Smart Grid Technical Advisory Project

Mid-Atlantic Conference of Regulatory Utility Commissioners

Smart Grid
Metering, Cost Recovery, Demand Response

June 28, 2010

Chuck Goldman, Project Manager
Electricity Markets and Policy Group
Lawrence Berkeley National Laboratory

Roger Levy, Levy Associates
Issues and Opportunities

1.0 Defining the Smart Grid (another definition)

4.0 Metering
   (1) Advanced metering technology
   (2) Cost Recovery

6.0 Demand Response

8.0 Smart Grid Technologies
1.3 Define Smart Grid

**Smart Grid is System Integration**

The Smart Grid is a system of information and communication applications integrated with electric generation, transmission, distribution, and end use technologies which will:

1. **Enable Consumers** to manage their usage and chose the most economically efficient offerings.

2. **Use automation** and alternative resources to maintain delivery system reliability and stability, and

3. **Utilize** the most environmentally gentle renewable, storage, and generation alternatives.

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
## 1.7 Define Smart Grid

<table>
<thead>
<tr>
<th>Feature</th>
<th>Current System</th>
<th>Smart Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utility Business Model</strong></td>
<td>• Utility Centric ownership</td>
<td>• Distributed ownership</td>
</tr>
<tr>
<td></td>
<td>• Centralized operation</td>
<td>• Distributed operation</td>
</tr>
<tr>
<td><strong>Obligation to Serve</strong></td>
<td>• Utility Provides All</td>
<td>• Utility Provides Some</td>
</tr>
<tr>
<td></td>
<td>• Customer Pays</td>
<td>• Customer Pays</td>
</tr>
<tr>
<td><strong>Generation Resources</strong></td>
<td>• Centralized</td>
<td>• Distributed</td>
</tr>
<tr>
<td></td>
<td>• Thermal dominates</td>
<td>• Renewable emphasis</td>
</tr>
<tr>
<td><strong>Transmission / Distribution</strong></td>
<td>One Way Power Flow</td>
<td>Micro Grids</td>
</tr>
<tr>
<td><strong>Metering-Measurement</strong></td>
<td>Accumulated Usage</td>
<td>Interval Measurement</td>
</tr>
<tr>
<td><strong>Rates (Pricing)</strong></td>
<td>Rates not Pricing</td>
<td>Actionable Prices</td>
</tr>
<tr>
<td><strong>Customer Role</strong></td>
<td>Passive</td>
<td>Active</td>
</tr>
</tbody>
</table>
4.0 Metering
4.1 Metering

What is Electric Metering?

An electric meter or energy meter is a device that measures the amount of electrical energy consumed by a residence, business, or an electrically-powered device.

Electric meters are typically calibrated in billing units, the most common one being the kilowatt hour. Summing kilowatts (kW) over a discrete period of time (hours) provides energy measures to support billing. Periodic readings of electric meters establishes billing cycles and energy used during a cycle.

4.2 Metering

Why is metering important to Smart Grid?

1. Electric meters provide an information link between the utility system (supply) and customer (demand).

2. Metering with integrated communications is expected to provide essential smart grid functions, including:
   - More timely usage and status information to the utility.
   - More timely usage information to the customer.
   - Support for more informative rates and pricing options.

4.3 Metering

What are the Smart Grid metering choices?

**Standard Meters**
- Standard kWh Electromechanical
- kWh Cumulative

**Advanced Meters**
- Remote Metering [AMR]
- kWh Cumulative or TOU
- kW Interval
- Communication Network
- HAN Gateway
- Remote Service Switch [connect / disconnect]

**Smart Meters**
- Smart Metering
- Enhanced Meter Data Management
- Enhanced Communication Network
Describe the differences between AMI and Smart Metering

- **AMI** [**advanced metering infrastructure**]: a **utility-owned** communication system that links interval meters at each customer site with back-office meter data management, billing and other application software.

- **Smart Meter**: AMI with an integrated service switch, HAN gateway, enhanced two-way communications network, and enhanced back office Meter Data Management, Demand Response and Price signaling software.

