Opportunities for collaboration: DTU perspective

Supergen ORE Hub Annual Assembly

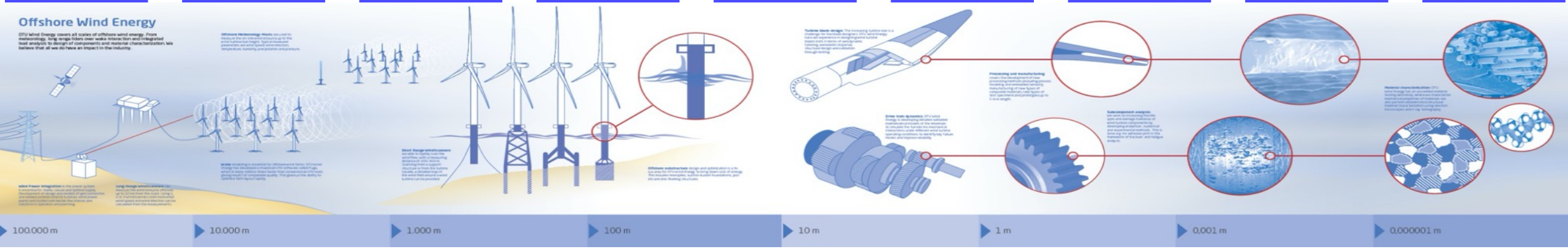
21st January 2021

Ignacio Marti
Head of Division Wind Energy Materials and Components. Technical University of Denmark (DTU)
Executive Secretary IEA Wind TCP

DTU Wind Energy research landscape

DTU Wind energy

- Resource Assessment Modelling
- Meteorology and Remote Sensing
- Grid Integration and Planning
- Loads and Control
- Fluid Mechanics
- Aerodynamic Design
- Structures and Component Design
- Test and Measurements
- Composites & Materials Mechanics



Wind Energy Materials & Components

Wind Turbine Design

Wind Energy Systems

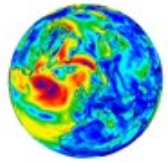
Education and Training

Research based consultancy and tests

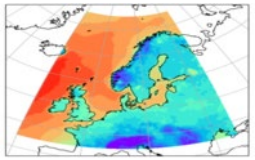
Wind Energy Systems Division

Atmosphere ---> Plant ---> Energy ---> Society

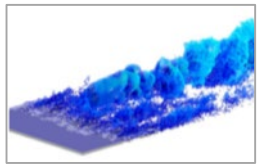
Wind Resource Assessment



Global



Regional



Site

- Multi scale flow modelling for offshore condition incl. blockage & wake effects
- Offshore meteorology, turbulence analysis and modelling
- Accurate spatial mapping methods for turbine design parameters
- WAsP (Wind Atlas Analysis Program): https://www.wasp.dk/
- Global Wind Atlas: https://globalwindatlas.info/

Wind Field Measurement

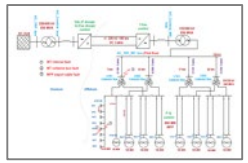
- 3D measurement of wind flow using lidar technology
- http://www.windscanner.eu/

System Design

TOPFARM

- Layout optimization of offshore wind farms (incl. floating)
- Park control & operation optimization strategies
- Energy production prediction (power estimation incl. wake losses)
- Design based cost engineering
- Hybrid system, Power to X (Green H_2 and others)

Grid Integration



- Electrical system design & component sizing
- Offshore HVDC, Converter & Plant control (AC-DC lab)
- Grid code compliance and Grid service
- Long term collaboration with ENTSO-E, IEC, IEA

Society
Market
Policy

- Wind farm financial and market models
- Wind project planning and development
- Social acceptance and Science communication
- Energy policy and EIA analysis

Wind Turbine Design Division

Rotor and airfoil design

- Engineering aerodynamics
- Aerodynamic validation
- Aerodynamic rotor design and optimization
- Aerodynamic control
- Airfoil design

Aero- and fluid dynamics

- Numerical fluid mechanics
- Aero acoustics, noise emission modelling
- CFD tools
- Fluid-structure modelling

