Second International

Transactive Energy Conference

2014

Energy Intelligence - The Coming Value Revolution

Prepared by

The GridWise Architecture Council

December 11 – 12, 2014

PNNL-SA-110089

About this Document

The GridWise Architecture Council was formed by the U.S. Department of Energy to promote and enable ***interoperability*** among the many entities that interact with the electric power system. This balanced team of industry representatives proposes principles for the development of interoperability concepts and standards. The Council provides industry guidance and tools that make it an available resource for smart grid implementations. In the spirit of advancing interoperability of an ecosystem of smart grid devices and systems, this document presents a model for evaluating the maturity of the artifacts and processes that specify the agreement of parties to collaborate across an information exchange interface. You are expected to have a solid understanding of large, complex system integration concepts and experience in dealing with software component interoperation. Those without this technical background should read the *Executive Summary* for a description of the purpose and contents of the document. Other documents, such as checklists, guides, and whitepapers, exist for targeted purposes and audiences. Please see the www.gridwiseac.org website for more products of the Council that may be of interest to you.

GRIDWISE
Architecture Council

RIGHT TO DISTRIBUTE AND CREDIT NOTICE

DISCLAIMER

Acknowledgments

This material is based upon work supported by the U.S. Department of Energy's (DOE's) Office of Electricity Delivery and Energy Reliability, and the Building Technologies Office within the DOE's Office of Energy Efficiency and Renewable Energy.

TABLE OF CONTENTS

INTRODUCTION

The GridWise® Architecture Council and Smart Grid Northwest held that the Second International Conference and Workshop on Transactive Energy on December 10-11, 2014 in Portland, Oregon at the World Trade Center.

The meeting brought together representatives of government, industry, utilities, vendor organizations and academia who have an interest in advancing transactive energy—an approach that combines economic and control techniques to improve power grid reliability and efficiency.

This year the event had a variety of opportunities for energy professionals, policy makers and anyone interested in the value revolution of intelligent electricity to participate in the conference and exchange information. The conference featured keynote talks from energy industry leaders, an international expert panel, selected presentations on topics critical to the success of transactive energy. Each of the four topical areas included a panel session and a facilitated workshop to engage the experts and interested stakeholders for a combined total of three hours of discussion of the topic with attention to both theory and practice.

The 2014 conference was a partnership between the GridWise® Architecture Council (GWAC) and Smart Grid Northwest with support from the U.S. Department of Energy's Pacific Northwest National Laboratory, the Bonneville Power Administration, Portland General Electric, and others.

GWAC was formed by the Department of Energy to promote and enable interoperability among the many entities that interact with the nation's electric power system.

These proceedings start with a summary of opening remarks and a recap of highlights of the 1st International Conference and Workshop on Transactive Energy held in 2013. The conference program is then presented with short summaries of each session and links to the presentations. The main body of the proceedings concludes with a framework progress summary, basically an overall recap of the conference, and discussion of next steps. Four appendices are included. Appendix A provides links to reference materials on transactive energy. Appendix B has the agenda for the meeting and finally, Appendix C has profiles for each of the conference or workshop speakers.

ABOUT THE GRIDWISE ARCHITECTURE COUNCIL

The GWAC was convened in 2004 by the U.S. Department of Energy (DOE), to promote and enable interoperability among the many entities that interact with the nation's electric power system, with PNNL providing administrative and technical support with DOE funding. As a volunteer council, the GWAC includes practitioners and leaders with broad-based knowledge and expertise in power, information technology, telecommunications, financial systems and other fields who are working together toward a coordinated GridWise vision—the transformation of the nation's energy system into a rich, collaborative network filled with decision-making information exchange and market-based opportunities.

ABOUT SMART GRID NORTHWEST

The mission of Smart Grid Northwest is to enable, promote and grow the smart grid industry and infrastructure in Oregon and the Pacific Northwest. Organized as a trade association, Smart Grid Northwest has two major goals:

- Advocacy/public policy: Smart Grid Northwest will work with smart grid stakeholders to craft and advocate for effective public policies that promote and grow Oregon's smart grid industry and infrastructure.
- Business promotion/networking: Through informational events, conferences and other forums, Smart Grid Northwest will be a catalyst for smart grid entrepreneurs and leaders to meet, interact, compare notes and work together to grow and promote the industry in the Pacific Northwest.

GRIDWISE Architecture Council

OVERVIEW AND OPENING REMARKS

CONFERENCE LEADER: RON MELTON, PACIFIC NORTHWEST NATIONAL LABORATORY

This 2nd International Conference and Workshop continued the efforts by the GridWise Architecture Council to engage the broad community interested in the topic of transactive energy. Since the 1st International Conference and Workshop interest in this topic has continued to grow. In November 2013 the Council published a draft of its Transactive Energy Framework. The following month, December 2013, the Council convened a workshop and asked the presenters to use the attributes of transactive energy systems defined in the Framework to describe their transactive energy efforts. This prompted valuable discussion on the Framework and helped identify areas that needed continued work. In February and September of 2014 the Council had workshop meetings focused on engaging the ISO / RTO community to discuss Framework comments they provided through the ISO / RTO Council. The first of these meetings, held at PJM in Philadelphia, resulted in definition of six principles for transactive energy systems. It also kicked off efforts to create a transactive energy infographic summarizing the primary features of transactive energy systems. At the second meeting, hosted by CA-ISO, the discussion continued with emphasis on emerging distribution system trends related to transactive energy systems such as the Distribution System Operator (DSO) construct.

For this Second International Conference in Portland the Council retained the panel session – facilitated workshop format following very positive feedback on this approach from the first conference. We moved from only having invited presentations to soliciting presentations and papers from the community. The Council wants to thanks all those who submitted abstracts for consideration. We received approximately 75 submittals for the 16 to 20 panel spots. We also included two plenary panels – a Regulatory, Legislative and Policy Barriers panel and an International Panel. Both of these panels provided invaluable perspective on challenges and opportunities. The audience found that this is truly and international challenge with important work and opportunity in Europe, Australia, India, Africa and by inference other parts of the world.

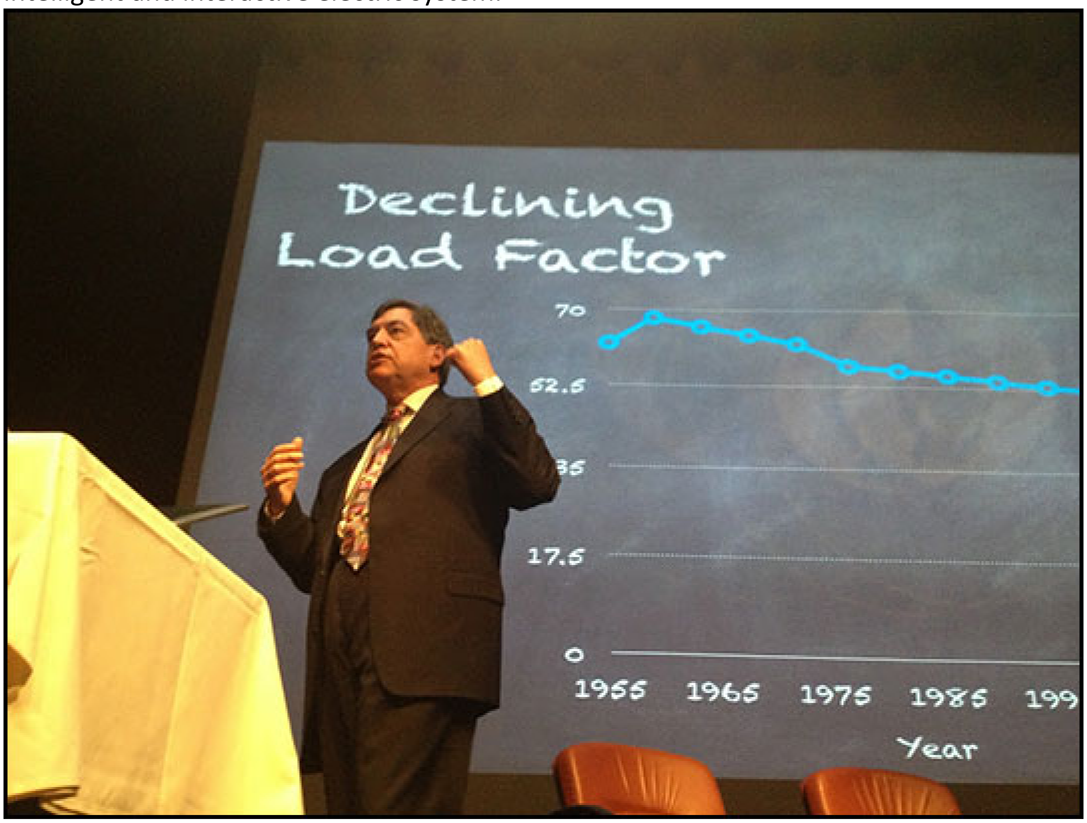
During the Councils foundational panel we discussed the Transactive Energy System principles and the updated definition of Transactive Energy included in the final version 1.0 of the Transactive Energy Framework, which was subsequently published in January 2015. A noteworthy change in the definition is that it is now system focused. The Council urges you to download V1.0 of the Framework document to review this and the other updates. The document is available at http://www.gridwiseac.org/pdfs/te_framework_report_pnnl-22946.pdf.

Looking forward, the Council continues to promote broad discussion on the topic of transactive energy systems in order to develop common language and understanding of these approaches to managing the increasing deployment of distributed energy resources. During 2015 the Council will work on a "Transactive Energy Decision Maker's Checklist" as a tool for regulators, policy makers and executives in the industry. We look forward to continued efforts to apply transactive energy systems in modernizing the electric power systems throughout the world. We expect to host the 3rd International Conference and Workshop on Transactive Energy during the first quarter of 2016 and look forward to hearing many reports of progress and lessons learned at that meeting.

2013 First International Transactive Energy Conference

The GridWise® Architecture Council (GWAC or Council), with support from Pacific Northwest National Laboratory (PNNL), the Bonneville Power Administration (BPA) and Smart Grid Oregon and Portland General Electric, convened the First International Conference and Workshop on Transactive Energy in Portland, Oregon, on May 23−24, 2013.

The Transactive Energy Conference and Workshop 2013 were organized by the GWAC as part of its mission to further the advanced thinking about the guiding principles, or architecture, of a highly intelligent and interactive electric system.



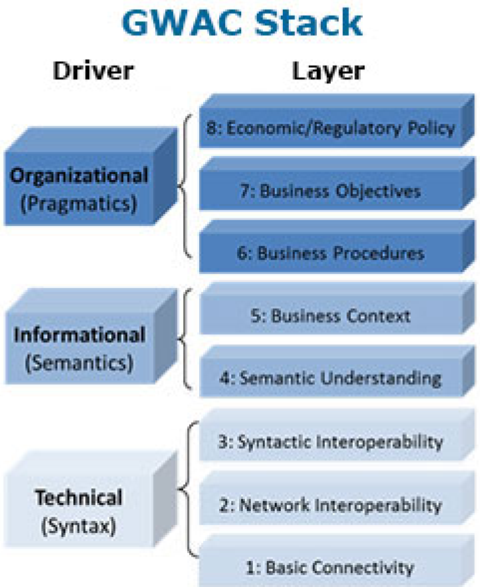
Chairman Jon Wellinghoff discussing a day in the life of the grid

The goal of the conference and workshop was to bring together organizations, researchers and practitioners that have been researching, developing and deploying transactive energy techniques and business models.

The conference was part of the continuing work of the GWAC in defining Transactive Energy and developing an overarching framework to support development of this technical area within the electric power and building technologies industries. The GWAC believes that these results will enable accelerated adoption of transactive energy policy and technologies policy worldwide.

This first of its kind conference offered industry participants an opportunity to demonstrate leadership, both in products and in industry evolution. Organizations were given an opportunity to help offset the cost of the conference through sponsorships and 25 of them did so. The Architecture Council and Smart Grid Oregon are thankful to them for their support.

GRIDWISE
Architecture Council



The conference structure was an adaptation of the "GWAC Stack" (a layered model of electric power system interoperability) to lay out theory (Architecture) and practice (Implementation) tracks for transactive energy. Within each track the layers of the GWAC Stack formed the scope of discussion. This started at the upper layers (Business and Policy) and moved through the middle layer (Control Architecture) to the lower layers of the GWAC Stack (Technical or Cyber-Physical). Two domain-specific workshops were included focused on building technologies from the perspective of grid integration and then looking at applying transactive approaches within buildings and facilities. Each of the four topical areas included two serial sessions to engage the experts and interested stakeholders and in combination spanned a total of three hours of discussion of the topic with attention to both theory and practice.

The complete proceedings PDF 11.5MB are available for download including the individual presentations. These proceedings start with a summary of opening remarks and some background material on the topic of transactive energy and the previous GWAC workshops on this subject. The conference program is then presented with short summaries of each session and links to the presentations. The main body of the proceedings concludes with a framework progress summary, basically an overall recap of the conference, and discussion of next steps. Four appendices are included. Appendix A provides links to the read ahead and other reference material for the conference and workshops. Appendix B has the agenda for the meeting. Appendix C presents the summarized discussion notes and takes always for each of the workshop sessions. Finally, Appendix D has profiles for each of the conference or workshop speakers.

GRIDWISE Architecture Council

DAY ONE

CONFERENCE WELCOME AND COMMENTS

SPEAKERS: DR. RONALD B. MELTON, GRIDWISE ARCHITECTURE COUNCIL ADMINISTRATOR; MR. MARK KNIGHT, GRIDWISE ARCHITECTURE COUNCIL CHAIRMAN; MR. LARRY BEKKEDAHL, PORTLAND GENERAL ELECTRIC VICE PRESIDENT, TRANSMISSION & DISTRIBUTION

The conference began with a welcome to Portland by Larry Bekkedahl from Portland General Electric. Ron Melton welcomed attendees on behalf of the GridWise® Architecture Council. Ron Melton provided a brief history acknowledging the participants in the previous GWAC transactive energy workshops and thanking the sponsors of this conference and workshop.

Welcome to the Portland and the Transactive Energy Conference Presentation

KEYNOTE – REALIZING THE VALUE OF TRANSACTIVE ENERGY

SPEAKERS:

CARL PECHMAN, SENIOR ADVISOR FOR ELECTRICITY FOR THE U.S. DEPARTMENT OF ENERGY

ROLAND RISSER, THE DIRECTOR OF DOE'S BUILDING TECHNOLOGIES OFFICE

Dr. Pechman is an expert on the economics of electricity and has been involved in the quadrennial energy review at the Department of Energy. The utility industry is changing, especially the role of the customer. Key issues are utility pricing, communications, and the harmonization of state and federal regulation of the energy market. As utilities change, there are still some economies of scale that support the original motivation for creating utility monopolies. Regulation is still important, but is changing in terms of jurisdiction.

The future utilities will be defined by scope, price as a control mechanism, retail rate issues, and wholesale price issues. Some of the scope issues include access by third party providers, vertically integrated versus unbundled, morphing into distribution service operators, and "Should we protect competition or competitors?"

The development of microgrids poses important issues. Some of these are about ownership, obligations to carry, cost recovery, choice of a communications architecture, and wholesale market transactions.

Roland Risser, the Director of DOE's Building Technologies Office, provided a framework for conference discussions, including the DOE vision for transactions-based approaches to energy, the potential national benefits to both the power system and to building owners of realizing it and an overview of DOE's R&D and implementation efforts.

