What’s missing from the current whole-house incentive program landscape?

• Behavior! Plug loads!

• While space conditioning and water heating upgrades are essential, other end-uses comprise nearly half of total energy use in California homes

• Successful feedback/behavior programs exist (e.g., in California: Opower, SMUD HER), but interventions aren’t integrated with whole-house efforts
BACKGROUND: California energy efficiency goals
How much do we need to save in the residential sector?

- 2008 usage *
- Savings goal (40% BTU reduction) **
- Measured savings to date (2.3% BTU reduction) ***

*** Among IOU and REN programs, Jan 2010-Aug/Sep 2013. Source: http://eega.cpuc.ca.gov/
BACKGROUND: Where is energy used in California homes?

2003

- HVAC/H₂O heating: 62%
- Other end-uses: 38%

2009

- HVAC/H₂O heating: 54%
- Other end-uses: 46%

BACKGROUND: Where is energy used in California homes?

BACKGROUND: Predicted savings vs. realized utility bill savings in California’s whole-house programs

\[ R^2 = 0.0659 \]

Source: BKi analysis of Energy Upgrade California EnergyPro models vs. actual PG&E, SCE, SoCalGas, and SMUD utility bills
**BACKGROUND:** What measures are included in current California whole-house incentive programs?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Home Upgrade</th>
<th>PG&amp;E Advanced</th>
<th>SCE/SoCalGas Advanced</th>
<th>SMUD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC equipment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Water heating equipment</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Envelope measures</td>
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<td>✓</td>
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<tr>
<td>Pool pumps</td>
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<td>✗</td>
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<tr>
<td>Screw-in lighting</td>
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<td>✗</td>
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<tr>
<td>Plug loads</td>
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<tr>
<td>Thermostat settings and other behavior-based approaches</td>
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<td>✗</td>
<td>✗</td>
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</tr>
</tbody>
</table>
Every home needs a unique savings plan

Similar annual energy bills ($)

**BUT**

Different consumption patterns
Guide users to the best path for savings

- Smart meter disaggregation
- Energy reduction recommendations and usage tracking
  - HVAC efficiency:
    - Cooling > 8BTU’s/sf/hdd
    - Heating > 4BTU’s/sf/hdd
    - Occupant owned SFR
  - Idle Mode exceeds 400W
  - Phone consultation
- Referral to Whole House Program
- Update of monthly interval data
Beyond Buildings: How to Incorporate Behavior Modification into Whole-House Energy Upgrade Programs

An example: Range of idle load by house size

Idle Load vs. Home Size

<table>
<thead>
<tr>
<th>Home Size in Square Feet</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1000sf</td>
<td>480</td>
<td>160</td>
<td>3710</td>
</tr>
<tr>
<td>1000-1500</td>
<td>710</td>
<td>202</td>
<td>2700</td>
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<tr>
<td>1500-2000</td>
<td>800</td>
<td>261</td>
<td>2280</td>
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<tr>
<td>2000-3000</td>
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<tr>
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<tr>
<td>&gt;5000sf</td>
<td>1278</td>
<td>300</td>
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</table>
Policy and program design recommendations

1) Expand definition of “whole house” to include plug loads and lighting

• Include behavior feedback/recommendations among “measures”

• Behavior has greatest impact on plug loads & lighting, but operational settings on HVAC & DHW is also important

• “Behavior” includes decision to purchase efficient appliances & equipment
Policy and program design recommendations

2) Sell multiple levels of upgrades under a single program umbrella

- Utilities currently operate loosely-integrated patchwork of incentive programs
- No- and low-cost behavior changes are a first an ongoing step to achieving deeper savings
- What about energy use attribution? We need to move beyond current paradigm of energy savings firewalls between programs
- Measure actual energy use via automated utility meter analysis; identify which measures contributed to what savings via disaggregation
Policy and program design recommendations

3) Incentivize realized energy savings in addition to asset improvements

• Customer rebates can be tied to both physical upgrade and actual energy use reductions
• Emphasizes the importance of behavior and operational settings, contributes to sustained savings
Policy and program design recommendations

4) Continue to quantify magnitude and persistence of energy savings from behavioral measures

- Build on wealth of existing studies and incorporate findings into cost-effectiveness tests
- Build and advocate for analysis techniques that allow attribution of behavioral savings within a comprehensive upgrade program
Questions?

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