

Thank you for joining the call.

As mentioned, we have spent the past year working with USDN and a small group of advisors from Baltimore, Denver, Berkeley and Charlotte to find a means of identifying the most fruitful opportunities for investing in efforts to achieve sustainability through shifts in behavior.

As those of you who know me probably already know, there is a growing body of research that suggests that we could reduce our **nation's** carbon emissions by at least 7.5% and our energy consumption by at least 10 percent in the next 8 years -- if we commit to investing more time and effort into helping people change their current energy use practices and help them make better decisions. In other words, by focusing on behavior, we have the opportunity to create significant reductions in energy use both quickly and at low-cost.

I suspect that many of you are already pursuing behavioral strategies. Many others would like to but have encountered some difficult hurdles along the way. What we've found is that one important hurdle is not knowing which behaviors offer the biggest impact.

Even though the growing body of behavior wedge research suggests that large savings are possible – we all know that there is a lot of variation from city to city as to which kinds of behaviors are likely to be most important. Cities in the Northeast have a bigger heating footprint and are more likely to rely more heavily on fuel oil as an energy source. Cities in the Southeast have a bigger air conditioning footprint with large implications for electricity consumption. Older cities face unique insulation challenges. Newer cities are often faced with the unique challenges of managing the footprint of *larger* homes, while cities with younger populations may be faced with greater plug load and phantom load demands. These examples illustrate the importance of providing city-specific information that can help identify the relative significance of different behavioral opportunities within a given city instead of relying on national-level research.

Presentation Outline

1. What are the National Carbon-Savings Opportunities?

2. What information is provided in a Behavior Wedge Profile for Cities?

3. Behavior Wedge Methodology and Data Sources



4. Value and Application



GARRISON INSTITUTE

On today's call I want to present information on the following four topics:

- 1) The scope and scale of National Carbon and Energy Savings Opportunities.
- 2) The scope of information provided in the Prototype Behavior Wedge Profile that we developed for the city of Baltimore.
- 3) The Research Methodology that is part of the estimation model and that was used to develop the prototype Behavior Wedge Profile, and
- 4) Some ideas around the Value and potential Application of the information contained in the profiles.

I will be spending the majority of time discussing the second of the four topics – or the information contained in the proto-type profile.

I also want to remind you that since this work is on-going, there is still plenty of opportunity to help shape this work and if you have ideas about other information that we should include or other ways of presenting it that might be more helpful – we would encourage you to share those ideas with me either in the Q&A session or sometime later via email.

National Behavior Wedge Research

	Dietz et al. (2009)	Laitner & Ehrhardt-Martinez (2009)	Gardner & Stern (2008)
Focus:	Carbon Emissions Savings	Energy Savings Opportunities	Energy Savings Opportunities
Scope:	17 Household Actions	110 HH Actions (Roughly)	27 HH Actions (Roughly)
Potential Savings: Residential Sector	20% (of HH Direct Emissions)	22%	30%
Potential Savings: National	7.4% (of National Emissions)	9%	11%
Period to Achieve Max. Annual Savings	10 years	5 to 8 years	N/A

Conservative estimates for Residential and Personal Transport only.



As mentioned earlier, several groups of researchers have recently been involved in the development of a set of studies aimed at estimating and documenting how much carbon and energy savings could be achieved through behavioral approaches. Each of these studies looks only at savings opportunities in the residential building sector and in personal transportation. In other words, they do not consider behavior-related savings from commercial buildings, food, water, waste reduction or any other areas.

I have summarized three of the most noteworthy studies and their findings in this chart.

The first study, by **Dietz et al. (2009)**, explores the potential energy savings from 17 household actions and suggests that a behavioral approach could save 123 million metric tons of carbon annually in year 10. Such savings represent 20% of household direct emissions or 7.4% of U.S. national emissions.

The second study, by **Skip Laitner and Ehrhardt-Martinez (2009)**, explores a more extensive list of household actions and finds potential energy savings of 22 % over a 5 to 8 year period – again looking only at household and personal transportation sectors. These savings are roughly the equivalent of 9 quads per year or 9% of total U.S. energy consumption.

The third study, by **Gardner and Stern (2008)**, explores 27 household actions and concludes that energy savings of nearly 30 percent are possible.

