Demand Response Enabled Appliances/ Home Energy Management System

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General Electric Consumer and Industrial
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NREL – Golden, CO
GE Consumer & Industrial

World Class Manufacturer of Consumer Products:
Lighting, Appliances, Electrical Distribution Equipment
Strong Brand Presence in Marketplace

– America’s #1 preferred appliance brand for nine years in a row*
– GE is ranked 4th as the world’s most valuable brand**

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>2007 Brand Rank</th>
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</thead>
<tbody>
<tr>
<td>Coca-Cola</td>
<td>1</td>
<td>6</td>
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<tr>
<td>Microsoft</td>
<td>2</td>
<td>7</td>
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<tr>
<td>IBM</td>
<td>3</td>
<td>8</td>
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<tr>
<td>GE</td>
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<td>9</td>
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<tr>
<td>Nokia</td>
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<td>Toyota</td>
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<td>McDonald’s</td>
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<td>Disney</td>
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<td>Mercedes-Benz</td>
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</table>

*Harris Poll 2006
**Business Week 2007

Source: Businessweek.com
ENERGY STAR® partner of the year

— ENERGY STAR is the DOE/EPA sponsored program to help consumers identify products with the highest energy and environmental performance.

2012 Demand

- 37% Residential
- 36% Commercial
- 27% Industrial


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Trends in the Utility Industry

• Demand is outpacing supply in certain locations and at peak times

• Legislation (CO2 regulation) and costs are stopping new fossil/nuclear power plant construction – renewable requirements being implemented

• Smart meters (AMI) are being deployed in significant numbers

• “Smart Grid” being rolled out and supported by DOE, regulators

• Pricing legislation (Tiered and TOU) will drive consumer behavior
Appliances & Lighting Energy as a Percentage of Household Energy Usage

- Water Heater: 13%
- Refrigerator: 5%
- Dishwasher: 2%
- Clothes Washer & Dryer: 6%
- Lighting: 10%
- Electronics: 7%
- Other*: 8%

Total: 36%

Source: www.energystar.gov
Energy Efficiency

Good progress has been made on product efficiency.

Average Energy
- 68W

Peak Power
- 10 x 68W

Refrigerator
Energy Efficiency

New solutions needed to address peak loads.

Average Energy

Peak Power

Wall-Oven

5W

100 x 100W

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“….. it is the *residential class* that represents most untapped potential for demand response

“While residential customers provide only roughly 17 percent of today’s demand response potential, in the AP (Anticipated Participation) scenario they provide over 45 percent of the potential impacts. This is illustrated in Figure 3.”

*Figure 3: U.S. Demand Response Potential by Class (2019)*
Manage the Load

Utility signals home to shed load.
Utility Perspective

Demand Reduction During Peaks is Important

DR Enabled Appliances

SW – capable for 1,2,3,4 response on module

Utility interface to radio signal through Web access
E-radio to set up radio station
Utility to use WEB interface control signal timing

E-Radio – tie, one way communication, low, med, high, critical
Direct tie to meter
ZigBee Smart Energy Profile 802.15.4

Optional configuration
Home plug interface
ZigBee Smart Energy Profile 802.15.4
GE Demand Reduction Approach

1. Price Event Signal to Smart Appliance
2. Smart Appliance will indicate to consumer Price Event has occurred
3. Smart Appliance will recommend to delay start
4. Consumer Choice
   - Over Ride?
     - No: Initiate delayed start function
     - Yes: Over Ride?
       - No: Initiate peak reduction mode
       - Yes: Run Normal operating mode
Home to Grid (H2G) Appliance Response

Demand Response (DR) – Energy Star

- Delay defrost
- Modification of run time during peak
- Reduced features during peak
- Energy saver mode – temperature shift

Refrigerator
H2G Appliance Response

Demand Response (DR) - Energy Star

- Delayed wash and dry
- Modified cycle time
- Manage water usage - cold wash
- Energy saver mode – smarter cycles

Washer and Dryer
H2G Appliance Response

Demand Response (DR) - Energy Star

- Delayed wash
- Modified cycle time
- Manage water usage
- Energy saver mode – smarter cycles

Dish Washer
H2G Appliance Response

Demand Response (DR)
- Reduced energy cooking
- Use of small cavity
- Cooking efficiency
- Electronic cook top

Range and Microwave
Hybrid Water Heater: Launch 2009

Energy Efficiencies
- Uses heat pump technology to generate energy savings of ~ 2500 kWh per year (uses 2300 KWH per year vs. standard 50 gallon 4800 kWh per year)

- EF rating of ~ 2.0 compared to .90-.93 standard electric water heater.

