Fraunhofer
IWES

Annual Report 2020/2021

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Bremen Bremerhaven

Lower Saxony

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Fraunhofer

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European Regional
Development Fund

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Dear readers,

As a research facility in the wind energy sector, the IWES is, of course, quite used to handling dynamics, uncertainties, and changes. 2020 certainly put our abilities to the test with the pandemic – and so far the institute has mastered this challenge with flying colors, too. "The institute" of course refers to all the employees who, with a passion for wind energy, have embraced the changes with enthusiasm and creativity and have made the best of the situation: dynamic communication via new digital formats, virtual conferences, intensive networking via social media...and, naturally, a great deal of discipline at the kitchen table, sometimes even with children on their laps.

It was a truly extraordinary year – hopefully, as we really can't bear many more like that one. And an extraordinary year also brings with it an extraordinary annual report. We are keeping it short, enabling new connections, and: we want to show that we are taking our challenges seriously but can also still have a laugh.

In addition to the obligatory figures regarding the institute's development (definitely a cause for celebration!) and a "summarized summary" of the institute's strategy, the following pages also offer an insight into four projects representative of the work of all the colleagues at the IWES: the presentation of the German-Danish ReliaBlade initiative from the Rotor Blade department; a few lines on boulder detection from the Sub-Surface Investigation department; an introduction to the HiL-GridCoP project from the Power Electronics department; and, last but not least, our new topic Green Gas for Bremerhaven from the Hydrogen department.

COVID-19 has been a constant companion in our everyday lives over the past few months – and can also be found here in an artistic representation.

Here's to entertaining and interesting insights – I hope you enjoy reading!

Prof. Andreas Reuter
Managing Director
Fraunhofer IWES

The IWES in figures: 2020 fiscal year

Fraunhofer IWES successfully coped with the impact of the COVID-19 pandemic in 2020 thanks to the tremendous efforts of all involved. It proved possible to increase the **operating budget** compared to the previous year.

COVID-19

The COVID-19 pandemic was a new experience for all of us: on the one hand, a challenge on a global scale, but, on the other hand, also linked to very definite personal consternation resulting from the prohibitions, omnipresent restrictions, and, in the most serious cases, even health issues. At the same time, this pandemic has shown what is possible when a problem is taken seriously – that provides a glimmer of hope for the issue of climate change, which remains a matter of urgency. And the same thing applies for both challenges – everyone needs to play their part.

At this point, I would like to thank all employees for their support and for the solutions found together for how we can collaborate successfully despite distance, digitally and within our own four walls. Team spirit and perseverance have shown us that we can overcome challenging situations. I would also like to thank all our colleagues, project partners, funding organizations, and friends of the IWES for the confidence they have shown in us and their continued support.

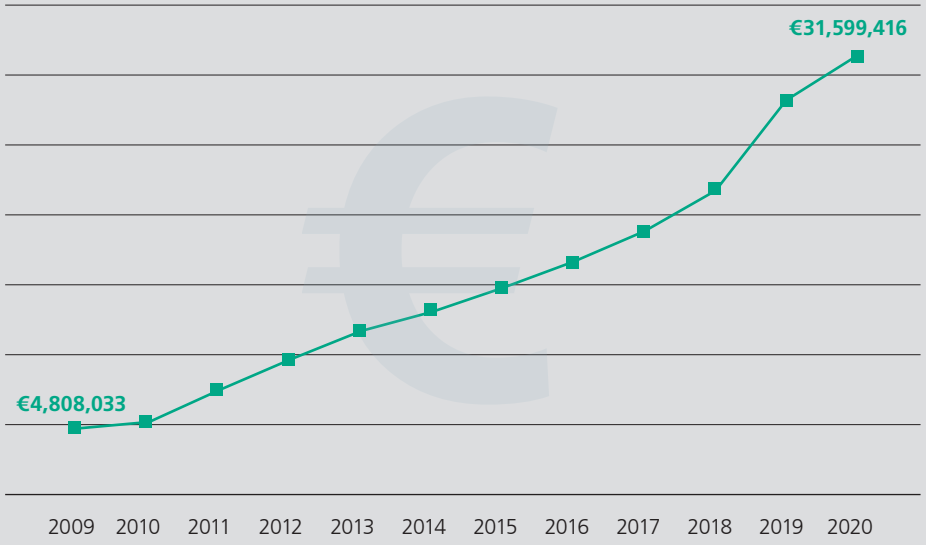
Andreas Reuter, Managing Director Fraunhofer IWES

– Wind energy is playing a decisive role in the successful realization of the energy transition. –

(Source: German Federal Ministry for Economic Affairs and Energy)

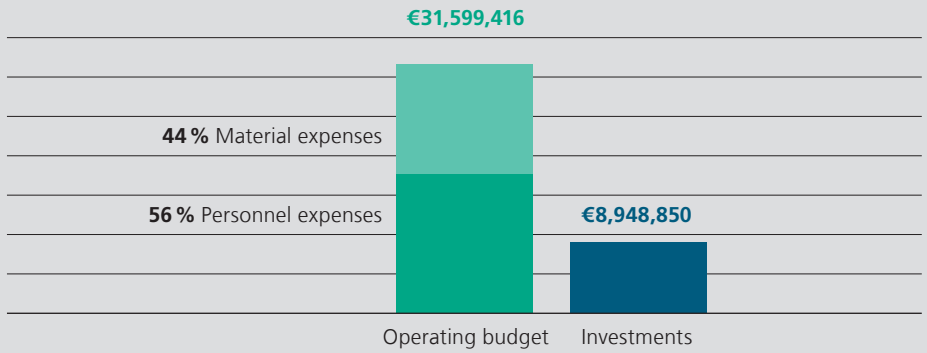
Development of the operating budget 2009 – 2020

Fraunhofer IWES is continuing its growth curve: the operating budget has increased considerably in recent years and all of the institute's research areas have reported higher incomes. At the same time, investments have been made in new infrastructure and the further development of the test benches. Additional public funding at federal and state level has also been successfully acquired, increasing from €7.5 million in 2015 to €18.3 million in 2020.



