

INTRODUCTORY INFORMATION

Welcome

The IEEE Power & Energy Society (PES) is proud to be holding its 2018 General Meeting in Portland, OR USA. The technical program theme of **“Re-Imaging the Electric Grid”** will provide a platform to offer new insights, innovative ideas and answers to some of the most intriguing and important questions facing the power industry today.

The Local Organizing Committee, PES Technical Committees and the General Meeting Coordinating Committee welcome colleagues and friends from all facets of the industry and corners of the world to a valuable technical program, productive committee meetings and exciting networking opportunities.

Our Thanks

PES gratefully acknowledges the support of the 2018 General Meeting’s host utility, Portland General Electric and of all our other generous meeting contributors.

Conference Overview

Below is a brief overview of the conference and meeting schedule and a description of each element of the meeting. The descriptions are in approximately the same order as they occur during the meeting.

Note: Attire for the conference is business casual. No denim jeans or shorts in the technical sessions or committee meetings, please.

CONFERENCE LOCATION

The 2018 General Meeting will be held at the Oregon Convention Center, Portland, OR USA.

CONFERENCE SCHEDULE AT A GLANCE: A quick overview of the meeting in chronological order. Detailed description of the events listed can be found elsewhere in the program.

Note: A limited number of sessions and events (in particular, some committee meeting) may fall outside this schedule.

**Tutorials, Technical and Leisure/Companion Tours and Evening Events, Student, Industry and Faculty Luncheon, and Awards Dinner are optional activities with limited capacities; they require an additional fee and tickets for admittance. Plain Talk courses are co-located with the General Meeting, and require a separate registration rather than General Meeting registration. See the General Meeting Registration page for more information about the Plain Talk courses*

<http://www.pes-gm.org/2018/>

Day	Time	Event/Sessions
Sunday	All Day	Registration/Information
		Committee Meetings, Tutorials*
	PM	Companion Tour - Portland Sightseeing City Tour * (12:45 - 4:30 pm)
	PM	New Attendees Orientation (4:00 PM)
	3:00 PM	Scholarship Plus, Smart Village Recognition Reception
Evening	Welcome Reception	
Monday	All Day	Registration/Information
		Companion Lounge for registered companions and registered children
		Companion Tour * - Willamette Valley Wine Tasting Tour (9:45 am – 3:00 pm)
	AM	Attendee and Presenter Breakfasts; Companion Breakfast
		PES Members Meeting (8:00-9:00AM)
		Plenary Session (9:00-11:00AM)
	11 AM	Committee Meetings start
PM	Committee Meetings, Technical Sessions, Tutorials*	
	Technical Tour* - Salem Smart Power Center (12:30 - 4:00 pm)	
Evening	Committee Poster Sessions, Fellows/Awards Reception, Candidates Meet-and-Greet (all co-located) (5:00-8:00 PM)	
Tuesday	All Day	Registration/Information
		Super Sessions, Committee Meetings, Technical Sessions
		<i>Plain Talk Course (co-located event, separate registration required)</i>
		Companion Lounge Program for registered companions and registered children
		Companion Tour* - Eastside Neighborhoods, Gardens & Food Carts (9:45 am – 3:00 pm)
	AM	Student Poster Contest and Attendee Breakfast (<i>co-located with the Student Poster Contest</i>); Presenter Breakfast; Companion Breakfast, Technical Tour* - Portland Down Town NetWork System (8:00 am – 11:30 am),
PM	Technical Tour* - Solar World I (1:00 – 4:00 pm)	

	Evening	Awards Dinner and Ceremony – <i>Ticket Required (7:00-9:30PM)</i>	
Wednesday	All Day	Registration/Information	
		Committee Meetings, Tutorials*, Technical Sessions	
		<i>Plain Talk</i> Course (co-located event, separate registration required)	
		Companion Lounge Program for registered companions and registered children	
			Companion Tour* - Oregon Coastal Tour & Cannon Beach (8:45 am - 4:30 pm)
	AM	Attendee and Presenter Breakfasts; Companion Breakfast	
		Technical Tour* - Pacific Air Switch Corporation (9:00 am – 12:00 pm)	
	Noon	Student / Industry / Faculty Luncheon – <i>Ticket required</i>	
1:30 PM	Student / Industry / Faculty Job Fair		
PM	Technical Tour* - Solar World II (1:00 – 4:00 pm)		
Evening	IEEE PES Women in Power Networking Reception; Young Professionals Seminar and Networking Reception		
Thursday	All Day	Registration/Information (until 12pm)	
		Committee Meetings, Technical Sessions, Tutorials*	
		<i>Plain Talk</i> Course (co-located event, separate registration required)	
	AM	Attendee and Presenter Breakfasts; Companion Breakfast	
		Companion Lounge Program for registered companions and registered children (until 12pm)	
		Companion Tour* - Multnomah Falls and Gorge Waterfalls Tour (8:45 am - 1:00 pm)	
		Technical Tour* - Salem Smart Power Center (8:30 am - 12:00 pm)	
Friday	All Day	Committee Meeting	

*Indicates an additional registration fee is required for this event / session.