- DR-enabled. Uses 800 W in peak mode vs. 4500 W in standard electric mode.

Convenience
- Similar installation as a standard water heater
- 50 gallon capacity
H2G – Home Energy Manager / DR 2010

Direct tie to meter
ZigBee Smart Energy Profile 802.15.4
Mesh network communication

Optional Configuration
Home plug interface
ZigBee transmitter

ZigBee Smart Energy Profile 802.15.4
Custom Commands for HEM

Home Energy Manager
HEM - SMART ADVANTAGE

Advanced algorithmic based system
• Energy manager/scheduler
• Displays Energy/Water Usage
• Weather forecast Advanced algorithms
• Power management with on-site solar
• Advanced management setting for appliances
• Vacation mode
• Two way communication

Home Energy Manager (HEM)
H2G Smart Thermostat

Demand Response (DR)

- Fully programmable Thermostat
- Screen selection
  - $KWh Usage
  - Instantaneous KWh
  - Instantaneous $Pricing
Home Energy Manager - Vision

- Zigbee Mesh Network Communication
- Smart Energy Profile V 1.0 (or 2.0)
- Remote Internet Access / Wifi Enabled
- Extensible Network Architecture
- Smart Meter Integration

Homeowner’s PC

Home Network

Smart Meter

Water Meter

Solar Generation

HVAC System

Remote Access

DR Enabled Appliances

Home Network

Internet

Home Energy Manager

Smart Meter Integration

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Solar Generation

Extensible Network Architecture

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Why Consumers Purchase Appliances

*Today’s Purchase Decision Equation*

Purchase Decision = \( f \) (Product Price, Features, Appearance... maybe energy)

*Smart Grid Purchase Decision Equation*

Purchase Decision = \( f \) (Product Price, Features, Appearance)

+ \( f \) (manage energy use and minimize operating costs)

**Education of Consumer is Critical**
GE C&I Products – for Pilot Programs

Energy Monitor and Smart Thermostat – available 1Q 2010

Appliances Available Aug 2009

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GE DR Appliances in “smart grid” Demonstration projects

Planned
• American Electric Power (AEP)
• Sacramento Municipal Utility District (SMUD)
• Reliant Energy (Houston)
• Florida Power and Light

Lab Demonstrations Underway
• Southern California Edison (SCE)
• Consumers Energy
• Centerpoint Energy
• AEP
LG&E / GE Pilot Program

- 46 DR Appliances installed in 15 homes in Louisville (GE Employees)
- 12 months of field experience
- Surveys, data gathering underway
- 2 Focus Group sessions
LG&E / GE Pilot Program

Survey Overview

- Gen1 product shedding load as expected
- Customers believe that they are saving money
- Customer behaviors are being modified

"it appears like I saved $10-$20 last month - some of that may be due to the energy mgmt system"

"I like the fact they interact with the LG&E meter to automatically make adjustments based upon the current rate period. That provides energy savings for me that I would have a difficult time duplicating otherwise."

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Refrigeration Demo – 4 Homes

27% reduction during peak hours
6% reduction on daily cost
The Future ..... 

Add Advanced Building Envelope Technology and on-site Generation to.....Smart Appliances and Home Energy Management Systems....
The Net Zero Energy Home

A Net Zero Energy Home (NZH) combines highly efficient appliances/HVAC and Home Energy Management with on-site Renewable Energy Generation to annually return as much energy to the utility as it takes from the utility, resulting in a net-zero energy consumption for the home over the course of a year.
Concept

Reduce Consumption to match Renewable Generation, manage energy use

Key enablers for Net Zero Energy Homes
<table>
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<tr>
<th>Energy Efficiency Products</th>
<th>Distributed Generation</th>
<th>Energy Optimization/Demand Response Appliances</th>
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| **GE Heat Pump Water Heater**
Uses less than half the energy of a conventional electric water heater. | **Solar Photovoltaic**
3 kW to 4 kW solar array on the roof to meet energy requirements of the home. | **Home Energy Manager**
The central nervous system for the net zero energy home helps homeowners optimize energy consumption. |
| **Demand Response Appliances**
High efficiency Energy Star Appliances shed load from the grid and help consumers save money during peak demand. | **Small Wind**
Supplementary renewable generation. | **Smart Meter**
A communication gateway between the Smart Grid and the home. |
| **Energy Efficient Lighting**
High efficiency CFL, LED and OLED lighting. | **Energy Storage**
Battery storage for backup power and peak loads. | **GE Water Filtration**
Filters, conditions and monitors home water usage. |
| **Geothermal Heat Pumps**
Reduces HVAC and water heating energy requirements by 30%. | | |
Thanks ... any questions?