Behavior Wedge Profiles for Cities:
A New Tool for Identifying Opportunities and Targeting Behavioral Programs

Stabilization Wedges

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1. Quick Overview of National Studies
2. Findings from the Prototype Model
3. Synopsis of the Methodology
Acknowledgements

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Supporters:
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# National Behavior Wedge Research

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Focus:</strong></td>
<td>Carbon Emissions Savings</td>
<td>Energy Savings Opportunities</td>
<td>Energy Savings Opportunities</td>
</tr>
<tr>
<td><strong>Scope:</strong></td>
<td>17 Household Actions</td>
<td>110 HH Actions (Roughly)</td>
<td>27 HH Actions (Roughly)</td>
</tr>
<tr>
<td><strong>Potential Savings: Residential Sector</strong></td>
<td>20% (of HH Direct Emissions)</td>
<td>22%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Potential Savings: National</strong></td>
<td>7.4% (of National Emissions)</td>
<td>9%</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Period to Achieve Max. Annual Savings</strong></td>
<td>10 years</td>
<td>5 to 8 years</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Conservative estimates for Residential and Personal Transport only.*
# Savings by Behavior Type

<table>
<thead>
<tr>
<th>Action Type</th>
<th>Estimated Savings (% of sector emissions)</th>
</tr>
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<tbody>
<tr>
<td>Invest. Buy a more fuel efficient vehicle</td>
<td>13.5%</td>
</tr>
<tr>
<td>Low cost Install and upgrade attic insulation and ventilation</td>
<td>Up to 7%</td>
</tr>
<tr>
<td>Beh. Car pool to work with one other person</td>
<td>4.2%</td>
</tr>
<tr>
<td>Beh. Replace 85% of all incandescent bulbs with cfls</td>
<td>4.0%</td>
</tr>
<tr>
<td>Beh. Get frequent tune ups and air filter changes</td>
<td>3.9%</td>
</tr>
<tr>
<td>Beh. Turn HH temperature down (heating) or up (cooling)</td>
<td>3.4%</td>
</tr>
<tr>
<td>Beh. Alter driving practices (no jack rabbit starts, etc)</td>
<td>3.2%</td>
</tr>
<tr>
<td>Invest. Install more efficient heating unit</td>
<td>2.9%</td>
</tr>
<tr>
<td>Invest. Replace poor windows with high efficiency windows</td>
<td>2.8%</td>
</tr>
<tr>
<td>Beh. Combine trips to ½ current mileage</td>
<td>2.7%</td>
</tr>
<tr>
<td>Beh. Cut highway speed from 70 to 60 mph</td>
<td>2.4%</td>
</tr>
<tr>
<td>Invest. Install more efficient AC unit</td>
<td>2.2%</td>
</tr>
<tr>
<td>13 Other Actions</td>
<td>6.6%</td>
</tr>
<tr>
<td>TOTAL potential savings (unadjusted)</td>
<td>58.8%</td>
</tr>
<tr>
<td>TOTAL potential carbon savings (adjusted for HH eligibility and double counting of savings)</td>
<td>30%</td>
</tr>
</tbody>
</table>

Source: adapted from Gardner and Stern (2008)
27 Actions Reviewed
Behavioral Approach

Benefits:
- Large Savings Opportunities
- Relatively Inexpensive
- Relatively Fast Change

Questions:
- How to Create the Change?
- Where to Focus the Efforts?

Problem/Need:
- National-level studies aren’t helpful.
- City-level Information about Behavioral Opportunities is needed.
Can We Create City-level Wedges?

Cities have suggested that a BWP could help them:

1. Document the scale of behavioral opportunities,
2. Identify specific behaviors with the most promise of resource savings for a particular city,
3. Evaluate the relative importance of behavioral initiatives as part of a larger, city-wide sustainability, climate, and/or energy initiative,
4. Write more effective funding proposals,
5. Make the case for pursuing behavior-based opportunities with team members, supervisors, partner organizations, city councils, and others,
City-level Behavior Wedge Profiles: Three Core Elements.

1. A low-cost approach:

2. A focus on **achievable** savings opportunities:
   - (Eligibility) \( \times \) (Likelihood of Participation) \( \times \) (Range of Savings)

3. Targeting behavioral solutions:
   - **Line-Drying Versus Dryer**
The **Sample Behavior Wedge Profile:** Residential Energy Sector – Baltimore, Maryland

**Core Profile Components:**

- **Summary/Overview**
- **Top Ten Lists**
- **Opportunities by End-Use**

**Behavior-Related Energy Savings Opportunities**

**Savings Opportunities Highlights**

- **Total Achievable Medium-Term Residential Sector Energy Savings:** 12.4% of residential consumption or 3.13 trillion Btu of energy per year.

- **Total Behavior-Related Energy Savings are greatest in single-family homes:** Total behavior-related energy savings are greatest in single-family versus multi-family homes in part due to the fact that single-family homes make up roughly 2/3 of the housing stock in Baltimore.

- **Heating offers the greatest savings opportunities:** Potential savings vary across particular energy end-uses with the largest potential savings associated with choices and practices in heating (63% of single-family and 56% of multi-family savings). Heating-related end uses are particularly important in Baltimore due to the large number of heating degree days combined with the disproportionately high-age of the housing stock.

