New and Ongoing Wind Power Research in Sweden 2016

A compilation of Swedish research programs and new scientific publications on wind energy

UPPSALA UNIVERSITET

NÄTVERKET FÖR VINDBRUK

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Front page: *Wind power plants at Näsudden on Gotland were replaced in 2011. The new wind turbines from Vestas have a capacity of 3MW, with a hub height of 80m and a rotor diameter of 90m.*
Photo: Maria Klemm.

Publications from the National Network for Wind Utilization are available for download via
www.natverketforvindbruk.se

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Contents

1. Introduction

Uppsala University Campus Gotland annually publishes a summary of current wind power research in Sweden. The summary is published in both printed form and on the website of the National Network for Wind Utilization.

This compilation is divided into two sections. The first is a presentation of the research centers and research programs active in wind power research in Sweden. Then a topic-based list of wind power research published in 2016 follows where at least one of the authors is active at a Swedish university. Here you will also find doctoral and licentiate theses as well as theses at the bachelor´s and master´s levels that have been published during the year. All have direct online links to the publications. This year this report also includes tables which compile the new publications and their comments.

The data for this report is taken from various databases and websites, and also from direct contact with universities, researchers and representatives of the various programs. We would like to take this opportunity to thank everyone for your contributions and help. To complete this report for the coming year, we would like to receive more tips and contributions.

Uppsala University Campus Gotland is the node with responsibility for education and competence building within the National Network for Wind Utilization which is financed by the Swedish Energy Agency. The 2016 summary of current wind power research is part of this task.

All editions of *New and Ongoing Wind Power Research* are published on the website of the Network for Wind Utilization, where both the English and Swedish versions are available.

2. Research programs and research centres

In Sweden there are several universities and colleges engaged in research related to wind power. The research is broad and deep and covers technical development, operational solutions, environmental impacts, acceptance and power issues and applies to both onshore and offshore wind power. This summary describes the 2016 operations at two research centres and three state programs that provide funding for wind power research. The aim is to provide a clear picture of Swedish wind power research in 2016.

2.1. Vindval

Vindval is a program whose research is focused on wind power's impacts on the marine environment, plants, animals and landscape. The program is a co-operation between the Swedish Energy Agency and the Swedish Environmental Protection Agency and is led by a board with representatives from both authorities. The board is assisted by a reference group with experts in the focus areas covered by the program.

The program started in 2005 and is now in its third stage which runs until the 30th of June 2018. The projects within this phase continue with the goal of knowledge building and follow up and convey experiences from parks that are in operation. Vindval also works to increase contact with other countries in order to achieve an effective international knowledge transfer. In previous phases, Vindval had a total of thirty research projects, four synthesis projects and sixteen films. Projects within the program were mainly conducted in four areas: people´s concerns when wind power is established, impact on birds and bats, marine life and finally on land living mammals. The results of this research can be used as a basis for environmental impact assessments and in planning and approval processes for wind power. Booklets and short information films that are developed refer to a broad audience and can be used, for example, in consultation.

In stage three, the current research is being conducted on how people experience sound in two research projects, both of which will be ready by the end of 2017. Four projects related to wind power and bats which started from 2016 will continue in 2017.

Below are the current projects from Vindval:

Vindval's progress report 2016: Wind power in society
The 2016 progress report presents new research projects decided in 2015. It also provides insight to issues outside the Vindval program which are connected to wind power and the environment: technical solutions aimed at reducing the risks for birds, energy systems and environmental impacts as well as international work on wind power and the environment. The report was published in February 2016.

The importance of social affluence in the permission application for wind power
This report analyses how community benefits are valued in wind power licensing processes. According to the report, there is clearer scope in the legislation to take into account the negative effects of wind power than to take into account the positive effects. The authors propose a change of rules so that the environmental benefits of wind power, and other similar activities, must also be done in the application of permits.

Authors: Kristina Ek, Associate Professor in Economics, Lars Bäckström, File Dr. and Scientific Researcher, and Maria Pettersson, Professor of Law. The authors are active at the Luleå University of Technology. The project was completed in 2016 and the report was published in January 2017, report no. 6738.

Cumulative effects of exploitation on reindeer husbandry - what needs to be done in permission processes

The report contains a case study with Vilhelmina Northern Sami which shows a significant loss of grazing area, measured in the overall disturbed area. The project also included a participatory policy analysis with contributions from officials from licensing authorities. The purpose was to identify proposals for measures to improve the consideration of the cumulative effects in the permission processes. Authors: Rasmus Kløcker Larsen (SEI), Kaisa Raitio, Per Sandström, Anna Skarin, (SLU) Marita Stinnerbom, Jenny Wik-Karlsson (SSR), Stefan Sandström (SLU), Carl Österlin (SU), Yann Buhot (SLU). Report No. 6722 (2016).

The report is part of the project "How does wind power affect the choice of pasture area in the operational phase - consequences for the reindeer and Sami reindeer husbandry". The report is published in SLU's report series; see Reindeer and Wind Power II - wind power in operation and effects on reindeer and reindeer husbandry

Underwater sound control regulation

Sweden currently has not set regulations for underwater noise levels, the point when the noise levels become so high and it can injure animals in the ocean. In the report *Underwater sound control regulation* (Report No. 6723, 2016), the authors provide suggestions on noise levels for injury and negative impacts that can be used to establish limit values for subsea noise adapted for Swedish waters and species.

The report contains technical descriptions of pile activities, underwater acoustics, sound propagation and impact on porpoises, cod and herring, fish eggs and fish larvae. Authors: Mathias H. Andersson (FOI), Sandra Andersson, Jimmy Ahlsén (Marine Monitoring), Brodd Leif Andersson (FOI), Jonathan Hammar (Marine Monitoring), Leif KG Persson, Jörgen Pihl, Peter Sigray (FOI), Andreas Wikström Monitoring).

Control program for wind power in water - compilation and review, as well as recommendations for the design of control programs

The information from existing control programs for wind power in water with a focus on Sweden, Denmark, Great Britain, the Netherlands and Belgium is used in the report to make recommendations for the design of wind power control programs in water. Authors: Carolina Enhus, M.Sc. Aquatic Ecology, Hanna Bergström, B.Sc. Biology, Roger Müller, fil.dr limnology, Martin Ogonowski, file. Dr. Aquatic Ecology, as well as Martin Iseus, File. Dr. Marine Ecology. All of which worked at the Aquabiota Water Research center. The project ended in 2016, the report was published in January 2017, report no. 6741.

Significance of habitats of the golden eagles, biotope selections and movements - Stage 2

The report describes biotope selection, flight altitude and movement patterns for golden eagles with GPS transmitters studied during 2011-2015 in northern Sweden. Detailed studies showed that the eagles flew higher when near wind turbines than when they were outside the park, though they seem to continue to use the area after the establishment of wind power. Authors: Navinder J Singh, SLU Umeå, Tim Hipkiss, SLU Umeå and Enviroplanning AB, Frauke Ecke, SLU Umeå and SLU Uppsala, and Birger Hörnfeldt, SLU Umeå. The project ended in 2016, the report was published in January 2017, report no. 6734-2.