It is important to emphasize that these estimates are very conservative and reflect what are often referred to as reasonably achievable savings and not the entire range of opportunities out there. Unlike the full universe of potential savings, reasonably achievable savings control for household eligibility, their likely participation, and include reasonable estimates as to the amount of energy and/or carbon that is likely to result. (More on this point in a few minutes.)

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.



So, in summary, the growing body of research suggests some compelling benefits of what I will refer to as behavior-oriented interventions.

First – such strategies offer large savings opportunities. **Second** – because they focus on shifting behavior rather than large-scale technology upgrades or expensive building retrofits – they can be considered as relatively inexpensive. (That is not to say that cities shouldn't invest in new technologies and retrofits but that behavior-oriented interventions offer either a low-cost alternative or a low-cost complement to those approaches. There is also some evidence to suggest that behavioral approaches might reduce the likelihood and/or size of subsequent rebound effects associated with technology-focused approaches.) **Finally** – behavior-oriented approaches represent opportunities for change in the short term when compared with large-scale retrofit programs and other technology-heavy approaches.

While most sustainability directors and urban planners find these benefits to be appealing, they also raise some important questions, namely:

- 1) What are the best means of creating the change? And
- 2) Where should we be focusing our efforts? (In other words, which sets of behaviors offer the largest opportunities?)

The problem is that national level assessments don't account for city-to-city variation in a whole host of variables such as climatic conditions, differences in the built environment, differences in technology saturation, and differences in household practices and technology use.

City-level Behavior Wedge Profiles: What Cities Want and Need.

1. A low-cost approach:



2. A focus on achievable
savings opportunities:

- (Eligibility) x (Likelihood of Participation) x (Range of Savings)

3. Targeting
behavioral
solutions:



Line-Drying
Versus
Dryer



 GARRISON INSTITUTE

As a result of these considerations and the reality that most cities are working with very limited financial resources, we set out to create a low-cost, easy-to-use approach for identifying city-specific opportunities for reducing energy consumption and carbon emissions and for achieving other sustainability goals through behavior-oriented approaches.

As in the national studies – this approach needed to focus on achievable savings opportunities. In order to do that, we needed to factor in savings eligibility, likelihood of participation, and likely savings. If a certain portion of the population is already actively managing their thermostat settings, then they are not among those who will be counted in this study. And if past studies suggest that only 50% of households are likely to take a particular action, we use 50 rather than 100% participation rate as the basis of our estimates.

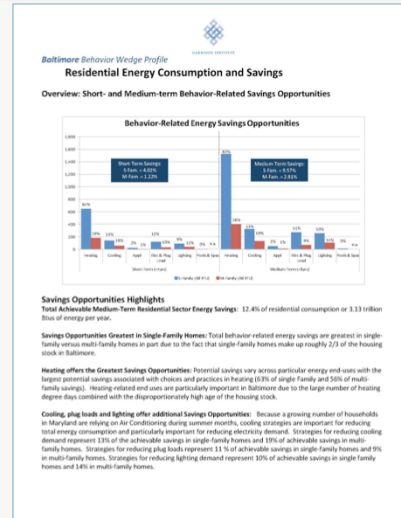
In order to assess the feasibility of the model, the first thing we did was to review a wide variety of different data sources that were already in existence and then evaluate our ability to use these data sources to estimate city-specific opportunities. The existing data sources provided information on residential energy consumption, commercial energy consumption, transportation, water use, food consumption, and waste and recycling.

While we hope to expand on the model that we ultimately developed so as to address each of these areas in the future, our initial focus was limited to residential sector energy consumption as we worked to develop our proof of concept. So the initial Behavior Wedge Profile for the City of Baltimore is also focused on savings opportunities within the residential energy sector.

The **Sample** Behavior Wedge Profile: Residential Energy Sector – Baltimore, Maryland

Core Profile Components:

