PES General Meeting 2017 – List of Panel Sessions as of 3/15/17

Title	Description
Impact of the Use of Node-Breaker Representation in Power Flow and Transient Stability Analysis Software on Dynamic Performance	This panel session will examine the impact of the node-breaker representation in power flows and transient stability analysis simulation tools on static and dynamic contingency analysis. This panel which includes both software vendors and users will provide a unique perspective from both developers and users. The panel includes participants from North America and Brazil. The panelist will discuss both the analytical issues and results on application to actual systems. The panel will also discuss the ability to directly import real-time data from state estimators.
Sharing experiences and insights involving the application of generic wind and photovoltaic transient stability models	Recognizing the need for transient stability models suitable for representing different types of wind and photovoltaic power plants in planning studies, the Western Electricity Coordinating Council (WECC), through its Renewable Energy Modeling Task Force (REMTF), has been leading a concerted effort to develop such generic models. The objective of the panel session is to disseminate and document the experiences and insights acquired by experienced users of these models. Issues related to the verification, implementation and application of generic models in system studies will be addressed by the panelists.
E-learning modules and resources in power engineering	In the last two decades there a number of e-learning resources and modules were created by various universities and professional organizations. Examples include the IEEE PES Resource Center, CUSP, Powerlearn, NPTEL and others. Some of these resources are freely available in the public domain and some are available through institutional licensing arrangements. This panel aims to summarize, document and share what is available with the Power and Energy community. The eventual goal will be to document and catalog these modules, and create a library to benefit all.
Industry presentations in university undergraduate and postgraduate programs	Power engineering education has been significantly changing with the introduction of many new courses. This has been due to massive penetration of renewable energy sources, ageing assets and extensive use of ICT in power systems. University laboratories are being updated regularly to cope up with the changes. Industry is adopting new tools and techniques to address the changes. University academics regularly invite industry practitioners in the class room to share their hands on experience. Industry practitioners can provide experience of state-of-the-art technologies used in the field for our students.
Reforming the Power Engineering Educational Curriculum amid the Industry Transformation	From the 1990's, power engineering programs in many universities underwent steady decline due to reduced funding sources and the rise of competing fields of information technology and consumer electronics. Recovery has slowly taken place in recent years, however, since the smart grid initiative programs under government and industry sponsorships. This panel session will discuss efforts in reforming the power engineering education curriculum amid the industry's transformation towards the new technological and operational paradigm of the future. Representing both academics and industry, the panelists will discuss both retrospective and prospective views of the curriculum development efforts, integration of power electronics as a necessary disciplinary area of curriculum to support renewable energy, industrial needs in workforce development, and experience from collaborative curriculum development across multiple universities.
Research and education for food water energy nexus	Food, energy, and water systems each are becoming more stressed with growing populations, aging infrastructures, climate change, and greater climate variability. Already, water scarcity threatens to constrain agricultural and electricity production. There is widespread scientific consensus that the problem is likely to grow substantially in the near future, especially if restrictions are placed on carbon emissions. The impacts caused by water's fundamental importance to agricultural and energy systems is referred to as the food-energy- water nexus. Greater integration between the food, energy and water systems is required to build resilience due to the changes, stresses, and fluctuations that are occurring in nature and our communities. In this panel several experts will discuss interdependencies between these systems to define a pathway towards research and education to address the food-energy- water nexus for a sustainable future.

Data sciences education and research in power systems	This panel focuses on discussing modern data sciences approaches and their applications in power systems in various domains. We explore a holistic view of data science that addresses exploratory data analysis, confirmatory data analysis and predictive data analysis. The panelists are experts in data science for power systems, having developed research, products and academic courses in the area. The goals for the panel are: (i) bring the power systems community up to date on data science approaches and pressing challenges for its application in power systems including education of future engineers; (ii) provide a forum for the broader engagement of data scientists with the power systems community and (iii) start the development of a curricula for data sciences in power systems.
Protection Challenges in Modern Power Systems: Trends and Educational Aspects	The deployment of smart grid technologies has their advantages and challenges. Examples of such technologies are renewable energy systems such as wind and solar systems, bidirectional communication systems, data acquisition with higher quality using PMUs, among others. Conventional protection schemes are unable to reliably address some of the challenges these technologies present. It is essential that the new generation of power system protection engineers become familiar with the protection challenges and opportunities of modern power systems. In this panel, experts from the power system protection field will discuss the trends in power systems protection and will discuss topics that should be included in power system protection course development at universities both at the graduate and undergraduate levels.
Understanding and Dealing with High Harmonic Distortions: How Much is Too Much? System and Equipment Immunity & Limits	Traditionally, harmonic limits are based on the thermal impacts on capacitors, transformers and motors. However, with the increasing number of power electronic interface devices to supply electrical loads these limits have little or no meaning. Tests and measurements have indicated that power electronic interfaces, such as power supplies, converters, etc., start to mal-operate at total voltage distortions higher than 15% - when the highest limit for lower voltages is between 8-10%. This panel will discuss the implications and mechanisms of higher values of harmonic distortions based on the impact of system and equipment immunity. Recent case studies of higher harmonic distortion equipment impact will be presented and examined.
Smart grid and sags: Characterization and need for new indices	For a long period of time, the sags were classified using UNIPEDE type tables. The IEEE P1564 Guide for Voltage Sag Indices proposed two indices: Sag Severity index and Sag Energy index. Recent work on sag characterization and evaluation opened the door for the development of new sag indices. This panel will discuss: 1. The impact of some Smart Distribution applications (i.e. Feeder reconfiguration, protection philosophy) on sag occurrence; 2. Additional standards methods for phase angle jump, dip type, characteristic voltage and PN factor as single event characteristics for voltage sags applications; 3. An update on Sag Severity and Sag Energy indices; 4. The impact of sags on new loads with power electronic interface; 5. Etc.
New challenges and issues related to interharmonic distortion modeling and simulation	There is a great interest in the academic, industrial and standard communities about the need of fixing limits for interharmonic voltages. Limits can be fixed only if there is a deep knowledge of the interharmonic causes and effects. The panel is intended to discuss different aspects of modeling, simulation and measurement of interharmonics in power systems. After an introduction on definitions, causes and effects, interharmonic generation will be investigated from the classical loads such as arc furnaces and LCI VSDs to new efficient VSI based VSDs. The possible interharmonic impact of renewable resources will be also addressed both from the theoretical point of view and through the description of incident experiences with wind farms due to interharmonics. The Light Flicker effect will be discussed in terms of impact on new lamp technologies and of propagation within the network. The panelists will present theoretical aspects and practical case studies.

DC Grids: Technology Needs, Design Considerations, Operational Challenges, and Case Studies	The interest in DC grids is growing due to a change in generation patterns as large amounts of renewable energy sources are replacing conventional generation. This trend will continue into the future, and it is expected that large offshore wind farms will also supply increasing load. An off-shore DC grid or a DC grid overlay on the existing AC grid is being researched for transmitting large amounts of power over long distances. However, there are several major technical challenges that must be overcome, which will be addressed in this panel: DC voltage and power flow control within the DC grid, DC voltage transformation and fast protection for isolation within the DC grid. In addition, other issues such as planning, design, and operational reliability and security, as well as the need for standardization and grid codes for DC grids shall be considered along with some real-world case studies.
Integration of (VSC) HVDC in existing power systems	VSC HVDC has received much attention from the industry, and the experience of the technology is rapidly increasing. During this panel, a number of realistic projects will be used to show the particular advantages of the technology over alternative options (LCC HVDC and AC technology). The focus is on how the advanced functionality was detrimental when determining the technology. This panel is organized by the working groups 15.05.19 and 15.05.18.
Economics and Operating Experience of HVDC and FACTS – Recent HVDC and FACTS refurbishments, installations, and special controls that are the economic choice	This panel will discuss the thinking behind recent HVDC and FACTS refurbishments, installations, and the opportunities presented by new controls and innovative uses of limited rights-of-way. The panel will address the economic reasons for HVDC and FACTS facilities and controls that can provide practical lessons learned.
Innovative monitoring issues of smart grid: Looking Back—Lessons and Learn	Innovative monitoring issues of smart grid: Looking Back—Lessons and Learn
Smart Grid Data Analytics and Integrations	Smart Grid Data Analytics and Integrations
Protection Design for Microgrids	This panel will discuss protection design needs for microgrids. Traditionally, distribution protection design is based on conventional grid configuration having a single source, typically a substation, with several distribution feeders for the downstream customers. For more than a decade generation is being directly connected to the actual distribution grid at medium voltage. DER generation is also being installed at the residential low voltage level. These distribution generation systems bring new challenges to the protection design. Not only can this generation create reverse power flow, but the different type of generation have an impact on the short circuit level. The transformer connections between each generation station can influence the grounding mode of the distribution system. The transition between the complete distribution system with all the interconnected generation to the several pockets of microgrids (and vice versa) also means some kind of adaptive protection schemes and settings is needed.
Update on DOE/IEEE T&D Initiatives	The Department of Energy (DOE) is working to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions. DOE and IEEE entered into a Memorandum of Understanding (MOU) to address grid modernization challenges including a focus on the distribution level. The MOU concentrates on both planning and operational challenges that include integrated resource planning and schemes for coordination, control, and information management. IEEE USA, the IEEE Standards Association (IEEE-SA), IEEE Smart Grid, and other IEEE societies will join IEEE PES in collaboration on the MOU, which includes four cooperative areas with the DOE: standards, technology, conferences, and education. This panel will provide an update on ongoing joint activities between DOE and IEEE.