The project "Study of control programs of noise at wind power turbines" has investigated and categorized control programs and reports relating to immune and emission measurements of wind noise. The study also includes producing checklists on what should be included in sound control programs. Project leader is Karl Bolin, KTH. Project Reporting: September 30, 2016, the report was published in March 2017, Report No. 6739.

Vindval also publishes a newsletter six times a year and is available on homepage.

Sign-up for the Vindval newsletter

Vindval Homepage

Ongoing research projects 2017-2018 (pdf)

Videos of Vindval's full-day seminar in November 2016 with presentations of current projects

2.2. Vindforsk IV

The program Vindforsk IV is set to run between 2013 and 2017. The aim of this program is to contribute to the skills and knowledge needed to plan, build and operate wind farms and to adapt the facilities and power system to a situation with an increasing share of wind power.

Vindforsk is a joint program between the Energy Agency and companies' active in the wind power field through the non-profit company Elforsk. The program has been funded 50 % by the industry and 50 % by the Swedish Energy Agency.

Vindforsk IV is structured into three business areas: Wind Resources; Project development and Establishment; Operation and Maintenance. The program also addresses wind power in the electrical system. At present 18 research projects are being conducted in areas that include wind turbine de-icing, gearbox maintenance, frequency regulation and synthetic inertia.

These ongoing projects include studies of how the topography of the surrounding landscape as well as how other wind turbines affect the production and the long-term maintenance needs for both individual turbines as well for wind power farms. For instance, how does one predict how production is effected by surrounding forested land? What wind conditions actually have the greatest impact on individual components of a wind turbine? Another issue that may affect production and maintenance needs is the formation of ice on the rotor blades. One of the ongoing research projects examines whether hot water dispersed from a helicopter can be used to remove ice from rotor blades.

Vindforsk IV, in addition to the above mentioned activities, also includes research on how wind turbines and electrical systems can be adapted to cope with a larger proportion of wind power in the Nordic electrical grid.

Vindforsk IV has its roots in the wind power research started in 1975 with funding from a Swedish government energy research program. Research has continued in a number of different programs and with different focuses. Vindforsk IV has the same main focus areas as its predecessor Vindforsk III, which ran between 2009 and 2012.

Reports from the wind research projects in Vindforsk are available via their homepage where it is also possible to sign up for their newsletter.

From 2017, Vindforsk will be part of the Energy Agency's new wind power research program VindEL. You can read more about VindEL in chapter 2.4 of this report.

There is also a plan for an industrial consortium that would form industrial and academy cooperation after Vindforsk IV ends.

Vindforsk via Elforsk

Vindforsk via Energiforsk

Report 2016:311. Projects in Vindforsk 2015 (pdf)

2.3. Wind Power in Cold Climate

In the program Wind Power in Cold Climate (Vindkraft i kallt klimat), the Swedish Energy Agency funds research on wind turbine icing. This research includes development of methods to predict ice coverage on wind turbines, how icing influences production and technical developments aimed at preventing icing. The program also includes research on environmental and safety concerns related to wind power in cold climates. The Wind Power in Cold Climate program started in 2013 and continued through 2016.

The long-term goals of the program have been to encourage and simplify the transition of the Swedish energy system, that Swedish research should be at the forefront of developing special knowledge in wind power in cold climate, facilitate the establishment of larger wind power parks in northern Sweden during the next decade and to address the challenges that arise when managing wind power in colder areas.

Accumulation of ice on turbine blades can lead to production losses, safety hazards and increased sound emissions. Low temperatures mean increased demands on construction materials. These factors lead to relative uncertainty when predicting energy costs and operational reliability in areas with a cold climate.

Production losses and ice accumulation caused by a combination of low temperatures and high humidity is not only a problem in northern Sweden but can occur in all of northern Europe. Even from a wider international perspective there is a need for more knowledge about the planning and management of wind power in cold climates. Even though nearly 20 GW of wind power capacity has been installed around the world in areas with a cold climate the knowledge about how to tackle these challenges are still mainly based on experience rather than scientific study.

The program has also been aimed at promoting the building of appropriate academic skills which will contribute to a necessary knowledge base for continued progress, primarily in research and development, in collaboration between academia and industry in cold climate application areas. It also aimed to promote the development of technical solutions that correspond to the issues which make it difficult and delay the establishment of wind power in cold climate.

In the fall of 2014 the Swedish Energy Agency decided to fund 10 projects focused on wind power in cold climates. From 2017, the program will continue within VindEL, which is the Energy Agency's new program for wind power research projects. Read more in Chapter 2.4.

More on Wind Power in cold climate

During 2016, the following projects were completed in the Wind Power in Cold Climate Program:

ICETHROWER - Mapping and tools for risk analysis
Project time 2013-10-01--2016-09-30. The project aimed to develop calculation models which can be used by wind power stakeholders in Sweden to analyse the risks of staying in or near a wind farm during wintertime when ice throw and ice crash can occur. The project consists partly of gathering empirical data from three wind farms in Sweden and partly by developing a physical and statistical model for risk calculation.

Sound impact of ice on wind turbines – Long term measurements of sound for verification
Project time 2013-09-01--2016-03-31. The project concerned long-term measurement of noise emissions from wind turbines, by measuring wind turbine noise with or without de-icing systems in four different wind farms. The overall purpose is to verify how rotor blade degradation affects the noise emission, i.e. the sound impact experienced by nearby real estate. Reliable values of noise emission are important for projectors and operators as well as designers of de-icing systems.

Imaging method for determining the air content of liquid water particles
Project time 2013-09-01--2016-12-31. The project intended to provide a direct method for determining the air's content of liquid water, LWC, and droplet size, MVD. These parameters are critical to the meteorological conditions which control the icing process, and tools to directly determine them are missing today. By measuring the parameters, both calculations of icing and new ice-measurement tools can be obtained. The method will utilize imaging technology and advanced sensors, and also will be tested in a climate chamber within the project framework. The aim is that the instrument should work in real conditions and be able to commercialize. Sponsors are Mittuniversitetet and Combitech, which manufactures wind turbine measuring instruments. The project contributes to more reliable measurement methods than those which are currently available.

Wind turbines in cold climate: Current mechanics, ice formation and terrain effects
Project time 2013-09-01--2018-06-30. The project aims to increase knowledge about how degradation affects noise from wind turbines, as well as how noise diffusion is affected by snow or ice formation on the ground, the nature of the terrain and temperature variations. The project will also investigate whether acoustic measurements can be used to detect the degree of icing. The results of this research will be used to develop freely available simulation tools and models implemented in open source tools.

Ice detection for smart de-icing of wind turbines
Project time 2013-09-01--2016-12-31. The project aimed to develop a new technology based on acoustic waves and laser (AWL), for detecting ice formation on rotor blades. The technology is based on combining two different methods of ice detection, thus enabling more efficient de-icing. An executive group consisting of persons from Chalmers University of Technology, the Chalmers Industrial Engineering Foundation and WindVector AB will develop theoretical models, methods and algorithms as well as build a demonstrator for an AWL based sensor system.