- Overview
- Top Ten Lists
- Detailed Assessment by End-Use

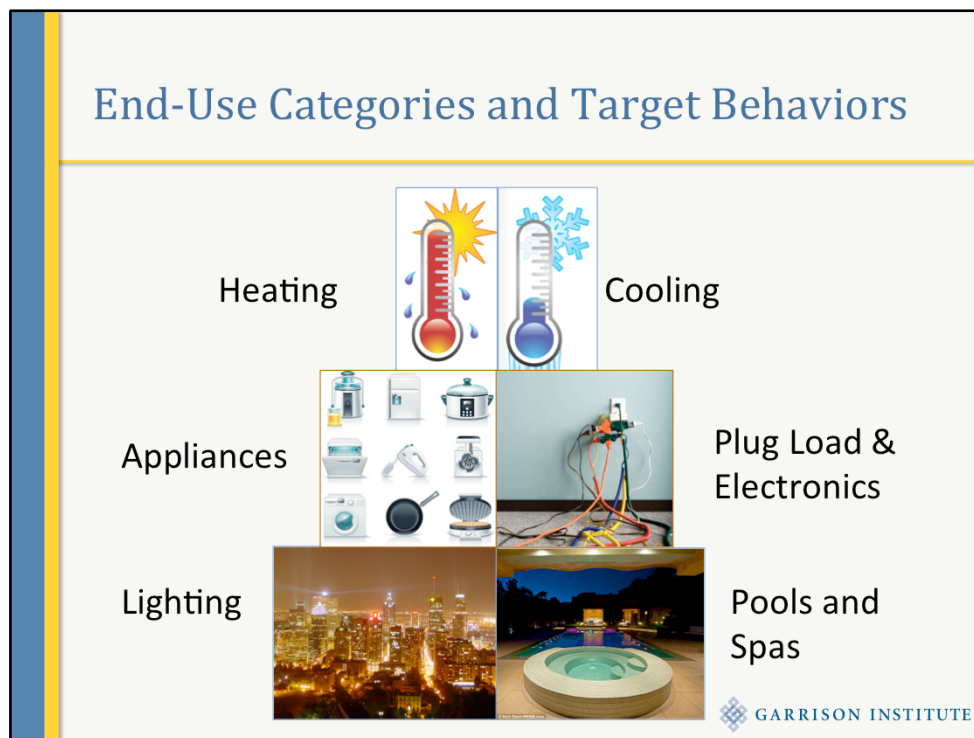


This slide shows an image of the cover page of the sample behavior wedge profile that we developed for Baltimore.

In its current form, the profile is focused exclusively on residential sector energy use and is only 9 pages long.

The sample profile contains 3 primary components:

1. The first is an overview of the aggregate savings opportunities. The overview estimates the proportion of current consumption that could be saved in the short-term (4 years or less) and the medium term (8 years or less). These savings opportunities are also broken out and shown separately for single-family and for multi-family homes.
2. The second component is a listing of the specific top ten behaviors (or savings opportunities) that promise the largest savings for single-family residences and a second top-ten list for multi-family residences.
3. Finally the third component involves a detailed breakdown of savings opportunities for a set of 6 specific residential-sector energy end uses. A detailed discussion of the savings opportunities by energy end use including heating, cooling, appliances, plug load and electronics, lighting and pools and spas.



Each of the specific end-use assessments look closely at one of the 6 specific end use categories as illustrated in this slide. The assessment begins by identifying and reviewing a set of behaviors that are associated with the end-use category in question and then generates estimates of the achievable savings for each through the development and application of a set of algorithms.

For example, the assessment of heating-related savings opportunities considers the saving opportunities that could be achieved through accelerated equipment replacement, equipment maintenance, the smart adjustment of thermostat settings and setbacks, weatherization, and shifting behaviors and practices in ways that reduce wasteful heating practices.

Similar end-use assessments are performed for cooling, appliances, lighting, plug loads and electronics, and pools and spas.

[Other examples – not in the presentation]

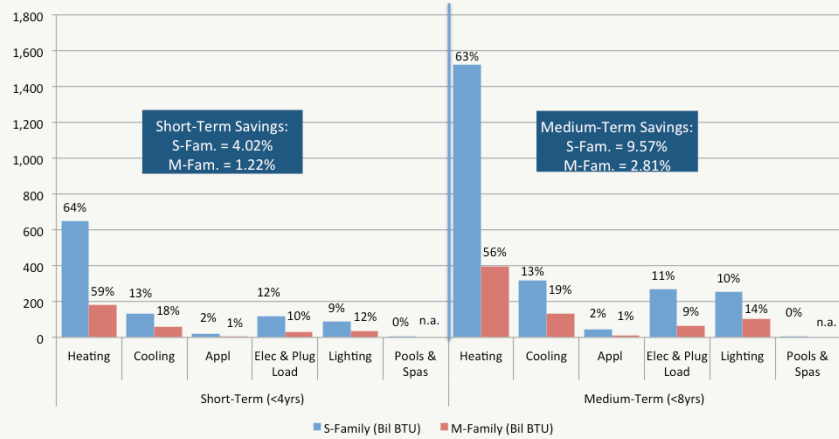
Cooling: equipment replacement, maintenance, adjustment of settings and setbacks, weatherization, and supplemental cooling strategies (ceiling fans, window film, etc.)