Realizing the Value of Transactive Energy Presentation
Powering Transactive Energy Principles through Transaction Bases Controls Presentation

FOUNDATIONAL SESSION – ELEMENTS OF A TRANSACTIVE ENERGY FRAMEWORK

MODERATORS: RONALD MELTON, GRIDWISE ARCHITECTURE COUNCIL ADMINISTRATOR

SPEAKERS: MARK KNIGHT, CGI, STEPHEN KNAPP; POWER GENERATION SERVICES, INC.; JEFFREY TAFT, PACIFIC NORTHWEST NATIONAL LABORATORY; CHRIS IRWIN, U.S. DEPARTMENT OF ENERGY

The overall purpose of this session was to update the conference attendees on the Council's work since the preceding conference and to help provide a common starting point for the workshop discussions. The presentations built on the outcomes of the GWAC workshops held during the preceding fifteen months. There were several themes including the tremendous level of activity and discussion of transactive energy in the industry; the updated transactive energy definition and transactive energy system principles from GWAC workshops; a summary of regulatory and policy drivers motivating the development of transactive energy systems for distributed energy resource integration; a review of related work on grid architecture, in particular the Distribution System Operator construct; an overview of transactive energy system concepts through a discussion of "A Day in the Life of a Transactive Grid"; and a look at planned future activities.

Transactive Energy Foundational Session Presentation

LUNCH KEYNOTE – REALIZING THE VALUE OF TRANSACTIVE ENERGY

SPEAKERS: CARL IMHOFF, SMART GRID STANDARDS AND INTEROPERABILITY COORDINATOR, U.S. DEPARTMENT OF ENERGY,

Carl Imhoff's keynote reflected on the decade-long transactive energy journey and share his perspectives on the road that remains ahead of us. It will summarize the key accomplishments and lessons learned from three demonstration projects that brought transactive grid concepts to life. He will also point to other efforts in the U.S. and Europe that enrich the transactive ecosystem, including broadening it beyond a grid focus to include energy transactions motivated by other consumer and societal needs. While these represent significant progress, this talk will pointed out much that remains to be accomplished before transactive energy concepts become an everyday reality at the level of retail consumers.

Looking forward, Carl described the role transactive energy concepts play in the U.S. Department of Energy's new Grid Modernization Initiative that he leads for the national laboratories, in context with the key role that new control architectures and control schema play in that initiative. Finally, he will pointed out some of the larger trends that are shaping the traditional view of grid business and management systems. These include threats to the current utility business model and the strong push, led by New York, California, and Hawaii, to examine alternative structures supporting broad access by consumers and third parties to the grid infrastructure, exemplified by concepts such as distribution system operators. These represent a changing environment that, in turn, is affecting both the need for, and role of, transactive energy concepts going forward.

The Transactive Energy Journey: Reflections on the Past and Future Presentation

1 BUSINESS AND POLICY BARRIERS

1A Business and Policy Barriers Paper Session

MODERATOR: WARD CAMP, LANDIS + GYR

Successful integration of transactive energy technology into the electric power system must take into account policy and business considerations. Presentations in this session will include identification and discussion of business and policy barriers to the deployment of transactive systems. Examples of the questions addressed by these presentations include:

• What are the key business and policy barriers to the implementation and deployment of transactive energy systems?
• How can the business and policy barriers be overcome?
• What information is needed to address business and policy barriers?
• What are the benefits of transactive energy to the various stakeholders?

SPEAKERS:

BECKY HARRISON, GRIDWISE ALLIANCE

FUTURE OF THE GRID – EVOLVING TO MEET AMERICA'S NEEDS

The U.S. Department of Energy's (DOE's) Office of Electricity Delivery and Energy Reliability (OE) and the GridWise Alliance partnered to facilitate a series of regional workshops and a National Summit entitled "Future of the Grid: Evolving to Meet America's Needs" to create an industry-driven vision of the grid in 2030 and, more importantly, to begin forging a path to realizing that vision. The vision that emerged is of an increasingly complex electric system, which will incorporate both central and distributed energy resources and where the role of the grid and the grid operator is significantly different from today. One of the scenarios discussed in the regional workshops was based on a future where transactive energy becomes a reality. This session will discuss the findings from the final report and the policy and regulatory questions that must be addressed to enable transactive energy to become a reality.

Harrison – Future of the Grid Evolving to Meet America's Needs Presentation

USMAN SINDHY, SIEMENS

Demystifying Challenges of Transactive Distribution Grid (TDG) and Finding Innovative Solutions

Transactive energy is the concept of linking supply and demand in the electricity systems. A Transactive Distribution Grid (TDG) provides a response to electric loads and generation on the consumer side using smart meters and other technologies to optimizes price signals. It provides a solution to growing challenges to system efficiency and reliability resulting from rapid adoption of distributed renewable energy. States of California, New York, and Massachusetts in the US; along with UK and Southern Europe, are seeing role of distribution grid evolve amid DER. Utility industry decisions-makers are asking how they can innovate the role of distribution grid without reducing top/bottom-line revenues and impact on customers? What technologies will help in managing influx of smart devices and embedding more control in the grid? The answers lie in a combination of energy and market management technologies with a platform approach. In this session Usman:

1. Reviewed both the technical and economic aspects of transactive energy
2. Learned how utilities are moving towards a transactive energy model in a phased approach
3. Discussed emerging applications that can manage smart devices ecosystem
4. Discussed practical approaches to implementation and provide examples of transactive energy in action.

Sindhu – Demystifying Transactive Distribution Grid (TDG) and Finding Innovative Solutions Presentation

ED CAZALET, TEMIX, INC.

BUSINESS AND REGULATORY MODELS FOR TRANSACTIVE ENERGY

Technology and public policy changes are shifting several electric systems to a more decentralized future. Advances in solar panels, storage batteries, power conversion systems, LED lighting, net zero buildings, intelligent control systems, internet communications and other technologies are lowering the cost of decentralized electricity and enabling the customer benefits of resiliency and reliability. In these electric systems the age of the prosumer is here and electricity customers, prosumers and producers are demanding choice. Transactive Energy (TE) can provide business and regulatory processes to support this trend to decentralization.

This paper considers the changes in the structure of the business and regulatory models that are suggested by TE. What should be the role of the customers, prosumers, decentralized generation and storage operators, distribution operators, energy retailers, exchanges, locational pricing markets, and transaction platforms? What is the role of legislatures, public utility commissions, and reliability regulators in fostering and regulating retail TE? How should retail tariffs be designed for TE? How should the interface with wholesale markets evolve to best interface with TE retail implementations?

The paper will suggest some policy answers to these questions with the intent of stimulating discussion, further work and implementations of TE.

Cazalet – Business and Regulatory Models for Transactive Energy Presentation

1B – Business and Policy Session Workshop

MODERATOR: DAVID FORFIA, ERCOT

After a short break following Paper presentations, the Workshop session will bring panelists back into the room for a Q&A Discussion. A professional facilitator and the paper session moderator lead the participants through this process.

The main topics and questions to address in this workshop are:

- What are the key business and policy barriers to the implementation and deployment of transactive energy systems?
- How can the business and policy barriers be overcome?
- What information is needed to address business and policy barriers?
- What are the benefits of transactive energy to the various stakeholders?

Audience Questions Policy Focus Workshop Results
The audience questions were extensively rephrased by the panel and were not captured.

Audience Answers to Core Questions Policy Focus Workshop

Question 1: What are the key business and policy barriers to the implementation and deployment of transactive energy systems?

Top answers:

Answer	Votes
Regulatory barriers that don't allow buyers/sellers to do business.	6
Rules don't exist for actors involved in TE ▪ **who does what?** ▪ **who gets paid and how?**	5
Commodity mindset when we need a service mindset.	5
Consumer Interest.	5
Fear of stranded investment.	5
Piecemeal nature of policy (between states within states).	5
Current process of socializing costs.	4
Incentivizing early adoption.	4
How to get appropriate price signals to consumers.	4
Market prices and participation for all players (T&D).	3
Costs for stranded assets.	3
Low stakeholder demand.	3
Economic conditions of inputs (too costly).	2
Support from utilities.	2
Lack of societal cost benefits analysis (incremental from existing techs).	2
Metrics for TE benefits.	2
Clear definition of TE scope.	2
Who is the DSO?	2
Strategic business case from consumer and provider views.	1
Utility participation varies.	1
Social justice considerations of a rapid rollout of Transactive energy.	0

Other answers:

Answer	Votes
Decoupling utility from amount of energy consumed.	3
Uncertainty of what buying.	2
Business barriers and perceived quality of service.	2

Enabling regulations.	2
Consumer protections must be defined.	1
More participants = more cost, time, uncertainty.	1
Need Clear Explanation of Benefits to all participants.	1
TE is a change to existing monopolistic utility model.	1
Cultural inertia limits extent of change in short term.	1
Short term vs. long term problem.	1
Ways to measure costs and benefits.	1
Definition of customer is need.	1
Cost, TOU, and perception of cost change.	1
How to protect low-income/disabled/tech-challenged.	1
Financial incentives.	0
Scale of cost is too high.	0
Future role of Distribution Utility?	0
Lack of infrastructure and equipment response.	0
Changing role of utility.	0
Pricing on cost or value.	0
Business values.	0
Education of stakeholders.	0
How to resolve policy question and engage all policy makers.	0
Lack of success stories and best practices.	0

Question 2: How can the business and policy barriers be overcome?

Top answers:

Answer	Votes
Demonstration projects: government/DOE. Some utilities into rates.	5
Federal guidelines (FERC) to outline a consistent standard (Example hot water heater communication).	5
High profile pilot projects to generate awareness + proof of concept.	4
Raise awareness of shift from dispatch generation to meet load to the other way around.	4
Relax regulation to allow utilities to participate in TE.	4
Technology selection guidelines.	4
Facilitate discussions between business and policy stakeholders (consumers).	4
Time, awareness, planning + impacts on consumers need to be acknowledged.	3
Regulation drives behavior change in an industry.	3
Painting the picture of “NO Action” comparison with cost benefits analysis.	2

Define benchmarks and metrics.	2
Need disaggregated view of costs.	2
Pricing reflecting true value.	1

Other answers:

Answer	Votes
Mechanisms to underwrite tech/risks for consumers.	4
Education campaign directed at policy makers (PUCs) -> enable utilities to pursue different business models.	3
Shake up profit motivates huge costs and benefits to drive change.	2
Accept that technology will be adopted + plan your reaction (legacy system will change).	2
Educate consumers through demonstration.	2
Community outreach/education to utilities with regard to benefits	2
Right regulatory incentives (e.g. solar, wind, RPS, ITC).	1
Educate to overcome utility culture and inertia.	1
Incentives (subsidy/tax credits/etc.).	1
Engage with aggregators to develop the business case model.	1
Rules	1
What's regulated by whom?	1
Phased transition from here to there.	1
Market signals must reach consumers from generators.	1
Recovery of fixed and marginal costs via a flexible system, responsive to the load on the system.	1
Give money to consumers for interest.	1
Make utilities not subject to risk to ink deals.	1
Tight policies to avoid financial leakage around programs.	1
Psychic income for consumers.	1
Make energy cost more, will cause better payback on investments.	0
o Demo performance and effectiveness. Define applications for different stakeholders and relevant metrics.	0

Question 3: What information is needed to address business and policy barriers?

Top answers:

Answer	Votes
Transparency in true cost + value.	6

Total cost of TE vs. BAU vs. Value-Value has many forms.	5
Ability to improve modeling.	5
Transparency into supply and marginal costs.	4
Many case studies, both general/stereotypical and outliers.	4
Gauging level of political support/consumer.	4
Metrics for TE benefits.	4
Stakeholder Concepts: monetary, societal, psychological.	3
Know what regulators are looking for.	2

Other answers:

Answer	Votes
Right to connect, supply power, consumer power-connection openness and right to disconnect from the grid.	4
Regulatory forgiveness if probabilistic resource is used.	3
What non-monetary value can be directed from TE systems (security, environmental)	3
Predictive info on load.	3
Enable info exchange among different systems: energy, financial, home automation, social.	3
Demonstration projects.	2
Customer notification + price elasticity behaviors.	2
What are costs associated with including all groups (consumers). Infrastructure costs.	2
Info that describes projected state of industry forecasts and long term pricing signals.	1
Understand true costs.	1
Clearly defined points of interaction. DR capacity for a given source.	1
Example/pilot project problems need to be highlighted. What didn't work?	1
How to gather, aggregate, analyze relevant info.	1
Regional demand curves.	1
Demonstrated reliability.	0
More Cost Studies.	0
Clear definition of TE Scope.	0

Question 4: What are the benefits of transactive energy to the various stakeholders?

Top answers:

Answer	Votes
Control the value mix/balance.	7
Business opportunities and local economic	5

development.	
A measure and balance of value: Reliability, Availability, Source-eco/green, interoperability, choice, and price.	5
More sustainable business model for utilities.	5
Integration of various consumers' social aspects.	4
Flexibility to utilize renewables when they occur.	3
Reliability for distribution, transmission, and customers.	3
Unbundling utility to separate producers/distribution/consumers.	3
Vendors/Tech Companies -new business opportunities -cogeneration / storage / etc.	2
Benefit less clear for residential customers.	1

Other answers:

Answer	Votes
Non-Wires alternatives to transmission.	3
Customers -control/options -passed-thru cost savings -potential new money for generation.	3
Ability to optimize system efficiency.	2
Cost savings from making fewer grid investments.	2
Ability of consumers to participate.	2
Prices should drop for utilities and consumers. Pricing transparency. More efficiency.	2
New business models.	2
More renewables.	2
Utilities -sustainable business model -potential new revenue streams -maximize operational efficiency.	1
Customer Satisfaction.	1
Allowing all participants to interact fairly may maintain more consumers to be connected to grid. More participation. Support for energy marketplace/co-generation.	1
Microgrids -new opportunities to participate.	0
New technologies.	0
C&I get more control and won't be subsidizing residential.	0
Distribution utility investments are clearer and easier to explain.	0
Enhanced system resiliency (through distribution).	0
Flexibility to consumers (Right to disconnect).	0
Cost to society and individuals.	0

2 CUSTOMER ENGAGEMENT

2A – Customer Engagement Paper Session

MODERATOR: TRACY MARKIE, ENGENUITY SYSTEMS

A key element of transactive systems is the broad engagement of responsive elements of the system most of which belong to customers. There is, then, a corresponding challenge to get customers to engage and participate in the transactive system. This session will include presentations on the challenges for customer engagement addressing questions such as:

• How do we move from passive customers to customers actively engaged through tools such as intelligent energy management systems and smart appliances?
• How do we facilitate the transition?
• What incentives or other approaches can engage customers to they want to participate?
• What are the transactive energy value propositions for consumers?

SPEAKERS:

TERESA WAUGH, BONNEVILLE POWER ADMINISTRATION

LESSONS LEARNED FROM THE PACIFIC NORTHWEST SMART GRID DEMONSTRATION

The transition from business-as-usual to smart grid requires careful planning and execution with communication to the "both sides of the meter." Utilities face new risks attempting to draw together customers into reliable systems, and are challenged to develop a customer base with a basic understanding and acceptance of intelligent energy management systems. Bonneville Power Administration's role in the Pacific Northwest Smart Grid Demonstration has drawn together lessons learned from all 11 utilities involved in the Project. This presentation focus on key communication lessons learned with the diverse set of utility participants.

Lessons Learned from the Pacific Northwest Smart Grid Demonstration Presentation

KENNETH WACKS, HOME, BUILDING & UTILITY SYSTEMS

CONSUMER PRODUCTS STANDARDS FOR TRANSACTIVE ENERGY

Effective Transactive Energy (TE) must be accepted by consumers and integrated into daily activities. This paper is based on the thesis that automation under customer management can make the control of TE practical for consumers. Many of the standards already developed for appliance control, home area network interface, and energy management of end-devices and distributed energy resources can be applied to automate TE.

