EBC Energy Resources Program:

Advanced Metering Infrastructure – The Challenges of Implementation
Welcome

John Wadsworth

Chair, EBC Energy Resources Committee

Partner, Brown Rudnick LLP
Program Introduction and Overview

Ron Gerwatowskis

Program Chair & Moderator
Electric Utility
Metering Basics
Electric Meters:
First, the older technology – Analog Meters

And the disk goes round and round . . . ., or backwards sometimes . . . .
Digital Meters -- The simple Watthour Meter

Separately reads energy in, and energy out.

Standard watthour meter only reads kilowatt-hours, not kilowatts (i.e., demand)
Comparison of analog meters to digital meters.

These two read kilowatt-hours only.
Comparison of analog to digital meters.

KWh energy only meters

Analog

Digital

KWh energy, KW and KVA demand meters

These two read both kWh and demand (kW)
Comparison of analog to digital meters.

These three are not “smart” meters.

KWh energy only meters

Analog

Digital

KWh energy, KW and KVA demand meters

But this one is “smart!”
The “Smart Meter”

Capable of reading all usage (kWh, kW, kVA) and output. It is able to record the precise time of day that the usage or output occurs.
Old-Style Manual Meter Reading

• Meter reader visits every account and manually records
A Meter Reader Can Use a Probe to Obtain Data from the More Sophisticated Meters

Feature that allows a meter reader to insert a probe to gather the stored data on smart meters.
Automated Meter Reading (AMR)

• Used instead of having individuals manually read and record the numbers on every meter each month
• A communication system is installed that allows drive-by reads from a vehicle
• Much faster than manual reads and avoids manual reading errors
  • But does not record in “real time”
• Not capable of taking advantage of all the “smart meter” capabilities
  • An alternative means of communication must be used for any “smart meter”
The “Gold Standard”
Advanced Metering Infrastructure (AMI)

• An extensive, state-of-the art metering and communication system is installed throughout the distribution system
• Every meter can be read remotely in “real time”
• Works in tandem with “smart meters”, except that probing for the monthly data is not required because of the communication system
• This system is needed to transform the distribution grid to a so-called “Smart Grid,” but it is very costly
• Not yet deployed by all utilities
Value of Grid Modernization and the Role of AMI

David J. O’Brien

Director, Energy Strategy & Operations
Navigant
GRID MODERNIZATION:
A MUST FOR THE ENERGY CLOUD

EBC ENERGY RESOURCES PROGRAM
JUNE, 2017
NAVIGANT ENERGY PRACTICE

OVERVIEW

WE COLLABORATE WITH CLIENTS TO HELP THEM THRIVE IN A RAPIDLY CHANGING ENVIRONMENT.

CLIENTS

- 50 largest electric and gas utilities
- 20 largest independent power generators
- 20 largest gas distribution and pipeline companies
- Leading oil & gas companies
- International, federal, and state government organizations
- Multiple new energy market entrants and investors

TEAM

- Industry’s largest energy management consulting team
- Consultants average 15 years of experience
- 60% have an advanced degree
- More than half have an engineering degree

NAME

- Among Top 10 in Vault's 2016 Best Consulting Firms for Energy
IN 2017 GRID MODERNIZATION IS TABLE STAKES

• The convergence of policy, technology and customer preference are reshaping the topology of the grid

• Grid intelligence, visibility to and ability to optimize DER will become the new normal in utility operations

• Equal to the technology discussion, is the need to dramatically change the regulatory paradigm

• Increasingly we need to connect the dots between policy objectives and the physical and business implications that are reshaping electric delivery
DER IN THE UNITED STATES
WE FORECAST STRONG DER PENETRATION GROWTH OVER THE NEXT DECADE

Observations
- DER deployments will reach 30 GW this year in the US, versus new central station generation (19.7GW)
- On a 5-year basis (2015-2019), DER in the US is growing almost 3 times faster than central generation (168 GW vs. 57 GW).
When will the growth of Distributed Energy Resources (DER) force a major shift in the utility business models?

What is the most important tipping point for utilities to aggressively pursue owning and operating DER?

1 State and Future of the Power Industry (special report)
THE ENERGY TRANSFORMATION – EMERGING ENERGY CLOUD\textsuperscript{1,2}

\textbf{TODAY: TRADITIONAL POWER GRID}
Central, One-Way Power System

\textbf{EMERGING: THE ENERGY CLOUD}
Distributed, Two-Way Power Flows

\begin{itemize}
    \item \textsuperscript{1} The Energy Cloud: Emerging Opportunities on the Decentralized Grid (white paper)
    \item \textsuperscript{2} Navigating the Energy Transformation: Building a Competitive Advantage for Energy Cloud 2.0 (white paper)
\end{itemize}

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LINE OF SIGHT – CONNECTING THE DOTS

**Requirements**

- Reduce Carbon
- Integrate DER
- Foster Markets
- Customer choice
- Safe and reliable
- Affordable, Equitable
- Access to capital
- Shareholder Value

**Functionality**

- Maintain system performance & reliability
- Asset protection
- Increased visibility
- Enhanced planning
- Data availability

**Enabling Technology**

- Automated switches
- Remote fault indication
- Substation automation
- Field area network
- DER management system
- Grid Analytics
- Long term planning tool
- Distribution Circuit Modeling
The Joint Utilities stakeholder group of New York identified essential functions of the "Distributed System Platform" ("DSP"), or otherwise known as the Distributed System Operator ("DSO").

