



DIGITAL PROCEEDINGS – TABLE OF CONTENTS

Session 1 – KEYNOTE SESSION

14:15 – 15:50 | 16 October 2019 | Redwood A/B/C | Session Chair: T. Ackermann (Energynautics, Germany)

- **Wind Integration 2020 & Beyond**
Liam Ryan (EirGrid, Ireland)
- **Integration, the Future is Here Now**
Mark O'Malley (NREL, USA)
- **Managing Inverter-Based Generation in the Australian Power System**
Babak Badrzadeh (AEMO, Australia)
- **Decarbonisation, Competition in Networks, RoCoF, August 9th**
Graham Stein (National Grid, United Kingdom)
- **Wind in Ireland – From Today to Tomorrow**
Noel Cunniffe (IWEA, Ireland)

THE CONTRIBUTIONS AND DISCUSSIONS OF THIS SESSION ARE NOT PART OF THE PROCEEDINGS.

SESSION 2A: ENTSO-E WORKING GROUP ON CONNECTION NETWORK CODES (WG CNC)

16:30 – 18:30 | 16 October 2019 | Redwood A | Session Chair: Helge Urdal (UrdalPowerSolutions,

United Kingdom)

- **The New EU Legislative Framework (Clean Energy Package – CEP) and Its Impact on Connection Network Codes in the Light of Future System Challenges**
R. Pfeiffer (Amprion, Germany), E. Milin (RTE, France), K. Johansen (energinet.dk, Denmark), O. Rychly (CEPS, Czech Republic), J. Sprooten (elia, Belgium), I. Theologitis (ENTSO-E, Belgium) ([Submission-ID WIW19-46](#))
- **Monitoring of Connection Network Codes Implementation in EU Member States**
O. Rychlý (ČEPS, Czech Republic), A. Johnson (National Grid ESO, United Kingdom), D. Ilisiu (Transelectrica, Romania), G. Levacic (HOPS, Croatia), I. T. Theologitis (ENTSO-E, Belgium) ([Submission-ID WIW19-53](#))
- **Connection Network Codes Assessment: The Outcomes of the First Three Expert Groups Established under the Grid Connection European Stakeholder Committee**
I. T. Theologitis (ENTSO-E, Belgium), R. Pfeiffer (Amprion, Germany), E. Milin (RTE, France), R. Wilson (National Grid ESO, United Kingdom) ([Submission-ID WIW19-43](#))
- **Panel discussion: The Way Towards RfG 2.0 – Objectives, Challenges and Opportunities**
Moderator: Helge Urdal
Panelists:
Ralph Pfeiffer (Amprion, Germany)
Ioannis T. Theologitis (ENTSO-E, Belgium)
Oldrich Rychlý (CEPS, Czech Republic)
Daniel Fraile (WindEurope, Belgium)
Andrew Roscoe (Siemens Gamesa, United Kingdom)
Bernhard Schowe-von der Brelie (FGH, Germany)

SESSION 2B: COUNTRY STUDIES

16:30 – 18:30 | 16 October 2019 | Redwood B | Session Chair: Paul Gardner (Paul Gardner Energy Consulting, United Kingdom)

- **Operating Experiences with High Penetrations of Variable Renewable Energy**
D. Lew (Debra Lew LLC, USA), **D. Bartlett** (Xcel Energy, USA), **A. Groom** (Australian Energy Market Operator, Australia), **P. Jorgensen** (Energinet, Denmark), **J. O'Sullivan** (EirGrid, Ireland), **R. Quint** (North American Electric Reliability Corporation, USA), **B. Rew** (Southwest Power Pool, USA), **B. Rockwell** (Kauai Island Utility Cooperative, USA), **S. Sharma** (Electric Reliability Council of Texas, USA) ([Submission-ID WIW19-149](#))
- **Technical and Regulatory Challenges and Solutions in Operating Low Inertia Power Systems**
A. Tuohy (EPRI, USA), **A. Kelly** (EPRI International, Ireland), **E. Farantatos** (EPRI, USA), **P. Dattaray**, **E. Lannoye** (EPRI International, Ireland) ([Submission-ID WIW19-171](#))
- **Non-Synchronous Penetration: Conflict between Wind Generation and HVDC Interconnection**
R. Davison-Kernan (System Operator Northern Ireland (SONI), United Kingdom), **B. Fox**, **S. McLoone** (Queen's University Belfast, United Kingdom) ([Submission-ID WIW19-27](#))
- **Common Mode Oscillations on the Power System of Ireland and Northern Ireland**
P. Wall (EirGrid, Ireland), **A. Bowen** (University College Cork, Ireland), **C. Geaney**, **B. O'Connell**, **N. Cunniffe**, **R. Doyle**, **D. Gillespie**, **J. O'Sullivan** (EirGrid, Ireland) ([Submission-ID WIW19-87](#))
- **Sector Coupling in Denmark – Entering the Next Phase of the Green Transition**
A. Orths, **A. Bavnthøj Hansen** (Energinet, Denmark) ([Submission-ID WIW19-160](#))
- **Research and Practice on Energy System Coupling for Achieving High Penetration of Wind Power in Northeast China Power Grid**
S. Yu, **L. Jiaqing** (Northeast Power Dispatching Center of SGCC, China) ([Submission-ID WIW19-69](#))

SESSION 2C: CONVERTER RELATED ASPECTS

16:20 – 18:30 | 16 October 2019 | Redwood C | Session Chair: Babak Badrzadeh (AEMO, Australia)

