Research Potentials in Industry seen from a Research Department

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Wind Energy Denmark
Annual Event 2016
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Mission

DTU will develop and create value using the natural sciences and the technical sciences to benefit society.

H.C. Ørsted, founder of DTU in 1829
Contribution to Danish Society from Wind Energy

Udvikling i vindenergi som andel af det samlede elforbrug 2006-2015

Turnover in the Danish wind industry, 2006-2015, Bn EUR

The wind industry's exports, 2006-2015, Bn EUR
**Jobs in the wind energy sector**

**Europe:**

EWEA estimates:
- 240,000 jobs in 2010 (30% from 2007)
- 520,000 jobs in 2020
- 800,000 jobs in 2030

**Denmark:**

Number of full-time employees, 2006-2015

- WIND INDUSTRY
- ENERGY COMPANIES

![Graph showing employment trends](image)

![Pie chart showing education levels](chart)
Good framework conditions for the sector

Well-established sector
• Costs
• Operation
• Integration

Focus on
• Industrialization
• Reliability, Quality and validation
• Optimization
• Innovation

Need for
• Access to leading knowledge
• Test and demonstration facilities
• Qualified staff
• Market for demonstration

University role
• Research (knowledge generation)
  – Education and training
  – Contribution to innovation
  – Tests and consultancy
Wind energy research - Comparisons

Web of Science - Publications

Public. 2010-15

Citations 2010-15

Web of Science 21-10-2016, topic: "wind energy" OR "wind power" OR wind turbine" OR "wind farm"
Research and test facilities

Public. 2010-15

- Full-scale testing facilities (Østerild and Høvsøre)
- Blade tests (Blaest)
- LORC
  - Nacelle tests
  - Support structures
  - Climate chambers
- Windscanner
- Research turbines
- National Wind Tunnel
- Large scale structural test facility (Villum foundation)
- Lab facilities
- ....
# National Research Budgets

<table>
<thead>
<tr>
<th>Nation</th>
<th>2015 Budget in mio EUR</th>
<th>Jobs X 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>14.3</td>
<td>31</td>
</tr>
<tr>
<td>Germany</td>
<td>91.1</td>
<td>150</td>
</tr>
<tr>
<td>Spain</td>
<td>86.4</td>
<td>20</td>
</tr>
<tr>
<td>Japan</td>
<td>117.2</td>
<td>4</td>
</tr>
<tr>
<td>USA</td>
<td>98.3</td>
<td>88</td>
</tr>
<tr>
<td>European Commission</td>
<td>91.9 (research)</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>197.6 (demonstr.)</td>
<td></td>
</tr>
</tbody>
</table>

Source: IEA Wind TCP, 2015 Annual Report
Research and Innovation Agenda in Europe ETIPWind

Objectives of the Strategic Research and Innovation Agenda 2016

Reduce costs
Facilitate system integration
Reinforce European technological leadership
Ensure first-class human resources
GRID SYSTEMS, INTEGRATION AND INFRASTRUCTURE
Developing wind energy capabilities to fit in a grid with significant shares of renewable energy.

OPERATION AND MAINTENANCE
More and further enhanced sensors enabling more reliable and efficient operation and maintenance of turbines, improving yields and optimising lifetime.

INDUSTRIALISATION
Developing the value chain and facilitating the interaction between stakeholders notably through standardisation to achieve economies of scale and faster production.

OFFSHORE BALANCE OF PLANT
Exploring new areas for offshore wind and making it competitive with conventional generation through the improvement of substructures and foundations, site access, offshore grid infrastructure, assembly and installation.

NEXT GENERATION TECHNOLOGIES
Consolidating the scientific base for wind research and enabling pioneering research to lead to breakthroughs.