This table shows how these functions are expected to phase in over time.

### Source: New York Joint Utility Supplemental DSIP Distributed System Platform ("DSP") Providers (Nov 1 2016)
CONTACTS

DAVID O’BRIEN
Director
781.270.8451
david.obrien@navigant.com

Navigant Energy Practice
http://www.navigant.com/industries/energy
Emerging AMI Technology and Benefits Enabled

Bruce A. Husta

Area Vice President

Itron, Inc.
Emerging AMI Technology and Benefits Enabled

Bruce A. Husta
Area Vice President
Itron, Inc.
AGENDA

» Today’s Topics
  • Technology Evolution
  • Business Case Evolution
  • The Active Grid
  • Benefit Examples
TECHNOLOGY EVOLUTION

AMR
- Manual meter reading
  - Meter
  - 1-way communication
  - Meter centric

AMI
- Advanced meter
  - 2-way communication
  - Big data
  - Network centric

SMART GRID
- AMI meter as sensor
  - Higher network throughput, lower latency
  - Bigger data
  - Back office centric

ACTIVE GRID
- Distributed computing platform
  - Adaptive communications
  - P2P communications
  - M2M computing
  - Analysis and action at the edge
  - The right data
  - Application centric
THE BUSINESS CASE EVOLUTION

Utility Benefits
- Manual meter reading
- AMR – Walk By, Drive By
- AMI
- Smart Grid
- Active Grid

Consumer Benefits
- Billing Accuracy Privacy
- AMI Plus: Distributed Platform for New Services, Prosumer Enablement, DER Integration, Safety Monitoring

AUTOMATION
OPTIMIZATION
EXTENSION
TRANSFORMATION
ENABLING THE ACTIVE GRID
Distributed Intelligence

NEW COMMUNICATION CAPABILITIES
» Multi-media (PLC, RF, Wi-Fi)
» Multi-modulation
» Peer-to-peer communication
» Local broadcast
The intelligence to choose among them

COMPUTING POWER AT THE EDGE
An iPhone or PC on every meter and grid device
A unified software platform running multiple apps, protocols
High resolution of data

OPEN-APPLICATION ENVIRONMENT
Support for multiple Communication and Application protocols
» Smart metering
» Distribution Automation
» Load Control
» Demand Response
» Home Area Network

LOCATION AWARENESS
On the distribution system
» Transformer
» Feeder
» Phase
» Relation to other meters/device
Continuously updated
DISTRIBUTED INTELLIGENCE
Enabling the Active Grid

» Analysis, decision making, and action

» Distributed across the solution stack from endpoints (edge) to back office based on the required:
  • Breadth of knowledge
  • Data resolution
  • Response time
DISTRIBUTED INTELLIGENCE SOLUTION MODELS

Traditional Back Office Analytic
- Outage Analysis
- Forecasting and Load Research
- Distribution Planning
- Advanced Billing

Distributed Analytic
- High Impedance Detection
- Intelligent Voltage Monitoring
- Load Disaggregation

Distributed Analytic With M2M
- Distributed Generation and Real Time Markets
- Location Awareness
- Outage Detection and Location
- Theft Detection
- Electrical Faults and Safety

Local Analysis and Action
- Active Load and Voltage Control
- Active Demand Response
- DA Device Integration
- Electrical Faults and Safety
CONSUMER BENEFITS PERSPECTIVE

Example AMI Direct Consumer Benefits
» Service switch automation
» No estimated bills
» Improved outage detection/response
» Improved call center service
» Selectable bill dates
» Increased customer satisfaction metrics

Example AMI-Enabled Consumer Benefits
» Web access to data
» Energy budget and management tools
» Dynamic rates
» Prepayment
» Load control/demand response
» Better outage information
» In-home devices

New Distributed Intelligence Consumer Benefits
» Load disaggregation driven services
» Market enablement
» Prosumer services
» DER management and integration
» Safety
LOAD DISAGGREGATION

What is it:
» Real time disaggregation of total premise load into individual appliance usages using 1 second data

Benefits:
» Scalable with distributed processing
» Improved consumer energy savings programs
» Improved marketing program evaluation

Output:
» API with disaggregated usage profiles for each consumer
» UI with disaggregated usage profiles for each consumer
» Consumer gateway with disaggregated usage profiles

Empower Consumers

New Revenue

✓ Device-based processing
✓ Access to very high-resolution data

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THANK YOU

Bruce A. Husta
860-655-6045
bruce.husta@itron.com
End-Use Customer Experiences with AMI

Greg Geller

Director, Regulatory and Government Affairs
EnerNOC
A Utility Perspective

Peter Zschokke

Formerly with National Grid
Advanced Metering Infrastructure

Peter Zschokke
Environmental Business Council of New England
June 2, 2017
Peter.zschokke@gmail.com
What problem is the industry trying to solve?