Applications of microgrids to improve the reliability, resiliency, and efficiency of distribution systems	Microgrids, as promoters of pervasive distributed generation, improved grid reliability, and the greener energy economy, have been significantly deployed over the past few years and are anticipated to grow even more in the near future. The many benefits of microgrids, however, cannot be efficiently captured if these costly installations are not intelligently designed. This session will bring together leading authorities in microgrid deployment to discuss Applications of microgrids for distribution reliability and efficiency improvement while offering some of the identified and proven solutions. This session will be coordinated by the IEEE Microgrid Taskforce within the Distributed Resource Integration Working Group.
DER Integration and DER Management Systems	Distribution systems are facing increasingly new economic and technical challenges due to the ever growing proliferation of distributed energy resources (DERs). Utilities are adopting new technologies to integrate DERs effectively. The DER management system (DERMS) is an appealing system to manage various types DERs such as Electrical Vehicles, different distributed generation (DG) technologies, and batteries, etc. DERMS system can be categorized based on their functionality. DERMS functionality can range from demand response to DG integration. DERMS implementation is usually customized, and DERMS applications can vary based on the utility requirements. This panel will discuss DER integration challenges faced by various utilities across the Europe and North America, and how DERMS can help address them. The panel will also discuss different DERMS implementation cases and vendor features. The panel will try to disseminate information and discuss DER integration challenges, utility requirements, DERMS vendor architectures, current DERMS trends and DERMS implementation experience.
Integration of distribution systems, data assimilation, and advanced modelling into on-line DSA	Dynamic Security Assessment is rapidly extending to include distribution system contribution to dynamic security, the assimilation of data sets, and various forms of advanced modelling including stability issues of power converters. The session will highlight the contribution of above concepts in theory, as well as in practical applications.
Industry Experiences in Dynamic-System Operational Monitoring and Control using PMUs	PMUs have considerable potential as a tool for operational monitoring and control. Many utilities are developing and integrating PMU-based applications into their control centers that focus on monitoring and control of the dynamic stability of the system. This includes a focus on transient, oscillatory, and voltage stability applications. Other applications are focusing on using PMUs directly in grid-stabilizing feedback controls. This panel will focus on utility industry experiences with these new applications.
Report on Measurements, Monitoring, and Reliability Issues Related to Primary Governor Frequency Response	The "IEEE Task Force Report on Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns" recommended future work on primary governing frequency response. The "LBNL Report on Use of Frequency Response Metrics to Assess the Planning and Operating Requirements for Reliable Integration of Variable Renewable Generation" further investigated the consequences of transitioning to variable renewable generation. This panel session addresses the concerns raised by those reports to provide a workable transition path from current amounts of variable renewable generation to 100% variable renewable converter interfaced generation including: 1) Required distribution of primary frequency response to assure reliability, 2) Stability issues associated with step frequency response based on frequency error, 3) Synthetic frequency response products, 4) Primary frequency response measurement, 5) Management of primary frequency response components in reliability standards or standard market design, 6) Economics of supplying primary frequency response.
Asset management – asset health assessment, ranking and intervention prioritization	With the growth of asset management, and organizational cultural changes which require both tactical response to condition and strategic response to industry trends, asset condition assessment and analysis is becoming a key factor in many industries. The need to identify anomalous performance or variations in fleet capability require data, analyses and interpretation. Subsequent ranking and intervention prioritization cover a huge range of opportunities. The approach requires clear thinking, an understanding of both the data and decision context. This session will look at aspects of condition assessment, ranking and intervention for different asset classes, in different applications and will provide an opportunity to learn from, and share experience with, practitioners.

Industry Experiences with Advanced Distribution Managements Systems	As the industry continues to deploy Distribution Management Systems (DMS) the concept of Advanced Distribution Management Systems (ADMS) has emerged. The difference between DMS and ADMS is typically the level of integration with other systems such as GIS, OMS, AMI, EMS, etc. While there are significant benefits to be gained by integrating these systems, there are also significant challenges. This panel will explore current industry experiences with the deployment of DMS and ADMS technologies, and discuss the future path of where the industry is moving.
Distribution Planning Under Uncertainties	The modern electric Distribution system is going through major changes and planning practices have to adapt. On one hand, DER (generation, storage) and new loads (EVs, Smart appliances…) are more and more connected to the distribution network while associated with an increasing use of Demand Response. One the other hand, new data is more and more available from different sources and sensors. Uncertainties of the available generation and of the new loads and the analysis of the new available data bring new challenges to distribution planners who have to deal with a new dynamic while designing the distribution system.
Integrated Resource Planning with Renewable Penetration and Distributed Energy Resources	The integrated resource planning is a comprehensive decision supporting tool to provide long-term planning that ensures that sufficient resources to meet forecasted customer needs at the least cost, taking into account the variety of supply and demand resources and applicable environmental mandates. With high penetration of renewables and adoption on DERs, the complexity of integrated resource planning has been significantly increased. This session will discuss the major challenges, opportunities and industry practices in the integrated resource planning process.
Transmission Planning for Non-Synchronous Variable Resources	This panel addresses how transmission expansion planning is adapting to the increasing penetration of non-synchronous resources with high short-term variability in the grid – notably inverter-connected wind/solar generation and storage devices. Practical solutions employed in the USA, Europe and Latin America are approached.
International Practices in Power System Planning: Processes, Methods and Techniques	The power systems around the world are facing the same challenges, as well as some special issues in their own systems. For example, integrating large amount of renewable resources in the power system is a common challenge faced by many countries, but the solutions are different. Some countries mainly use the local integration method, which requires a strong and smart distribution system. And some apply the method of large amount centralized integration. Therefore, different planning processes, methods and techniques will be used. The purpose of this panel is to invite experts and practitioners around the world to share and exchange practices and techniques in this important field with a view to promote best practices in power system planning.
Flexibility: How can systems ensure the right type and quantity?	This session will focus on the different approaches to ensuring sufficient flexibility being adopted around the world in light of increasing variable renewable energy. Different mechanisms have been proposed and are in the process of implementation to incentivize available flexible resources and emerging energy storage and demand response technologies, to be available when needed for ramping. The discussion will focus on comparing the drivers for each approach and provide some insight into the resulting response.
Network Restoration Operation Procedure with Renewable Energy Sources	After a blackout of the power system the transmission system operator has to coordinate the power system restoration. Due to the increasing number of variable renewable energy sources in the system (esp. solar and wind) they have an impact on the restoration procedure. The panel session has two focus areas: how the transmission system operator can include renewable energy sources in the network restoration procedure and how distribution systems coordinate distributed energy resources and supports power system restoration.

Grid Modernization Opportunities and Challenges	This panel will focuses on: · Operational challenges and opportunities offered by DERs and Microgrids · Providing energy, capacity and ancillary services from DERs and Microgrids · Modeling the flexibility of energy storage devices for healing ramping scarcity events · Creating visibility and control end to end (Devices to Distribution and Transmission)
Advanced Data Analytics for EMS	The nation's grid faces significant transformation in supply, demand, consumer expectations, and markets. While unprecedented large amount of data set has been integrated into energy management systems (EMS), technical barriers still exist today to bring more value associated with data management and communication systems to enable full visibility of grid system state and to handle uncertainties originating from renewable resources or load. New breakthrough technologies should be developed and incorporated into EMS so as to transform the future power grid into a fully integrated, highly resilient, suitable paradigm. This panel will discuss how to improve situation awareness in the control room and to improve the grid's capabilities to analyze Big Data by looking at both traditional and non-traditional data or advanced analytics developed for new applications.
Flexible Transmission System Operation with Natural Gas Constraints	The increase in the installed capacity of the renewable energy resources and the fluctuation and uncertainty in demand side requires higher flexibility in generation and transmission sectors to maintain the stability and reliability of the electricity network. Integration of natural gas generation as fast response resources improves the flexibility of the electricity network. However, the constraints and contingencies in the natural gas supply chain could limit the effect of such generation assets to compensate for the imbalances in generation and demand. This panel is focused on flexibility in generation and transmission sectors considering the imposed constraints and contingencies in the natural gas networks in short-term operation planning of electricity network. The coordination between the natural gas and electricity network to improve the flexibility of the electricity networks with high penetration of renewable energy resources were addressed from academic and industrial perspectives.
Grid 3.0 Market Transformation	The pace of change is accelerating in the power industry. Grid 1.0 interconnected classical utilities till the late '90s. Grid 2.0 brought efficiency through regional operations over the last 20 years. We are now standing on the edge of a transformation to Grid 3.0 with an explosion in the volume and complexity of participants/devices and associated transactions. Essential business functions of Grid 3.0 will leverage, where appropriate, experiences from wholesale markets of Grid 2.0, but also extended to meet broader challenging requirements of Grid 3.0. We need to address critical challenges including traversing different tiers in the top-to-bottom grid and business architecture, and in parallel coordinating with other distributed/aggregated entities. The panel of experts will share their experiences and visions reflecting their diverse perspectives.
Practical solutions for mitigating uncertainties in the future grid	This panel addresses practical solutions implemented at utilities in North America and France to mitigate uncertainties in the future transmission and distribution grid. Managing the grid is becoming more challenging because of evolving grid influences, such as growth of variable renewable generation resources, distributed generation, microgrids, demand response, and customer engagement programs. Concurrently, however, there are nascent technologies and other advances that improve our ability to manage future grid operations. These technologies include new sub-second synchrophasor measurements and analytics; advances in high performance computing, visualization platforms, digital relays, cloud computing, etc. Other advances include adding more intelligence at substations and distribution systems, as well as self-managed microgrids and wide area monitoring systems. One key initiative is to create a 'predict and mitigate' proactive paradigm to enable better anticipation so that timely decisions can be made, to mitigate problems before they spread across the grid.

