DTU Wind Energy in profile

2019

Contents

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Today, it is possible to test seven wind turbines in Østerild.

Wind Energy for the World

At DTU Wind Energy, our purpose is to develop wind energy for the world. We do this by

- enabling the scientific and engineering foundation through research
- educating bright young staff for the sector through our master, PhD and continued education programs
- innovating, testing and validating new technology in close cooperation with the industry and societal stakeholders
- offering decision support to authorities, organisations and companies through research-based scientific advice.

The climate challenge is global, the transition towards sustainable energy is global, and the wind industry, including Danish industry, is global. Hence, a global outlook and international cooperation is not only necessary, but also deeply ingrained in our daily life as a mission-driven department.

At DTU Wind Energy, we strongly believe that wind energy is part of the global sustainable energy system of tomorrow. Nevertheless, to exploit the full potential of the technology, we need to continue to reduce the cost of wind power, increase its value and develop new solutions to make the technology environmentally and socially sustainable.

We also believe that the development and deployment of wind energy can contribute significantly to several of the UN's Sustainable Development Goals. The way to do so is to create international partnerships.

At DTU Wind Energy, we are proud of our international activities and collaboration across the globe. In addition, we are even prouder of being able to attract the best scientists, engineers and students. In addition, for many we are the preferred university partner in wind energy.

On this basis, our vision is to be the preferred university partner for the national and international wind energy sector as regards research, education, innovation and advice.

"Our vision is to be the preferred university partner."

Peter Hauge Madsen
Head of Department

Research

DTU Wind Energy collaborates with leading research institutions, universities, industry and governments from all over the world, providing added value to the industry and society. The research is organized in four strategic programmes to ensure effective planning, coordination and implementation of the research and innovation efforts.

Wind Turbine Technology

The focus is on how to further develop and mature the wind turbine technology by providing methods, models and tools to extent the rotor design complex, and cover new concepts, components and their design fundamentals.
We develop High Fidelity turbine models to improve design validation and risk assessment of existing and new turbine concepts.
We investigate how the integration of rotor design, control, support structures, drive train models and electrical system can enable the optimization of Wind turbine design.

Offshore Wind Energy

The aim is to maximize the value of offshore wind energy by developing research-based solutions to the challenges specific to the offshore sector. This includes reducing risk in the design and installation phases, optimizing O&M and Wind farm layout as well as developing new offshore grids, transmission and distribution concepts.
With advanced metocean measurements and models that account for wind, waves, currents, loads and environmental exposure, we aim to optimize wind farm layout including electrical infrastructure.

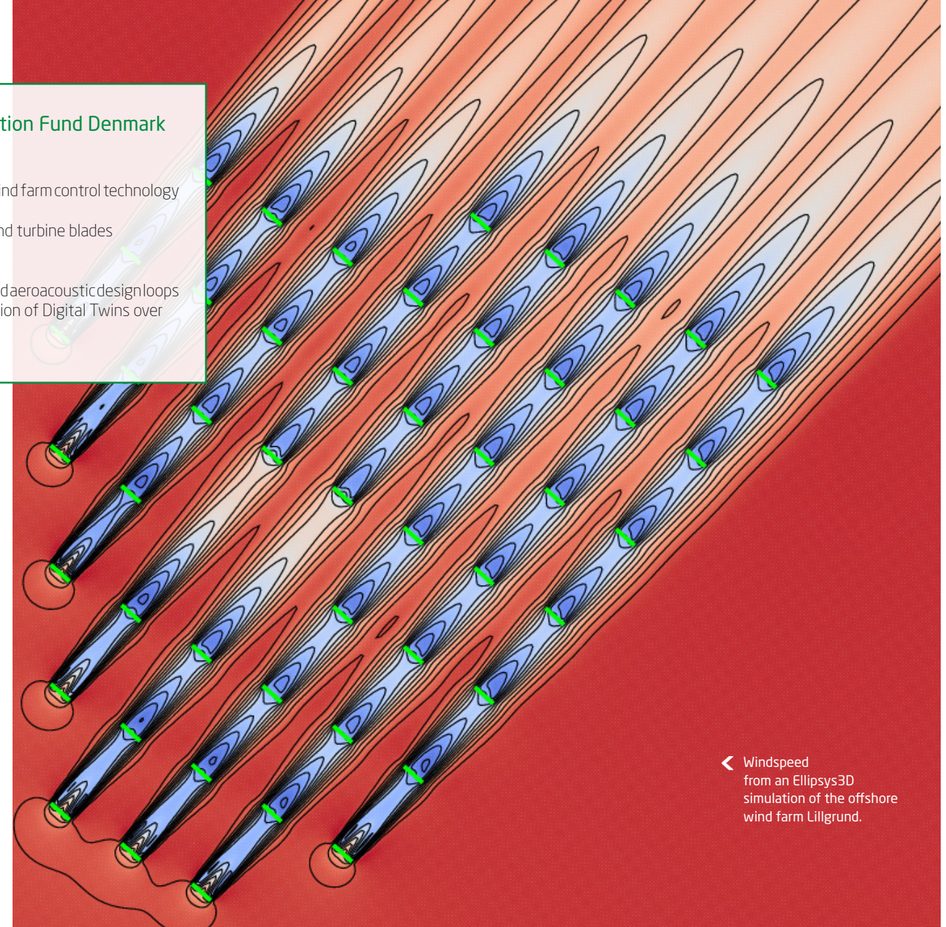
Recent Research Grants from EUDP and Innovation Fund Denmark

