So We Think We Understand Energy Efficiency!!

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Traditional Energy Efficiency “Stuff”

- Compact Fluorescent Light (CFL)
- LED Lighting
- High efficiency Air Conditioners
- High efficiency refrigerators
- Window caulking, ceiling insulation
- Energy Star appliances
- Commercial Lighting
- Space heating
- Space cooling
- High efficiency chillers
- Utility/State energy efficiency programs/rebates
Which Industry is the Single Largest User of Electricity?

1. Aluminum
2. Steel
3. Data Centers
4. Electric Utilities
5. Plastic
Significant Opportunity to Improve End to End Efficiency

Breakdown of Electricity Use

<table>
<thead>
<tr>
<th>Generation</th>
<th>Transmission</th>
<th>Distribution</th>
<th>Residence/Buildings</th>
<th>Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>~6%</td>
<td>~3%</td>
<td>~6%</td>
<td>~60%</td>
<td>~25%</td>
</tr>
</tbody>
</table>

Electricity Industry is the Single Largest End User of Electricity
Reducing T&D Losses by 10% in Essence Doubles our Installed Wind Capacity (~2006)

Efficient T&D systems for a Carbon-Constrained World

Reducing 10% T&D Losses = kWh generated by 11GW of wind generation in US
Project Goals & Objectives

- Develop and demonstrate consistent method to quantify losses

- Compile credible data to quantify the costs, benefits, and risks of using energy efficiency and loss mitigation as part of planning

- Demonstrate real life examples where loss mitigation options have been implemented and validate realized loss reduction
Green Circuit Project
Today: 61 ckts, 24 states and 2 countries

As of Oct, 08, 2008
What is the single largest category of electricity consumption in US residential buildings?

1. Space Heating
2. Space Cooling
3. Water Heating
4. Refrigeration
5. Lighting
6. Miscellaneous
Change in Residential Electricity Intensity

Change in Intensity

- Space Heat: -13%
- Space Cool: -17%
- Water Heat: -25%
- Refrigeration: -34%
- Lighting: -4%
- Other Uses: 17%
- TV/PC: 27%

Source: DOE/EIA Annual Energy Outlook 2007, with Projection to 2030

35% to 43% increase in Misc. Devices

Today

- TV/PC: 9%
- Refrigeration: 10%
- Water Heat: 18%
- Lighting: 10%
- Space Heat: 10%
- Space Cool: 18%
- Other Uses: 26%

2030

- TV/PC: 13%
- Refrigeration: 7%
- Space Heat: 9%
- Space Cool: 16%
- Lighting: 18%
- Other Uses: 30%

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Growth in Plug Connected Loads

PC with High End Video Card
350W during gaming

Set Top Box
30W, 100% duty cycle in a year

Digital photo frame
(6W-15W)

Plasma TV
300W, ~5.5 hrs/day

Limited Load Research Data on Plug Connected Loads
Making Electronics More Efficient:
Key Focus Area of EPRI Energy Efficiency R&D

120V ac~100W
η~70%
AC/DC PS

12V dc~70W
η~85%
DC/DC PS

1.2V dc~60W

The μ Processor world runs on 1V-2V dc
Converting 120V ac to 1V-2V dc could result in 40% Losses
About 6 to 10% of all U.S. electricity use requires ac/dc conversion

Tier 1 Power Supply and Power Management Requirements:
Effective July 20, 2007

| New EPA Energy Star Standard for Computers Directly Influenced by EPRI Research | 80% minimum efficiency at 20%, 50%, and 100% of rated output and minimum Power Factor 0.9 |

EPRI Research Resulted in New Energy Star Specification for Computer Power Supplies
What is the trend of electricity consumption in California over the past 10 years?

1. Upward
2. Downward
3. Flat
4. All of the above
The Chart that you most likely have seen.....

CA’s flat per capita consumption as a result of their EE efforts
The Chart that you most likely have NOT seen.....

Total Electricity Consumption Growing at the Same Rate as US
The Chat that you most likely have NOT seen.....

Figure 25: PG&E Planning Area Use per Household


per household electricity use is increasing
Contribution of Energy Efficiency and Change in Sectoral Activity

Economic Activity Moving from Industrial base to Service base
Price Induced Energy Efficiency

@ 37 cents/kWh Tier 4 Rate It will cost $195/yr to power a 60W incandescent light bulb that costs 50 cents to buy
How many refrigerator magnets does it take to make a zero energy refrigerator?