- **Overview, Status and Outline of the New CIGRE Working Group C4.49 on Converter Stability in Power Systems**
Ł. Kocewiak (Ørsted Wind Power, Denmark), **C. Buchhagen** (TenneT TSO, Germany), **Y. Sun** (DNV GL, Netherlands), **X. Wang** (Aalborg University, Denmark), **G. Lietz** (DlG SILENT, Germany), **M. Larsson** (ABB, Switzerland) ([Submission-ID WIW19-146](#))
- **Need for Grid-Forming Converter-Control in Future System-Split Scenarios**
C. Heising, **D. Meyer** (Avasition, Germany), **T. Hennig**, **K. Vennemann** (Amprion, Germany), **G. Deiml**, **W. Winter**, (TenneT TSO, Germany), **H. Wrede** (University of Applied Sciences Düsseldorf, Germany), **J. Lehner**, **S. Wenig** (TransnetBW, Germany), **J. Weidner**, **S. Küchler** (50Hertz Transmission, Germany), **J. Fortmann** (University of Applied Sciences (HTW) Berlin, Germany) ([Submission-ID WIW19-99](#))
- **Impact of Converter-Interfaced Generation to the Frequency Response of the European Power System**
R. Musca (University of Palermo, Italy), **L. Busarello** (NEPLAN AG, Switzerland) ([Submission-ID WIW19-223](#))
- **A Positive Sequence Screening Tool to Identify Areas of Potential Inverter Instability in Inverter Dominated Systems**
J. Ruddy, **D. Ramasubramanian**, **P. Dattaray**, **E. Farantatos**, **A. Gaikwad** (EPRI, Ireland) ([Submission-ID WIW19-101](#))
- **Analysis of AC-Side Grid Interaction of MMC-Based HVDC Systems Utilizing a Laboratory Demonstrator**
C. Heising (Avasition, Germany), **T. Stoetzel** (Ruhr-University Bochum, Germany), **K. Vennemann** (Amprion, Germany), **D. Meyer** (Avasition, Germany), **V. Staudt** (Ruhr-University Bochum, Germany), **K. Kleinekorte** (Amprion, Germany) ([Submission-ID WIW19-97](#))
- **A VSM Converter Controller Implemented for RMS Simulation Studies of Electrical Power Systems**
R. Heydari (Aalborg University, Denmark | ABB Corporate Research, Sweden), **N. Johansson**, **L. Harnefors** (ABB Corporate Research, Sweden), **F. Blaabjerg** (Aalborg University, Denmark) ([Submission-ID WIW19-91](#))

SESSION 3A: FREQUENCY ASPECTS

08:40 – 10:40 | 17 October 2019 | Redwood A | Session Chair: Julia Matevosyan (ERCOT, USA)

- **Ensuring Future Frequency Stability in the Nordic Synchronous Area**
R. Eriksson, N. Modig (Svenska kraftnät, Sweden), M. Kuivaniemi (Fingrid Oyj, Finland) (Submission-ID WIW19-143)
- **Design & Implementation of Fast Frequency Response Service for a Low Inertia System**
J. Deegan, D. Dixon, H. W. Qazi, M. V. Escudero, I. Connaughton, J. O'Sullivan (EirGrid, Ireland) (Submission-ID WIW19-114)
- **Probabilistic Estimation of the aFRR Requirement in the Future European Power System with High RES Penetration**
J. Morin, G. Prime, Y. Wang (EDF R&D, France) (Submission-ID WIW19-22)
- **A Frequency Security Analysis of Wind Integrated Power Systems with Frequency Controls**
J. Steinkohl, X. Wang, P. Davari, F. Blaabjerg (Aalborg University, Denmark) (Submission-ID WIW19-141)
- **Ultra-Fast Frequency Response of Converter-Dominant Grids Using PMUs**
H. N. Villegas Pico (Iowa State University, USA), V. Gevorgian (NREL – National Research Laboratory, USA) (Submission-ID WIW19-280)
- **Impact of Flexibility Service Requirements on Investment Decisions and Costs**
C. O'Dwyer, D. Flynn (University College Dublin, Ireland) (Submission-ID WIW19-76)

SESSION 3B: CAN WIND ENERGY MAKE THE POWER SYSTEM HAPPY?

09:00 – 10:40 | 17 October 2019 | Redwood B | Session Chair: Daniel Fraile (WindEurope, Belgium)

- **Towards a Roadmap for Very High Shares of Variable Renewable Energy**
Soenke Engelken (Enercon, Germany)
- **The Role of System Strength and Inertia Management in Transitioning to Higher Share of Inverter-Connected Generation**
Babak Badrzadeh (AEMO, Australia)
- **TBA**
Inga Skrypalle (Vestas, Denmark)
- **From Grid Codes to Support Services: The Challenges for Wind Power Plant Owners and Operators**
Gustavo Quiñonez (Acciona, Spain)

SESSION 3C: MODELLING

08:40 – 10:40 | 17 October 2019 | Redwood C | Session Chair: Poul E. Sørensen (DTU Wind Energy, Denmark)

- **Call for Adequate RMS Approach for Grid Stability Assessment with a Significant Share of Converter-Interfaced Units**
V. Akhmatov, C. F. Flytkær (Energinet, Denmark) (Submission-ID WIW19-56)
- **Enhancing Quality of Vendor-Specific Dynamic Models Representing Wind Turbine Generators and Other New Power System Components in Interconnection Studies**
M. Borodulin (KIIP Consulting, USA) (Submission-ID WIW19-25)
- **High-Resolution Real-Time Analysis of HVDC-Connected Wind Farm with 100 Wind-Energy Plants Utilizing a High-Performance Calculation Cluster**
T. Jersch, P. Thomas, S. Khan, M. Wiens (Fraunhofer IWES, Germany), M. Kleine Jäger, D. Meyer, R. Bartelt, C. Heising (Avasition, Germany) (Submission-ID WIW19-102)
- **Large-Scale Wind Generation Simulations: Estimating Missing Technical Parameters Using Random Forest**
M. Koivisto, K. Plakas, P. Sørensen (DTU Wind Energy, Denmark) (Submission-ID WIW19-107)
- **Introducing a Flexible Platform for Modelling Energy Systems Integration**
M. McPherson (University of Victoria, Canada), T. Akhtar (University of Guelph, Canada) (Submission-ID WIW19-79)
- **A Study of Hydrogen as an Energy Vector for Future Renewable Energies**
J. Zaba, N. Schofield (University of Huddersfield, United Kingdom) (Submission-ID WIW19-236)

SESSION 4A: GRID FORMING I

11:10 – 13:00 | 17 October 2019 | Redwood A | Session Chair: Debra Lew (Debra Lew LLC, USA)

