Results from Phased Deep Retrofits in Florida Homes

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Phased Deep Retrofit Project

• U.S. Department of Energy, Building America Program
  – Administration, auditing, monitoring, analysis and reporting

• Florida Power & Light
  – Retrofit equipment purchase and installation
Phased Deep Retrofit Project

- Detailed Residential Field Metering Project in FPL Service Territory
- 60 Homes Evaluated for over Two Years
- Establish Retrofit Impacts on Energy Reductions and Economics at Two Levels:
  - Shallow Retrofit (56 Homes – lost 4)
  - Deep Retrofit (10 Homes)
### Site Characteristics

- **60 All Electric Homes**

<table>
<thead>
<tr>
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<th>Average</th>
<th>Range</th>
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<tbody>
<tr>
<td>Area</td>
<td>1,777 ft²</td>
<td>1,000 - 2,650 ft²</td>
</tr>
<tr>
<td>Vintage</td>
<td>1984</td>
<td>1942 - 2006</td>
</tr>
<tr>
<td>Occupancy</td>
<td>2.6 persons</td>
<td>1 - 6 persons</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
<td>R-22</td>
<td>R-8 - R-38</td>
</tr>
<tr>
<td>Airtightness</td>
<td>8.5 ach50</td>
<td>4.4 – 16.4 ach50</td>
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- **Typical Study Home:**
  - Single-glazed windows
  - Slab-on-grade foundation
  - R-3 masonry walls
  - Asphalt shingle roof
  - Electric resistance water heating
  - 2003 Air conditioner
  - (1/3 had pools)
  - Pre-Study Annual Use: ~17,000 kWh
Extensive End-Use Metering

- Monitoring Aug 2012 - Mar 2013
- Tracking 18 Data Points, Hourly
  - Whole house power
  - All major end uses
- Plug Load Monitoring
  - E.g. TV & surrounding equipment
- Interior Temperature & Humidity
End-Use at Each Site

Vast Differences in End-Uses by Site

(Jan 2013 – Dec 2013)
No Single End-Use Dominates
Space Heating/Cooling/DHW only 45% of total
What Make Up Peak Load?

Peak Load: 5:00pm
Shallow Retrofit Measures

- Changed incandescent lighting to CFL or LED lighting
- Added exterior insulation to hot water tank
- Installed low-flow shower fixtures if existing flow > 2.2 gpm
- Set pool pump hours to ≤5 hours/day
- Cleaned dirty refrigerator coils
- Installed smart power strip if standby power loads ≥10 Watts continuous
Shallow Retrofit Evaluation

Shallow Retrofit at Site #7
March 28th, 2013

- Hot Water (7.7/5.9)
- Refrigerator (2.0/2.1)
- Pool pump (16.0/9.4)
- Lights, fans, plugs (14.0/11.1)

kWh per Day

Julian Date (February 28th – April 28th, 2013)
Shallow Savings Were Durable

- 9% Whole House Savings Among 56 Sites
- Biggest Impact: Lighting, Water Heating, Refrigerator
  - Pool pump retrofit savings reverted
- Simple Utility Pass Through Audits can Make a Difference!
Preliminary Cost Analysis

- Costs Average: $370/site*
- Average Hard Costs: $250/site
  - Lighting @ $211
  - Showerhead @ $31 & WH Insulation @ $23
  - Smart power strips @ $42 (2 at some sites)
  - Refrigerator coils – labor only
- Savings: 1,310-1,530 kWh/yr ($13-15/mon**)
- 2 year payback
- Disadvantage: **Invisible to Consumer**

* Labor @ $30/hr
** $0.12/kWh
Deep Retrofit Measures

- Upgrade to Existing HVAC
  - 16 or 17 SEER heat pump
  - Repair ducts
  - Learning thermostats
- Install Heat Pump Water Heater
- Replace Appliances with Energy Star
  - Washer & dryer
  - Refrigerator
  - Dishwasher
- Install Variable Speed Pool Pump
- Air Sealing and Insulation
Deep Retrofit Site #19

- Short-Term Total Power: 100 to 30 kWh/day
Deep Retrofit Site #19

• Longer-Term Total Power: 70 to 35 kWh/day

Whole House Power at Site 19

- 2013
- 2014

January - July

50% Savings

Deep Retrofit
Aug - Nov 2013

Shallow Retrofit
HVAC Retrofit at Site # 19

- 30 kWh/day Cooling Energy Savings: 50% (May – Oct, 2013)
- < 10 SEER to 16 SEER
- Duct Sealing (Qn,out: 0.09 to 0.05)
- NEST (3.5%)
Learning Thermostat

- Some Homeowners Prefer Low Temperatures
- Defeated “Auto-Away”
- Cooling Energy Savings: -8% to 4%
- Average: -0.6% negative savings
Heat Pump Water Heaters

- Dependable Savings vs. Electric Resistance Water Heaters
- 65% Overall Savings: 5.2 kWh/day 80gal
Heat Pump Water Heaters

- Dependable Savings vs. Electric Resistance Water Heaters
- 65% Overall Savings: 2.1 kWh/day 60gal
Energy Star Dryer

- 6 Months Average Dryer Energy Use Savings: 18% (0.6 kWh/day)
- 23% Savings in Heaviest Use Site
- One Home with Negative Savings (used to line dry)
Variable Speed Pool Pump

- Pre: 18.7 kWh/day
- Post: 1.9 kWh/day
  90% savings
- Huge Demand Reduction
- 1.8 kW @ 5 PM!
Early Analysis on Deep Retrofit

- Pre vs. Post Retrofit for Six Homes
  - Pre: Oct 2012 - Jan 2013
  - Post: Oct 2013 - Jan 2014
- 34% Whole House Energy Savings
- Final Annual Whole House Savings Likely 35 to 40%
  - Period does not include energy intensive summer
  - Weather was more harsh in post period (both heating and cooling)
  - Not all retrofits complete over before Oct 2013
Preliminary Cost Analysis

- Outright Cost Average: $14.2K/site
- Incremental Cost Average: $7K/site
  - Replace at burnout
- Estimated Annual Savings: ~ 7,000 kWh/yr ($70/month)
- *Highly Visible to Consumer*
- Rate of Return and Simple Payback:
  - Outright: ~6%, 17 year payback
  - Incremental: ~12%, 8 year payback
Conclusions

• Shallow Retrofits Demonstrate:
  • Simple Utility Pass Through Audits can Make a Difference: 9% whole house savings
  • Small, very cost-effective savings
  • However, invisible to the consumer

• Deeper Retrofits Demonstrate:
  • High-level whole house savings: 35 - 40%
  • Highly effective & reliable technologies
  • Attractive economics when retrofits coincide w/ major equipment & appliance replacement