  - **HAN** [**home area network**] - communication system(s) within the customer facility that link **consumer-owned** communicating devices including thermostats, pool pumps, appliances, distributed generation sources, gateways, routers, entertainment devices, health monitors, fire, security and other applications. SmartMeter OpenHAN gateway integrates the HAN into the meter. HAN typically remains independent of the meter.

  - **Service Switch**: a switch that allows the utility to remotely: (a) disconnect and reconnect the customer’s electric service and (b) establish a demand limit, which if exceeded will disconnect the customer’s electric service.
4.51 Metering

D. Service Switch

E. HAN Gateway Transceiver(s)

A. Metrology

B. Utility Network Transceiver

C. Computing & Memory

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
### Meter Function Description

<table>
<thead>
<tr>
<th>Meter Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Metrology</strong></td>
<td>Interval recording of usage.</td>
</tr>
<tr>
<td><strong>B. Utility Network Transceiver</strong></td>
<td>Connects the meter via a network or multiple networks to the utility back office</td>
</tr>
</tbody>
</table>
| **C. Computing and Memory**                         | - Supports meter computations, storage of interval data, storage of price or billing metrics, rating periods, billing parameters, storage of customer usage, device, other data.  
|                                                    | - Support upgrades, bug fixes, security, etc.                              |
| **D. Service Switch**                               | - Remote connect / disconnect  
|                                                    | - Remote whole facility demand limiting                                    |
| **E. HAN Gateway Transceiver(s)**                   | One or more transceivers to link the Utility Network Transceiver into the customer facility. |
### 4.6 Metering

#### Describe the difference between AMI and Smart Metering

<table>
<thead>
<tr>
<th>Metering System</th>
<th>Advanced</th>
<th>Smart</th>
<th>Tradeoffs - Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Function</td>
<td>Interval Recording</td>
<td>Interval Recording</td>
<td>Identical, no issues</td>
</tr>
<tr>
<td>Communications Capability</td>
<td>Network, two-way</td>
<td>Network, two-way into customer premise</td>
<td>• Need increased bandwidth</td>
</tr>
<tr>
<td>Demand Limit Connect-Disconnect Service Switch</td>
<td>A separate piece of equipment</td>
<td>Integrated</td>
<td>• Reach into customer premise</td>
</tr>
<tr>
<td>Home Area Network Gateway</td>
<td>Separate system</td>
<td>Partially Integrated</td>
<td>Cost Justification</td>
</tr>
<tr>
<td>Cost Range per Meter [excludes customer devices]</td>
<td>$70-$150</td>
<td>$130-$250</td>
<td>Hardware Integration</td>
</tr>
<tr>
<td>Data Collection</td>
<td>Interval kWh</td>
<td></td>
<td>Cost, Depreciation, Obsolescence</td>
</tr>
<tr>
<td>Rate Forms Supported</td>
<td>Flat, Tiered, TOU, Dynamic</td>
<td>Flat, Tiered, TOU, Dynamic</td>
<td>• More complex data</td>
</tr>
<tr>
<td>Support for Usage Displays</td>
<td>Remote Access Separate Service</td>
<td>Integrated Plus Separate Service</td>
<td>• Security and Privacy</td>
</tr>
<tr>
<td>Obsolescence Ranking</td>
<td>Low to Moderate</td>
<td>Moderate to Uncertain</td>
<td>No issues</td>
</tr>
<tr>
<td>Support for Market Based Devices and Services</td>
<td>Open</td>
<td>“Gate Keeper” Potential</td>
<td>Thru the Meter</td>
</tr>
</tbody>
</table>

- **Lawrence Berkeley National Laboratory** - Smart Grid Technical Advisory Project

