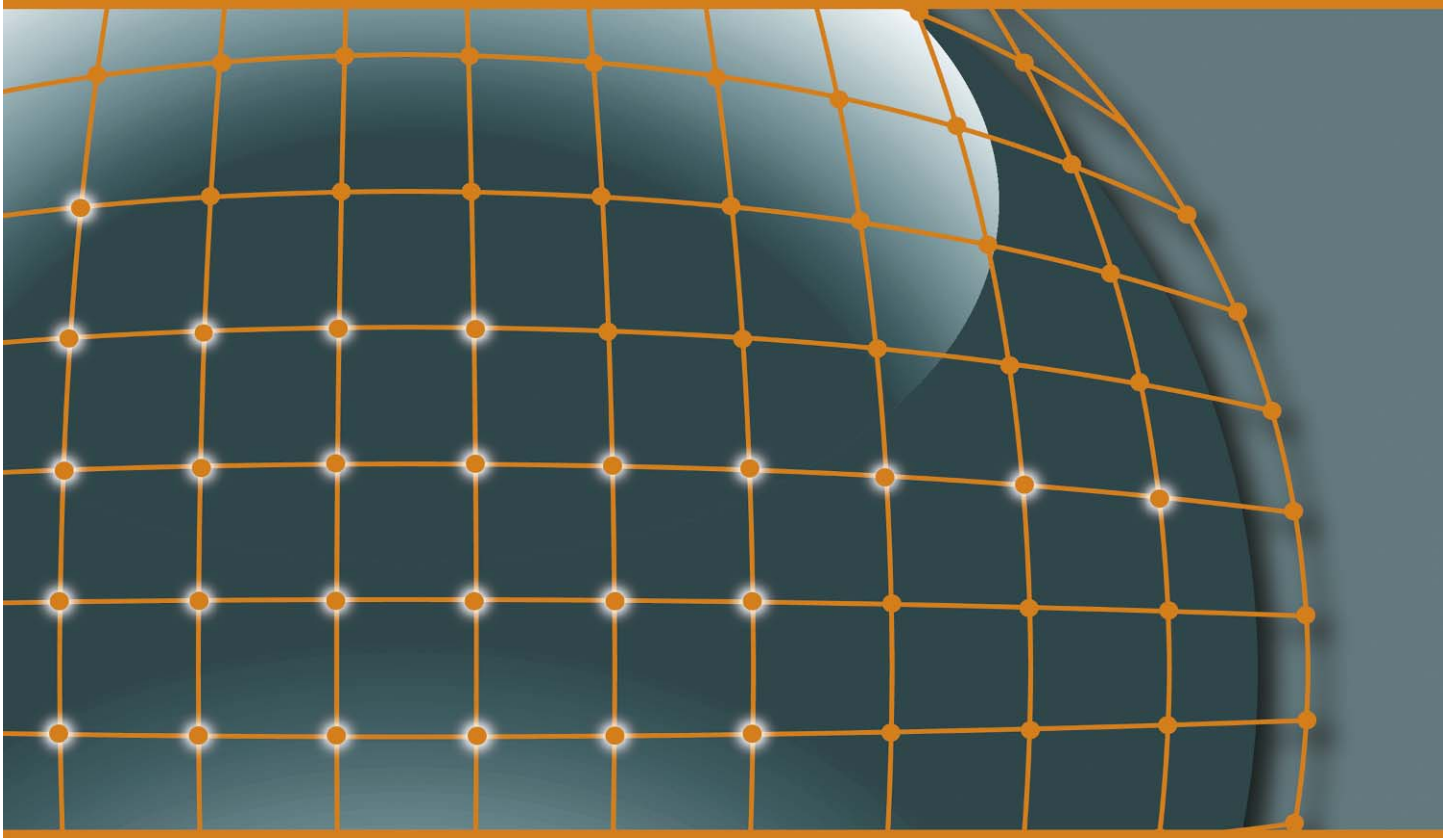
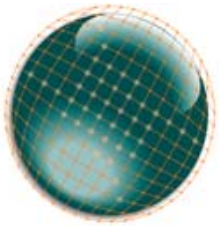
4th International Conference on

Integration of Renewable and Distributed Energy Resources

Conference Proceedings



December 6th – 10th, 2010
Hyatt Regency Albuquerque
Albuquerque, New Mexico, USA



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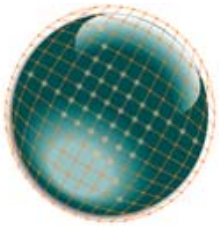

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Conference Overview

The growth of decentralized generation, liberalized markets, modern power electronics, and the introduction of advanced integrated circuit technologies are leading to a dramatic change in the management and operation of electricity grids worldwide. In response, the 4th International Conference on the Integration of Renewable and Distributed Energy Resources—building upon three previous international conferences, the first of which was initiated in Brussels in December 2004 by the European Commission—was organized to develop knowledge sharing around the technical, market, and regulatory issues that challenge the integration of renewable energy (RE) and distributed energy resources (DER) into the transmission and distribution grid.

The week-long event, which comprised technical tours, workshops, tutorials, breakout meetings, and a poster presentation session (numbering 60+ posters!), in addition to the main program, provided an unparalleled forum for North American, European, Asian, and Australian practitioners and researchers in the renewables and DER fields to discuss experiences and research findings in a highly focused and interactive environment. Held in Albuquerque, New Mexico, December 6-10, 2010, the conference was jointly organized by the Electric Power Research Institute (EPRI) and Sandia National Laboratories, and sponsored by 10 governmental and industry organizations.A 50-person Scientific Committee developed the technical program, determining content and associated speakers. Attendance numbered over 325 registrants from 15 countries spanning six continents. Complementing their diverse geographic make-up, attendees lent perspectives from a variety of professional backgrounds, including government (25), national labs (42), universities (70), industy research (28), utilities and operators (83), industry suppliers (56), consulting (26), and developers (10).

This report contains an accounting of the conference's proceedings, along with summaries of key themes and issue takeaways. In addition, a list of poster presentations, Scientific Committee members, and attendees, among other information is provided. **Please visit the conference website (http://www.4thintegrationconference.com/index.asp) to review and download all event materials, including speaker and poster presentations.**

Conference Week-At-A-Glance

Monday, December 6, 2010	8:00 AM – 12:00 PM	Pre-Conference Workshop: R&D Collaboration for DG-Ready Grid Architecture (8:00 AM - 12:30 PM)		Pre-Conference Tutorial: Technology-specific Overviews: PV, Wind	
	1:00 PM – 5:00 PM	Pre-Conference Workshop: Inverter Communications Coordination Meeting	Pre-Conference Workshop: Solar Variability and Resource Prediction / Monitoring (1:00 PM - 5:15 PM)	Pre-Conference Tutorial: Technology-specific Overviews: CHP, Energy Storage (1:00 PM - 4:00 PM)	Pre-Conference Tutorial: The OpenDSS Application: A tool for better understanding DER and storage interactions on the distribution system
	4:00 PM – 7:00 PM	Pre-Conference Technical Tour: Hotel Andaluz (~1 hour per tour)			
Tuesday, December 7, 2010	8:30 AM – 9:00 AM	Conference Program: Welcome Address			
	9:00 AM – 12:15 PM	Conference Program: Policies and Programs (Session 1)			
	12:15 PM – 1:30 PM	Lunch			
	1:30 PM – 5:00 PM	Conference Program: Reporting on Results of Large Project Portfolios (Session 2)			
	6:30 PM – 8:30 PM	Poster Presentation Session			
Wednesday, December 8, 2010	8:30 AM – 12:00 PM	Conference Program: First of a Kind Achievements in Technology, Systems Integration, Modeling & Simulation (Session 3)			
	12:00 PM – 1:30 PM	Lunch			
	1:30 PM – 3:00 PM	Conference Program: Regulatory Implementation (Session 4A)			
	3:20 PM – 5:00 PM	Conference Program: Markets and Operations (Session 4B)			
	6:30 PM – 8:30 PM	Gala Dinner			
Thursday, December 9, 2010	8:00 AM – 12:00 PM	Conference Program: Advanced Research and Novel Concepts, Future Scenarios (Session 5)			
	12:00 PM – 1:30 PM	Lunch			
	1:30 PM – 3:30 PM	Conference Program: Key Technical, Regulatory and Market Gaps (Session 6)			
	3:30 PM – 4:00 PM	Conference Program: Closing Session			
Friday, December 10, 2010	Various Please See Workshop Detail	Post-Conference Workshop: EPRI, DOE, and International Smart Grid Project Reviews (8:00 AM - 4:20 PM)	Post-Conference Technical Tour: Sandia National Laboratories (7:30 AM - 2:00 PM)	Post-Conference Technical Tour: PNM Control Room and Intel Labs' Energy Systems Research Center (9:00 AM - 2:30 PM)	