REGISTRATION AND INFORMATION -

Oregon Convention Center

<i>Sunday, 5 August</i>	<i>10:00AM - 8:00PM</i>
<i>Monday, 6 August - Tuesday, 7 August</i>	<i>6:30AM - 7:00PM</i>
<i>Wednesday, 8 August</i>	<i>6:30AM - 4:00PM</i>
<i>Thursday, 9 August</i>	<i>6:30AM – 12:00PM</i>

All attendees are required to register for the 2018 General Meeting and pay the appropriate fee in order to participate in any aspect of the meeting.

At the registration counters, you may pick up your advance registration packets, register on-site, purchase tickets for luncheons or companion and evening events (depending on availability), ask questions at both the registration and information counters.

Conference Proceedings: All registrants for the technical program will be able to download a copy of the conference proceedings from a secure web site. Or, if when registering you indicated you wanted a copy of the proceedings on a USB stick, you can pick that up at registration. You must indicate you want the proceedings on USB stick when registering for the conference in order to receive it on USB stick. Information on downloading the proceedings will be sent via the registration when the proceedings are available.

INCLUDED WITH REGISTRATION -

Attendee registration fees include: Continental breakfasts Monday-Thursday, Welcome Reception Sunday evening, full technical session and committee meeting program (including the Poster Session and Reception on Monday evening, and Student Poster Contest on Tuesday morning), the conference proceedings either via download or USB stick, the opportunity to participate in any of the available optional events open exclusively to registrants at the prevailing registrant rate.

Companion and Children registration fees include: Continental breakfasts Monday-Thursday in the Companion Lounge, welcome reception on Sunday evening, Poster Session and Reception/ Fellows Reception on Monday evening, companion lounge Monday-Thursday, the opportunity to participate in companion tours and any of the other available optional events open to registered companions at the prevailing registered companion rate. Companions are not admitted to technical session nor do they receive a copy of the proceedings. *Note: Registered children must be accompanied by a registered companion when in the companion lounge or participating in any conference activities, including tours.*

The Companion Lounge is located in the Oregon Convention Center.

Student registration fees include: Continental breakfasts Monday-Thursday, welcome reception Sunday evening, full technical session and committee meeting program (including the poster session and co-located receptions on Monday evening and the Student Poster Contest on Tuesday morning), the conference proceedings either via download or USB stick, participation in any program elements designed exclusively for students. If you wish to attend the Student/Industry/Faculty Luncheon on Wednesday, you must purchase a ticket for the luncheon. Plus optional events open to registrants at the prevailing registrant rate.

IN AND AROUND THE REGISTRATION AREA

PES-Related Displays: Tables with literature and with materials about PES and IEEE membership, programs, publications and future meetings.

Information Booth: Staffed by local volunteers, you can obtain information about the meeting, the venue and the Portland area from knowledgeable people.

NEW ATTENDEES ORIENTATION SESSION

Sunday, 5 August 4:00PM - 5:00PM

A short orientation session will familiarize first-time attendees with PES and the PES General Meeting. Session will provide an understanding of the various types of technical sessions, committee meetings, tutorials, technical tours, and social events. At the end of the session, the newcomer should be able to navigate confidently through the General Meeting and obtain

maximum value from the experience. Session will include a question and answer period.

WELCOME RECEPTION

Sunday, 5 August

6:00PM – 9:00PM Oregon Museum of Science and Industry

Take this opportunity to renew old acquaintances and meet more members of the power and energy community. You are invited to enjoy a complimentary hors d'oeuvre buffet and a cash bar. Photo ID will be required to purchase alcoholic beverages

Name badges are required. You will not be allowed to the Welcome Reception without it.

ATTENDEE BREAKFASTS

Monday, 6 August 6:30AM – 7:45AM Oregon Convention Center
Tuesday, 7 August 7:00AM – 9:30AM Oregon Convention Center
Wednesday, 8 August 6:30AM – 8:30AM Oregon Convention Center
Thursday, 9 August 6:30AM-8:30AM Oregon Convention Center

Complimentary continental breakfasts for all conference registrants will be available Monday through Thursday. Note that a general breakfast is not offered on days other than these.

PRESENTERS BREAKFASTS

Monday, 6 August 6:30AM – 7:45AM – Oregon Convention Center
Tuesday, 7 August 6:30AM – 8:30AM – Oregon Convention Center
Wednesday, 8 August 6:30AM – 8:30AM – Oregon Convention Center
Thursday, 9 August 6:30AM – 8:30AM – Oregon Convention Center

Presenters must attend a special breakfast on the day of their sessions where final plans for the session at which they will present will be made. See additional information in the “Information for Presenters” section of this program.

PES MEMBERS MEETING

Monday, 6 August 8:00AM - 9:00AM Oregon Convention Center

PES President, Saifur Rahman , will update the membership on various PES activities. Candidates for the office of IEEE Division VII Director Elect will speak. (*Meet the candidates face-to-face at a reception that will be co-located with the Monday Night Poster Session Location to be announced, 5:00PM-8:00 PM, Monday, 6 August.*)

PLENARY SESSION - LOC

Monday, 6 August 9:00AM - 11:00AM Oregon Convention Center

PES President Saifur Rahman will moderate the Plenary Session which begins immediately following the PES Members Meeting

COMMITTEE MEETINGS

Most administrative and technical committee meetings are scheduled from Monday 11:00AM (following the Plenary Session) through Friday morning. Some additional committee meetings are scheduled on Sunday, 5 August. See the Committee Meeting section of the program for details. Last minute updates to the program will be posted on the message board in the Registration area as well as via push notifications for those who will be using mobile app.

