Smart Grid: Key Considerations

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Chief Technology Officer

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Agenda

• Consumer Engagement with the Smart Grid

• Architecture, Interoperability and Standards

• Security
Observation: Consumer Engagement Is Now “Table Stakes”

“We thought we were undertaking an infrastructure project but it turned out to be a customer project.”

Chris Johns, President, PG&E
Time To Customer Engagement With AMI Shrinking

**PG&E SmartMeter**
- **2006**: AMI Deployment Begins
  - 1st Major AMI Deployment
  - Smart Meter Upgrade (with HAN)
- **2009**: Customer Engagement Begins
  - Customer interval data available on PG&E web portal
  - Launched SmartRate Pricing Program
- **2010**: Customer engagement technologies deployed alongside AMI
  - Time from initial deployment to customer engagement ~3+ years

**BG&E Smart Grid Initiative**
- **2010**: Project approved by Maryland Public Service Commission
  - Customer communication to begin before technology deployment
- **2011**: AMI Deployment Begins
  - Customer engagement technologies deployed alongside AMI

Recent Commission Scrutiny (BG&E, HECO) is Prudent, but … Adoption Curve Has Been Both Traditional and Expected
Consumer Education Case Study: PG&E

**Overview:** Many lessons learned during first phase of PG&E deployment, including
- Poor timing/location of initial deployment (Central California, mid-summer, rate hike)
- Lack of customer education/awareness
- Limited advertising

**Results:** Increasing awareness of the Smart Grid and its benefits through:
- Newspaper editorials
- Senate hearings and Editorial board meetings
- Press conferences
- Advertisement development
- 2009 EEI demo
Consumer Education Case Study: AEP

Overview: AEP’s gridSMART pilot program helps engage consumers on the benefits of the Smart Grid and shows its value.

Results:

• Pilot program offered potential to publicize results
• Customer video increased internal and external program visibility
• Mobile demo unit provided 1:1 customer education opportunities
• gridSMART program boosted employee and customer awareness
• Press conference with Secretary Chu to announce win of Demo City Grant
Consumer Education Case Study: OGE

Overview: OGE’s pilot program for engaging consumers on the benefits of the Smart Grid helped show immediate consumer value and foster support among OGE customers.

Results:

• Project video increased internal and external visibility
• State fair participation boosted customer awareness
• Positive Energy Together site boosted employee and customer awareness
• Community outreach programs helped build groundswell of support
• Protective communications programs responded in a timely fashion to negative press

Early results
• 16-20% peak reduction
• 4-5% overall reduction
• Most consumers save $
• Low income results better
Agenda

- Consumer Engagement with the Smart Grid
  - Architecture, Interoperability and Standards
- Security
### Smart Meter Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost (Millions - PVRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency</td>
<td>212</td>
</tr>
<tr>
<td>PMO</td>
<td>150</td>
</tr>
<tr>
<td>Customer and Other</td>
<td>191</td>
</tr>
<tr>
<td>System Integration</td>
<td>248</td>
</tr>
<tr>
<td>Meter and Network HW</td>
<td>217</td>
</tr>
<tr>
<td>Meter and Network HW</td>
<td>1236</td>
</tr>
<tr>
<td>Total</td>
<td>2,255</td>
</tr>
</tbody>
</table>

### Smart Meter Benefits

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost (Millions - PVRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Conservation</td>
<td>311</td>
</tr>
<tr>
<td>Direct Load Control</td>
<td>155</td>
</tr>
<tr>
<td>Pricing Programs</td>
<td>290</td>
</tr>
<tr>
<td>T&amp;D</td>
<td>179</td>
</tr>
<tr>
<td>Billing</td>
<td>218</td>
</tr>
<tr>
<td>Disconnect/Reconnect</td>
<td>256</td>
</tr>
<tr>
<td>Meter Operations &amp; Customer services</td>
<td>984</td>
</tr>
<tr>
<td>Total</td>
<td>2,393</td>
</tr>
</tbody>
</table>

### Benefits of AMI

- Customer awareness
- Ability to lower energy consumption
- Lower energy bills
- Reduced operating costs
- Improved grid efficiency
- Improved grid reliability

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**Consumers Pay in All Cases, So Leveraged Investment is Critical**

Source: PG&E Business Case, Electric Only

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Leverage Occurs By Taking A Platform Approach

Reliable, Secure, End to End IP
Interoperability (NIST definition)

“The ability of diverse systems and their components to work together—is vitally important to the performance of the Smart Grid at every level. It enables integration, effective cooperation, and two-way communication among the many interconnected elements of the electric power grid.

