

## Final report

### 1.1 Project details

<b>Project title</b>	Megavind – The strategic partnership for Wind Energy
<b>Project identification (program abbrev. and file)</b>	File number: 64013-0118
<b>Name of the programme which has funded the project</b>	EUDP
<b>Project managing company/institution (name and address)</b>	Danish Wind Industry Association Rosenørns Allé 9, 5. Sal DK-1970 Frederiksberg C
<b>Project partners</b>	The project had no partners, but was instead supported by 16 companies organized in a steering committee (see the complete list in section 1.2)
<b>CVR</b> (central business register)	10401488
<b>Date for submission</b>	09-07-2013

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## 1.2 Short description of project objective and results

Megavind is the strategic research partnership for the entire Danish wind industry. Megavind is where the industry and academia meet and work together to chart a course for wind energy research, development, testing and demonstration.

Megavind (2013-2016) is a continuation and further development of Megavind – A Strategic Partnership for Wind Energy, which has produced sector strategies and recommendations since its foundation in 2006.

The Danish wind industry is still among the leaders on the world market for wind energy and Megavind has supported the continuation and consolidation of the stronghold of the Danish wind industry through a focused and strategic sector approach to research, development, test & validation, demonstration and education.

Megavind's vision is for Denmark to maintain and further develop its position as the hub of the world's leading companies and research institutions within the field of wind energy and that these companies will be the first to deliver competitive wind energy on market terms (without subsidies) in the dominating wind energy markets.

Megavind's objective is to continue to be the national platform on which the industry and research institutions develop strategies and recommendations for research, development, test and validation, demonstration and education within the field of wind energy technology.

Megavind is supported by all major stakeholders in the Danish wind industry through representatives from the leading Danish wind turbine manufacturers, energy companies, universities and companies that provide components and tests to the industry.

The members of the Megavind Steering Committee are:

- Siemens Wind Power A/S, Per Hesselund Lauritsen (Chairman)
- Aalborg University, John Dalsgaard Sørensen
- Danish Research Consortium for Wind Energy, Peter Hjuler Jensen
- DNV GL, Bente Vestergaard
- DONG Energy, Jørn Scharling Holm
- DTU Wind Energy, Jens Nørkær Sørensen
- E.ON Wind, Niels Emsholm
- Envision Energy, Anders Rebsdorf
- Fritz Schur Energy A/S, Torben Jørgensen
- Global Lightning Protection Services A/S, Søren Find Madsen
- Ib Andresen Industri, Søren Eriksen
- MHI Vestas Offshore Wind, Henrik Bæk Jørgensen
- Mita-Teknik A/S, Thomas Andersen
- Vattenfall Vindkraft A/S, Bo Svoldgaard
- Vestas Wind Systems A/S, Peter Lindholst
- Øglænd System A/S, Claus Vilhelmsen
- Energinet.dk, Aja Brodal (observer)
- The Danish Energy Agency (EUDP), Hanne Thomassen (observer)
- Offshoreenergy.dk, Maj Sallingboe (observer)

The fifth phase of Megavind (2013 – 2016) has built on the strategies and recommendations from earlier phases and has added the following six new strategies:

- Danish Knowledge institutions and their Contribution to a Competitive Wind Industry
- Increasing the Owners' Value of Wind Power Plants in Energy Systems with Large Shares of Wind Energy
- A common industry method and benchmark tool to calculate Levelized Cost of Energy for offshore wind energy
- Technological solutions to reduce the environmental impacts of wind-energy systems
- Test and Demonstration Facilities for Wind Energy Needed to Promote a Competitive Wind Industry in Denmark
- Strategy for Extending the Useful Lifetime of a Wind Turbine

### 1.3 Executive summary

Megavind has guided the strategic research, development, test & validation, demonstration and education agenda within the wind industry to focus on the areas with the largest potential for reducing cost of energy. In phase five (2013 – 2016) it has done so in the areas of: Cooperation between industry and research institutions, increasing production value for owners of offshore wind farms, cost of energy calculation, externalities from wind turbines, test and demonstration and extension of life time for wind turbines.

Below is a list of the main recommendations from the six strategic areas:

#### M1: Danish Knowledge Institutions and their Contribution to a Competitive Wind Industry

Main recommendations for further research within the areas of:

- Mapping of R&D cooperation needs
- Address gaps/ barriers between industry and university competences
- Create awareness in industry and universities of current R&D opportunities
- Find and market the "exemplary cases"
- Analysis of existing gap in educational value chain

#### M2: Increasing the Owners' Value of Wind Power Plants in Energy Systems with Large Shares of Wind Energy

Main recommendations for further research within the areas of:

- Retrofit of components
- Power tuning apps and flexible power limitation of individual turbines
- Reducing lost production via diagnostics
- Reactive power CAPEX reduction
- Increased voltage levels in power collection grids
- New ancillary services

#### M3: LCOE Calculator Model

Megavind developed a calculator for levelized cost of energy (LCOE), which has been widely accepted in the industry. The LCOE calculator functions as a tool for dialogue in the cooperation between e.g. a wind turbine manufacturer and a supplier, who might have different ways of calculating cost. Furthermore, it functions as a guidance for universities in prioritizing the research areas with the largest potential for reducing cost of energy.