Best Practices on Integration and Operation of Grid-scale Energy Storage Systems	The recently accelerated trend in deployment of energy storage at a large scale is a great testimony to the values that energy storage can bring to several sectors in electricity industry, including generation, transmission and distribution, while providing services to support real-time balancing of demand and supply, network congestion management and reduce the need for investment in system reinforcement. As the pilot projects have been developed globally to gain more experiences with energy storage, there is a great need to share these experiences among investors, system operators and end-users and to inspire more discussion on the future development. This panel will assemble expertise from industry, academia and national laboratory to assimilate the best practices on integration and operation of energy storage.
Decision support tools for economic valuation of energy storage	The academic research is rife with storage-valuation studies. At the same time, the electricity industry suffers from a shortage of robust modeling tools that can be used for their own in-house storage studies. This panel seeks to address this issue by discussing how some off-the-shelf and publicly available models can be used for storage valuation. It also discusses some of the realities of how energy storage participates in energy markets, and the implications of those market realities on how storage should be modeled.
Challenges, Opportunities, and Approaches for Integrating Demand Response in Markets and Distribution Systems	Demand response (DR) can contribute to stability and reliability to manage intermittency and uncertainty from renewable generation. Whereas conventional DR can compromise comfort by shifting loads, integrated DR improves resource flexibility (PV, energy storage, EV, etc.) while maintaining consumers' utility, by coordinating electricity and natural gas with distributed energy resources (DER). Coordinated energy hubs can reduce peak loads and costs, thus enhancing system security and economy. However, experience highlights issues affecting DR-DER performance and participation. Aggregating smaller customers is necessary commercially but must allow market operators to manage congestion. Synergy with storage can use the same market designs reflecting participants' costs, providing comparable opportunities but reflecting differences from generators. DR can provide dispatchable energy, reserves, and resource adequacy, all of which affect market settlements. This panel presents R&D results on optimization and control for large-scale integration, lessons learned on technical challenges and market mechanisms, and future research directions.
Facilitating Energy Storage Integration into Electricity Markets	With large increases in variable energy resources to meet ambitious clean energy goals in states such as New York, California, and Massachusetts, a significant amount of flexible, dispatchable resources will be needed to maintain system reliability. To meet this need, additional energy storage may enter the grid through policy mandates or market incentives. This session with a mix of Industry, ISO/RTO, and Research Institution panelists with first-hand experience in energy storage will focus on the latest technologies and market developments that can enable energy storage resources to support electric system reliability and increase system efficiency.
Incorporating Distributed Energy Resources in the ISO Wholesale Electricity Market	Distributed energy resources, such as solar photovoltaic, combined heat and power, microgrid, wind turbine, energy storage, etc. are experiencing a tremendous growth in recent year. DER are generally located in the distribution system and categorized as "behind-the-meter" generators. DERs are small, sparsely located in the distribution system, not visible nor directly controlled by the system operator and uncertain in output level. The large penetration of DERs will not only bring benefits, but also challenges. This panel will discuss the following questions: • What are the roles and benefits of DER for the ISO market? • What are the control technologies for aggregated DERs, and how they are going to be coordinated with existing controls? • What are challenges brought by DERs to ISO operations, and how are they going to be dispatched by the ISO? • What is the viable market mechanism for aggregated DERs to participate in the wholesale electricity market?

Distributed Energy Resources and Market Design Considerations for Local Energy Markets (DSOs)	Distributed energy resources are changing the energy landscape and are blurring the boundaries of the transmission and the distribution grid. As a result, distribution grid operations are gaining an increasingly important role in power system operations. The flexibility of these resources creates new opportunities in power markets, but also new challenges that need proper management to ensure maximum value is materialized for the benefits of consumers. A major challenge that has recently emerged is the development of organized Local Energy Markets at the distribution level (DSOs) capable of producing visible market locational prices at the distribution level. To some extent, the emergence of Local Energy Markets has to do with the evolution of wholesale energy markets, which are currently being reconfigured to allow nascent distributed energy resources to compete with traditional resources to provide services critical to the reliable operation of the power grid.
Energy Storage and Conventional Resources: Complementarity, Rivalry and Substitutability	Grid-scale energy storage devices will soon be heavily deployed in transmission and distribution grids. These devices can provide simultaneously a variety of grid services. Contrary to conventional generating units, energy storage devices can only inject previously accumulated energy; and contrary to transmission lines, which move energy in space, storage moves energy in time. As a consequence, energy storage installation and operation should be coordinated with the rest of the system. This panel of experts will discuss the state-of-the-art energy storage integration, expected economic and technical impacts, as well as proposed operating and planning tools to capitalize on multi-purpose energy storage benefits. The overall value proposition of energy storage devices will be compared against competing supply- and demand-side resources. The ultimate objective of the panel will be to identify key contributions required to pave the way for the successful energy storage roll-out.
Tuning the measurement weights in power system state estimation	It has long been known that the quality of the results provided by power system state estimators crucially depends on how well measurement errors are characterized. In particular, the actual standard deviation of errors is of tantamount importance, as the weighting coefficients customarily used by industrial tools are fully determined by this statistical quantity. In spite of that, and the hundreds of publications devoted to power system state estimation, little attention has been paid so far to this relevant aspect. In fact, many end users believe the weighting coefficients adopted by their estimators have not been properly tuned or have become obsolete. This panel will gather speakers from industry and academy who will share and discuss both theoretical issues and practical experiences showing how measurement weights should be chosen and the benefits attained from this optimal choice.
Decentralized architectures for power system protection, estimation and control	The modernization of existing Energy Management Systems is one of the main technological challenges to face in future power systems. To solve this problem, the designers of high performance computing systems are revisiting the architectural requirements, design criteria and assumptions related to scalability, adaptability, flexibility, and technological evolution. Data heterogeneity represents a major problem, and massive data management represents another relevant issue to address. Even if sophisticated mathematical models for measured data streaming analysis are available, many problems need to be fixed. Moreover, the conceptualization of a decentralized, self-organizing, proactive, and holistic computing framework for decision support in a massive-data, but information-sparse domain, represents one of the most relevant research directions. The adoption of these paradigms allows improving the grid operation procedures with a set of information services for knowledge discovery and data mining, delivering the most useful information, in useful time, to the correct operators.
Challenges and Technologies in Bulk Power System Outage Management	Scheduling and coordination of outages is an important function that transmission owners and grid operators perform which has direct reliability and economic impacts to the grid operations and market participants. There are many challenges today in bulk power system outage management, including the assessment and management of the operational and economic risks, the interdependencies of both generation and transmission outages, the integration of renewable energy resources, gas-electric power system coordination, generation retirements, etc. This panel serves as a forum for the grid operators and researchers to share the challenges in outage management, discuss metrics and tools being used today, and identify new technologies needed to further improve the accuracy and efficiency of outage scheduling and coordination.

Recent Developments in High-Fidelity Large-Scale Power System Datasets	It is widely recognized that the research community lacks high-fidelity, public, large-scale power system datasets that accurately characterize the challenges faced by modern network operators such as, distributed renewable generation and evolving load profiles. This dataset shortfall has presented a significant challenge for researchers of optimization and control algorithms, because the available datasets are too easy to optimize, too small in scale, and lack a sufficient number of scenarios to fully test the robustness of novel methods. This panel brings together a diverse group of power system modeling experts to present recent developments in power system datasets, which represent a new generation of publicly-available datasets with the detail and scale required to validate emerging power system algorithms.
Grid Architecture to Integrate Massive Distributed Resources into Bulk Power Systems	The penetration of distributed energy resources (DERs) continues to grow at a rapid pace. This could be creating tremendous challenges for a future power grid in ensuring its safety, reliability and efficiency. This difficulty is partially attributed to the fact that these small-sized, distributed DERs are not visible and controllable to the system operators. It also greatly limits the value of DERs which can contribute to the reliability and efficiently of the power systems. This panel will discuss the challenges in the large-scale integration and coordination of DERs from the system operation perspective, impacts on wholesale electricity markets and new lines of thoughts on novel grid architecture that could deviate from today's practices. This new grid architecture is critical to enable the viability of DERs while improving the reliability and resilience of the future power grid
Global Best Practices on Natural Disaster Mitigation: Operation Technologies, Communication, and New Trends	In responding to natural disasters, electric utilities have developed comprehensive plans for emergency preparation, incident response structure and procedures, service restoration process, and evaluation matrices during and after events. Response plans are gradually developed based on field experience starting from the emerging of modern power grids. New technologies in smart grid and asset management have shown great ad-vantages on natural disaster mitigation. Communication plays the key role throughout the mitigation efforts, ranging from internal information flow on disaster evaluation, asset allocation, and decision making, to awareness in publicity domain. Pre- and post-event scenario analysis presents the nature of best practices and discover knowledge and lessons-learned from real world events. In this panel, best practices of natural disaster mitigation around the world will be discussed, with the focus on the evolution of Operation Technology, Data and Communication, and role of new technologies.
Accommodating intermittent renewable energy by multiple energy systems integration: forecasting, operations and planning	Multiple energy systems integration is an emerging way of accommodating renewable energy, since the power system, heat system and gas system, are strongly complementary in terms of efficiency, controllability and flexibility among various process such as energy generation, transmission and distribution, conversion, storage, and consumption. New devices are available for the integration of multiple energy systems and information technology associated with these devices. Integrating these energy systems thus has great potential of exploiting the flexibility of energy system to better accommodate renewable energy. So far, researchers have mainly focused on the combined forecasting on energy consumption, coordination of gas and electricity, and thermo-electric coordination. This panel will address this promising and dynamic area, while focusing on the new theoretical insights, innovative forecasting and modeling techniques and practical experiences on using multiple energy systems integration to accommodating intermittent renewable energy.
Probabilistic Reliability Assessment for Grid with Increasing Uncertainty from Renewables	The US power system is undergoing fundamental transformation with increase of variable generation. To maintain reliability of the power system, NERC and ISO/RTO advance its probabilistic assessment. Existing procedures and rules for reliability assessment have evolved and work well for predictable generation. Dealing with the increasingly uncertain generation requires new data driven probabilistic methods using load forecast models, load forecast error data, and historical outage and failure data. Assessing essential reliability services requires collection, modeling, and analysis of new data types, beyond the existing procedures. Regulatory implementation requires that the methods are simple and verifiable. The proposed panel will provide multidimensional view of the analysis methods and requirements that are needed to address the on-going change. The speakers include academic/consultant, NERC, ISO, and utility. The panel will include four individual talks and a short moderated discussion. The presentations will provide cohesive coverage of the subject.