- Since the energy crisis of the 1970’s, how can costs be managed and kept low for customers?

- How can use of electricity become more efficient?

- How does the industry motivate customers to use energy more efficiently?

- Will customers respond to price signals and improve their efficient use of electricity?
Dynamics of Regulation

- Decisions based upon weight of evidence and argument
- Arguments focus on the benefit to customers
  - E.g., need for strong utility financials to keep costs low for customers
  - Or, will investment provide benefits to customers in excess of cost?
  - What is value of reliability for customers?
- Dynamics differ for utilities in states with competition and those without competition
Plug-in Hybrid Vehicles – Plug-in hybrid vehicles can store energy in their batteries. When connected to the distribution grid, plug-in hybrid vehicles can serve as an additional source of energy, providing power back to the grid during times of peak demand.

Renewables – Renewable energy sources, such as wind turbines and solar panels, are more readily integrated into the smart distribution grid compared to a traditional power grid.

Sensors – Advanced communication equipment on the grid, including sensors, enable utilities to monitor, identify and quickly correct problems. Increased reliability of power is the result.

Smart House – A Smart House tracks usage information through smart meters installed in the home. Customers will have a variety of options through which they can interface with to learn about the most cost-efficient energy usage patterns. Increased information empowers consumers to reduce their energy use.

Traditional Generation – Over time, traditional generation assets such as coal-fired generation plants will be offset by renewable energy sources in providing energy to the distribution grid.

National Grid Smart Grid Pilot Proposal
Worcester, Massachusetts
Energy Market is evolving – 
Grid Modernization is an essential enabler

Traditional Energy Market - supply driven

- Large centralised generation
- Small range of conventional technologies
- Static infrastructure
- Energy flows to users

Today's Evolving Market - customer driven

- Customers focus on economic and environmental value, using a wider range of products and services
- Electricity flows to users, and surplus from distributed generation flows back to grid
- Energy volume drives energy company revenue

- Intermittency management
- Technology choice proliferates
- CO2 emission reduction and water energy services drives energy company revenue
- CO2 transport and storage
- CO2 reduction charged to customers

- Onshore and offshore wind
- Hydro-electric power
- Nuclear power station
- Micro CHP
- Solar water heating
- Heat Pumps
- Efficient Boilers
- Micro Biomass
- Smart metering
- Storage
Grid Modernization ("Smart") technology opens a world of possibility

What is Smart Technology?

- Meter that records interval data
- 2-way communications, remote configuration
- Informative display
- Meter Data Management System

- Sensors & measuring devices
- Analytical programs e.g. pattern recognition
- Automatic switches & controls
- Decision support tools & graphical interfaces

- Customer portal & Home Area Network
- Automated thermostats, switches, plugs & appliances
- Load controllers e.g. PHEV controller

What does it allow you to do?

- Automatic meter reading
- Enable customer choice and control
- Choice of tariffs e.g. time of use – peak shifting
- Catalyst and validation of Energy Efficiency programs
- Remote configuration

- Enable Distributed generation
- Remotely detect, diagnose, predict and correct network problems & faults
- Condition-based, preventative maintenance
- Automatic fault prevention, isolation & restoration

- Automatically optimize selected home appliances
- Demand response programs
- Improve satisfaction levels
Utility Perspective on AMI

- Meter data can assist in design and operation of system
  - VVO/CVR can be designed differently using the data
  - Load profile of feeder could be known
  - Improved understanding of causal reasons for issues on grid
  - These capabilities are available from other technologies as well
- Meters can assist in locating extend and cause of outages
- AMI can provide opportunity to save with remote turn-ons and turn-offs
  - Avoid those for bill payment issues
Utility Perspective on AMI: Cost

- Those with meter readers will create significant savings to justify AMI
  - E.g., National Grid eliminated the bulk of meter readers with implementation of AMR: Savings unavailable
- Amount of investment and impact on rates
- Recovery of customer related costs from energy charges with significant declines in usage form EE and solar net metering
- Stranded cost of existing stock of meters and software
- How often will upgrades by necessary with changes in comms technology?
Questions

- MA Grid Mod: Will customers participate and operate in a manner to save costs? How Many?

- NY REV: what will it take to develop a transactional market at the local level? How long?

- Given customer choice of technologies and availability, how do we fund the grid of the future in a sustainable manner?

- How do we engage customers who, primarily, want their businesses to run, their drinks to be cold, their vegetables fresh and their TV on demand?
Panel Discussion

Moderator: Ron Gerwatowski

Panelists:

• Bruce Husta, *Itron, Inc.*
• David O’Brien, *Navigant*
• Peter Zschokke
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