Turbine response and control

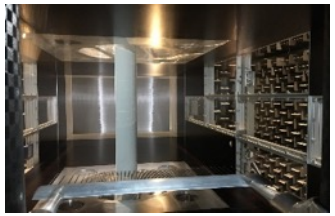
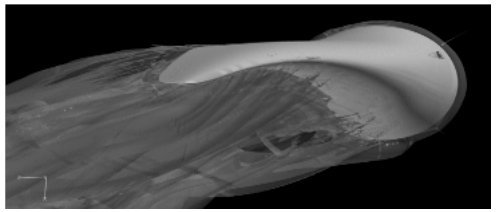
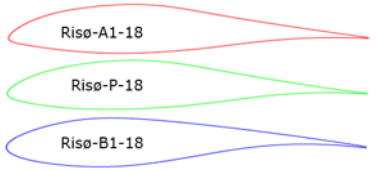
- Dynamics
- Aeroelasticity
- Load models and validation
- Hydrodynamics
- Wave and current loads modelling and validation
- Control models and validation

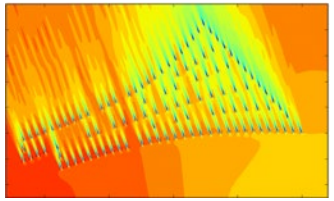
Measurement systems and methods

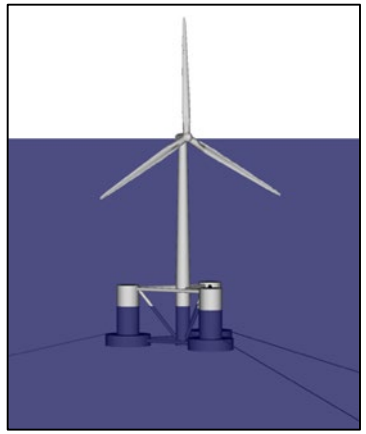
- Measurements systems
- Sensor development
- Lidar development
- HW and SW
- Data management

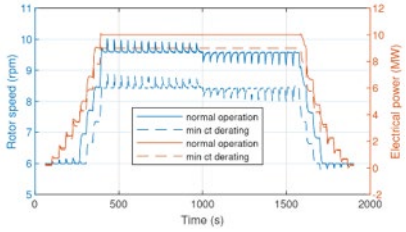
Testing and calibration

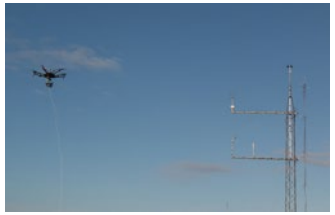
- Turbine performance testing (loads, power, noise, electrical)
- Testing methods for turbines
- Calibration methods





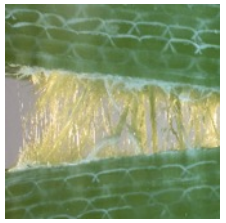


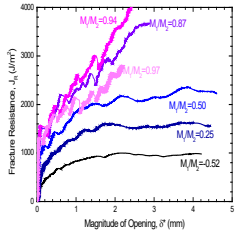


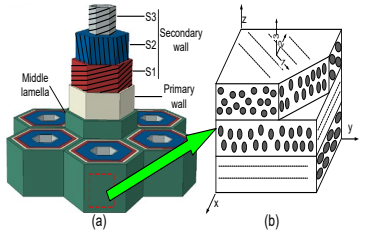

Wind Energy Materials and Components Division

Materials Structures Components

Composites Analysis and Mechanics

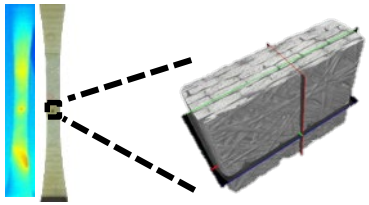






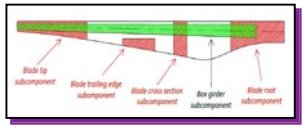
- Composite materials
- Composite mechanics and micromechanics. NDT
- Microscale degradation
- Damage modelling of materials and structures
- Blade coatings and Leading Edge Erosion
- Blade repair methods

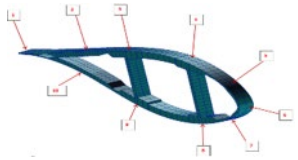
Composites Manufacturing and Testing

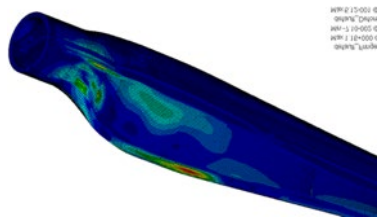


- Manufacturing techniques and modelling, BLADELAB
- Material characterization. X-ray Tomography
- Mechanical testing. FIBERLAB, TESTLAB, MICROLAB
- Sustainable composites: bioresins, biomaterials, thermoplastics,
- Recycling of composites