TECHNICAL SESSIONS AND OTHER TECHNICAL EVENTS

See the “Technical Session and Other Events” section of the program for a complete listing and description of all technical sessions. Descriptions include an abstract of each event and papers presented during each session. Last minute updates to this program will be posted in the Registration area as well as via push notifications for those who will be using mobile app. Technical meetings are planned for Monday afternoon and evening and all day Tuesday, Wednesday and Thursday. The following types of sessions are scheduled:

Super Sessions: a series of presentations in composite sessions designed to fully explore topics from different perspectives. Experts from several PES technical committees will address subjects that are of significant interest to the profession:

- Late Breaking News
- Moving Towards Less Inertia on Power System
- New application of technology in the Power Industry
- Data Science and Data Quality as Applied to Power System
Emergency Response

Panel Sessions: Invited papers on a wide variety of noteworthy subjects.

Transactions Paper Sessions: Presentation of high quality IEEE PES Transactions papers on many issues of significance to energy and power professionals.

Paper Forums: Multiple authors present brief overviews of their quality papers followed by time for a discussion with the individual author(s) of your choice.

Poster Session: A Monday evening special event with hundreds of authors representing all aspects of the industry, each presenting a poster version of his/her paper. Enjoy hot and cold hors d'oeuvres and refreshing beverages as you browse the posters and discuss the papers one-on-one with their authors.

Student Poster Contest: The Student Poster Contest will be held in conjunction with the Tuesday morning attendee breakfast (on 7 August) in the *Oregon Convention Center*

Tutorials: Thirteen tutorials will be presented during the meeting. Classes are taught by top professionals in the field. Earn PDHs and CEUs for your attendance (see below for an explanation of PDHs and CEUs). Full or one-day conference registration plus an additional fee is required in order to attend any of these courses. For complete information about the tutorials including pricing, information about the instructors and schedule, see the Tutorial section of the program in the pages that follow, or the GM website. Tickets may be purchased at the Registration desk if seats remain. See the Tutorial section of this document for a complete listing and descriptions of the tutorials.

Technical Tours: Six half-day inspection trips are offered. Registration is permitted through only. **No on-site technical tour registration is available.** Valid photo ID must be presented at the beginning of each tour. See the Technical Tour section of the program for descriptions and details of each tour.

MONDAY NIGHT POSTER SESSION and RECEPTION

Monday, 6 August

5:00PM-8:00PM

Oregon Convention Center

(co-located with the Fellows/Awards Reception, the Meet the Candidates)

A popular feature of the PES General Meeting technical program is the Poster Session, where papers from each represented committee and all topics will be presented. A complimentary hors d'oeuvre buffet will be served and cash bar will be available. Attendee or Companion badges are required for entrance to the Poster Session; Photo ID will be required to purchase alcoholic beverages at the bar. (*The Student Poster Contest will be held Tuesday morning, 7:30AM - 9:00AM, during which an Attendees' Breakfast will be available.*)

CANDIDATES MEET & GREET RECEPTION

Monday, 6 August

5:00PM-8:00PM

Oregon Convention Center

(co-located with the Poster Session and New Fellows Reception)

The PES candidates for IEEE Division VII Director Elect will each make a short presentation of his/her views for the Society and IEEE so you can make an informed decision when you vote during this year's election.

NEW FELLOWS/AWARDS RECEPTION

Monday, 6 August

5:00PM-8:00PM

Oregon Convention Center

(co-located with the Poster Session, Candidates Reception)

As part of PES's recognition of extraordinary achievements in the technical and professional fields of energy and power, during the reception held in their honor you are cordially invited to stop in and congratulate the newly elected IEEE Fellows to the class of 2018 who are members of PES and the 2018 Power & Energy Society Award winners.

STUDENT POSTER CONTEST –

Tuesday, 7 August

7:00AM-9:30AM

Oregon Convention Center

(co-located with Attendee Breakfast)

Take this opportunity to see the work done by hundreds of the top students in our field. Plan to spend some time discussing topics of mutual interest with the participants.

AWARDS CEREMONY AND BANQUET

Tuesday, 7 August

7:00PM—9:30PM

Oregon Convention Center

US\$80/\$85

Join us for a banquet dinner where IEEE and PES award winners are honored for their outstanding achievements. Vegetarian/vegan meals are available upon request. Seating is limited. This is a ticketed event. You may purchase tickets on-site at the Registration Desk if there are seats remaining. A cash bar serving beer and wine will open at 6:30 pm and be available thru dinner. Photo ID will be required to purchase alcoholic beverages.