Active de-icing of wind turbine blades with advanced surface coatings

Project time 2013-09-01--2015-08-31. The project aimed to develop a new de-icing technology for wind turbine blades. The technology is based on the heating of a thin surface layer through the absorption of microwaves. The microwave absorbent layer is covered by a surface coating with good characteristics for passive de-icing. The display system is said to provide significantly lower energy consumption than conventional de-icing systems. The project also includes tests and documentation regarding compliance with safety requirements regarding, for example, level of radiation at ground level. Final report published 2016.

Vibration and loads of wind turbines with ice load

Project Time 2013-09-01--2017-10-31. The project concerns research in ice formation, flow mechanics, structural dynamics and load monitoring to contribute to the development of technical solutions for cost-effective construction, operation and maintenance of wind power in cold climate. Through national and international collaboration, the research team will develop methods for the simulation of ice growth, flow of ice-rudder blades, linear and nonlinear dynamics as well as cargo monitoring.

Modeling of icing and production losses

Project Time 2013-09-01--2018-02-28. Weather models used by Sweden's meteorological and hydrological institutes, WeatherTech Scandinavian AB and Uppsala University will be refined with focus on parameterization of cloud physics and turbulence. The aim is to optimize the models' ability to calculate depletion and production loss of wind turbines operating under de-icing conditions. The project is expected to contribute to safer assessments of ice events and production losses.

2.4. VindEL

VindEL is the Swedish Energy Agency's new research and innovation program in wind power. The program starts in 2017 and it indicates that the Agency is taking a holistic approach to wind farm operations. The program can also be seen as a continuation of the previous programs Wind power in cold climate and Vindforsk IV which, together with Vindval, are the primary research efforts in wind power that are sponsored by the Swedish Energy Agency.

The program's goal is to contribute to the wind energy impact targets that the Energy Agency points out in its wind power strategy:

- Wind power is an important part of the Swedish electricity supply.
- Wind power contributes to the climate, business development and stability of the electricity system.
- The operation and expansion of wind power takes into account social, ecological and economic sustainability.

VindEL aims to contribute to the transition to a sustainable and renewable energy system through research and development of technologies, systems, methods and issues related to wind power. The program has three overall priority areas of action:

1. Wind power in Swedish conditions
2. Long-term sustainability
3. Integration into the electrical system

VindEL has funding of 133 million SEK which is spread over five years, ending 2021. As with the Energy Agency's other research and innovation programs, a large portion of the programs funding will be distributed to projects through research calls. The first announcement will be for approximately 50 million SEK and has the closing date of the 20th of June 2017. Accepted research projects will begin in November 2017 at the earliest and could continue until 31 December 2021.

The first announcement in VindEL

More about VindEL

2.5. STandUP for Wind

STandUP for Wind is a research center for the establishment and development of wind energy in Sweden. The center is a collaboration between the Royal Institute of Technology KTH, Uppsala University, Luleå Technical University and the Swedish University of Agricultural Sciences within the framework of the government's strategic research area STandUP for Energy.

STandUP for Energy was formed in 2009, following a government decision to allocate funds to universities and colleges for the development of 24 research areas which were considered strategically important. One of these areas was renewable electricity generation on a larger scale and its integration into the power grid. Within this framework, wind farms were gathered in the research center STandUP for Wind, where the goal is to facilitate the development towards a larger proportion of electricity from wind power in the grid through interdisciplinary working methods.

Researchers from the respective higher education institutions meet regularly and exchange knowledge and experience. Within the framework of STandUP for Wind, there is also a knowledge exchange with companies in the wind power industry. The aim is to ensure that research is done on the issues which are most important for industry to solve and that the research results reach relevant recipients.

STandUP for Wind, which aims to facilitate the conversion to renewable energy sources and the development of the needed network conditions, has profiled itself a leader in project development and planning of wind farms in Sweden. The Center's research topics range from how the wind is generated to how electricity is integrated into the Swedish grid.

In an evaluation initiated by the Swedish Energy Agency, STandUP for Wind has been identified as a strong research environment with special strengths around both project development and grid conditions.

Projects are currently underway in the following areas:

- Wind mapping and cold climate
- Current mechanics for wind turbines in parks and forests
- Electrical systems
- Sound
- Vertical wind power systems
- Generators and control systems
- Landscape and participatory planning
- Operation and maintenance

STandUP for Wind

2.6. Swedish Wind Power Technology Centre

Swedish Wind Power Technology Centre (SWPTC) was founded in 2010 with the goal of strengthening competence in wind power technology in Sweden, at a time when the international market for wind power technology was rapidly expanding. Today SWPTC focuses on improving the construction of wind turbines in ways that optimize the costs of manufacturing and maintenance. The center also seeks to gather sufficient knowledge about components and systems that will make possible the development and production of both components of wind turbines as well as entire wind turbines in Sweden.

SWPTC assists the wind power industry with knowledge about construction questions and the education of engineers. SWPTC is led by Chalmers Technical University and run in cooperation with Luleå Technical University as well as companies in the wind power industry.

At present, stage 2 of the Centre is ongoing. This second stage has funding until September 2018 when the current projects should be completed. Planning for stage 3 is in progress and it will begin in October 2018.

The research at SWPTC is focused on major wind farms in forested, mountainous and offshore areas and it is conducted within six thematic groups reflecting the design and operation of wind turbines. These are:

- Electricity and control systems
- Turbine and wind load
- Mechanical power transmission and system optimization
- Ocean-based
- Maintenance and reliability
- Cold climate

In 2016, the following six new SWPTC projects began:

- Wind turbines with difficult operating conditions
- Wind power in forests - Impact of forest glades
- Driving dynamics modelling based on data from monitoring systems,
- Analysis of floating wind farms
- Optimal maintenance of wind turbines
- Increased availability of de-icing equipment on wind turbine blades.

In two of the projects, life-time calculations for components and wind turbines as a whole are included.

SWPTC via Chalmers

2.7. Summary

The various research programs and research centers presented in this report provide a picture of what is happening in wind power research in Sweden. The Swedish Energy Agency is a main financier for Vindval, Wind power in cold climate, for the new VindEL program and provides partial financing for Vindforsk IV.

Vindval is collaboration between the Swedish Energy Agency and the Swedish Environmental Protection Agency with a focus on the impacts of wind power on people, nature and the environment. Vindforsk IV has a technical focus and is financed by the Swedish Energy Agency and the wind power industry through Energiforsk. Wind power in cold climate has a clear focus on the challenges for wind power in cold areas.

In 2017 the Swedish Energy Agency will collect its wind power research into the new VindEL program. This will provide a holistic approach to the continuation of previous Vindforsk and Wind power program in cold climate. There is also a plan for an industrial consortium for industry-academic cooperation that can take place after completion of Vindforsk IV.

STandUP for Wind is a research center which is collaboration between the Royal Institute of Technology, Uppsala University, Luleå Technical University and the Swedish University of Agricultural Sciences. Here, wind energy research targets a goal of facilitating development towards a larger proportion of electricity from wind power in the grid through interdisciplinary approaches.