This paper introduces the national and international standards that enable appliances to participate in energy management including TE via a home networks linked to an external network. The external network may be operated by a utility, an energy management services supplier, or a link to a TE participant. Among the standards to be discussed are:

- A system for energy management supporting demand response (DR) for appliances and distributed energy resources (DER) with extensions to TE

- An interface for adapting end-devices including appliances for a variety of home networks

- A gateway between a home area network and a wide area network used for DR and TE

- A method for achieving interoperability among appliances that were designed for incompatible networks.

Consumer Product Standards for Transactive Energy [Presentation]

CHRIS BLACK, TENDRIL
THE TRANSACTIVE ENERGY VALUE PROPOSITION: PERSONALIZING THE CUSTOMER EXPERIENCE

The increase in distributed energy resources, and the emergence of a new kind of customer are paving the way for the broader adoption of transactive energy. Because of the complexity of the transactive energy framework, its benefits must be properly articulated to fully engage the average energy consumer.

The key to engagement lies in personalizing these benefits to consumers, such as lower costs and the ease of a “set and forget” paradigm that together help to fundamentally improve a consumer’s energy experience.

Energy providers have access to a wealth of customer data, such as demographic data, past program participation, home audit information, and energy consumption and generation data. Techniques like micro targeting and personalization, powered by data and analytics, can open up the doors to providing more tailored messaging, fostering a more active and engaged consumer base.

This session cover how micro targeting and personalization can:

•Transition passive rate payers into engaged participants
•Predict a customer’s propensity to participate in programs
•Provide an individualized value proposition on the benefits of transactive energy
•Deliver and cross-sell value-added services to customers
•Improve customer satisfaction.

The Transactive Energy Value Proposition: Personalizing the Customer Experience [Presentation]

CRISTINA MARINOVICI, PACIFIC NORTHWEST NATIONAL LABORATORY
CUSTOMER ENGAGEMENT IN AEP GRIDSMART® RESIDENTIAL TRANSACTIVE SYSTEM

The increase in distributed energy resources, and the emergence of a new kind of customer are paving the way for the broader adoption of transactive energy. Because of the complexity of the transactive energy framework, its benefits must be properly articulated to fully engage the average energy consumer.

The key to engagement lies in personalizing these benefits to consumers, such as lower costs and the ease of a "set and forget" paradigm that together help to fundamentally improve a consumer's energy experience.

Energy providers have access to a wealth of customer data, such as demographic data, past program participation, home audit information, and energy consumption and generation data. Techniques like micro targeting and personalization, powered by data and analytics, can open up the doors to providing more tailored messaging, fostering a more active and engaged consumer base.

This session will cover how micro targeting and personalization can:

- Transition passive rate payers into engaged participants
- Predict a customer's propensity to participate in programs
- Provide an individualized value proposition on the benefits of transactive energy
- Deliver and cross-sell value-added services to customers
- Improve customer satisfaction.

The Transactive Energy Value Proposition: Personalizing the Customer Experience Presentation

2B – Customer Engagement Workshop

MODERATOR: ERICH GUNTHER, ENERNEX

After a short break following Paper presentations, the Workshop session brought panelists back into the room for a Q&A Discussion. A professional facilitator and the paper session moderator lead the participants through this process.

The main questions to address in this workshop were:

- How do we move from passive customers to customers actively engaged through tools such as intelligent energy management systems and smart appliances?
- How do we facilitate the transition?
- What incentives or other approaches can engage customers to they want to participate?
- What are the transactive energy value propositions for consumers? background.

WORKSHOP OUTCOMES

Audience Questions Customer Focus Workshop

There are sometimes vast differences between price and cost (value). How do you see this difference affecting the value signal that is sent in a TE strategy?

To all: What are the key operational data elements that would need to be communicated with a transactive system that are not related to price (value) or load?

How do you avoid gaming of the system to self-maximize rewards for the participants?

Can or should the cost of operations on power grid equipment (wear and tear) be factored into TE solutions or platforms?

What changes in power equipment in the low voltage grid (capacitor banks, low voltage transformers) are required to support TE increased operation over DR?

How can the consumer be protected from automated transactions with fluctuations in market prices?

What is the best policy/method to avoid "gaming the system" (e.g. people getting paid for what they would do anyway)?
How do we engage customers initially and keep them engaged month-after-month, year-after-year? Answer for residential and commercial customers.
For both residential and commercial consumers, how do we design a tariff that the customer can relate to actions they can take and the value that those actions provide to them?
What percentage of the customer base in high, middle, and low income classes are likely to be turned from passive to active, over what time frame, and why?
Is there a risk to engaging customers before the utility is ready and the technology has matured, especially given the large vendor base of non-interoperable technologies?

Audience Answers to Core Questions Customer Focus Workshop
Question 1: How to we move passive customers to actively engaged customers?

Top answers:

Answer	Votes
Automated, simple, self-configured home energy systems.	8
Instantaneous rewards.	4
Role models and word of mouth most effective for consumers.	3
Explain the cost benefit of using demand side resources verses utility central solutions.	3
Effective marketing and communication of benefits (which may be non-monetary, e.g. more information, social responsibility).	3
Education, including K-12. Allow utility marketing/public relations/education in rate base.	2
Educating Consumers.	2
Carrot and stick on pricing and penalties.	2
Good program design.	1

Other answers:

Answer	Votes
Financial incentives.	0
Effective marketing: celebrity endorsements, social media, infographics. Targeted and broad.	0
Easy, cool, cost effective.	0
Automation.	0
Demand side participation is more "green" vs. utility solution.	0
Make it easy, demystify.	0
Make it cool, fun, gamify.	0
Incentives the customer understands.	0
Automated systems, but make sure customers still have ability to control.	0
Maintain awareness (e.g. phone & email alerts).	0

Question 2: How do we facilitate the transition?

Top answers:

Answer	Votes
Targeted messaging to customer segments: environmental, cost avoidance, grid reliability, get more out of the existing investment.	6
Targeted and incremental. Fail early and learn from mistakes.	5
Don't overpromise. Under promise and over deliver. Transparent with managed expectations. Pilot demonstrations.	4
Communicate the benefits, financial and otherwise.	4
Get more out of existing systems (hardware) & marketing networks (e.g. web, mail, social media).	4
Standardized hardware communications (interoperability) with interpretive software.	3
Targeted & incremental marketing. Go for low-hanging fruit	2
Public infrastructure investment.	1

Other answers:

Answer	Votes
Be transparent, managed expectations, under promise & over deliver.	0
Piggyback on other selling points e.g. smart appliances.	0
Technologies.	0
Metcalfe's Law.	0

Question 3: What incentives or other approaches can engage customers so they want to participate?

Top answers:

Answer	Votes
Combine incentive with customer values, social and non-monetary: e.g. competitions, social media tie-ins.	5
Financial incentives.	4
Increased comfort, convenience, easy to use.	4
Comfort, convenience, easy to use.	2
Higher reliability and faster restoration.	2
Research market segmentations/customer demographics and their needs, and tailor incentives accordingly.	2

Other answers:

Answer	Votes
In-kind incentives (e.g. more information on my home/processes).	0

Financial (variety of forms, rebates, coupons, tax credits).	0
Engage with manufacturers to make more cool products and smart appliances.	0
Social incentives, introduce competition, Drive innovation, like the X-Prize.	0
Efficiency to the customer, DR to the provider.	
Engage manufacturers to build embedded smart functions.	
For consumers, price, rebate, coupons. For commercial, price and tax incentives.	0
Social non-monetary incentives, X-Prize-like programs.	0
Low cost of no cost to customer.	0
Targeted and incremental, fail early and often.	0
Be transparent, under promise, over deliver.	0
Offer coupons.	0
Trust.	0

Question 4: What are the transactive energy value propositions for consumers?

Top answers:

Answer	Votes
Reliability – prevents sags, swells, blackouts, brownouts.	6
Opportunity to make a contribution, social responsibility.	5
Economics drivers.	4
For people with PV & wind, TE can improve the existing value proposition.	4
Convenience, comfort, gadget factor.	3
Do it for the children (environmental).	3
Offer low, no cost beta testing in homes.	3
Low-touch home orchestration.	2
Cost avoidance.	2
Increased reliability/resiliency.	1

Other answers:

Answer	Votes
For consumers that have PV/wind, TE offers additional tools maximize the value of PV .	0
For consumers, feel in control of their energy destiny, savings, and societal value.	0
Reduce O&M expenses, bill savings, and process improvements, additional revenue opportunities (commercial and industrial).	0
For commercial and industrial, educed O&M costs,	0

process improvement, increased revenue, tax credits.	
Convenience, comforts, gadgets. Low-cost or no-cost beta testing.	0
Diversity of energy resources.	0
Bragging rights.	0

Plenary Panel – Regulatory, Legislative and Policy Considerations for Transactive Energy

Moderator:

Marty Rosenberg, Penton

Panelists:

Philip Jones, Commissioner, Washington Utilities and Transportation

Tom Sloan, State Representative, Kansas House of Representatives

Chris Villarreal, Regulatory Analyst, California Public Utilities Commission

Jeff Morris, Representative,

Washington House of Representative

Jason Salmi Klotz, Climate Change Lead, OREGON Public Utilities Commission

Implementation of transactive energy systems will require consideration by regulators, legislators and policy makers. This panel will discuss what information and tools are needed to support the decision making by these people. Other topics of discussion may include regional cooperation and future challenges to the power system that may be addressed by transactive energy systems.

Day One Closing Comments

Presenters: Dr. Ronald B. Melton, GridWise Architecture Council Administrator; mark knight, CGI, Executive Consultant, Utility Solutions

The first day of the conference and workshop was marked by very interesting plenary presentations, more depth of discussion with the moderated plenary panel and time for audience questions. The workshop sessions engaged the participants with focused presentations and discussion questions.

Key takeaways from the first day included the following:

- The importance of continuing to establish common language for describing transactive energy systems
- Consideration of what will drive change – in particular in regulatory constructs related to retail customer engagement
- The importance of understanding value streams in both business and policy considerations and in effective customer engagement
- What dependencies exist for residential customers to participate before transactive energy gains critical momentum for large scale implementations?

- How does the regulation of the industry as commodity suppliers complicate the messaging and adoption of transactive energy systems as providers of services?
- Aligning work around a set of common goals is really important

Day Two

Keynote – Toward an Integrated Grid- Transformation of Electricity Delivery

Presenter: Carl Zichella, Natural Resources Defense Council

Mr. Zichella spoke from the perspective of a policy developer. He noted that climate change is happening and is being measured. "The longer we wait, the more expensive it will be and the more limited the choices." Suburbs, not cities, are the big emitters of carbon dioxide. He is confident that "Engineers will solve the climate mess and will not get the credit." The grid needs speed, efficiency, enhanced coordination, and control. Flexibility, reliability, resiliency, and security are the most critical needs. "The grid we have today will not be the grid of the future. The integrated grid will be one big, cheap, reliable, green machine."

Congress will be a drag in addressing climate change. However, efforts to reduce incentives for solar and wind through subsidies, feed-in tariffs, and net metering have been defeated. The momentum is independent of political changes in Washington. "I feel upbeat about things."

Consumers want reliable service, affordable price, and cleaner power. Some also want information and control over their supply (active customers); others just want convenience or cannot afford to engage beyond a minimal level. Innovation and the shift to clean energy is all about systems that interact with politics, regulation, and finance, as well as with adjacent industries such as transportation, real estate, and telecommunications.

There is a need to integrate a generation portfolio plus storage plus demand response. "The revolution in grid operation is not reversible." Coordination among increasingly complex generation and loads is essential and requires new approaches. Transactive Energy provides a viable model for coordination.

Toward an Integrated Grid – Transformation of Electricity Delivery [Presentation]

Plenary – International Perspectives on Transactive Energy

Moderator: Terry Mohn, General MicroGrids, Inc.

Panelists described the challenges facing electric power system modernization in their countries and discuss the potential role of transactive energy systems in addressing those challenges. Moderator Terry Mohn as CEO of General Microgrids presented his experience of working on energy related issues internationally. Terry also heads the UN workgroup on Microgrids. UN's Sustainable Energy for All program aims to double the amount of energy and renewable energy worldwide, eliminate energy poverty. The new global social, political and economic events require new ways of energy delivery through innovative business models instead of the unsustainable handouts and grants. Terry also described the work his company is doing in creating models for clustering and aggregation of microgrids to create viable business models for rural electrification. He also spoke about the need for transactive energy approaches as a means to create standardized trading platforms for various energy and power characteristics to enable the aggregation of microgrids.

PANELISTS:

MARK PATERSON, DOMAIN LEADER – GRIDS & RENEWABLE ENERGY INTEGRATION, CSIRO, NATIONAL ENERGY FLAGSHIP

AUSTRALIA - IDEAL LIVING LABORATORY FOR TRANSACTIVE ENERGY?

Australia is the world's largest island and only nation-continent, and has a widely distributed population of only 23-million. Not surprisingly, therefore, providing reliable, cost-effective electricity across Australia's cities, regional towns, farming and mining communities has always been a major challenge!

Australia's national Future Grid Forum has confirmed that the coming decades will bring an entirely new range of challenges and opportunities with up to 50% of generation provided by distributed sources in 2050. Due to the low population density and 'long skinny' rural networks, several of the developed world's RE-integration challenges are materializing first in Australia.

In addition, over the last decade Australia has become a world leader in appliance demand response standardization for both local and global brands of air conditioners, electric hot water systems and swimming pool pumps. The AS/NZS4755 standard provides an enabling platform for effecting: (i) subtle peak demand reduction across millions of homes for network optimization and, (ii) load-matching of essential appliance operating times with peak periods of renewable energy generation.

Given these unique challenges, the national standards already developed and Australia's long-range likely futures, Mark shared the significant opportunities for Transactive Energy as perhaps a dominant construct for architecting the nation's electricity future.

Australia – Ideal Living Laboratory for Transactive Energy? [Presentation]

FRITS BLIEK, PRINCIPAL CONSULTANT, SMART ENERGY, DNV GL – ENERGY

THE ENERGY FRAMEWORK – SPECIFICATIONS AND GUIDELINES FOR SMART ENERGY SYSTEMS

Fritz described the Green Village program, which is setting up a smart DC grid that can island off the main grid. He also spoke about the Smart Energy framework, which is trying to create a level playing field for all kinds of transactions to help unlocking the flexibility from demand-side resources. Fritz is the founder of Power-matcher City program, which also involves the TNO (Koen Kok). He presented a video on power-matching city in Netherlands (Thompson Street project), which can automatically match the demand of power with the local supply.

The Energy Framework – Specifications and Guidelines for Smart Energy Systems Presentation
Power Matching City Video

KOEN KOK, SENIOR SCIENTIST INTELLIGENT ELECTRICITY, TNO (THE NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH)

BENEFITS AND BOTTLENECKS IN TRANSACTIVE ENERGY SYSTEMS DEPLOYMENT - THE POWERMATCHER EXPERIENCES

The PowerMatcher is an award-winning transactive energy system that has been developed in a series of EU and NL-national projects and is deployed in several successful field-deployment projects.