STUDENT PROGRAM

An exciting student program for IEEE PES Student Members includes a Poster Contest, and the Student/Industry/Faculty luncheon (ticket required) as well as the Student/Industry/Faculty Job Fair. Student members are invited to participate in all other aspects of the General Meeting as well. After registering for the General Meeting, students may visit <http://www.pes-gm.org/2018/> for more information about the program. Students must be prepared to verify their status by providing their ID and IEEE Membership number when picking up their registration packets on-site.

STUDENT / INDUSTRY / FACULTY LUNCHEON

Wednesday, 8 August 11:30PM-1:30PM

Oregon Convention Center

US\$40/45;

Students US\$20 \$25;

Student/Industry/Faculty Luncheon: Attend a luncheon designed to bring together students, industry representatives and faculty advisors. The recipients of the Student Poster Contest will be recognized. This is a ticketed event. All meeting registrants are invited to purchase tickets and join the luncheon as long as there are seats remaining. Seating is limited.

STUDENT / INDUSTRY / FACULTY Job Fair

Wednesday, 8 August 1:30PM- 3:00PM Oregon Convention Center

International Job Fair for Students: Employers and university graduates and undergraduates can participate in an International Job Fair for Students following the luncheon. This job fair will provide a forum for employers and students who share a common interest in the power and energy industry to meet and discuss career opportunities. It enables one-to-one conversations between company engineers or recruitment professionals and students who will soon be in the job market. Students will sit with a potential employer during lunch. Students may circulate among recruiting tables for further conversations. Doors will open following the conclusion of the Luncheon.

NETWORKING RECEPTION - Hosted by PES and IEEE PES WiP (Women in Power) COMMITTEE

Wednesday, August 8

5:00PM – 6:30PM

Oregon Convention Center

All registered attendees are invited to this complimentary informal reception held to encourage networking between industry, government and university participants. From 5:00PM – 6:30PM, interact with one or more of the woman successful in the power industry who has been invited to share experiences and wisdom with those attending the reception. There will be plenty of

opportunity to network with other attendees at the reception as well. Light refreshments will be provided.

YOUNG PROFESSIONALS - SEMINAR AND RECEPTION

Wednesday, August 8 6:00PM – 7:30PM Oregon Convention Center

The Young Professionals reception and seminar provides an opportunity for all conference attendees, in particular, current students and engineers that have graduated within the last ten years to network, meet officers of IEEE PES, and to make contacts among their peers in the Power & Energy community. Find out how you can contribute to PES and how it can help you.

COMPANION ACTIVITIES

Access to the activities described below is limited to registered companions and registered children in the company of a registered companion.

Registered companions and children are invited to mingle and relax in the Companion Hospitality Lounge, located in the Oregon Convention Center. The lounge will be open
Sunday 12:00PM - 5:00PM
Monday through Wednesday, 7:00AM - 5:00PM
Thursday 7:00AM – 12:00PM

Complimentary breakfast will be served Monday through Thursday, 7:00AM - 9:30AM.

Many fun activities are being planned for the lounge. Please check on-site in the lounge for more details and activity sign-up.

COMPANION TOURS

A full program of optional tours has been planned for registered companions.

PLAIN TALK ABOUT THE ELECTRIC POWER SYSTEM FOR POWER INDUSTRY PROFESSIONALS

IEEE PES PLAIN TALK courses for the power industry professional will help you to understand technical aspects of the electric power industry, even if you do not have an engineering background. You will gain insights into the concerns of engineers, the demands of regulators and consumer groups, and the factors and trends that impact the operation of today's electric power systems. These courses are also appropriate for new engineers to the industry, or for engineers in other fields who are transitioning to the electric power industry. These courses aim to increase your understanding of the electric power system by providing you with practical knowledge that you can use as you work in or with this important industry.

IEEE PES PLAIN TALK courses are co-located events rather than parts of the General Meeting, and thus, conference registration is not required to attend these courses. The fee to register for the courses on-site is US\$2,150 for three courses, US\$1,510 for two courses and US\$795 for a single course. (If you register on or before 10 July prices are lower. See the Plain

Talk web page noted below for specifics.) The course fee includes continental breakfast, lunch and all course materials. Breakfast and registration: 7:30AM – 8:00AM. Courses start promptly at 8:00AM. You may register on-site if seats are available.

Information and Registration can be found at: <https://www.ieee-pes.org/plain-talk-in-portland-or-2018>

Power System Basics – Understanding How the Bulk Electric Power System Works

Tuesday, 7 August

8:00AM - 5:00PM

The focus of this course is to provide a fundamental foundation in electric power systems, from basic formulas to the planning, operations, and equipment involved in generating, transmitting, and distributing electric power. Basic electrical terminology will be explained in simple to understand language with regard to design, construction, operation and maintenance of power plants, substations and transmission and distribution lines. Topics covered in the course include an introduction to the fundamentals and basic formulas of electricity as well as the equipment involved in the electric power system. An overview of generation, substations, transmission, distribution, and utilization is provided. Protection, reliable operation, and safety are among the topics covered.

Instructor: William J. Ackerman

Distribution System – Delivering Power to the Customer

Wednesday, 8 August

8:00AM - 5:00PM

(Prerequisite for this course is Power System Basics or a familiarity with basic formulas and power system equipment.)

