Technologies and Trends for Residential Smart Grid

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DOE EERE Residential Energy Efficiency Meeting
Denver, CO
June 21, 2010
Agenda

• Bringing the Smart Grid Home
  • Smart Meters ≠ Smart Grid
  • From Asset-Based to Operational Efficiency
  • Home Automation: Convenience vs. Energy Management

• Tendril Approach to Home Energy Management
  • Home Energy Management Landscape
  • Platform
  • Applications and Devices
  • Ecosystem
  • Successes

• Research Areas
  • Demand response
  • Boosting operational efficiency
  • Social marketing approaches
What is the Smart Grid?
Beyond Smart Meters

Smart Grid = Energy Information

- AMI (smart meters)
- AMR (drive-by meters)
- Cellular
- Wireless
- Broadband
Utility Outlook
Asset-Based Paradigm

CONCERNS

Increase capacity, boost asset-based efficiency
- New generation
- New T&D
- DSM programs

DOMAINS

Generation

Reliability

Bottom Line

T & D
Utility Outlook
Smart Grid: the Information-Based Paradigm

CONCERNS

Reliability

Bottom Line

DOMAINS

Generation

T & D

Better utilize existing capacity, improve operational efficiency through information and control
FERC Report: Demand Response Potential

Figure 1: U.S. Summer Peak Demand Forecast by Scenario

- **BAU**: Business-as-Usual
- **Achievable Participation**: 0.6%
- **No DR (NERC)**: 1.7%
- **Full Participation**: 0.0%
- **Expanded BAU**: 1.3%

Source: FERC Assessment of Demand Response & Advanced Metering 2009
Assumptions: smart meters, dynamic pricing default, enabling technologies
"It is the residential class that represents the most untapped potential for demand response."

source: FERC Assessment of Demand Response & Advanced Metering 2009, p.29
Home Energy Management Landscape
From Convenience to Energy Management

Convenience

Home Energy Management

- Energy Awareness
- Load Control and Demand Response
- Home Energy Management Ecosystem

Logos of companies and technologies involved in home energy management: Google Powermeter, Microsoft, Hohm, eMeter, Opower, Comverge, GridPoint, Tendril.
Tendril At A Glance

- Company Overview
  - Founded in 2004
  - Venture-backed with > $50M raised to date
  - Headquartered in Boulder, Colorado
  - ~ 90 Employees

Welcome to Tendril
The Tendril Platform
Linking Smart Grid Utilities and Their Customers

1. Open software platform
2. Utility application suite
3. Family of in-home devices and applications
## Consumer-Facing Smart Grid Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distributed Generation</strong></td>
<td>Effectively integrate distributed generation assets</td>
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<tr>
<td><strong>Electric Vehicle</strong></td>
<td>Coordinate and optimize the charging of electric vehicles</td>
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<tr>
<td><strong>Energy Management</strong></td>
<td>Enhanced insight and control of home energy use</td>
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<tr>
<td><strong>Energy Awareness</strong></td>
<td>Feature-rich in-home information portal for energy use insight</td>
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<tr>
<td><strong>Tendril Tracker</strong></td>
<td>Low-cost participation with no AMI and minimal in-home hardware</td>
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**Vision:** Full-featured, engaging info and control

**Insight:** Everyday info and control appliance

**Vantage and Tracker:** Web-based info and control portals

**Setpoint:** Tendril’s smart thermostat

**Volt:** Tendril’s smart outlet

**LCS:** Hard switch for legacy loads

**Transport:** Broadband gateway device

**Translate:** Communicate with legacy AMR meters

**Relay:** Extend HANs
The Growing Tendril Ecosystem

Industry partners

- Landis+Gyr
- Itron
- EnTek
- Current
- Silver Spring Networks
- Better Place

...for integrated utility solutions

Consumer partners

- GE
- Intel
- Fat Spaniel
- Energate
- DMN3

...for compelling in-home experience
Summer 2010 Projects

- 14 states
- 17 projects
- > 10k homes
- Utilities represent 25% of US population
Residential Smart Grid Research

- Residential smart grid technologies a perfect match for BAP
  - Today’s solutions scalable from low-cost portals to complete home energy management systems
  - Combined home performance monitoring/data logging and home energy management functionality
  - Facilitates innovative neighborhood- and community-scale approach

- Three core research areas:
  1. Improving operational efficiency
  2. Demand response and load control
  3. Community-scale approaches
Improving Operational Efficiency

- Behavioral
  - How much energy can we save by engaging homeowners with energy usage and cost information?
  - How readily will homeowners implement energy tips?

- Technical
  - How much of the retrofit/new construction opportunity is comprised by residential home energy management and associated operational efficiency improvements?
  - What level of technical sophistication do we need for optimized controls? (Learning, model-based, etc.)
  - How can we provide targeted, accurate energy tips to consumers using minimally invasive techniques (remote audit)?
  - Can we intelligently disaggregate home energy use data without the need for extensive sub-metering?
Demand Response and Load Control

- Behavioral
  - What are typical participation rates in residential DR events?
  - What causes homeowners to opt out of various DR events?

- Technical
  - What are realistic demand reduction potentials for various smart appliances?
  - Do advanced control techniques (e.g. model-predictive control) improve demand response under various rate structures?
  - To what extent can thermal storage in residential buildings be used to level loads and increase renewables penetration?
  - What are the limits to a home’s load elasticity?
  - How do we coordinate and integrate EV charging and DG at the community scale?
Community Approaches and Social Marketing
Harnessing Competition for Operational Efficiency

- Are consumers motivated by knowing their neighbor’s energy use?

- Community-level competitions: Cost-effective? Participation?

UTILITIES
Purchase program package

BAP TEAM
Promote, track and bank incentives

CONSUMER TEAMS
Participate and redeem rewards
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Pilots Indicate Smart Grid Devices are Improving Peak Reduction

Source: Brattle Group, 2010.