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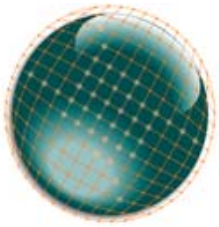
Media Coverage

The 4th International Conference on the Integration of Renewable and Distributed Energy Resources was well-publicized by local and national media. Below are some of the U.S. media outlets that picked up coverage provided by the Associated Press.

Albuquerque Journal*	KTAR (Arizona)
ABC News	KWES News West (Texas)
CNBC	News Tribune and Bellingham Herald (Washington State)
Forbes.com	Philadelphia Inquirer
Huffington Post	Reading Eagle (Berks County, Pennsylvania)
Los Angeles Times	Standard Examiner (Utah)
Miami Herald	Univision Television
MSN Money	Yahoo! Green
KCCI (Des Moines, Iowa)	WHEC (Rochester, New York)
KRQE (Albuquerque)	WLOX (Mississippi)

*non-AP story



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Message from the Chairmen

Abraham Ellis

Thomas Key

We are witnessing a slow but steady evolution of the international electricity sector toward a more modern and efficient grid. Over the last decade, growth in renewable generation has increased dramatically as deployments were stimulated by improved generation technology, system operations practices, innovative incentive policies, information technology, markets structures, and standards. As Smart Grid concepts are adopted, the opportunities for future growth are even greater. However, wide-spread deployment of renewable and distributed energy resources continues to pose a grand challenge for researchers, practitioners, and policy-makers around the world.

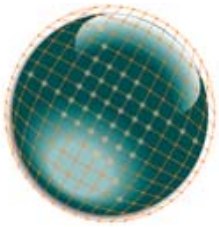
Like the previous editions held in Brussels (2004), Napa Valley (2006) and Nice (2008), the 4th International Conference will address recent deployment experience, research results, and innovative ideas related to integration of renewable and distributed energy resources on the grid. The goal is to strengthen the dialog and collaboration among individuals and projects at both the regional and global scale. We firmly believe that our intention to converge technical, market and policy aspects is a unique strength of this conference.

Including pre- and post-events, the conference will address a broad range of current integration topics. Our plenary session spans three days of discussions with subject matter experts. During the first day, attendees will learn about innovative policies and regional programs that are leading the way to enabling high penetration and large scale integration of renewable and distributed energy resources. During the second day, academia, utilities, industry and policy-makers will review the most recent and significant research and development results, including technical, market, and regulatory issues. The last day will be devoted to advanced simulation, modeling, architectures, technology development, standards and policy/regulatory approaches needed to enable high penetration scenarios.

On behalf of the Conference Hosts, Organizers, Scientific Committee and Financial Sponsors, we invite you to actively participate in the 4th International Conference on Integration of Renewable and Distributed Energy Resources, held here in Albuquerque, New Mexico. We are confident that this conference will provide useful insights and promote lasting cooperation on these important topics.

Dr. Abraham Ellis, Scientific Committee
Chairman, Sandia National Laboratories

Thomas Key, Conference Planning
Chairman, Electric Power Research Institute



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Please note: all speaker presentations are available for download at the conference website (http://www.4thintegrationconference.com/presentations.asphttp://www.4thintegrationconference.com/detailed.asp)

Welcoming Remarks

Tuesday, December 7 | 8:30 a.m. – 9:00 a.m.

Opening remarks outlined conference goals and objectives and served to bridge previous conferences with future meetings.

Welcome - Tom Key, Electric Power Research Institute (EPRI) [Conference Committee Chairman]; Marjorie Tatro, Sandia National Laboratories (SNL) [Conference Sponsor and Albuquerque Host Organization]; Gary Stone, PNM Resources (PNM) [Conference Sponsor and Albuquerque Host Organization]

- Tom Key identified the conference's primary objective: To "gather researchers, industry leaders and policy-makers from around the world, and review advances and share experiences on grid integration of renewable and distributed energy resources." Key noted that electric grids worldwide have continued to modernize and renewable energy has gained prominence in the electricity mix. This has resulted in an increased need for collaborative discussions addressing the complexities of technical, market, policy, and regulatory issues.

  Key outlined the evolution of the conference since its inception and noted the depth and breadth of experience present including utilities, operators, academia and government.

- Marjorie Tatro greeted attendees and discussed SNL's enthusiasm for and role in the conference. Tatro encouraged attendees to consider economy, environment, and security when evaluating grid integration activities. She challenged conference attendees with the question, "Is there an outcome-oriented goal that we can take on and overcome together?"

- Gary Stone greeted attendees and discussed a brief overview of PNM's role in and support for grid integration activities, including in the integration of large-scale renewable energy.

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Policies and Programs

Tuesday, December 7 | 9:00 a.m. – 12:00 p.m.

Session Chairs:

Charlie Hanley, Sandia National Laboratories

Wiktor Raldow, European Commission

This session covered new and innovative policies and significant regional programs established to enable high penetration and large scale integration of renewable and distributed energy resources. The primary question to be addressed was: With an increasing electricity mix, what are some of the successful programs linking technology deployment with innovative policy framework?

Modernizing the Grid: Using the Smart Grid to Enable Integration - Patricia Hoffman, U.S. Department of Energy (DOE)

- Grid has evolved incrementally, which has resulted in a lack of balance and an inability to effectively manage supply/demand; need to increase monitoring/situational awareness and operational response
- U.S. DOE/OE are focused on smart grids and the development of tools and technologies that can accommodate holistic load management and variability of renewables and distributed generation (DG)
- Objectives include elimination of peak issues and implementation of DG to address ramping

The EU Electricity Grid Research Programme: Addressing DER Integration - Wiktor Raldow, European Commission

- Governments must update and redesign aging grid infrastructure to adapt to changing and variable resources
- Collaboration and alliances are necessary to address national/international grid issues; EU Electricity Grids Initiative addressing technology, market design, information exchange, and policy; focus is on system-level innovation
- Consumers are quickly becoming engaged 'pro-sumers' who drive electricity markets

Canada Renewable Energy Science and Policy Programs - Geoff Munro, Natural Resources Canada

- Company concern for economy, environment, and security align with Marjorie Tatro's introduction
- Must consider policy-driven change, which is expected to increase worldwide; value to utilities and other stakeholders of being proactive
- R&D at early stages represents a higher cost burden to taxpayer but moves to lower price as technologies mature

Integrating Renewables and DER in the Australian Market - Grahame Foulger, SmartGrid Partners

- Total Australian federal renewable investments are currently around $8B; other incentives to promote renewables include feed-in tariffs and a Solar Bonus Scheme
- Very difficult to find balance around increased peak demand, consumer demand for affordable power, and increased regulations

- Economy, environment, and security are the ”triangle of trouble”; how can the grid be used to balance conflicting priorities?