SWPTC is run by Chalmers Technical University in collaboration with Luleå University of Technology. Its research aims to strengthen expertise in wind power technology to meet the needs of the rapidly expanding global wind power industry. The focus of the Centre is on the development of wind turbine construction that optimizes the cost of both manufacturing and maintenance.

3. Published scientific articles and reports

3.1. Financing, electricity market

Business Model Innovation for Internationalization: The Case of the Chinese Wind Turbine Manufacturer Envision
Danilovic, M. et al. Asia Pacific Journal of Advanced Business and Social Studies, ISSN 2205-6033, Vol. 2, no 3, 57-68 p. Halmstad University 2016

Invention, innovation and diffusion in the European wind power sector
Grafström, J. et al. Technological forecasting & social change, ISSN 0040-1625, E-ISSN 1873-5509, Vol. 114, 179-191 p. Luleå University of Technology 2016

Mapping key economic indicators of onshore wind energy in Sweden by using a geospatial methodology
Siyal, S. et al. Energy Conversion and Management, ISSN 0196-8904, E-ISSN 1879-2227, Vol. 128, 211-226 p. Royal Institute of Technology 2016

Techno economic and environmental assessment of wind assisted marine propulsion systems
Talluri, L. et al. Ocean Engineering, ISSN 0029-8018, E-ISSN 1873-5258, Vol. 121, 301-311 p. Cranfield University, United Kingdom 2016

3.1.1. Conference

Forecasting Balancing Market Prices Using Hidden Markov Models
Dimoulkas, I. et al. 13th International conference on the European Energy Market (EEM), IEEE conference proceedings, 2016. Royal Institute of Technology 2016

Economic Impact Assessment of using Congestion Management Methods to enable increased Wind Power Integration on Gotland, Sweden
Gliniewicz, V. et al. Conference paper. Vienna, Austria: Wind integration workshop, Vattenfall R&D 2016

On the flexibility of electricity consumers: Introducing notice time
Herre, L. et al. Conference paper. 13th International Conference on the European Energy Market (EEM). Royal Institute of Technology 2016

On the flexibility of electricity consumers: Modelling, Quantification and Analysis of Notice Time
Herre, L. et al. Conference paper. Swedish Association for Energy Economics (SAEE) Conference 2016, Luleå. Royal Institute of Technology 2016

3.2. Wind resources, energy calculations

Statistics of LES Simulations of Large Wind Farms
Andersen, S.J. et al. Journal of Physics: Conference Series Vol. 753, (3), 032002, 2016. doi: 10.1088/1742-6596/753/3/032002. DTU 2016

A linearised numerical model of wind-farm flows
Ebenhoch, R. et al. Wind Energy. doi: 10.1002/we.2067. University of Stuttgart 2016

Wind Turbine Wake Modeling – Possibilities with Actuator line/disc approaches
Ivanell., S. & Mikkelsen, R. Book chapter in: Alternative Energy and Shale Gas Encyclopedia. DOI: 10.1002/9781119066354.ch12. Wiley series on energy, 2016

A Linearized k – e Model of Forest Canopies and Clearings
Segalini, A. et al. Boundary-Layer Meteorology. (2016) 161: 439–460, doi: 10.1007/s10546-016-0190-5. Royal Institute of Technology 2016

The actuator disc concept in PHOENICS
Simisiroglou, N. et al. Energy Procedia / [ed] Tande, JOG; Kvamsdal, T; Muskulus, M, 2016, Vol. 94, 269-277 p. Uppsala University 2016

3.2.1. Conference

Development of free vortex wake model for wind turbine wake aerodynamics under yaw condition
Abedi, L. et al. 34th Wind Energy Symposium, 4-8 January 2016 San Diego, USA

Wind Flow Resource Analysis of Urban Structures: A Validation Study
Aihara, A. et al. 12th EAWE PhD Seminar on Wind Energy in Europe. Uppsala University 2016

Validation of an Actuator Line Model Coupled to a Dynamic Stall Model for Pitching Motions Characteristic to Vertical Axis Turbines
Mendoza, V. et al. STandUP for ENERGY Conference Uppsala, Uppsala University 2016

Long-wave instabilities of two interlaced helical vortices
Quaranta, H. et al. Journal of Physics; Conference Series, ISSN 1742-6588, E-ISSN 1742-6596, Vol. 753, no 3, 032022. Royal Institute of Technology 2016

Validation of the actuator line and disc techniques using the New Mexico measurements
Sarmast, S. et al. Journal of Physics; Conference Series, ISSN 1742-6588, E-ISSN 1742-6596, Vol. 753, no 3, 032026. Royal Institute of Technology 2016

Validation of the actuator disc approach in PHOENICS using small scale model wind turbines
Simisiroglou, N. et al. Journal of Physics; Conference Series, 2016, Vol. 753, 032-028 p. Uppsala University 2016

3.3. Design and loading of wind turbines

Examination of the mechanism behind observed canopy waves
Arnqvist, J. et al. Agricultural and Forest Meteorology, ISSN 0168-1923, E-ISSN 1873-2240, Vol. 218, 196-203 p. Uppsala University 2016

Influence of Icing on the Modal Behaviour of Wind Turbine Blades
Gantasala, S. et al. Energies, ISSN 1996-1073, E-ISSN 1996-1073, Vol. 9, no 11, 862. Luleå University of Technology 2016

Improved design of tubular wind tower foundations using steel micropiles
Matos, R. et al. Structure and Infrastructure Engineering, ISSN 1573-2479, E-ISSN 1744-8980, Vol. 12, no 9, 1038-1050 p. ISISE, University of Coimbra, Faculdade de Ciências e Tecnologia da Universidade de Coimbra 2016

Noise Emission of a 200 kW Vertical Axis Wind Turbine
Möllerström, E. et al. Energies, ISSN 1996-1073, E-ISSN 1996-1073, Vol. 9, no 1, 19. Halmstad University 2016

Turbulence influence on wind energy extraction for a medium size vertical axis wind turbine
Möllerström, E. et al. Wind Energy, ISSN 1095-4244, E-ISSN 1099-1824, Vol. 19, no 11, 1963-1973 p. Halmstad University 2016

Observations of turbulence in a Kelvin-Helmholtz event on 8 September 2015 by the Magnetospheric Multiscale mission
Stawarz, J. E. et al. Journal Of Geophysical Research-Space Physics, ISSN 2169-9380, Vol. 121, no 11, 11021-11034 p. Imperial College London 2016

Dynamic Line Rating for Wind Power
Talpur, S. et al. Journal of Renewable and Sustainable Energy, ISSN 1941-7012, E-ISSN 1941-7012, Vol. 8. S. Royal Institute of Technology 2016

Wind turbine gearboxes: Maintenance effect on present and future gearboxes for wind turbines
Ukonsaari, J. & Bennstedt, N. Vattenfall & Autoinvent. ISBN 978-91-7673-279-3. Rapport 2016:279. Vindforsk 2016

Extreme water-hammer pressure during one-after-another load shedding in pumped-storage stations
Zeng, W. et al. Renewable energy, ISSN 0960-1481, E-ISSN 1879-0682, Vol. 99, 35-44 p. Wuhan University, China 2016

