H_2Mare update

01 / 2022

Flagship Project
H_2Mare

Siemens Gamesa Renewable Energy

Green hydrogen economy: full speed ahead!

H_2Mare centers around the development of an innovative wind turbine. The aim is to enable the direct offshore generation of hydrogen with an offshore turbine for the first time ever thanks to an integrated platform concept. The turbine does not require a connection to the power grid as it employs electrolysis to convert wind energy directly into hydrogen. As a result, areas far from land become appropriate for hydrogen production, the application and construction process for the grid connection is no longer required, and furthermore, the grid is not burdened with another feeding point. The production of hydrogen synthesis products out at sea is also an important goal. Among other things, a floating PtX platform is being developed for this purpose.

Within four years, H_2Mare intends to lay the foundations for Germany as one of the future hydrogen centers and contributes to the achievement of climate targets by reducing greenhouse gas emissions more rapidly. The H_2Mare project is subdivided into four joint research projects, the goals of which are outlined below.

OffgridWind

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This project pursues the implementation of a turbine concept that realizes electrolysis directly at the offshore wind turbine without an electrical connection to the power grid, thereby aiming for a high degree of efficiency.

H_2Wind

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This project aims to develop a 5-MW PEM electrolysis system that can electrically be coupled directly to an offshore wind turbine. The system solution calls for a durable system design with optimal adaptation to the offshore environment, seawater desalination to provide process water, and maximum use of volatile wind conditions.

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**H_2Mare conference,
on June 8th–9th, 2022, in Berlin.**
wasserstoff-leitprojekte.de/h2mare-konferenz

Dear readers,

The partners in the H_2Mare joint projects have been striving to take the production of hydrogen and its downstream products out to sea – to where wind energy is abundantly available – for a year already. We are certain that connecting hydrogen production directly to such a practically inexhaustible source of energy will not only help to reduce CO_2 emissions but also contribute to energy security in Germany and Europe as a whole.
However, we are still in the early stages of our project – there is plenty left to research, evaluate, test, and develop. What is already evident, however, is how beneficial the close interlinking of research and industry as well as the interdisciplinary cooperation is in the scope of the research projects. The 32 partners are making an important contribution to the implementation of the German National Hydrogen Strategy, the Energy Transition 2.0, and the safeguarding of Germany's leading technological position.
H_2Mare with its four joint projects (OffgridWind, H2Wind, PtX-Wind, and TransferWind) was launched in April 2021 and is set to run until the end of March 2025.
It is one of three flagship projects being funded by the Federal Ministry of Education and Research (BMBF) in the scope of the "Hydrogen Republic of Germany" ideas competition.
This newsletter will keep you up to date with the progress of the project, inform you of the latest findings, and provide ideas for further dialogs twice a year.
We hope that you enjoy reading it, look forward to active interest, and also invite you cordially to attend our upcoming events (conferences, trade fairs, ...).

Yours sincerely,

Matthias Müller,
Siemens Energy, H_2Mare coordinator

Electrolyzer container from the KIT – Karlsruhe Institute of Technology

PtX-Wind

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Complementing pure offshore hydrogen production, this project will investigate the conversion to more easily transportable, synthetic energy carriers and fuels such as liquid methane, methanol, ammonia, and Fischer-Tropsch products. The synthesis gas required for this will be generated using carbon dioxide and nitrogen harvested from the air or the sea as well as the hydrogen produced via electrolysis. Innovative approaches such as high-temperature electrolysis for the production of synthesis gas from water and carbon dioxide as well as direct saltwater electrolysis will also be tested. In addition, the delivery of reactants by ship will also be considered.

TransferWind

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TransferWind focuses on the transfer of knowledge to the public and to related projects as well as the exchange of expertise across related activities. This also includes aspects of the design of infrastructures, framework conditions for safe operation in the offshore sector, possible use cases and potentials of the products generated offshore, as well as environmental protection aspects.