Electricity Technologies in a Carbon-Constrained World - Bryan Hannegan, EPRI

- EPRI’s focus is on moving technologies to commercialization and using smart grids to enable efficiency and distribution of renewables
- Successfully advancing the electricity grid requires finding balance in two key sets of priorities: electricity supply and demand, and carbon reductions achieved at an equal or lower cost of electricity
- EPRI’s Prism 2.0 tool identifies key benefits associated with regional climate solutions

Korea Technology Roadmap and International Collaboration - Jong Bae Park, Konkuk University

- Korea’s electricity market is driven by the country’s Low Carbon Green Growth Energy Policy and related greenhouse gas GHG targets, as well as its Smart Grid Initiative
- Renewable technologies are divided into weighted categories for evaluation under Korea’s Renewable Portfolio Standards; achieving the country’s aggressive targets for renewable and GHG reductions will likely drive an increase in electricity costs
- Korea’s smart grid roadmap includes technologies designed to create ‘smart consumers’ and enhance demand response and storage

Summary/Key Themes of Session 1: ***Policies and Programs***

- Presenters noted the same three priorities Marjorie Tatro identified in her introduction: economy, environment, and security
- Electric grids continue to evolve; they need to be designed/re-designed for flexibility and responsiveness
- Renewables are variable but variability can be properly managed at the system level
- There is a shared international focus on smart grids and harmonization of standards and codes
- There is a need for collaboration on all levels—local, regional, national, international— to include government, national labs, academia, non-profits, utilities, and regulators
- Consumers are increasingly concerned about both clean energy and energy security, but affordability is still the key driver
- Current technologies do not sufficiently address grid issues; substantial investments in research, development, and deployment (RD&D) are still needed
- All countries are dealing with changes driven by climate-related policies, albeit at different rates

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Reporting on Results of Large Project Portfolios

Tuesday, December 7 | 1:30 p.m. – 4:30 p.m.

Session Chairs:

Tom Key, Electric Power Research Institute (EPRI)

Dana Levy, New York State Energy Research and Development Authority (NYSERDA)

This session provided a review of world-leading examples enabling the high-penetration integration of various renewable and distributed energy resources into the electric system.

NEDO's PV Integration in Japan - Keiichi Watanabe, New Energy and Industrial Technology Development Organization (NEDO)

- Smart grid in Japan has evolved from development of a single renewable technology to full demonstration of smart community technologies
- Using multiple demonstration projects to address anticipated issues with high penetration of solar, including storage, voltage control, and grid instability
- Strong focus on use of partnerships and collaborative projects to fully address depth and breadth of issues related to high penetration of renewables

Large-Scale Renewable Energy Integration in Spain - Miguel de la Torre Rodriguez, Red Eléctrica de España

- Incentive programs and the country's Renewable Energies Plan have driven high levels of penetration in Spain
- Electricity transmission operator Red Eléctrica de España's goal is to integrate high levels of renewable energy while maintaining system integrity and security of the electricity supply
- Spain's Control Centre for Renewable Energies monitors wind generation for voltage dips, balancing, and congestion; methodology is transferable to other renewable technologies

E-Energy: Smart Grid Made in Germany - Matthias Kuom, Federal Ministry of Economics and Technology (BMWi)

- Consumers become 'pro-sumers' through private networks, intelligent metering, ICT gateways, energy management; adds demand-driven supply and demand-side response to mix
- Communication technology can benefit the energy sector by providing information and feedback; smart control through real-time networking of all renewable energy system components
- Evaluation of model regions throughout Germany confirmed need for regional collaboration and laid groundwork to develop core standards for smart grid

CHP Portfolio in the United States - Bruce Hedman, ICF International

- Combined heat and power (CHP), or co-generation, viewed as cost-effective CO_2 reduction technology; contributes small percentage of U.S. electricity supply
- CHP activity mostly in states with favorable regulations or incentives; growing interest in waste heat to power

- Potential game-changers for CHP are similar to those for renewables: technology, climate change regulation, smart grid, and market outlook for conventional fuels

Ontario's Feed-In Tariff Program - Travis Lusney, Ontario Power Authority

- In much of Ontario there is no available capacity and new projects are constrained because of transmission bottlenecks; renewable projects are expected to drive transmission development for the next five to seven years
- Objective is a generally uncongested system (i.e., congested < 5% of the time or less on critical transmission paths) that allows for some inevitable congestion
- Key issues with FIT include large number of applications, system constraints identified by utilities, how to integrate uptake of small generation installations, and significant intermittent supply requires new grid management plan

Integration of DG in MV-grids: Challenges Encountered by the Grid Operator - Dirk van Houwelingen, Stedin BV

- Need to reduce sub-station construction time; determined that modularization and standardization are key to reducing project execution time
- Using scenario-based methods to identify proactive solutions; though they are more complicated and time-consuming, they are considered necessary when high levels of distributed generation exist
- Despite current economic challenges, utilities and transmission operators need to keep planning for economic boom times and higher energy demand

Summary/Key Themes of Session 2: ***Reporting on Results of Large Project Portfolios***

- RE/DER integration is not new, and significant experience has been accumulated. There is a clear need to share approaches and results to identify best practices, identify common challenges, and guide future deployment initiatives.
- Technology can support grid evolution in numerous ways to facilitate integration of DER and RE, from monitoring and metering to demand-side management and communications
- Regulations and incentives are key drivers to increase integration of DER and RE, and their influence is increasing; consumer prices are still the critical driver
- Most large-scale deployment projects pursue multi-pronged in objectives: environmental benefits/carbon reduction; economic growth; energy surety and security; consumer prices; safety
- Renewable and distributed generation are starting to drive transmission development rather than vice versa

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First-of-a-Kind Achievements in Technology, Systems Integration, Modeling & Simulation

Wednesday, December 8 | 8:30 a.m. – 12:00 p.m.

Session Chairs:

Mark McGranaghan, Electric Power Research Institute (EPRI)

John Eli Nielsen, Technical University of Denmark

In this session, participants learned about innovative approaches to facilitate integration of renewable and distributed energy resources on the grid.

Simulation of Microgrids and V2G - A.P. (Sakis) Meliopoulos, Georgia Institute of Technology

- Evaluating effects of increased electricity usage by the transportation sector; driven largely by security issues created by reliance on oil
- Use analysis and simulation to identify and characterize effects of microgrids/distributed energy resources on control functions, system management, operations planning; proper modeling necessary to capture limitations of the grid
- Properly designed and operated smart grids can create opportunities for increased efficiency and reliability while enabling renewable technologies and creating job opportunities for highly skilled engineers and technicians

Modeling PV Penetration Effects with Different Inverter Operating Modes - Jeff Smith, EPRI

- PV/Storage Communications project; collaborative effort (utilities, industry, national labs/academia) to identify common set of desired functions for smart, communicating inverters
- Autonomous volt/var control can help mitigate voltage fluctuations inherent to PV by surpassing steady state voltage limitations as PV is added
- Use of simulations permits a wide range of testing options

Active Distribution Network (ADINE) Project Results - Sami Repo, Tampere University of Technology

- Research project examining active network management of distributed network, including DG; resulted in technical solutions including protection relay and fault location applications, software prototypes, and voltage control applications
- Development of new network architecture driven by climate change regulations, quality of network service, and regulations
- Active network management is viable today using existing equipment and automation systems; further research is needed to balance use of existing technology with development of new solutions and systems

