Customer Assets – A New Era in the Electricity Industry

Oct 2015
Life During my PAI Years

Slow
Fast
Decoupling
Singular Perturbations
Manifolds
Life During my GE Years

DEC vt100
Coherency
Equivalencing
Modes
Mode Shapes
PSS
Life today

Distributed
Connected
Renewable
Electronics
Transport/Heat
Responsive
Transactive
Smart
Ownership!
Fundamental Changes Happened

2000s

Wholesale

Changed the Transactional Layer
More Changes Underway

Changing the Transactional and Physical Layers
Changing Landscape

• California on Path to 33% Renewables by 2020
  – 250,000 Rooftop solar PV today; 3GW

• Electric Vehicles 0.4 Million growing exponentially
  – CA target of 1.5 Million Vehicles by 2025

• Battery Sales at 100MW in 2014, Growing to 900MW by 2019.
  – CA mandate of 1,300 MW by 2020.

• NEST Thermostats are selling at 100,000 units / month

• 46 Million Customers (31.5%) on Smart Meters
  – 29 GW potential peak reduction from Demand Response
  – 5 Million Customers on Demand Response programs
Utility Business Model

• Challenges Today
  – Earn money on capital investments. With a flat demand and already-built grid, where are the next capital investment opportunities?
  – Distributed Gen is getting closer to customers and thus squeezing the utility delivery opportunity.
  – Grid Defection renders the utility as a backup option that is difficult to value.
  – Competitive Transmission Biz.
  – Grid Edge – What to do?
  – Big Data – Liability? Operational Excellence?

• Opportunities
  – Extracting value out of Poles and Wires business.
  – Smart Grid data analytics to drive operational decisions and customer service.
  – Leveraging beyond the meter assets (smart inverters, home controls, EV, storage) to lower utility service costs or increase service revenues.
  – Grid of Things - adaptable to new technology
  – Customer Experience and Value Add
Can the Utilities Compete?

How to transition from analog mindset to the digital age?
How to explore outside the golden cage?
How to leverage the aging assets?
Customer Energy Assets

• Customer Assets
  – Smart Load Controls
  – Energy Efficient Lighting and Appliances
  – Solar PV
  – Battery Storage
  – Genset
  – Electric Vehicle or Plug-In Hybrid
  – Smart Inverters

• Enable Customers to Sell Grid Services
  – Reduce Demand, thus accommodating other customers on the same utility infrastructure.
  – Reduce/Increase/Shift Energy Consumption
  – Produce and Sell Energy
  – Regulate Energy Flow, dynamically
  – Voltage Support
  – Backup Power, Black Start capability
  – Generate Harmonic Current
  – End of Line Monitoring driving predictive asset maintenance programs and workforce optimization.
Life in future Years

Multi-Disciplinary:
- Energy
- Electronics
- Software
- Communication
- Finance
- Customer Service

Unbundled Prices
Demand Flexibility
Differentiated Reliability
Production Intermittency
Diminishing Thermal Fleet
Prosumers
Integrated Services
Smart Buildings
Energy Apps
SUPPORTING SLIDES
Can the Utilities Compete?

- 150 million Customers
- 3,300 Utilities
- 7,000 Power Plants
- 5 million mile Lines
- $1 Trillion Net Assets,
- $7,000 per customer
Consulting Opportunities – Takeaways

• Landscape includes more than Utilities – OEMs, Integrators, Retailers, Investors, Commerce Platforms, ...

• All layers are Changing – Transactional, Informational, Physical

• Technology Changes will bring cost savings and new liabilities/risks, and will require continuous product/service innovations

• Consulting landscape is also crowded, requiring focus on core expertise and collaboration within ecosystem.
RTOs
Key Innovations – Distributed Solar

USA Solar Growth

- Cost hits inflection point in 2009
- Some U.S. markets at grid parity now
- Further cost drop during 20-year trend

Grid parity accelerating adoption

Source: IMS Market Research
Key Innovations: Distributed Storage

Storage Cost and Volume Trend

- Cost inflection point reached in 2012
- Inflection point to high growth expected in the next few years

Source: Goldie-Scot, L.. (2014) “European End-User Storage: A Battery In Every Home?”, BNEF.
Key Innovations - Energy Efficiency

Annual Per-Capita Utility Investment in Energy Efficiency Programs by State

<table>
<thead>
<tr>
<th>State</th>
<th>Per-Capita Utility Investment</th>
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<tbody>
<tr>
<td>Vermont</td>
<td>$49.38</td>
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<tr>
<td>New Jersey</td>
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<td>Pacific Northwest*</td>
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* Information from at least one known electric program administrator is missing from this state.
** Includes aggregated data from Idaho, Montana, Oregon, Washington, the Northwest Energy Efficiency Alliance and the Bonneville Power Administration.
† A portion of this state's budget is incorporated into Tennessee Valley Authority's regional budget.

Impact of Energy Efficiency and Load Management

Energy Savings (Thousand MWh) - Actual Peak Load Reduction (MW)


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Proliferation of PMUs

Phasor Measurement Units across North America

2009 vs. 2014
Smart Meters

Source: U.S. Energy Information Administration
Behind the Meter Assets

• SCE Dec 2014 Local Capacity Requirement RFO Results:

- CC Gas Plant 68%
- Peaking Gas Plant 5%
- Ahead of Meter Storage 5%
- Behind the Meter Storage 8%
- Behind the Meter Renewables 2%
- Demand Response 4%
- Energy Efficiency 7%

27% of the Capacity is Addressed by non-generation Technologies! Can we push it higher??
NY Drive Towards Consumer Participation

• **Drivers:**
  – Peak Demand Outstripped Supplies in Constrained Areas.
  – Aging Infrastructure requires Billions in Investments
  – Price Volatility due to demand inelasticity and lack of fuel diversity

• **Objectives:**
  – Enable consumer participation to promote efficiency and resiliency

• **How:**
  – Market-Based Signals
  – Clean and Distributed Technologies

New York REV Order Poised to Deliver More Clean Energy, a Stronger Grid & Lower Bills for New Yorkers
Almost 20% of USA capacity held by 10 IPPs
Impact of Customer Energy Assets

• Value Creation
  – Enable existing utility grids to serve more customers without additional capital investments.
  – Increase grid reliability and resiliency.
  – Enable optimization of bulk generation plants thus reducing energy cost and volatility.
  – Reduce Grid Losses.

• Business Models
  – Grids Buy/Sell from/to customers.
  – Customers buy/sell to each others.
  – Aggregators/Retailers buy/sell from/to Customers and interact with Grids.