PowerMatcher is currently running in ~1000 households and industry sites in NL, D and DK with a high involvement of grid operators, energy supply companies and power tech companies. Since its incarnation in 2004, the PowerMatcher has been implemented in four major software versions. In a spiral approach, each software version was implemented from scratch and was tested in simulations and field experiments. The results of field experiments and simulation studies show that the PowerMatcher: (i) improves the wholesale market position of energy trade and supply businesses, (ii) contributes to active management of electricity distribution networks, (iii) raises the electricity system's accommodation ceiling for renewable power generation, and (iv) is scalable to mass-application levels. At the same time, the technology defends the interests of electricity end-customers by protecting their privacy and autonomy, maximizing their consumption of self-produced electricity and minimizing costs by shifting demand to off-peak hours. PowerMatcher defines a single interface specification for all communication throughout the distributed software solution. This specification is available as interoperability standard through the Flexiblepower Alliance network (FAN). FAN also maintains the open-source reference implementation for PowerMatcher which is available for free commercial use under an Apache license. Several productizing and commercialization efforts are performed by industrial partners.

Benefits and Bottlenecks in Transactive Energy Systems Deployment - The PowerMatcher Experiences Presentation

REJI KUMAR, PRESIDENT, INDIA SMART GRID FORUM

OVERVIEW OF THE INDIAN POWER SYSTEM

Reji presented an overview of the Indian power system, which is one of the largest grids in the world, operating at one frequency, and has 250GW of installed capacity. A third of India’s population has zero access to electricity and the rest of the population experiences several hours of power cuts daily. Hence, the problems in India are different and most related to energy access. The government in 2010 started looking at emerging smart grid technologies, as one of the measures to address the problem, and also joined the International Smart Grid Action Network (ISGAN). India Smart Grid roadmap was unveiled last year, which includes 30,000 microgrids to be deployed in the next 15 years. The new government (2014) has launched a mission to develop 100 smart cities, and has established a target of 100 GW of new grid connected solar energy by 2022. Reji described the tremendous potential for exports of new smart grid related technologies and products in India.

KEYNOTE – TOWARD AN INTEGRATED GRID- TRANSFORMATION OF ELECTRICITY DELIVERY

PRESENTER: ARYEH FISHMAN, EDISON ELECTRIC INSTITUTE

Aryeh Fishman explained that the leaders of the investor-owned utilities are focused on short-term problems like cyber security and clear-air rules. EEI is focusing on reducing net-energy metering. Nevertheless, these leaders acknowledge that change is happening. How business models will change is the point of difference.

How will we move forward with integrating renewables and storage? EEI sees storage as a game changer. EEI is working on these issues, but is not talking about them, and will be reactive. He talked about the development of a demand-side provider (DSP). A fully functioning power grid is a national asset. Operators of the grid are focusing on reliability and safety. They are just starting to talk about how to solve these problems requiring that the industry stakeholders all learn to talk about these problems together.

The investment community is not involved in Transactive Energy. How will those who will fund the upgrades needed for Transactive Energy react? There needs to be definitional clarity. How soon with Transactive Energy happen? 2020 is an ambitious date. The use of transactive energy systems is more near-term than we have imagined. EEI and other organizations will need to begin to get involved in the discussion.

Projects for TE are important. We need to determine the scope of TE. Are we dealing with wholesale or retail aspects of the power industry? Are we talking about Standard Market Design (SMD)? Demonstration projects are "super important" to build confidence and trust. We should prove by demonstrations that the lights will not go off and that the communications system will support all the transactions.

He noted that load growth has been flat. Also, a stable financial regulatory environment will not go away. We need to determine where the subsidies should or should not be. He noted there are different views in Germany and Australia about market developments. "Not everyone views markets in a positive light." Policy makers need options. We should determine how to have informal discussions with regulators.

He concluded, "I have a lot to take back and will look for opportunities to work with this group further."

3 From Demand Response to Transactive Energy Systems

3A – From Demand Response to Transactive Energy Systems – Paper Session

MODERATOR: JEFF TAFT, PACIFIC NORTHWEST NATIONAL LABORATORY

Demand response has been used by many utilities for peak load management through infrequent load shedding and shifting. Transactive systems are generally based on a more continuous engagement of responsive elements with response in the form of both adding and dropping load. Presentations in this session will explore the challenges of transitioning from demand response to transactive systems by considering questions such as:

- What are the requirements for effective response in transactive energy systems?
- What are the operational / business requirements that transactive energy can address?
- What are the operational issues in moving from demand response to transactive energy systems?

SPEAKERS:

BOB RAN, TNO

DEVICE-LEVEL FLEXIBILITY ABSTRACTION MODELS AND AN END-CUSTOMER-LEVEL RUN-TIME PLATFORM FOR TRANSACTIVE ENERGY SYSTEMS

Key challenges in the realization of large-scale transactive energy systems are (i) the lack of an interfacing standard for flexible devices (from household appliances to industrial devices) and (ii) multiple coexisting control and coordination implementations. Current available solutions provide a tight coupling between a specific algorithm and the specific devices found in the field. For a massive market introduction of transactive energy systems, it should be possible to make any combination between devices and control algorithms. To achieve this, a flexibility abstraction interface is needed to decouple these two. The FlexiblePower Alliance Network (FAN) has standardized this interface which describes dynamic flexibility capabilities of energy consuming, producing and storage devices. This presentation will identify the 4 archetypes of energy devices and describes how their flexibility can be expressed, using the FAN data model.

In addition to this interface, the FAN also provides an end-customer-level runtime environment that makes it possible to quickly design and implement new transactive energy services. The FlexiblePower Application Infrastructure (FPAI) enables deployment and configuration of 'Energy Apps' and device drivers, and provides easy interaction through the flexibility interface. Now, device manufacturers can write generic device drivers for their appliances that can be used by any control algorithm that runs on FPAI. Also any control algorithm that is developed on FPAI can make use of all available drivers. All of platform development is done in open source (see https://github.com/flexiblepower) so, anyone can contribute to this framework and vendor lock-in is prevented. Field trials are currently under way.

Device-level Flexibility Abstraction Models and an End-Customer-Level Run-time Platform for Transactive Energy Systems Presentation

AUSWIN THOMAS, IOWA STATE UNIVERSITY

AN AGENT-BASED TEST BED FOR THE INTEGRATED STUDY OF TRANSMISSION-DISTRIBUTION OPERATIONS

Power system studies generally focus on the bulk transmission system or on the distribution system. However, with the advent of smart grid developments such as distributed energy resources (DER) and price-responsive retail demand, it becomes important to consider the feedback effects between the two systems. This talk will discuss our ongoing efforts to develop a test bed suitable for the integrated study of transmission and distribution (T-D) operations under alternative system conditions. In work to date, we have developed an Integrated Retail and Wholesale (IRW) Power Systems Test Bed that models an ISO-managed wholesale electric power market operating over an AC transmission grid with multiple distribution feeders at user-specified buses. Each distribution feeder consists of a distribution grid populated by residential households with both conventional and price-sensitive loads. We are currently extending the IRW Test Bed to more fully incorporate distribution system software (GridLAB-D) in order to achieve a more realistic representation of the distribution system. This extended test bed will be used to study T-D effects arising from distribution system voltage fluctuations, and from the increased penetration of DER and price-responsive retail demand. For an overview of this work, see the slide set posted in the notes section.

An Agent-Based Test Bed for the Integrated Study of Transmission-Distribution Operations Presentation

GRAHAM HORN, ENABALA POWER NETWORKS

HARVESTING CUSTOMER FLEXIBILITY FOR REAL-TIME GRID OPERATIONS

Today's grid is changing – and fast. Policy is driving the grid toward a cleaner and distributed resource mix, favoring renewable energy, responsive demand, and energy storage. The result is a more variable system that is less predictable in both load and supply patterns. It has become increasingly clear that to manage today's grid, real-time flexible resources are required to maintain reliable and safe operation. The core services involve real and reactive power, frequency, and voltage. Response is needed on a continuous, fast time-cycle basis – not just a few hours per year.

A variety of distributed energy resources (DERs) can provide these attributes to manage transmission and distribution grid operations. For example, building automation systems and data centers have inherent flexibility within defined customer constraints. The challenge is to harvest this flexibility in a robust manner that doesn't impact customer operations. The use of distributed control systems leveraging optimization algorithms at the customer interface and at the various grid operational layers can address these requirements. These techniques are applicable to all forms of flexible DER. This paper will discuss these transactive control methods based on actual ISO/RTO real-time production experience in North American.

Co-authors: Arthur Vos, Paul De Martin

Harvesting Customer Flexibility for Real-Time Grid Operations Presentation

JAMES MATER, QUALITY LOGIC, INC.

INTEGRATION WITH OPENADR WITH A TRANSACTIVE ENERGY SYSTEM

The integration of DG and Renewables into the operation of electrical grid systems can be done by the management of traditional dispatchable generation, pro-active management of the demand side of the grid or a combination of the two. In either case, challenges occur in the determination of when each asset should be deployed and how to communicate those deployment decisions within the grid to achieve an optimized, balanced integration of DG and Renewables.

Transactive Control addresses these challenges by using localized decision logic coupled with forecasted values of power delivered at each location. The PNWSGDP demonstrates a distributed hierarchical system that includes a set of transactive value (price) signals that are used to coordinate and balance future supply and load.

Integration with OpenADR with a Transactive Energy System Presentation

3B – From Demand Response to Transactive Energy Systems - Workshop

MODERATOR: RON AMBROSIO, IBM T.J. WATSON RESEARCH CENTER

After a short break following Paper presentations, the Workshop session panelists returned for a Q&A Discussion. A professional facilitator and the paper session moderator will lead the participants through

this process.
The main questions to address in this workshop are:

• What are the requirements for effective response in transactive energy systems?
• What are the operational / business requirements that transactive energy can address?
• What are the operational issues in moving from demand response to transactive energy systems?

Workshop Results

Audience Answers to Core Questions DR to TE Focus Workshop

Question 1: What are the operational/business requirements TE can address?

Top answers:

Answer	Votes
Balancing supply and demand.	8
Interoperable devices.	6
Communication systems.	6
Flexibility.	5
Not have to upgrade system as often, avoid wasted value during surplus generation/supply.	5
Be FUN! -Load resource balancing, incorporate DER better, improve DR, optimize thermal & battery storage, engage customers better-be fun!	5
Lowest cost operation.	5
Renewables balancing.	4
Integrate emerging technologies; reduce barriers to entry.	4
Increase efficiency (cost/ease) of measurement and verification settlement.	4
Customer awareness and enrollment.	4
Operational awareness & insight: customer can better optimize their business operations when variable energy price becomes a variable, like in an ERP system.	3
Updates -load, price (information).	3
Sustainable, reasonable, incentive (no fatigue).	3
Exchange platform operational, financial, and informational.	3
Efficiency, equity, freedoms of choice, customer understanding, utility control, customer control.	3
Appropriate units (e.g., voltage, power, multiple TE signals).	3
Device status/general health.	3
Incorporate DER better.	3
Be fun!	3
Foster outage restoration.	3
Decreasing number of facilities needed to serve load.	2

Fix voltage problems and congestion problems.	2
Outage isolation.	2
Safety – TE should do no harm.	1
Improve DR.	1
Optimize thermal and battery storage.	1
Safe paralleling of generator systems (e.g., islanding issues).	1
Transmission zones and balancing authority interactions.	1
Fewer outages.	0
Less brittle grid.	0
Load-resource balancing.	0
Interaction between electric and gas appliances.	0
Accurate time synchronizing.	0

Other answers:

Answer	Votes
Automating complex decision making.	4
Security, privacy.	4
Accuracy in price forecasting.	3
Behavior models.	3
Deploy smart devices.	3
Peak load.	3
Reliability.	3
Accounting for distributed generation.	2
Interoperability.	2
Energy/ non-energy benefits: control, flexibility, reliability, operation, maintenance.	2
Measurement, sensors.	2
Value proposition.	2
Having the right incentives, value proposition.	2
Accurate M&V.	2
Customer can choose their own reliability level.	2
Maintain reliability at lower cost.	1
Capability to leverage slow responding and fast responding assets/ resources.	1
Visibility to all players.	1
Specify subsets for TE to support.	1
Decarbonization or implement other public policy.	1
Reduce spinning reserves and their costs.	1
Control algorithm.	1
Regulation.	1
Fewer perverse incentives.	0
Perfect forward hedging. Flexibility to adjust high.	0

Transparency.	0
Forecasts.	0
Audit.	0
Confirmation (settlement).	0
Better allocate peak wholesale costs to customers who would pay.	0
Automated systems.	0
Maintain operational reserves.	0
Internodal negotiations.	0
Transparency on ROI of investment.	0
Enhanced predictive models.	0
Congestion.	0
Situational awareness (asset health).	0
Optimization of consumption and generation.	0
Better price on your value streams.	0

Question 2: What are the operational issues moving from DR to TE systems?

Top answers:

Answer	Votes
Shift from rate-recovery utility model to TE -regulatory changes -cost structure changes.	5
The culture of the operating system is hard to change.	5
Impact on today's Generation and Transmission systems: AGC, e-Tags, power flow simulation, state simulator.	4
Accommodate legacy system.	4
Accommodate different entities (ISO, DSO, RTO, prosumer) who might set a price.	4
Measurement and verification.	4
Change management and culture within utility & how employees see their role.	3
More robust communications.	3
Current regulatory structure and potential changes required (NY REV).	3

Other answers:

- Messaging/ 2 way communications for transportation. 3

Answer	Votes
Lower overall system costs.	3
Reliability risk and financial risk.	3
Two-way communication.	3
Adapt rate-setting model – cost tariff.	3
More active participation.	2
Improved forecasting.	2
Increasing resource diversity increases resiliency/	2

reliability.	
Algorithm to process price signal.	2
Significant changes to customer billing.	2
Some customer backlash.	2
Enable generator/ utility to reduce level of balancing reserves and ancillary services.	1
Appropriate interface, intelligent devices.	1
Educating customers on the impact to them. Requires a giant PR program.	1
Risk management/ reliability/ security of new TE systems.	1
Inter-silo trust inside utility.	1
Potential stranded assets.	1
Scarcity pricing is constrained because of market design limitation.	1
Retail-level power flows on distribution system need to be understood in modeling TE intervention (VARs, etc.)	1
Risk of market price manipulation.	1
Big need to educate customers.	1
Not done through direct load control (usual DR program), more organic.	0
Triggering reclosers.	0
Does it compete with existing grid controls?	0
Match price with cost at the return you expect.	0
Hardware requirements.	0
An appropriate economic signal.	0
Product identification.	0
Internal customer learning within the customer organization.	0
Impacts on distribution linepersons.	0
More frequent operations.	0
Safety – More safety issues than DR.	0

Question 3: What are the requirements for effective response to TE systems?

Top answers:

Answer	Votes
Many organizations, values, constraints; is resource still available? PNNL: 1 signal, 1 market, the 1 signal has a multi-variable optimization function. Example from Netherlands: n signals and n markets.	4

Other answers:

Answer	Votes
Management of the infrastructure.	2
Robust real-time communication network.	2

Be able to forecast over time device output and capability.	2
Must be distributed and intelligent.	2
Prevent gaming of the system.	2
Ability to opt out.	2
Signals need to be reliable with adequate bandwidth, an issue with customer-owned internet.	2
Load shaping.	2
Educated customers/Simple to use (set it and forget it).	2
Follow/conform to standards – Plug and Play.	2
Revenue recovery (revenue=cost+roe).	2
Comparison of forecast to actual (M&V).	1
Prevent gaming – market mechanism.	1
Utility system still operator. Customer control vs. utility control.	1
Shift from episodic events to continuous loop- process changes, system changes, automation, interoperability.	1
Increasing array of stakeholders in TE, increases complexity.	1
Accommodating DER and leverage.	1
Align with green objectives.	1
Align with energy savings objectives.	1
How to link market mechanism bids, meets, settlements (financial) with DSO mechanisms.	1
Targets designed by parties.	0
Supply, demand, market mechanism, no monopoly, monopoly.	0
Cost/ value.	0
Quality measurement, dis the response happen?	0
Aggregators have business rules, does DSO need to know? Is it transparent?	0

4 Security

4A – Security – Paper Session

Moderator: James Mater, QualityLogic, Inc.