12
## 4.7 Metering

<table>
<thead>
<tr>
<th>Meter Function</th>
<th>Advanced Meters</th>
<th>Smart Meters</th>
<th>Technical, Performance and Polity Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Metrology</td>
<td>1</td>
<td>1</td>
<td>1. Storage capacity/organization determine support for time-differentiated / other rate forms.</td>
</tr>
</tbody>
</table>
| B. Utility Network      | 2,3,4           | 2,3,4,9      | 2. Capacity for interval data retrieval  
3. Capacity for outage management / customer service inquiries  
4. Carrying capacity for DR signals, near real-time usage, appliance registrations, parameter retrieval |
| Transceivers            |                 |              |                                                                                                                                                                                                                                       |
| C. Computing and Memory | 5               | 5,6,9        | 5. Sufficient processing and storage to support customer service, DR and DER operations, upgrades, security /bug  
6. Potential obsolescence with HAN and related components |
| D. Service Switch       |                 | 7,8,9        | 7. Notice and operation of remote connect / disconnect.  
8. Notice and operation of “full outage” demand limiting  
9. Increased cost for smart meter capability. |
| E. HAN Gateway Transceivers | 9,10,11 ,12,13 |              | 10. Potentially constrains customer third-party service EE, DR, DER, and information service providers  
11. Potential conflicts with other customer networks (entertainment, security, IT, health, etc.)  
12. Privacy implications for retrieval of customer appliance parameters, settings  
13. Potential liability with customer appliance operations |
Policy Issues

1. Should there be a demarcation point between the customer and utility?
   a) Should the utility be collecting data from inside the customer premise?
   b) Should the meter communication network also be used to support pricing and demand response?
   c) Should a HAN be incorporated into the residential meter?

2. Should utility or some other entity broadcast or make price and reliability signals available over a public network or should the meter communication network be the exclusive channel for this information?

3. What are the privacy implications of AMI and Smart Meters and how can they be mitigated?

4. Do AMI and smart meters have different obsolescence issues?

5. Should a service switch be integrated into every meter?
# Metering – Cost Recovery

<table>
<thead>
<tr>
<th>Approach</th>
<th>At Risk</th>
<th>Description</th>
</tr>
</thead>
</table>
| Regulatory Assets             | Shareholder     | - Shareholder at risk  
- Reasonableness determination to rate-based when ‘used and useful’                                                                         |
| Trackers and Bill Riders      | Depends on Application. | - Tracks and recovers unpredictable costs  
- Forecasted costs with next year reconciliation  
- Typically ends after next rate case |
| Balancing Accounts            | Depends on recovery time | Recovers costs unrecovered through rate due to external conditions                                                                         |
| Customer Surcharge            | Customer        | Typically applied to all customer in a class                                                                                            |
| State and Federal Funding     | Depends on treatment | Costs may be covered by state and/or federal funding sources                                                                             |
| Other                         | Uncertain       | - Typically results from settlement agreements for non-smart grid issues  
- May include a investment on behalf of shareholders in smart grid/AMI components                                                            |
4.91 Metering

Metering – Cost Recovery

Example 1: First Energy

- Pennsylvania PUC Implementation Order, June 2009
  “Those costs that provide benefit across multiple classes should be allocated among the appropriate classes using reasonable cost of service practices” (Implementation Order at 32).

- First Energy proposal – allocate costs based on class and number of customers because smart meter costs are “akin to traditional metering and meter-related costs” (PUC Order at 48).
  Consumer advocates argued to allocate based on energy and demand to better reflect the benefit realization.

- PUC adopts First Energy’s proposal –
  “costs will be incurred without regard to energy consumption or customer demand, and because the smart meter technology will be provided to all metered customers” (PUC Order at 55).

- PUC decision - functionalization of customer costs is made regardless of usage. The typical costs assigned to customer costs include meters, meter reading, and billing.
California PUC addressed risk in two ways:

1) Established formula for cost overruns
   - 10% of $100 million in additional project costs at shareholder risk
   - Cost overruns greater than $100 million subject to reasonableness review for any rate recovery

2) Per-meter offset from operational benefits
   Most of this benefit is a result of reduction in meter reading costs and based on four-year forecast

This model was adopted for SCE and SDG&E
4.93 Metering

Metering – Cost Recovery

Other Issues

Societal benefits

- Hard-to-quantify and long-term realization by customers
- Ratio of societal to operational benefits greater than one suggests over-reliance on societal benefits

