

# PROCEEDINGS

## 16<sup>th</sup> Wind Integration Workshop

International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants



25 - 27 October 2017 | Berlin, Germany

Tera Sponsor:



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# PROCEEDINGS

Edited by Uta Betancourt / Thomas Ackermann

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## **IMPRINT**

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# Welcome...

## to the 16th International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants

We have come a long way from the first edition of the workshop at the Royal Institute of Technology in Stockholm, Sweden in 2000 and we have almost come full circle. Let me seize this opportunity to announce that next year's Wind Integration Workshop will go back to its roots. **Mark your calendars and save the date for the 17<sup>th</sup> Wind Integration Workshop in Stockholm, Sweden from 15 – 19 October 2018!**

17 years, with 15 Wind Integration Workshops under my belt, have been filled with many great experiences and I am looking forward to the 16<sup>th</sup> Wind Integration Workshop in Berlin, Germany. This venue gives us the opportunity to re-visit one of our most popular conference cities. I am sure that this time around we will have as many exciting and eye-opening moments as we had at our last Berlin Conference in 2014. Yet, this is also a good moment to reflect on how times and circumstances change. Over the past years, we have always succeeded in reflecting the shifting focuses in the area of wind integration. This way, the workshop has developed into a renowned international platform for discussing the subject of grid integration of wind power into existing power systems.

Another way for Energynautics as an organizer to go with the times is take our participants' wishes and suggestions into account and offer a wider range of topics when it comes to RE grid integration. In October 2011, on the occasion of the 10th International Wind Integration Workshop the conference was held in conjunction with the Solar Integration Workshop for the first time. That conference is by now celebrating its 7<sup>th</sup> edition. This year we take the next step towards a comprehensive yet diverse RE conference experience and commemorate the first edition of the E-Mobility Power System Integration Symposium as we feel it necessary to discuss the impact of a larger share of EVs in transportation on the grid.

I am sure it is one of our shared goals to contribute with our work to assisting the goals outlined in the Paris Agreement. Yet, several studies show that with the current commitments, the probability of keeping the increase in global average temperature below 2°C is only 5%. We need to do even more to increase that probability and to give our planet a fair chance!

One goal that many countries have committed to apart from integrating a larger share of renewable energies is to also decrease Greenhouse emissions in the transport sector substantially by increasing the share of electric mobility. Yet, E-Mobility can only be considered a sustainable climate protection measure if vehicles are charged with power from renewable energies. Otherwise, emissions are only shifted to the location of the generation plants. New questions and challenges arise regarding the grid integration of a larger share of fluctuating power supply from renewable energies. Energynautics reflects this correlation with its new Workshop Setup and offers three conferences in one week that go hand in hand. The newly established Berlin Workshop Week offers many combination opportunities for its participants to account for the inherent synergies of the conference topics.

The programs of the Wind and Solar Workshops for example are especially designed to include sessions that are suitable for both interest groups on the shared Wednesday, like the IEA session "Recommended Practices for Wind / PV Integration" (IEA Tasks 14 and 25) or the ENTSO-E session "System Challenges & Solutions to Move Towards 100% RES Penetration". Another highlight in our Wind program is the session on the Black Out in Australia that is being discussed for the first time in detail in Europe. Another recurring focus of this year's workshop will be ancillary services. Due to last year's great feedback we offer the Wind Tutorial "Ancillary Services and Wind Power Plants: Status and Experiences" again on 24 October 2017. Make sure to check out the conference programs for those presentations that are most interesting to you and your line of work.

I would like to thank you all for making the Wind Integration Workshop to what it has become over the years: a great communion of like-minded researchers, economists and practicing engineers from different fields relating to wind power and transmission systems. Exchanging knowledge and discussing experiences in the area of large-scale integration of wind power into power systems and transmission networks for offshore wind power plants: that's what we do at the workshop. I would also like to welcome all our new participants and tell you: you have come to

the right place to immerse yourselves in the area of wind power integration. Brace yourselves for an exciting mix of both theoretical discussion and practical applications!

While bringing people together has always been the workshop's purpose, it is our guests' participation, their papers and their presentations that fill the frame we set with life. In 2000, we started with 4 sessions in total – this year we received such a large number of outstanding abstracts that we can offer again a two-and-a-half day program with 25 sessions.

We work hard at these Workshops, but it is very important to me personally to give our participants the time to mingle and network in a more casual setting as well. That is why the Wind Integration Workshop offers Accompanying Events such as the combined Solar and Wind Dinner (25 October 2017) that will take place at the Wasserwerk, a former water works facility. It is the perfect opportunity to mingle with both solar and wind experts. On Thursday, the spotlight will be on our poster presenters. Researchers and practitioners present their projects in poster sessions during the Workshop and at the especially dedicated Poster Reception on 26 October 2017. This Networking Event is a platform for poster presenters to showcase their findings and discuss them with workshop participants in a casual get-together. I encourage you to make good use of these unique educational and networking opportunities!