Running the Cell Controller Pilot Project as a Virtual Power Plant: 2010 Test Results - Per Lund, Energinet.dk

- Denmark has set a renewable energy standard (RES) of 70% by 2025; strategic goal is to develop the “world’s best RES-based power system in safe operation [by] 2025”

- Redevelopment of grid to accommodate RES goal requires focus on three pillars: strong grid and interconnections; integration of transportation and heat sectors; and intelligent controls
- Cell controller pilot project employs a layered control hierarchy; combines distributed agent technology with high-speed fiber network

University of California San Diego (UCSD) Campus Micro-Grid: A Living Laboratory for the Smart Grid - Jan Kleissl, UCSD

- UCSD creating smart microgrid that will include advanced master controller, real-time data acquisition, and a re-scheduler platform for dynamic market signals
- USCD identifies energy storage as the 'enabler technology'; currently pursuing four energy storage projects to evaluate storage opportunities and issues
- Investing heavily in DER business models, including self-permitting, tariffs, incentives, and analytical tools that can help utilities and operators select and prioritize DER and solar integration

Impact of Distributed Solar on SMUD's Peak Load and Local Distribution System - Mike Keesee, SMUD

- Collecting and analyzing generation, load, and performance data from two sub-divisions with residential PV installations
- Analysis has determined that PV systems have not adversely affected voltage regulation and has identified significant potential peak demand savings for the distribution system
- Suggests that utilities monitor impacts of PV generation at several nodes: substation, transformer, source

High Penetration Wind in the Republic of Ireland - Mark O'Malley, University College Dublin

- Flexibility in power systems is key; a combination of solutions and a collaborative approach are the most effective means to address
- Interconnection on island or remote locations is a primary issue and requires a different solution; need to understand how to tie large penetration of a variable resource (wind) into a larger grid and forecast energy losses across long transmission lines
- Smart grid interacts bi-directionally with three main pillars: markets and policy, sources; and loads

Smart DER Integration in MV and LV Grids: Austrian Project Examples - Andreas Lugmaier, Siemens

- Planning and operation of Advanced Network Operation System that can effectively manage high levels of DER and consumer integration (i.e., load management, e-mobility)
- Network system divides problem zones into groups; accounts for electrical and operational restrictions and reduces activation of adjacent feeders
- Focus is on active distribution grids and decentralized energy management

Summary/Key Themes of Session 3: ***First-of-a-Kind Achievements in Technology, Systems Integration, Modeling & Simulation***

- Accurate modeling and simulation are essential to evaluating current and expected future impacts of DER and renewable energy on the grid
- Evolution toward Smart Grid should be viewed as an opportunity to enable RE/DER deployment, in addition to increasing efficiency and service reliability
- High penetrations of RE and DER require new paradigms in grid and load management, communications, and balancing supply and demand
- Continued research and innovation is important, but technology already exists to address a range of grid issues related to high penetration of DER and RE
- Flexible, adaptable grid and generation infrastructures are critical to high penetration of DER and RE

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Regulatory Implementation

Wednesday, December 8 | 1:30 p.m. – 3:00 p.m.

Session Chairs:

Session Chairs: Jason Marks, New Mexico Public Regulation Commission (NMPRC)

Martin Scheepers, Energy research Centre of the Netherlands (ECN)

This session reviewed best examples of effective regulatory practices that encourage and integrate renewable and distributed generation, including both mandated and market-based approaches.

Successful U.S. State Policies for Supporting Renewable and Distributed Generation - Jason Keyes, IREC

- Key issues in net metering include facility and program size capacity, excess generation, standby charges, and meter aggregation; mid-Atlantic, mid-West, California, Southwest score highest
- Key issues in interconnection include facility size, insurance, costs, disconnects, and network interconnections; a few U.S. states have RE/DER interconnection rules and regulations that score an "A,", but others do not.
- Third-party ownership affects use of net metering; market potential currently limited by dispute over whether third-party owners are public utilities

Assessment of Feed-In Tariffs and Other Market Support Mechanisms in the EU - Karina Veum, ECN

- Feed-in tariffs have had largest effect on driving new renewable energy capacity in the EU
- International/cross-border cooperation is essential but requires strategy to address nontransferable costs and benefits
- Integration of new energy sources can deplete transparency of costs to the consumer; incentives can be too successful

Successful Regulatory and Incentive Policy for Renewable Energy / Smart Community - Osamu Onodera, NEDO

- Combination of incentives and regulations important; Japan's RPS system and subsidies historically incentivized solar
- Recent accomplishments in solar by other countries has motivated Japan to reinstate subsidies and a surplus buy-back system; also considering FIT
- Access is an issue – utilities can control interconnection; increased DER and RE also raise issue of who pays for remote connections and how

The EU-funded IMPROGRES Project: Quantifying and Addressing Cost Impacts of High Penetration of DG - Frans Nieuwenhout, ECN

- IMPROGRES (Improvement of the Social Optimal Outcome of Market Integration of DG/RES in European Electricity Markets) addresses increases in DG/RE electricity production and

subsequent increases in power generation, network integration, and system integration costs
- Analyzed and compared varying incentive schemes across EU countries; included forecasting effects of additional amounts of RE/DG and changes in regulatory structure
- Found that demand response and active generation control of DG can contribute to market integration of RE

Summary/Key Themes of Session 4 (A): ***Regulatory Implementation***

- Incentive and interconnection programs benefit from regulatory support and attention to the relationship between appropriate support levels and generation costs for various technologies
- In the context of high penetration RE and DER, regulatory frameworks must include careful consideration of non-transferable costs and benefits
- Rate design remains a major factor in consumer choices about energy use
- Costs to the consumer need to be considered and balanced against benefits of renewable and distributed technology integration
- Highly successful incentive programs can backfire if they are depleted too quickly or if they spurn high penetration of renewables without first considering and addressing the potential effects on the grid

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Markets and Operation

Wednesday, December 8 | 3:20 p.m. – 5:00 p.m.

Session Chairs:

Lisa Dignard-Bailey, Natural Resources Canada

Grahame Foulger, SmartGrid Partners

This session discussed successful market structure operation strategies being adapted to manage high penetration of renewable and distributed energy resources.

Distribution Control Center: Control & Management to Mitigate the Impact of Distributed Resources - Rolf Apel, Siemens

- ICT Architecture provides Distribution System Operators an opportunity to know DER in real-time, validate schedules, and mitigate issues associated with integration of distributed energy resources
- Demonstration addressed several issues including the complexity of large deployments, reluctance on the part of the utility, and the fact that aggregation of DER from varying technologies is not currently permitting in Spain
- Collaboration between DER owners and utilities can result in win-win opportunities; working with DER owners adds a new layer of complexity

Operating a Much More Variable Power System – Challenges and Opportunities - Ken Kozlik, Ontario Independent

Electricity System Operator (IESO)

- Important to consider all factors that can impact demand such as weather, cloud cover, and consumer demand
- Increasing use of smart meters throughout Ontario; with meters, customers move to time-of-use rates; IESO responsible for centralized meter data management
- Dynamic pricing an important element in overall integration of distributed and renewable energy

Control Room Operational Visualization and Operational Data Management for Integration of Renewables - Zeb Tate,

University of Toronto

- Rapid ramps in output can lead to inability to meet stated interchange regulation; sustained ramping can exhaust reserve margins
- Data management method proposes using a max/min optimization and penalty functions to forecast 'worst case' renewable energy generation scenarios; can help plan for optimal start-up and shutdown of generation
- Rapid influx of new technologies impacts efficacy of existing models; advanced telemetry and data management can help

Distribution System Management Approaches for Integrating Distributed Energy Resources - Mark McGranaghan, EPRI

- Distribution Management Systems can help address issues associated with increased demand response, electric vehicle charging, high penetration of PV, energy storage, and control
- As consumer environment becomes more complex, advanced metering can help level load conditions
- System management standards are important to modeling efforts, integration of distribution generation and storage, and integration of enterprise systems

Summary/Key Themes of Session 4 (B): ***Markets and Operation***

- Improved forecasting can help manage variability
- Large sets of high resolution data can be very challenging to manage in the context of system operations; visualization tools can significantly help
- Advances in metering, Distribution Management Systems, Distribution Controls, and other technologically-based approaches can greatly facilitate system operations with RE and DER

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Advanced Research and Novel Concepts

Thursday, December 9| 8:00 a.m. – 12:00 p.m.