Siemens Gamesa Renewable Energy test field in Brande, Denmark

Facts & figures concerning the project

Partners:
32

Total funding:
More than €100 million

Projektl term:
April 2021 to March 2025

H_2Mare is one of three hydrogen flagship projects funded by the German Federal Ministry of Education and Research (BMBF) for the implementation of the national hydrogen strategy

www.h2mare.de

Introducing the innovations

Next generation system design

The innovative wind energy & electrolysis system calls for a compact design and a large platform at a safe height so as to allow for positioning of the containers with the required technological components. Regarding the harsh operating conditions at sea, an enclosure that can permanently withstand water splashes and salty air while protecting the system components within is a fundamental requirement for reliable operations. But how will the individual components in the container be arranged? How can service and maintenance be ensured out at sea, where every minute of service time is expensive? How is it ensured that the dynamic excitation of the platform by the motion of the waves and the rotation of the wind turbine's rotor blades does not impair the functionality of the subsystems? The researchers in the H_2Wind project are addressing these questions.

Digital twins and system model

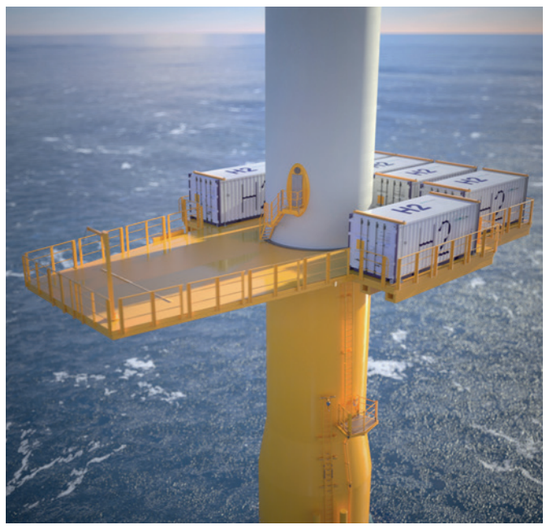
Digital twins will be utilized to optimize the system and the interaction between the offshore wind turbine and electrolysis system even further, aiming, in particular, for operational management and to make statements regarding the economic efficiency. At simulation level, a complete system model of a wind turbine will be compiled from partial models for the first time ever, modeling the entire production chain from the wind to the electricity right up to the hydrogen. This will serve as the basis for considering different operating scenarios with regard to the lifespan of the wind energy & electrolysis system.

Further development of material for stacks

The further development for offshore operation encompasses the material and design of the bipolar plates as well as new test and validation procedures for the diagnosis and prediction of degradation mechanisms. In order to investigate them in a targeted manner, a test infrastructure will be built and operated at the Fraunhofer Hydrogen Lab Leuna.

At cell level, the project partners will investigate the best way to achieve a very compact mechanical construction. As the components must be both very durable and extremely efficient (at the same time construction, materials), the membrane electrode assembly (MEA) is also to be optimized. In order to achieve these goals, a highly specialized infrastructure for the performance of cell component tests will be constructed and employed for the investigations.

PEM electrolyzers housed in a container with a maximum output of 5 MW capacity will be developed under the lead of Siemens Energy. Corresponding to the power class of the wind turbine, three electrolyzers are to be combined on its platform to give a total output of 15 MW.
Due to the difficult accessibility of offshore sites, the intervals for control inspections should not be shorter than one year. As such, the system must be able to function autonomously as a stand-alone solution and the individual components must be designed to be very robust. This results in special requirements at cell, stack, and (system) design level.



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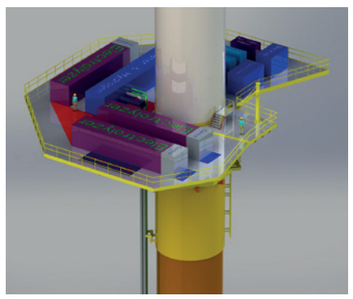
Platform concept for the new wind energy electrolysis system



Thomas Schwabe, SGRE, in the scope of the H_2Mare Science Panel on 04/25/2022

Design of the platform for positioning of the required containers.