Innovationsfonden Denmark
- DecoWind - Development of low-noise and cost-effective wind farm control technology
- FloatStep
- DURALEDGE - Durable leading edges for high tip speed wind turbine blades

Energiteknologisk Udviklings- og Demonstrationsprogram
- AeroLoop - Accelerate and increase quality in aerodynamic and aeroacoustic design loops
- RELIABLADE - Improving Blade Reliability through Application of Digital Twins over Entire Life Cycle
- GASP - Global Atlas for Siting Parameters

Siting and Integration

This aim is to develop knowledge and tools for a more cost effective siting and integration of single wind turbines and wind farms, including the electrical design and control aspects of wind turbine technology as well as planning and public perception.
With a better understanding of the atmosphere through the study of meteorology and turbulence, we enable new planning tools and new design basis for wind turbines/farms.
The goal is to establish a validated system engineering framework for an optimal design and siting of wind farms, including turbine characteristics, control, load reduction and power assessment.



Windspeed from an Ellipsys3D simulation of the offshore wind farm Lillgrund.

Materials and Structures

This programme will enable the development of the next generations of efficient and sustainable materials and structures for wind turbine systems, based on targeted research producing innovative tools and methods for design, modelling, manufacturing, testing and decommissioning.
In addition, we work on increasing the reliability of structures by linking numerical methods and testing from microscale, over coupons and sub-components to full scale.
This programme also focuses on reducing operational expenses (OPEX) of wind turbine systems by improving the fatigue performance of materials and structures, and by improved lifetime predictability of individual components.

Duraledge

Duraledge is a new project funded by Innovation Fund Denmark. The aim is to improve the lifetime of wind turbine blades, and to reduce service and maintenance costs during the operation of the turbines by predicting, modelling and understanding the leading edge erosion mechanisms and by developing new highly durable protective coatings and guidelines for the coating development.

Education

DTU Wind Energy provides education and training in most critical wind energy disciplines such as, aerodynamics, atmospheric physics and materials, grid integration and offshore wind energy. The department offers courses in various wind energy related topics and hosts two master programs in wind energy.

Graduate degrees (MSc)

DTU is the only university in the world to offer a full two-year graduate programme in wind energy. The students acquire a thorough knowledge of technologies related to wind power production that qualifies them to analyse, design, develop and operate future wind energy systems.

PhD

An important part of DTU Wind Energy is our PhD programme. PhD students carry out an important part of the department's research. We also have industrial PhDs, which means that they are partly funded by companies and spend part of their time there.

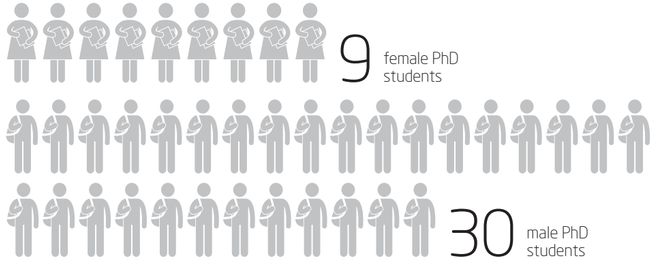
As of September 1st 2018, there are 39 PhD Students enrolled at DTU Wind Energy. Twelve of them are expected to finish their PhD in 2018

Advisory Board

An advisory board for education has been established with participants from the industry and former students, creating a forum for discussion and initiatives with the purpose of ensuring the readiness of the students for the labour market. In general, the students are encouraged to do their MSc project in collaboration with an industrial partner.