Decision Support Methods for Capital Planning Under Uncertainty	It is widely appreciated that when making capital planning decisions, or designing markets, best practice is to consider what plan or policy will hedge against different possible future system backgrounds – in particular the best plan for hedging against uncertainty may well not be optimal with respect to any single possible future. This panel will explore a range of quantitative methods in uncertainty quantification, expert elicitation, and computation for optimization under uncertainty. The aim is to bring together researchers and analysts active in this area to exchange ideas, and to disseminate more broadly the current state of the art.
Current R&D in Photovoltaics: Technology and Grid Integration	By the end of 2008, the largest PV installation in the United States was the 14MW PV at Nellis Air Force Base in Nevada. The largest installation in the world was just a 60MW plant located in Spain. There is currently over 9 GWac of major solar projects operating in the USA. In addition, there is a substantial amount of capacity in the pipeline, with over 30 GW of PV and CSP projects either under construction or under development. Eight of the ten largest solar plants are installed in the US including a 579 MW PV facility went online in 2015. Driving the unprecedented growth of PV are the aggressive renewable portfolio standards set by many states and the falling solar panel and balance of system costs. Every major utility company is currently faced with growing penetration of solar generation, and this is beginning to create operational and planning challenges.
Power System Flexibilty: Challenges and Enhancement Solutions	Increasing penetration of intermittent renewable energy resources is contributing to shortage of flexibility and ramping resources in power systems operation. There has been a recent focus in the technical community on developing new operation models, market mechanisms and services to enhance the flexibility of power systems in order to respond to fast sub-hourly ramping of renewable resources, and reduce the frequency and intensity of ramping scarcity events. This panel session brings together experts from academia and industry practitioners to discuss the challenges of flexibility in power systems operation, as well as to explore solutions that assist in enhancing operational flexibility.
Reliability Modeling and Evaluation of Dependent Cyber-Physical Systems	The power grid today experiences fundamental transformation that requires new approaches to assess the risks and assure its stable and reliable operation. Interactions between physical and cyber elements of a Cyber-Physical System (CPS) are much more complex than in traditional systems, therefore the methods for assessing the reliability must be reconsidered. There is a tremendous need for research and development in the area of modeling and assessing the reliability of CPS. The overall goal of this panel is to present state-of-the-art research and practical applications in the area of modeling and reliability evaluation of cyber-physical systems. Changing the nature of the grid requires continued and elevated engagement in developing proper models and to assure the reliability of power systems in both planning and operational environments. Understanding interactions and dependencies between physical components (lines, transformers, generator, etc) and cyber components (communication links, intelligent electronic devices, control and metering devices, etc.) is essential to develop appropriate reliability models and tools.
ENERGY DEVELOPMENT IN AFRICA: Engineering Towards Sustainability : Natural Gas, Renewable Energy Micro Grids, ICT and aligning with Global R&D	Previous IEEE PES panel sessions on Africa have discussed the strategic importance of the Interconnection of electric power systems of regions, states and individual territories as Africa's economic role is acquiring a visible and growing scale of importance in world economics. Within these analyses, issues of Sustainable Development (SDGs), Rural Electrification, security, infrastructure modernization, new technologies and education have been looked at to suggest practical optimization and implementation strategies. This panel session will address the Role of Natural gas, Renewable Energy Micro Grids, the increasing importance of ICT and aligning with Global R&D. The Session presents some results of current studies and new developments in several of these areas.

Various Aspects of Water Power Generation	"This panel will discuss various aspects of water power generation in a panel discussion forum, to encourage electrical engineers especially within the Power and Energy Society to participate in research, development, and demonstration of water power generation activities, to open dialog among many different experts and stakeholder organizations working in the area of water power generation for possible future collaborations. The panelists include engineers and researchers actively involved in research and development efforts in both marine and hydrokinetic and hydropower technologies to improve performance, lower cost and ultimately support our ability to sustainably meet its growing energy demand. Marine and hydrokinetic technologies capture energy from waves, ocean thermal gradients, and tidal, ocean and river currents."
Big data for Integrated Energy Systems	This panel session aims to explore big data for efficient energy integration from three perspectives: data theory, data technology, and data utilization. Information technologies change the energy sector dramatically, both in renewable energy technologies (i.e. wind, solar, storage) and in traditional energy sectors (i.e. utility, oil and gas). Data science has not yet provided tools to overcome all the challenges energy technologies face. The information revolution challenges traditional energy operations and optimizations that work with small data, using largely deterministic tools. This session brings together energy sector experts, data scientists, and computer scientists. It will explore: 1) How to characterize big data in the energy sector? 2) How does it differ from big data in other industries? 3) How do big data and information technology transform the energy sectors (upstream, horizontal, and downstream)? 4) What new developments in tools and algorithms will transform data understanding, classification, and utilization?
Advanced Interconnection Features of Transmission-connected Renewable Power Plants	As interconnection requirements imposed on renewable facilities have continued to increase, vendors have introduced or reviewed the introduction of new capabilities, including features like black start, island operation, synthetic inertial response, operation at low short circuit ratio, turbine-based energy storage, advanced voltage or frequency controls, and advanced modeling capabilities. Many of these capabilities may not be well known in the power industry. This panel would include representatives from major vendors (invitees will include major Americas-base vendors like GE, Siemens, Vestas, Senvion, Gamesa, and Electrocon, as well as academics) who will describe a new advanced feature that is or may be of interest to the transmission community. The selection of the specific feature or control will be left to the discretion of the invitee.
Developments in Energy Storage Technology with Renewable Generation Sources	Energy Storage has multiple technical and economic facets that are rapidly evolving. This panel will focus on recent developments, with examples of technology actually in use or under active development that include rotating machine technology.

Lessons Learned from Implementing Portable and Reconfigurable Microgrids for Resilient Operation	This panel will explore the lessons learned in implementing microgrid technology for small, portable, and reconfigurable power system for reliable and resilient energy delivery. This style of microgrid targets applications such as small military base camps, disaster relief operations, and other temporary encampments. Networking generators in these environments offers the potential for fuel savings, renewable resource integration, and system flexibility. Panel speakers will offer perspectives that span both the military communities' efforts and civilian efforts and applications.
Challenges and Advancements for Renewable Power Plants in Weak Grid Applications	As the penetration of renewables - particularly wind and PV - continues to increase, the prevalence of weak grid applications will, too. The industry has continued to improve the methods and controls to enable stable operation and robust recovery from disturbances for weaker and weaker grid conditions. The panel will cover the latest advancements and associated challenges from OEMs, National Labs, and Academia.
Design of Electromagnetic Synchronous Compensators and Converter Synchronous Controls for Renewable Applications	As the penetration of renewable resources using phase-locked-loop controls increases, the need for either synchronous compensators (also called "synchronous condensers" in North America) to provide synchronizing power has increased, resulting in the application of synchronous compensators for several large renewable projects. In contrast to typical applications of synchronous compensators, which are often retired steam turbines kept in service to provide local voltage support for areas with otherwise poor voltage regulation (necessitating a wide dynamic reactive range), synchronous compensators for renewable applications have somewhat different design emphases, including maximal subtransient and transient short circuit contributions and rapid response to system conditions. This panel will feature representatives from major synchronous compensator vendors, including Siemens, ABB, and GE, who will describe design features of synchronous compensators for renewable applications, as well as designers of converter synchronous controls, who will describe the design of converter controls for synchronization of renewable resources.
Multi-agent Field Deployment Platforms	Automation is increasing at the edges of the electric power system and multi-agent systems are being applied to coordinate the operation of these automated electricity resources. The deployment of intelligent power devices and systems are relying on information and messaging platform technologies to simplify the integration of agent-based logic into devices that interact to optimize local and systemic objectives. This panel explores some of these platforms to explain not only their operating performance requirements, but the capabilities that they offer to streamline the integration of agent-based automation, as well as their ability to scale and manage the multi-agent system.
Unlocking Grid Flexibility - Energy Systems Integration	Flexibility of operation—the ability of a power system to respond to changes in demand and supply— is critical to enable higher levels of variable generation. One way to unlock this potential flexibility is tap into other energy domains such as thermal and fuels systems as well as other services such as water and transportation systems. Energy systems integration is the process of coordinating the operation and planning of energy systems across multiple pathways and/or geographical scales to deliver reliable, cost- effective energy services with minimal impact on the environment. This panel will examine the role of energy systems integration in unlocking the flexibility of the electrical power system.
Modern Heuristic Optimization Techniques for Renewable Energy Sources Integration with Energy Storage Devices: Optimization Under Uncertainty	Power systems are experiencing a revolution caused by the increase of power generators fed by renewable sources. This trend has been mixing with the concurrent course in power generation practice of preferring distributed and dispersed medium and small power generators. Beyond the great benefits, there are still some significant drawbacks. The intermittency, which characterizes renewable sources, is one of the main concerns. In particular, energy storage systems have been coupled with renewable energy sources to mitigate the impact of the aleatory behavior. This introduces new challenges, as energy storage systems should be optimally managed in accordance with the stochastic profiles and with the intrinsic characteristic of the particular energy storage technology. In this panel, practitioners from industry, regulatory bodies and academia will come together to discuss what is being implemented, best practices and the challenges concerning the optimal management of energy storage systems integrated with renewable energy sources.