- **Cooling, plug loads and lighting offer additional savings opportunities:** Because a growing number of households in Maryland are relying on Air Conditioning during summer months, cooling strategies are important for reducing total energy consumption and particularly important for reducing electricity demand. Strategies for reducing cooling demand represent 13% of the achievable savings in single-family homes and 15% of achievable savings in multi-family homes. Strategies for reducing plug loads represent 11% of achievable savings in single-family homes and 9% in multi-family homes. Strategies for reducing lighting demand represent 10% of achievable savings in single-family homes and 14% in multi-family homes.
Overview of behavior-related energy savings opportunities

- **Short-Term Savings:**
  - S-Fam. = 4.02%
  - M-Fam. = 1.22%

- **Medium-Term Savings:**
  - S-Fam. = 9.57%
  - M-Fam. = 2.81%
The Sample Behavior Wedge Profile: Residential Energy Sector – Baltimore, Maryland

End-Use Categories and Target Behaviors

- Heating and Cooling
- Plug Load & Electronics
- Appliances
- Lighting (Pools And Spas)
The Sample Behavior Wedge Profile: Residential Energy Sector – Baltimore, Maryland

Achievable Savings from Heating-Related Practices

Short-Term Savings:
S-Fam. = 4.9%
M-Fam. = 6.0%

Medium-Term Savings:
S-Fam. = 11.5%
M-Fam. = 13.2%

Short-Term (<4yrs):
- Equip. Replacement: 7% S-Fam., 10% M-Fam.
- Maintenance: 48% S-Fam., 22% M-Fam.
- Settings and Setbacks: 27% S-Fam., 16% M-Fam.
- Weatherization: 11% S-Fam., 14% M-Fam.
- Waste Reduc.: 23% S-Fam., 5% M-Fam.

Medium-Term (<8yrs):
- Equip. Replacement: 9% S-Fam., 14% M-Fam.
- Maintenance: 34% S-Fam., 34% M-Fam.
- Settings and Setbacks: 24% S-Fam., 29% M-Fam.
- Weatherization: 34% S-Fam., 11% M-Fam.
- Waste Reduc.: 22% S-Fam., 17% M-Fam.
The Sample Behavior Wedge Profile: Residential Energy Sector – Baltimore, Maryland

Cooling-Related Energy Savings Opportunities

Short-Term Savings:
- S-Fam. = 4.5%
- M-Fam. = 6.3%

Medium-Term Savings:
- S-Fam. = 10.6%
- M-Fam. = 14.6%

Bar Chart showing:
- Short-Term Savings: Equip. Replacement, Maintenance, Settings and Setbacks, Weatherization, Supplemental
- Medium-Term Savings: Equip. Replacement, Maintenance, Settings and Setbacks, Weatherization, Supplemental

Legend:
- S-Family (Ttl mmBTU)
- M-Family (Ttl mmBTU)
The Sample Behavior Wedge Profile: Residential Energy Sector – Baltimore, Maryland

**Top Ten Strategies for Reducing Energy Consumption in *Single Family Homes***

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Savings</th>
</tr>
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<tbody>
<tr>
<td>1 Heating &amp; Cooling: Setbacks and programmable thermostats</td>
<td>3.20%</td>
</tr>
<tr>
<td>2 Heating: Furnace maintenance</td>
<td>1.84%</td>
</tr>
<tr>
<td>3 Heating: Reduce wasteful heating practices</td>
<td>1.72%</td>
</tr>
<tr>
<td>4 Plug load: Plug Load management</td>
<td>1.09%</td>
</tr>
<tr>
<td>5 Heating &amp; Cooling: Weatherization</td>
<td>1.06%</td>
</tr>
<tr>
<td>6 Lighting: CFL bulb replacement</td>
<td>0.89%</td>
</tr>
<tr>
<td>7 Heating: Accelerated furnace replacement</td>
<td>0.67%</td>
</tr>
<tr>
<td>8 Cooling: AC maintenance</td>
<td>0.43%</td>
</tr>
<tr>
<td>9 Electronics: Accelerated replacement of desktops with laptops</td>
<td>0.26%</td>
</tr>
<tr>
<td>10 Cooling: Alternative technologies and reductions in solar heat gain</td>
<td>0.20%</td>
</tr>
</tbody>
</table>

**Total Achievable Savings** 11.36%
Behavior Wedge Assessment Methodology

Five Steps

• Identify data sources and Develop algorithms
• Extract necessary data
• Recode and normalize data as needed
• Weight using census data
• Apply algorithms to develop estimates
Behavior Wedge Assessment Methodology

Primary Data Sources

• The Energy Information Agency’s Residential Energy Consumption Survey (RECS) and U.S. Census data

4 Sets of Algorithms across 23 Behaviors

| cooling conservation actions | ((# of SF homes) x (% of homes with central AC) x (% of homes in which bedrooms > HH occupants) x (short-term participation rate)) x ((avg. BTUs for AC per HH) x (est. % savings per HH)) |

Example is for short-term savings for cooling conservation action in SF homes only.
**Sum:** Behavior Wedge Profiles provide a low cost means of generating city-level estimates that reflect local conditions and practices.

**Next steps:** Residential and Commercial for 5 cities.

**Future:** Looking for funding and collaborators to extend the model to transportation and beyond and for other cities/states who are interested in getting a profile.
The Full Paper
This presentation is based on a paper prepared for the 2013 BECC Conference. The full citation appears below.


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