- **Will Grid Forming Inverters Be the Key for High Renewable Penetration?**
J. Matevosyan (ERCOT, USA), **B. Badrzadeh** (AEMO, Australia), **T. Prevost** (RTE, France), **E. Quitmann** (Enercon, Germany), **D. Ramasubramanian** (EPRI, USA), **H. Urdal** (UrdalPowerSolutions, United Kingdom), **J. MacDowell** (GE Power, USA), **S. Achilles** (GE Power, USA), **S. Hsien Huang** (ERCOT, USA), **V. Vital** (Arizona State University, USA), **J. O'Sullivan** (EirGrid, Ireland), **R. Quint** (NERC, USA) ([Submission-ID WIW19-273](#))
- **Progress statement from ENTSO's Pan-European Technical Group on High Penetration of Power Electronic Interfaced Power Sour Quiñonezces Focused on Performance Aspects of Grid Forming Converters**
H. Urdal (ENTSO-E, Belgium) ([Submission-ID WIW19-74](#))
- **Practical Experience of Operating a Grid Forming Wind Park and its Response to System Events**
A. Roscoe, **P. Brogan**, **D. Elliott**, **T. Knueppel**, (Siemens Gamesa, United Kingdom), **I. Gutierrez** (Scottish Power Renewables, United Kingdom), **J-C. Perez Campion** (Iberdrola Renovables, Spain), **R. Da Silva** (Scottish Power Renewables, United Kingdom) ([Submission-ID WIW19-26](#))
- **Comparison of Selected Grid-Forming Converter Control Strategies for Use in Power Electronic Dominated Power Systems**
B. Weise, **A. Korai**, **A. Constantin** (DlgSILENT, Germany) ([Submission-ID WIW19-145](#))

SESSION 4B: EIRGRID/IRELAND – ROCOF

11:10 – 13:00 | 17 October 2019 | Redwood B | Session Chair: EIRGRID (IRELAND)

- **Introductory remarks**
Jon O'Sullivan (EirGrid, Ireland)
- **TBA**
Tony Hearn (ESBN, Ireland)
- **ROCOF Testing – Process & Learnings**
Colm McManus (EirGrid, Ireland)
- **ROCOF – Generator's Perspective**
Stephen Carrig (ESB PG, Ireland)

SESSION 4C: FORECASTING I

11:10 – 13:00 | 17 October 2019 | Redwood C | Session Chair: Hans-Peter Wald (Overspeed, Germany)

- **Probabilistic Forecasting Tools for High-Wind Penetration Areas: An Irish Case Study**
C. Möhrle, **U. Vestergaard** (WEPROG, Denmark), **J. Ryan**, **K. Conway** (EIRGRID., Ireland) ([Submission-ID WIW19-60](#))
- **Forecasting of Wind Power Curtailment Events**
J. Koch, **S. Vogt**, **A. Braun**, **D. Jost**, **J. Dobschinski** (Fraunhofer IEE, Germany) ([Submission-ID WIW19-117](#))
- **Forecasts for the Vertical Grid Load**
O. Steinert, **J. Kuehnert**, **E. Arndt**, **J. Rosenkranz**, **U. Focken**, **M. Lange** (energy & meteo systems, Germany) ([Submission-ID WIW19-148](#))
- **Forecasting Vertical Loads for Grid Nodes at the Transition from Medium to High Voltage: A Concept and the Realization**
A. Wessel, **K. Brauns** (Fraunhofer IEE, Germany) ([Submission-ID WIW19-72](#))
- **Forecasting Vertical Power Flows at Transmission Grid Nodes Characterized by High Penetration of Renewable Generation and Consumption**
D. Jost, **A. Braun**, **K. Brauns**, **J. Dobschinski** (Fraunhofer IEE, Germany) ([Submission-ID WIW19-89](#))

SESSION 5A: CHALLENGES AND SOLUTIONS FOR FUTURE TRANSMISSION NETWORKS – RESULTS FROM HORIZON PROJECT

MIGRATE

14:00 – 15:40 | 17 October 2019 | Redwood A | Session Chair: Jako Kilter (Elering / TalTech, Estonia)

- **Massive Integration of Power Electronic Devices (MIGRATE) – Results and Future Challenges**
J. Kilter (Tallinn University of Technology, Estonia), S. Rüberg (TenneT, Germany), B. Heimisson (Landsnet, Iceland), T. Prevost (RTE, France), D. Lopez (Red Electrica, Spain), M. Val Escudero (Eirgrid, Ireland) (Submission-ID WIW19-255)
- **Power System Stability Issues Arising from Increasing Levels of Power Electronics Interfaced Generation**
V. Sewdien (TenneT / TU Delft, The Netherlands) (Submission-ID WIW19-287)
- **Wide Area Controls for Improved System Stability in Low Inertia System – Experience from Iceland**
B. Heimisson (Landsnet, Iceland) (Submission-ID WIW19-288)
- **From Grid-Forming Definition to Experimental Validation with a VSC**
C. Cardozo (RTE, France) (Submission-ID WIW19-285)
- **Power System Protection Solutions for Future Transmission Networks**
R. Andriano Gallego (REE, Spain) (Submission-ID WIW19-289)
- **Control of Wind Energy Converters in Power Systems with Very High Share of Renewables**
K. Almunem (TU Berlin, Germany) (Submission-ID WIW19-290)

SESSION 5B: LATEST DEVELOPMENTS OF IEC TC 88 WIND POWER GENERATION STANDARDS IN RELATION TO GRID CONNECTION REQUIREMENTS

14:00 – 15:40 | 17 October 2019 | Redwood B | Session Chair: Frank Martin (Siemens Gamesa Renewable Energy, Denmark)