Trusted monitoring and Intelligent Consumption data management for smart buildings	Intelligent buildings have to tackle the challenges of smarter energy management, enhanced automation and connectivity. Facing environmental policies and cost-reduction objectives, building managers are asking for adequate solutions to predict, monitor, control, command, and optimize energy consumption, in the context of all the energy transactions and service provision opportunities. The trend toward smart building is enabled by the growing integration of Information Technology and Operational Technology. An unwanted consequence of this is the growing exposure to cyber-attacks. Legacy automation systems have been traditionally thought secured by isolation and physical protection. Now, they are exposed to fast-expanding cyber-threats, targeting their availability, integrity and confidentiality. A joint initiative, gathering engineers and researches from energy, automation, ICT and security background is likely to deliver the innovative intelligent building system architecture and a set of advanced technological capabilities to solve the dilemma of efficiency and security in intelligent buildings.
Resilient Control Systems for Cyber Physical Power and Energy Systems	This panel addresses the design, developments and implementations of resilient control systems for power and energy systems driven by cyber (computer networks and communications) systems. The smart grid is a cyber physical power and energy systems (CPPES). CPPES control systems' complexity is enormous given its nature of system of systems, multi-time scale requirements, variability, uncertainty, security, platforms for simulation and test beds, and many others. The panel will emphasize on many of these issues.
Evaluating the Performance of Modern Heuristic Optimizers on Smart Grid Operation Problems	The increasing penetration of renewable energy sources and the new and adaptive patterns of demand side response entail a higher level of variability of the operation of electrical sustainable power systems. In this context, operational problems posse highly complex mathematical properties (e.g. non-convexity, discontinuity, multi-modality, high-dimensionality) and high computational burden, which emphasizes the need of advanced optimization solvers in order to find optimal solutions that guarantee efficient and flexible operations. This panel introduces two benchmark problems, namely, Stochastic OPF Based Active-Reactive Power Dispatch, and the Optimal Scheduling of Distributed Energy Resources. Besides, the panel will present the results and a comparative evaluation concerning the performance of different modern heuristic optimization algorithms, which are developed by different researchers worldwide. These researchers are challenged to solve the benchmarks, which are treated as black-box problems. They are only allowed to improve the methodological framework of their algorithms.
Intelligent Systems for Voltage Control in Smart Grids	This panel will address the growing challenges in voltage control and reactive power management in smart grids. Renewable energies such as wind power and solar PV systems impact the voltage profiles of the power system, both at the transmission and distribution systems. The dynamics is complex and intelligent systems are required to model and control such systems. This panel will provide applications of intelligent systems to better monitor, model and control voltage and reactive power in smart grids.
Intelligent Control Systems for Micro-grids	A microgrid is a small scale, self-supporting power network driven by on-site generation sources with the ability to separate from an external grid for sustainability or energy security purposes. Microgrids integrate modular distributed energy sources, such as wind, solar, and fuel cells, with storage devices and controllable loads to form a low-voltage distribution system. The optimal control of microgrids is challenging task and requires foresight and insight of the variable sources and sinks including their types. This panel will address advances from the intelligent system community in optimal and sustainable operations of microgrids.
Lessons Learned from Cyber Attack Incidents and How to Mitigate them?	The focus of this panel is to share knowledge and discuss the following issues in cyber security of the power grid: (i) growing number and sophistication of cyber attacks targeted towards energy delivery systems around the world; (ii) case studies of recent attacks on power systems and lessons learned from these incidents; (iii) R&D experiences and best practices to improve the security of the modern power grid. The panel will have experts drawn from academia, national lab, and industry.

IEEE Standards and Guides Developed by the Hydroelectric Power Subcommittee	Presentation by the subcommittee working group chairs and task force leaders to inform attendees of the exciting new guide P1827 Guide For Electrical & Control Design of Hydroelectric Water Conveyance Facilities, the updates to IEEE 1010 - Guide for Control of Hydroelectric Power Plants, 1248 - Guide for the Commissioning of Electrical Systems in Hydroelectric Power Plants, and 1147 Guide for the Rehabilitation of Hydroelectric Power Plants, the IEC and IEEE 125 Governor soft harmonization underway, and the subcommittee vision and collaborative activities.
Integrating Wind and Solar with Your Hydro	Presentation by utilities, consultants, and manufacturers on the challenges and impacts of wind and solar integration on a hydrogenating power plant. The impact to controls, operations, speed governors, and other challenges will be explored.
Contribution for the Development of Smart Grid Technology	Smart Grid is a Modernized Grid that uses extensively Information and Communication Technology right from generation from various sources including Renewable Energy Sources to utilization of electricity through transmission and distribution with a view to improve efficiency, reliability, economics, and sustainability. It may be applicable to very large integrated grid as well as small isolated one due to some restriction. This panel session, therefore, is marked by presentations highlighting contribution for the Development of Smart Grid Technology with coordinated generation, transmission, and distribution to meet the time-varying load maintaining quality as such and sharing the experience gathered for further applications elsewhere within the region or outside.
Asian and Australasian Experience on Application of Smart Grid Technology	With contributions made towards development of Smart Grid Technology as defined in the power sector, this panel session aims at reporting various successful applications in different parts of Asia & Australasia through some presentations in the areas that are covered in this inter-disciplinary subject. Idea behind this is to share experiences gathered so that the same could be further used in the countries of the region or outside.
EMC Grid Task Force	capture the latest grid requirement imposed and study the impact to the electrical machine design in order to suggest updates to electrical machine standards.
Renewable Resources and Demand Response Integration Using the CIM Standard	The electric power system is changing to accommodate the growing deployment of distributed energy resources (DERs) and demand response (DR) systems as well as a shift from a central supply model to a distributed supply model. These changes are increasing the complexity of operating both the transmission and distribution systems that deliver power to electricity end-users. The utilities face new challenges in coordinating the new DERs that may be owned by the utility, third-parties or utility customers. To effectively address these challenges, new DER and DR management systems are under development and these will need to be fully integrated into the utility space. The Common Information Model exchange and Interoperability standards are moving quickly to aid in the integration of these new needs in the utility industry.
Tools for Managing Electricity Markets and Reliability for Grid with Very High Renewable Resources	The increasing penetration (50% or more) of renewable energy sources in the coming years in the electrical grid and the advances in smart grid technologies require new efficient algorithms and tools to reliably & economically manage the power grid and electricity markets. The variability and uncertainty associated with the renewable resources will require more efficient monitoring, situational awareness tools, advanced market applications and fast and sophisticated controls of the power grid. The uncertainty and variability associated with renewable resources may cause renewable forecasting error and this may cause over or under generation. The fast and effective tools for both electricity markets and grid control are needed to minimize the variability and uncertainty associated with renewable resources. There will also be a need for more advanced modeling and optimization techniques for the market applications.

Power Grid Cascading - Industry Perspectives	Cascading failures in electric power systems is a complicated and difficult problem to assess and presents a critical threat to power grid security, with severe consequences to society. Addressing this problem requires adequate cascading methodologies and tools that are accepted by industry and regulatory bodies. The goal of this panel is to present and share industry experience in the field of simulation, analysis and prevention of cascading outages. It will highlight recent developments and practical applications in identifying measures for minimizing cascading risk. It will also identify industry needs and research priorities in this area, and discuss ways of solving the future challenges and opportunities associated with new technologies such as renewable energy sources, microgrids, PMUs, etc. This Panel brings together experts from ISOs and utilities in US, Europe and Asia, who provide a wide range of expertise on cascading techniques and applications that have been recently implemented by industry.
On the Importance of Benchmarks to Drive Innovation in Grid Modeling	In many areas of technology, benchmarks have been used to drive a community view of progress and achievement. In high performance computing, the Top 500 Benchmark is used to highlight and motivate advancements in parallel computing architectures. For power grids, there are no commonly accepted approaches to defining measures of performance for important algorithms and calculations, in particular those at large scale for important problems of interest. Without such benchmarks, research in parallel computing for the electric grid modeling and simulation lacks quantifiable targets for achievement. Therefore, this panel is to discuss the importance of benchmarking for shaping research agenda in the parallel computing for the grid. We will examine benchmarks used in other fields such as fluid dynamics and math libraries, how these are developed, and common pitfalls. Finally, the panel will discuss how the community might develop and deploy benchmarks for use in grid research and commercial use.
Computing in Optimization – Tales from Methodology Developers, Tool Makers and Users	New Optimization technologies and computer architectures are essential analytical tools in planning and operating power systems. Recent developments in power systems such as distributed energy resources, demand-side management, and integration of renewables stain these analytical tools to solve larger, more complex and possibly decentralized problems. This panel will present some advances in optimization methodologies, innovation in hardware architectures, and users' experience and feedback on optimization tools. Through the panel open discussion, the participants will share their visions and discuss possible gaps and potential solutions.
State-of-the-art of GMD Modeling and Monitoring	This session will review the state-of-the art of tools and simulation techniques related to the analysis and simulation of geomagnetic disturbances (GMD) as they relate to the reliable operation of the high voltage transmission system. Interest and efforts in this area have grown significantly in the past few years, in part, as a response to the introduction of GMD reliability standards in North America. Some of the areas to be covered include earth impedance modelling (e.g., 1D, 3D, coastal effects), transformers, off-the-shelf simulation tools, control room real-time simulation tools. Deployment of traditional monitoring equipment such as GIC and harmonic monitors, as well as utility-grade magnetometers will also be reviewed. Additional topics include the state of space weather prediction, and the testing and validation of tools and models.