Session Chairs:

Reza Iravani, University of Toronto

Andrea Mammoli, University of New Mexico

This session presented advanced and novel research concepts and approaches including modeling and simulation, architecture concepts, future technologies and performance standards that will enable future high penetration scenarios of renewable and distributed energy resources.

Technology Development for Large Scale Grid Integration *- Kevin Lynn, U.S. Department of Energy (DOE)*

- DOE is focused on supporting R&D that examines high penetrations of PV into utility distributions; must provide maximum value to PV system owner and the utility
- Includes stakeholder engagement as well as work in standards and codes, modeling and analysis, variability studies, test and demonstration
- Work at national labs includes oversight of Solar Energy Grid Integration Systems and High Penetration activities, modeling and simulations, system-level testing, distribution systems analysis, and smart grid and advanced communications

OGEMA, Open Source Application Platform Connecting Building Automation and Smart Grids *– Philipp Strauss, Fraunhofer-IWES*

- Ten households in smart grid test lab; focus is on energy 'prosumers'; consumption decisions executed by Bi-directional Energy Management Interface (BEMI) and Automated Energy Management applications; BEMI allows for variable pricing schedules
- Gateway applications can serve as a firewall between private and public grids
- Field trials using 'energy butlers' that carry out automatic load shift according to day-ahead variable tariffs; provides real-time data; demonstrated benefits of load-following generation

The Open ADR Communication System *- Mary Ann Piette, Lawrence Berkeley National Laboratory (LBNL)*

- Research center focuses on energy systems integration and strategic issues (e.g., dynamic tariffs and rate design), buildings (e.g., communications and control, behavioral response to tariffs), and industry (e.g., automation, end-use and controls)
- Three key steps to link efficiency, DR, and renewables are shift loading to maximize use of RE, facilitating smoother ramp, and providing reserves to manage forecast error and intra-hour variability
- Open Automated Demand Response platform has applications in large commercial and industrial demand response (e.g., demand and/or capacity bids, peak choice) and in price response notification and automation (e.g., critical peak pricing)

Microgrid Architectures Old and New Friends and the Paradigm Shifts They May Cause *- Chris Marnay, LBNL*

- Evaluating three types of microgrid: customer (i.e., downstream of meter); utility (between meter and substation); virtual (non-co-located)
- Limitations to a super-grid include load growth, interdependency on infrastructure, conflicting policy objectives, and intermittency of renewables; dispersed control and heterogeneous power quality and reliability at local level can balance some of the limitations
- Microgrids can drive down total cost of reliability by using dispersed control; can buffer variability in 'macro-grid' and allow for heterogeneous local supply changes

PV Output Variability, Characterization and Modeling - Joshua Stein, Sandia National Laboratories (SNL)

- Modeling and analysis activities aimed at developing validated methods to estimate and predict single and aggregated PV plant output profiles for plants of any size in any location, using high-resolution data and weather data/forecasts
- Goal is to mitigate uncertainty and understand overall variability and uncertainty that can lead to higher costs
- SNL using novel approaches including method to estimate one-minute irradiance variability from satellite imagery and one-minute PV output profiles from 10 sites in Nevada

How Demand Response Can Mitigate Renewable Intermittency - David Chassin, Pacific Northwest National Laboratory

- GridLAB-D simulates smart grid; includes models, multiple technologies, links to existing tools, ability to add/extract customized modules
- Based on simulations the market "finds" retail price of energy needed to match supply and load follows generation
- Suppliers need to consider three keys types of load control and how they affect consumers: load shifting (few customer concerns), load curtailment (moderate customer concerns), and load suppression (high customer concern)

Grid Integration Research in Australia - Glenn Platt, The Commonwealth Scientific and Industrial Research Organisation

- Cooperative approach to research in Australia: universities, industry, CSIRO; Australian electricity prices heavily influenced by 'peaks,' variation from $10/MWh to $10,000/MWh possible in one day
- Australia policy: electricity sector abatement goal of 25% reduction on 2000 levels by 2020; includes significant increase in use of renewable energy sources
- Uptake and distribution network capacity spatially variable; distribution network analyses require local uptake projections conducting using diffusion modeling; used focus group to identify uptake drivers

Masdar City: Building the World's Most Sustainable City - Jack Whittier, CH2M HILL

- Masdar City designed around One Planet Living principles that include carbon-neutral, free of fossil fuels, economically profitable; seven square kilometers in size; 40,000 residents and 50,000 daily commuters; first land-based city to operate without fossil fuel vehicles
- Follows traditional Arabic city design, which contains sustainable city elements: narrow streets, use of natural shade, high-density living, public spaces, mixed use buildings, pedestrian friendly; designed to meet Masdar City principles while ensuring community satisfaction
- Ongoing challenges for Masdar City: triple bottom line goals driving decisions; grid connection and carbon balance; competition from surrounding developments

Summary/Key Themes of Session 5: ***Advanced Research and Novel Concepts***

- Multi-pronged approaches are essential; no single solution will address all issues associated with high penetration of renewable and distributed energy sources
- Increasing communications links among grid operators, market loads and sources are essential to achieving high penetration
- Information-sharing and open source platforms should be utilized to benefit all stakeholders
- Providing a high degree of service reliability to *all* customers is expensive and difficult to achieve. Differentiated levels of reliability according to customer needs can be far more cost-effective.
- Microgrids and distributed systems can co-exist with the existing grid and enhance value to utilities and consumers if designed and managed correctly
- Validation and development of standard metrics critical to accurate and trusted modeling
- Load response and shifting load patterns are a viable solution to managing variability and changes in supply/demand

4th International Conference on

Integration of Renewable and Distributed Energy Resources

December 6–10, 2010
Albuquerque, NM USA

Key Technical, Regulatory, and Market Gaps

Thursday, December 9| 8:00 a.m. – 12:00 p.m.

Session Chair:

Mark Rawson, Sacramento Municipal Utility District (SMUD)

This session discussed from a broad and higher level perspective the most critical technical, regulatory and market elements that must be addressed to achieve high penetration of RE and DER on the grid. Speakers were charged with presenting new, forward-looking, provocative approaches behind national or regional RDT&D programs which have been based on gap analyses.