- **IEC TC 88 Wind Power Generation Standards in Relation to Grid Connection Requirements**
B. Andresen (Aarhus University, Denmark), F. Martin, T. Dreyer, K. Ntovolos (Siemens Gamesa, Denmark), F. Brinch Nielsen (Energinet, Denmark), P. Sørensen (DTU Wind Energy, Technical University of Denmark, Denmark), Ł. H. Kocewiak (Ørsted Offshore Wind, Denmark) (Submission-ID WIW19-211)
- **IEC 61400-27 Series – Electrical Simulation Models of Wind Generation Systems**
P. Sørensen (Technical University of Denmark, Denmark)
- **Application of IEC 61400-21 and -27 for Grid Compliance Measurements, Model Development and its Validation – Manufacturer Experience and Perspective**
F. Martin, P. Mahat (Siemens Gamesa Renewable Energy, Denmark), T. Dreyer (Siemens Gamesa Renewable Energy, Germany), K. Ntovolos (Siemens Gamesa Renewable Energy, Denmark)
- **Application of IEC 61400-21 and -27 for Grid Compliance Measurements, Model Development and Its Validation – Developer's Experience and Perspective**
Ł. Kocewiak (Ørsted Wind Power, Denmark)

SESSION 5C: HARMONICS I

14:00 – 15:40 | 17 October 2019 | Redwood C | Session Chair: J. Charles Smith (ESIG, USA)

- **High-Frequency Resonance in HVDC and Wind Systems: Root Cause and Solutions**
J. Sun, I. Vieto (Rensselaer Polytechnic Institute, USA), E. Larsen (eLarsen Power System Consulting, USA), C. Buchhagen (TenneT Offshore, Germany) ([Submission-ID WIW19-275](#))
- **Improved Procedures for Determining Harmonics – Findings of the German Research Project NetzHarmonie**
L. Ziemann, O. Edalati, J. Rauch, M. Mühlberg (FGW, Germany), R. Klosse (delta energielösungen, Germany), A. Prost (WindGuard Certification, Germany), M. Hoven, H. Vennergeerts (FGH, Germany), J. Meyer, M. Domagk (Technische Universität Dresden, Germany), F. Safargholi (Technische Universität Chemnitz, Germany), K. Malekian (WRD, Germany), F. Santjer (UL International, Germany) ([Submission-ID WIW19-208](#))
- **PROMOTioN Work Package 16 Harmonic Resonance Demonstrator: Wind Turbine Generator Input-Impedance Measurement in DQ Frame**
Y. Sun, A. N. Fabian Perez, Y. Yang, A. W. Burstein (DNVGL, Netherlands), E. C. W. de Jong (DNVGL, Netherlands | Eindhoven University of Technology, Netherlands), B. Tang (Ming Yang Smart Energy, China) ([Submission-ID EMOB19-177](#))
- **Automation of Impedance for Measurement of Harmonic Stability Assessment of MMC-HVDC Systems**
D. Yang, X. Wang (Aalborg University, Denmark), M. Ndreko, W. Winter (TenneT TSO, Germany), R. Juhlin, A. Krontiris (ABB, Germany) ([Submission-ID WIW19-126](#))
- **Passivity-Based Harmonic Stability Analysis of Offshore Wind Farm Connected to a MMC-HVDC**
H. Wu, X. Wang (Aalborg University, Denmark), Ł. Kocewiak, J. Hjerrild, M. K. Bakhshizadeh (Ørsted Wind Power, Denmark) ([Submission-ID WIW19-47](#))

SESSION 6A: COMPLIANCE TESTING

16:10 – 18:30 | 17 October 2019 | Redwood A | Session Chair: Eckehard Tröster (Energynautics, Germany)

- **National RfG-Implementations – An Update to Grid Codes and Compliance Schemes**
B. Schowe-von der Brelie (FGH Zertifizierungsgesellschaft, Germany), M. Meuser, S. M. Ali, J. Döll (FGH, Germany) ([Submission-ID WIW19-262](#))
- **Compliance Testing in Ireland and Northern Ireland**
F. Kalverkamp, B. Schowe von der Brelie, J. Rauber, S. M. Ali, E. Makki (FGH, Germany) ([Submission-ID WIW19-221](#))
- **Ensuring Grid Code Compliance in a New and Changing RfG Landscape**
L. Ulvgård, T. Gehlhaar (DNV GL, Germany) ([Submission-ID WIW19-174](#))
- **Compliance Testing, Type Testing on Simulator Combined with Performance Testing on Site**
L. S. Christensen, T. Lund, B. W. Andersen, F. R. Londono (Vestas Wind Systems, Denmark), N. Ryan (ESB O&M Renewables Wind, Ireland), R. R. Bekker (Vestas Wind Systems, Denmark), M. Hughes (ESB O&M Renewables Wind, Ireland) ([Submission-ID WIW19-95](#))
- **Comparison of Under-Voltage-Ride-Through Measurements Between Field Tests and DyNaLab Grid Simulator Tests of the Siemens Gamesa D8 Direct-Drive Wind Turbine**
T. Siepker, T. Dreyer (Siemens Gamesa Renewable Energy, Germany), P. Ghimire, F. Martin (Siemens Gamesa Renewable Energy, Denmark), B. Nedjar (Siemens Gamesa Renewable Energy, France), S. Azarian, T. Jersch, S. Khan, G. Quistorf (Fraunhofer IWES, Germany) ([Submission-ID WIW19-135](#))
- **Transformer Based FRT Test Unit Becomes Common**
R. Klosse (delta energieloesungen technischer anwendungen, Germany), F. Loh (GE Renewable Energy, Germany), W. Alasadi (GE Renewable Energy, USA), M. Brand (Windtest Grevenbroich, Germany), L. Undevall (INNIO Jenbacher, Germany), D. Slowinski (WindGuard Certification, Germany) ([Submission-ID WIW19-231](#))

SESSION 6B: POWER SYSTEM ISSUES

16:10 – 18:30 | 17 October 2019 | Redwood B | Session Chair: Hannele Holttinen (recognis, Finland)