Presentations in this session explored the practical challenges in implementation of transactive systems. Questions that were addressed included:

• What are the requirements for cyber-physical components of transactive energy systems?
• Are there unique security requirements for transactive energy systems?
• What risks are associated with implementation and deployment of transactive energy systems and how can they be addressed?

SPEAKERS:

SHAWN CHANDLER, PORTLAND UNIVERSITY

PRACTICAL LESSONS FOR TRANSACTIVE CONTROL SYSTEM DEVELOPMENT

Utilities face new challenges seeking to develop cyber-physical systems required for reliable, efficient and secure transactive grid infrastructure. The integrated nature of transactive energy systems requires communications and security which extends across typical utility business domain boundaries, encompassing real-time power marketing, customer service, and engineering concerns. This presentation outlined the infrastructure requirements from a practical utility project perspective with emphasis on future capabilities supportive of industry standards common to substation communications, advanced meter infrastructure, demand response, distributed utility scale storage, and control system environments. Lessons learned from the Pacific Northwest Smart Grid Demonstration project are highlighted.

Practical Lessons for Transactive Control System Development Presentation

DOUG HOUSEMAN, ENERNEX ON BEHALF OF MARY ANN PIETTE, LAWRENCE BERKELEY NATIONAL LAB

AUTOMATED MEASUREMENT AND VERIFICATION OF TRANSACTIVE ENERGY SYSTEMS

As we move toward transactive energy systems and related energy markets there is a need to have standard methodologies to measure and quantify energy transactions. This paper describes an open source automated energy measurement and verification system to quantify long or short-term energy transactions using whole building or end-use time series data. This software is available in several open source platforms. We also describe low-cost smart meter data acquisition systems that are also open source software platforms. The LBNL open source M&V algorithms are being used both in utility pilots to provide M&V for whole building energy efficiency activities, and in advanced demand response tests that evaluate the consistency of response to DR events. We discuss the underlying algorithms, the open source implementation, and the statistical results from applying these algorithms to test buildings.

Automated measurement and verification of transactive energy systems Presentation

PAUL MURDOCK, LANDIS + GYR

ARCHITECTURAL RESILIENCY

Utilities In 2013, the National Electric Sector Cybersecurity Organization Resource (NESCOR) published a document on cybersecurity failure scenarios and impact analysis across the following domains of the electric sector:

1. Advanced Metering Infrastructure (AMI)
2. Distributed Energy Resources (DER)
3. Wide Area Monitoring, Protection, and Control (WAMPAC)
4. Electric Transportation (ET)
5. Demand Response (DR)
6. Distribution Grid Management (DGM)

(The domains align with those identified in the National Institute of Standards and Technology (NIST) Special Publication 1108, NIST Framework and Roadmap for Smart Grid Interoperability Standards.)

This paper uses the failure scenarios and threats described by NESCOR to explore the cyber-physical, security and risk management challenges of reference architectures in the context of transactive energy systems. The paper rationalizes the architectural strategies in the presence of such threats and proposes guidance on improving resiliency by both the use and, where appropriate, the improvement of existing standards and best practices.

The paper is delivered in collaboration with colleagues from the European Union Framework 7 Project, SPARKS.

Architectural Resiliency Presentation

JASON CRABTREE, RATIOEM

CYBER-PHYSICAL SYSTEM SECURITY FOR TRANSACTIVE ELECTRIC POWER SYSTEMS

Integrated approaches to cyber-physical security are increasingly required to reliably and cost-effectively operate electric power systems. Utilities seeking to maximize network performance and effectively protect critical infrastructure assets require an approach which effectively balances anticipatory and reactive costs among threats, vulnerabilities, compliance, and natural events. This paper provides analysis demonstrating that advancing transactive energy models to facilitate future electric power system operations will facilitate improved operational risk management and system-wide reliability and security across a broad range of operating conditions. A framework is proposed outlining simultaneous consideration of costs, likelihood, and system resilience for multiple future potential transactive power system states and security conditions. Continuous processes for exploring future system and operating environment states provide improved situational awareness along with both proactive and reactive organizational response escalation. A summary of key cyber security trends and normative principles—stemming from the widespread utilization of information and communication technologies inside operational control and business systems— is also provided. Finally, a series of recommendations for aiding utility operators and policy makers in improving their collective ability to reliably operate the bulk electric power system and facilitate delivery to retail consumers in an increasingly interconnected world is given.

Cyber-Physical System Security for Transactive Electric Power Systems Presentation

4B – Security - Workshop

MODERATOR: DOUG HOUSEMAN, ENERNEX

The main questions to addressed in this workshop were:

- What are the requirements for cyber-physical components of transactive energy systems?
- Are there unique security requirements for transactive energy systems?
- What risks are associated with implementation and deployment of transactive energy systems and how can they be addressed?

Workshop Results

Audience Questions Security and Cyber Security Focus Workshop

What are the most current protocols/ methodologies to use to protect systems from attack?

What are the unique security requirements for TE? How is cyber security different for power systems and TE compared to other IT and technology systems?

Regulatory compliance under NERC-CIP is not going away. How can TE be effectively integrated without increasing the risk to compliance violations

What mistakes have you seen in current and upcoming TE systems (security mistakes)?

Are IT and OT going to a converged network?

TE security looks like an optimization exercise where the objective function is not known. Some industries, such as banks, have a lot of data. TE is just beginning. How can we bring TE to risks comparable to credit card services?

What were the communications takeaways from the PNWSGDP?

Since TE is ultimately a cyber-physical system, do you agree that security cannot be complete without high level rules to protect interests, investments and life?

What about the tin hat crowd?

How do we best quantify risk that a TE participant will not deliver the promised resource?

How would you suggest providing security for automated transactions of energy by customers, prosumers and DER on a distribution grid?

Audience Answers to Core Questions Security and Cyber Security Focus Workshop

Question 1: What are your concerns with transitioning to a cyber-physical system to support TE?

Top answers:

Answer	Votes
When you don't own/control assets, where is the trust?	8
The absence of aggregator operating rules, risks of non-performance.	3
Who sets standards?	2
Reserves requirement against contingencies not clear.	1

Other answers:

Answer	Votes
Barriers to success lie in uncovering new hurdles.	0

Unknown unknowns.	
Excessive change.	0
Rules of participation aren't clear.	0

Question 2: What risks are you concerned with? Suggestions to address these?
<u>Top answers:</u>

<u>Risks</u>

Answer	Votes
Regulations are too slow to accommodate new technologies.	6
Auditability of transactions, physical and financial settlements, curation of data.	6

Solutions:

Answer	Votes
Differentiate assets based on their interoperability/features (gold/silver/bronze tiers).	6

Risk/Solution pairs:

Answer	Votes
Risk: Market manipulation.	0
Solution: Market enforcement.	0
Risk: The number of nodes.	0
Solution: decentralized control, expand centralized control using aggregation.	0

<u>Other answers:</u>

Risks:

Answer	Votes
Increased risk of DDOS attacks.	3
Winner-take-all, low market diversity.	1
Privacy & Protections.	1
Maintaining data geolocation.	0
Jurisdictional gridlock.	0
Opacity of Nest network.	0
Data network resiliency.	0
Forward investment adequacy.	0

Solutions:

Answer	Votes
TE is a regulated utility.	3

Standards/Liability for software	2
More federal funding for proof of concept ideas.	2
Google disrupts from the bottom up, or forces access to smart meter data.	1
Preemptive regulatory actions & experiments.	1
Laissez-faire.	0
Architectural specs that are auditable/simulatable.	1
Minimal information standards for transactions/market participation.	0

TRANSACTIVE ENERGY: NEXT STEPS

The growth in attendance, active discussions, and response to the call for abstracts indicate a growing community of interest and practice for the topic of transactive energy systems. The International Panel provided a valuable perspective of the global nature of the challenges facing the industry which transactive energy systems can address. The applicability of transactive energy systems was described for both green field efforts in developing countries such as India and in mature economies in Europe and Australia, reinforcing the flexibility for the applications of these systems. The expanding deployment of diverse mixes of resources and the growing deployment of intelligent devices and systems within both the power systems and end uses of electricity call for these new approaches to coordinating supply and demand.

In spite of this growth in interest and activity there is much work to be done. As outlined by Chris Irwin, for the U.S. Department of Energy, work is needed on modeling, valuation, theory, further field deployment and testing, and in working through business, policy and regulatory dimensions. This challenging work is interdisciplinary and cuts across traditional stovepipes within the electric power system industry, the end uses of electricity, and between the two. The need for integrated approaches based on sound system architecture principles was emphasized in the material presented by Jeff Taft, as well as the need for interdisciplinary teams to address the challenges ahead.

At the time of the Conference and in the recent months discussions have continued in parts of the United States that are seeing drivers for change in the near future. Massachusetts, Minnesota, California, New York, and Hawaii have ongoing activities that have begun to include the notion of transactive energy systems in their discussion of the future of their respective power grids.

A similar set of activities were summarized for us by Mark Paterson from the Commonwealth Industrial and Scientific Research Organization (CSIRO) in Australia. Based on Australia's work with their Future Grid Forum Mark described the response they are developing to the changing nature of their grid and emphasized the growing consensus that transactive approaches are required. As he stated in his closing remarks, "The question isn't what will it cost to implement transactive energy but rather what will is the cost of not implementing transactive energy."

With that in mind we look forward to continued activity and progress and your participation in the 3rd International Conference and Workshop on Transactive Energy in 2016.

Closing Comments & Special Thanks

The GridWise® Architecture Council and Smart Grid Oregon thank all of the speakers, session leaders, student volunteers and sponsoring organizations. Last, but not least, we thank the participants. The discussions during the course of the conference and the workshop sessions are very valuable in helping the GWAC prepare the Transactive Energy Framework.

Organizers

The Council organized the First International Transactive Energy Conference and Workshop as part of its mission to further advanced thinking about the guiding principles, or architecture, of a highly intelligent and interactive electric system.

Program Committee

Ron Ambrosio, IBM Research, GWAC Past Chairperson Emeritus
Paul De Martini, Newport Consulting, GWAC Member Emeritus
William Cox, Cox Software Architects
James Mater, QualityLogic, GWAC Member
Ron Melton, PNNL, GWAC Administrator
Aryeh Fishman, Edison Electric Institute
Erich Gunther, EnerNex, GWAC Chairperson Emeritus
Mark Knight, CGI, GWAC Chair
Terry Oliver, BPA
Anant Venkateswaran, Utilities Consulting

Planning Committee

Kelly Cowan, Smart Grid Northwest
Roger Hicks, Smart Grid Northwest
Sherry Kowalski, GWAC Project Coordinator
James Mater, Smartgrid Northwest and GWAC Member
Ron Melton, GWAC Administrator
Ken Nichols, EQL Energy
Portland General Electric
Ken Wacks, GWAC Member

Downtown Portland

Our Sponsors

PREMIUM SPONSORS

GOLD SPONSORS

SILVER SPONSORS

SUPPORTING SPONSORS

ENDORSING SPONSORS

Appendix A – Reference Material

Advanced Grid Planning & Operations
http://www1.eere.energy.gov/solar/pdfs/advanced_grid_planning_operations.pdf

AEP Demonstration Project website
http://www.smartgrid.gov/project/aep_ohio_gridsmartsm_demonstration_project

A Foundation for Transactive Energy in a Smart Grid World
http://www.pointview.com/data/files/2/1062/1878.pdf

Bain & Co. Distributed Energy Business Models
http://www.bain.com/publications/articles/distributed-energy-disrupting-the-utility-business-model.aspx

Caltech Resnick Institute Grid2020 Discussion Series
http://www.resnick.caltech.edu/learn/grid.html

Cisco Ultra Large-Scale Power System Control Architecture
http://www.gridwiseac.org/pdfs/cisco_control_architecture_white_paper.pdf

Control of the Grid in 2020, and How Economics Can Help Us
http://www.newton.ac.uk/programmes/SCS/seminars/2013042409301.html

DOE Building Technologies Office
http://www1.eere.energy.gov/buildings/index.html
http://www1.eere.energy.gov/buildings/technologies/sensors_controls_research.html
http://www1.eere.energy.gov/buildings/commercial/index.html

Electric Utility Business Models of the Future
http://www.edisonfoundation.net/iee/Documents/Fox-Penner_IEE_071510_Final.pdf

Energy Interoperation Version 1.0
http://docs.oasis-open.org/energyinterop/ei/v1.0/cs02/energyinterop-v1.0-cs02.html

Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide
http://www.sandia.gov/ess/publications/SAND2010-0815.pdf

German energy consumers transform into local energy providers
http://www.guardian.co.uk/sustainable-business/blog/german-bioenergy-villages-energy-supply

Green Button
http://energy.gov/sites/prod/files/Green.Button.webinar.for_.DOE_.Apps_.Energy.pptx

Grid 2020: Towards a Policy of Renewable and Distributed Energy Resources
http://resnick.caltech.edu/learn/docs/GRID_2020_Resnick%20Report.pdf

GridWise Architecture 2011Transactive Energy Workshop
http://www.gridwiseac.org/

GridWise Architecture Council 2012 Transactive Energy Workshop Proceedings
http://www.gridwiseac.org/pdfs/tew_2012/tew_2012_proceedings.pdf

GridWise Architecture Council 2013 Transactive Energy Conference Proceedings
http://www.gridwiseac.org/pdfs/gwac_tec_052313/tec_2013_proceedings_pnnl_sa_96361.pdf

GridWise Architecture Council 2013 Transactive Energy Workshop Proceedings - December
http://www.gridwiseac.org/historical/tew2013/tew2013.aspx

GridWise Architecture Council Transactive Energy Framework
http://www.gridwiseac.org/pdfs/te_framework_report_pnnl-22946.pdf

GridWise Architecture Council Transactive Energy Infographics
http://www.gridwiseac.org/pdfs/te_infographics_061014_pnnl_sa_103395.pdf

GridWise Architecture Council Transactive Energy Principles
http://www.gridwiseac.org/pdfs/te_principles_slide_pnnl_sa_103625.pdf

Integrated DER Pricing & Control
http://newportcg.com/wp-content/uploads/2012/11/CIGRE_DER_PricingControl082412.pdf

LBNL CERTS Distributed Resource Integration Website
http://certs.lbl.gov/certs-randm.html

Navigant - Potential Use of IOU Demand Response Programs for Integration of Wind and Solar Energy Needed to Achieve California's Renewables Portfolio Standard
http://www.cpuc.ca.gov/NR/rdonlyres/E77C1B30-2989-463F-A178-E8610410AEA6/0/UseofDRforRenewableEnergyIntegration.pdf

New utility business models: Experts predict the 3 stages of our evolution
http://www.smartgridnews.com/artman/publish/Business_Electronomics/New-utility-business-models-Experts-predict-the-3-stages-of-our-evolution-4481.html#.UYR-tmbn_IU

Pacific Northwest Demonstration Project website
http://www.pnwsmartgrid.org/publications.asp