The focus of this course is to provide attendees with an overview of the issues associated with the planning, engineering, design, operation, and automation of electrical distribution systems. Types of distribution systems and network circuits, as well as engineering issues related to distribution systems will be explored. New concepts in the design, challenges, and operation of smart grid will be addressed. This course is intended for those who are not familiar with the delivery of electricity to the end user.

Topics covered in the course include an introduction to the types of distribution systems, issues associated with distribution planning such as outages and reliability, distribution engineering considerations relating to radial and secondary networks, and distribution automation. The course also provides an overview of electrical distribution operations, including the roles of utility personnel, construction and maintenance considerations, and trends in the industry. Smart grid and its impact on the distribution system will be explored.

Instructors: Joseph L. Koepfinger and Maurice Ney

Transmission System – The Interconnected Bulk Electric System

Thursday, 9 August

8:00AM - 5:00PM

(Prerequisite for this course is Power System Basics or a familiarity with basic formulas and power system equipment.)

The focus of this course is to provide participants with knowledge of how electric power is transferred from generation sources to distribution systems via the interconnected electric bulk power system known as “the grid.” Basic physical laws governing the grid will be introduced, as well as the regulatory agencies involved in its governance. The great blackouts will be explored. This course is intended to increase participant’s understanding of the electric grid and how it functions in the electric power system. Topics covered in the course include an introduction to the fundamental concepts of power, energy, and power system stability as they relate to the grid. The grid is explored in terms of its interconnections, power flow, North American interconnections, and governing bodies such as NERC/ERO, ISOs, and RTOs. Reliability standards and contingency analysis are addressed. Issues related to the planning and operation of the grid, such as transmission and economic constraints, determining transmission transfer capability, and dealing with congestion are reviewed. The course also discusses the great blackouts, their root causes, and lessons learned.

Instructor: Robert W. Waldele

TECHNICAL PROGRAM INFORMATION

INFORMATION FOR PRESENTERS

Presenter/Chair Breakfasts

All presenters, panelists and session chairs **MUST** meet at breakfast the day of their session(s) to discuss session arrangements. Attendance is required. All presenters should have received e-mails providing the dates of their sessions and breakfasts.

Presenter Breakfasts

Monday, 6 August 6:30AM – 7:45AM – Oregon Convention Center
Tuesday, 7 August 6:30AM – 8:30AM – Oregon Convention Center
Wednesday, 8 August 6:30AM – 8:30AM – Oregon Convention Center
Thursday, 9, August 6:30AM – 8:30AM – Oregon Convention Center

AUDIO-VISUAL EQUIPMENT AND PRESENTERS PREPARATION ROOM

Technical Session rooms will be equipped with an LCD projector and screen, power and extension cords, podium, microphone if appropriate, and a wireless mouse. Speakers who wish to use a computer during their presentations are required to provide their own laptop computers and are responsible for ensuring compatibility with on-site equipment.

Committee meeting rooms will be equipped with a screen, and power and extension cords. **No projector or computer will be provided.** Arrangements, including payment via credit card,

for any additional audio-visual equipment you wish to rent from the meeting's AV provider must be made in advance.

The Presenters Prep Room, located in the *Oregon Convention Center*, will be equipped with an LCD projector with the same specifications and compatibility as those in the Technical Session rooms. The equipment is provided to allow presenters to become familiar with, and to ensure that, their laptop computers are compatible with on-site equipment provided. Please check at the Information Booth or Paper Sales area for exact location, hours and access.

PDHs AND CEUs FOR ATTENDEES

Continuing Education Units (CEUs) offered by IEEE

A Continuing Education Unit (CEU) is ten contact hours of participation in an organized continuing education experience under responsible, qualified direction and instruction. A unit generally consists of courses of study that refresh, update and enhance knowledge, skills and experience of professional personnel. Any course that offers CEUs which is presented by an IEEE entity has been reviewed and approved according to standards set by IEEE. All registered students who complete an IEEE course offering CEUs will receive a certificate via email from the IEEE attesting to the CEUs earned by the attendee.

It is up to each student to determine if a specific course or program fills the needs of the discipline or certifying body for which the CEUs are intended.

Professional Development Hours (PDHs)

Continuing professional education for licensed engineers is measured in Professional Development Hours (PDH). A PDH is one contact hour of instruction or presentation. Currently, approximately thirty states mandate Professional Development Hours to maintain P.E. licensure, each with varying requirements. CEUs readily translate into PDHs (1CEU=10 PDHs), though PDHs do not convert automatically to CEUs.

The licensee is responsible for maintaining records to be used to support PDH credits claimed. PES does not track this information. Unlike the procedure for CEUs, courses are not pre-approved by the IEEE for PDHs.

At many PES meetings, forms are readily available that can be completed by attendees of any session and signed by the session chair to verify attendance. The completed forms are held by each attendee. They are not submitted to IEEE. It is up to each licensee to provide the forms to the certifying body or employer, and to determine if a specific course or program fills the needs of the discipline or certifying body and/or employer for which the PDHs are intended.

TECHNICAL TOURS

Technical tours are a unique element of the PES General Meeting technical program.

