

2017

Entity: Energy Development and Power Generation Committee

Chair: Ward Jewell

Vice-Chair: John Yale

Secretary: Robert Thornton-Jones

1. Significant Accomplishments:

The Committee is made up of the following subcommittees:

- Distributed Energy Resources
- Excitation Systems and Controls
- Hydroelectric Power
- Integration of Renewables
- International Practices
- Renewable Technologies
- Station Design, Operation and Control
- Technologies for Greenhouse Gas Mitigation and Adaptation

Significant accomplishments in the past year are broken down by subcommittee as follows:

The Subcommittee on Technologies for Greenhouse Gas Mitigation & Adaptation hosted a panel session, Regulatory and Environmental Impact on Power Grid: Simulation and Implication, at the General Meeting. It was well-attended. Panelists were from major RTO/ISOs in the US, a university in the UK, and State Grid in China. The subcommittee also established a working group “Low Carbon Energy System Transition and Policy”, led by Prof. Qixin Chen from Tsinghua University and Dr. Xinyu Chen from Harvard University.

The Station Design, Operation, and Control Subcommittee has three working groups with active PARs, all related to standards. The standards are IEEE Std 665-1995 IEEE Guide for Generating Station Grounding, IEEE Std 666-2007 IEEE Design Guide for Electric Power Service Systems for Generating Stations and IEEE Std 1050-1989 IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations.

The Subcommittee on Distributed Energy Resources has four working groups:

1. *Microgrid Applications and Implementation*, Anurag Srivastava and Melanie Johnson
2. *Global Laboratory Infrastructure for Distributed Energy Resources – Application and Testing*, Georg Lauss
3. *Management of Distributed Battery Storage Systems*, Caisheng Wang
4. *High Renewable Energy Penetrations within Isolated and Remote Area Power Systems*, Michael Negnevitsky. This is a new working group formed in 2017.

The Excitation System and Controls Subcommittee is maintaining 6 standards: 421.1-421.6. A PAR is in place and revisions are underway to update IEEE 421.1 Standard Definitions for Excitation Systems for Synchronous Machines for ballot in 2018. IEEE 421.2 Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems and IEEE 421.4 Guide for the Preparation of Excitation System



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Specifications were revised and published in 2014. IEEE 421.3 Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines and IEEE 421.5 Recommended Practice for Excitation System Models for Power System Stability Studies were both revised and published in 2016. Brand new IEEE 421.6 Recommended Practice for the Specification and Design of Field Discharge Equipment for Synchronous Machines was successfully balloted and published 23 March 2017. The subcommittee had a 2 hour panel session on Power System Stabilizer and Excitation Limiter Practical Issues in the Modern Grid. This led to a request to revise the Power System Stabilizer tutorial document and panel. Additionally, members of the Subcommittee presented the impacts of Grid Codes on Excitation Systems standards and design and use of the SC standards 421.2 and 421.5 at the 2017 general meeting.

The Hydroelectric Power Subcommittee (HPS) governor harmonization taskforce completed a draft harmonization of governor terms and definitions between IEEE and IEC governor standards and submitted the proposed harmonization document to the IEC TC14 working group for review and comment. The HPS and TC14 have agreed to form a joint working group to develop a project for creating a dual logo standard containing harmonized speed governor terms and definitions. The subcommittee presented two panel discussions at the 2017 PES General Meeting; one titled “Integrating Wind and Solar with Your Hydro”, and the other titled “IEEE Standards and Guides Developed by the Hydroelectric Power Subcommittee.”

The Renewable Technologies Subcommittee organized a well-attended Panel Session titled “Current R&D in Photovoltaics: Technology and Grid Integration” at the General meeting. There were 7 panelists. This was organized by Dr. B. Chowdhury of UNCC.