Smart Grid Development by the U.S. Department of Energy - Dan Ton, U.S. DOE

- Goals of DOE smart grid program: dynamically optimize grid operations and resources; fully integrate demand response and consumer participation into grid resource planning and operations
- Funding of $4.5 B from the American Recovery and Reinvestment Act of 2009 for grid modernization, i.e., investment grants, smart grid demos, resource assessment and transmission planning, workforce training, smart grid interoperability standards
- Funding focus areas for research, development, and deployment include Integrated Distribution Management Systems for Distribution Automation; Advanced Sensing, Monitoring, and Control Technologies for Enhanced Asset Utilization and Grid Reliability; and Voltage Regulation and Overvoltage Protection for High Penetration of Renewable Generation

The Clean Energy Ministerial and the International Smart Grid Action Network - Russell Conklin, U.S. DOE

- DOE investing in diverse collaborative approaches: bi-lateral (US-EU Energy Council), regional (APEC Smart Grid Initiative), international (International Smart Grid Action Network and Clean Energy Ministerial)
- First Clean Energy Ministerial held in United States in 2010; members represent more than 70% of global GDP and more than 80% of global GHG emissions; policy and program collaboration using 'distributed leadership' model
- International Smart Grid Action Network focused on accelerating development and deployment of smarter electricity grids worldwide; centered on knowledge-sharing in five topic areas: policy, standards, and regulation; finance and business models; technology and systems development; workforce skills and knowledge; user and consumer engagement

EEGI: European Electricity Grid Initiative - Anh Vu, Électricité Réseau Distribution France (ERDF)

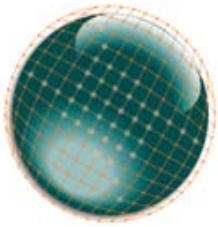
- EU has a 20-20-20 objective: at least a 20% reduction in GHG emissions (below 1990 levels), goals of 20% of EU energy consumption from renewables, and a 20% reduction in primary energy; driving the European Strategic Energy Technology Plan and European Electricity Grid Initiative (EEGI)
- EEGI: nine-year program initiated by transmission and distribution network operators to accelerate innovation and development of European electricity networks into smart grids; R&D to approach four key barriers: public barriers, technology barriers, RD&D organization barriers, and market failures and distortions
- EEGI includes a multi-level governance structure, with each layer responsible for different goals of the program

Japan's Smart Community Initiatives - Tatsuya Shinkawa, NEDO

- Japanese policy includes GHG reductions of 15% from 2005 levels by 2020 and 25% below 1990 levels by 2030; includes doubling of original PV installation capacities (now 28 GW by 2020 vs. previous requirement of 14 GW)
- Strategic Energy Plan of Japan includes requirement for zero-emission power source ratios of 70% (more than double the current level)
- Japan has goal to move from smart grid to smart community models to maximize use of renewable and manage variability by facilitating energy sharing across numerous consumers/users; also includes strategic integration of electric vehicles; four large-scale pilot projects underway in 2010

Summary/Key Themes of Session 6: ***Key Technical, Regulatory, and Market Gaps***

- Collaboration and multi-pronged approaches are critical even at the federal level
- Effective international efforts benefit from a shared leadership approach and a focus on knowledge sharing
- Long-term solutions require long planning windows, engagement of stakeholders at all levels, and public and private investment
- Motivations for smart grid R&D can vary from country to country but benefits of improvements in electricity generation and distribution are common and should be discussed on international level



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Pre- and Post-Conference Events

Please note: all Workshop and Tutorial materials are available for download at the conference website (http://www.4thintegrationconference.com/prepost.asphttp://www.4thintegrationconference.com/detailed.asp)

Pre-Conference Activities (Monday, December 6)

Morning Sessions

8 am – 12 pm Workshop: R&D Collaboration for DG-Ready Grid Architecture

8 am – 12 pm Tutorial: Technology-specific Overviews: PV, Wind

8 am – 12 pm Tutorial: Grid Codes for High Penetration DER

Afternoon Sessions

1 pm – 5 pm Workshop: Inverter Communications Coordination Meeting

1 pm – 5:15 pm Workshop: Solar Variability; Resource Prediction & Monitoring

1 pm – 5 pm Tutorial: The OpenDSS Application – A Tool for Better Understanding DER and Storage Interactions on the Distribution System

1 pm – 4 pm Tutorial: Technology-specific Overviews: CHP, Energy Storage

4 pm – 7 pm Technical Tour: Hotel Andaluz

Preliminary Post-Conference Activities (Friday, December 10)

Morning Sessions

8 am – 12 pm Workshop: EPRI, DOE, and International Smart Grid Project Reviews

7:30 am – 2 pm Technical Tour: Sandia National Laboratories

9 am – 2:30 pm Technical Tour: PNM Control Room and Intel Labs' Energy Systems Research Center

Afternoon Sessions

1 pm – 4:20 pm Workshop: EPRI, DOE, and International Smart Grid Project Reviews (cont'd)

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Poster Presentations

On Tuesday, December 7, the 4th International Conference on the Integration of Renewable and Distributed Energy Resources hosted a well-attended poster session. Organized and managed by Satish Ranade of New Mexico State University and Philipp Strauss of Fraunhofer IWES, the session contained over 60 student and professional posters that offered insights into a wide range of research and project developments germane to the grid integration of renewables and DER.

The posters, available for download via the conference website (http://www.4thintegrationconference.com/posters.asp), were organized according to five core topics and nine sub-topic areas, listed below. Following is a directory of all of the poster presentations along with their corresponding authors, in addition to recognition of the five posters that received awards for their overarching quality.

Core Topic Areas

- Future Vision (e.g., novel proposals on large-scale DER integration projects)
- Regulations & Standards (e.g., innovative regulations and rulemaking conducive to DER expansion)
- Integration Planning (e.g., inventive business models and system planning involving DER aggregation)
- Engineering, Implementation, System Operation and Markets (e.g., results of on-going large- and small-scale experiments involving DER aggregation)
- Advances in Equipment, Topologies and Reliability (e.g., innovative IC technology enhancing DER expansion, such as control, metering, and electricity storage)

Sub-Topic Areas

- Application and Demonstration Projects
- Lab/Field Monitoring, Forecasting, and Testing
- Enabling Technology (Communications & Control)
- Enabling Technology (Inverters & Storage)
- Demand (Flexibility, Response, and Management)
- Modeling / Analysis of Distributed Energy Resources
- Transmission Grid (Integration & Operations)

- Future Electricity Network Architectures
- National / International Programs and Standards

Poster Awards

Best Poster: *Vehicle to Micro-Grid: Leveraging Existing Assets for Reliable Energy Management*
Michael Simpson, Tony Markel, and Michael O'Keefe, NREL

Outstanding Poster: *Towards a Semantic Communication Interface between Information and Automation Layer in Smart Grids*
Sebastian Rohjans, Mathias Uslar, Astrid Nieße, OFFIS - Institute for Information Technology

Outstanding Poster: *Evaluating Future Standards and Codes with a Focus on High Penetration Photovoltaic System Deployment*
Michael Coddington, Benjamin Kroposki, Tom Basso, NREL; Kevin Lynn, U.S. DOE

Best Student Poster: *The Role of Demand Response in Offsetting the Variability of Wind Power*
Torsten Broeer, Dan Wang, Ned Djilali, Andrew Rowe, University of Victoria

Outstanding Student Poster: Multi Agent Platform for Active Network Management
M.J. Dolan, E.M. Davidson, C. Morris, G.W. Ault, S.D.J. McArthur, University of Strathclyde

1. Application and Demonstration Projects

1.01 Advanced Mobile Micro Grid Energy Architecture: Electronic Power Control & Conditioning Technology Development and Demonstration
Max M. Dorflinger, Roland G. Kibler, William L. Siddall, *NextEnergy*

1.02 The Community Power Project - Flagstaff Pilot
Eran Mahrer, Michelle Lehman, *Arizona Public Service*

1.03 Fighting Clouds with Clouds
Guy AlLee, *Intel Labs*

1.04 Addressing Solar PV Operations and Maintenance (O&M) Challenges: A Survey of Current Knowledge and Practices
Nadav Enbar, Aminul Huque, Tom Key, *Electric Power Research Institute*

2. Lab/Field Monitoring, Forecasting, and Testing

2.01 High Voltage Modules Using Microsystems-enabled Photovoltaics (MEPV) for Improved Shading and Spectral Performance
Anthony L. Lentine, Gregory N. Nielson, Murat Okandan, William C. Sweatt, Jose L. Cruz-Campa, Vipin Gupta, *Sandia National Laboratories*