Challenges and Solutions of Interfacing Techniques for EMT/TSA Hybrid Simulation	In recent years power systems have been undergoing significant changes due to wide use of power electronics devices. Electromagnetic transient (EMT) type programs are good at simulating the transients of power electronics devices. At the sametime, Transient Stability Analysis (TSA) programs are powerful tools to simulate the interaction between power electronics devices and large power systems. It is a natural way of thinking to develop hybrid simulation techniques which can combine the advantages of both EMT and TSA programs, achieving both a precise and accurate simulation. This panel session will invite experts from some of the major power system simulation tool vendors to discuss the challenges and solutions of hybrid simulation interfacing techniques in industry applications. The objective of the panel is to provide a state-of-the-art description of EMT-TSA hybrid simulation to researchers and engineers.
Modeling, Simulation, and Control of Distributed Energy Resources	The increasing penetration of Distributed Energy Resources (DER) into the power system necessitates an in-depth understanding of their characteristics and ability to adequately model their interaction with the host networks. Such know-how should enable better planning, control, and performance. To this end, this panel will discuss various timely aspects of modeling, simulation, and control of DER, in the context of large-scale utility grids as well as within small-footprint systems (microgrids). The panel will benefit both academic researchers and practicing engineers
Advances in Accelerated Distribution System Time-Series Analysis	Quasi-static time-series (QSTS) analysis has received increasing interest from the power system analysis community as it promises refined insight into power system operating and planning concerns. This is particularly true for distribution system analysis on circuits with many time dependent and potentially time-variable components as is the case for deployments of large numbers of distributed energy resources (DERs). Unfortunately, detailed QSTS analysis is also currently computationally intensive as yearlong simulations may take days to complete using standard computing platforms available to typical utilities. This panel present multifaceted research focused on dramatically decreasing the amount of time required to complete accurate QSTS analyses. Time-series approximation techniques, methods to speed the power flow solution, and parallelization techniques appropriate for standard computing platforms will be discussed and the latest results presented. Additionally, the data requirements for QSTS analysis, and newly developed models to meet this need, will be discussed.
Distribution System State Estimation: Algorithm, Metering and Data Exchange: Advances and Challenges	With significant rolling out of smart meters for facilitating smooth uptake of distributed generation, fast computation of network state is very vital. The absence of reliable and high speed communication is a major bottle necks in taking advantage of the development in the network. Faster computation in the presence various discrete control is very much vital for active control of the network. Quality, adequacy and accuracy of measurements have significant impact on the effectiveness of active network control.

Advancing Distribution System Modeling Tools for PV Integration	Leading vendors and model developers will present software advancements in regards to modeling and addressing distribution systems with both existing PV and potentially large amounts of future PV. Distribution system hosting capacity, availability and accuracy of new data with new integration services, working towards automation of PV Interconnection Studies, and advancements in Quasi-static Time Series Simulations will be presented.
Smart grid monitoring and control	Rollout of smart metering and increasing automation and PMUs use in the electric grids enable a new wide range of opportunities for improved monitoring and control. This panel addresses the current and envisioned smart grid monitoring and control, with contributions from industry and academia. Presentations will address applications regarding consumers, aggregators, generation, and the electric grids focusing real applications and new solutions under development. These and related topics will be discussed covering technical and economic aspects as well as their impact in different regions in the world.
Network cost allocation: who should pay for green network infrastructure?	The costs associated with new network infrastructure needed to cope with increasing renewable generation capacity, have to be covered and allocated to network users. Also, incentive policies that benefit renewable generation investment may allocate costs disproportionally among network users (including both generation and demand) so as to foster development of remote renewable generation. Who are the actual beneficiaries of new network investment? Which are the right price signals to foster efficient system expansion? Should locational tariffs be applied in the context of renewables? And overall: Who should pay for green network infrastructure? In this panel, invited experts will share their views and ideas with regard to network cost allocation under increasing transmission and distribution infrastructure for renewables.
Planning 21st-century's electricity infrastructure under uncertainty: challenges and opportunities	Recent advances in optimization under uncertainty techniques and computational power have provided highly powerful tools for planning future electricity infrastructure. Such tools and computational power, however, are not unlimited and thus we have to model only those features that are considered relevant in system planning to keep our problems tractable. In this context, which operational details and features should we consider in planning studies? What is critical for designing a transmission network under uncertainty that is consistent with 21th-century needs and opportunities? Problem complexity is also compounded by the increasing participation of new generation and flexible network technology, demand response, storage and further smart grid technology. In this panel, invited experts will share their views and ideas with regard to what is critical for designing 21st-century's electricity infrastructure under uncertainty.
Sustainability Issues in Grid Modernization	Power grid modernization is a global process of integrating new technologies, market and economical advances, and regulatory strategic development. Environmental Sustainability issues play key roles in these efforts, in terms of renewable energy integration, empowering energy service and efficiency, and reduction of use of land (ROW) etc. Competitive system planning could bridge long-term capital gains into transmission service market, cops with energy spot markets, and calls economical sustainability through "smart" and "sustainable" designs. Regulatory impacts on sustainable power grid developments are also evident globally. Pollution reduction and control has become a denominate trend around the world to integrate clean energy resources. Long distance energy delivery and intermittent have been a long-time challenge for power system planners and regulators. This panel will discuss the current best practices and challenges on these topics and address the outmost challenges to utilize sustainability issues with new grid technologies.

Analysis, Integration and Implementation of Distributed Energy Storage in Power Systems	Various distributed energy resource technologies have been tested and shown great potential as one of the enabling technologies in grid modernization by accommodating renewable sources, increasing reserve and operating capabilities of the grid, improving system stability and reliability, and lowering cost, as well as deferring system upgrades. Distributed energy resources have shown strong growth in the past couple of years and will continue this growth as more companies have announced plans to significantly increase manufacturing capabilities on storage. However, great challenges remain unresolved in the areas of energy management, system integration, reliability and actual implementation. On this panel, the panelists from industry and academia will discuss the topics on distributed energy resource system aggregation, system integration and market operation, reliability evaluation and enhancement, and actual implementation and operation experiences of distributed energy storage systems in utilities and ISO/RTOs.
High Renewable Energy Penetrations within Isolated and Remote Area Power Systems	Isolated and Remote Area Power Systems utilizing renewable energy technologies to satisfy the majority (>50%) of their annual energy consumption are evaluated within this panel session. Isolated power systems face significant challenges under high renewable energy penetrations given the lack of system size and inertia. Papers presenting solutions to optimize system cost and performance, possibly involving renewable energy technologies, ancillary technologies or control and application methodologies are requested.
International practices in energy internet	In January 2011, the Energy Internet was described in the Proceedings of the IEEE. In July 2014, Energy production and consumption have kept increasing as economies grow. The large-scale development and utilization of fossil energy has resulted in serious problems such as resource shortage, environmental pollution and climate change. Energy internet is among the few major technological development areas for energy and the next generation ICT technologies. It is the next level of smart grid technology aiming for more renewable penetrations and greater prosumer participations. In this panel, speakers from different countries will talk about their experience and good practices in this area and also future trend.
International practices in smart grid for smart city	As a result of information technology advanced and its deep integration with the electric power industry, smart grid forms a solid foundation to build smart city. Meanwhile, the construction of smart city will also greatly stimulate the enormous potential of smart grid. City managers must be fully aware of the potential of the smart grid, so that the smart urban construction can play an important role. It is expected that with the continuous advancement of technology, smart grid and smart city construction will mutually promote and facilitate each other. Electricity consumption and electricity load are a true reflection of the socio-economic health of a city. The selection of data mining technology to analyze the mass amount of data from smart grid to support decision making for the government to effectively reduce operating costs and improve operational efficiency of smart city will be one of the big issues.
Optimal Integration of Variable Renewable Generation into Power Systems – Coordination of measures at TSO and DSO level	The integration of variable renewable energy resources (RES) impacts the electricity system in various ways, as system loading, voltage profiles, stability levels, etc. Since different RES technologies are connected with the grid at the different voltage levels, the grid integration issues concern both, the transmission and the distribution grids. Thus, in order to keep the system operation stable as whole, it is necessary to consider the system characteristics at particular levels and coordinate activities, especially, regarding the application of flexibility options at different voltage levels. This session will give an overview of the approaches used in the European countries regarding the grid planning and grid operation tasks within the power system with high penetration of RES. The issues regarding optimal application of flexibilities at the TSO and DSO level and the possible synergies between these levels will be focused. The results of some European and national projects will be presented.

