The Shell Game: Finding Thermal Savings in Residential Retrofit Programs

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Outline

• Background
• Programs
• Evaluations
• Savings
• Reasons
• Conclusions
Rigorous evaluation can tell us not only how well a program is doing but also provide a range of what a program can do.

Impact evaluations of 7 residential retrofit programs in the northeast US shows remarkable similarity in the percent savings of pre-treatment usage.

The limiting factors are likely investment costs and the potential savings available in the housing stock.
BACKGROUND
The Stage

- Residential space and water heating are a potentially large source of energy savings
- Residential efficiency programs have been operating in the United States for several decades. There is a wide range of program designs addressing this market
- Our focus is programs attempting to obtain large savings from a substantial investment
Northeastern United States

- Demographically and Geographically diverse
- Include some of most urban and rural areas of the United States
- Heating degree days (°F) for this area range from 4,590 to over 10,000
- Analysis confined to NE region where housing stock and market characteristics are relatively similar
The Programs
Types of Programs

• Market Based
  • Contractor provides a home assessment to homeowner.
  • Homeowners discretion as to which recommendations to follow.
  • Incentives provided to homeowner and contractor

• Direct Program
  • Utility or agency offers audit and referral to contractor
  • Incentives provided directly to homeowner

• Low income
  • Audit is provided for eligible dwellings
  • Measures with the greatest benefit within funding constraints are installed at no cost to participant
All Programs

- Provide an assessment by a trained auditor
- Provide a relatively large incentive for completing work
  - Market based programs have incentives in the range of $2,000 to $3,000
  - Low income programs usually start with ~$6,500 this may be leveraged with other sources. Can cover 100% of project cost.
- Provide assistance with contracting
The Evaluations
Evaluation Criteria

• Only included programs with a similar level of evaluation rigor
• All evaluations used billing analysis with pre and post consumption to estimate savings
• The programs needed to install major energy savings measures such as insulation and heating system replacement
## Residential Programs of the Northeast

<table>
<thead>
<tr>
<th>Program</th>
<th>Delivery Entity</th>
<th>Service Territory</th>
<th>Program Type</th>
<th>Program Year of Most Recent Impact Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Energy Services (HES)</td>
<td>Multiple Program Administrators</td>
<td>Massachusetts</td>
<td>Market Based and Direct Programs</td>
<td>2010/early 2011</td>
</tr>
<tr>
<td>Residential Retrofit Market Rate Program (RMR)</td>
<td>Vermont Gas (VGS)</td>
<td>Vermont</td>
<td>Direct Program</td>
<td>2008-2010</td>
</tr>
<tr>
<td>Residential Retrofit Low Income Program (RLI)</td>
<td>Vermont Gas</td>
<td>Vermont</td>
<td>Low Income</td>
<td>2008-2010</td>
</tr>
<tr>
<td>Home Performance with Energy Star (HPwES)</td>
<td>Efficiency Vermont (EVT)</td>
<td>Vermont</td>
<td>Market Based</td>
<td>2008-2010</td>
</tr>
<tr>
<td>EmPower</td>
<td>NYSERDA</td>
<td>New York</td>
<td>Low Income</td>
<td>2007-2008</td>
</tr>
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<td>Home Performance with Energy Star (HPwES)</td>
<td>NYSERDA</td>
<td>New York</td>
<td>Market Based</td>
<td>2007-2008</td>
</tr>
<tr>
<td>EnergyWise</td>
<td>National Grid</td>
<td>Rhode Island</td>
<td>Market Based</td>
<td>2010</td>
</tr>
</tbody>
</table>
The Savings
# Program Estimating of Savings