The Integration of Renewable Energy into the Transmission and Distribution Grids Subcommittee has two Working Groups:

- Wind Plant Collector System Design (Chair: Doug Price)
- Wind and Solar Plant Interconnection Working Group (new name, Chair: Jens C. Boemer). The scope of this WG was revised:
 - Serve as a focal point for technology and solutions providers within the Power and Energy Society (PES) for addressing issues related to interconnection performance requirements, testing, and validation of transmission- and distribution-connected wind and solar plants.
 - Contribute expertise from the manufacturers and developer’s perspective on **grid interconnection standards, grid supportive functions** and **plant control modes** to meet **modern grid codes**.
 - Conduct activities to promote the **sharing of knowledge and experience among diverse organizations** working on similar issues through the conduct of symposia, workshops, paper sessions, (joint) panel sessions, and tutorials.
 - Publish working group papers to document results of working group activities and to share working group positions on issues related to wind and solar plant interconnection.

The Subcommittee completed the wind plant grounding guide, started a solar grounding and dc design guide, and initiated a PAR for personnel safety related to wind and solar plant grounding. The Subcommittee also sponsored two panels and supported three technical sessions at the 2017 General Meeting.

2. Benefits to Industry and PES Members from the Committee Work:

The various subcommittees within the Energy Development and Power Generation Committee inform members and other interested individuals through standards and paper / panel sessions as mentioned above on new developments in their areas of expertise. In coordination with the T&D Distribution Subcommittee and the T&D



Distributed Resources Integration WG, the committee offers a technology perspective about the state of the art of grid integration and interconnection requirements technology solutions.

3. Benefits to Volunteer Participants from the Committee Work:

By actively working on the committee, members are able to contribute their knowledge to the industry while at the same time earning Professional Development Hours that count toward their various PE continuing education requirements.

Volunteers get opportunities to propose panel sessions, discuss cutting edge power system operation and planning problems with leaders and experts in specific fields, and invite right individuals to attend panel sessions.

Volunteers also benefit from technical paper reviews and presentations.

The IEEE 421 series of excitation system standards, developed and maintained by the Excitation System and Controls Subcommittee, are used worldwide by all vendors, transmission planners and operators and generator owners to specify, commission, test, tune and model excitation controls and confirm coordination of limiters and protections to meet current and evolving electric grid codes. Work is underway in IEC to harmonize or adopt IEEE standards, in particular 421.5, to recognize the international nature of excitation system design, tuning and testing.

Hydroelectric Power Subcommittee participants are afforded a reason to attend meetings that are held at the PES General Meeting and HydroVision (alternating years). These conferences, and of course, the working group meetings themselves are excellent opportunities for networking and continuing education.

Participants gain an understanding of the technical issues discussed during ongoing working group standard revision efforts. This provides alternative approaches and experiences to address common challenges and supports knowledge transfer of best practices.

4. Recognition of Outstanding Performance:

The Committee presented the Distinguished Individual Service Award to Michael Basler for his years of service as Secretary, Vice Chair, and Chair of the Committee.

The Excitation System and Controls Subcommittee thanks past chair Robert Thornton-Jones for his excellent stewardship and tireless work and wishes him success in his equally demanding new role in Grid Code and synchronous machine standards and special publications. The Subcommittee also acknowledges Leonardo Lima who received an IEEE-SA Standards Medallion “for outstanding contributions across several IEEE committees including technical and administrative work on standards, papers, panel sessions and as secretary, draftsman and author.” Leo is an editor and draftsman without peer not only in Excitation Systems but in several other working groups and subcommittees.

Dave Apps and Mathieu Bergeron of the Hydroelectric Power Subcommittee have put in a commendable effort in meticulously comparing and merging terms and definitions and leading the effort to harmonize IEEE and IEC speed governor related terms and definitions.

Tom Key, chair of the Integration of Renewable Energy into the Transmission and Distribution Grids Subcommittee, received the 2017 IEEE-PES Ramakumar Family Renewable Energy Excellence Award “for pioneering contributions in renewable energy resource development and integration”. This award was established to recognize outstanding contributions to developing, utilizing and integrating renewable energy resources in the

national and global energy scenarios. The primary objective of this award is to promote the innovations as the increased use of energy technologies with minimal carbon footprint continues to grow.