Wind Energy Master

In 2017, DTU Wind Energy launched a new Online Master, that covers all essential aspects of wind energy engineering based on the research activities taking place at DTU Wind Energy. The Wind Energy Master programme is a web-based education with a broad academic profile. The programme covers all essential aspects of wind energy engineering based on the research activities taking place at DTU Wind Energy. (http://www.wem.dtu.dk/)



www.vindenergi.dtu.dk/english/education
www.coursera.org/learn/wind-energy

MOOC

MOOC is a Massive Open Online Course about wind energy is available at no cost through Coursera.org. Through online video lectures and calculation exercises, participants can learn the basics of wind energy engineering and consider a future career in this field. Since the beginning in February 2016, almost 37.000 people have participated in the course

European Wind Energy Education

The Erasmus Mundus European Wind Energy Master (EWEM) is a two year programme where the students can specialise in the following tracks: Wind Physics, Rotor Design, Electric Power Systems, and Offshore Engineering. The programme involves four universities: Delft University of Technology, Technical University of Denmark, Norwegian University of Science and Technology and Carl von Ossietzky Universität Oldenburg.

"Working on my PhD project at DTU Wind Energy by the wind turbines next to my office is a great experience! I have become part of a well-established system at the department and my work contributes to that. I have all the support to present my work at conferences all over the world and learn from others. That is how research grows."

PhD Özge Sinem Özçakmak

"Coming to DTU Wind Energy you're close to the industry. You know that if you produce something valuable to the industry, it will be put to the test right away and be used. I think that is really motivating."

PhD Mads Holst Aagaard Madsen

Innovation at DTU Wind Energy

DTU Wind Energy ensures that the knowledge resulting from its research is applied in the real world to create jobs, growth and support the development wind energy for the world.

Industry standard software

DTU Wind Energy has developed several software tools that have become industry standard software within the areas of wind energy resource assessment, wind power integration, wind farm layout, turbine design and advanced models for wind flow in terrain as well as around the turbine blades.

Innovative solutions for mega turbines

DTU Wind Energy has developed a number of innovations that have changed the possibilities for wind energy technology. Together with Danish Company, LM Wind Power, DTU Wind Energy developed a hybrid composite material that enable LM Wind Power to construct the world's longest wind turbine blade. At 88,6 meter, each blade is longer than the wingspan of a Boing 747.

Projects (public and commercial)

From the design of new wind turbine blades to the optimization of towers and substructures or the layout of wind farms, DTU is working with industry to make wind power cheaper and more reliable.

What kind of layout results in the optimal economic performance of the wind farm throughout its lifetime? That is, among others, exactly the question that the TopFarm framework tries to answer. This open source tool is developed at DTU Wind Energy and is partly funded by the department, external research projects and through direct collaboration with our industrial partners.

DTU has developed the advanced software that allow the use of 3 laser scanners to make 3D images of wind fields behind wind turbines at up to 6 kilometers distance and systems that can be used in wind tunnels for precise wind measurements.

The wind tunnel is one of the biggest university wind tunnels in the world with a fan driven by a 2.4 MW motor, giving a volume flow up to 630 cubic meter per second corresponding to a maximum test section velocity of about 105 m/s or 378 km/h.

Scientific advice at DTU Wind Energy

DTU Wind Energy provides research-based fact-finding, consultancy and advisory services to Danish and international authorities on technical requirements and strategies for planning in the wind energy sector. Through our activities around the world, DTU Wind Energy is supporting the promotion of wind power and building long lasting institutional partnerships.