The LCOE calculator has been adopted by e.g. Siemens Wind Power, MHI Vestas Offshore Wind, DTU Wind Energy, and Wind Europe (the European wind industry organization) and it is used by many more stakeholders in the industry.

In the long term it is the ambition, that the LCOE calculator shall make it possible to produce a benchmark for progress towards reducing LCOE in offshore wind.

#### M4: Technological solutions to reduce the environmental impacts of wind-energy systems

Main recommendations for further research within the areas of:

- Wind-turbine noise
- Visual impact
- Wind-turbine impact on radar systems
- Birds
- Marine mammals
- Bats
- Decommissioning offshore wind farms
- Ice throw and blade failure

#### M5: Test and Demonstration Facilities for Wind Energy Needed to Promote a Competitive Wind Industry in Denmark

Main recommendations for further research within the areas of:

- Ensure availability of additional test pads for full-scale wind turbines
- Further develop and strengthen Danish facilities and capabilities for full scale nacelle testing
- Develop a converter-based grid test facility for test of wind turbine generators (WTG's)
- Build test facilities for 100+ meter blades
- Improve our understanding of operational environmental conditions and develop more efficient, accelerated test methods
- Develop more efficient methods for measuring offshore wind conditions
- Faster and more efficient, advanced blade-test methods
- Strengthen higher education in testing

#### M6: Strategy for Extending the Useful Lifetime of a Wind Turbine

Main recommendations for further research based on four scenarios:

- No design basis
- System-level turbine parameters available without operational measurement history
- SCADA-based measurements are available for at least a few years
- Multiyear load measurements are available

### **1.4 Project objectives**

#### **M1: Danish Knowledge Institutions and their Contribution to a Competitive Wind Industry**

The completion of the strategy was delayed from the original plan of publication date in April 2014, since it wasn't planned, that the secretariat should author the strategy. It required more resources than there was available at the time and therefore it was approved by the steering committee to delay the strategy. The strategy was further delayed due to challenges in access to updated data from the research portal [energiforskning.dk](http://energiforskning.dk).

The strategy was completed in May 2015 and a workshop was held at The Danish Innovation Fund. Since then, DTU Wind Energy has followed up on the recommendations. Based on the Megavind recommendations they subsequently published an analysis on how DTU Wind Energy can improve their cooperation with small and medium sized

companies. The analysis can be found [here](#).

**M2: Increasing the Owners' Value of Wind Power Plants in Energy Systems with Large Shares of Wind Energy**

Work on the strategy started as planned in the fall of 2013 and was published in the summer of 2014. Subsequently a strategy release was held at Energinet.dk in August 2015.

**M3: LCOE Calculator Model**

The ambition was to continue the work on the Megavind 2010 Offshore strategy, which made the goal to reduce cost of energy for offshore wind by 50% between 2010 and 2020. Therefore, the ambition of this strategy was to produce a benchmark of the development towards the 50% cost reduction goal. However, it turned out to be impossible to collect (even historical) data from the industry due to competition legislation. Therefore, that part of the strategy could not be completed.

However, Megavind has produced a very accurate calculator for levelized cost of energy (LCOE) for offshore wind.

Work on the strategy started in the fall of 2013 as planned, but the strategy was delayed due to the challenges in collecting data for the benchmark analysis. The LCOE calculator was published and presented at the [EWEA Offshore conference](#) in March 2015.

**M4: Technological solutions to reduce the environmental impacts of wind-energy systems**

The startup of the strategy was delayed from May 2014 – April 2015 due to delays in M1 and M3. The strategy was published in May 2016 with presentations at the DTU event "[Acoustic Day](#)".

**M5: Test and Demonstration Facilities for Wind Energy Needed to Promote a Competitive Wind Industry in Denmark**

This strategy was an update of the Megavind 2008 strategy "Strategic areas for research, development and demonstration of wind energy". The recommendations of the 2008 strategy led to the establishment of Østerild - National Test Centre for Large Wind Turbines.

Work on this strategy was initiated in November 2014 and completed in January 2016. The strategy was delayed due to the fact, that LORC (who were hired to author the strategy), ended the contract due to changes in staff. The Megavind secretariat therefore had to author the strategy.