3.3.1. Conference

Actuator line simulations of a Glauert and Tjeareborg rotor using spectral element and finite volume methods
Kleusberg, E. et al. Journal of Physics: Conference Series 753 (8), 082011, 2016. doi: 10.1088/1742-6596/753/8/082011. Royal Institute of Technology 2016

Dynamic performance of the standalone wind power driven heat pump
Li, H. et al. Applied Energy Symposium and Forum, REM2016: Renewable Energy Integration with Mini/Microgrid, Mälardalen University 2016

Turbulence influence on optimum tip speed ratio for a 200 kW vertical axis wind turbine
Möllerström, E. et al. Journal of Physics; Conference Series, ISSN 1742-6588; 753. Halmstad University 2016

Aerodynamic noise prediction for a wind turbine using numerical flow simulations and semi-empirical modelling approaches
Rasam, A. et al. 22nd AIAA/CEAS Aeroacoustics Conference, American Institute of Aeronautics and Astronautics, Trinity College Dublin Ireland 2016

Detached-eddy simulation of a horizontal-axis wind turbine
Rasam, A. et al. 6th Symposium on Hybrid RANS-LES Methods, Trinity College Dublin Ireland 2016

Frequency analysis of tangential force measurements on a vertical axis wind turbine
Rossander, M. The 6th international conference on "The Science of Making Torque from Wind", Munich. Uppsala University 2016

Approximate Bayesian Computation by Subset Simulation for Parameter Inference of Dynamical Models
Vakilzadeh, M. K. et al. Model Validation and Uncertainty Quantification. Conference Proceedings of the Society for Experimental Mechanics Series. 34th IMAC Conference and Exposition on Structural Dynamics, Orlando, Florida 2016. (2191-5644). Vol. 3, p. 37-50. Chalmers University of Technology 2016

Stochastic Finite Element Model Updating by Bootstrapping
Yaghoubi, V. et al. Model Validation and Uncertainty Quantification, vol 3. Conference Proceedings of 34th IMAC Conference and Exposition on Structural Dynamics, Orlando, Florida, 2016 (2191-5644). p. 117-130. Chalmers University of Technology 2016

3.4. Electrical grids, integration into electrical grid, electrical power

Study of Centralized and Distributed Coordination of Power Injection in Multi-TSO HVDC Grid with Large Off-shore Wind Integration
Babazadeh, D. et al. Electric power systems research, ISSN 0378-7796, E-ISSN 1873-2046, Vol. 136, 281-288 p. Royal Institute of Technology 2016

A Simplified Model for Predicting Primary Control Inadequacy for Nonresponsive Wind Power
Chavez, H. et al. IEEE Transactions on Sustainable Energy, ISSN 1949-3029, E-ISSN 1949-3037, Vol. 7, no 1, 271-278 p. Royal Institute of Technology 2016

Virtual Power Plant for Grid Services using IEC 61850
Etherden, N. et al. IEEE Transactions on Industrial Informatics, ISSN 1551-3203, E-ISSN 1941-0050, Vol. 12, no 1, 437-447 p. STRI AB 2016

An Importance Sampling Technique for Probabilistic Security Assessment in Power Systems with Large Amounts of Wind Power
Hamon, C. et al. Electric power systems research, ISSN 0378-7796, E-ISSN 1873-2046, Vol. 131, 11-18 p. Royal Institute of Technology 2016

Variability in Large-Scale Wind Power Generation
Kiviluoma, J. et al. Wind Energy, ISSN 1095-4244, E-ISSN 1099-1824, Vol. 19, no 9, 1649-1665 p. Smart Energy and System Integration 2016

Network-Constrained AC Unit Commitment Under Uncertainty: A Benders' Decomposition Approach
Nasri, A. et al. IEEE Transactions on Power Systems, ISSN 0885-8950, E-ISSN 1558-0679, Vol. 31, no 1, 412-422 p. Royal Institute of Technology 2016

Restoring the missing high-frequency fluctuations in a wind power model based on reanalysis data
Olauson, J. et al. Renewable energy, ISSN 0960-1481, E-ISSN 1879-0682, Vol. 96, 784-791 p. Uppsala University 2016

Simulating intra-hourly wind power fluctuations on a power system level
Olauson, J. et al. Wind Energy, ISSN 1095-4244, E-ISSN 1099-1824. Uppsala University 2016

Determining demagnetisation risk for two PM wind power generators with different PM material and identical stators
Sjökvist, S. et al. IET Electric Power Applications, ISSN 1751-8660, E-ISSN 1751-8679, Vol. 10, no 7, 593-597 p. Uppsala University 2016

A Comprehensive Review of Smart Energy Meters in Intelligent Energy Networks
Sun, Q. et al. IEEE Internet of Things Journal, ISSN 2327-4662, Vol. 3, no 4, 464-479 p., 7365417. Mälardalen University 2016

Simplified analysis of balancing challenges in sustainable and smart energy systems with 100% renewable power supply
Söder, L. Wiley Interdisciplinary Reviews: Energy and Environment, ISSN 2041-8396, E-ISSN 2041-840X, Vol. 5, no 4, 401-412 p. Royal Institute of Technology 2016

A Phase Measurement Unit Based Fast Real-Time Oscillation Detection Application for Monitoring Wind Farm-to-Grid sub-synchronous Dynamics
Vanfretti, L. et al. Electric power components and systems, ISSN 1532-5008, E-ISSN 1532-5016, Vol. 44, no 2, 123-134 p. Royal Institute of Technology 2016

Data Mining via Association Rules for Power Ramps Detected by Clustering or Optimization
Yildirim, N. et al. Transactions on Computational Science XXVIII: Special Issue on Cyberworlds and Cybersecurity / [ed] Gavrilova, ML; Tan, CJK; Sourin, A, Springer Berlin/Heidelberg, 2016, 163-176 p. Uppsala University 2016

Decompositions of harmonic propagation in wind power plant
Yang, K. et al. Electric power systems research, ISSN 0378-7796, E-ISSN 1873-2046, Vol. 141, 84-90 p. Luleå University of Technology 2016

3.4.1. Conference

Optimization and Experimental Validation of Medium-Frequency High Power Transformers in Solid-State Transformer Applications
Bahmani, A. et al. 2016 IEEE Applied Power Electronics Conference, 2016, 8 p. RISE, SP – Sveriges Tekniska Forskningsinstitut, SP Mätteknik, Elektricitet 2016

Hosting capacity of the grid for wind generators set by voltage magnitude and distortion levels
Cundeva, S. et al. IET Conference Publications, CP711, 2016. 73-80 p. University of Ss Cyril and Methodius 2016

The Influence of PM Material Properties on Choice of Generator Magnetic Circuit Topology
Eklund, P. et al. Manuscript, XXII International Conference on Electrical Machines (ICEM), Uppsala University 2016

Frequency Characterization of Type-IV Wind Turbine Systems
Espinoza, N. et al. IEEE Energy Conversion Congress and Exposition (ECCE), Milwaukee, WI, 2016