International scientific advice

DTU Wind Energy has a long history of supporting the development of wind energy globally. Since the early 1980's the wind energy department located at DTU Risø Campus has helped setup wind energy test stations, performed wind resource assessments that has led to national promotion of wind power as in countries such as South Africa and Mexico.
Today, part of these activities are done through the DTU Renewable Energy Service initiative that supports the international efforts in establishing integrated energy systems and the utilization of variable renewable energy sources. (www.repli.dtu.dk)

DTU Wind Energy actively supports the UN Sustainable Development Goals on affordable and clean energy.

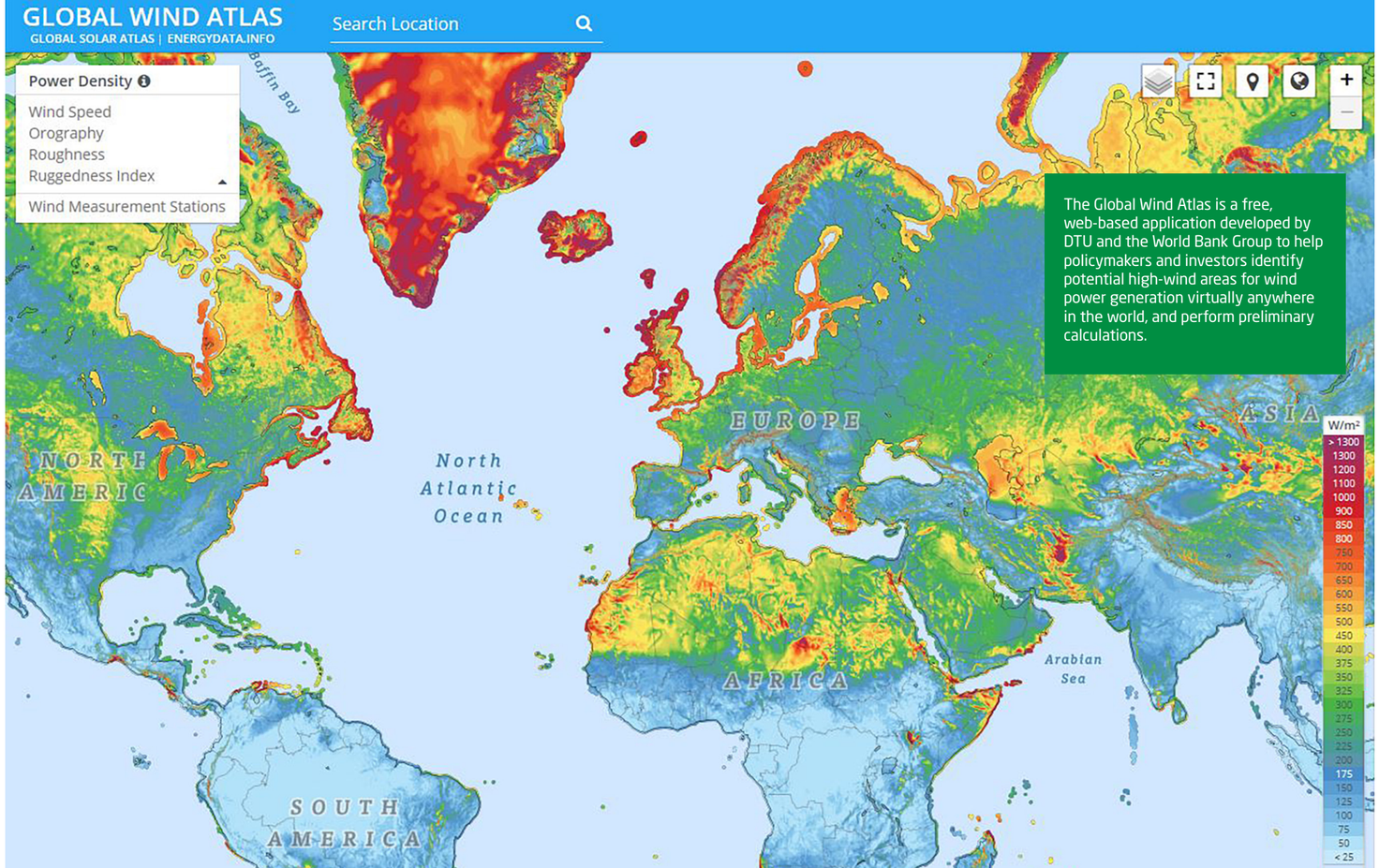
Capacity building - education

As an international front runner in wind energy research and education, DTU Wind Energy is continuously offering courses and workshops around the world to support capacity building as new countries enters into wind energy development at national scale. Courses combine background courses in the use of software such as WAsP and tailored courses addressing country specific needs.

