



**Fraunhofer**  
IWES

**Fraunhofer Institute for Wind Energy Systems IWES**

Wind energy research  
with added value

Our added value

## ... for industry and society

We are convinced that applied research is very important for our industry and society. It helps to bring new scientific findings directly into practical applications that move us forward technologically. When research institutions and companies work together closely, innovative products and solutions evolve. These not only strengthen our industry and Germany as a business location, but also improve quality of life.

A good example of this is the Fraunhofer IWES: We are developing new methods to advance the use of wind energy and increase the production of green hydrogen. This can reduce risks, costs and accelerate expansion. Our research ensures that new technologies can be used more quickly. This is how we create added value!

We work on the success of the energy transition every day. Our research work at the Fraunhofer IWES makes a significant contribution to solving the global challenges of our time and therefore creates sustainable added value for society.

# Offshore

Fraunhofer IWES has many years of expertise in offshore projects in national and international waters.

- Wind measurements with lidar buoys
- Seismic surveying of the offshore subsurface
- Improved yield simulations

Our expertise increases the quality of the measurement and reduces the costs of project development as well as the financing costs of offshore wind farms.

# Hydrogen

The production of green hydrogen to defossilize industrial processes makes an important contribution to climate targets and is a link in a renewable economic system.

- Operation of electrolyzers with fluctuating availability of renewable energies
- Optimization of materials and components through electrochemical analysis for mechanical and thermal loads

Fraunhofer IWES supports the industry in establishing a sustainable hydrogen economy.

# Testing infrastructure

Worldwide unique large-scale test benches for realistic and accelerated lifetime testing are the focus of the Fraunhofer IWES.

- Wind turbines: test rigs for rotor blades, blade segments, blade bearings, nacelles, grid integration electrical systems and support structures
- Electrolyzers: test facilities for electrolyzer systems and components as well as electrical properties and quality of the input media

We offer an efficient and intelligent test strategy in coordination with the respective product and technology development.

# Digitalization

With the integration of digital methods, Fraunhofer IWES supports all areas from data acquisition and data analysis to the modeling of individual components or even entire systems.

- Improved reliability of wind turbines through analyzing data from different manufacturers and operators
- Flow analyses optimize wind farm planning.

In addition to standards such as data monitoring, big data and digital twin have also found their way into research. They are used and further developed at Fraunhofer IWES in many different scientific fields.

# Overall system measurement and simulations

Our added value



... for industry



... for society

## Overall system measurement

- Independent, certified measurements
- Measurements for special and particularly complex situations

- Improved acceptance of onshore wind farms through advanced noise measurements and turbine parameters

## Electrical measurement of prototypes in the field through to component-based measurement of the generation unit

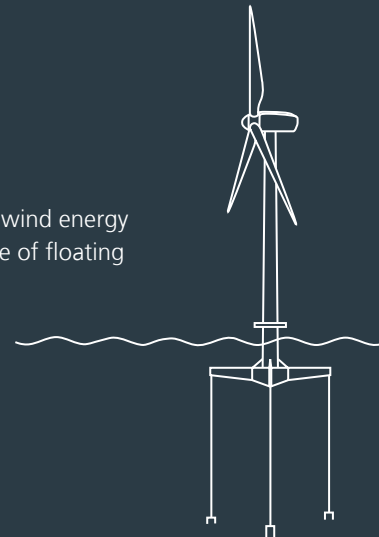
- Fast and controlled testing and certification of the electrical system of a wind turbine in all requirements of current grid codes up to 44 MVA under laboratory conditions
- Parallel measurement in the field and on the test rig can reduce the overall duration of prototype testing by approx. 4 months.

- Around 4.9 GW<sup>2</sup> of onshore wind turbines whose electrical properties were tested at Fraunhofer IWES are installed in Germany.

## System dynamics of floating wind turbines

- Interface between turbine and foundation system manufacturers for a better overall system
- Highlighting the needs of suppliers<sup>1</sup>

- Cost reduction of offshore wind energy through the prospective use of floating wind turbines