Structural Design and Testing

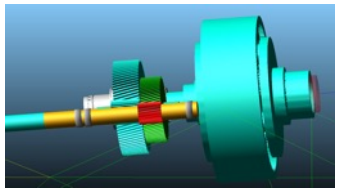


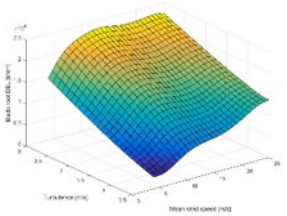


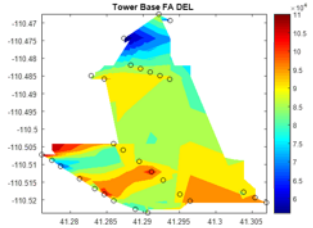


- Blade structural response and design
- Fatigue, failure mechanisms and progressive damage
- Design for manufacturing
- Experimental techniques. LARGE SCALE FACILITY (blade testing)
- Digitalization. BECAS design tool
- Digital twin (blades)
- Bearings: white etching cracks. BEARINGS TEST LAB

Structural Integrity and Loads Assessment







- Modelling environmental conditions, loads, risk and reliability
- Prediction of failure probability, probabilistic design
- Offshore support structure design, floating wind turbine system design
- Remaining life and life extension, O&M strategies
- Digital twin (drive train, support structures)

Digitalization

Sustainability

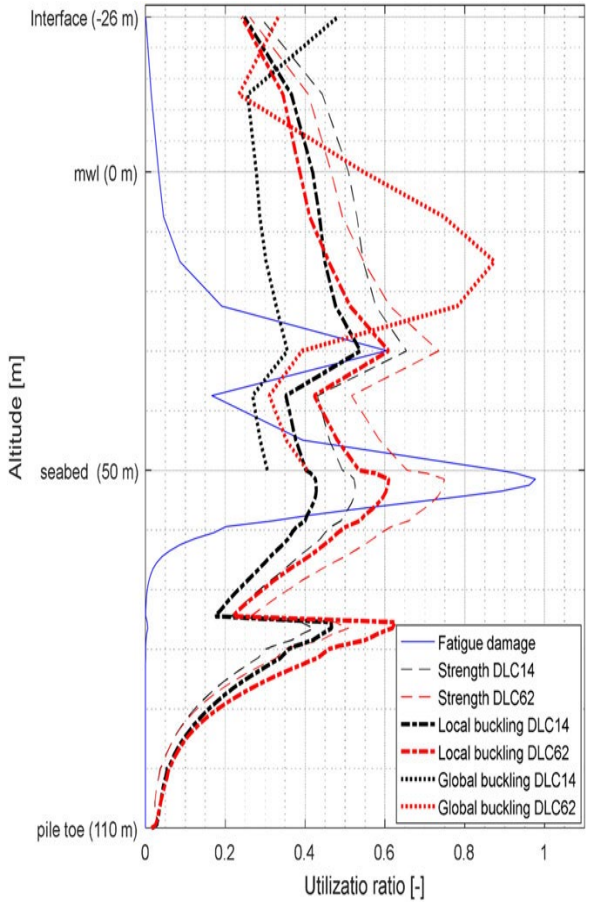
REMAINING LIFE OF OFFSHORE WIND FARMS

Opportunity for collaboration:

Remaining Life Prediction of Offshore Support structures based on Measurements and calibrated load simulations

- Support structures are designed for site specific conditions.
- Life Extension of wind turbine is strongly dependent on the fatigue life margins available on the support structure
- Assessment of the support structures of the full wind farm.