Partnerships

A particular focus for DTU Wind Energy's international scientific advice is the collaboration with international organisations such as the World Bank. DTU Wind Energy has developed the Global Wind Atlas, subsequent projects with the World Bank and international partners have supported further advancements.

The Kenya MiniWind project investigates the potential for integrating small wind turbines in solar powered minigrids in Kenya. Together with the NGO Vedvarende Energi, Vestas and local partner Kenya Climate and Innovation Centre, the project is looking at regulatory, social and technical issues that shape the market for wind in hybrid mini-grid systems. The project is funded by Danida Market Development Partnerships programme.



The Global Wind Atlas is a free, web-based application developed by DTU and the World Bank Group to help policymakers and investors identify potential high-wind areas for wind power generation virtually anywhere in the world, and perform preliminary calculations.

Test Stations and Research Facilities

DTU Wind Energy is responsible for the operation of two of the best test sites for very large turbines and home to a range of state-of-the art test facilities for commercial validation and research development

Material Testing

At DTU Wind Energy, we work within all fields of wind energy. We have well-equipped laboratories for manufacturing as well as accredited equipment for mechanical testing of composite materials for wind turbine blades. Our work is focused on control and monitoring of the vacuum infusion process and development of methods for static and fatigue testing, together with damage detection.

Large Scale Facility

Large Scale Facility provide research projects and companies with possibilities to perform tests at very large scale. In addition to the testing facilities, DTU Wind Energy offer cooperation with a dedicated team of leading scientists and techniques that can deliver state of the art analysis.

The facility consists of a 1560 square metre test hall with three test stands capable of testing 45 m, 25 m and 15 m blades or other slender structures.

Large Scale Facility at DTU Risø Campus was inaugurated November 2017

WATCH VIDEOS

- Østerild test centre **dtu.dk/profile4**
- Poul la Cour Wind Tunnel **dtu.dk/profile5**

Poul La Cour Wind Tunnel

The wind tunnel is among the biggest university owned tunnels in the world, and the combination of test possibilities makes the wind tunnel one of a kind, not just nationally but globally. This is due to the size of the wind tunnel and high flow speed as well as the possibility to combine measurements of aerodynamics and noise.

Høvsøre

Today, seven wind turbines are being tested at Høvsøre. The wind conditions at Høvsøre allow an almost uninterrupted wind speed coming from the North Sea and it reaches the wind turbines at a very high speed corresponding to the turbines erected offshore.

Østerild

Altogether nine test sites are placed in Østerild. In 2017, The Danish government decided to expand the test centre to nine test stands and allow for the erection of test turbines of up to 333 metres. At the visitor centre in Østerild, guests can learn more about wind energy and the wind turbines at the National Test Centre for Large Wind Turbines.

The research wind turbine V52

The wind turbine is used for the researchers' experiments at DTU. Especially for tests of meteorological equipment, structural and electric measurements and verifications of models of calculations. The 850 kW wind turbine arrived at DTU Risø Campus in 2015.

Network and Alliances

International alliances and strategic partnerships are essential to excel in research, education, scientific advice and innovation; promoting quality, impact and synergy.
The department has a leading role in major Danish, European and international alliances and partnerships.

IEA Wind TCP secretariat

In 2019, DTU Wind Energy takes over the secretariat for the International Energy Agency's Technology Collaboration Programme for Wind. Led by Ignacio Marti, a dedicated group at DTU Wind Energy will support the IEA Wind Executive Committee and collect the intelligence on developments in wind energy research and innovation.

European collaboration

DTU has been a leading member of the Joint Programme for Wind Energy under the European Energy Research Alliance (EERA) and is also a member of the steering committee of the European Technology and Innovation Platform for Wind Energy (ETIPWIND) and the European Academy for Wind Energy (EAWE). Our activities here are important to extend collaboration and knowledge sharing as well as to support European policy makers in creating the right funding instruments and priorities for wind energy research in Europe.