TUTORIALS

Meeting registration plus an additional fee is required to attend any of these courses. Earn CEUs and PDHs for your attendance. You may register on-site if seats are available.

Energy Storage: An introduction to Technologies, Applications and Best Practices

Date Sunday August 5, 8:00 am-5:00 pm

Price Early Bird \$295, Regular \$395; Student Early Bird \$100, Student Regular \$150

Instructors Dr. Hamid Zareipour, University of Calgary; Dr. Sudipta Lahiri, Distributed Energy Resources, DNV GL Energy; Dr. Michael Klinberg, Senior Consultant – Energy Advisory, DNV GL – Energy; Dr. Ramteen Sioshansi, the Ohio State University

Energy storage is becoming an attractive solution for today's smart grid, either being operated independently as asset or interacting with other resources like wind/solar generation or demand response. This tutorial is a full-day course which will provide participants a solid understanding of the basics and the state-of-the-art energy storage application, its implications on the grid's reliability and the system's economics and how-to on evaluating its performance and cost-benefit. Instructors with diverse backgrounds on this subject will bring the field deployment experience of energy storage applications and real-world examples to demonstrate the analytic tools used in assisting utility planning and operation decisions. The course is suitable for non-technical, as well as technical audiences, including regulatory, legislative, and utility staff members.

Smart Inverters for Distributed Generators

Date Sunday August 5, 8:00 am-5:00 pm

Price Early Bird \$295, Regular \$395; Student Early Bird \$100, Student Regular \$150

Instructors Rajiv Varma, The University of Western Ontario, Babak Enayati, National Grid, Michael Coddington, NREL, Richard Bravo, Southern California Edison, Mahesh Morjaria, First Solar,

This proposal is for the third delivery of this Tutorial based on the success of its recent second delivery in the IEEE PES General Meeting at Chicago in July 2017 attended by 36 participants (the third largest attendance among all the Tutorials presented in the PESGM), AND; its first successful delivery at the IEEE PES Transmission and Distribution Conference and Expo in Dallas in May 2016 with 29 attendees.

Different countries are setting up ambitious targets of PV solar based Distributed Generators (DGs) installations. However, the integration of PV based DGs has led to several challenges, mitigation of which typically require expensive compensating and protection equipment, as well as complex network management strategies. DG inverters primarily produce real power at unity power factor. However, power electronics has now made it possible for inverters to perform multiple functions for grid support, in addition to real power generation. Such inverters are termed Smart Inverters as they are capable of effectively minimizing several grid integration challenges of DGs without additional equipment. Recognizing the significant potential of smart inverter technology, utilities across the globe are actively considering implementation of smart inverters.

The technology of smart inverters is i) new, ii) rapidly evolving, and iii) has outpaced the technical regulations and standards which are needed to allow its implementation. Different PV interconnection and testing standards around the world are being revised to allow the different features of smart inverters to be implemented. US DOE, EPRI, NREL are testing and demonstrating the smart inverter technologies on several pilot projects.

This proposed IEEE Tutorial on Smart Inverters holds special significance as the IEEE 1547 Standard is undergoing Full Revision which will hugely accelerate the growth of smart inverters.

This Tutorial is being proposed to present a comprehensive and structured knowledge on the need, functions, operation and protection, integration and testing standards, system studies of benefits, demonstration projects and actual installations of this new technology. This Tutorial will be very helpful for academics, utilities, practicing engineers, consultants, system operators and planners, DG developers, and inverter manufacturers for understanding the various facets of this technology and to fully exploit its vast capabilities in their T&D grids.

Transmission System Planning- A Fundamentals Course for Electric Power Engineers, Non-electrical Engineers, and Others Working in the Electric Power Industry

Date Sunday August 5, 8:00 am-5:00 pm

Price Early Bird \$295, Regular \$395; Student Early Bird \$100, Student Regular \$150

Instructor James Feltes, Siemens Power Technologies International, Michael Henderson, ISO New England, Sundar Venkataraman, GE Energy Consulting, Rafael Ferreira, Empresa de Pesquisa Energética (EPE)

The need for expansion of the electric power transmission system is driven by public policy, the development of remote resources, and the retirement of old generating facilities that are located near load centers. National reliability standards must be respected and the economic performance of the system improved through the judicious development of new transmission facilities. The student will understand transmission system needs and the proper application of new equipment to address those needs.

- Know the why, what, where, and when of developing new transmission lines and applying technologies that improve the use of existing rights-of-way
- Learn how to determine and relieve thermal, voltage, and stability constraints through major system improvements and application of special controls and other techniques that better utilize existing infrastructure
- Use analytical concepts that facilitate decisions for new line expansion, utilization of phase-angle-regulators, and use of transformer taps and both static and shunt elements to provide voltage control.
- Gain basic understanding of how applying system technologies affect the overall operation and planning of the system.