Monopile Limit State Evaluation



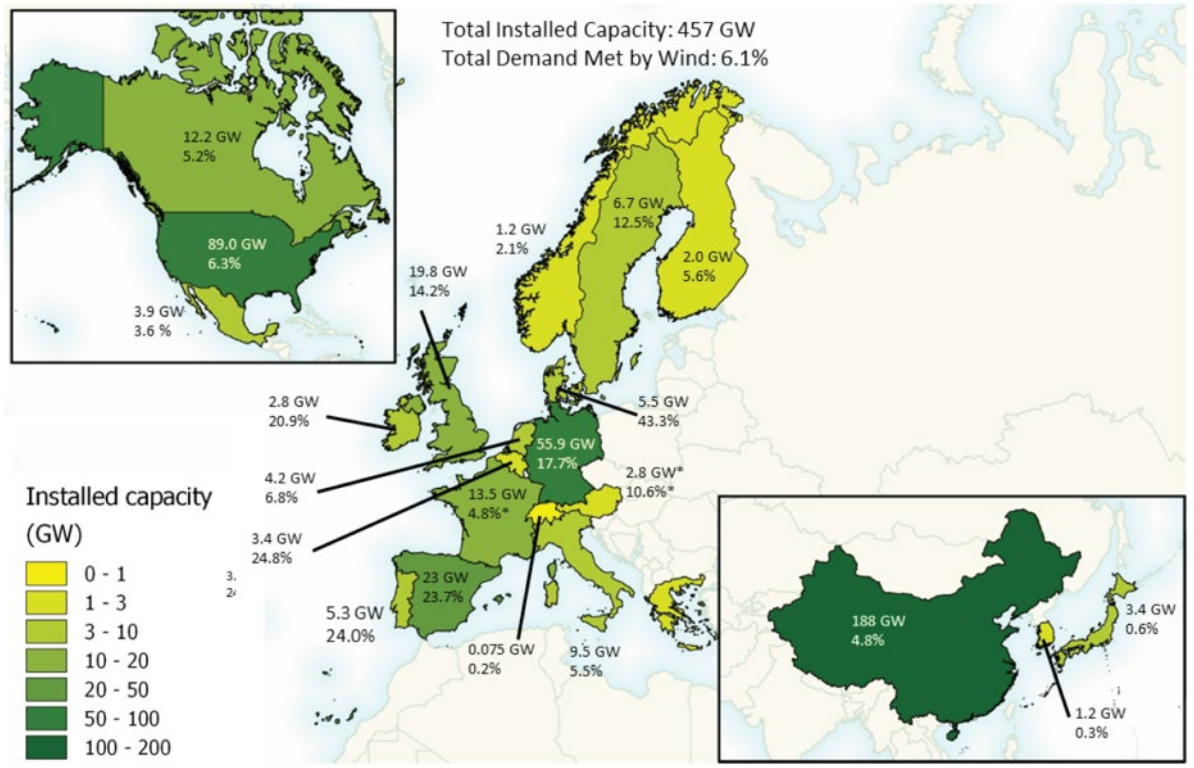
IEA Wind Technology Collaboration Program

ieawind.connectedcommunity.org

Contact point for the UK:
ORE Catapult
(Steve Wyatt)