Building on strengths

The Danish wind energy sector has a long and unique tradition for public-private collaboration. DTU Wind Energy is an active partner in the collaboration, but we also continue to develop the ideas and initiatives to maintain a strong Danish wind power hub in a global business environment. The department contributes to this through Megavind, which is the Danish platform for research and innovation in the wind energy sector.

International Energy Agency

ETIP Wind
EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

DANISH WIND INDUSTRY ASSOCIATION

DFFV
Danish Research Consortium for Wind Energy

EERA
European Energy Research Alliance
JP WIND

Wind EUROPE

eawe
european academy of wind energy

Recent Highlights

DTU Wind Energy Researcher Appointed Research Data Ambassador

The Research Data Alliance (RDA) has appointed researcher Nikola Vasiljevic as one of its first European Ambassadors.

RDA is a community-driven initiative launched in 2013 by the European Commission, the United States Government's National Science Foundation and National Institute of Standards and Technology, and the Australian Government's Department of Innovation with the goal of building the social and technical infrastructure to enable open sharing and re-use of data.

As a RDA Ambassador, Nikola Vasiljevic will act as liaison between wind energy and RDA communities, enabling two-way communication and engagement vector: promoting RDA outputs and perspectives while streamlining insights and practical contribution from domain focused data communities into the work of RDA.

New Generation of Wind Scanners Developed by DTU

Researchers at DTU Wind Energy have developed and tested a new generation of short-range wind scanners that with six-inch optics have a sufficiently high resolution to measure tip vortices from measurements behind the turbine from ground level.

As the first in the world, the researchers have made measurements of eddy current in the so-called tip vortices with the new wind scanners.

Tip vortex are circular patterns of rotating air behind e.g. a wind turbine blade or an aircraft wing. Up until now, it has not been possible to measure vortex from the big turbines directly in the air behind the turbines.

Results from the 4-Rotor Concept Turbine

From April 2016 to December 2018, Vestas Wind System A/S has built and operated a wind turbine equipped with four rotors at the Risø Campus. Vestas Wind System A/S has investigated the power curve and wind turbine wake in close collaboration with DTU Wind Energy. Power curve measurements and numerical simulations showed that the interaction of the closely spaced rotors could lead to a gain in power of about 0-2 per cent below rated. The power gain can result in a 1.5 per cent increase in annual energy production. Additionally, numerical simulations predicted a shorter wake recovery distance of 1-1.4D compared to an equivalent single rotor wind turbine with a rotor diameter D. The faster wake recovery has the potential to reduce the wind turbine inter spacing in wind farms of multi-rotor wind turbines.

The results will be published in scientific discussion article https://www.wind-energ-sci-discuss.net/wes-2018-77/, which is currently under review.

Danish-Norwegian Cooperation on Offshore Wind Expanded

DTU, the Norwegian University of Science and Technology (NTNU) and the research institute SINTEF enter into even closer cooperation.

The new cooperation is also the start of a new joint research centre on offshore wind.

The new centre, Nordic Offshore Wind R&I Centre - NOWRIC will develop better and reasonable solutions for offshore wind farms together with the industry.

Topics for the collaboration include:

- Foundations, materials and marine operations
- Network connection, system integration and energy storage
- Digitization, operation and maintenance and management systems for offshore wind farms
- DTU, NTNU and SINTEF have some of Europe's strongest marine environments. Furthermore, research environment and infrastructure complement each other.

Organization

DTU Wind Energy consists of 11 sections

The management of the department includes the Head of Department, Peter Hauge Madsen, and the Deputy Head of Department, Peter Hjuler Jensen. The management structure of the department is organized with a single management team with the Head of Department as chairman and the Deputy Head of Department and the ten head of sections as members.

Vision

DTU Wind Energy is a globally leading department for wind energy with scientific and engineering competences in the international front and with a unique integration of research, education, innovation and public/private sector consulting.