5. Coordination with Other Entities (PES Committees, CIGRE, standards, etc.):

Members of the Subcommittee on Technologies for GHG Mitigation & Adaptation have worked with Global Energy Interconnection Development and Cooperation Organization to promote global energy interconnection under the framework of United Nation's sustainable development goals. They have attended the meeting in UN headquarter on this topic, and the collaborative work for the year of 2018 has been discussed.

The Distributed Energy Resources Subcommittee has informal exchanges with CIGRE Study Committee C6 "Distribution Systems and Dispersed Generation". Professor Nikos Hatziargyriou acts as a liaison.

The Excitation System and Controls Subcommittee has work underway in IEC to harmonize or adopt IEEE standards, in particular 421.5, to recognize the international nature of excitation system design, tuning and testing.

The Hydroelectric Power Subcommittee maintains a Category D Liaison with IEC/TC 4, Hydraulic Turbines, Randall Groves. The Hydroelectric Power Subcommittee was targeting input to National Electric Code (NFPA 70) 2020 version small hydro section through Liaison, Russ Fostiak. The Subcommittee has participated in multiple conference calls and continues to monitor activity on P2775 (SGCC smart hydro standard).

The Integration of Renewables Subcommittee and its working groups have started to closely coordinate with other relevant entities as follows:

- PES Wind and Solar Power Coordinating Committee (WSPCC) (Chair: Debra Lew, GE Energy Connections)
- IEEE SA SCC21 Standards Coordinating Committee on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage (Past-Chair: Thomas Basso, Chair: Mark Siira)
- IEEE P1547 (Chair: David Narang, NREL)
- EDPG Distributed Energy Resources Subcommittee
- EDPG Renewables Technology Subcommittee (Chair: Rama Ramakumar, Ok State University)
- EDPG Photovoltaic WG (Chair: Badrul Chowdhury, UNCC)
- T&D Distribution Subcommittee (Chair: Julio Romero Agüero, Quanta)
- T&D Distributed Resources Integration WG (Past-Chair: Julio Romero Agüero, Quanta, Chair: Babak Enayati, National Grid)
- Electric Machinery (EMC) Renewable Energy Machines and Systems Subcommittee (Chair: István Erlich)
- EMC Generator Subcommittee Task Force on the Impacts of Grid Codes upon Generator Design and Standards

6. New Technologies of Interest to the Committee:

The Subcommittee on Technologies for Greenhouse Gas Mitigation & Adaptation is interested in the topics of super-low emission technologies for coal fired power plants and low carbon energy system transition technologies.

The Distributed Energy Resources Subcommittee's interest is centered on Distributed Energy Resources themselves, their roles in microgrids and remote power systems, and laboratory infrastructures for testing Distributed Energy Resources.

Variable speed pumped storage is of particular interest to the Hydroelectric Power Subcommittee, as is ocean/wave/tidal power, and the HPS is seeking expertise from individuals involved in these technologies.

The Renewable Technologies Subcommittee has interests in various aspects of biomass utilization, small hydro, geothermal, integrated renewable energy systems, and ocean energy (wave and tidal).

7. Significant Plans for the Next Period:

The Subcommittee on Technologies for GHG Mitigation & Adaptation has significant plans for the coming years:

- Panel sessions for PES general meetings. The working group will host three panel sessions for the PES general meeting in 2018, including:
 - Mechanisms for Optimizing Emissions in Wholesale Electricity Markets
 - Market Model and Operations of Virtual Power Plants
 - Energy System Transition towards High Penetration of Renewables under Low Carbon Policies
- Working Group development and engagement events. This subcommittee will host and develop the working Group on “Low Carbon Energy System Transition and Policy”. The aim of this working group is to deepen the understanding of how the environmental regulations and low carbon polices influence the operation, planning and marketing of power systems in different countries. Panel session as well as subcommittee meetings will be hosted during general meeting. Several side events will also be hosted by this working group and the subcommittee to promote the collaborative efforts and engage potential members:
 - Online seminar: working with NACPPA to host an online seminar relating the theme of de-carbonization;
 - Joint symposium: working with Harvard University and Global Energy Interconnection Development and Cooperation Organization on several high level symposiums to promote the efforts of GHG mitigation.
- Joint Sponsorship for high-level Public Seminar. The subcommittee, together with Global Energy Interconnection Development and Cooperation Organization, is planning for a joint symposium led by Former Chairman of Liu Zhenya at Harvard University in April, on the topic of global energy interconnection with high penetration of renewables, to facilitate the dialog on deep de-carbonization between US. and China.
- Proposal of Special Issue on IEEE Transactions. We plan to propose for special section relating to deep de-carbonization in the upcoming year.
- Reports and White papers. Under the working group of Low Carbon Energy System Transition and Policy, we plan to write two reports over the three-year duration of 2018-2021:
 - Report #1: Roadmaps of decarbonizing power systems in major countries.
 - Report #2: Towards Higher Penetration of Renewables in US and China: Opportunities and Challenges