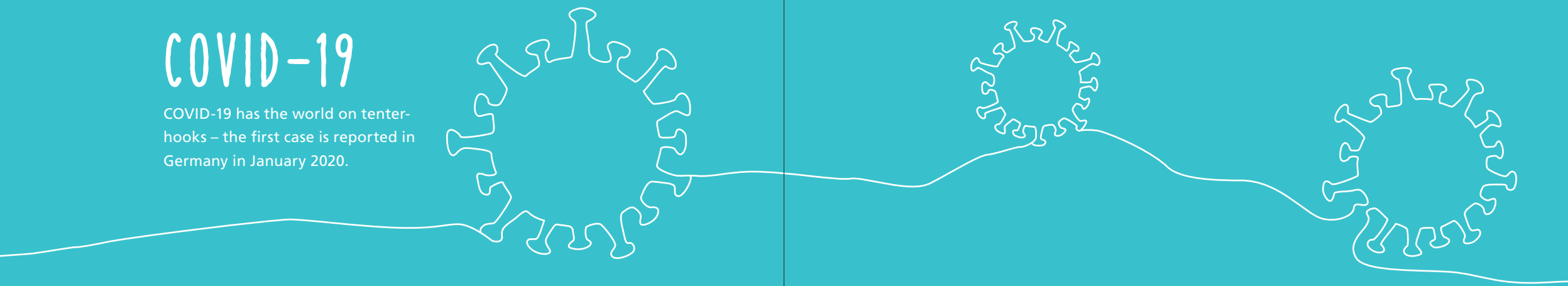
Composition of operating budget

The IWES' operating budget totaling €31.6 million comprises 56 percent personnel expenses and 44 percent material expenses. In addition to the operating expenses for the test benches, these high material expenses include the costs for the use of the AD8 wind turbine and ship charters for the IWES' offshore activities. The IWES also had around €8.9 million in investment resources at its disposal in 2020.



COVID-19

COVID-19 has the world on tenterhooks – the first case is reported in Germany in January 2020.



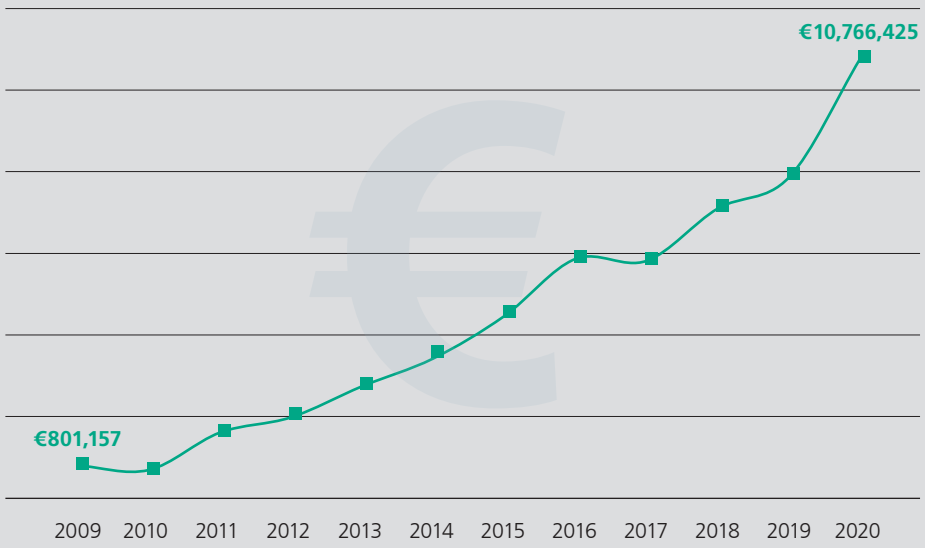
– Wind energy accounts for the largest share of renewable electricity in Germany. –

(Source: German Renewable Energy Federation)

Growing industrial income in the operating budget

A new record value of around €10.8 million will be added in 2020 to the steadily increasing industrial income since the institute was founded. That corresponds to an economic rate of return of 35.1 percent. Fraunhofer IWES' results are thus in line with the specifications of the Fraunhofer-Gesellschaft: one third of the income should come from orders from industrial companies.

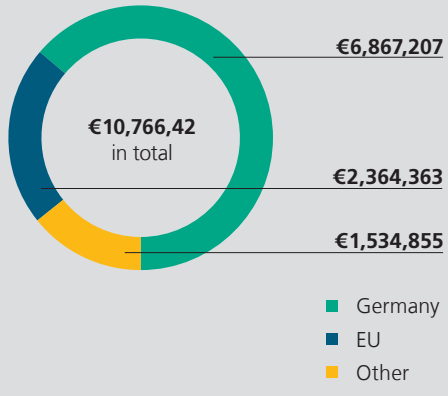
Development of industrial income



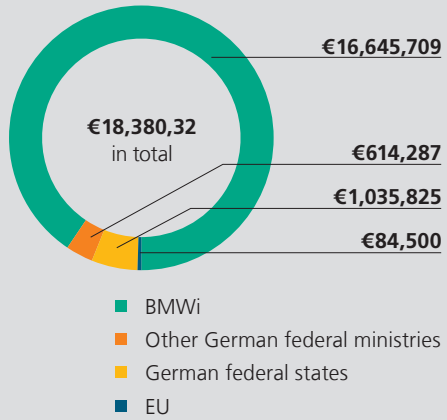
Origin of income in the operating budget

In 2020, the share of industrial income with companies in the wind industry in Germany increased to €6.8 million, in particular due to the expansion of the cooperation with developers and operators in the offshore industry. The classic test bench-based research services continue to be realized on a large scale with European customers. In addition to contracts from industry, Fraunhofer IWES also successfully acquired public funding from the federal and state governments, with the largest provider of funding being the German Federal Ministry for Economic Affairs and Energy (BMWi).