<table>
<thead>
<tr>
<th>Program</th>
<th>State</th>
<th>Program Type</th>
<th>Average Pre Install Use (Therms/year)</th>
<th>Program Reported Savings (% of Pre Install Use)</th>
<th>Evaluated Savings (% of Pre Install Use)</th>
<th>Overall Realization Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>HES*</td>
<td>MA</td>
<td>Direct and Market</td>
<td>1,195</td>
<td>15%</td>
<td>12%</td>
<td>76%</td>
</tr>
<tr>
<td>VGS RMR</td>
<td>VT</td>
<td>Direct</td>
<td>1,255</td>
<td>26%</td>
<td>22%</td>
<td>89%</td>
</tr>
<tr>
<td>VGS RLI</td>
<td>VT</td>
<td>Low Income</td>
<td>882</td>
<td>26%</td>
<td>16%</td>
<td>62%</td>
</tr>
<tr>
<td>EmPower</td>
<td>NY</td>
<td>Low Income</td>
<td>1,090</td>
<td>13%</td>
<td>9%</td>
<td>70%</td>
</tr>
<tr>
<td>HPwES</td>
<td>VT</td>
<td>Market Based</td>
<td>915</td>
<td>35%</td>
<td>18%</td>
<td>51%</td>
</tr>
<tr>
<td>HPwES</td>
<td>NY</td>
<td>Market Based</td>
<td>1,055</td>
<td>25%</td>
<td>16%</td>
<td>65%</td>
</tr>
<tr>
<td>EnergyWise</td>
<td>RI</td>
<td>Market Based</td>
<td>1,168</td>
<td>13%</td>
<td>13%</td>
<td>99%</td>
</tr>
</tbody>
</table>

*Includes only insulation and air sealing measures
The Great Divide

- Projections by Build America Program suggest the potential for savings of 30% to 50% annual consumption. This is an often sited policy goal.
- Current programs are increasing the thermal efficiency of the housing stock in the northeast states from 9% to 22%

Why is there such a large divide between the program’s results, the suggested potential and policy goals?
Reasons
### Availability of Financial Assistance

<table>
<thead>
<tr>
<th>Program</th>
<th>Service Territory</th>
<th>Measures</th>
<th>Percent of Cost Incentivized</th>
<th>Maximum Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>HES</td>
<td>Massachusetts</td>
<td>Shell Measures</td>
<td>75%</td>
<td>$2,000</td>
</tr>
<tr>
<td>RMR</td>
<td>Vermont</td>
<td>All Measures</td>
<td>33%</td>
<td>$2,100</td>
</tr>
<tr>
<td>EnergyWise</td>
<td>Rhode Island</td>
<td>Shell Measures</td>
<td>75%</td>
<td>$2,000</td>
</tr>
<tr>
<td>HPwES</td>
<td>Vermont</td>
<td>All Measures</td>
<td>Performance Based</td>
<td>$2,100</td>
</tr>
<tr>
<td>HPwES</td>
<td>New York</td>
<td>All Measures</td>
<td>10%</td>
<td>$3,000</td>
</tr>
</tbody>
</table>

A deep energy retrofit pilot in Massachusetts completed by the US Department of Energy and National Grid, Inc. found that the average cost for completing work on a single family home was $34.6/ft² (USDOE 2014). ($30,000 or €25,000/1000m²)
Existing Housing Stock

Age of building is a defining factor in savings opportunities

- there are greater savings opportunities in older housing stock than in new housing stock

- New homes are built to higher thermal standards

- Older construction styles such as balloon framed buildings have many thermal bypasses or may have health and safety issues that need remediation

- Heating equipment efficiencies have improved over time

• Other factors include maintenance and operational characteristics of the home
Savings Potential By Age of Home
United States

### Before 1950
- Percentage of Total Housing Stock: 60%
- % Savings Low Scenario: 0%
- % Savings Medium Scenario: 10%
- % Savings High Scenario: 20%

### 1950 to 1969
- Percentage of Total Housing Stock: 40%
- % Savings Low Scenario: 10%
- % Savings Medium Scenario: 20%
- % Savings High Scenario: 30%

### 1970 to 1989
- Percentage of Total Housing Stock: 30%
- % Savings Low Scenario: 20%
- % Savings Medium Scenario: 30%
- % Savings High Scenario: 40%

### 1990 to 2009
- Percentage of Total Housing Stock: 20%
- % Savings Low Scenario: 30%
- % Savings Medium Scenario: 40%
- % Savings High Scenario: 50%

### Average Across Housing Stock
- Percentage of Total Housing Stock: 15%
- % Savings Low Scenario: 15%
- % Savings Medium Scenario: 30%
- % Savings High Scenario: 45%
Savings Potential By Age of Home
Germany

Before 1949
1949 to 1978
1979 to 1995
After 1996
Average Across Housing Stock

Percentage of Total Housing Stock
% Savings - Low Scenario
% Savings Medium Scenario
% Savings High Scenario
Conclusions

– Impact evaluations of similar programs, using rigorous methods, can provide a benchmark for the effectiveness of the programs potential in a market

– A profile of the age of residential housing stock provides a method of assessing potential savings

– Current program designs in the US residential retrofit market may not be providing sufficient financial incentives to achieve policy goals
Questions?

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