<table>
<thead>
<tr>
<th></th>
<th>Duke Energy (Indiana)</th>
<th>SDG&amp;E</th>
<th>SCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Timeline</td>
<td>20 years</td>
<td>20 years</td>
<td>25 years</td>
</tr>
<tr>
<td>Meters</td>
<td>810,000</td>
<td>1,300,000</td>
<td>5,300,000</td>
</tr>
<tr>
<td>Capital Costs ($MM)</td>
<td>483</td>
<td>490</td>
<td>1,227</td>
</tr>
<tr>
<td>Operational Benefits ($MM)</td>
<td>372</td>
<td>1,433</td>
<td>1,990</td>
</tr>
<tr>
<td>Societal Benefits ($MM)</td>
<td>602</td>
<td>1,196</td>
<td>295</td>
</tr>
<tr>
<td>Societal/Operational Benefit Ratio</td>
<td><strong>1.62</strong></td>
<td><strong>.97</strong></td>
<td><strong>.15</strong></td>
</tr>
</tbody>
</table>

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
4.94 Metering

Metering – Cost Recovery

Other Issues

- **Depreciation**
  - Must consider both the remaining life of existing meters and depreciation of new, digital meters
  - Function of rate of meter replacement
  - Potential credit to customers if current depreciation schedules yield greater depreciation expenses than new depreciation schedules

- **Back office billing systems**
  - Shared expense not attributable to a specific customer class
  - Capability to support dynamic pricing and new billing features

- **Customer Education**
  - Link to meter investment or efficiency, demand response, program initiatives?
6.0 Demand Response
6.1 Demand Response

Transforming Demand Response to a Smart Grid Environment

Conventional Grid

- Incentives
- Technology
- Utility Control

Smart Grid

- Technology Platform
- Price, Reliability, Event Signals
- Customer Control Strategies

Infrastructure

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
6.2 Demand Response

Providing Demand Response Signals - Two Options

1. Private Network
   Meter Communication System
   - Through the Meter
     Two-way Narrowband

2. Public Network
   Broadband or Narrowband
   - Public or Private
     Two-way Broadband
   - Radio Broadcast
     One-way Narrowband

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
6.3 Demand Response

Facilitating Demand Response– Three Options

- **Direct Control**
  - Utility or Service Provider
  - Customer Facility
  - Control Signal
  - Customer Facility
  - Appliance or Load

- **Price Response**
  - Utility or Service Provider
  - Customer Facility
  - Price, Reliability, or Event Signal
  - Customer Facility
  - Appliance or Load

- **Price Response**
  - Utility or Service Provider
  - Customer Facility
  - Price, Reliability, or Event Signal
  - Customer Facility
  - Smart Appliance

Source: “Direct versus Facility Centric Load Control for Automated Demand Response, Grid Interop 2008, Koch, E., Piette, M”

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
6.4 Demand Response

**Incentive**
- Participation Payment
- Monthly Bill
- Customer

**Utility**
- Aggregator
- Control System
- Utility Control Signal

**Aggregator**
- Control System
- Ag. Control Signal

**Customer End-Uses**
- Renewables
  - Refrigerator
  - Dryer
  - Washer
  - Pool Pump
  - Water Heater
  - HVAC

Flat Rate, Fixed Incentive, Direct Control

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
6.5 Demand Response

- Utility
- Aggregator
- Customer
- Control System

- Monthly Bill
- Utility Price Signal
- Ag. Control Signal

- Renewables
  - Refrigerator
  - Dryer
  - Washer
  - Pool Pump
  - Water Heater
  - HVAC

Customer End-Uses

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
6.6 Demand Response

Direct Control and Participation Payments vs. Price Response

Hot Day, August 15, 2003, Average Peak Temperature 88.5\(^{\circ}\)

### 6.7 Demand Response

<table>
<thead>
<tr>
<th>Participation</th>
<th>Conventional DR</th>
<th>Smart Grid DR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted, Limited to Large C/I &amp; Residential</td>
<td>All Customers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who Controls</th>
<th>Utility</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted</td>
<td>Utility</td>
<td>Customer</td>
</tr>
<tr>
<td>Limited to Large C/I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>All Customers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What is Controlled</th>
<th>Utility Provided</th>
<th>Customer Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interruption Rates</td>
<td>Few Suppliers</td>
<td>Many Market Suppliers</td>
</tr>
<tr>
<td>HVAC, Water Heating</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control Equipment</th>
<th>Utility Provided</th>
<th>Customer Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed / Participation Payments</td>
<td>Few Suppliers</td>
<td>Many Market Suppliers</td>
</tr>
<tr>
<td>Baseline metrics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Incentives</th>
<th>Utility Provided</th>
<th>Customer Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed / Participation Payments</td>
<td>Few Suppliers</td>
<td>Many Market Suppliers</td>
</tr>
<tr>
<td>Baseline metrics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DR Products</th>
<th>Generally limited to Reliability</th>
<th>Capacity, Energy, Ancillary Services Markets; Congestion Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

| DR, EE, Renewable Integration | No                             | Yes                                                                  |