Origin of industrial income



Origin of public income



LOCKDOWN

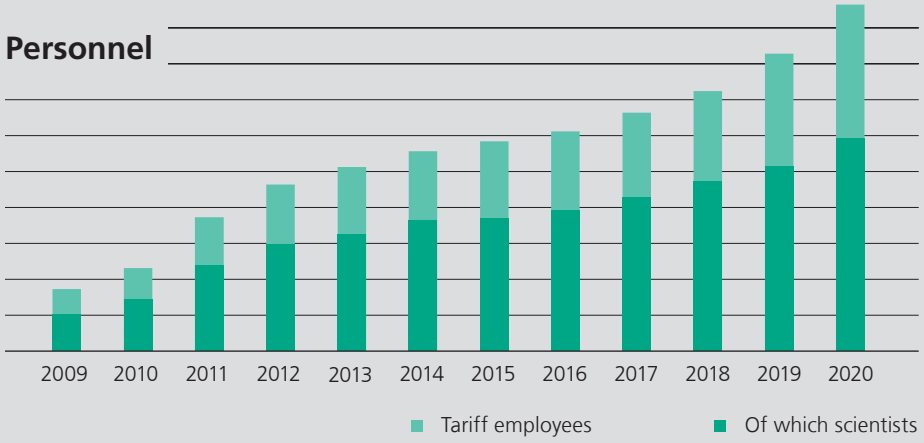
Closed businesses, contact restrictions, mobile working – lockdowns should help lower the infection rates.

– In addition to the potential for electricity generation, the expansion of the offshore wind energy sector also brings with it great opportunities for the German economy. –

(Source: German Federal Ministry for Economic Affairs and Energy)

The team is growing

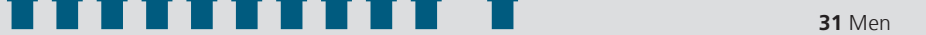
Since its founding, the IWES has continually been able to recruit experts from the most varied of disciplines. The broad field of wind energy requires a wide range of qualifications and knowledge – diversity is an obvious asset here. In the year of its founding, 42 employees helped the young institute to find its way towards a successful growth path. Today, there are 250 employees contributing day in, day out to ensure the IWES' mission takes shape. They do so at five locations in North Germany, each with an inspiring environment and state-of-the-art infrastructure. Family-friendly working hour models helped increase the share of female members of staff in 2020: in terms of the new hires, a third of the positions were filled with women.



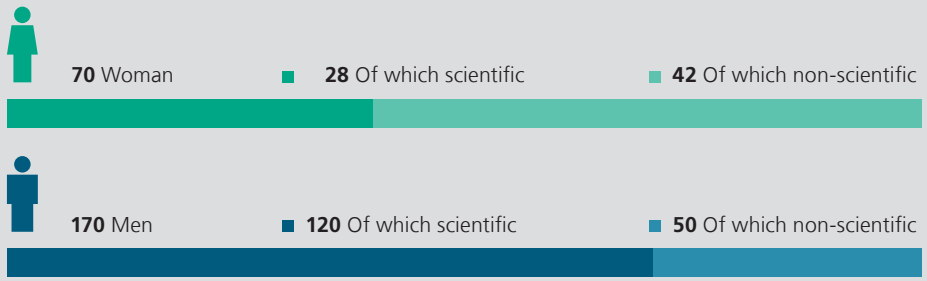
Diversity is our strength

Fraunhofer IWES creates a working environment where all employees can participate equally – irrespective of their ethnicity, religion or ideology, gender or age, sexual identity or disability.

New hires in 2020

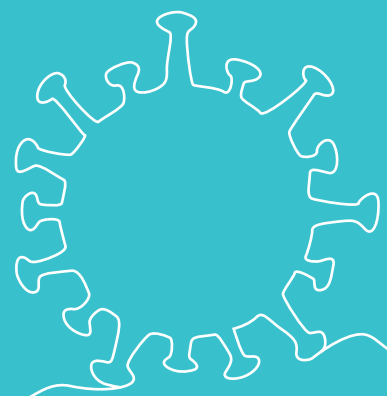


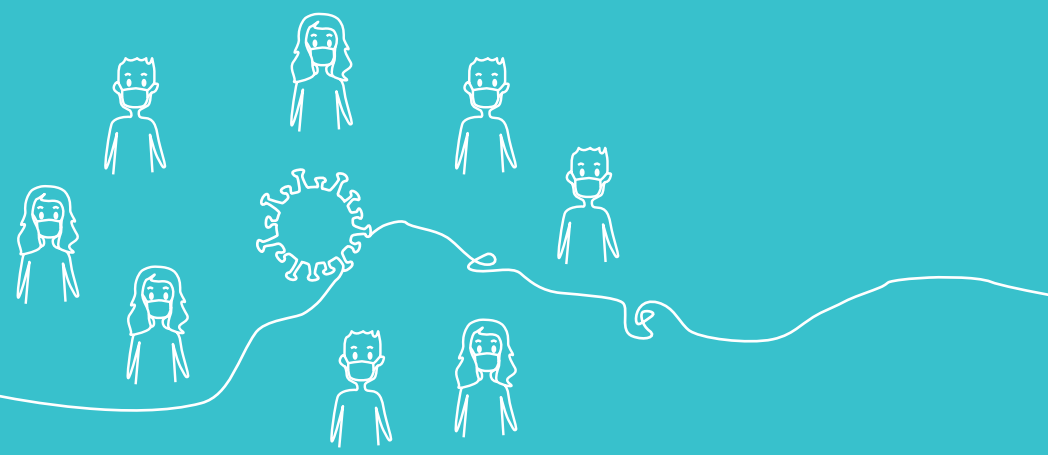
Number of female and male employees



SOLIDARITY

There for each other:
A willingness to help can be infectious too.