Short-term planning of hydro-thermal system with high wind energy penetration and energy storage
Khastieva, D. et al. IEEE Power and Energy Society General Meeting, IEEE, 2016 Conference paper. Royal Institute of Technology 2016

A Comparative Study of Techniques Utilized in Analysis of Wind Turbine Data
Mazidi, P. et al. 7th China International Conference on Electricity Distribution (CICED 2016). Royal Institute of Technology 2016

Harmonic mitigation in wind power plants: Active filter solutions
Schwanz, D. et al. 17th International Conference on Harmonics and Quality of Power. Luleå University of Technology 2016

3.5. Operation and maintenance

Effects of load variation on a Kaplan turbine runner
Amiri, K. et al. International Journal of Fluid Machinery and Systems, ISSN 1882-9554, E-ISSN 1882-9554, Vol. 9, no 2, 182-193 p. Luleå University of Technology 2016

Wind turbines' end-of-life: Quantification and characterisation of future waste materials on a national level
Andersen, N. et al. Energies, ISSN 1996-1073, E-ISSN 1996-1073, Vol. 9, no 12, 999, Energi Funktion Komfort Skandinavien AB, 2016

Airborne de-icing solutions for wind turbines
Gedda, H. et al. Gedda Consulting AB & Alpine Helicopter AB. ISBN 978-91-7673-300-4. Rapport 2016:300, Vindforsk 2016

Frequency Control Operation of Frequency Control Schemes in Power Systems with Large Amounts of Wind Power
Hamon, C. et al. KTH. ISBN 978-91-7673-278-6. Rapport 2016:278. Vindforsk 2016

Quantification of icing losses in wind farms Assessment and optimization of the energy production of operational wind farms: Part 3
Hansson, J. et al. Kjeller Vindteknikk. ISBN 978-91-7673-299-1. Rapport 2016:299. Vindforsk 2016

Post-construction production assessment of wind farms: Assessment and optimization of the energy production of operational wind farms: Part 1
Lindvall, J. et al. Kjeller Vindteknikk. ISBN 978-91-7673-297-7. Rapport 2016:297. Vindforsk 2016

Wind Turbine Prognostics and Maintenance Management based on a Hybrid Approach of Neural Networks and Proportional Hazards Model
Mazidi, P. et al. Journal of Risk and Reliability, ISSN 1748-006X, E-ISSN 1748-0078. Royal Institute of Technology 2016

Net load variability in Nordic countries with a highly or fully renewable power system
Olauson, J. et al. Nature Energy, ISSN 2058-7546, Vol. 1, 1-8 p., 16175. Uppsala University 2016

Liquid Water Content and Droplet Sizing Shadowgraph Measuring System for Wind Turbine Icing Detection
Rydblom, S. et al. IEEE Sensors Journal, ISSN 1530-437X, E-ISSN 1558-1748, Vol. 16, no 8, 2714-2725 p., 7384444. Mittuniversitetet

Use of remote sensing for performance optimization of wind farms Assessment and optimization of the energy production of operational wind farms: Part 2
Turkyilmaz, U. et al. Kjeller Vindteknikk. ISBN 978-91-7673-298-4. Rapport 2016:298. Vindforsk 2016

On the Shaker Simulation of Wind-Induced Non-Gaussian Random Vibration
Xu, F. et al. Shock and Vibration, ISSN 1070-9622, E-ISSN 1875-9203, 5450865. Beihang University 2016

3.5.1. *Conference*

Analysis of SCADA data for early fault detection with application to the maintenance management of wind turbines
Bangalore, P. et al. presented at Cigre Session 46, Paris, August 2016

A Performance and Maintenance Evaluation Framework for Wind Turbines
Mazidi, P. et al. International Conference on Probabilistic Methods Applied to Power Systems (PMAPS), Oct. 16-20, 2016 Beijing, China. Royal Institute of Technology 2016

3.6. Combinations of wind power, solar power and hydrogen production

3.6.1. *Conference*

Evaluation of Solar PV and Wind Alternatives for Self Renewable Energy Supply: Case Study of Shrimp Cultivation
Nookuea, W. et al. CUE2015-Applied Energy Symposium and Summit 2015: Low carbon cities and urban energy systems. Mälardalen University 2016

3.7. Planning

Spatial optimization of residential urban district - Energy and water perspectives
Campana, P. et al. Energy Procedia, ISSN 1876-6102, E-ISSN 1876-6102, Vol. 88, 38-43 p. Mälardalen University 2016

Offshore wind farms' decommissioning: a semi quantitative Multi-Criteria Decision Aid framework
Kerkvliet, H. & Polatidis, H. Sustainable Energy Technologies and Assessments, ISSN 2213-1388, E-ISSN 2213-1396, Vol. 18, 69-79 p. Uppsala University 2016

Kumulativa effekter av exploateringar på renskötseln - vad behöver göras inom tillståndsprocesser
Kløcker Larsen, R. et al. SEI, Vilhelmina norra sameby, SSR, SU, SLU. Rapportnr 6722 (2016). Vindval 2016

3.7.1. Conference

GIS-based methods for sustainable wind power planning
Byström, G. et al. Conference paper, Poster. Energy Dialogue. Royal Institute of Technology 2016

3.8. Regional development, public benefits

A geospatial assessment of the techno-economic wind power potential in India using geographical restrictions
Mentis, D. et al. Renewable energy, ISSN 0960-1481, E-ISSN 1879-0682, Vol. 97, 77-88 p. Royal Institute of Technology 2016

The benefits of geospatial planning in energy access - A case study on Ethiopia
Mentis, D. et al. Applied Geography, ISSN 0143-6228, E-ISSN 1873-7730, Vol. 72, 1-13 p. Royal Institute of Technology 2016

Correlation between wind power generation in the European countries
Olauson, J. et al. Energy, ISSN 0360-5442, E-ISSN 1873-6785, Vol. 114, 663-670 p. Uppsala University 2016

Sustainable Energy Transitions in China: Renewable Options and Impacts on the Electricity System
Sun, X. et al. Energies, ISSN 1996-1073, E-ISSN 1996-1073, Vol. 9, no 12, 980. China Univ Petr, Peoples R China 2016

3.8.1. Conference

Introducing Multi-Criteria Decision Analysis for Wind Farm Repowering A Case Study on Gotland
Bezbradica, M. et al. Proceedings of the 2016 International Conference Multidisciplinary Engineering Design Optimization (MEDO), Uppsala University 2016

Framework for System Analyses of Smart Grid Solutions with Examples from the Gotland Case
Wallnerström, C. et al. 2016 International Conference on Probabilistic Methods Applied to Power Systems (PMAPS), IEEE. Royal Institute of Technology 2016

3.9. Acceptance

Objectively best or most acceptable? Expert and lay knowledge in Swedish wind power permit processes
Larsson, S. et al. Journal of Environmental Planning and Management, ISSN 0964-0568, E-ISSN 1360-0559, Vol. 59, no 8, 1360-1376 p. Blekinge Institute of Technology 2016