Membership Represents 85% of Global Capacity

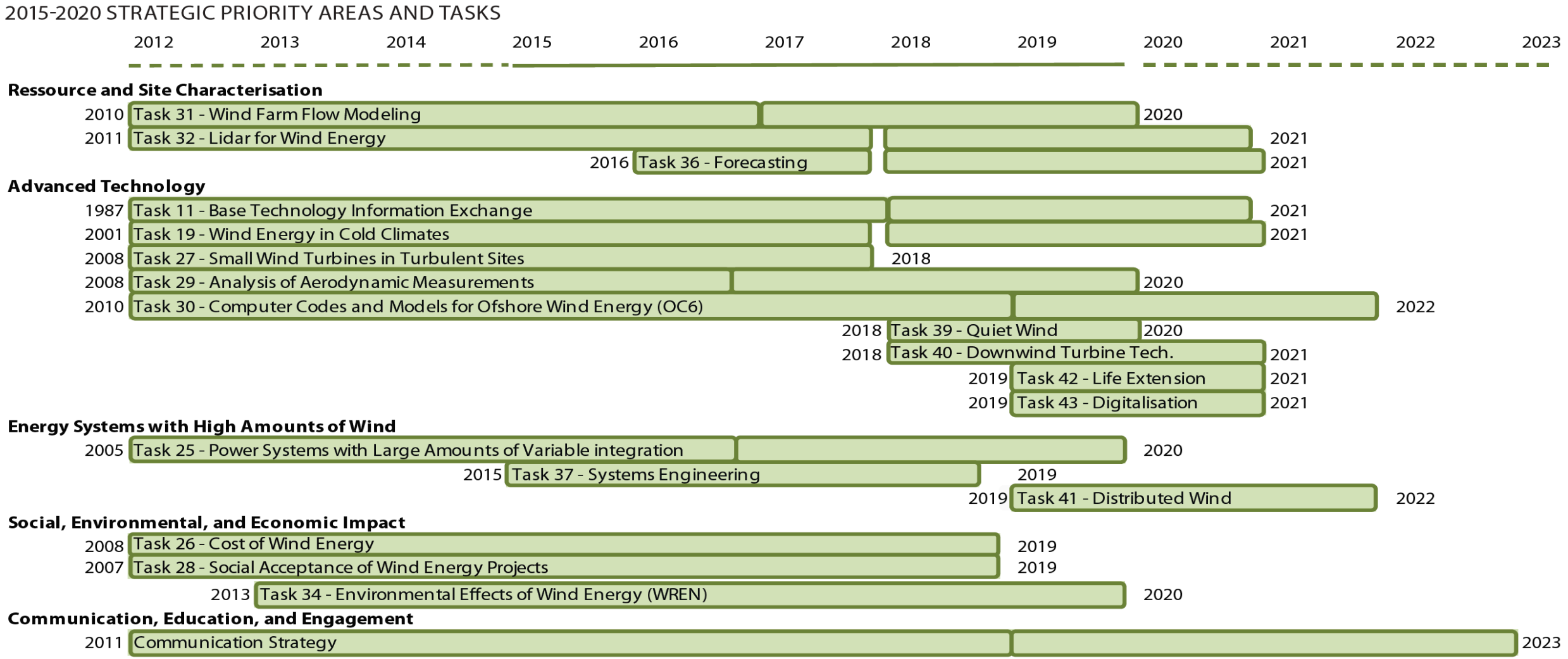
- Austria
- Belgium
- Canada
- Chinese Wind Energy Assoc.
- Denmark
- European Commission
- Finland
- France
- Germany
- Greece
- Ireland
- Italy
- Japan
- Korea
- Mexico
- Netherlands
- Norway
- Portugal
- Spain
- Sweden
- Switzerland
- United Kingdom
- United States
- WindEurope



In process:

- India
- Romania
- Singapore
- Vietnam

IEA Wind TCP collaborative Research Tasks overview



UK participation in IEA Wind TCP active Research Tasks (I)

- **Task 11. Base Technology Exchange**. ORE Catapult
- **Task 19. Cold Climate**. DNV GL
- **Task 25. Design and Operation of Power Systems with Large Amounts of Wind Power**. Imperial College, Strathclyde University
- **Task 26. Cost of Wind Energy**. ORE Catapult
- **Task 30. Offshore Code Comparison Continuation with Correlation and unCertainty (OC6).** DNV GL, Orcina, University of Exeter, Queen's University, Newcastle University, University of Strathclyde

UK participation in IEA Wind TCP active Research Tasks (II)

- **Task 32. Lidar**. Babcock International Group, Carbon Trust, DNV-GL, EDF Energy, Fraunhofer Applied Photonics, Frazer-Nash Consultancy, GE Renewables, Innogy, Mott MacDonald, Natural Power, NEL, Nordex, ORE Catapult, Ørsted, RES, SgurrEnergy, SSE, Texo Drone, University of Glasgow, University of Strathclyde, Wind Farm Analytics, Wood, ZephIR Lidar, ZX Lidars
- **Task 34. WREN – Working together to Resolve Environmental Effects of Wind Energy**. Marine Scotland Science
- **Task 36 Forecasting for wind power**. UKMO, UK MetOffice, University of Strathclyde, University of Reading
- **Task 37. Wind Energy Systems Engineering**: Integrated Research, Design and Development. BVG Associates Ltd., DNV GL, ORE Catapult

IEA Wind Task 45: Recycling of wind turbine blades

Increasing amount of end of life wind turbine blades (Europe, USA, China will be the first ones). A lot of research on recycling is ongoing, however **only few recycling solutions are available**.

>> The purpose of this task is to identify the barriers and mitigation strategies for the implementation of large scale wind turbine blades recycling solutions.

3 Focus areas:

1. Technical aspect of recycling and reuse of blade materials;
2. Analysis and value chain;
3. Legislations, standards and certifications.

Goals: Establish best practice for the management of end of life blades (incl. social and environmental impacts), Guidance on upscaling recycling processes and establishment of recycling value chains.

Start: Early 2021
Coordination: DTU/NREL