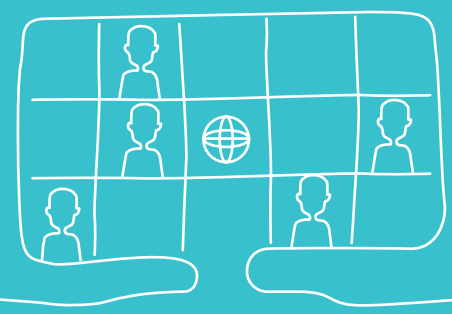


Wind energy

Germany aims to become climate-neutral by 2045 at the latest: CO_2 emissions should be reduced by 65 percent by 2030 and 100 percent by 2045. With this in mind, the German Federal Government has set itself the goal of increasing the share of renewable energies in gross electricity consumption to 65 percent by 2030.
The consequences of the EU goals for the expansion of the wind energy sector in Germany: an annual increase of at least 9 GW in wind energy is required to produce sufficient CO_2-free electricity for Germany.

MS TEAMS

Lockdown on March 17, 2020, perfectly connected for mobile working as of March 18, 2020: Thanks, IWES IT!



– Wind energy creates workplaces: The sector employed around 100,000 people in Germany in 2020. –

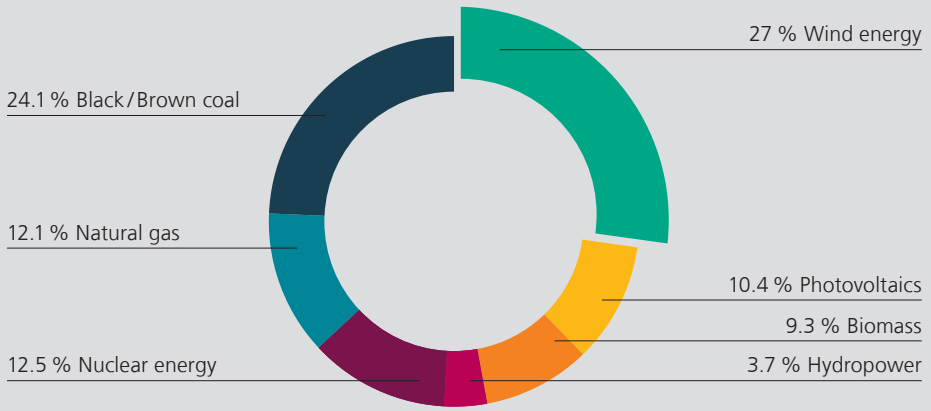
(German Wind Energy Association)

Wind energy: Most important source of energy for climate protection

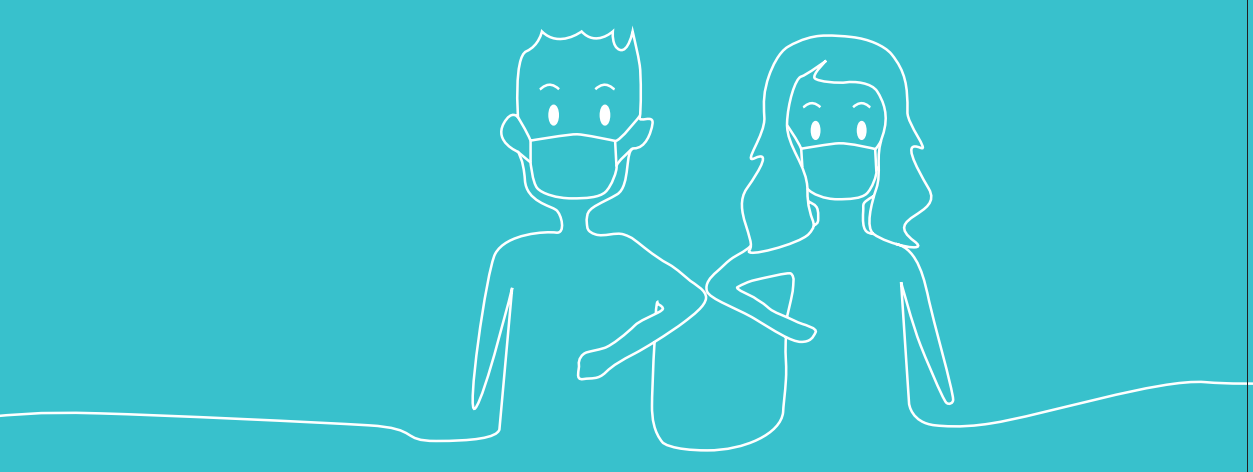
Wind energy produced around 132 terawatt-hours (TWh) of electricity in Germany in 2020: a production increase of around 4.6 percent compared with 2019. This put wind energy top of the energy mix, followed by brown coal, nuclear energy, gas, and solar energy. The share of onshore wind energy was approx. 105 TWh, with the remaining 27 TWh coming from offshore wind farms. The installed onshore wind capacity at the end of November 2020 was 54.6 GW; there were turbines with 7.74 GW installed offshore.

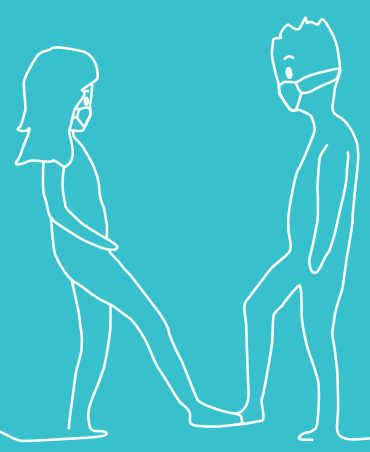
This wind energy development is based on the technologically highly developed systems technology, which, in turn, is the result of a variety of innovative research projects. In the past five years alone, work in the scope of almost 500 research projects at the Fraunhofer IWES has contributed to further reducing costs and optimizing wind energy technology. Numerous other research projects in the years to come will result in further substantial cost reductions and speed up the energy transition.