- **Operating the Ireland and Northern Ireland Power System with 70% Renewables by 2030: Technical Scarcity Identification**
S. Nolan, D. McSwiggan, P. Wall, **H. Qazi**, D. Corcoran, J. Kelliher, J. O'Sullivan (EirGrid, Ireland) (Submission-ID WIW19-229)
- **Modeling of Wind Power Plant Dynamics in Power System Planning and Operation Studies: Lessons to Learn from the 2016 South Australian Blackout**
M. Borodulin (KIIP Consulting, USA) (Submission-ID WIW19-23)
- **System Analysis 2019 of German TSOs on Demand for Reserve Generation Capacity**
F. Jahns (50Hertz Transmission, Germany), U. Janischka (TransnetBW, Germany), **R. Pfeiffer**, C. Spieker (Amprion, Germany), S. Spieker (50Hertz Transmission, Germany), G. Weidhas (Tennet TSO, Germany), (Submission-ID WIW19-35)
- **Impact on Power System Protection by a Large Penetration of Renewable Energy Sources**
A. Boricic, J. Wang, Y.Y. Li (ABB Corporate Research Center, Sweden), S. Zubic (ABB Substation Automation Products, Sweden), **N. Johansson** (ABB Corporate Research Center, Sweden) (Submission-ID WIW19-54)
- **Controlling Power Generation and Ancillary Services from Variable Renewable Energies (Wind and Solar) in India**
T. Ackermann, T. Schlösser, D. Masendorf (Energyonautics, Germany), U. Focken, V. Gaur, E. Arndt (energy & meteo systems), S. Garud (The Energy and Resources Institute, India), C. Nabe (Navigant Energy), M. Kaur (GIZ, India) (Submission-ID WIW19-286)
- **Probabilistic Security Limits of Power Grids with Large Integration of Wind Generating Resources**
S. Kim (Sangmyung University, Republic of South Korea), S. Jung, J. Lee, S. Park (Korea Electrical Power Corporation, Republic of South Korea), Y. Cho (Daegu Catholic University, Republic of South Korea), J. Hur (Sangmyung University, Republic of South Korea) (Submission-ID WIW19-50)

SESSION 6C: IEA WIND TASK 36 OPENSOURCE DISCUSSIONS

16:10 – 18:15 | 17 October 2019 | Redwood C | Session Chair: Corinna Möhrten (WEPROG, Denmark)

- **IEA Task 36 Open Space Session on Wind Power Forecasting and System integration Issues - Introduction**
C. Möhrten (WEPROG, Denmark), J. Zack (UL - AWS Truepower, USA), W. Shaw (PNNL, USA), T. Göçmen (DTU, Denmark), C. Draxl (NREL, USA), R. Bessa (INESC TEC, Portugal), G. Giebel (DTU, Denmark) (Submission-ID WIW19-127)
- **Work group Topic 1: Standards and Industry Guidelines for Data Exchange and IT Solutions in Power Industry: Where Do We Need Them?**
Moderators: A. Tuohy (EPRI, USA) and A. Kaifel (ZSW, Germany) (ZSW, Germany)
- **Work group Topic 2: Meteorological Measurements and Instrumentation Standardization for Integration into Grid Codes: What Can We Learn from the WMO?**
Moderator: W. Shaw (Pacific Northwest National Laboratory, USA)
- **Work group Topic 3: Application of Probabilistic Forecasts in Grid Operation and Marketing: What Should a Guideline Contain?**
Moderators: J. Koch (Fraunhofer IEE, Germany) and C. Möhrten (WEPROG, Denmark)
- **Work group Topic 4: Recommended Practices on Forecast Solution Selection: Which Areas Are Not Covered Sufficiently?**
Moderator: J. Zack (UL AWS Truepower, Denmark)
- **Work group Topic 5: Uncovering Uncertainty Origins through the Entire Modelling Chain: Which Applications Can Benefit from That Knowledge?**
Moderators: A. Wessel and S. Vogt (Fraunhofer IEE, Germany)

SESSION 7A: GRID FORMING II

09:00 – 10:40 | 18 October 2019 | Redwood A | Session Chair: Bernd Weise (DIGSILENT, Germany)

- **Experiences and Perspectives on Grid-Forming Systems**
S. Achilles, **D. Howard** (General Electric (GE) Energy Consulting, USA) (Submission-ID WIW19-246)
- **A Proposed Grid-Forming System for 100% Inverter-Based Generation**
P. Marinakis (HVDC Technologies, United Kingdom), N. Schofield (Huddersfield University, United Kingdom) (Submission-ID WIW19-234)
- **Modified Grid Forming Converter Controller with Fault Ride through Capability without PLL or Current Loop**
A. Abdelrahim (University of Strathclyde, United Kingdom), M. Smailes, P. McKeever (ORE Catapult, National Renewable Energy Centre, United Kingdom), K. Ahmed, **A. Egea-Álvarez** (University of Strathclyde, United Kingdom) (Submission-ID WIW19-256)
- **Influence of Grid-Forming Inverter Control on Short-Term Voltage Stability in Distribution Grids**
M. Coumont, B. Braun, J. Hanson (Technische Universität Darmstadt, Germany) (Submission-ID WIW19-66)
- **Grid-Forming Converters in Weak Grids – The Case of a Mediterranean Island**
R. Musca, G. Zizzo (University of Palermo, Italy), M. Bongiorno (Chalmers University of Technology, Sweden) (Submission-ID WIW19-224)

SESSION 7B: OFFSHORE WIND POWER

09:00 – 10:40 | 18 October 2019 | Redwood B | Session Chair: Łukasz H. Kocewiak (Ørsted Offshore, Denmark)

- **Integration of AC Connected Offshore Wind Power Plants with Long Runs of Export Cables**
A. Atallah (Siemens, Germany), A. Shafiu (Siemens, United Kingdom) (Submission-ID WIW19-232)
- **Kriegers Flak Combined Grid Solution – Real Time Power Transmission Control and Method for Transmission Capacity Calculation for Meshed Offshore Grids**
V. Akhmatov, T. Bentzon Sørensen (Energinet, Denmark), A.-K. Marten, R. Stornowski (50Hertz Transmission, Germany) (Submission-ID WIW19-15)
- **Sequence Current Controllability Analysis of Offshore MMC-HVDC during Asymmetrical Faults**
H. Wu, **X. Wang** (Aalborg University, Denmark), J. Hjerrild, Ł. Kocewiak, L. Zeni (Ørsted Wind Power, Denmark) (Submission-ID WIW19-48)
- **Coordinated Control of Wind Turbines in Diode-Rectifier-Connected Offshore Wind Power Plants with Frequency Support Capability**
A. Arasteh, A. Bidadfar, O. Saborío-Romano, N. A. Cutululis (Technical University of Denmark, Denmark) (Submission-ID WIW19-263)