1. Few
2. Many
3. Undetermined
4. You cannot make a zero energy refrigerator with magnets
Sample of a EE Program Elements

Market Transformation Activities Could be a Large Portion of Deemed Savings

- Energy Star Home MTP: 30%
- C&I Programs: 13%
- Res. & Small Com. Program: 18%
- A/C Distributor /Installer MTP: 16%
- Load Management: 15%
- Other Programs: 8%
Risk and Uncertainty in Measuring “Saving a Watt”

- Uncertainty in estimating savings from Market Transformation Programs (MTP)
- Uncertainty in extrapolating limited set of measurement data to estimate program wide savings
- Uncertainty in estimating energy savings coincident with utility peak demand
- Uncertainty in tracking the persistence of energy savings measures – takeback effect
- Uncertainty in estimating free riders taking advantage of programs that they would have otherwise undertaken

These Uncertainties Need to be Accounted in an Integrated Resource Plan and Could Result in a Wide Band of Estimates for Energy Savings Potential
How much kWh savings can be achieved by making customers aware of their electricity consumption through real time displays and other direct feedback?

1. ~ 2%
2. ~ 5%
3. ~ 10%
4. ~ 25%
5. All of the Above
Information Is Critical to Energy-Use Decisions

• Habits of residents greatly affect energy use

• Feedback helps customers understand the cause-effect link

• Time between action (behavior) and consequence (resulting energy use and cost) is very important

• Feedback most useful when accompanied by goal ($ savings, prevent blackouts, reduce carbon emissions)
Display Devices
A wide variety of studies have been conducted over the past 20 years to quantify the impact of information on electricity consumption:

- **Indirect feedback** – provides consumers with more detailed and in-depth analyses of billing information
- **Direct feedback** – provides consumers direct access to the meter contents

The reported impacts over both feedback types, reductions in total kWh consumed, range from zero to 25%

Electronic display results also exhibit a wide range of energy reduction values

Most studies involved only very few (under 150) participants for a year or less.
What is the metric of energy efficiency?

1. kWh use
2. CO2 reduction potential
3. BTU use
4. All of them
5. None of them

- kWh use: 4%
- CO2 reduction potential: 69%
- BTU use: 0%
- All of them: 0%
- None of them: 27%
Carbon Footprint of End Use Energy in U.S., 2006

Total U.S. CO₂ Footprint of Delivered Energy
- 5.9 Billion Metric Tons

- 40% Petroleum: 7 Billion Barrels
- 14% Natural Gas: 15 Trillion Cubic Feet
- 43% Other
- 3% Electricity: 3,661 Billion kWh

In a Low Carbon Future Carbon Footprint Becomes the Primary Metrics to Gauge the Scale of Energy Efficiency
The Expanded Scale of Energy Efficiency

• **Traditional Energy Efficiency Measures**
  – Reducing carbon footprint by reducing use of electricity through increasingly higher efficiency

• **Electrifying End Use Processes**
  – Reducing carbon footprint by replacing direct combustion of fossil fuel in end use processes with low carbon electricity

• **Electrifying Transportation**
  – Reducing carbon footprint by replacing direct combustion of petroleum with low carbon electricity

**Significant Opportunity to Expand the Scale of Energy Efficiency**
Energy Efficiency + Heat Pump + 20 Mile PHEV

PHEV Replaces Mid-Size Car
20 Mile All-Electric Range

+5,000 Lbs.

Gasoline -58%
-304 Gallons
Total CO₂ -31%

Electricity 33%
+3,180 kWh

-7,800 Lbs.

-13,200 Lbs.
Electricity as a Low Carbon Fuel

Decarbonizing the Electricity Sector Increases the Opportunity to Reduce Carbon Footprint Through Efficient Use of Electricity
Opportunity for Expanding Scale of Energy Efficiency

Effects of Traditional Energy Efficiency, Heat Pump Heating & Cooling, Mid-Size PHEV, and Low Carbon Generation
There is Much More to EE Than Traditional Energy Efficiency “Stuff”

• Compact Fluorescent Light (CFL)
• LED Lighting
• High efficiency Air Conditioners
• High efficiency refrigerators
• Window caulking, ceiling insulation
• Energy Star appliances
• Commercial Lighting
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