FROM R&I TO DEPLOYMENT
Adapting markets and policies for optimal integration of renewables, integrating wind turbines into their natural surroundings, ensuring public engagement and acceptance and deploying human resources.
Research Coordination and co-operation in Denmark

The Danish Research Consortium for Wind Energy (DFFV)

• The Danish Technical University (DTU)
• Aalborg University (AAU)
• Aarhus University (AU)
• SDU
• DHI
• FORCE Technology
• DELTA.
1. Wind resources, external design conditions and wind energy forecast
2. Aerodynamics, aeroelastics and aerocustics
3. Structural design, machine elements and materials
4. Electrical design
5. Power system integration
6. Offshore wind energy
7. Experimental test & measurements
8. Environmental issues
9. Societal issues
European Research Collaboration
European Energy Research Alliance - JPWind

- Wind Conditions.
  Coordinated by DTU, Denmark.

- Aerodynamics.
  Coordinated by ECN, the Netherlands.

- Offshore Wind Energy.
  Coordinated by SINTEF, Norway.

- Grid Integration.
  Coordinated by Fraunhofer IWES, Germany.

- Research Facilities.
  Coordinated by CENER, Spain.

- Structures and Materials.
  Coordinated by Fraunhofer IWES, Germany.

- Wind Integration – economic and social aspects.
  Coordinated by DTU, Denmark

New pilot programme on cold climate potentially in the making
# EERA JPWIND Members

## Full participants
- DTU Wind Energy (DK)
- ECN (NL)
- SINTEF (NO)
- CRES (GR)
- CENER (ES)
- Fraunhofer IWES (GER)
- Forwind - University of Oldenburg (GER)
- LNEG (POR)
- VTT (FI)
- TUBITAK (TU)
- University of Strachclyde (UK)
- CNR (IT)
- Belgian Energy Research Alliance (BE)
- EPFL (CH)

## Associated Participants
- DHI, University of Aalborg, Dublin (IR) (DK)
- TU Delft, WMC (NL)
- NTNU, IFE, UoB, CMR (NO)
- MARINTEK, Sintef MC (NL)
- NKUA (GR)
- CIEMAT, IREC, CTC, CIRCE, Tecnalia, IK4 Alliance (ES)
- IEN (PO), DLR, TU München (GER)
- Forwind Hannover, Uni. of Stuttgart, RWTH Aachen (GER)
- University of Porto (POR)
- CATAPULT, Loughborough Uni. (UK)
- Politecnico di Milano, RSE S.p.A. (IT)

## Applicant(s):**
- TNO (NL), IMP PAN (PL), LORC (DK), Uni. of Uppsala (SE), Cranfield (UK), BSC (ES)
Navigation in Danish, European and global “waters” – Focus and work sharing

Reflections on objectives

Maintain and strengthen Denmark as a leading center for

- Development and demonstration of wind turbine technology
  - Rotor design
  - Controls
  - Converter design
  - …

- Deployment (markets, projects)
  - Geo-physical models
  - Integration
  - Planning, public engagement
  - …

How and who

- Education and training
  - Based on pre-competitive, basic (fundamental research, low TRL-levels)
    - Through dual degree cooperation, e-learning

- Cooperation with large enterprises
  - Enabling research (Knowledge, concepts, models)
  - Commissioned research support
  - Sharing through partnerships

- Cooperation with SMEs
  - Innovation and testing
Cooperation between industry and research institutions

PRESENT

• Collaborative co-financed research with Danish or EU public funding
• Training courses
• Software (proprietary)
• Research-based services
  – Commissioned research
  – Consultancy work
  – Testing and measurements

FUTURE

As present plus new models

• Collaborative research with multi-memberstate funding
• Collaborative research without public funding
  – Bilateral, Joint Industry Projects
• Open science & Innovation
• SMV (Inno-booster)
• Digital training solutions
  – E-learning, Lecture streaming
• Software
  – Open source, joint development

Research creates value
-if and when-implemented in society
Concluding remarks

• Strategic focus to strengthen the competitive advantage of Denmark
• Together strengthen the strategic priority of public wind energy research in Denmark
• New models for industry-university cooperation
• Focus and coordination of the Danish research, test and education efforts through MEGAVIND
• Plan the Danish effort in an European and global context

Thank you for your attention