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
6.8 Demand Response

Static Pricing
- Flat-Tiered
- Time of Use

Dynamic Pricing
- Critical Peak Pricing
- Real Time Pricing

Rate Design
- Daily Energy Efficiency
- Time-of-Use Energy
- Daily Peak Load Managed
- Day-Ahead (slow) DR
- Real-Time DR

System and Customer Capability to Respond
- Spinning Reserve (fast) DR

Metering and Communication Needs
- Increasing Levels of Granularity of Controls
- Increasing Speed of Telemetry

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
# 6.9 Demand Response

## Technologies to Send Signals

<table>
<thead>
<tr>
<th>No.</th>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Through the Meter Two-way Narrowband</td>
<td>[ZigBee-HomePlug, OpenADR]</td>
</tr>
<tr>
<td>2</td>
<td>Public or Private Two-way Broadband</td>
<td>[Internet via DSL, cable, fiber, etc.]</td>
</tr>
<tr>
<td>3</td>
<td>Radio Broadcast One-way Narrowband</td>
<td>[RBDS/RDS, Satellite, Pager to the devices]</td>
</tr>
</tbody>
</table>

### NIST#14, #15 SEP 2.0
- Requirements doc to be released soon
- Specification doc to be ready May 2010
- Testing to begin 2011

### NIST#13 OpenADR
- Server available today
- Open source in 2010
- Open to Aggregators

### NIST#13 OpenADR
- OpenADR bridge client to RBDS/RDS tested
- Proprietary Paging

## Technologies to Receive and Act on Signals

<table>
<thead>
<tr>
<th>Energy Managers</th>
<th>Thermostats</th>
<th>Smart Appliances</th>
<th>Third-party services</th>
</tr>
</thead>
<tbody>
<tr>
<td>~50 EMCS, BAS, etc.</td>
<td>U-SNAP TX interface</td>
<td>Proprietary devices</td>
<td></td>
</tr>
<tr>
<td>Not tested with IP (network/transport)</td>
<td>Products use older incompatible stack</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Commercial/Industrial
- ~50 EMCS, BAS, etc., products already have OpenADR clients
- 7 years of field testing

### Small Commercial & Residential Thermostats
- U-SNAP TX interface

---


Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
### 6.91 Demand Response

<table>
<thead>
<tr>
<th>Rights</th>
<th>Obligations</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **1. CUSTOMER CHOICE:**  
- the right to receive price and reliability signals without enrolling in utility programs  
- without registering their equipment with their utility. | Utilities are obligated to broadcast price and reliability signals which can be received by customer equipment that is neither registered with the utility nor used in a utility program. | • Broadcasting price and reliability signals creates “operational“ information.  
• Broadcasting price and reliability signals encourages open market response and equipment options. |
| **2. CUSTOMER CHOICE:**  
- the right to choose if and how they will program their communicating devices to respond to price and reliability signals. | Vendors of programmable communicating devices are obligated to provide a means of setting the device to not respond to signals, and a means of overriding programming. | • Customer choice promotes participation, eliminates dropouts, and increases DR effectiveness.  
• Open market vendors as well as utilities should provide equipment and services to support DR.  
• DR systems and equipment should support a minimum required set of common functions. |
| **3. CUSTOMER CHOICE:**  
- the right to purchase, rent or otherwise select any vendor, devices, and services used for energy management or other purposes in their premise. | Utilities are obligated to provide open communication protocols that do not restrict customer DR equipment or service choices. | • Common, open communication protocols promote competitive markets for DR, features and services customized to customer needs, lower costs and more rapid, widespread implementation. |

