WELCOME TO THE ERA OF TRANSACTIVE ENERGY

Presented by: Paul Heitmann
The Drive Toward Standards-Based Transactive Energy (TE) Solutions

“Interesting Times” for the Electric Grid
Potential for Energy Management Standards to Enable TE
The P825 Guide Development
An Example: The Exergy Blockchain
Pre-standards Activities

- Long term visions of what the smart grid in each technology space will look like 20 to 30 years out.
- Forward looking use cases, applications scenarios for SG, and corresponding enabling technologies for SG of the future snap shots of years 2015, 2020, 2030, and beyond.
Physical Segments of the Electric Power System

FERC / ISO

NARUC / IOU / MUNI

DECENTRALIZED CONTROL...
# Value Drivers of the Electrical Energy System

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<th>GENERATION</th>
<th>DISTRIBUTION</th>
<th>CONSUMPTION</th>
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<td>• Cheap Fuel</td>
<td>• Reliable Service</td>
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<td>• Low Maintenance</td>
<td>• (SAIDI, SAIFI)</td>
<td>• Low and Predictable Cost</td>
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<td>• ROI</td>
<td>• Allowed Rate Base</td>
<td>• Clean energy</td>
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<td>• Reliable Delivery Access</td>
<td>• (Cost Recovery)</td>
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<td>• To Robust Markets</td>
<td>• Energy Sourcing/Contract Certainty</td>
<td>• Simple and Intuitive Data.</td>
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<td>• Hedging and Risk Management</td>
<td>• Platform flexibility</td>
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### DISTRIBUTION

- Reliable Service (SAIDI, SAIFI)
- Allowed Rate Base (Cost Recovery)
- Energy Sourcing/Contract Certainty
- Platform flexibility
- Cost of Capital
- Regulatory Compliance

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### CONSUMPTION

- Reliable Service
- Low and Predictable Cost
- Clean energy
- Efficient Use
- Simple and Intuitive Data.
- Power Quality Demands (ie. Data Centers)
GENERATION

- Low Capex/Opex CCT/Peakers (NatGas)
- Uneconomic Base Load Gen (Nuclear, Coal)
- Utility scale Renewables w/Storage reaching parity
- The Need For (and Resistance To) T&D Cost/Siting

- Duck Curve effect is driving many inefficiencies:
  - Spilling surplus renewable energy
  - Increasing ramping stress on base gen
  - Creating negative market pricing

- Carbon Tax / Constraints
• Network Congestion Points
• Aging Infrastructure (“Wires”)
• Load Defection + Demand Destruction
• Stranded Asset Risk
• Regulatory Barriers (FERC vs? NARUC)
• Grid Instability from DER Growth
• Pressure to Open Data Access
• Incompatible Comm Systems/Protocols
GRID EDGE / CUSTOMER

Technology Trends
- Blockchain
- Energy Storage / EV
- Advanced EMS / EVSE
- Smart Inverters

Regulatory Trends
- Microgrid Development / NWA
- Energy Resale Permission
- “Smart” Cities/Buildings/Vehicles

Operational Impacts
- Grid Instability (Intermittent) from DER
- Higher Energy Efficiency / Energy Productivity
- Flexibility and Utilization Improvement
But these streams of energy data are stranded at the grid edge, unable to communicate with other assets.
Combining blockchain with the Internet of Things could enable the negotiation of distributed power transactions. By using distributed wireless or wireline data links in a...
Standards-Based Transactive Energy (TE) Solutions

IEEE1547.1

- DER-AEPS Interconnection Layer
- Connection/Communication/Control Protocol Layer
- Program/Application Layer

IEEE P825

- OpenFMB
- OpenADR
- IEEE 2030.7
- IEEE 2030.5
- IEEE 2030.2
- IEC 61850
- IEEE 1815
- ....
IEEE 2030 Smart Grid Key Highlights

The IEEE 2030 is a Standard Guide for Smart Grid Interoperability

• It addresses the basic Smart Grid definitions, frameworks, challenges and three different architectural perspectives (Power & Energy, Communications and IT) with interoperability tables and charts

• The architectures adopt a methodical end-to-end, system engineering approach to address the need for secure, modular and scalable Smart Grid interfaces and building blocks

• The IEEE 2030 Series of standards will address more specific technologies and implementation of Smart Grid system
IEEE 2030 Series Smart Grid Projects

- **IEEE 2030™ Guide for Smart Grid Interoperability**
- **IEEE 2030.1.1™ Standard Technical Specifications of a DC Quick Charger for Use with Electric Vehicles**
- **IEEE 2030.2™ Guide for Energy Storage Systems Integrated with the Electric Power Infrastructure**
- **IEEE 2030.3™ Standard for Test Procedures for Electric Energy Storage Equipment and Systems**
- **IEEE P2030.4™ Guide for Control and Automation Installations Applied to the Electric Power Infrastructure**
- **IEEE P2030.5™ Standard for Smart Energy Profile 2.0 Application Protocol**
- **IEEE P2030.7™ Standard for the Specification of Microgrid Controllers**
- **IEEE P2030.8™ Standard for the Testing of Microgrid Controllers**
- **IEEE P2030.9™ Recommended Practice for the Planning and Design of the Microgrid**
- **IEEE P2030.10™ Standard for DC Microgrids for Rural and Remote Electricity Access Applications**
- **IEEE P2030.100™ Recommended Practice for Implementing an IEC 61850 Based Substation Communications, Protection, Monitoring and Control System**
- **IEEE P2030.101™ Guide for Designing a Time Synchronization System**
- **IEEE P2030.102.1™ Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems**
Relevant IEEE Activity