The electricity mix in Germany in 2020 (net)



Source: Strom-Report





COVID-19 GREETINGS

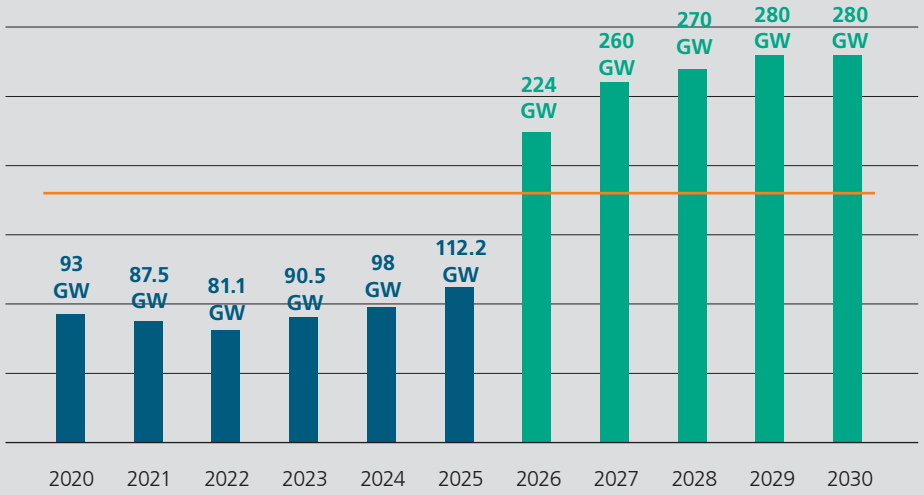
Hi/goodbye! Say hello with your elbow or offer your feet when you meet.

– The global energy transition is irreversible. –

(Source: IWR – International Economic Forum for Regenerative Energies)

Annual expansion of wind energy sector required globally

The annual expansion of the wind energy sector must be increased in this decade in order to keep the global average temperature rise well below two degrees Celsius.



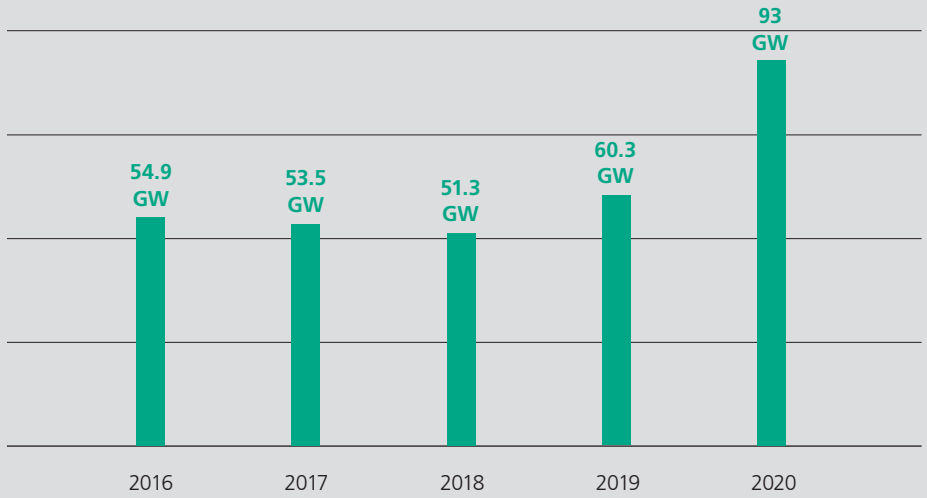
- Current market outlook
- Estimated installations to reach 2030 cumulative target for well below 2°C pathway (IRENA TES)
- Average installation level from 2020-2030 for well below 2°C pathway (IRENA TES)

Source: GWEC

NOTE: 180 GW is GWEC's calculation for the average annual wind installations required from 2020-2030 under IRENA's TES scenario, which targets 2,526 GW cumulative wind capacity by 2030 to keep global warming well below 2°C above preindustrial levels by the end of the century. See: IRENA (2020), Global Renewables Outlook: Energy transformation 2050.

Global increase in new wind power installations

2020 was a record year for the global wind energy industry. According to the Global Wind Energy Council (GWEC), wind turbines with a total capacity of 93 GW were installed onshore and offshore – primarily in China and the U.S.



Source: GWEC

DIGITAL CELEBRATIONS

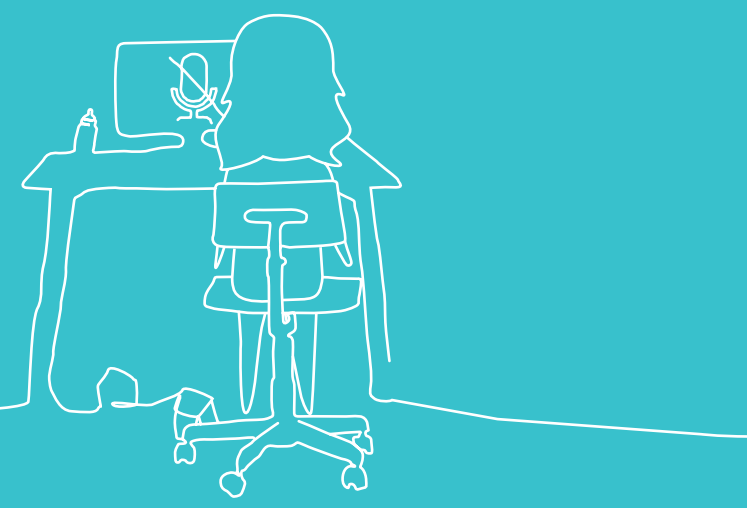
Digital, but heartfelt: Singing Happy Birthday online reinforces the bond between colleagues; the virtual advent calendar delivers surprises.