2.02 Intra-Hour Forecasting with a Total Sky Imager at the UC San Diego Solar Energy Testbed
Bryan Urquhart, Chi Wai Chow, Matt Lave, Jan Kleissl, Janet Shields, *University of California, San Diego*

2.03 Distribution Photovoltaic Monitoring Program
Chris Trueblood, Gary Aumaugher, Tom Key, *Electric Power Research Institute*; Elizabeth Philpot, *Southern Company*

2.04 Testing Commercial PV Inverters for Standard Effectiveness
Daniel Martin, Kuan-Hung Wu, Jih-Sheng Lai, Chien-Liang Chen, Chris Hutchens, *Virginia Polytechnic Institute and State University*

2.05 Hi-Penetration PV Initiative
Elaine Sison-Lebrilla, *Sacramento Municipal Utility District*; Dora Yen Nakafuji, Hawaiian Electric Company; Ronald Davis, *BEW Engineering*

2.06 Experiences with Validation and Large-Scale Deployment of Smart Grid Demonstration Projects
E.C.W. de Jong, F.W. Bliek, P.M. Kropman, P.T.M. Vaessen, *KEMA Consulting B.V.*

2.07 Architectural Design and First Results Evaluation of the PowerMatching City Field Test
René Kamphuis, Bart Roossien, *Energy research Centre of the Netherlands*; Frits Bliek, Albert van den Noort, *KEMA/Gas Consultancy Services*; Jorgen van de Velde, Johan de Wit, *HUMIQ*; Marcel Eijgelaar, *Essent NV*

2.08 A European Distributed Energy Resources Laboratory: the DERri Infrastructure
Paolo Mora, *Ricerca sul Sistema Energetico - RSE S.p.A*; Maria-Luciana Rizzi, *Ricerca sul Sistema Energetico - RSE S.p.A. and DERlab e.V.*

2.09 PV System Evaluations for High Penetration Deployment
A. Huque, C. Trueblood, T. Key, *Electric Power Research Institute*; S. Kuszmaul, S. Gonzalez, *Sandia National Laboratories*

3. Enabling Technology (Communications & Control)

3.01 Towards a Semantic Communication Interface between Information and Automation Layer in Smart Grids
Sebastian Rohjans, Mathias Uslar, Astrid Nieße, *OFFIS - Institute for Information Technology*

3.02 Cybersecurity for Renewable Energy Systems
Annie McIntyre, *Sandia National Laboratories*; Laurie Burnham, *Dartmouth College*

3.03 Elements Enable High-level Communication in Power Systems
Daniel Kullmann, Henrik Bindner*, Risø DTU National Laboratory for Sustainable Energy*

3.04 Robust Broadcast-Communication Control of Electric Vehicle Charging
Konstantin Turitsyn, Nikolai Sinitsyn, Scott Backhaus, Michael Chertkov, *Los Alamos National Laboratory*

3.05 Implementation and testing of topology-aware aggregators for power balancing in distribution grids
Manos Psychogyiopoulos, Oliver Gehrke, Henrik Bindner, *Risø DTU National Laboratory for Sustainable Energy*

3.06 Agent-based Informatics for Autonomous Microgrids
Steven Goldsmith, *Sandia National Laboratories*

4. Enabling Technology (Inverters & Storage)

4.01 Enabling Microgrid and Demand Response through Advanced Inverter Technology: Demand Response Inverter (DRI)
Darren Hammell, *Princeton Power Systems*

4.02 A Multi-Source Hybrid System with Li-ion Storage for Smart Buildings
M. Ferraro, F. Sergi, G. Brunaccini, N. Randazzo, G. Napoli, V. Antonucci, *Consiglio Nazionale delle Ricerche-Istituto di Tecnologie Avanzate per l'Energia (CNR-ITAE)*

4.03 SOFC/Battery Hybrid System
M. Ferraro, G. Napoli, F. Sergi, G. Brunaccini, G. Dispenza, V. Antonucci, *Consiglio Nazionale delle Ricerche-Istituto di Tecnologie Avanzate per l'Energia (CNR-ITAE)*

4.04 Development of a 100 kWh/100 kW Flywheel Energy Storage Module
Norman J Sendler, Jr, *Beacon Power*

4.05 Demonstration of Energy Networks and Fuel Cells in Apartment Buildings
Hirohisa Aki, *National Institute of Advanced Industrial Science and Technology (AIST)*; Yukinobu Taniguchi. *Unaffiliated*; Itaru Tamura, Akeshi Kegasa, Hideki Hayakawa, *Osaka Gas Co. Ltd.*; Shigeo Yamamoto, Yoshiro Ishikawa, *KRI Inc.*; Ichiro Sugimoto, *Center for Promotion of Natural Gas*

4.06 Grid Tied PV Battery Systems
Tom Hund, Sigifredo Gonzalez, Keith Barrett, *Sandia National Laboratories*

4.07 Implementation of a Long-Lifespan, Two-Stage Photovoltaic AC-Module
Christopher Hutchens, Jih-Sheng Lai, *Virginia Polytechnic Institute and State University*

4.08 Batteries? We Don't Need No Stinking Batteries! Using Building HVAC Components to Support Distributed PV Generation
Hans Barsun, Andrea Mammoli, Rick Burnett, *University of New Mexico*

4.09 Solar Energy Grid Integration Systems (SEGIS): Toward Commercialization of Intelligent Interconnect Advances for Photovoltaic Systems
Ward Bower, Scott Kuszmaul, Sig Gonzalez, Abbas Akhil, *Sandia National Laboratories*

5. Demand (Flexibility, Response, and Management)

5.01 EIT-KIC InnoEnergy BeNeLux: Intelligent Energy-Efficient Buildings and Cities
Johan Driesen, Tom De Rybel, Alain Smolders, Ronnie Belmans, *K.U.Leuven*; Donald Vanbeveren, Edwin Haesen, *Eandis*; Guy Vekemans, Carlo Mol, Gerrit Jan Schaeffer, *VITO*; Lucienne Krosse, Henk Miedema, *TNO*; Marius Monen, Lex Lemmens, Jan Blom, *TU/e*

5.02 Vehicle to Micro-Grid: Leveraging Existing Assets for Reliable Energy Management
Michael Simpson, Tony Markel, and Michael O'Keefe, *National Renewable Energy Laboratory*

5.03 Integrative Energy Management in the Distribution Grid
Astrid Nieße, Ontje Lünsdorf, Christoph Mayer, Stefan Scherfke, Steffen Schütte, Martin Tröschel, Carsten Wissing, *OFFIS – Institute for Information Technology*; Michael Sonnenschein, *Carl von Ossietzky University Oldenburg*

5.04 A Control Room Demonstration Suite (CoRDS) to Investigate Management Issues of Active Distribution Networks
Stepahnie Hay, Graham Ault, *University of Strathclyde*

5.05 The Role of Demand Response in Offsetting the Variability of Wind Power
Torsten Broeer, Dan Wang, Ned Djilali, Andrew Rowe, *University of Victoria*

5.06 Achieving a Synergy by Integrating Air Conditioners with Photovoltaics: An Evolutionary-Algorithm Approach
Cristian Perfumo, Julio Braslavsky, *University of New Castle*; Glenn Platt, John Ward, *Australian Commonwealth Scientific and Industrial Research Organization (CSIRO)*

5.07 The Aggregation of Demand Flexibility in the ADDRESS European Project
R. Belhomme, Ph. Eyrolles, *Électricité de France (EDF)*; R. Cerero, *Iberdrola Distribución*