Standards

• IEEE 1547   • IEEE 2030.2   • IEEE 2030.5   • IEEE 2030.7
  DER Interconnect   Energy Storage   SEP 2.0   Microcontrollers

Initiatives

• IEEE Blockchain for IoT (P2418)   • IEEE SA Open Source
• IEEE PES Smart Buildings, Loads and Customer Systems (P825)
IEEE Standards Classification

**Standard**: documents specifying mandatory requirements. (shall)

**Recommended Practice**: documents in which procedures and positions preferred by the IEEE are presented (should)

**Guide**: documents that furnish information - e.g., provide alternative approaches for good practice, suggestions stated but no clear-cut recommendations are made (may)
The Playing Field – The Drive Toward TE

FULL TRANSACTIVE (PREDICTIVE)
PARTIAL TRANSACTIVE (PROACTIVE)
NET ENERGY METERING (PERMISSIVE)
RESPONSIVE LOAD (REACTIVE)

Building Enabling Networks for Distributed Energy Resource
IEEE P825 Standard Development

New IEEE PES “SBLC” Technical Committee Launched mid 2016
- Advance the Grid Edge flexibility and participation technologies
- Multiple Subcommittees and Workgroups formed - International Scope

PAR Submitted to IEEE SA for Transactive Energy
- Scope defined and Form selected (Guide)
- Approved Dec 2016
- First Draft planned Nov 2018

This section identifies the primary stakeholder segments and explains the impact and opportunity for adopting Transactive Energy methods within this Guide.

This section defines the TE domain and describes the context for the evolution of Transactive Energy relative to emerging interoperability standards.
IEEE P825 Standard Development

This section identifies and compiles the primary individual standards that relate to a developing Transactive Energy platform. Oriented toward primary physical and logical grid segments. (Device Type subsets?)

This section takes an inventory and provides reference links to major initiatives that are being evaluated in world regions.

This section summarizes and presents the leading architectural approaches to implementing Transactive Energy – dependent on specific Use Case, Market Restrictions, etc..

P825 Guide
1 – Intended Users and Application
2 – TE Background and Definition
3 – Standards Inventory
4 – Ref TE Example and Demos
5 – TE Architecture and Models
6 – Foundational Technology Elements
7 – Recommended Action Paths
This section compiles short summaries of current and emerging technologies that are particularly relevant to enabling Transactive Energy systems. Also provides trends within the technology and specific context for its role in TE.
This guide will permit common transactive grid services to be exercised by connected Distributed Energy Resource assets behind the meter. The guide brings together a broad set of grid interoperability standards that will utilize the underlying IEEE1547 Interconnection conformity as an integration platform while leveraging multiple communications protocols.
This section summarizes and presents the leading architectural approaches to implementing Transactive Energy – dependent on specific Use Case, Market Restrictions, etc..

OPEN SOURCE DEVELOPMENT
Premises Example: Transactive Energy

People automatically manage facilities and devices in response to Transactive Retail Tariffs from TE Platforms.
But these streams of energy data are **stranded at the grid edge**, unable to communicate with other assets *or* with the ISO/DSO.

Slide Courtesy of LO3 Energy
Blockchain-based Microgrid Intelligence System

- Transactive, distributed intelligence system to control microgrids
- Based on open-source, cryptographically-secure protocol layer delivering military-grade cybersecurity and real-time data
- Auditable, immutable, secure device control

TransActive Grid
Tokenization of energy production, storage and consumption networks creates efficient local markets.

Efficient Local Markets attract investment, increase impacts and create local value for energy, environment and community.

Rise of the Prosumers neighbor-to-neighbor, neighbor-to-business community transactions reward local markets and return community value.

Reward efficiency and resiliency allowing participants to optimize existing energy spend according to individual values, priorities and outcomes.
Community Energy – Sharing Economy

Blockchain-Enabled Energy Platform

DEMO AT SEPA TRANSACTIVE ENERGY CONFERENCE (June 12th – 14th MIT Boston)
Local community microgrids

Prosumers stake Exergy-compliant meters onto the platform via XRG (token)
- Make their generation available to the local market
- Price signals delivered to influence self-consumption and asset performance

Consumers stake their mobile apps to participate in the local market via XRG
- Set preferences for energy mix and prices
- Purchase local clean energy

Slide Courtesy of LO3 Energy
Urban e-mobility platforms

- Exergy-compliant charging stations are **staked** onto the platform
- Price signals (*tenders*) delivered to influence charging behaviors
- Curtailable loads available for grid services
- Data valuable to different entities for:
  - Using EVs to participate in vehicle-to-grid applications
  - Understanding e-mobility customer trends
  - Better planning of EV support infrastructure and retail outlets

Slide Courtesy of LO3 Energy
DSO-operated DR and grid services platform

Consumers and prosumers stake their flexible appliances and self-generation equipment onto the Exergy platform via XRG

... and permission verified meter and device performance data on the network

Commercial and industrial (C&I) customers stake their meters and assets onto the platform via XRG

... and customize their procurement and DR participation preferences

... and provision its load and assets as available and AI-controllable for grid services and performance

Local DSO uses the data aggregated to optimize demand-supply schedule

... and implement machine-to-machine price signals for grid balancing
Thank You!

IEEE

Email(s):
  paul.heitmann.us@ieee.org
  pheitmann@lo3energy.com

Paul Heitmann

(HAT1)
(HAT2)