Strategic alignment 2025

The development and expansion of renewable energies also requires restructuring of the energy system, which is why Fraunhofer IWES has been expanding its strategic alignment for the period until 2025 with research activities covering all aspects of the topics of digitalization, sector coupling, and project planning optimization as well as the operation of wind turbines and farms.

MOBILE WORKING

Multitasking when mobile working:
Employees become caregivers.



– A large share of the energy demand in Europe could be covered by offshore wind energy. –

(Source: Ørsted)

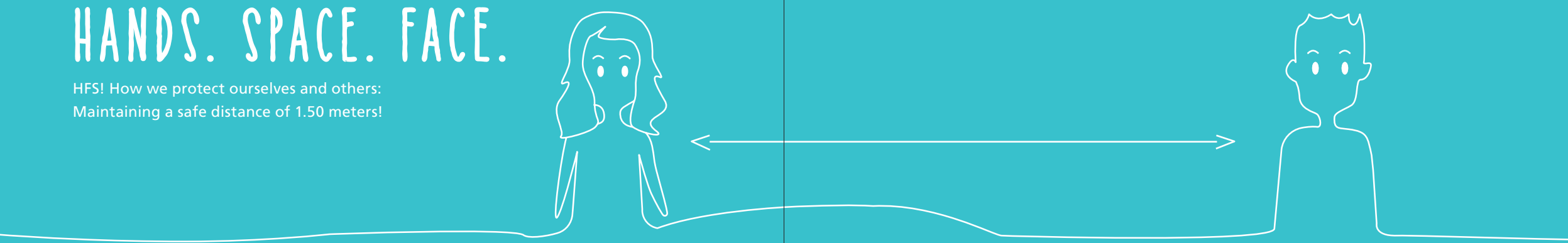
Fraunhofer IWES' Strategy 2025: Constant change as a "development constant"

True to the motto "Mehr Brain, weniger Beton" (more brain, less concrete), the IWES is focusing on digitalization, intensified research activities with regard to the requirements of project developers and operators, and sector coupling topics. Those are the key elements of the IWES' Strategy 2025 as developed over the last year. What initially sounds quite clear, however, also includes fundamental change processes at the institute, which can be most easily understood for the challenge of developing digital business models. These processes are very different in comparison with the classic test bench business, but it still makes sense to link them. Our keywords here are: virtual test benches, digital twins, etc.

Four projects are presented as examples of this transition on the following pages and illustrate the IWES' orientation in the current decade – from the classic rotor blade with new virtual approaches right up to the hot topic of hydrogen. Although a broad spectrum is being addressed with new approaches, the IWES brand essence remains Focus on Validation.

HANDS. SPACE. FACE.

HFS! How we protect ourselves and others:
Maintaining a safe distance of 1.50 meters!



– The global race to become the technology leader in climate protection has begun. –

(Source: Windkraft-Journal)

Lighthouse project: ReliaBlade

Improved monitoring and digital modeling of wind turbines and their rotor blades contributes to optimizing service costs for wind farm operators. This requires information about the service lives of rotor blades.
In order to achieve this, the ReliaBlade project is expanding knowledge of typical types of damage and defects in the rotor blade and modeling them. Damage models are being measured and validated both at component level and in full blade tests in cooperation with the Technical University of Denmark (DTU). When doing so, attention is paid to how the damage behaves when exposed to loads.

A wide range of different types of damage can be covered by introducing specific production errors – for example, faulty adhesive joints – into the rotor blades in a reproducible manner. Two approximately 30-meter-long rotor blades are being produced internally at Fraunhofer IWES for this purpose. The production process is also being closely monitored in order to be able to map influences and deviations precisely. The project partners expect the ReliaBlade project to result in a significant advance in the description of the material and structure behavior. In addition, the findings also represent the important initial steps on the road to a rotor blade's digital twin. Digitalization should help to lower the levelized cost of energy even further here.

Lighthouse project: Boulder Detection

The development of the offshore wind energy sector requires a precise understanding of the geological substrate at the site in order to be able to plan and install the foundations with great precision. In particular, large stones in the substrate (boulders) – which are encountered predominantly in glacial areas – pose a challenge for operators, as they can delay or even prevent the installation of the foundations.

In the Boulder Detection research project, the IWES in cooperation with the project partners investigated different seismic detection approaches with the aim of identifying boulders at depths of up to 60 meters below the seafloor. Special data collection and processing procedures were developed to render seismic diffractions useful for detecting boulders. In addition, efficient techniques for the processing and analysis of large quantities of data were developed to complete the operators' digital subsoil model efficiently. This research project was successfully completed in 2020 with the filing of two patents.

It was possible to demonstrate the direct benefit for the project planning of offshore wind farms afterwards: the Manta Ray surveying system developed in the project has already been employed for the detection of boulders at the Baltic Eagle offshore wind farm.

– Direct knowledge transfer in the industry in the scope of BMWi projects is at 90 percent. –

(Source: Research Alliance Wind Energy)

Lighthouse project: HiL-GridCoP

The necessary restructuring of the supply network due to the decentralized feed-in points combined with simultaneous tightening of the network requirements poses new challenges for the wind energy sector. Consequently, the focus is increasingly on the verification of the grid compatibility of wind turbines. In order to satisfy these requirements, a new test bench with a highly dynamically controllable drive unit has been set up within the framework of the HiL-GridCoP project and coupled with the grid emulator of the Dynamic Nacelle Testing Laboratory (DyNaLab).

A test methodology is also being developed in order to automate electrical certification in the laboratory and render future grid requirements verifiable. The test object consists of the following minimum system: generator, converter, and transformer as well as the wind turbine controller. The remaining components of the wind turbine are simulated virtually using the hardware-in-the-loop (HIL) method, which enables manufacturers to conduct precisely planned and cost-effective certification and validation tests. Operators of wind turbines benefit from being able to qualify their own retrofit and reproduce fault situations from the field.