SESSION 7C: FORECASTING II

09:00 – 10:40 | 18 October 2019 | Redwood C | Session Chair: Arne Wessel (Fraunhofer IEE, Germany)

- **Lessons learnt from the OpenSpace Discussion – TBC**
J. Zack (UL AWS Truepower, USA)
- **Wind Power Forecasting Based on Deep Artificial Neural Networks and Multi-Task Learning**
S. Vogt, A. Braun, J. Dobschinski (Fraunhofer IEE, Germany), B. Sick (University of Kassel, Germany) (Submission-ID WIW19-121)
- **Reduced Cost and Increased Wind and Solar Prediction Quality by the Generic Anemos Platform for Forecast Handling, Optimisation and Benchmarking**
H.-P. Waldl, F. Dierich (Overspeed, Germany) (Submission-ID WIW19-170)
- **Prediction of Power Flow in Electrical Networks**
I. Vdovichenko, M. Bengfort, D. Syga, B. Jordan, J. Rosenkranz, U. Focken, M. Lange (energy & meteo systems, Germany) (Submission-ID WIW19-161)

SESSION 8A: VIRTUAL SYNCHRONOUS MACHINES

11:10 – 13:00 | 18 October 2019 | Redwood A | Session Chair: Jens Fortmann (HTW Berlin, Germany)

- **Dispatching Parameters, Strategies and Associated Algorithm for VSM (Virtual Synchronous Machines) and Hybrid Grid Forming Converters**
R. Ierna, C. Li (National Grid ESO, Warwick, United Kingdom), M. Sumner, S. Pholboon (University of Nottingham, United Kingdom), M. Yu, A. Egea-Álvarez (University of Strathclyde, United Kingdom), H. Urdal (Urdal Power Solutions, United Kingdom) ([Submission-ID WIW19-193](#))
- **Enhanced Virtual Synchronous Machine (VSM) Control Algorithm for Hybrid Grid Forming Converters**
R. Ierna (National Grid ESO, United Kingdom), M. Yu, A. Egea-Álvarez, A. Avras, A. Dyško, C. Booth, H. Urdal (University of Strathclyde, United Kingdom), C. Li (National Grid ESO, United Kingdom) ([Submission-ID WIW19-192](#))
- **VSM (Virtual Synchronous Machine) Power Quality, Harmonic and Imbalance Performance, Design and Service Prioritisation**
M. Sumner, S. Pholboon (University of Nottingham, UK, United Kingdom), R. Ierna, C. Li (National Grid ESO, United Kingdom, United Kingdom) ([Submission-ID WIW19-93](#))
- **VSM (Virtual Synchronous Machine) Control System Design, Implementation, Performance, Models and Possible Implications for Grid Codes**
R. Ierna (National Grid ESO, United Kingdom), S. Pholboon, M. Sumner (University of Nottingham, United Kingdom), C. Li (National Grid ESO, United Kingdom) ([Submission-ID WIW19-92](#))
- **Power Angle Small-Signal Stability Analysis of Grid-Forming Wind Turbine Inverter Based on VSM Control**
L. Lu, Ö. Göksu, N. A. Cutululis (Technical University of Denmark, Denmark) ([Submission-ID WIW19-175](#))

SESSION 8B: IEA – ACCELERATING THE ENERGY TRANSITION TO BOOST SYSTEM FLEXIBILITY WITH HIGHER SHARES OF RENEWABLES IN ASIA-PACIFIC

11:10 – 13:00 | 18 October 2019 | Redwood B | Session Chair: Peerapat Vithayasrichareon (IEA, France)

- **Enhancing System Flexibility for High Share of Renewables in Asia**
C. Hart (IEA, France)
- **How Renewables Will Drive Power System Growth in South-East Asia: Roadmap to 2030**
M. Pujantoro (Agora, Germany)
- **IEA Wind International Research Collaboration**
J. McCann (SEAI | IEA TCP, Ireland)
- **A 30MW Grid Forming BESS Boosting Reliability in South Australia and Providing Market Services on the National Electricity Market**
S. Cherevatskiy, S. Zabihi (ABB Power Grids Australia, Australia), R. Korte, H. Klingenberg (ElectraNet, Australia) ([Submission-ID WIW19-237](#))

SESSION 8C: HARMONICS II

11:10 – 13:00 | 18 October 2019 | Redwood C | Session Chair: Andrew Burstein (DNV GL, Netherlands)

- **Analysis of Harmonic Impedance of Wind Farms**
L. Cai (University of Rostock, Germany), X. Meng (SEWPG European Innovation Center, Denmark), U. Karaagac (Polytechnic University, Hong Kong), J. Mahseredjian (Polytechnique Montréal, Canada) ([Submission-ID WIW19-206](#))
- **Control of Type-III Turbines to Avoid Subsynchronous Resonance with Different Types of Transmission Systems**
I. Vieto, J. Sun (Rensselaer Polytechnic Institute, USA) ([Submission-ID WIW19-49](#))
- **Impact of Wind Turbine Converters on the Harmonic Emission Levels and Harmonic Stability of HVAC-Connected Offshore Wind Farms**
L. Depla, R. Cremers, K. Velitsikakis (DNV GL Energy, Netherlands) E. Prieto-Araujo, M. Cheah-Mane (CITCEA-UPC, Spain) ([Submission-ID WIW19-281](#))
- **Updated Harmonic and Interharmonic Current Summation Rule in Wind Power Plants with Type III Wind Turbines**
H. Ghanavati (Iran University of Science and Technology, Iran), Ł. Kocewiak (Ørsted Wind Power, Denmark), A. Jalilian (Iran University of Science and Technology, Iran) ([Submission-ID WIW19-151](#))

SESSION 9A: RESILIENCY ASPECTS AND SYSTEM RESTORATION

14:00 – 15:40 | 18 October 2019 | Redwood A | Session Chair: Nicholas Miller (HickoryLedge, USA)