The Station Design, Operation and Control Subcommittee Distributed Energy Resources Subcommittee has three approved PARs for standards development and is planning submitting revisions on these standards in 2018.

The Distributed Energy Resources Subcommittee has submitted proposals for two panels for the IEEE PES General Meeting 2018 as follows. Melanie Johnson and Anurag Srivastava propose “Measuring and Enabling



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Resiliency using Microgrid”; Michael Negnevitsky co-ordinates “High Renewable Energy Penetrations within Isolated and Remote Area Power Systems”

In 2018 the Excitation System and Controls Subcommittee will have a combo session with the Electric Machines Committee on the interrelationship between Grid Codes, Excitation standards 421.2 and 421.5, and synchronous machine standards C50.13, 115 and 1110. This continues ongoing collaborative work with Excitation System members contributing to various synchronous machine working groups. We have also requested an 8 hour tutorial session IEEE TUTORIAL COURSE: POWER SYSTEM STABILIZATION VIA EXCITATION CONTROL. This tutorial is widely used and is due to be freshened and presented.

The Hydroelectric Power Subcommittee plans to submit 1010, 1147, and 1248 to REVCOM and ballot. Ongoing work includes continued work on the governor taskforce and 125. New projects will include opening PARs for work on 1249 and 1020. The HPS also plans to form a variable speed hydro taskforce with the intent to produce a white paper for the PES resource center.

The Renewable Technologies Subcommittee is undertaking activities to increase membership and participation in the subcommittee. A group of members interested in electric vehicles will be organized for the nascent WG. At least two panel sessions are being planned for 2018 GM in Portland, WA (one on ocean energy and the other on solar PV integration).

The Integration of Renewable Energy into the Transmission and Distribution Grids Subcommittee has submitted proposals for four panels/technical sessions and one tutorial for the 2018 IEEE PES General Meeting:

Tutorial

Smart inverters for distributed generators (similar to tutorial at PES GM 2017, once again lead by Rajiv Varma, Western University)

Panels/technical Sessions

- EDPG/T&D/PSDP panel session on lessons learned from “Blue Cut Fire Event” NERC presentation on proposed requirements for solar plants. IOU presentation on system modeling, impacts, and mitigation. Vendor presentation on technology challenges and solutions. R&D presentation on implications for DER interconnection requirements.
- EDPG/T&D/EMC session on “Best Practices for Interconnection Performance Requirements.” Similar to IEEE PES General Meeting 2016 T&D-sponsored panel session on “International Interconnection Requirements for Transmission-Connected Renewable Energy Plants”
- EDPG/T&D panel session on Grid Integration Aspects and Operating Experiences of Distributed Energy Resources Revised IEEE Std. 1547 and German VDE-AR-N 4105 & 4110 Operating Experience with Smart Inverters – Distribution Focus Impact of Reactive Power and Voltage Control with Distributed Energy Resources on the T&D Interface Lessons learned from early application of IEEE Std 1547 Status Update on revision of IEEE Std 1547.1
- EDPG panel session on Solar Plant Grounding for GM (Portland)

8. Global Involvement

| Total Number of committee members | Officers from regions 8,9 and 10 | Subcommittee officers from regions 8, 9 and 10 | Subcommittee members from regions 8,9, and 10 |
|-----------------------------------|----------------------------------|------------------------------------------------|-----------------------------------------------|
| 57 | 2 | 2 | >10 |

Submitted by: Ward Jewell

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