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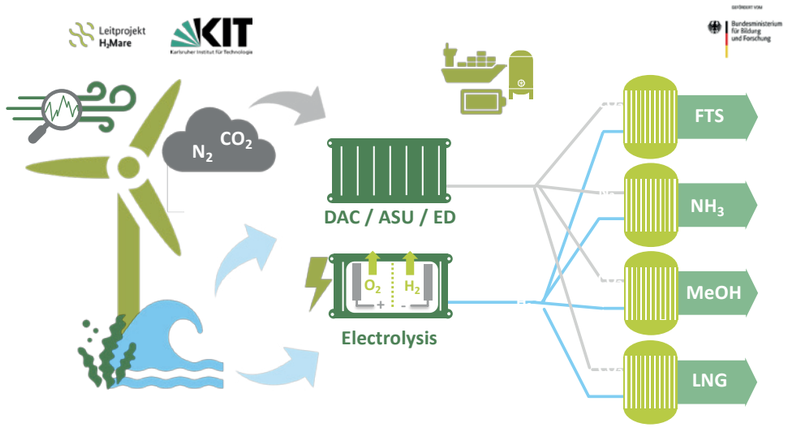
In the simulation, the wind farm can be combined as a unit for which optimal operating strategies are to be determined.



PtX-Wind UAP 1.9 | Philipp Rentschler

Power-to-X offshore process

The H_2Mare flagship project is also set to include the first ever example of offshore power-to-X conversion. The varying wind speeds mean that the power supply on a self-sufficient production platform fluctuates, which is why the chemical conversion processes must be designed dynamically. In addition to the production of hydrogen, the process routes of methanation for the production of liquid natural gas, methanol synthesis, ammonia synthesis, and Fischer-Tropsch synthesis are also being considered for the replacement of products from fossil resources.

Depending on the limitations of the dynamic operation possibilities of the complete system, the sizes of the intermediate storage facilities for electricity and reactants will be optimized in order to determine an optimal capacity utilization for the combined system.

Three different stages of development are distinguished within the project:

1. Floating test platform (TP) – Autonomously operated, for investigation of the effects of weather and corrosion conditions. Systems will initially be tested onshore at the Energy Lab 2.0 in Karlsruhe before finally being operated as a combined system on the offshore TP at the end of the project.
2. Research platform (RP) – A detailed concept of the RP is one of the project's primary goals. The RP should serve to clarify the remaining open questions regarding the offshore application of PtX processes.
3. Production platform (PP) – Conceptual work within the project. The work will serve as a template for the subsequent implementation of a platform for the offshore production of PtX products.

Water supply for the electrolysis process

The water supply for the electrolysis process is a key point and one which will be tested in two innovative ways: desalination using waste heat from the electrolysis process will be simulated on a test infrastructure at the Hydrogen Lab Bremerhaven. Here, the modular, scalable water processing will be investigated and the possibilities for optimal process integration will be determined. In addition, process technology for direct seawater desalination will be developed which takes into consideration the high requirements on water quality, serviceability, durability, and the fluctuating plant operation.