Potential Role of Demand Response Resources in Maintaining Grid Stability and Integrating Variable Renewable Energy
http://www.calmac.org/publications/7-18-12_Final_White_Paper_on_Use_of_DR_for_Renewable_Energy_Integration.pdf

Renewable and Distributed Power in California
http://media.hoover.org/sites/default/files/documents/energy-policy-tf-grueneich-study.pdf

Resnick Institute Report – Grid 2020: Towards a Policy of Renewable and Distributed Resources
http://www.energy.ca.gov/2012_energypolicy/documents/2012-11-07_workshop/2012-11-06_Resnick_Institute_Report-Grid_2020_Towards_a_Policy_of_Renewable_and_Distributed_Energy_Resources_TN-68383.pdf

SGIP SGAC Conceptual Model and Details
http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPCommitteeProductsSGAC/Smart_Grid_Conceptual_Model_20100420.pdf

Southern California Edison's Approach to Evaluating Energy Storage
http://www.edison.com/files/WhitePaper_SCEsApproachtoEvaluatingEnergyStorage.pdf

Standardization of a Hierarchical Transactive Control System
http://www.gridwiseac.org/pdfs/forum_papers09/don-business.pdf

Transaction-based Techniques for Bulk Power Operation Will Be Useful in Distribution
http://smartgrid.ieee.org/september-2011/158-transaction-based-techniques-for-bulk-power-operation-will-be-useful-in-distribution

Transactive Device Architecture and Opportunities
http://www.cazalet.com/images/GI12-Paper-12032012-Final_Cazalet_Sastry.pdf

Understanding Microgrids as the Essential Architecture of Smart Energy
http://www.gridwiseac.org/pdfs/forum_papers12/considine_paper_gi12.pdf

Ultra Large-Scale Power System Control Architecture
http://www.cisco.com/web/strategy/docs/energy/control_architecture.pdf
Virtual Power Plants, Real Power
http://spectrum.ieee.org/energy/the-smarter-grid/virtual-power-plants-real-power

Virtual Power Plants in Real Applications in EU
http://www.iwes.fraunhofer.de/de/publikationen/uebersicht/2009/virtual_power_plantsinrealapplications-pilotdemonstrationsinspai.html

Appendix B – Agenda

Wednesday December 10, 2014

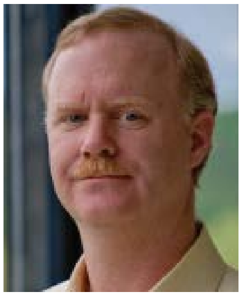
Time	Session
7:30am - 8:00am	Arrival and Check-In
8:00am - 8:30am	Day 1, Welcome Comments
8:30am - 9:15am	Day 1, Opening Keynote - Carl Pechman and Roland Risser (U.S. Dept. of Energy)
9:15am - 10:30am	Day 1, Foundational Session - GWAC - TE Framework / Roadmap
10:30am - 11:00am	Break and Exhibits
11:00am - 12:30pm	Day 1, Paper Session 1 (Barriers)
11:00am - 12:30pm	Day 1, Paper Session 2 (Engagement)
12:30pm - 2:00pm	Day 1, Luncheon Keynote - Carl Imhoff (Pacific Northwest National Laboratory)
2:00pm - 3:30pm	Day 1, Workshop 1 (Barriers)
2:00pm - 3:30pm	Day 1, Workshop 2 (Engagement)
3:30pm - 4:00pm	Break and Exhibits
4:00pm - 5:00pm	Day 1, Plenary Panel: Regulatory, Legislative and Policy Considerations for Transactive Energy
5:00pm - 5:30pm	Day 1, Closing Comments
5:30pm - 7:00pm	Evening Reception (Day 1)

THURSDAY, DECEMBER 11, 2014

Time	Session
8:00am - 8:30am	Arrival and Check-In
8:30am - 9:30am	Day 2, Welcome and Keynote Speaker
9:30am - 10:00am	Break and Exhibits
10:00am - 11:30am	Day 2, Plenary Panel: International Perspectives on Transactive Energy
11:30am - 12:00pm	Break and Exhibits
12:00pm - 1:30pm	Day 2, Luncheon Keynote - Aryeh Fishman (Edison Electric Institute)
1:30pm - 3:00pm	Day 2, Paper Session 3 (From DR to TE)
1:30pm - 3:00pm	Day 2, Paper Session 4 (Security)
3:00pm - 3:15pm	Break
3:15pm - 4:45pm	Day 2, Workshop 3 (From DR to TE)
3:15pm - 4:45pm	Day 2, Workshop 4 (Security)
4:45pm - 5:15pm	Day 2, Wrap-up Conclusions and Adjourn

GRIDWISE Architecture Council

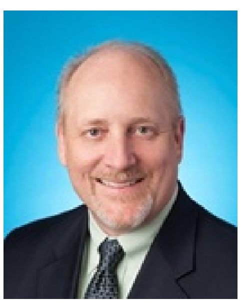
APPENDIX C – SPEAKER'S PROFILES



Ron Ambrosio

Vice President, Transmission and Distribution, Portland General Electric

Ron Ambrosio oversees IBM's Energy & Utilities Industry activities in its eight world-wide Research Laboratories. Ron joined IBM in 1981 at the T.J. Watson Research Center, working in a variety of areas including embedded operating systems, distributed application frameworks and pervasive computing environments, ultimately focusing on networked embedded computing with particular emphasis on what he coined "Internet-scale Control Systems" – the interoperability of sensor networks and control systems with enterprise systems and business processes. He helped establish IBM's activities in both Intelligent Utility Networks and Sensors & Actuators.



Larry Bekkedahl

Global Research Executive, Energy & Utilities Industry, IBM T.J. Watson Research Center

As vice president, transmission and distribution, Larry Bekkedahl is responsible for PGE's transmission and distribution engineering and operations functions. He oversees the company's Transmission and Reliability, Engineering and Design, Distribution Services, Asset Management, System Control Center and Dispatch, and Substation Operations sections. He joined PGE in 2014

Bekkedahl was previously senior vice president for transmission services at the Bonneville Power Administration, and has held other leadership and management positions at BPA, Clark Public Utilities, PacifiCorp and Montana Power Company.

He holds a Bachelor of Science degree in electrical engineering from Montana State University, and serves on the Electric Power Research Institute's transmission executive committee, as a U.S. board member for the International Council on Large Electric Systems (CIGRE), and on the member's advisory committee for Peak Reliability, the reliability coordinator for the western grid. He is a strong supporter of technological innovation and has led efforts to deploy smart grid technologies, road maps, and wide-area visualization tools.

Bekkedahl also has international utility experience gained by participating in a six month exchange program with Hokuriku Electric Power Company in Toyama, Japan, developing hydro projects in the Philippines, and participating in United States Agency for International Development (USAID) exchange projects in Bangladesh, the Republic of Georgia, and the Philippines.

Chris Black

Chief Technology Officer, Chief Operating Officer, Tendril

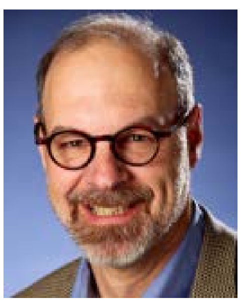
Chris Black has spent the past 18 years creating and growing numerous early to mid-stage software companies. He has an abiding passion for technology, operational improvement, and building smart, productive teams within a collaborative culture. Chris joined Tendril in 2011 as Chief Technology Officer with the goal of delivering world-class software solutions for the evolving energy market.

At Tendril, Chris applies his deep technology knowledge, performance management and leadership to his role as CTO. Chris is responsible for executing on Tendril's vision to deliver solutions that make a tangible difference in the way customers use energy.

Frits Bliek

Principal Consultant, Smart Energy

Frits Bliek is initiator and technical director of the USEF foundation, a joint industry initiative to develop a smart energy framework to accelerate the development of smart energy products, services and solutions. He is the founding father and program coordinator of PowerMatching City the first full concept smart energy demonstration. In 2010 he established the Smart Energy Collective that develops 4 large scale smart energy demonstration projects in the Netherlands based on the USEF framework. Frits joined DNV GL in 2003 and as a Principal Consultant he is responsible for innovation and business development in smart energy systems. He has over 15 years of experience in the energy industry along the entire energy value chain. He graduated at the FOM institute for Plasma Physics / University of Utrecht on Energy Physics (1993) and got his PhD at the Kernfysisch Versneller Instituut / Rijskuniversiteit Groningen on Atomic Physics and Thermonuclear Fusion (1997).



Ward Camp

VP, Regulatory & Environmental Policy, Landis + Gyr

A 30-year veteran of the energy and utility industry, Ward Camp is VP, Regulatory and Environmental Policy for Landis +Gyr Energy Management Solutions N.A. He is a current board member of the GridWise Architecture Council, Co-Chair of the SGIP Business and Policy, Domain Expert Working Group and the Demand Response and Smart Grid Coalition (DRSG). He is also a member of the GridWise Alliance and the Association for Demand Response & Smart Grid (ADS). Previously, he served in executive roles as part of the Senior Management of DCSI (now Aclara), USPowerSolutions and Avistar, a Public Service Company of New Mexico subsidiary. Mr. Camp has worked extensively with utilities and public utility commissions throughout the United States. He spent the first 17 years of his career as an attorney with a focus in energy and utilities. Mr. Camp obtained his Juris Doctor from the University of Oklahoma.

Ed Cazalet

CEO, The Cazalet Group

An internationally recognized electric industry expert, Dr. Cazalet is a leader in the analysis and design of markets for electricity and the analysis of transmission, generation and load management investments. For his industry contributions, Public Utilities Fortnightly magazine in 2000 named Dr. Cazalet “Innovator of the Year”. Ed is also Vice President and Co-Founder of Megawatt Storage Farms, Inc., storage advisory and project development firm. He formerly was a Governor of the California Independent System Operator and founder and CEO of both Automated Power Exchange, Inc. (APX) and Decision Focus, Inc. (DFI). He has a PhD from Stanford in Engineering-Economic Systems. Dr. Cazalet is Co-Chair of the OASIS Energy Market Information Exchange (eMIX) Technical Committee and a member of the OASIS EnergyInterOp and WS-Calendar Technical Committees.

Shawn Chandler

Smart Grid Architect, Portland General Electric

Shawn Chandler is the Smart Grid Architect at Portland General Electric, Oregon’s largest electric utility. Mr. Chandler provides expertise regarding technical process development in support of next-generation electrical system design and smart-grid development. His prior management roles include Chief Technology Officer for Camouflage Media, a pervasive technology implementer and Director of Information Systems for Enkido, a North American optical telecommunications carrier. Mr. Chandler is a member of Smart Grid Oregon, the Smart Grid Interoperability Panel (SGIP), the executive project committee for the Solar Electric Power Association and a member of the Interoperability and Standards Working Group for the DOE Pacific Northwest Smart Grid Demonstration Project. Mr. Chandler is a graduate of Portland State University and Atkinson School of Management, Willamette University.

Jason Crabtree

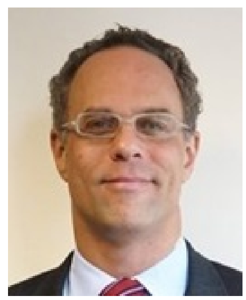
Chief Executive Officer, Rationem

Jason Crabtree is the CEO of Rationem, where he leads an effort focused on developing next-generation operational risk management and situational awareness tools and the improvement of cyber information-sharing. Rationem also provides bespoke analysis, advisory, and technology development services with an emphasis on risk management and intelligent decision-support systems for the most demanding security, risk management, energy and financial services applications.

Jason most recently served as a Special Advisor to senior leaders in the defense cyber community, with responsibilities ranging from policy advice and operational support, to research direction and technology transition with partners across the Intelligence and Defense enterprise. He is a licensed professional engineer and complex adaptive systems aficionado with a strong background in modeling, simulation, and data analysis who is currently focused at the nexus of cyber security, critical infrastructure, and operational risk management. He also serves as a contributor and consultant for global strategic analysis and geopolitical risk management firms including Oxford Analytica.

He has been an invited participant, panelist and speaker on energy, risk management, finance, and security for organizations including the Financial Services Roundtable, the Center for New American Security, the Markle Foundation, the Ditchley Foundation, the Gridwise Architecture Council, and RAND in both the United States and United Kingdom. Jason is the co-author of Driven by Demand: How energy gets its power, which is being published by Cambridge University Press in 2015. He is currently co-authoring two additional books on cybersecurity one is focused on decision-making and risk management for industry professionals while the second is focused on a discussion of U.S. national security strategy for cyberspace in the face of increasing transitive risks, exposure to common mode failures, and technology democratization.

Jason has also worked extensively on large-scale cyberspace modeling, analysis, and risk management technology research, to include supporting ongoing work within the Defense Advance Research Agency's cyberspace portfolio. Jason was also selected as a 2014 Cyber Policy Fellow with the Madison Policy Forum in New York City. He holds a B.S. in engineering from the United States Military Academy at West Point, where he was selected as the First Captain and Brigade Commander of the Corps of Cadets and elected as a Rhodes Scholar (Washington and Magdalen) and Marshall Scholar (declined). He later completed an M.Sc. by Research in Engineering Science at the University of Oxford before leading infantry troops in Afghanistan in 2012. Jason is also a graduate of the U.S. Army Ranger School, Sapper Leader Course, Airborne School, the Asymmetric Warfare Group Adaptive Leader Program, and an Honor Graduate of Pathfinder School.



Aryeh Fishman

Associate General Counsel, Edison Electric Institute

Aryeh practices law and policy before the Federal Energy Regulatory Commission, the Federal Communications Commission, the Department of Energy and other federal agencies, departments and appellate courts. Aryeh provides advice and leadership to the investor-owned electric industry on a wide variety of issues. Aryeh also supports legislative matters in his areas expertise by participating in strategy development, analyzing and proposing legislative modifications.

Prior to joining EEI, Aryeh provided counsel in private practice to investor-owned electric and gas utilities, public power entities, industrial energy customers and major financial institutions on electric and gas utility regulation. He participated in administrative and appellate litigation, as well as advising on a variety of energy-related transactional matters.

David Forfia

Senior Director, Information Technology Services, Electric Reliability Council of Texas

David Forfia is Director of Enterprise Architecture at the Electric Reliability Council of Texas, or ERCOT, where he is responsible for the IT architect for the systems which maintain electric grid operations 24/7. During his tenure at ERCOT, he has served in many roles including Director of Infrastructure & Operations, Application Services and multiple roles on the Texas Nodal implementation. He has more than 25 years of experience in the industry, and began his career at Austin Energy in 1987. Forfia received his bachelor's from the University of Texas and MBA from St. Edward's University, both in Austin. Forfia is PMP certified and currently sits on the Board of the Smart Grid Interoperability Panel.

Erich Gunther

Chief Technology Officer, EnerNex

Erich Gunther is the Chairman and Chief Technology Officer for EnerNex Corporation in Knoxville Tennessee where he helps EnerNex clients define their strategic direction in basic R&D, technology and product development. Mr. Gunther has 30 years of experience in design and development of innovative solutions to a wide array of power system problems, most notably ways to take advantage of communications networks and technology to improve the efficiency, operating practices and security of the electric power system. Erich has a leadership role in many of the key grid modernization groups and standards organizations including the GridWise Architecture Council, IEEE PES Intelligent Grid Coordinating Committee and the Utility Communications Architecture International Users Group as the chairman of those organizations. He is presently serving as the administrator for the NIST SGIP effort and is working with several utilities developing their smart grid development roadmaps.