3.10. Climate impacts

Wind energy and green economy in Europe: Measuring policy-induced innovation using patent data
Lindman, Å. et al. Applied Energy, ISSN 0306-2619, E-ISSN 1872-9118, Vol. 179, 1351-1359 p. Luleå University of Technology 2016

Wind power activism: epistemic struggles in the formation of eco-ethical selves at Vattenfall
Skoglund, A. et al. Towards a Cultural Politics of Climate Change / [ed] Harriet Bulkeley, Matthew Paterson, Johannes Stripple, Cambridge: Cambridge University Press, 161-173 p. Uppsala University 2016

Climate change impacts on the power generation potential of a European mid-century wind farms scenario
Tobin, I. et al. Environmental Research Letters, ISSN 1748-9326, E-ISSN 1748-9326, Vol. 11, no 3, 034013. SMHI, Research Department, Climate research - Rossby Centre 2016

3.11. Others

Underlag för reglering av undervattensljud vid pålning
Andersson, M. H. et al. FOI & Marine Monitoring. Rapportnummer 6723. Vindval 2016

Decentralized desalination of brackish water using an electrodialysis system directly powered by wind energy
Malek, P. et al. Desalination, ISSN 0011-9164, E-ISSN 1873-4464, Vol. 377, 54-64 p. The University of Edinburgh, United Kingdom 2016

Capacity value assessments of wind power
Milligan, M. et al. Wiley Interdisciplinary Reviews: Energy and Environment, ISSN 2041-8396, E-ISSN 2041-840X. Royal Institute of Technology 2016

Increasing the applicability of wind power projects via a multi-criteria approach: methodology and case-study
Polatidis, H. et al. International Journal of Sustainable Energy, ISSN 1478-6451, E-ISSN 1478-646X, Vol. 35, no 10, 1014-1029 p. Uppsala University 2016

Renar och vindkraft II: Vindkraft i drift och effekter på renar och renskötsel
Skarin, A. et al. Rapport/Sveriges lantbruksuniversitet, Institutionen för husdjurens utfodring och vård, ISSN 0347-9838 ; 294. Sveriges lantbruksuniversitet 2016

Study on a hypothetical replacement of nuclear electricity by wind power in Sweden
Wagner, F et al. The European Physical Journal Plus, ISSN 2190-5444, E-ISSN 2190-5444, Vol. 131, no 5, 173. Royal Institute of Technology 2016

Simulation of Wind Speed in the Ventilation Tunnel for Surge Tanks in Transient Processes
Yang, J. et al. Energies, ISSN 1996-1073, E-ISSN 1996-1073, Vol. 9, no 2, UNSP 95. Wuhan University China 2016

3.12. Reviews

A Review of Research on Large Scale Modern Vertical Axis Wind Turbines at Uppsala University
Apelfröjd, S. et al. Energies, ISSN 1996-1073, E-ISSN 1996-1073, Vol. 9, no 7, 570, Uppsala University 2016

Wind and solar energy curtailment: A review of international experience
Bird, L. et al. Renewable & sustainable energy reviews, ISSN 1364-0321, E-ISSN 1879-0690, Vol. 65, 577-586 p. 2016

Power production and environmental opinions: Environmentally motivated resistance to wind power in Sweden
Haikola, S. et al. Renewable & sustainable energy reviews, ISSN 1364-0321, E-ISSN 1879-0690, Vol. 57, 1545-1555 p. Linköpings University 2016

3.13. Summary of published scientific articles and reports

Table 1. Number of scientific articles and reports published in 2016, including papers and contributions to conferences, compiled by New and ongoing wind power research from 2015 and 2016.

Subject areas	2015	2016
Financing, electricity market	5	8
Wind resources, energy calculation	5	11
Design and loading of wind turbines	4	17
Electricity grid, integration into electricity grid, electric power	7	21
Operation and maintenance	4	13
Combinations of wind power, solar power and hydrogen production	2	1
Planning	2	4
Regional development, public benefits	5	6
Acceptance	1	1
Impact on birds	1	-
Climate impact	3	3
Sound or noise from wind turbines	1	-
Others	-	7
Reviews	2	3
Total	**42**	**95**

According to Table 1, the number of publications in wind power research has doubled since 2015, with 42 publications in 2015 and 95 in 2016. In the year 2016, a special sub-heading has been added for conference contributions.

The large increase in the number of publications may be due to the fact that more research has been published during the year and partly because this compilation has been extended to searches in more sources and databases.

In the number of published articles, the subject categories Wind Resources and Energy Calculation, Design and Loads on Wind Power, Power Grids, Power Grid and Power, Operations and Maintenance have increased the most. Within these areas there are strong research environments in Swedish universities today. In social science research most publications are in the categories Regional Development, Social Benefits and Planning.

Several research projects will be reported in 2017 for both impacts on birds and noise from wind turbines.

The category *Others* has been added for articles that could not be placed in previous subject categories.

4. Academic dissertations and theses

4.1. Doctoral dissertations

Development of Vortex Filament Method for Wind Power Aerodynamics
Abedi, H. PhD thesis in Thermo and Fluid Dynamics, Department of Applied Mechanics, Chalmers University of Technology 2016

Experimental investigation of a Kaplan runner under steady-state and transient operations
Amiri, K. Doctoral thesis. Luleå University of Technology 2016

Grid Connection of Permanent Magnet Generator Based Renewable Energy Systems
Apelfröjd, S. Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology, ISSN 1651-6214; 1436, Uppsala University 2016

Load and risk based maintenance management of wind turbines
Bangalore, P. PhD thesis in Electric Power Engineering, Department of Energy and Environment, Chalmers University of Technology 2016

Strategies, Methods and Tools for Solving Long-term Transmission Expansion Planning in Large-scale Power Systems
Fitiwi, Desta Zahlay. Doctoral thesis. Royal Institute of Technology 2016

Storskalig vindkraft i skogen: Om rationell planering och lokalt motstånd
Gradén, M. Doctoral thesis. Uppsala University 2016

Biodiversity Protection in an Aspiring Carbon-Neutral Society: A Legal Study on the Relationship between Renewable Energy and Biodiversity in a European Union Context
Malafry, M. Doctoral thesis. Uppsala University 2016

Vindkraft och lokala förankringsprocesser: Perspektiv på deltagande, förståelse och acceptans
Mels, S. et al. Doctoral thesis. Karlstad University 2016

Modelling Wind Power for Grid Integration Studies
Olauson, J. Doctoral thesis. Uppsala University 2016

On stability and receptivity of boundary-layer flows
Shahriari, N. Doctoral thesis. Royal Institute of Technology 2016

Demagnetization and Fault Simulations of Permanent Magnet Generators
Sjökvist S. et al. Doctoral thesis. Uppsala University 2016

Stochastic model updating and model selection with application to structural dynamics
Vakilzadeh, M. K. PhD thesis, 2016, Chalmers University of Technology 2016

Optimal bidding of a hydropower producer insequential power markets with riskassessment: Stochastic programming approach
Vardanyan, Y. Doctoral thesis. Royal Institute of Technology 2016