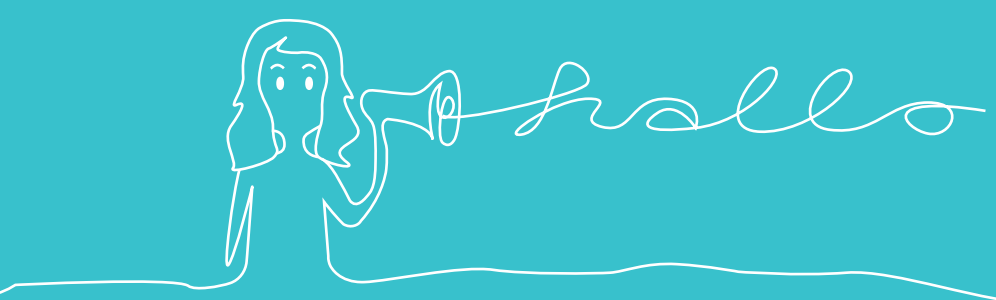
HiL-GridCoP key technical figures

- Test bench: 9 MW (13 MW overload) @1,000-1,800 revolutions per minutes (rpm)
- Grid emulator: Power of 44 MVA – up to 36 kV rated voltage, FRT-capable (emulation of grid faults)

Lighthouse project: Hydrogen – Green Gas for Bremerhaven

The Hydrogen Lab Bremerhaven is currently under construction at the former Luneort airport in Bremerhaven under the project title Hydrogen – Green Gas for Bremerhaven. This is where the systemic behavior of hydrogen technologies (especially electrolyzers and fuel cells), particularly in connection with wind energy, will be investigated from late 2022. Two electrolyzers in the megawatt class, a fuel cell, and an H2 CHP unit will be set up and operated to this end. Each of these systems will be set up on a flexibly usable site, with additional sites available to industrial customers.

The increasing decentralization of power generation due to the increased feed-in of renewable energies is a major challenge for the power grids, which have, so far, been geared to centralized large-scale generators. To ensure grid compatibility, the electrolyzers are connected to the virtual 44 MVA medium-voltage grid of the Dynamic Nacelle Testing Laboratory (DyNaLab). This can be used to test susceptibility to faults and grid compatibility. It will enable wind farm operators to assess the economic viability of employing hydrogen technologies at an early stage. Parallel to the test field setup, work is under way in other project groups at Fraunhofer IWES on developing a digital twin. The findings obtained here can be validated on an ongoing basis with real tests on the test field.

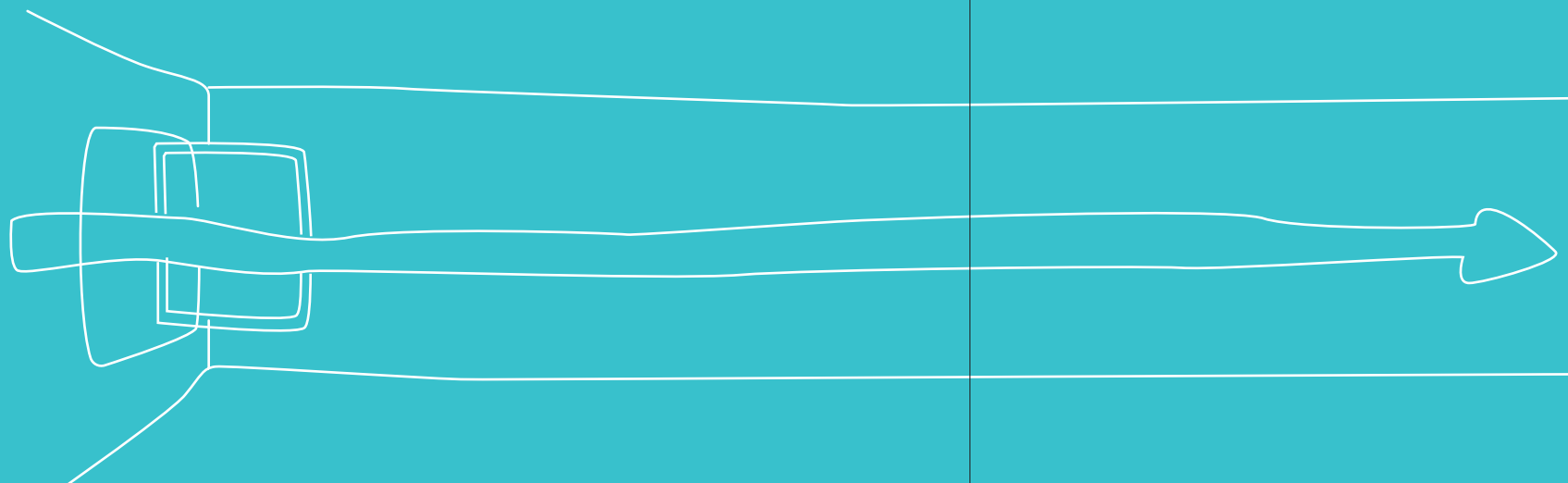


EMPTY OFFICES

Office plants and coffee machines aren't the only ones missing personal contact: IWES employees have largely switched over to mobile working since Wednesday, March 18, 2020.

One in wind energy

When everyone pulls together, a strategy can really become a reality. In the scope of an internal vision process, the IWES has been searching for answers to important questions such as: “How do we work?”, “What distinguishes us?”, and “What motivates us?”.



VENTILATE

Open windows frequently: Fresh air helps in the fight against COVID-19.

– The future of the planet will be decided within the next ten years. –

(Source: Siemens Gamesa Renewable Energy)

The IWES vision: One in wind energy

"As identifiers of opportunities and safeguarders of the future, we want to become (number) ONE in wind energy research – and contribute to the future viability of wind energy with the demands we place on innovation, our technological excellence, and the special IWES spirit. We are making our contribution to the energy transition for a global future worth living."