The most interesting papers from the Solar and Wind Workshops will again be published in a Special Edition of the *IET Renewable Power Generation (due late 2018)*<sup>1</sup>. Because of the high interest in the workshop proceedings, we will again submit this year's proceedings to international libraries and organizations who operate citation index systems such as the (i) FIZ – Fach Informations Zentrum Karlsruhe, (ii) Elsevier, (iii) ETDE, (iv) Reuters, (v) Compendex, (vi) Thomson Citation Index so that the proceedings are more easily available for academia and industry worldwide.

The 16<sup>th</sup> Wind Integration Workshop would not be possible without our sponsors and we would like to thank them for their support. Our Tera Sponsor this year is: the wind turbine manufacturer **ENERCON** (Germany), our Giga Sponsors: the Transmission System Operator **TenneT** (Germany), the consulting and software company **DigSILENT** (Germany), the energy group **DONG Energy** (Denmark), the wind turbine manufacturer **Siemens Gamesa** (Denmark) and the wind turbine manufacturer **Vestas** (Denmark).

In addition, the workshop is supported by Wind Europe (Belgium), the IET Digital Library (United Kingdom), the Renewables Grid Initiative (Germany), HTW – Hochschule für Technik und Wirtschaft Berlin (Germany), ENTSO-E (Belgium), UVIG – Utility Variable Generation Integration Group (USA) and the European Energy Students Network (EESN) as well as the media partners Offshore Wind Industry (Germany), Sun & Wind Energy (Germany), WindTech International (Netherlands), SmartGridSpain (Spain), et - Energiewirtschaftliche Tagesfragen (Germany), and the LinkedIn Group "Energy Storage Demand Response and Grid Technologies".

I would also like to thank all those who supported the organizers of this workshop: all the members of the International Advisory Committee as well as Uta Betancourt, Ines Drewianka, Elke Müller, Anke Ost and Elvan Varvoda (all Energynautics, Germany).

Enjoy some inspiring days in Berlin and seize the numerous networking opportunities!

*Thomas Ackermann*

*Energynautics*

PS: Comments are always welcome, feel free to contact me at: [t.ackermann@energynautics.com](mailto:t.ackermann@energynautics.com)

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<sup>1</sup> The first special edition based on the 2013 Workshop was published in January 2015 (Volume 9, Issue 1), the special edition from the 2014 Berlin Workshop was published in January 2016 (Volume 10, Issue 1), and the special edition from the 2015 Brussels Workshop was published in February 2017 (Volume 11, Issue 3), see <http://digital-library.theiet.org/content/journals/iet-rpg>

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C. Siebels (TenneT TSO, Germany)

### **North Sea Wind Power of the Future**

M. van der Meijden (TenneT TSO, Netherlands)

### **Presentation 3**

TBA

### **Social Acceptance is the Achilles' Heel of the Energy Transition**

L. Hartman (TenneT TSO, Germany)

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TBA

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09:00 – 10:40 / 27 October 2017 / Room Alexander 3 / Session chair: A. Estanqueiro (LNEG, Portugal)

**Integrating Energy Storage Solutions into Wind Power Plants: the Faroe Islands Case Study**

D. McMullin, B. Lenz, D. Gamboa, E. Quitmann, J. Anderlohr (ENERCON, Germany), T. Nielsen (Elfelagið SEV, Faeroe Islands)

**Modular Multilevel Converter with Energy Storage System for Grid Support Services in Wind Farms – Main Features and Computational Simulations**

S. Rodríguez González (GPTech, Spain), P. Carlos, P. Castro (EDP – NEW R&D, Portugal), B. Silva, J. Aguiar (INESC TEC, Portugal)

**Integrating High Shares of Variable Renewable Energy in Costa Rica**

P.-P. Schierhorn, T. Ackermann (Energynautics, Germany), F. Fernandez (DlGSILENT, Germany), C. Echevarría Barbero, J. R. Paredes, C. Tagwerker (Inter-American Development Bank IDB, USA/Costa Rica)

**Enhancing the Value of Wind and PV Generation through Optimal Aggregation**

A.R. Machado, A. Couto, J. Duque, A. Estanqueiro (LNEG, Portugal)

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11:10 – 13:00 / 27 October 2017 / Room Alexander 1 / Session chair: TBA