Dynamic Modelling of Offshore Wind Farms for Transient and Dynamic Analysis and Control System Design

Date Sunday, August 5, 8:00 am-12:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructors Bikash Pal, Imperial College London, Dr Linash P Kunjumammed, Imperial College London, Prof. Dr.-Ing. Kai Strunz, Technische Universität Berlin,

The year 2016 witnessed about 50 GW of new installed capacity of wind generation taking the total global capacity to 484 GW. China ranks at the top with a total installed capacity of 173 GW, but 15% of total energy produced from Chinese wind farms in 2015 was wasted because of a weak power grid. Significant operational challenges have also been reported for wind farms connected to the grids of Europe and North America. Normally, the large wind farms (onshore or offshore) are being built at the best wind resource sites. However, these are typically not the locations of a strong transmission network, resulting in poor dynamic interaction and even disconnection from the grid. Unlike those for synchronous machines, the dynamics associated with variable speed wind turbine generators are not well understood.

The need to better understand wind farm dynamics and controls will be addressed through this tutorial. It will cover dynamic modelling of variable speed doubly fed induction generators (DFIG) and permanent magnet synchronous generator (PMSG) wind generation system including their controls. The models will be suitable for transient stability and low frequency electromechanical stability analysis and control design. The theory is complemented by worked examples to maximize the educational value to IEEE PES meeting attendees.

Demand Response: Overview, Applications, and Field Experiments

Date Sunday August 5, 1:00 pm-5:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructors Farrokh Rahimi, OATI, Ning Lu, NCSU, Jianming (Jamie) Lian, PNNL, Haiwang Zhong, Tsinghua University

The electric utility operational requirements and business model are changing due to a number of factors, including increasing levels of renewable and distributed energy resources, new technologies, and increasingly savvy consumers/prosumers. Current power grid operation predominantly relies on scheduling and regulating generation resources to supply loads and balance load changes. Increased variability of renewable generation resources, changes the conventional “load following” paradigm to a new “generation following” regime resulting in the need for higher levels of balancing requirements from demand-side participation. With the advancement of information technologies, power system end-use loads are becoming more agile and can participate in provision of balancing energy and other grid services. This tutorial will cover demand response fundamentals and business case, and provide lessons learnt in the DR demo and actual field implantation projects carried out in recent years.

Fundamentals and Best Practices of Energy Management Systems and Automatic Voltage Control

Date Sunday August 5, 1:00 pm-5:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructors Vedran S. Perić, GE Energy Consulting, Qinglai Guo, Tsinghua University, Mike Zhou, InterPSS Systems, Manu Parashar, GE Power, Qinglai Guo, Tsinghua University, Jianzhong Tong, PJM

Energy Management Systems (EMS) play a central role in operation of modern power systems. This tutorial will focus on the architecture, fundamentals, and best practices of a modern EMS system and the overview of most important power system applications enabled by EMS. A special focus will be given to Automatic Voltage Control that is becoming more and more critical in the era of smart grid. Voltage Control will be covered from the perspective of the required architecture, enabling technologies and

focus on challenges imposed by integration of large-scale renewable power generation. In addition, the tutorial will benefit from the presentation of the experience gained in China and North America. Therefore, the goal of the tutorial is to explain and establish a basis for full understating of the current EMS systems as well as applications that are enabled by EMS systems including Automatic Voltage Control.

Power Quality: Distributed Resource Integration

Date Sunday August 5, 1:00 pm-5:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructors Surya Santoso, The University of Texas at Austin, Roger C. Dugan, EPRI, Mark F. McGranaghan, EPRI, Math Bollen, LTU

Distributed energy resources, such as solar photovoltaic, wind turbines, and energy storage, presents opportunities and challenges in planning and operation of utility distribution circuits. This short course presents the following topics: (1) Introduction to distribution system planning strategies and analysis tools for integrating DERs into existing circuits: desired DER grid services, operational use and stacked benefits, sizes and locations, and impacts of the interconnection, particularly voltage regulation. (2) Voltage regulation and control: characteristics and factors influencing voltage regulation, control methods using volt/var, and mitigation options at both at the primary and secondary wires. (3) Harmonics and supraharmonics: low and high-order harmonics, origin, propagation, and resonance. (4) System-wide monitoring: strategies, placements, and applications.

Grid Architecture: Methods and Concepts for Modernizing Electric Power Systems

Date Monday August 6, 1:00 pm-5:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructor Ron Melton, Pacific Northwest National Laboratory, Jeffrey Taft, Pacific Northwest National Laboratory, David Hardin, Smart Electric Power Alliance

Grid Architecture is the application of system architecture, network theory, and control theory to the electric power grid. A grid architecture is the highest-level description of the complete grid, and is a key tool to help understand and define the many complex interactions that exist in present and future grids. Grid architecture can be used to: help manage complexity (and therefore risk); assist communication among stakeholders around a shared vision of the future grid; identify and remove barriers and define essential limits; define interfaces and platforms, identify gaps in theory, technology, organization, regulation; and provide a framework for complex grid-related development activities.

The discipline of grid architecture provides a modern set of methods to assist in thinking about grid complexities, to aid in understanding interactions and technical gaps, to enable new capabilities and remove old unnecessary limits, and to support communication among stakeholders. This is increasingly important as we modernize the electric power system moving to an increasingly distributed system most usefully viewed as a network of structures. This tutorial will introduce the basic tools of grid architecture with examples of how to apply them.