Erich received his Masters of Engineering degree in electric power from Rennsaelaer Polytechnic Institute in 1984. He is a registered professional engineer in Tennessee and speaks geek in multiple languages including power systems engineering, computer science, enterprise architecture, and communications technology. Presently he is applying his skills in promoting the application of systems engineering principles to smart grid development, and he is actively facilitating information exchange among the many organizations and institutions working on smart grid development.

Becky Harrison

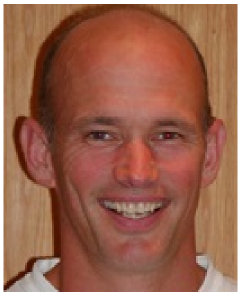
Chief Executive Officer, GridWise Alliance

Becky Harrison is the CEO of the GridWise Alliance. The GridWise Alliance, founded in 2003, is a coalition of public and private stakeholders that advocates for the transformation of the electric grid to achieve a sustainable energy future. The Alliance facilitates the effective collaboration among stakeholders, to promote, educate, and advocate for the adoption of innovative smart grid solutions that will intelligently integrate the actions of all users and devices connected to it.

Under Harrison's leadership, the GridWise Alliance has developed a state-by-state Grid Modernization Index, which ranks states on how they are doing in modernizing their electric grid. Recently, the Alliance partnered with the Office of Electricity Delivery and Energy Reliability at the Department of Energy to conduct a series of regional workshops, followed by a National Summit in Washington, DC to develop an industry driven vision of the role of the grid, the grid operator in 2030 and recommendations for advancing the industries efforts to achieve this vision.

Prior to joining the GridWise Alliance, Harrison was the Director, Smart Grid Technology and Outreach for Progress Energy. She was responsible for establishing the Progress Energy's Smart Grid Program for both its Carolina and Florida service territories. Under Harrison's leadership, Progress Energy was awarded a $200M ARRA Smart Grid Investment Grant.

Harrison has a BS in Electrical Engineering from the University of South Carolina and an MBA from Wake Forest University. She is a registered professional engineer in North Carolina and South Carolina with over 25 years experience in the electric utility business in distribution and information technology. Harrison has managed several successful business transformation efforts that leverage new technologies to drive business value. Harrison is active in the industry's efforts to advance Smart Grid..



Graham Horn

Vice President, Business Development, Enbala Power Networks

Graham leads all Business Development initiatives for Enbala in Western North America, including Hawaii. His primary responsibility is to develop and advance Enbala's control and optimization solutions within large, multi-stakeholder sales opportunities.

Prior to Enbala, he was Executive Vice-President and Chief Operating Officer of Cloudworks Energy Inc., a BC-based developer of small hydroelectric facilities. Graham holds a Bachelor's degree in Economics from the University of Victoria and a Master's in Business Administration from the University of British Columbia.

Doug Houseman

Vice President Technology and Innovation, Enernex

Doug Houseman is a 30 year veteran of the utility and consulting industries. He is a retired Naval Officer who has worked on 6 continents on issues related to electricity, water, and gas. He is recognized as an industry leader in demand management and smart energy.

Carl Imhoff

Manager, Pacific Northwest National Laboratory

Mr. Imhoff manages the Electric Infrastructure market sector within Pacific Northwest National Laboratory's Energy and Environment Directorate. The market sector conducts advanced electric infrastructure research and product development with the U.S. Department of Energy, state governments, vendors and commercial energy firms. In this role he is responsible for PNNL's research and development programs on innovations in the areas of advanced power transmission reliability concepts, demand response, development of improved integration concepts for renewable energy generation technologies, policy and strategy for smart grid concepts and cross-cutting grid analytic tools in visualization and high performance computing. It is widely recognized that PNNL's grid activities bring substantial impact and thought leadership to the nation's smart grid agenda. During his 30 years at PNNL, Mr. Imhoff has conducted and managed a broad range of energy research. His technical work emphasizes systems engineering and operations in the areas of power system reliability, smart grid, energy efficiency, energy storage and clean generation. He has been actively involved in a number of electric power system organizations and bodies, including the North American Synchrophasor Initiative, the GridWise Alliance, the Consortium for Electric Reliability Technology Solutions and the Western Electric Coordinating Council.

Chris Irwin

Smart Grid Standards and Interoperability Coordinator, U.S. Department of Energy

Christopher Irwin has spent over 17 years in a diverse spectrum of high technology fields from HVAC to III-V semiconductor manufacturing, and most recently in communication networks for advanced metering (AMI) and Smart Grid infrastructure. He is a member of the Department of Energy team administering the Smart Grid Investment Grants, and is responsible for standards and interoperability activities, including participation in the NIST-led Smart Grid Interoperability Framework.

Prior to joining the Department of Energy, he served as Director of Products at an AMI communications vendor, also participating in Technology Discovery and Business Development. In that role, he gained a full market perspective on the electric energy sector, as well as natural gas and water infrastructure. This experience, combined with his semiconductor and satellite communications background, contributes to a unique perspective on the US energy business under transformation. Chris holds a B.S. in Mechanical Engineering from the University of Maryland, College Park, and an M.B.A. from the W.P. Carey School of Business at Arizona State University.

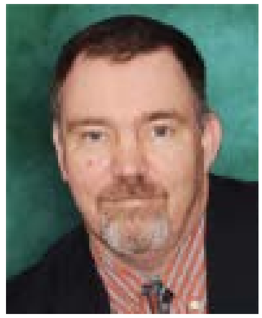
Philip Jones

President, NARUC

Appointed by Governor Gregoire in March 2005, re-appointed in January 2011 and confirmed unanimously by the State Senate, Commissioner Jones is currently President of NARUC and serves as chair of its Board of Directors and its Executive Committee. He previously served on the Board of NRRI (National Regulatory Research Institute) and as its chair and co-chaired the Washington Action Program. Commissioner Jones is a member of the International Relations and Telecommunications Committees of NARUC. Prior to his commission appointment, he served as managing director of Cutter & Buck (Europe), BV in Amsterdam, the Netherlands for five years.

From 1983 to 1988 he served as senior legislative assistant to Senator Daniel J. Evans, the former U.S. Senator from Washington State, and staffed him on energy policy issues before the Senate Energy and Natural Resources Committee, as well as international trade policy. He was responsible for a broad range of energy issues, including hydroelectric re-licensing, nuclear waste management, energy conservation and renewables and the Bonneville Power Administration.

Jones is a native of Spokane, Washington. He graduated from Harvard College with honors with a degree in East Asian Studies in 1977.



Mark Knight

Executive Consultant, Energy Solutions, CGI

Mark Knight is an Executive Consultant in CGI's USEM IP Solutions & Onshore Delivery Business Unit where he works with Utilities to enhance operations and business practices. Mr. Knight draws upon 25 years of experience to deliver business solutions that leverage the integration of people, business (processes, systems, data) and technology to support innovative, effective and practical solutions for CGI's clients.

Mr. Knight's background includes a mix of information technology work and business process work both as a consultant and as a utility employee in the United Kingdom and the United States and has spanned several areas including distribution, transmission, metering, systems integration, deregulation, interoperability, asset management and risk management.

Mr. Knight is a graduate of Imperial College, London and is also a member of the GridWise Architecture Council, a group formed by the U.S. Department of Energy to promote and enable interoperability among the many entities that interact with the nation's electric power system. The GWAC has broad, balanced representation among its 13 members selected to represent the full spectrum of industry and academia.

Koen Kok

Senior Scientist Intelligent Electricity, TNO

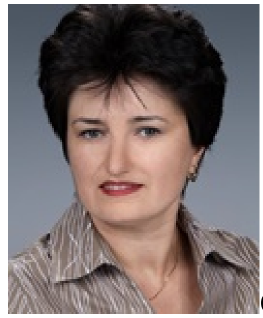
Koen Kok is Senior Scientist Intelligent Electricity Systems at TNO, the largest applied research institute in The Netherlands, and part-time Visiting Researcher at the Center for Electric Power and Energy (CEE) of the Danish Technical University DTU. He is involved in several research and development projects focusing on the integration of renewable energy into the electricity system through demand response, dynamic pricing and transactive energy systems. Kok is one of the inventors of The PowerMatcher, an award winning transactive smart grid technology that improves the integration of renewable generation and mitigates congestion (i.e. local network overloading) in distribution networks. This technology has been field deployed and is commercialized through the Flexiblepower Alliance Network (FAN) in an open innovation model.

Reji Kumar

President, Smart Grid India Forum

Reji Kumar is a renowned expert in the power sector with 30 years of global experience in the electricity industry in diverse functions across the entire value chain. He has been a key member of many multidisciplinary teams that were engaged in reform and restructuring of power and water utilities in Asia, Middle East, and Africa. He possesses advanced qualifications in Engineering, Finance, Management and Law. In his most recent role as head of Energy & Utilities industry vertical in IBM India/South Asia, Reji spearheaded promotion of Smart Grids in India. Prior to IBM, Reji was the founder and CEO of a highly successful energy infrastructure services company operating in the APAC and Middle East regions. He has also worked in National Thermal Power Corporation (NTPC), India's largest energy producer and was a Senior Consultant with ADB, USAID and World Bank. A recognized thought leader in Smart Grid technologies, Reji is a popular key-note speaker at international symposiums and conferences on Smart Grids and Cleantech. He has contributed to several articles and books. Reji is a member of Indian Angel Network (IAN), India's largest angel network and serves on the board of several technology startups.

Reji is also the President of India Smart Grid Forum, a public – private partnership initiative of Government of India for accelerated development of smart grid technologies in the Indian Power Sector.



Cristina Marinovici

Software Engineer, Pacific Northwest National Laboratory

Cristina Marinovici (M'2010) has an MS and PhD in Mathematics from Louisiana State University, an MS in Automated Controls and BS in Computer Science from "Gh. Asachi" Technical University of Iasi in Romania. She joined the Pacific Northwest National Laboratory (PNNL) as a software engineer in August 2010. At PNNL, as part of the Advance Power and Energy Systems group, Dr. Marinovici is responsible for directing and supporting the research and development of techniques and tools that assist in ensuring the reliability and security of the electric grid in North America. Her research interests include power system operations, smart grid and renewable energy integration, as well as scientific computing and parallel processing. She is a member of the IEEE, IEEE Women in Engineering (IEEE WIE), Society of Women Engineers (SWE), and the Society of Industrial and Applied Mathematics (SIAM).

Tracy Markie

President / Chief Executive Officer, Engenuity Systems

Tracy Markie has more than 25 years of experience in the control systems and energy markets. He is President/CEO of Engenuity Systems, Inc., a leading distributor and value-added-reseller of energy solutions and building automation products.

Mr. Markie participates in a number of industry groups. He is currently serving on the GridWise Architecture Council, a group sponsored by the U.S. Department of Energy. Mr. Markie also serves on the boards of LonMark International, as Chairman, LonMark Americas and the SunSpec Alliance, an association dedicated to bring interoperability standards to the solar industry.

A published author and presenter, Mr. Markie's articles on the subjects of automation and energy management using networked solutions have appeared in more than a dozen national publications. He often participates at local and national industry and business events as an invited speaker.

Mr. Markie is a Certified Energy Manager and a Certified LonWorks Professional. He received his B.S. in Electrical Engineering Technology from the University of Maine and his MBA from the University of Connecticut, specializing in marketing, finance and management information systems. He has held various technical and managerial positions at National Semiconductor, Norden Systems/United Technologies, Intel Corporation, and Tronix Corporation.

James Mater

General Manager and Smart Grid Director, QualityLogic, Inc.

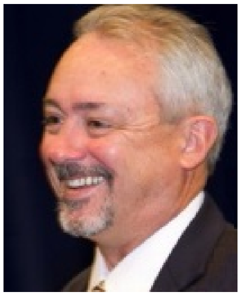
James Mater co-founded and has held several executive positions at QualityLogic from June 1994 to the present. He is currently Co-Founder and Director working on QualityLogic's Smart Grid strategy, including work with GWAC, the Pacific Northwest Smart Grid Demonstration Project, the SGIP Test and Certification Committee and UCA's OpenSG Conformity Work Group, which includes giving papers and presentations on interoperability. From 2001 to October 2008, James oversaw QualityLogic as President and CEO. From 1994 to 1999, he founded and built Revision Labs, which merged with Genoa Technologies to become QualityLogic. Prior to QualityLogic, James held product management roles at Tektronix, Floating Point Systems, Sidereal and Solar Division of International Harvester. Mater holds a BS degree in physics from Reed College, Portland, Oregon and an MBA from the Wharton School, University of Pennsylvania.

Ronald Melton

Administrator, GridWise Architecture Council, Pacific Northwest National Laboratory

Ron Melton is the administrator of the GridWise® Architecture Council (GWAC) and a senior power systems engineer at Pacific Northwest National Laboratory. He is also Project Director for the Pacific Northwest Smart Grid Demonstration Project, managed by the Pacific Northwest Division of Battelle.

Dr. Melton has over 25 years of experience in systems engineering applied to interdisciplinary problems. He received his BSEE from University of Washington and his MS and PhD in Engineering Science from the California Institute of Technology.



Terry Mohn

Chief Executive Office, General MicroGrids, Inc.

Terry Mohn is CEO of General MicroGrids, an international microgrid consultancy and developer. He also is Managing Partner of CleanSource Energy Partners, LLC, an international renewable energy project developer. He is also Program Director of the Global Microgrid Center (501 c3), a microgrid test and certification center. He recently started the Microgrid Alliance, a non-profit organization based in Washington DC, focused on microgrid advocacy.

He is also the United Nations Foundation MicroGrid Work Group Chairman and presently serves his second three year appointment as the Department of Commerce's federal advisor to NIST in its Smart Grid Federal Advisory Committee.

He has 30 years' experience in large-scale system architecture, business strategy, and technology investment strategy. Terry also is very involved in technology research, funding and commercialization and works closely with major California universities.

Terry is an advisor to the DOE for smart grid and advisor to the California Energy Commission for demand response and emerging technologies.

Terry was previously chief technology strategist for the Sempra Energy utilities, with emphasis on smart grid. He specialized in the application of modern technology for all parts of the utility business. While with Sempra, Terry became a founding member and Vice Chairman of the GridWise Alliance.

Terry was very involved writing and editing the GWAC Framework for Interoperability, EPRI's Intelligrid and Galvin's Electricity Initiative.

Prior to his energy roles, Terry was chief technology officer for an international broadband media company and founder of two Internet companies.

Jeff Morris

Representative, Washington House of Representatives

Jeff represents the 40th District that includes San Juan County and parts of Skagit and Whatcom Counties.

A fourth-generation native of the San Juan Islands, Morris is one of the preeminent sources of critical thought on policy issues in the public and private sectors in the areas of energy, critical infrastructure, biotechnology, and technology commercialization.

His private sector work in energy policy and assisting new energy technology companies is internationally recognized. Morris has been selected by his North American peers to head two regional policy organizations in the Council of State Governments West and the Pacific Northwest Economic Region and co-found Northwest Energy Angels. Morris owns his own business Energy Horizon LLC.

Paul Murdock

Chief Software Architect, Landis + Gyr

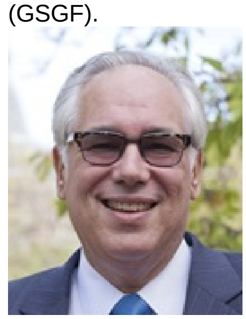
Paul has many years experience in software engineering and has held development, architecture and management positions in research, financial and industrial organizations. He joined Landis+Gyr as Chief Software Architect in December 2008 and as a member of the corporate CTO Team has responsibility for software strategy across the Landis+Gyr group. Paul is a longstanding member of the ACM and the IEEE and is a member of the Swiss IEC TC57.