Energy Efficiency and Smart Cities	The increasing population in cities is an additional challenge and it requires an enormous effort for reducing the greenhouse gases. Cities have a high and still increasing demand on electricity, gas, heating and cooling. An optimal use of multi energy systems in the urban environment using smart control and communication technologies and the implementation of e-mobility is the key towards highly efficient and carbon-reduced cities. The panel will provide the newest research results and information about running pilot and demonstration projects in Europe concerning energy efficiency and smart cities. The main issues of multi-energy systems, cogeneration and urban smart grid technologies will be pointed out under different perspectives. In general, the impact of mass implementation of distributed generators and energy efficiency measures on our daily live in cities now and in the future will be discussed.
HVDC Grids and related activities in Europe	The energy revolution in Europe places new requirements on the transmission grid. If it comes to large scale wind power integration in the north of Europe, as well as bulk solar power production in south, long distance bulk power transmission becomes integral part of an entirely new power system where new controllable devices will operate to make transmission smarter. In the last consequence a new network layer based on HVDC technology will be built which is referred to as an overlay grid in Europe. This session is about activities carried out in Europe and focusing on the meshed HVDC grids.
A decade of blackout prevention	The energy revolution in Europe places new requirements on the transmission grid. If it comes to large scale wind power integration in the north of Europe, as well as bulk solar power production in south, long distance bulk power transmission becomes integral part of an entirely new power system where new controllable devices will operate to make transmission smarter. In the last consequence a new network layer based on HVDC technology will be built which is referred to as an overlay grid in Europe. This session is about activities carried out in Europe and focusing on the meshed HVDC grids.
ICE-BREAKING PROJECTS IN ELECTRIC POWER SYSTEM ENGINEERING	The world's growing demand for sustainable energy is the driving force behind many research and development and industrial projects. The world tallest building, unmanned offshore oil platforms, floating LNG processing vessels, HVDC multi-terminal power transmission, long-distance AC transmission, FACTS design and installation, integration of dispersed generation, implementation of energy efficiency, and, last but not least, power system control have one thing in common: superior electrical engineering. This session presents an overview of the ice-breaking research and development and industrial projects from all over the world, many of them being unique or even world records, and their impact on the trends driving the electric power system engineering development. The session aims at bringing together lead engineers from various disciplines to provide information on cutting-edge engineering techniques and solutions.
Placeholder	Placeholder
Best Conference Paper Session #1	This session covers the Best Conference Papers on the topics of...
Best Conference Paper Session #2	This session covers the Best Conference Papers on the topics of...
Best Conference Paper Session #3	This session covers the Best Conference Papers on the topics of...
Best Conference Paper Session #4	This session covers the Best Conference Papers on the topics of...
Regulatory and Environmental Impact on Power Gird: Simulation & Implication	The transition to clean power is happening faster than expected around the world. The impacts of the policy each country/region will be reflected in energy prices, system operation and reliability, and the broader economy. This panel will review some(PJM and MISO) of the past studies done at ISO/RTO level in the United States and NREL will present its study. China's effort to clean energy is tremendous, SGGC will show its road map.

Risk Based Planning	There are increasing uncertainties in power system because of the integration of wind and solar resources on generation side and increasing distributed generation, and demand side management on load side. Furthermore, NERC reliability standard requires to review a range of credible conditions and identify events producing more severe system impacts. Therefore, the traditional deterministic planning needs to be reinforced by supplementing probabilistic planning. In the past several years, there are a lot of activities in developing probabilistic planning methodology and tools. This panel will invite experts from ISOs, research institutes and universities to talk about the probabilistic planning frameworks, challenges in probabilistic planning tool development, and the potential applications of these tools. We want to discuss the stochastic method vs random samples based on probability distribution, and have a debate about how to determine such as how many random samples are sufficient, how much probability space needs to be covered.
Power System Stabilizer Practical Issues in the Modern Grid	A discussion of technical and regulatory issues related to power system stability controls and associated excitation limiters in the environment of international grid code compliance requirements. Practical issues of design and performance testing and reporting will be presented by industry leaders.
Advanced Topics in Electrical Machines I	Advanced Topics in Electrical Machines
Advanced topic for eletrical machine II	Advanced topic for eletrical machine II
Smart Buildings, Loads and Customer Systems: Paving the Way for Customer-side Engagement in Power Systems	Panelists are asked to submit abstracts supporting the treatment of techniques, methods and requirements for interfaces between consumer-side and grid planning, dispatch operations, and control architectures (e.g., SCADA / EMS, DMS, transactive systems, market systems, third-party aggregators, etc.), and treatment of the methods or approaches to integration with other energy service provider business systems to support customer-side resources and services.
Discovering the Value of Transactive Energy	This panel seeks to explore approaches to value transactive energy for addressing future electric system goals and the challenges to achieve these goals. Panelists are encouraged to consider the specification of scenarios (use cases) that may emphasize future system objectives, as well as requirements for modeling and simulation of these use cases to represent non-coordinated growth of distributed energy resources (DER) and transactive energy mechanisms for coordination of such DER assets. Methods for assessing the value of transactive energy should be explored at a minimum.
VPP for power system operation and electricity markets	Virtual power plant, VPP represents an he as demand response resources, distributed battery storage, electric vehicle(EV)s, and smart buildings. VPP could provide grid services and flexibility requirement in an era of large penetration of variable renewable generation such as solar photovoltaic and wind power. This panel will explore: 1)dispatchable energy resources in smart buildings and smart houses and from EV, 2) demand response trading market, and 3) the implications for reliable power system operation.
Addressing Grid Changes and Challenges through IEEE Global Collaborative Initiatives	The energy industry worldwide is experiencing significant changes caused by rapid technology transformation, security and environmental concerns, and evolving consumer needs. The initiatives we undertake today affect the way in which the grid is operated and maintained in the future. To help address opportunities and challenges, IEEE has recently initiated cooperation with the U.S. Department of Energy (DOE), the U.S. Federal Energy Regulatory Commission (FERC), the North-American Energy Reliability Corporation (NERC), European Union (EU), and California Public Utility Commission (CPUC). This panel discusses how government and regulatory agencies address opportunities and challenges and initiatives with IEEE to bring together communities and agencies for a helpful impact on the global energy directions through grid modernization.

Advances in the Computation of Power System Transients	This panel session is about solution methods and models for the computation of power system transients. The focus is on electromagnetic transients in power systems. Both off-line and real-time simulation methods are presented. This panel presents recent research on accurate models, such as power electronic converters, wind turbine generators, transformers, circuit breakers and synchronous machines. This panel also presents recent contributions in fast and accurate simulation methods for power electronics circuits. Model order reduction methods and parallelization techniques are contributed for efficient simulations of very large networks. Co-simulation approaches are also presented for combining different types of solution methods and models.
Power System Transient Overvoltages, Field Measurement and Their Analysis	Transient overvoltages caused by equipment switching or lightning strikes are common to power systems from distribution to transmission networks. Severe transient overvoltage could cause significant damages to substation connected equipment including power transformers and circuit breakers. Utilities often rely on EMTP type of simulation to study the switching transient to select proper equipment rating or mitigation methods. Having actual transient overvoltage measurement from the field will help utilities to verify their power system transient models, select proper equipment rating, and prevent equipment failure. However, measurement of transient overvoltages, in particular for EHV networks, is a non-trivial task. This panel session will report on measurement principles and some of the issues associated with using different voltage transducers. These include capacitively coupled voltage transducers, resistance and capacitor voltage dividers, and optical solutions. In addition, field measurement data will be presented to demonstrate measurement technologies capabilities.
Future Trends in Computer Hardware for Power Grid HPC Applications	The advent of digital computer in the 1950s transformed the power industry facilitating the shift from analysis on miniature scale models of the power grid networks, using AC network analyzers or calculating boards, to a faster and flexible solution of the actual grid. The rapid growth of the computing industry since then, from mainframe computers to multicore/many-core CPU architectures and general purpose graphical processing units (GPGPUs) available today, has resulted in the development of a myriad of power grid applications that can solve much larger and complex problems. In this panel session, leading experts from computer hardware will present the recent and future trends in computing hardware and deliberate its implications on power system HPC applications with power grid experts.
Regulating the Future of Microgrids	This panel imagines a future where urban distribution systems include a network of interconnected microgrids. In an environment such as this, what is the role of the regulated utility, the third party energy producer, or the consumer? How does the current regulatory structure need to change to accommodate such a system? Who should be allowed to own critical assets within a Microgrid?
Smart Distribution Application: Distribution System Operator (DSO)	As the utility business model changes to become more transaction focused, the applications used to manage the distribution system must also change. This panel discusses the benefits that utilities, customers, and 3rd party energy producers will realize through the implementation of DSO software, as well as the challenges in implementing such solutions. What steps should utilities be taking today to prepare for DSO implementation?
Engineering and Planning - Energy Storage Roadmap	This panel discusses a roadmap for application of energy storage in Transmission and Distribution systems and associated cost benefits analysis. Business benefits and penetration levels of energy storage for several combined applications such as capacity deferral and integration of distributed generation will be assessed by panelists from a utility, consultant and vendor perspectives.
Utility Data Analytics	With AMI meters, PMU's and other connected devices becoming more commonplace at utilities, the amount of data that utilities have access to has increased. This panel will discuss different ways that this data can be utilized to deliver value to customers and deliver insight to utilities. What are leading companies currently doing with this data, and which ambitious uses are yet to be tested? Which decisions can be improved by utilizing this data?