- **Processes and Systems for Using Flexibility from Distribution Grid to Integrate a High Share of RES in a Resilient, Stable and Efficient Operated Energy Supply System**
M. Staudt (Mitteldeutsche Netzgesellschaft Strom mbH, Germany), S. Wende-von Berg (Fraunhofer IEE, Germany | University of Kassel, Germany), W. Albers, C. Calpe (innogy SE, Germany), B. Silva (INESC TEC, Portugal) ([Submission-ID WIW19-57](#))
- **“Greenstart” – Integrating Inverter-Interfaced Energy Sources into System Restoration**
S. McGuinness, J. Ruddy, A. Kelly, E. Lannoye (EPRI, Ireland) ([Submission-ID WIW19-120](#))
- **Dynamic Simulations of a Black Starting Offshore Wind Farm Using Grid Forming Converters**
M. Aten (Uniper, United Kingdom), R. Shanahan (Carbon Trust, United Kingdom), F. Mosallat (Manitoba Hydro International, Canada), S. Wijesinghe (Innogy, United Kingdom) ([Submission-ID WIW19-28](#))
- **Co-Simulation Hardware in the Loop Test Bench for a Wind Turbine: Validation of a Wind Turbine Black Start Capability**
A. Fabián Pérez, Y. Sun, **A. W. Burstein** (DNV GL, Netherlands), A. Harson (DNV GL, United Kingdom), B. Tang (Ming Yang Smart Energy Group, China) ([Submission-ID WIW19-115](#))

SESSION 9B: HYBRID POWER PLANTS

14:00 – 15:40 | 18 October 2019 | Redwood B | Session Chair: Torsten Lund (Vestas, Denmark)

- **Dynamic Modelling of Wind-Solar-Storage Based Hybrid Power Plant**
K. Das, A. D. Hansen, J. Sakamuri, P. Adamou, X. Giagkou, J. García Carretero, S. Majumder, F. Rigas (Technical University of Denmark, Denmark), M. Altin (Izmir Institute of Technology, Turkey), E. Nuno (Suzlon Energy, Germany), P. Sørensen (Technical University of Denmark, Denmark) ([Submission-ID WIW19-248](#))
- **Performance of Hybrid Power Park Technologies in Future OFTO Networks with the Aim to Achieve Grid-Forming Capability**
M. Yu, R. Ierna (National Grid ESO, United Kingdom), **A. Dysko**, A. Egea-Álvarez, A. Avras (University of Strathclyde, United Kingdom), C. Li, M. Horley (National Grid ESO, United Kingdom), C. Booth, H. Urdal (University of Strathclyde, United Kingdom) ([Submission-ID WIW19-191](#))
- **Assessment of Battery Energy Storage System for Grid System Frequency Response Service**
R. Guo, N. Zhao (University College Dublin, Ireland), N. Schofield (University of Huddersfield, United Kingdom) ([Submission-ID WIW19-239](#))
- **Impedance Measurement of Wind Turbines using a Multimegawatt Grid Simulator**
S. Shah, P. Koralewicz, **V. Gevorgian**, R. Wallen (National Renewable Energy Laboratory (NREL), USA) ([Submission-ID WIW19-277](#))
- **Challenges in Integration of MMC STATCOM with Battery Energy Storage for Wind Power Plants**
S. Chaudhary, R. Teodorescu (Aalborg University, Denmark), Ł. Kocewiak (Ørsted Offshore Wind, Denmark), P. Johnson (Ørsted Offshore Wind, United Kingdom), C. Y. Chen, B. Berggren, L. Harnefors (ABB, Sweden) ([Submission-ID WIW19-183](#))

SESSION 9C: GRID INTEGRATION SOLUTIONS

14:00 – 15:40 | 18 October 2019 | Redwood C | Session Chair: Ralph Pfeiffer (Amprion, Germany)

- **An Application of Modular FACTS Devices to Relieve Transmission Constraints and Accelerate Wind Farm Connections and Firm Access**
R. Fenlon (Smart Wires, Ireland) (Submission-ID WIW19-233)
- **Optimization of the Electricity and Heating Sectors Development in the North Sea Region towards 2050**
J. Gea-Bermúdez, M. Koivisto, M. Münster (Technical University of Denmark, Denmark) (Submission-ID WIW19-109)
- **Case Study Results of Wind Power Integration with Dynamic Line Rating**
R. Kuwahata, H.-M. Nguyen (Ampacimon, Belgium) (Submission-ID WIW19-199)
- **Dynamic Line Rating and Hotspot Analysis for Electric Utilities**
T. Speet, B. Faerber, J. Rosenkranz, U. Focken, M. Lange (energy & meteo systems, Germany) (Submission-ID WIW19-139)
- **Back-Casting Analysis How Dynamic Line Rating Would Increase Usage Ratio of European Interconnection**
R. Kuwahata (Ampacimon, Belgium), A. Michiorri (MINES ParisTech | PSL University, France), Y. Yasuda (Kyoto University, Japan) (Submission-ID WIW19-32)

Session 10 – CLOSING SESSION – Panel Discussion

16:00 – 17:00 | 18 October 2019 | Redwood A/B/C | Moderator: Julia Matevosyan (ERCOT, USA)

Very High Shares – up to 100% – of Renewables in the Grid

Panelists:

- Jonathon Dyson (Greenview Strategic Consulting, Australia)
- Vahan Gevorgian (NREL, USA)
- Dustin Howard (General Electric (GE) Energy Consulting, USA)
- more tbc