Mark Paterson

Domain Leader - Grids & Renewable Energy Integration Follow CSIRO, National Energy Flagship

Mark leads the CSIRO Energy Flagship's applied research and solution development for future electricity grids with a multidisciplinary team of approximately 30 researchers. He is responsible for the strategic direction and industry alignment of CSIRO's electricity research informed by both national and global developments. This involves the fusion of applied science, engineering, business and strategic foresight disciplines together with a distinctive outcomes-focused orientation.

Mark has three decades of professional experience across Australia's power and electro-mechanical industries. He chairs the CSIRO Future Grid Forum the Smart Grid Australia - R&D Working Group and, Standards Australia – AS/NZS4755 Demand Response committee. Mark is Australia's intergovernmental representative to the International Smart Grid Action Network (ISGAN) and also engages with the Global Smart Grid Federation (GSGF).



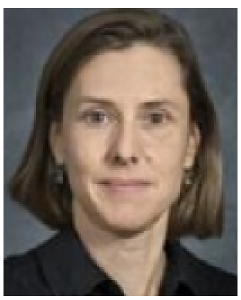
Carl Pechman

Senior Advisor for Electricity, U.S. Department of Energy

Dr. Carl Pechman is the Senior Advisor for Electricity for the Office of Energy Policy and Systems Analysis at the Department of Energy. He is an expert on the economics of electricity with extensive experience in state and federal regulation. During his tenure as an economist at the New York Public Service Commission, he worked on a wide variety of issues, including performance-based ratemaking, generation and transmission siting, avoided cost theory and estimation, Integrated Resource Planning, cost analysis and pricing, and creation of the New York Independent System Operator.

In 1997, Dr. Pechman founded Power Economics, Inc., a firm providing consulting and strategic advice to a broad array of clients (including major utilities, an array of customer groups from low income to industrial customers, Attorneys General, cities and national environmental groups), navigating the move to competition in the electric power industry. While at Power Economics, Dr. Pechman was involved in power market design, resource adequacy and power system design in various regions throughout the country. He acted as a special consultant to the Speaker of the California Legislature on efforts to resolve the California Energy Crisis and served as an expert witness to the California Parties on the causes and damages associated with the crisis. Dr. Pechman led review and made public the Enron Trader tapes that demonstrated their market manipulation practices.

Dr. Pechman left Power Economics to join the Office of Energy Policy and Innovation at the Federal Energy Regulatory Commission, where he worked on issues related to power market design, demand response, renewable resource integration and transmission planning. He is author of numerous papers on issues related to power markets, as well as the book "Regulating Power: the Economics of Electricity in the Information Age" (Kluwer Academic Publishers, 1993), which focuses on the role of models in the regulation of utilities and power markets. Dr. Pechman received his B.S., M.S. and Ph.D. degrees from Cornell University in Ithaca, New York.



Mary Ann Piette

DRRC Research Director, Lawrence Berkeley National Lab

Mary Ann Piette is a Staff Scientist at Lawrence Berkeley National Laboratory and the Director of the PIER Demand Response Research Center. http://drrc.lbl.gov/

Ms. Piette has at LBNL since 1983 and has extensive experience in energy efficiency and demand response research. Ms. Piette has a BA in Physical Science and a MS Degree in Mechanical Engineering from UC Berkeley and a Licentiate from the Chalmers University of Technology in Gothenburg, Sweden.

Ms. Piette provides a research perspective to her candidacy for the SGIP. She has experience working with government agencies, facility owners, utilities, control companies, technology developers, and other researchers and academics. She has worked closely with the California Public Utilities Commission, California Energy Commission, grid operators, EPRI, NIST, UCA, OASIS, and ASHRAE.

Ms. Piette was the lead researcher in developing the Open Automated DR Communication (OpenADR) Specification that was one of the 1st 16 Smart Grid standards announced by NIST and DOE in May 2009. OpenADR is an open data model for electricity prices and DR reliability signals. It is used in over 230 large facilities throughout the west and provides over 70 MW of DR and is used by over 30 companies providing interoperability between control systems and utility and ISO signals. This technology allows end-use systems to be pre-programmed automated DR strategies based on continuous signals from utility and ISO providers. Both commercial buildings and large industrial facilities are using this technology.

Ms. Piette has written over 90 conference papers, reports, and journal articles related to demand response and energy efficiency. Building are 70% of electricity use in the US and the dominant loads. The DRRC under her direction has developed public domain DR strategy guides and case studies for a number of sectors including buildings, refrigerated warehouses, and waste water facilities. The DRRC has also developed public domain simulation tools to allow facility managers to develop DR strategies using prototypical systems.

During 2009 OpenADR was demonstrated to provide ancillary services and spinning reserve DR capability automating DR in sites that had been participating in prices response programs. The DRRC worked with utilities to demonstrate fast DR automation using the same open data model.

Ms. Piette has been a leader in integrating new supply and demand side technologies to enable more intermittent low carbon power on the smart electric grid.

Tom Sloan

State Representative, Kansas House of Representatives

Rep. Sloan is serving his eighth term in the Kansas House of Representatives and is Chairman of the Vision 2020 Committee (House "long-range planning committee), as well as a member of the Energy & Utilities and Government Efficiency & Technology Committees. He is a leading legislative voice on Kansas' electric, natural gas, telecommunications, and water policies. He is a member of the National Wind Coordinating Committee's Steering Committee; Vice Chairman, Council on State Government's Energy & Environment Task Force; member, U.S. Dept. of Energy's Electricity Advisory Committee.

Rep. Sloan has organized 12 Summits on renewable energy/transmission lines; reservoir sustainability; rural broadband; and health-care research at which the Chairmen/Commissioners of FERC/FCC; Administrators of NIH/FDA; and Assistant Secretary of the Army joined Kansas and regional stakeholders to promote increased collaboration.

Dr. Sloan is Chairman of Douglas County Rural Water District #1, former member of the Lower Republican Basin Advisory Committee, and the only state legislator to serve on the Kansas Water Authority, the state's water planning body. He was Assistant Professor of Political Science at Kansas State University and continues to teach on public policy formation at Kansas University and private colleges.

Dr. Sloan is President of Sloan & Associates, a firm that facilitates strategic planning and general communications with the client's customers, employees, and other targeted audiences. The firm has advised and assisted small businesses in Kansas and regional professional associations in the mid-west since 1995. With his wife, Gail, he owns a registered sheep farm with non-irrigated corn, soybean, and hay production.

Dr. Sloan earned an A.B. from Syracuse University, M.A. from Michigan State University, and a PhD from the University of North Carolina at Chapel Hill. He has held management positions in the private and not-for-profit sectors. He was an Assistant Professor at Kansas State University, served as Chief-of-Staff for the President of the Kansas Senate, and has held other positions in Kansas' state government. He may be reached at Sloan & Associates, 772 Hwy. 40, Lawrence, KS 66049, 785-841-1526. On legislative matters, he may be reached at tom.sloan@house.ks.gov and on consulting issues at glsloan@prodigy.net

Bob Ran

Scientist, TNO

Bob Ran is currently working as a technical consultant in the area of Smart Grids in the Service Enabling and Management department at TNO (institute for applied science) in The Netherlands. He works in a various number of European and Dutch research projects where he develops and implements smart energy services for both pilots and commercial deployments. One of the main projects he have worked on is: the FlexiblePower Application Infrastructure. This is an open source framework for home gateways which comprises a runtime environment for energy services and a standardized protocol for information exchange with smart appliances. In this project he worked on many facets, namely: concept development, protocol development and the actual software implementation.

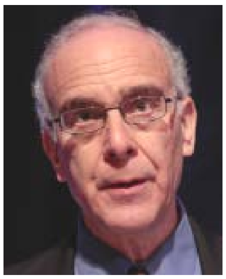
http://flexiblepower.github.io/
https://github.com/flexiblepower/

Rolland Risser

Director, Building Technologies Office, U.S. Department of Energy

Roland Risser is the Director for the Building Technologies Office (BTO) at the U.S. Department of Energy (DOE). BTO has an R&D portfolio of building-related technologies (Emerging Technologies), Residential and Commercial Market Integration programs designed to support the cost effective uptake of more efficient technologies and processes, the US model Building Code program, as well as the Appliance and Equipment Standards program. Prior to this position Roland was the Director of Customer Energy Efficiency for Pacific Gas and Electric Company (PG&E), and held many other positions there including Director of R&D, and Director of Tariffs and Compliance.

Roland has briefed Congress, State Agencies, FERC and national and international forums on energy issues, was a member of the National Action Plan for Energy Efficiency Leadership Group, Chairman of the Consortium for Energy Efficiency, an advisor to the Institute of Electric Efficiency, and a board member of the American Council for an Energy Efficient Economy (now ex officio). Currently, Roland is the Chairman of ISO Technical Committee 242 (ISO 50001 – Energy Management).



Martin Rosenberg

Editor-In-Chief, EnergyBiz

Martin Rosenberg is editor-in-chief of EnergyBiz, a national publication covering the energy industry that circulates to 24,000 senior executives and managers of the electric and natural gas industry, energy experts, analysts and regulators.

In 2005, 2006, 2007, 2008 and 2010, the magazine received prestigious Eddie Award gold medals in a competition sponsored by Folio magazine. The awards were for best execution of editorial mission by publications covering the "energy/utilities/engineering" sectors.

Martin Rosenberg has written extensively about energy, technology, finance and international business. His freelance work has appeared in the New York Times, USA Today, Seattle Times, Japan Times and other publications. He previously was editor-in-chief of Utility Business, a monthly publication that won numerous journalism awards.

He was a business writer at the Kansas City Star from 1985 to 1998 and worked for newspapers in Oregon. He was a Fulbright Fellow to Japan, where he studied economics, and he received a grant from the German Marshall Fund of the United States to study international energy and economic issues.

He is a graduate of Reed College and holds a Master's degree from Northwestern University's Medill School of Journalism. He and his wife, Matilda, reside in Kansas City and have three children.

Jason Salmi Klotz

Climate Change Lead, Oregon Public Utility Commission

Usman Sindhu

Siemens

Eight years of experience in consulting, market research, and advisory to provide actionable advice to IT professionals in implementing solutions that impact people, process, and technology for energy and other industries. Currently providing insights to energy companies and solution providers on a number of technology areas such as analytics, cloud computing, cybersecurity, data management, and social business. In addition, helping technology leaders such as Chief Information Officers (CIOs) succeed by understanding the impact of new technologies on the business models.

Jeffrey Taft

Connected Energy Networks Chief Architect, Cisco

Jeffrey Taft's focus is on the development of architectures for ultra-large scale systems, including smart grids and other smart structured physical systems, through the application of distributed sensing, data management and analytics and decision/control/optimization, supported by advanced low latency networking, to produce business outcomes.

His professional experience includes technology and technology strategy development, system architecture development, product and project engineering, process and methodology development, staff development and training, marketing, and management of business operations with P&L responsibility.

Specialties: Advanced architectures and integration for ultra large-scale systems utility systems, devices, operations, intelligent grid analytics, networking for utilities, signal processing, distributed and hierarchical decision/control/optimization, distributed and real time analytics and data management architectures.

Auswin Thomas

PhD Student, Iowa State University

I am Auswin, a PhD student in Electrical Engineering at Iowa State University (ISU), USA working under Professor Dr. Leigh Tesfatsion. In summer 2014, I worked as a PhD intern at the Pacific Northwest National Lab in Richland, Washington

My research interests are power system operations, power markets, computational optimization, mathematical modeling and power system software development. Here is my resume and a link to my google scholar profile.

I have always been fascinated by science and technology, apart from which, I love cooking and I am very much inclined to playing different sports and following them on TV/online as well.

Chris Villarreal

Regulatory Analyst, California Public Utilities Commission

Chris Villarreal is a Senior Regulatory Analyst in the Policy and Planning Division at the California Public Utilities Commission. Since 2008, he has been actively involved in the CPUC's Smart Grid proceeding, including cyber-security and privacy issues. He has been involved as part of Commission staff on a number of issues including demand response, dynamic pricing, energy storage and Smart Grid. Prior to joining the Commission, he was a Paralegal in Washington, D.C., primarily focused on energy matters before FERC. He has a BA in History from Baylor University.

Kenneth Wacks

President, Home & Utility Systems

Dr. Wacks has been a pioneer in establishing the home systems industry and a management advisor to 150 clients worldwide. His business spans home and building systems, utility customer services and digital entertainment networks (including HDTV and IPTV).

Corporate managers depend on Dr. Wacks to identify business opportunities in emerging markets with clear and practical advice relevant for product development and market positioning. Dr. Wacks serves companies of all sizes from startups to the Fortune 500. His worldview, insights and expertise are valued by executives for enabling competent decisions on complex technology issues. Clients seek his help to locate strategic business partners, financing and new customers. He also provides due-diligence for investors and expert witness services for litigants.

He was appointed by the U.S. Department of Energy to the 13-member GridWise Architecture Council to develop smart grid strategies for reliable and efficient distribution of electricity. For electric and gas utilities, he has designed and demonstrated new customer services by linking utility communications with home automation to deliver demand response and value-added services.

The Consumer Electronics Association chose Dr. Wacks to chair the international committee (ISO/IEC) establishing world standards for home and building automation. In addition, he has written American National Standards in home automation. He contributed to the development of standards for networking home appliances under the auspices of the Association of Home Appliance Manufacturers (AHAM).

Dr. Wacks is a frequent speaker and panel session organizer at industry conferences. He has written and delivered more than 200 papers and presentations, and has been granted patents in home systems.

Dr. Wacks chairs the Editorial Advisory Board of the CABA magazine iHomes & Buildings (available at www.caba.org) and is a featured contributor under the byline “Ken Wacks’ Perspectives.” He was honored with the inaugural CABA Volunteer of the Year Award. Dr. Wacks authored the book *Home Automation and Utility Customer Services*, distributed by Aspen Publishers. As an entrepreneur at a venture-backed startup, he developed UNIX workstations for the semiconductor industry. Dr. Wacks received his PhD from MIT as a Hertz Fellow and studied at the MIT Sloan School of Management.

Teresa Waugh

Public Affairs Specialist

Teresa Waugh currently leads communications and outreach for the Pacific Northwest Smart Grid Demonstration Project as a public affairs specialist for the Bonneville Power Administration. Her diverse set of experiences include directing public relations and marketing projects and programs at Denver International Airport, serving as one of the first civilian station managers of a military facility in Antarctica and performing as a major-market broadcast journalist for ABC. She holds a bachelor’s degree in digital technology and computer information systems.

Carl Zichella

Director of Western Transmission, Natural Resource Defense Council

Carl Zichella is the director for western transmission for NRDC. He is the organization’s lead staff for western U.S. renewable energy transmission siting and serves on a nationwide team working on renewable energy development issues. In this role he works with stakeholders from environmental organizations, renewable energy development and transmission industries, local, state and national governments, regulatory agencies and the public to find renewable energy transmission solutions that accelerate renewable energy development while respecting wildlife and land conservation efforts. Before joining NRDC he was the director for western U.S. renewable projects for the Sierra Club. He served in leadership capacities on the Sierra Club staff for 23 years.

Mr. Zichella is a former director of the Climate Action Reserve, a director of the Center for Energy Efficiency and Renewable Technology (CEERT), environmental representative to the Western Governor’ Association Renewable Energy Zone identification process, environmental representative for the Western Electricity Coordinating Council’s Transmission Expansion Planning Policy Committee, and was a founding director of the American Wilderness Coalition.

He lives in Davis, California with his wife Sarah and their dogs Lambchop and Dudley.