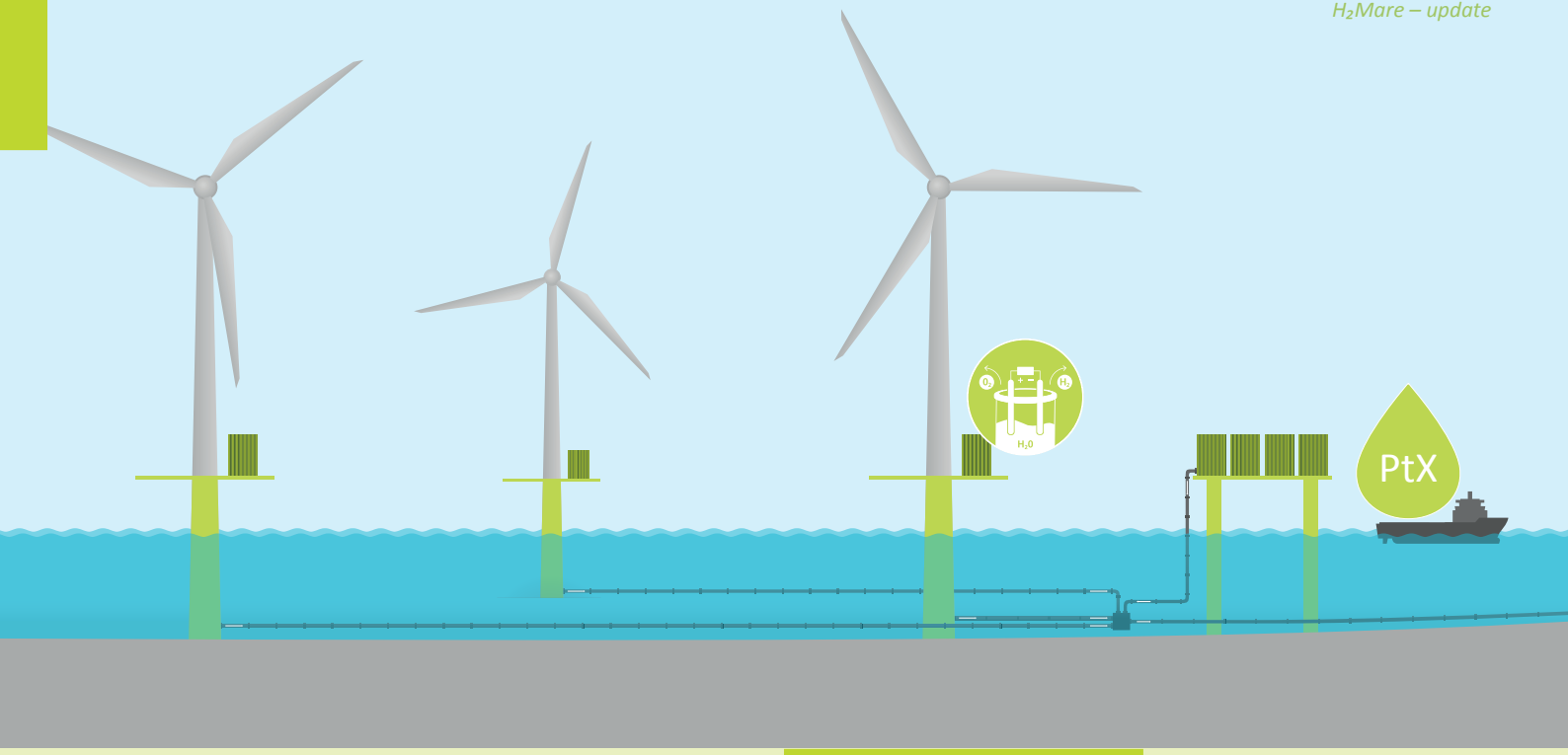
Environmental protection and acceptance

In addition to the technical aspects of the various value chains, H_2Mare focuses on overarching questions regarding certification, safety, and environmental aspects. These aspects will be systematically recorded over the whole term of the project and compatible solutions for emission-free and safe operation will be developed.

Experts and the interested public will be involved in the development process from an early stage by means of stakeholder dialogs, citizens' forums, exhibitions, and innovative education and training concepts.

The topic of acceptance is thus anchored centrally within the project.

The TransferWind project is dedicated to these matters and ensuring that findings from the stakeholder dialog and from ecological issues are fed back into the H_2Mare project as a whole in order to design processes in such a way that all sides are given the best possible consideration.



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This newsletter is published twice a year in both English and German.

Upcoming important dates:

H_2Mare conference on June 8th–9th in Berlin:

The first day is open to the public and will be streamed. The second day is dedicated to project internal co-operation.
https://www.wasserstoff-leitprojekte.de/h2mare-konferenz

WindEnergy Hamburg from Sept. 27th–30th:

Meet the hydrogen flagship projects at hall A2, booth no. 201 at H_2EXPO & CONFERENCE.

Please also visit our English website:
https://www.wasserstoff-leitprojekte.de/home

www.h2mare.de