 2023

CONFERENCE PROCEEDINGS

- Second-order difference & sum-frequency wave loads in the open-source potential flow solver NEMOH [PDF] - 2022
- Using The Helix Mixing Approach On Floating Offshore Wind Turbines [PDF] - 2022
- Derivation of Met-Ocean Conditions for the Simulation of Floating Wind Turbines: a European case study [PDF] - 2023
- Computation of Second-Order Wave Loads on Floating Offshore Wind Turbine Platforms in Bi-Chromatic Bi-Directional Waves Using Open-Source Potential Flow Solver NEMOH [PDF] - 2023
- Annotated Guidelines for the Simulation of Floating Offshore Wind Turbines in a Real Environment [PDF] - 2023
- Optimal Control for Wind Turbine Wake Mixing on Floating Platforms [PDF] - 2023
- Development of phase-resolved real-time wave forecasting with unidirectional and multidirectional seas [PDF] - 2023
- Optimization of a Floating Offshore Wind Turbine Platform and Mooring Lines according to an Innovative Wind Farm Wake Control Technique [PDF] - 2023

Final Info Day

The FLOATECH Final Meeting and Info Day were organized between the 30th of November and the 1st of December 2023 by the Technische Universität Berlin in Berlin, Germany.

On Thursday, 30 November, the Final Meeting provided us with the opportunity to convene once more to prepare the end of the project, the road ahead towards the finalization of the last deliverables, the final report, and the preparation of the project review with the European Commission in the early 2024.

FLOATECH consortium members

On Friday, 1 December, the Final Info Day was an opportunity to present and explain the innovative technologies for the Floating Offshore Wind sector. Our experts discussed some great topics such as the development of software, notably the QBlade-Ocean technology, and FOWT control strategies. As a major result, our experts explained how this project is helping to reduce the levelized cost of energy. We finished the first part of the day with a very interesting presentation of the FLOATFARM project, which will start at the beginning of 2024!

More than 30 participants attended the event on site and were glad to assist to an enriching panel discussion regarding the Future of Floating Offshore Wind. Lizet Ramirez from WindEurope was invited to animate the discussion between:

- Andreas Walstad Freelance journalist specialized on renewable energy
- Guilherme Vaz, CEO of Blue Oasis
- Athanasios Kolios, President of the EAWE
- Alessandro Bianchini from WindEurope and assistant professor at Unifi (Università degli Studi di Firenze)
- Navid Nayeri, coordinator of the FLOATECH project and research associate at TU Berlin

The speakers delivered interesting discussions about the fostering of a robust supply chain and the conduction of further research to address gaps in grid connection, innovative installation methods, major component replacement, and optimized upfront design.

To reach a wider target, the Final Info Day was organised as a hybrid event through a YouTube livestream. Registration was free, but mandatory for all participants. We registered more than 130 views of the event.

Check the **agenda of the Final Info Day** and the **recording of the entire event** on YouTube.

Presentation by D. Coiro (SEAPOWER) on LCOE financial breakdown

Once again, thanks to the organisers, Technische Universität Berlin for their warm welcome, as well as the eight other partners of the project, Ecole Centrale de Nantes, TU Delft, Università degli Studi di Firenze, SEAPOWER, Saipem SA, BW IDEOL, Next Ocean and Euronovia!

Panel discussion regarding the Future of Floating Offshore Wind

What's next?

FROM FLOATECH TO FLOATFARM

Building on the outcomes of FLOATECH, a new project running from January 2024 until December 2027 is receiving funding under Horizon Europe: FLOATFARM will bring the technologies developed within FLOATECH to the next level of technological readiness, complementing them with a significant number of new concepts, innovations and methods, in order to make FOW enter a new phase of industrial maturity.

In addition, FLOATFARM will pay special attention towards **decreasing the negative environmental impacts on marine life and to enhancing the public acceptability** of FOW farms.

With FLOATFARM, nine additional partners (3 academic and 6 industrial partners) have joined the FLOATECH consortium: Universiteit Gent (UGE), Danmarks Tekniske Universitet (DTU), Sofresid Engineering, Sowento, Innosea, Consiglio Nazionale delle Ricerche (CNR), BlueOASIS, France Energie Marines (FEM), Hagnesia.

More information on this new project will be released during the course of December on the FLOATECH website and social media. Stay tuned!

MORE INFO
Visit www.floatech-project.com

Floatgen
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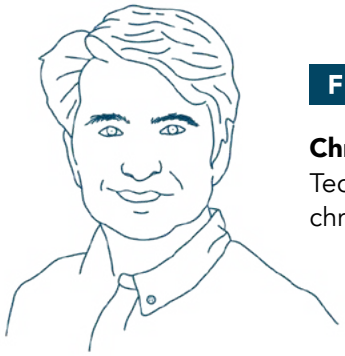
Contacts



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