The strategy was released at LORC at a conference with participation of the Minister for Energy, Utilities and Climate. Subsequently this had led to the initiation of a work between the government, DTU Wind Energy and The Danish Wind Industry Association on the realization of the recommendation, for further prototype test pads.

**M6: Strategy for Extending the Useful Lifetime of a Wind Turbine**

Due to delays in M1 and M3 the startup of the strategy was postponed until the fall of 2015. The final strategy was published in July 2016.

Megavind will have an exhibition stand for the strategy at the conference "[Vindtræf](#)" hosted by the Danish Wind Turbine Owner's Association, which will take place on November 5<sup>th</sup> 2016.

## 1.5 Project results and dissemination of results

Megavind's objective is to continue to be the national platform on which the industry and academia develop strategies and recommendations for research, development, test and validation, demonstration and education within the field of wind energy.

This objective has been strengthened through this fifth phase of Megavind.

It has done so by:

- Being the united voice of industry and academia on research for wind energy. This is e.g. exemplified by the fact, that the Minister for Energy, Utilities and Climate received the strategy "Test and Demonstration Facilities for Wind Energy Needed to Promote a Competitive Wind Industry in Denmark" on behalf of the government
- Hosting conference sessions at the EWEA Offshore conference and the conference "Wind Energy Denmark"
- Developing own web page ([Megavind.windpower.org](http://Megavind.windpower.org)), where all information about Megavind is published along with the strategies
- Writing more than 15 articles specifically about the strategies that were published in the newsletter of the Danish Wind Industry Association (5000 recipients)

## 1.6 Utilization of project results

The strategies and recommendations are public available and distributed in the industry through several channels. Firstly, the 16 members of the Megavind steering committee functions as ambassadors in order to use and to distribute the recommendations to the industry. Secondly all strategies are launched at an event (either individual event or at a conference). Thirdly the recommendations and strategies are communicated to the broad wind industry through the newsletter of The Danish Wind Industry Association (app. 5000 recipients) and finally all strategies and information about Megavind is available on the Megavind webpage.

## 1.7 Project conclusion and perspective

See section 1.3.

The research recommendations from the strategies outlined in section 1.3 work as a guideline for the research areas with largest potential for reduction in cost of energy for the wind industry. A few examples on how the recommendations have been received is given below.

The Megavind recommendation "address gaps/ barriers between industry and university competences" and "create awareness in industry and universities of current R&D opportunities" in the strategy "Danish Knowledge Institutions and their Contribution to a Competitive Wind Industry" have led to the analysis "[Vindbranchens vækstlag](#)" from DTU Wind Energy focusing on how DTU can increase their cooperation with SME's. Furthermore the same Megavind recommendations have led to the project "[Udviklingsprogram for underleverandører i vindmølleindustrien](#)" funded by the North Denmark Region, Central Denmark Region and the European Regional Development Fund.

The recommendation for further prototype test pads in the wind industry from the strategy "Test and Demonstration Facilities for Wind Energy Needed to Promote a Competitive Wind Industry in Denmark" has led to the establishment of a working group in the Danish Business Authority working with the Danish Wind Industry Association and DTU Wind Energy on the establishment of further prototype test pads.

In the same strategy the recommendation for further develop and strengthen Danish facilities and capabilities for full scale nacelle testing has been used in the application for funding to the HALT (Highly Accelerated Lifetime Test) test bench at LORC.

The LCOE Calculator Model has led to the fact, that Siemens Wind Power, MHI Vestas Offshore Wind and DTU Wind Energy now utilizes the Megavind model as their basis model for calculating cost of energy.

## **Annex**

Learn all about Megavind at: <http://megavind.windpower.org/> and find the strategies here:

### **M1: Danish Knowledge Institutions and their Contribution to a Competitive Wind Industry**

- [Article](#)
- [Strategy launch](#)

### **M2: Increasing the Owners' Value of Wind Power Plants in Energy Systems with Large Shares of Wind Energy**

- [Article](#)
- [Strategy launch](#)

### **M3: LCOE Calculator Model**

- [Article](#)
- [Strategy launch, article from strategy launch](#)

### **M4: Technological solutions to reduce the environmental impacts of wind-energy systems**

- [Article](#)
- [Strategy launch](#)

### **M5: Test and Demonstration Facilities for Wind Energy Needed to Promote a Competitive Wind Industry in Denmark**

- [Article, Article on main recommendation](#)
- [Strategy launch, Article from strategy launch](#)
- Other events: [workshop, conference session on test and demonstration](#)

### **M6: Strategy for Extending the Useful Lifetime of a Wind Turbine**

- [Article](#)
- Strategy launch: Megavind will have an exhibition stand at the conference "Vindtræf" hosted by the Danish Wind Turbine Owner's Association, which will take place on November 5<sup>th</sup> 2016.