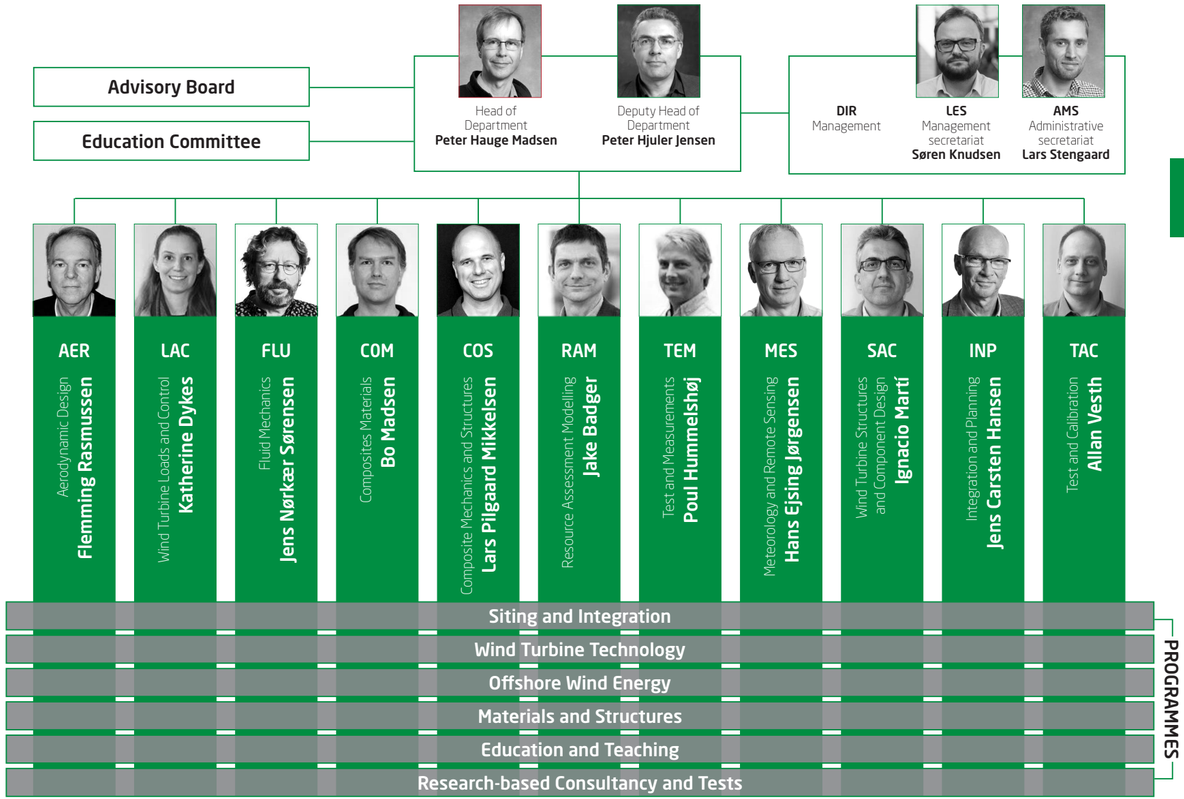
DTU Wind Energy is a key contributor to the realization of the vision of Denmark as a world leading wind power development centre and the activities support and develop the global wind energy sector with a special effort on national industrial development and innovation.

Mission

To develop new opportunities and technology for global and Danish exploitation of wind energy and improve the competitiveness compared to other energy sources

To develop scientific and engineering knowledge and competencies in key fields, which are central for the development and use of wind energy and provide the basis for advanced education at DTU in national and international co-operation.

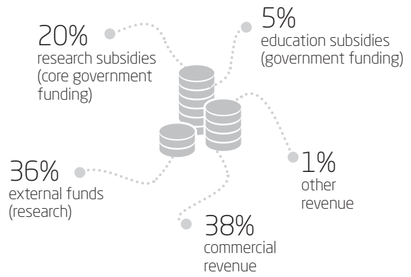
To facilitate the implementation and exploitation of research and development through research-based consultancy and services to industry and the public sector, innovation and education comprising training courses at DTU.



Finances

Income

€28 million



Ordinary operating costs

€25 million

Investments 4%

Publications

Scientific contributions to conferences	138
Scientific articles in WoS indexed journals:	122
Scientific publications, articles and contributions without peer review:	79
PhD theses:	11
Contributions to books and reports:	8
Scientific articles in other journals:	6
Contributions indicated as popular:	4
Monographs:	1

Human resources in 2018

255 total staff

21 % are women
48 % have an international background
36 different nationalities
43 is the average age of people employed at DTU Wind Energy

37 PhD fellows employed at DTU Wind Energy

81 % have an international back ground
18 % are women

DTU

www.vindenergi.dtu.dk/english

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