Effective interoperability is built on a unifying framework of interfaces, protocols, and the other consensus standards. These standards facilitate useful interactions so that, for example, ‘smart’ appliances and meters will tell consumers how much power they are using and at what cost, providing them with more control over their power consumption and energy bills. Widely adopted standards also will help utilities to mix and manage varying supplies of solar, wind, and other renewable energy sources and better respond to changing demand.”

The NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0
Section 1.3.1 (PDF page 19)
• Are there really two “types”?  
  • Inter-system: interfaces (typically legacy) systems  
  • Intra-system: ensures compatibility within any given SG domain  
  • Sometimes (confusingly) presented as a “choice”

• Interoperability derived via “layering”, standards mapped to layers  
  • Application layer: metering, DA, DR, OMS …  
  • Networking layer: communications, addressing, routing …  
  • Physical layer: wired, wireless

• Layering in the real world – “language analogy”  
  • Application layer: comedy, drama, news, mystery …  
  • Networking layer: English, Spanish …  
  • Physical layer: newspaper, book, DVD, digital download …
Standards

- Standards sufficiency – consider Internet analogy
- Example of poor (non-layered) standard: ANSI C.12.22
- Key currently available standards (layered)

<table>
<thead>
<tr>
<th>Layer</th>
<th>Existing Deployed Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>IEEE 802.15.4 (Zigbee), IEEE 802.15.4g (SUN), IEEE 802.11 (WiFi), IEEE 802.16 (Wimax) …</td>
</tr>
<tr>
<td>Networking</td>
<td>IPv4, IPv6</td>
</tr>
<tr>
<td>Application -- metering</td>
<td>ANSI C.12.18, C.12.19, C.12.21</td>
</tr>
<tr>
<td>Application – distribution automation</td>
<td>DNP3</td>
</tr>
<tr>
<td>Application – demand response</td>
<td>OpenADR, Smart Energy Profile 2.0</td>
</tr>
<tr>
<td>Application – Home Area Networking</td>
<td>Smart Energy Profile 2.0</td>
</tr>
</tbody>
</table>

Foundational Standards in Place (or Nearing Completion)
Agenda

• Consumer Engagement with the Smart Grid
• Architecture, Standards and Interoperability
• Security
Security

- Myths
  - “Smart Grid makes the grid less secure than it is today”
  - “Licensed spectrum is more secure than unlicensed spectrum”
  - “Proprietary security is better than standards-based security”
  - “IP is inherently vulnerable”, “IP means data is on the Internet” …

<table>
<thead>
<tr>
<th>NISTIR 7628 Domain</th>
<th>Existing Congruent, Deployed Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authentication, authorization</td>
<td>Public Key Infrastructure (PKI) for digital certificate management [ vs. proprietary IDs, system-wide/static keys ]</td>
</tr>
<tr>
<td>Data/channel privacy</td>
<td>NSA Suite B encryption standards, AES 129/192/256, TLS, IPSEC, … [ vs. proprietary encryption/scrambling ]</td>
</tr>
<tr>
<td>Data integrity</td>
<td>Hashing via SHA1, SHA256, HMAC-SHA256-80 [ vs. simple CRCs ]</td>
</tr>
<tr>
<td>Viral attack resistance</td>
<td>Least-privilege design, admission control, … [ vs. assumption of device integrity ]</td>
</tr>
<tr>
<td>Insider threat protection</td>
<td>Layered authorization, … [ vs. assumption of trust ]</td>
</tr>
<tr>
<td>&lt;Other threats&gt;</td>
<td>…</td>
</tr>
</tbody>
</table>

NISTIR 7628 Provides Framework/Checklist for Ensuring Standards-Based Security
Summary

• Consumer engagement is now a significant focus

• Grid benefits achievable concurrently

• Platforms provide that leverage
  • Key/sufficient standards
  • Layering, flexibility, upgradability
  • Incremental, evolving

• Selection and validation criteria