# Sub-surface investigation

Our added value



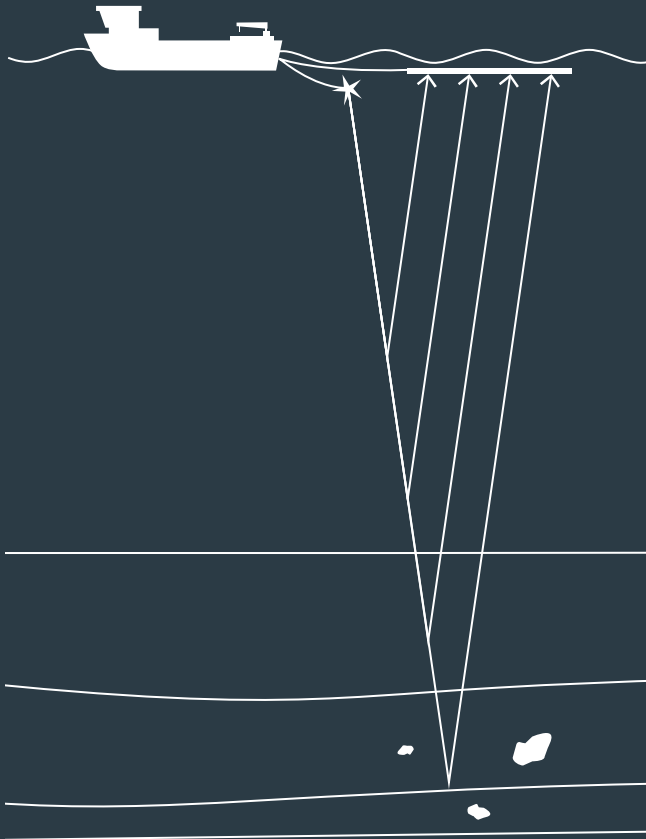
... for industry

- High planning reliability for offshore wind farms
- Ultra-high-precision resolution of measurements reduces the need for additional investigations afterwards.



... for society

- Fraunhofer IWES has so far investigated 14.4 GW of offshore wind farm areas in Germany for the Federal Maritime and Hydrographic Agency. The data from these investigations have provided significant support for the tenders for the pre-investigated areas.



# Hydrogen

*Our added value*



... for industry



... for society

## Validation and qualification

- Provision of an independent data basis for the future certification of electrolyzers and components, the establishment of series production, the optimization of lifetime performance and the identification of weak points and defects
- Establishment of a reliable basis for calculating operating and maintenance intervals for complete systems within the multi-megawatt range

## Validation of electrolyzers and desalination plants

- Supply of reliable, independent data for well-founded investment decisions: calculation of operating and maintenance costs of electrolyzers and components in the multi-megawatt range
- Creation of reliable, independent data basis for compliance with environmental regulations: Purity level of the produced hydrogen can be validated and reduces the need for additives.

- More reliable electrolyzers: Validations at the test rigs support the development of new electrolysis processes.

Hydrogen Lab Bremerhaven

Hydrogen Lab Leuna

Hydrogen Lab Görlitz



- Lower resource requirements: Efficient processes reduce waste (components that do not meet defined requirements).

# Hydrogen

Our added value



... for industry



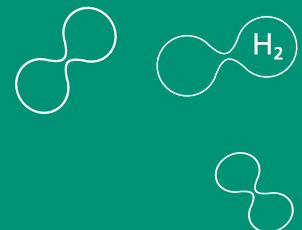
... for society

## Simulation and application of efficient electrolysis systems

- Reduced risk when upscaling to new performance classes and areas of application through experimental testing and subsequent modeling
- Contribution to long-term investment security: independent and reliable data basis for individual energy scenarios and concepts
- Faster investment decisions: By reducing the risk involved in investment decisions, modern electrolysis systems can be brought into use more quickly and reliably. This increases the proportion of green hydrogen in the energy mix.

## Test procedures of stacks, cells and components

- Faster and more meaningful decision-making basis for the selection of suitable components and stack design: independent performance evaluation under transparent framework conditions and benchmarking of results
- Increased cost-effectiveness and system lifetime by reducing costs and fault tolerances as well as faster readiness for use of components through early identification of weak points and defects
- Contribution to the replacement of critical raw materials and reduced consumption of precious metals



# Rotor blades

Our added value



... for industry

## Structural-mechanical testing of fiber composite structures and components

- Certified rotor blades: Three test benches on which rotor blades up to 120 m in length are tested in accordance with IEC 61400-23.
- Shorter test periods: test period reduced by up to 65% thanks to new test methods, depending on the rotor blade and the specific test program

## Digitalization, automation and process development in the production of large fiber composite structures

- Support in the establishment of more efficient manufacturing processes, e.g. with a saving of up to 20% adhesive for the main glued seams of a rotor blade with a simultaneous time saving of approx. 30 min per blade<sup>3</sup>
- Lower raw material requirements: Higher process quality and better process monitoring enable optimized design.

## Sustainable and recyclable rotor blades

- Reducing the footprint of wind turbines by increasing the proportion of recycled material
- Reducing the need for raw materials



... for society

- Reliable rotor blade tests since 2009: In Germany, there are more than 8.8 GW<sup>2</sup> of wind turbines whose rotor blades have been tested on one of the Fraunhofer IWES test benches and produce renewable electricity.

- More cost-effective wind turbines: More efficient processes and lower raw material consumption reduce the costs of wind turbines and electricity from wind energy.

- Development of further recycling processes for rotor blades increases the applicability in new products.