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

POSTER PRESENTATION PAPERS

- **Making Use of Analytical Wake Models for Large Scale Power System Models by Generation of Generic Efficiency Fields**
G. Erichsen, O. Schülting, A. Kather (Hamburg University of Technology, Germany) (Submission-ID WIW19-19)
- **Multi-Objective Optimization of Cable Sizes of an Offshore Wind Power Plant Collector System**
C. Kaufmann (Fraunhofer ISIT – Fraunhofer Institute for Silicon Technology | Hamburg University of Applied Sciences, Germany), J. Dakic, O. Gomis-Bellmunt (CITCEA-UPC, Polytechnical University of Catalonia, Spain) (Submission-ID WIW19-31)
- **Dynamic Stability Assessment of the Large Offshore Wind Power Plant at Kriegers Flak**
R. B. Glasdam, V. Akhmatov, L. Dall, H. Abildgaard (Energinet, Denmark), H. Jóhansson (Technical University of Denmark (DTU), Denmark) (Submission-ID WIW19-36)
- **Dynamic Model of Current-Source Converter-Based Wind Power Plant Composed of Series-Connected Wind Turbine Generators and Synchronous-Compensator-Commutated Thyristor Inverter**
S. Nishikata (Tokyo Denki University, Japan), K.-i. Yamashita (Salesian Polytechnic, Japan) (Submission-ID WIW19-37)
- **A Current-Source Converter-Based Wind Power Plant Capable of Controlling Power Factor and Its Basic Characteristics**
S. Nishikata, F. Tatsuta (Tokyo Denki University, Japan) (Submission-ID WIW19-39)
- **Modelling Wind Speeds Using CorRES: Combination of Mesoscale Reanalysis Data and Stochastic Simulations**
G. M. Jónsdóttir (University College Dublin, Ireland), M. Koivisto, P. E. Sørensen (Technical University of Denmark, Roskilde, Denmark), F. Milano (University College Dublin, Ireland) (Submission-ID WIW19-58)

- Development of Practical Allocation Method About Reactive Power Reference for Wind Farms Through Inner-Voltage Restriction**
S. Jung (Hanbat National University, Republic of South Korea), Y. Yoo, G. Jang (Korea University, Republic of South Korea) (Submission-ID WIW19-65)
- Optimal Sizing and Location of Reactive Power Compensation in Offshore HVAC Transmission Systems for Loss Minimization**
J. Dakic, M. Cheah-Mane, E. Prieto-Araujo, O. Gomis-Bellmunt (CITCEA-UPC – Politechnical University of Catalonia, Spain) (Submission-ID WIW19-73)
- Comparison of European Network Codes for AC- and HVDC-Connected Renewable Energy Sources**
B. Nouri, A. Arasteh, Ö. Göksu, J. N. Sakamuri, P. E. Sørensen (Department of Wind Energy, Technical University of Denmark, Denmark) (Submission-ID WIW19-86)
- Experimental Studies Using 1.5kW DFIG on Power Control for Wind Power Generation and Transmission Line Impedance effect**
H. Nakamura, Y. Ota, T. Nakajima (Tokyo City University, Japan) (Submission-ID WIW19-110)
- Study on the Review and Establishment of Grid Code Criteria in South Korea According to the Expansion of Renewable Power Sources**
J. Han, H. Kwon, Y. Jo, J. Jung, M. Lee, Y. Cho (Daegu Catholic University, Republic of South Korea), B. Kang, J. Myong, H. Yi (Korea Power Exchange (KPX), Republic of South Korea), J. Hur (Sangmyung University, Republic of South Korea) (Submission-ID WIW19-131)
- A Study on the Optimal Methodology for Power System Development Plan to Expand Renewable Energy in South Korea**
H. Kwon, Y. Cho (Daegu Catholic University, Republic of South Korea), J. Hur (Sangmyung University, Republic of South Korea), K. Lee, E. Kwak (Korea Electric Power Corporation Operator (KEPCO), Republic of South Korea) (Submission-ID WIW19-132)
- An Open-Loop Offshore Voltage Control for VSC-HVDC Systems in AC Meshed Offshore Grids with Various HVDC Technologies**
C. Neumann, H.-G. Eckel (University of Rostock, Germany) (Submission-ID WIW19-136)
- Small-Signal Analysis of Grid-Supporting Droop-Based Converter Control for Wind Power Application**
M. Gierschner, F. Uster, A. Schöley, S. Gierschner, H.-G. Eckel (University of Rostock, Germany) (Submission-ID WIW19-153)
- Grid Current Observer for Wind Energy Systems with LCL-Filter**
A. Schöley, M. Gierschner, T. Jeinsch (University of Rostock, Germany) (Submission-ID WIW19-155)
- IEA Wind Task 36: The New Phase for the Wind Power Forecasting Task**
G. Giebel (DTU, Denmark), W. Shaw (PNNL, USA), H. Frank (DWD, Germany), C. Draxl (NREL, USA), J. Zack (AWS Truepower, USA), P. Pinson (DTU, Denmark), C. Möhrten (WEPROG, Denmark), G. Kariniotakis (MINES ParisTech, France), R. Bessa (INESC TEC, Portugal) (Submission-ID WIW19-190)
- WT Type 4 Benchmarks for IEC 61400-27-1**
R. Musca (University of Palermo, Italy), G. Cott (NEPLAN AG, Switzerland) (Submission-ID WIW19-222)
- Thermal Modelling Characteristics of Sodium-Nickel Chloride Battery for Transient Energy Storage Systems**
Y. Hu (University of Huddersfield, United Kingdom), N. Zhao (University College Dublin, Ireland), R. Bull (Beta Research, United Kingdom), N. Schofield (University of Huddersfield, United Kingdom), R. Tilley (Beta Research, United Kingdom) (Submission-ID WIW19-240)
- Modelling the Intra-Hour Power System Balancing of the Danish Power System for 2020, 2030 and 2050**
P. Kanellas, **K. Das**, P. E. Sørensen, J. Gea-Bermudez (Technical University of Denmark (DTU), Denmark) (Submission-ID WIW19-242)
- Comparison of Compliance Verification Methods of Wind Power Plant Controllers in Germany and Ireland**
S. M. Ali, B. Schowe-von der Brelie, P. Tavasoli, S. E. Makki, R. S. Ghare (FGH, Germany) (Submission-ID WIW19-249)
- Best Practice Experiences Regarding Virtual Power Plants and the Usage of APIs**
T. Buschmann, D. Treumann, J. Rosenkranz, M. Lange, U. Focken (energy & meteo systems, Germany) (Submission-ID WIW19-250)
- Impact of Different Load Types on Voltage Stability of Power System Considering Wind Power Support**
M. Sarkar, M. Sørensen, P. E. Sørensen, A. D. Hansen (DTU Wind Energy, Technical University of Denmark, Denmark) (Submission-ID WIW19-258)
- Development of a Global Atlas of Off-River Pumped Hydro Energy Storage**
M. Stocks, R. Stocks, B. Lu, **C. Cheng**, A. Blakers (Australian National University, Australia) (Submission-ID WIW19-265)