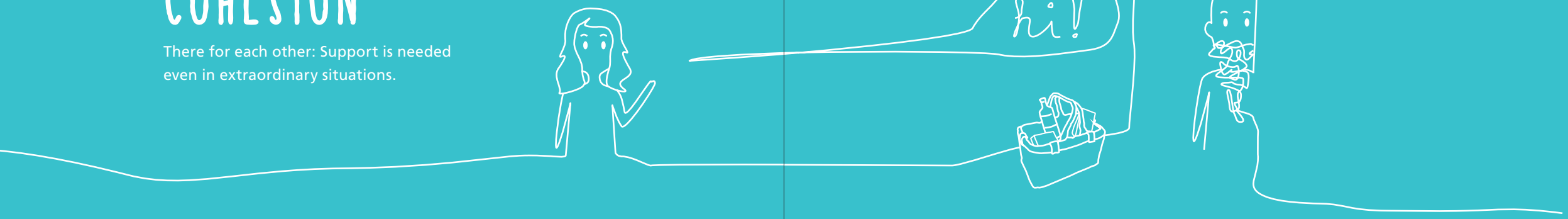
The very dynamic change process in the direct work environment, but also in the wind energy industry, is accompanied and focused with this snappy summary of our vision – the value-oriented and connecting orientation of the institute. The necessity arises from the quantity of simultaneous developments: accelerated globalization and consolidation in the wind industry, digitalization and virtualization of all processes, new work, and decentralization of the working environment – and all accompanied or even accelerated by the consequences of the pandemic.
This environment requires connecting fixed points for all employees with their very different duties, possibilities, and demands. With this in mind, a vision process was launched in 2020, which has provided the necessary guard railings for such a fast-paced environment.

"ONE in wind energy" is not meant to be understood in an arrogant or delimiting way, but rather as a claim to make a significant difference together with our work and to utilize our excellent capabilities optimally for this purpose. We understand wind energy as a team sport, which creates new spaces together with different talents, orientations, and expertise in addition to developing synergies.

ONE
in wind energy

COHESION

There for each other: Support is needed even in extraordinary situations.



– As technology leaders, German companies are at the forefront of the international trend toward CO_2-free energy production. –

(Source: German Wind Energy Association)

Fraunhofer IWES management team

The management team at Fraunhofer IWES is characterized by diversity, a passion for wind energy and the exciting challenges in the sector, and specialist expertise. We are "One in wind energy". Together with its partners and customers, the institute takes on complex challenges at eye level and looks for solutions – including with unusual approaches. The IWES brings movement into deadlocked initial situations with fresh ideas. Innovation is both an incentive and a promise at the same time. Joining forces will allow the IWES to continue to pave the way to the future of energy.

IWES SPORTS PROGRAM VIRTUAL

Fit and healthy on your screen:
The IWES gets you moving.

– Technological progress:
The IWES contributes to innovative capacity with 33 registered patents. –

(Source: Fraunhofer IWES)

The board of trustees – calibration with experts from the industry, research, and funding organizations

The institute's different stakeholders are reflected in the composition of the board of trustees: turbine manufacturers, operators, and suppliers as well as scientists and awarding authorities are all represented. They meet once a year to discuss new developments, strategic decisions, and the "guarding rails" for positioning on the wind market – similar to a supervisory board in the private sector. Different perspectives on global events ensure that the institute can better assess and serve customer groups around the globe. Further scientific networking is also promoted by the course set in this body.

Members of the board of trustees
Dr. Stephan Barth – ForWind
Dr. Maite Basurto – Siemens Gamesa Renewable Energy, SGRE
Prof. Dr. Werner Beba – CC4E /HAW Hamburg
Rüdiger Eichel – Ministry for Science and Culture of Lower Saxony
Dr. Ursula Eul – Fraunhofer LBF
John Feng – Titan Technologies Co., Ltd.
Timo Haase – German Federal Ministry for Economic Affairs and Energy
Andrew Jamieson – ORE Catapult
Bento Koike – Korecarbon
Frank Virenfeldt Nielsen – JSB Plast A/S
Matthias Schubert – wyncon GmbH
Paula Segelken – Ørsted
Dr. Antje Wagenknecht – Fachagentur Windenergie an Land e. V.

Scientific innovation

Scientific excellence is of central importance for Fraunhofer IWES in order to be considered by politicians and funding bodies as an outstanding player in the German scientific landscape, to acquire and retain customers as an attractive cooperation partner, and to be successful in the fight for the best brains.

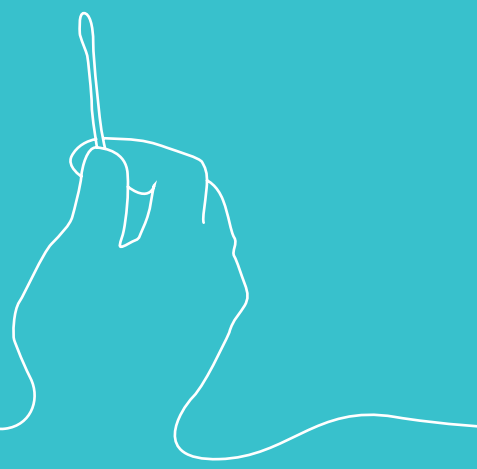
Between 2016 and 2020, Fraunhofer IWES realized a total of 462 research projects. This included 133 public, nationally funded projects and 16 EU projects. The remaining 313 research projects were cooperations with companies in the industry.

Patents are of great economic importance: with its 33 registered patents, the IWES contributes to technological progress and the innovative strength of companies.

54 master's and diploma theses supervised by IWES employees were completed in 2020, nine research-focused doctoral students completed their doctorates, and a total of 100 peer-reviewed scientific publications were published by IWES researchers.

ALMOST DONE

Test, vaccinate, stay optimistic:
We are looking forward to returning to normality!



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