5.08 Home Energy Management System for Adjusting Supply and Demand Balance of the Power System
Takashi Ikegami, Kazuto Kataoka, Yumiko Iwafune, Kazuhiko Ogimoto, *University of Tokyo*

5.09 Developing an Operational Eye on Solar
Dora Nakafuji, *Hawaiian Electric Company*; Lisa Dangelmaier, *Hawaii Electric Light Company*; Elaine Sison-Lebrilla, *Sacramento Municipal Utility District*

5.10 Multi-Objective Power Network Planning Tool for High Penetrations of Distributed Energy Resources with Specific Emphasis on Electric Vehicles
Steven Inglis, G.W. Ault, S.J. Galloway, *University of Strathclyde*

6. Modeling / Analysis of Distributed Energy Resources

6.01 Innovative Solutions to Optimise Low Voltage Electricity Systems: Power Snap-Shot Analysis by Meters (PSSA-M)
H. Brunner, B. Bletterie, M. Stifter, A. Viehweider, *Austrian Institute of Technology (AIT)*; A. Abart, *Energie AG Oberösterreich Netz*; J. Lichtnekert, R. Pitz, Salzburg Netz; R. Pointner, *Siemens AG Österreich*; H. Taus, *Wien Energie Stromnetz*

6.02 Optimizing Dispatch and Location of Distributed Energy Resources: Breaking the Box
George Simons, Collin Elliot, Stephan Barsun, *ITRON*; Emma Stewart, Billy Quach, Ron Davis, *BEW Engineering*

6.03 High-Penetration PV Impact Analysis on Distribution Systems
Jeff Smith, Roger Dugan, Tom Key, *Electric Power Research Institute*

6.04 Analysis of a High Penetration of DER and Electric Vehicles on Residential Distribution Networks
Shahin Abdollahy, Olga Lavrova, Andrea Mammoli, *University of New Mexico*; Manuel Sanchez, John Hawkins, Steve Willard, Brian Arellano, *Public Service Company of New Mexico*

6.05 Integration of PV into the Electricity Grid
Ann Peterson, Smita Gupta, *Itron, Inc.*

6.06 Voltage Profile Variations in Residential Sub-urban Feeders with High PV Penetration
R. Tonkoski, D. Turcotte, T. EL-Fouly, *Natural Resources Canada*

6.07 Advanced Techniques for Modeling Distributed Renewable Resources for Distribution Impact Analysis
Jeff Smith, Roger Dugan, Wes Sunderman, *Electric Power Research Institute*

6.08 Options for Control of Reactive Power by Distributed Photovoltaic Generators
Konstantin Turitsyn, Petr Sulc, Scott Backhaus, Michael Chertkov, *Los Alamos National Laboratory*

6.09 Load-Side VAR Compensation without the Reliability Problems of a Capacitor-based Solution for a Distributed Energy System
Divya Balakrishnan, Robert S. Balog, *Texas A&M University*

6.10 PV Output Variability Modeling Using Satellite Imagery
Matthew Reno, Joshua S. Stein, Abraham Ellis, *Sandia National Laboratories*

6.11 Solutions for Deploying PV Systems in New York City's Secondary Network System
Michael H. Coddington, Benjamin D. Kroposki, Kate H. Anderson, *National Renewable Energy Laboratory*

7. Transmission Grid (Integration & Operations)

7.01 A New Method and Apparatus to Prevent Voltage and Transmission Angle Instability of HVDC Systems
Walter Kuehn, *Frankfurt University of Applied Sciences*

7.02 The Impact of Energy Storage in Systems with High Wind Penetration
Aidan Tuohy, *Electric Power Research Institute*; Mark O' Malley, *University College Dublin*

7.03 Dynamic Impact Studies for Integration of Large (Utility-Scale) Solar Photovoltaic Systems onto Distribution Systems
Farid Katiraei, Atousa Yazdani, Farbod Jahanbakhsh, Julio Romero Aguero, *Quanta Technology*

7.04 Quantifying the Value of Hydropower in the Electric Grid
Tom Key, Lindsey Rogers, *Electric Power Research Institute*; Patrick March, *HPPi*

7.05 Notional Dynamic Model of Florida Grid for Assessing the Impact of Renewable Energy Integration
T. Alquthami, H. Ravindra, J. Langston, K. Schoder, M. O. Faruque, M. Steurer, R. Meeker, S. Dale, T. Baldwin, P. McLaren, *Florida State University*

8. Future Electricity Network Architectures

8.01 LINEAR: Local Intelligent Networks and Energy Active Regions
E. Peeters. *VITO*; H. Lenaerts, J. Driesen, R. Belmans, *KU Leuven*; C. Develder, *Ghent University*; J. Das, *IMEC*

8.02 Open Architecture for Secondary Nodes of the Electricity SmartGrid
Andreas Lugmaier, Friederich Kupzog, Elisabeth Broneder, *Siemens AG Osterreich*

8.03 Multi Agent Platform for Active Network Management
M.J. Dolan, E.M. Davidson, C. Morris, G.W. Ault, S.D.J. McArthur, *University of Strathclyde*

8.04 A Stochastic Optimisation Approach for the Expansion Planning of Active Distribution Networks
Robert MacDonald, Graham Ault, *University of Strathclyde*

8.05 Integration of Intermittent and Variable Renewables: Ongoing Work at Carnegie Mellon University
Paulina Jaramillio, *Carnegie Mellon University*

8.06 An Analysis of U.S. Energy Portfolio through 2050
Rahim Khoie, Victoria Yee, Vikas Azad, Matt Varni, Evan Angeli, *University of the Pacific*

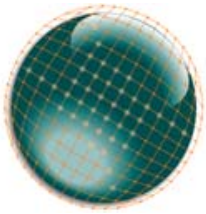
9. National / International Programs and Standards

9.01 NEDO's Demonstration Projects for Integration of Renewable Energy
Keiichi Watanabe, Michio Seita, Satoshi Morozumi, *The New Energy and Industrial Technology Development Organization (NEDO)*

9.02 Bringing Together International Research on High Penetration PV in Electricity Grids - The New Task 14 of the IEA-PVPS Programme
C. Mayr, R. Bründlinger, *Austrian Institute of Technology*; H. Fechner, *Institute for Renewable Energy*; M. Braun, *Fraunhofer IWES*; K. Ogimoto, *Collaborative Research Center for Energy Engineering (CEE)*; K. Frederiksen, *Energimidt*; B. Kroposki, *National Renewable Energy Laboratory*; G. Graditi, *ENEA - Centro Ricerche Portici*; I.F. MacGill, *University of NSW*

9.03 Grid-Supporting Requirements for DER Plants Connected to the German MV-Distribution System
Gunter Arnold, *Fraunhofer IWES*

9.04 Evaluating Future Standards and Codes with a Focus on High Penetration Photovoltaic (HPPV) System Deployment
Michael Coddington, Benjamin Kroposki, Tom Basso, *National Renewable Energy Laboratory*; Kevin Lynn, *U.S. Department of Energy*



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Glenn Platt, CSIRO
John K. Ward, CSIRO

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Andreas Lugmaier, Siemens
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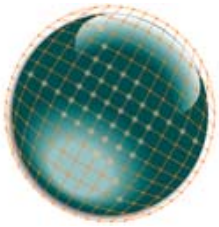
Abbas Akhil, Sandia National Labs
Ward Bower, Sandia National Labs
Abraham Ellis (Chair) , Sandia National Labs
Charles Hanley, Sandia National Labs
Andreas Mammoli, University of New Mexico



4th International Conference on
Integration of
Renewable and Distributed
Energy Resources
December 6–10, 2010
Albuquerque, NM USA

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