4.2. Licentiate dissertations

Drive Train System Dynamics Analysis: Application to Wind Turbines
Asadi, S. Thesis for the degree of Licentiate Engineering, 2016:01, ISSN 1652-8565, Department of Applied Mechanics, Chalmers University of Technology 2016

Rare Earth Metal–Free Permanent Magnet Generators
Eklund, P. Licentiate thesis. Uppsala University 2016

Blade force measurements and electrical torque ripple of a vertical axis wind turbine
Rossander, M. Licentiate thesis. Uppsala University 2016

A body force method for high precision offshore wake modelling simulations
Simisiroglou, N. Licentiate thesis. Uppsala University 2016

4.3. Master theses (two years)

Modeling the optimal energy mix in 2030: Impact of the integration of renewable energy sources
Arthur, C. Royal Institute of Technology 2016

Improving the Design of Wind Turbine Plants: Future Design of Wind Turbine Plants
Chaath, A. Halmstad University 2016

The performance of CFD RANS models in predicting wind loads on flat plates: A comparative study with DNS
Dahlqvist, E. Royal Institute of Technology 2016

Simulation of thermal tests in the climatic wind tunnel CD7 at Scania Master thesis project in fluid mechanics
De Laval, J. Royal Institute of Technology 2016

Building predictive models for dynamic line rating using data science techniques
Doban, N. Royal Institute of Technology 2016

The impact of wind conditions on wind turbines
Eriksson Petersen, L. Royal Institute of Technology 2016

Development of Business Models for Electrical Energy Storage in Europe - Techno-economic evaluation of combining storage services
Esser, K. Royal Institute of Technology 2016

Assessment of simulation codes for offshore wind turbine foundations
Faruk, Ö. & Mutungi, H. Master's Thesis in the Master's Programme Structural Engineering and Building Technology, Chalmers University of Technology 2016

Economic Impact Assessment of using Congestion Management Methods to enable increased Wind Power Integration on Gotland: Performed in collaboration with Vattenfall R&D
Giliniewicz, V. Royal Institute of Technology 2016

Modeling the Future Wind Production in the Nordic Countries
Granberg, V. Royal Institute of Technology 2016

Risk assessment of marine energy projects
Gueguen, S. Royal Institute of Technology 2016

The challenges in installation of offshore wind farms, A case of Lillgrund and Anholt wind farms
Habakurama, I. & Baluku, J. Institutionen för bygg- och miljöteknik, nr: BOMX02-16-104), Chalmers University of Technology 2016

Balancing an Increasing Share of Intermittent Wind Power Production: A comparison between the characteristics of wind power variations in Sweden and the technical flexibility of a major district heating utility
Hartman, A. Royal Institute of Technology 2016

Evaluating the Potential for Floating Offshore Wind Power in Skagerrak: The Golden Triangle
Jonsson, F. Uppsala University 2016

Development of EMT Simulation Model to Use RMS Control Model
Kalikavunkal, P. Royal Institute of Technology 2016

Application for Wind Farm Integration Complying with the Grid Code by Designing an Outer Control Strategy for the Converter
Kapidou, A. Royal Institute of Technology 2016

Rating of Power Cables for Dynamic Load Situations
Kitimbo, A. Royal Institute of Technology 2016

Forecasting Maximum Wind Speed at Offshore Sites
Letellier, B. Royal Institute of Technology 2016

Distribution On Load Tap Changer Control Using IEC61850 Client/Server Architecture
Maneikis, A. Royal Institute of Technology 2016

Generation of wind speed and solar irradiance time series for power plants with storage
Mauger, L. Royal Institute of Technology 2016

Application of dynamic rating to improve transportation capability of the power systems connected to wind power plants
Merante, M. Royal Institute of Technology 2016

Photovoltaic power potential on Gotland: A comparison with load, wind power and power export possibilities
Zaar, E. Uppsala University 2016

4.4. Master theses (one year)

Application of SCADA Data Monitoring Methodology and Reliability Analysis of Wind Farm Operational Data
Alavanja, B. Uppsala University 2016

Study Of Requirements For Post-Construction Automated Bird Mitigation Systems From Stakeholder’s Perspective
Crasilşcic, V. Uppsala University 2016

Wind Energy Utilization in Arctic Climate – Racmo 2.3 Greenland climate runs project
Da Silva Soares, J. Uppsala University 2016

Investigating Dimming Of Obstruction Lights In A Swedish Wind Farm
Jansson, A. Uppsala University 2016

Development of a pitch based wake optimisation control strategy to improve total farm power production
Jun Liang T. Uppsala universitet 2016

Defining the Wake Decay Constant as a Function of Turbulence Intensity to Model Wake Losses in Onshore Wind Farms
Kollwitz, J. Uppsala University 2016

The Battle in the Wind Energy Industry: The Case of Envision Energy
Lind, C. Halmstad University 2016

A stochastic analysis of Turbulence Intensity influence over various sizes of HAWT: *Study of hypothetical relationship between Rotor Diameter and influence level of Turbulence Intensity*
Nicholas, A. Halmstad University 2016

Development and application of framework of suitability assessment for onshore wind farm foundations
Stale, L. Uppsala University 2016

Investigation of Potential Reasons to account for the Underperformance of an Operational wind farm
Tücer, R. Uppsala University 2016

Quantifying the Shadow Effect between Offshore Wind Farms with Idealized Mesoscale Models and Observed Wind Data
Werner, D. Uppsala University 2016

4.5. Bachelors theses

Wind Power Integration and Operational Challenges
Alnaami, Z., Duenas, J. Royal Institute of Technology 2016

Vindkraftverk med trätorn: Miljöpåverkan och kostnad jämfört med ståltorn
Andersson, M. Royal Institute of Technology 2016

Study and Analysis of the Electrical and Mechanical Parts in a Wind Turbine Authors
Bin Bai. et al. Blekinge Institute of Technology 2016

Wind Power Integration and Operational Challenges
Duenas, J. Royal Institute of Technology 2016

European Wind Power Development, Factors That Influenced Change and What Can Be Learned
Gillies, J. Uppsala University 2016

Development of an Energy Management System for HVDC Grids
Jarnehammar, F. Royal Institute of Technology 2016

Övervakningssystem för vindkraftverk: Monitoring system for wind turbines
Jebur, M. Halmstad University 2016

Risk Identification, Analysis & Response Planning of a Typical Wind Power Project in Greece
Liapodimitris, D. Uppsala University 2016

Wind power plants integration to the power grid
Shames, S. Royal Institute of Technology 2016

Specification and Classification of Wind Power Plants
Tamadon, N. Royal Institute of Technology 2016

4.6. Summary of academic dissertations and theses

Table 2. Number of doctoral, licentiate, master and bachelor theses from 2016. Summary of this report and *New and ongoing wind power research in Sweden 2015.*

Level	2015	2016
Doctoral theses	11	13
Licentiate theses	3	4
Master theses (2 years)	17	22
Master theses (1 year)	16	11
Bachelors theses	10	10
Total	**57**	**60**

It is noted that the number of doctoral and licentiate theses increased during the year and a small increase in the number of total theses and papers in 2016 compared with 2015.