# Testing and system validation of large mechanical components

Our added value



... for industry



... for society

## Testing of rotor blade bearings

- Validation of new bearing and drivetrain designs prevents costly errors in the field.
- System approach to testing validates the entire pitch system.
- Reliable rotor blade bearing tests since 2015: 2.8 GW<sup>2</sup> of wind turbines in Germany with rotor blade bearings tested at Fraunhofer IWES.

## Testing of mechanical drive trains

- Test campaigns can be simulated in advance and tailored to the requirements of the test specimen.
- Real-scale testing of innovative ideas on the test rig at lower costs and risks than in direct field tests
- Lower costs allow more innovative ideas to be tested in full scale.

## Testing of support structures and components, validation of design approaches

- Reduced installation risk of new designs through better modeling
- Reduced environmental impact during the installation of offshore wind farms (e.g. noise pollution)

# Electrical components and system validation



... for industry



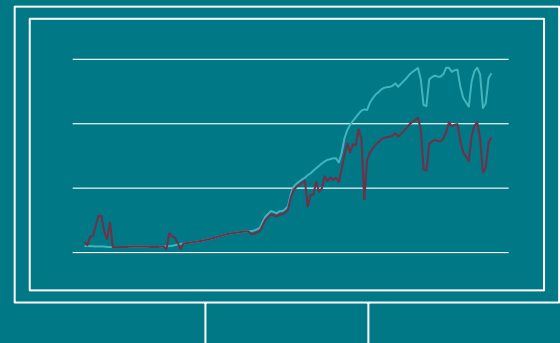
... for society

**Our added value**

## Reliability of power electronics

- With the help of Fraunhofer IWES, new generations of converters and components with lower failure rates can be tested and developed.
- More precise knowledge of the reasons for failures of power electronics in the field

- The improved data basis from the field will make new generations of the tested components more reliable and thus reduces the number of failures.



## Reliability, monitoring and yield analysis

- Forensics after incidents
- Determination of the market value of wind farms and detailed yield estimation including uncertainties for large-scale wind farm effects or complex terrain

- Support for offshore wind farm connections for already 1.5 GW in the tendering and installation phase reduces risk and increases the predictability of costs.

# Wind measurement and modeling

Our added value



... for industry



... for society

## Wind measurement

- During the planning phase: High-precision measurement of wind conditions on site reduces uncertainty and thus the financing costs of wind farms.
- Measurement of the power curve in (offshore) wind farms makes it easier to prove the performance of offshore wind turbines.
- Fraunhofer IWES has so far carried out wind measurements on areas for 5.5 GW of offshore wind energy in Germany. These are made available to the industry for tenders.

## Wind modeling

- Reduced uncertainty of the expected annual energy yield of onshore and offshore wind farms in the planning and operating phase through the implementation of current research in the simulations
- Fraunhofer IWES has simulated the expansion of offshore wind energy for the German Exclusive Economic Zone up to 2045 – more than 70 GW – for the Federal Maritime and Hydrographic Agency. These results are available to industry and society for informed decisions.



# Publication details

## Publisher

Fraunhofer Institute for Wind Energy Systems IWES  
Am Seedeich 45 | 27572 Bremerhaven | Germany

info@iwes.fraunhofer.de  
www.iwes.fraunhofer.de

Fraunhofer Institute for Wind Energy Systems IWES  
is a constituent entity of the Fraunhofer-Gesellschaft,  
and as such has no separate legal status.  
Fraunhofer-Gesellschaft zur Förderung der  
angewandten Forschung e.V.  
Hansastraße 27 c | 80686 München | Germany  
www.fraunhofer.de

Published: September 2024

## Editorial

Inna Eck, Head of Communications  
Enno Dietrich, Project coordination  
Manja Polednia, Stakeholder management

## Layout

Fraunhofer IWES

## Printing

UmweltDruckhaus Hannover GmbH  
30851 Langenhagen | Germany  
www.umweltdruckhaus.de  
Printed in offset printing with organic inks on  
Circle Offset Premium White 100% recycled paper

## Photo credits

Cover page: waves: Photocase taviphoto,  
illustration: Fraunhofer IWES

Pictogram globe: iStock kadirkaba  
Pictogram certificate: iStock TongSur

## Source list

1 Results from the research project AFLOWT:



<https://vb.nweurope.eu/media/21054/aflowt-fowdp-2023.pdf>

2 Fraunhofer IWES analysis using the market data register

3 Read more in our blog:



Might stick around: IWES tackles rotor  
blade production challenges with the  
Variable Glue Applicator

## Contact

---

Fraunhofer Institute for Wind  
Energy Systems IWES

Am Seedeich 45  
27572 Bremerhaven, Germany

[info@iwes.fraunhofer.de](mailto:info@iwes.fraunhofer.de)  
[www.iwes.fraunhofer.de/en.html](http://www.iwes.fraunhofer.de/en.html)

Phone: +49 471 14290-100