IEEE 1547 Interconnection Standard

Date Monday August 6, 1:00 pm-5:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructors Babak Enayati, National Grid, David Narang, NREL, Jens Boemer, EPRI Leo Casey, Google X, Mark Siira, ComRent, Bob Fox, Sunspec, Charlie Vartanian, MEPPi, Andy Hoke, NREL

Due to the increasing amount of Distributed Energy Resources (DERs) interconnections with the Electric Power System, the IEEE 1547 standard is going through a major revision to address some of the technical issues associated with high penetration of DERs i. e. grid support functionalities, etc. The participants will learn about the major changes to the IEEE 1547 i. e. voltage regulation, response to abnormal system conditions (including voltage and frequency ride through), power quality, islanding, interoperability, etc.

Synchronous Compensator (Condenser) Design and Applications

Date Wednesday August 8, 8:00 am-5:00 pm

Price Early Bird \$295, Regular \$395; Student Early Bird \$100, Student Regular \$150

Instructors Jim Lau,

This tutorial will teach the attendees how synchronous compensators (commonly called “synchronous condensers”) are designed and applied, with particular emphasis on renewable applications. Presently, several vendors offer synchronous compensators as a separate product line, with unique features. But many synchronous compensators are retired synchronous generators that are adapted for use as synchronous compensators. This tutorial will describe the design and attributes of both the new unit application as well as conversion of existing synchronous generators as synchronous compensators.

Managing Uncertainties in the Future Grid- Evolution of EMS Control Centers – Synchrophasor Solutions Keeping the Lights On – yesterday, today, tomorrow

Date Wednesday August 8, 1:00 pm-5:00 pm

Price Early Bird \$195, Regular \$240; Student Early Bird \$50, Student Regular \$75

Instructors Jay Giri, GE Grid Solutions, Mark Adamiak, GE Energy Connection,

Managing the future grid will require creative, innovative solutions. This is because of uncertainties being introduced by the growth of less predictable & reliable renewable generation resources, demand response programs, distributed generation, microgrids, potential cyber-security issues and the aging infrastructure. Energy Management Systems (EMS) have been deployed for decades at utility control centers to manage the electricity grid in real-time. Today these EMS capabilities are poised to be enhanced quite dramatically with growth of synchrophasor PMU measurements. Solutions to decentralize management of the grid are also being introduced – these include Distribution Management Systems, Substation Automation and advances in grid control devices. These new solutions will help us manage the uncertainties and challenges of the future smart grid.

21st Century Distribution Management and Operation: The Future is Now!

Date Thursday, August 9 8:00 am-5:00 pm

Price Early Bird \$295, Regular \$395; Student Early Bird \$100, Student Regular \$150

Instructors *Larry Clark, Alabama Power Company, Anil Pahwa, Kansas State University, Chad Abbey, Smarter Grid Solutions, Robert Uluski, UISOL, Ethan Boardman, GE Grid Solutions, Julio Romero Aguero, Quanta Technology, Grant Gilchrist, Enernex, Terry Saxton, Xtensible Solutions*

The Future is Now for the 21st Century Distribution Management and Operation systems. The 21st Century smart grid systems involve the complete chain of energy delivery from generation to transmission to distribution to the customers. Many of the smart grid applications will occur at the distribution level since this is where new communication infrastructure will enable new automation schemes, integration of distributed generation, and integration of customer systems with the operation of the power delivery system. Smart grid applications such as VVO and FLISR will incorporate Distributed Energy Resources (DER) to improve the functionalities. Distributed Energy Resources Management systems (DERMs) with the growing use of storage are advancing the 21st Century smart grid systems. New emerging technologies include electric vehicles and EV Management to supplement the improved system efficiencies. The modern power system organizations will exploit these technologies in concert with the impact of microgrids and potential TSO/DSO interactions.

Smart Distribution: DA/DMS Systems and ADMS Integration with DERs and Microgrids

Date *Thursday August 9, 8:00 am-5:00 pm*

Price *Early Bird \$295, Regular \$395; Student Early Bird \$100, Student Regular \$150*

Instructors *Jiyuan Fan, PhD, Southern States LLC, John D. McDonald, P.E*

GE Power's Grid Solutions Business

This course introduces the intuitive concepts, fundamental theories, practical technologies on distribution system modeling, analysis, automation and management, including the core functionalities and real use cases of the Distribution Automation and Management Systems (DA/DMS) and the advanced applications in Smart Distribution, as well as the integration with Distributed Energy Resources (DERs) and Microgrids. The potential audience would include power system planning/operation engineers, project/product managers, business leaders in power utilities, smart grid solution providers, system developers, research institutes, as well as individual researchers, college students and other individuals working on or interested in the Smart Distribution Solutions. The course will cover the following break-down topics: Overall Framework and Architecture of DA/DMS Systems in Smart Distribution, Distribution System Modeling for operation analysis, automation and management, Static and Dynamic Data management, Advanced Real-time and Analytic Applications in DMS, integration with other systems (OMS, AMI, DRM) in Smart Distribution, integration with DERs and Microgrids in Advanced DMS (ADMS), including DERs/Microgrids connection and disconnection to/from the Distribution Grid; and New Trends in ADMS Development.