## 6.92 Demand Response

<table>
<thead>
<tr>
<th>Rights</th>
<th>Obligations</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. OPEN MARKET FOR DR:</strong> Vendors have the right to compete in an open market to sell HAN related systems, devices and services to all utility customers.</td>
<td>Utilities are obligated to not restrict customers enrolled in utility programs, to equipment that uses the AMI communication protocol.</td>
<td>• Open market vendors as well as utilities should provide equipment and services to support DR.</td>
</tr>
<tr>
<td><strong>5. OPEN MARKET FOR DR:</strong> Utilities have the right to offer DR and energy management services to customers which utilize the information and communication capabilities of their AMI system.</td>
<td>Customers are obligated to maintain their equipment used in utility programs, in good working order, and to provide any communications translation device if needed.</td>
<td>• Common, open communication protocols promote competitive markets for DR, features and services customized to customer needs, lower costs and more rapid, widespread implementation. • Customer choice promotes participation, eliminates dropouts, and increases DR effectiveness.</td>
</tr>
<tr>
<td><strong>6. OPEN MARKET FOR DR:</strong> Customers have the right to participate in utility sponsored programs and at the same time, use equipment, not involved in the utility program, to receive price and reliability signals.</td>
<td>Utilities have an obligation to provide price and reliability signals through their AMI two-way signal system and through a one-way signal system.</td>
<td></td>
</tr>
</tbody>
</table>

8.1 Smart Grid Technologies

Issues and Opportunities

A. Microgrids
B. Solar Photovoltaic
C. Wind
D. PHEV’s
E. Consumer Controls and Appliances
   a) Programmable Controllable Thermostats
   b) Smart Appliances
   c) In Home Displays
   d) Interoperability
8.2 Smart Grid Technologies

Programmable Controllable Thermostat
8.3 Smart Grid Technologies

Demand Response Equipment Evolution
- Switches to thermostats
- Thermostats to embedded controls
- Utility to customer control

- Conventional Air Conditioner Control Switch mid 1970's
- Programmable Communicating Thermostat 1999
- Programmable Communicating Thermostat
- Programmable Communicating Thermostat 2009

CEC PCT Cost Effectiveness Benchmark

CEC PCT First Release Commercially Available 2009

Projected 2009

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
8.4 Smart Grid Technologies

Smart Appliances

Price Event Signal to Smart Appliance

Smart Appliance displays Price Event has occurred

Smart Appliance recommends response strategy

Over Ride?
Yes

Over Ride?
No

Initiate delayed start function

Run Normal operating mode

Over Ride?
No

Initiate peak reduction mode

Demand Response Strategy
• Delay defrost
• Modify peak run time
• Reduced Peak features
• Energy saver mode
• temperature shift

Lawrence Berkeley National Laboratory - Smart Grid Technical Advisory Project
8.5 Smart Grid Technologies

Utility Smart Network Access Port (Usnap)

- The **U-SNAP Alliance** is an open industry association developing de-facto standard for connecting energy aware consumer products with smart meters.

- The Alliance will create and publish a standard, establish testing and certification procedures for product conformance and educate consumers, utilities and vendors on the benefits of the standard.

- Alliance membership is comprised of utilities, manufacturers, consultants and other parties interested in developing or deploying the standard. For more information, or to find out how to join the Alliance, please visit [www.usnap.org](http://www.usnap.org)

ZigBee, Z-Wave, RDS, Wi-Fi,
Technology Issues

- Low incremental costs with short payback (< 1 yr)
- Existing interfaces (e.g., i-Phone paradigm)
- Future proofing to avoid stranding investments
- End-to-end system integration, e.g., Internet
- Cyber-security, e.g., online banking, military, ...
- Automation controlled by the consumer or proxy
- Open standards, common information model
- Product certification, similar to UL
Policy Issues

- Utility-owned vs. customer-owned equipment
  - Compatibility with IT, security, etc., networks
  - Equipment support and liability
- Utility-control vs. customer choice
  - Single function vs. multi-function devices
- Utility programs vs. open-market initiatives
  - Cost of Smart AC vs. retail thermostat
  - Deterministic vs. stochastic load reduction