State-of-the-art of GMD modeling and monitoring	This session will review the state-of-the art of tools and simulation techniques related to the analysis and simulation of geomagnetic disturbances (GMD) as they relate to the reliable operation of the high voltage transmission system. Interest and efforts in this area have grown significantly in the past few years, in part, as a response to the introduction of GMD reliability standards in North America. Some of the areas to be covered include earth impedance modelling (e.g., 1D, 3D, coastal effects), transformers, off-the-shelf simulation tools, control room real-time simulation tools. Deployment of traditional monitoring equipment such as GIC and harmonic monitors, as well as utility-grade magnetometers will also be reviewed. Additional topics include the state of space weather prediction, and the testing and validation of tools and models.
Modeling, Simulation, and Control of Distributed Energy Resources	The increasing penetration of Distributed Energy Resources (DER) into the power system necessitates an in-depth understanding of their characteristics and ability to adequately model their interaction with the host networks. Such know-how should enable better planning, control, and performance. To this end, this panel will discuss various timely aspects of modeling, simulation, and control of DER, in the context of large-scale utility grids as well as within small-footprint systems (microgrids). The panel will benefit both academic researchers and practicing engineers.
Advances in the Computation of power system transients	This panel session is about solution methods and models for the computation of power system transients. The focus is on electromagnetic transients in power systems. Both off-line and real-time simulation methods are presented. This panel presents recent research on accurate models, such as power electronic converters, wind turbine generators, transformers, circuit breakers and synchronous machines. This panel also presents recent contributions in fast and accurate simulation methods for power electronics circuits. Model order reduction methods and parallelization techniques are contributed for efficient simulations of very large networks. Co-simulation approaches are also presented for combining different types of solution methods and models.
Practical Aspects of Ferroresonance	provide a tutorial of practical aspects of ferroresonance.
Big Data Access and Big Data Research Integration in Power Systems	The electric power industry, interacting with one of the largest customer-serving critical networks and going through drastic rapid changes in both business and technical paradigms, is presenting limitless opportunities for big data studies. However, research and development on big data is meaningful only if one has access to big data. Accordingly, this panel will discuss: 1) the type, resolution, and volume of the power system data that is needed to support different types of big data research and development activities in power systems; 2) the challenges and practical obstacles in sharing real data in power systems; 3) tools and techniques, such as sensitive data masking methods, which can overcome these obstacles.
Latest Advances in Wind and Solar Power Integration	We will present the latest advances in the state of knowledge of wind and solar power integration in the bulk power system. This includes: lessons learned and best practices in wind and PV integration studies; storage as an enabler for higher wind and PV penetrations; use of wind and solar forecasts in system operations; how to manage impacts of DERs on the bulk power system; reliability of inertialess power systems; how markets need to evolve with high penetrations of wind and PV; and how generation and transmission planning need to evolve.

Big data Analytics for Electricity Markets	Increased penetration of distributed energy resources and variable generation bring unprecedented complexity and uncertainty. These challenges call for fundamental market reforms to promote flexibility and efficiency in generation, network operation, and particularly on the demand side. This panel will explore implications of this revolution to existing and new markets. We will investigate tools and algorithms to extract information relevant to market design and operation throughout the supply chain. The panel will discuss: New markets enabled by the smart grid and smart metering data, that could deliver major benefits to consumers, such as local energy markets and peer-to-peer energy markets; Benefits to market design from more accurate load and resource forecasting; Energy/ancillary market design and use of network charges to promote flexibility at all levels; Use of big data to facilitate the transition from DNO to DSO; Data tools help to detect and minimize market power.
Big Data in Power Systems: Transmission, Distribution, and Data Analytic Applications	The large-scale, heterogeneous, and complex data sets collected by ubiquitous sensor networks have great potential to transform the way we model, monitor and control the electric power system at the bulk transmission level, and at the distribution system with DERs. The challenges, opportunities and success stories of big data applications in electric power system at both transmission and distribution levels will be discussed. Integrating data tools across different levels of operation, this panel will also focus on analytical approaches and methodologies to integrate, analyze and visualize the spatiotemporal data sets that are available from cyber and physical components of the power networks. This panel will bring together experts to discuss rapidly developing data analytics techniques that can address architectural, computational, and practical challenges in power transmission and distribution networks in presence of the DG high penetration levels.

Emerging technologies and new power system data challenges	With the advance of power electronics, energy conversion and communication, innovative technologies are increasing grid observability and situational awareness. For example, an intelligent sensor may capture current, voltage and environmental measurements at 130 samples each cycle. Devices serving to control power flow may also yield valuable grid and line measurements. With the increasing penetration of solar inverters and energy storage devices, will come tides of data for equipment diagnosis, demand response, power marketing, etc. While thrilled by the potential of better reliability and sustainability, power companies are also challenged by the massive amount data. This session will explore the data challenges introduced by emerging technologies from user and product vendor perspectives: • Emerging technologies and impact on power system operation • Data volume and impacts on legacy IT systems • Communication protocols and efficiency • Benefits and promising applications • Successful use cases
Power Quality Issues with Solar Power Plants	Solar power plants contribute green energy to our power grids, but the conversion of energy from dc to ac voltage introduces power quality issues to utility distribution and transmission systems. Learning from past lessons will allow the industry to prevent future concerns
Cybersecurity of the Electric Power Transmission and Distribution System	Securing Electric Power System from cyber-attacks is of national importance and in North America NERC is spearheading the effort in developing and enforcing Critical Infrastructure Protection (CIP) Standards for Bulk Electric System (BES). Local and state regulating agencies are also looking at cybersecurity of the Electric Power Distribution Systems. Substation protection, automation and control systems along with distribution field devices have changed significantly in the past decade and will continue to change with technology advancements. tutorial discusses cybersecurity basics including passwords & access management, authentication, encryption, network security monitoring, techniques in cyber alarming, logging, and auditing. The tutorial also covers NERC CIP requirements applicable to T&D systems along with brief overview of IEEE and IEC standards. Cybersecurity implementation examples of substation protection, automation and controls systems including devices inside as well as outside the substations are also discussed. Utility perspective on Cybersecurity and NERC CIP compliance will be included.

Automation, Protection, Reliability and Voltage Engineering of Power Distribution Systems with DER	Power distribution systems are evolving rapidly as a consequence of the proliferation of Distributed Energy Resources (DER). The adoption of this technology, particularly of photovoltaic distributed generation, is impacting all aspects of modern distribution engineering and introducing new challenges that need to be addressed holistically, from a variety of perspectives. For instance, application of distribution automation is a key multidisciplinary area that requires not only expertise in related equipment and technologies, but also understanding of protection systems and communications, and evaluation of reliability benefits to developing business cases that justify cost-effective deployment. Traditional techniques used for application of distribution automation in radial distribution systems need to be revisited and updated before being applied to scenarios that include high penetration of DER, furthermore, new techniques and solutions are needed to deal with new concepts such as microgrids and energy storage. This panel session will explore the implications of the proliferation of DER in key distribution engineering aspects, particularly in distribution automation, switching and overcurrent protection, reliability and voltage engineering.
Industry Experiences and Trends in Grid Modernization	Modern society has reached a point where virtually every crucial economic and social function depends on the secure and reliable operation of the electrical power and energy infrastructures. The electric power systems around the world are undergoing an unprecedented transformation prompted by the need to comply with new technology deployment trends, environmental concerns, new weather patterns, changing consumer needs, and regulatory requirements. In the US, this evolution has been clustered and described under various terms, including smart grid, grid of the future, grid modernization, and utility of the future. Despite slight differences among these terms, all of them recognize that the status quo is no longer able to fulfill the changing needs and growing expectations of end users, while providing electric utilities and other industries with the opportunity to thrive in a dynamic and modern market; therefore, they have encouraged the introduction of new paradigms. The terms “smart grid,” “grid of the future,” and “grid modernization” emphasize the need to build an intelligent grid that can be monitored and controlled in real-time to allow for providing a reliable, safe, and secure service and empower customers to actively participate and benefit from greater and more diverse market opportunities and services. Building this intelligent grid is a monumental task (particularly on the distribution and grid-edge sides which are vast and heterogeneous) that has led to the emergence of new concepts, technologies, and paradigms. This panel session will discuss recent trends, challenges, solutions and developments pertaining to grid modernization initiatives being implemented by the US electric utility industry.
Electric Distribution Reliability Best Practices	The panel will focus on utility practices that provide the best possible reliability for their customers. Although we use SAIFI and SAIDI as metrics to grade our systems, this does not mean that a rural company that has limitation and cost restrictions cannot have better practices than an urban company with multiple ties in their system. The intent is to share some of the programs and practices that are working in the industry, and to share these practices with other utility companies in the same region and other areas of the U.S. The panel will consist of industry leaders that have proven track records to continue to improve the reliability of their systems. Emphasis will be on identifying the restrictions and limitations that are unique to each company and how they are continuing to improve reliability, and where they see programs and practices moving to in the future

An international review on perspectives, market potential, technical and economic benefits from the application of energy storage in electric power systems	This panel provides an international perspective of energy storage. The material partly results from a high-level feasibility study for battery-based energy storage in Latin America. The presentation summarizes market potential for energy storage to address the renewable integration issues faced by major utilities in selected countries. A summary of the US energy storage regulatory landscape is provided, along with a vision of the opportunities, barriers (including regulatory and economic) and recommendations for successful introduction into the selected countries' power systems and energy markets. The speakers will present an overview of different BESS technologies, compare them, and show the key applications of energy storage. The presentation will address how a larger list is narrowed down to the top 3-5 applications currently existing in the selected countries. The presentation concludes with a summary of the technical and financial feasibility of large-scale BESS implementations in the presented countries.
Distribution System Technology and Innovations	Technology case studies for utility companies will be discussed on this panel.
Flicker Standards - Applications and Advancements	Voltage fluctuations/flicker continue to be an issue for utility industry with the introduction of new lighting technologies along with the increased penetration of new flicker sources such as variable generation including wind and solar along with conventional flicker sources such as electric arc furnaces. This panel session will provide practical applications of the latest flicker standard IEEE Standard P1543. Real world case studies demonstrating various flicker sources and the impact of changes in system configuration will be presented. Software tools that have been developed for easy application of flicker standards for real world applications will also be presented. Then, the latest research that is being performed with regards to flicker performance of LED drivers will be presented. Finally, few improvement areas in flicker standards such as rapid voltage changes (RVCs) have been identified and the same will be addressed using real world utility scale solar plant as an example.
Operational Reliability of FACTS & HVDC	With the increase in high voltage power electronic installations, a major issue of concern for owners is operational reliability. Utility experience is to be presented along with results from a global survey focused on static var compensators.