**A Statistical Method for Aggregated Wind Power Plants to Provide Secondary Frequency Control**

J. Hu, C. Ziras, H. W. Bindner (DTU, Denmark), X. Han (National Development and Reform Commission, China)

**Frequency Support from OWPPs connected to HVDC via Diode Rectifiers**

O. Saborío-Romano, A. Bidadfar, Ö. Göksu, M. Altin, N. A. Cutululis (DTU, Denmark)

**Coordinated Frequency Control by Inertial Response of Wind Power and Electric Vehicles in Japanese Power System**

J. Qi, T. Tsuji (Yokohama National University, Japan)

**Impact of Large Scale Integration of Wind Inertia on Power System Frequency Stability**

R. Denninger, P. Dubucq, G. Ackermann (Hamburg University of Technology, Germany)

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11:10 – 13:00 / 27 October 2017 / Room Alexander 2 / Session chair: TBA

**A Quantitative Method for Evaluation of Variation Management Strategies for Integration of Variable Renewable Electricity**

V. Johansson, L. Thorson, L. Göransson (Chalmers University of Technology, Sweden)

**Experimental Stability Assessment of Converter-Dominated Electrical Grids**

L. Reguera Castillo, A. Roscoe (University of Strathclyde, United Kingdom)

**Following the Demand by Using Strategical Wind and Solar Complementarity – the Case of Portugal**

A.Couto, J. Silva, A. Estanqueiro (LNEG, Portugal)

**Impact of Climate Change on a Future Highly Renewable European Power System**

M. Schlott, A. Kies, T. Brown, D. Schlachtberger, J. Hoersch, S. Schramm (Frankfurt Institute for Advanced Studies, Germany), M. Greiner (Aarhus University, Denmark)

## Session 8C: Grid Operation Tools

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11:10 – 13:00 / 27 October 2017 / Room Alexander 3 / Session chair: N. Cutululis (DTU, Denmark)

### **Demand Side Response in Multi-Energy Sustainable Systems to Support Power System Stability**

V. García Suárez, P. Ayivor, J. L. Rueda Torres (Delft University of Technology, Netherlands), M.A.M.M. van der Meijden (Delft University of Technology | TenneT TSO, Netherlands)

### **Can Benchmarks and Trials Help Develop new Operational Tools for Balancing Wind Power?**

C. Möhrle (WEPROG, Denmark), C. Collier (DNV GL, USA), J. Zack (AWS Truepower, USA), J. Jørgensen (Vaisala, USA)

### **Active Power Control for Mitigation of Short-term Fluctuation of Wind Power**

C. T. Urabe, T. Saitou, K. Kataoka, K. Ogimoto (University of Tokyo, Japan), T. Ikegami (Tokyo University of Agriculture and Technology, Japan)

### **Loss-Reduced Reactive Power Control Strategies for Transmission System Support with Renewable Energy Sources**

H. Köppe, B. Engel (Technical University Braunschweig, Germany), R. Grab, S. Rogalla (Fraunhofer ISE, Germany)

### **Improving the Reactive Power Balance between a German MV and HV Grid through Coordinated Reactive Power Provision by Wind Power Plants**

L. Hülsmann, E. Tröster (Energynautics, Germany), U. Ohl, M. Koch (EWR Netz, Germany)

## Session 9A: Wind Power Developments

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14:00 – 15:15 / 27 October 2017 / Room Alexander 1 / Session chair: N. Martensen (Energynautics, Germany)

### **Implementation of Current Signature Analysis to Monitor DFIG Wind Turbines**

E. Artigao (Renewable Energy Research Institute – IIER, Spain), A. Honrubia-Escribano, E. Gomez-Lazaro (University of Castilla – La Mancha, Spain)

### **Limit Voltage Dips & Inrush Currents When Energizing Power Transformers – Controlled Switching of Gang Operated Switches —Theory and Case Study**

P. Taillefer, L. Poutrain (Vizimax, Canada), J. Sanchez (France)

### **The Evolving Role of Simulation and Data Analytics in Wind Power System Development and Operation**

G. Dudgeon (MathWorks, USA), G. Schrabberger (MathWorks, Germany)

## Session 9B: German Sinteg Projects

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14:00 – 15:15 / 27 October 2017 / Room Alexander 2 / Session chair: TBA

### **Overview of SINTEG Projects Germany**

M. Kurt (Tennet, Germany)

### **DESIGNETZ – Toolbox Energy-Transition – From Individual Solutions Towards an Efficient System for the Future**

E. Wagner, T. Wiedemann (Designetz/Westnetz, Germany)

**TBA**

N.N.

## Session 10: Closing Session – Panel Discussions

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15:30 – 16:30 / 27 October 2017 / Room Alexander 1 – 2 / Session chair: TBA

**The contributions and discussions of this session are not part of the proceedings.**

## Poster Presentation Papers

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## Workshop Participants

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