Appliances: eliminate or downsize second refrigerator or freezer, replace old washing machine with energy efficient model, change settings and use frequency, and air-dry laundry.

Plug Load and Electronics: vampire load management with smart strips, plug load management with settings and conservation strategies, and replacing desktops with laptops.

Lighting (and Pools and Spas): light bulb replacement with CFL or LED, turning off unnecessary lighting, enhanced day-lighting, and using more efficient pool pumps, settings and solar covers.

The Sample Behavior Wedge Profile: An Overview of the Opportunities



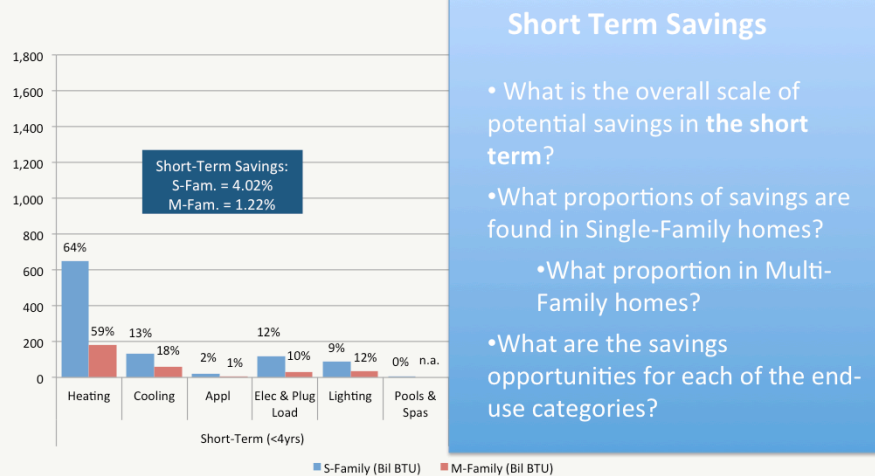
GARRISON INSTITUTE

So now I would like to walk through a few of the profile charts and graphs that were developed as part of the sample profile for the city of Baltimore.

This slide shows the overview graph with short-term savings on the left side of the chart and medium-term savings on the right.

Also note that the savings are broken out by end use type along the X axis, and that single-family households are represented by the blue bars while multi-family homes are represented by the red bars.

The Sample Behavior Wedge Profile: An Overview of the Opportunities



Short Term Savings

- What is the overall scale of potential savings in the **short term**?
- What proportions of savings are found in Single-Family homes?
 - What proportion in Multi-Family homes?
- What are the savings opportunities for each of the end-use categories?

GARRISON INSTITUTE

Let's take a minute to focus on the information provided about short-term savings opportunities.

As specified in this text box, this chart answers a number of important questions.

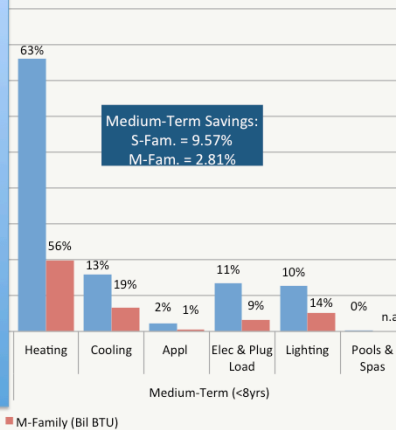
In particular it tells us 1) the overall scale of potential short-term savings, 2) the proportion associated with single-family homes and with multi-family homes, and 3) the savings opportunities from each of the 6 end-use categories.

As shown here, estimates of Baltimore's *achievable short-term* savings suggest that the city could help residents reduce current levels of residential energy consumption by a total of just over 5% in the next 4 years. The majority of those savings opportunities are associated with single-family homes and are likely to come from four specific energy end uses: heating, cooling, plug load, and lighting. Additional savings could also be achieved by addressing heating-related behaviors in multi-family residences.

The Sample Behavior Wedge Profile: An Overview of the Opportunities

Medium Term Savings

- What is the overall scale of potential savings in the **medium term**?
- What proportions of savings are found in Single-Family homes?
 - What proportion in Multi-Family homes?
- What are the savings opportunities for each of the end-use categories?



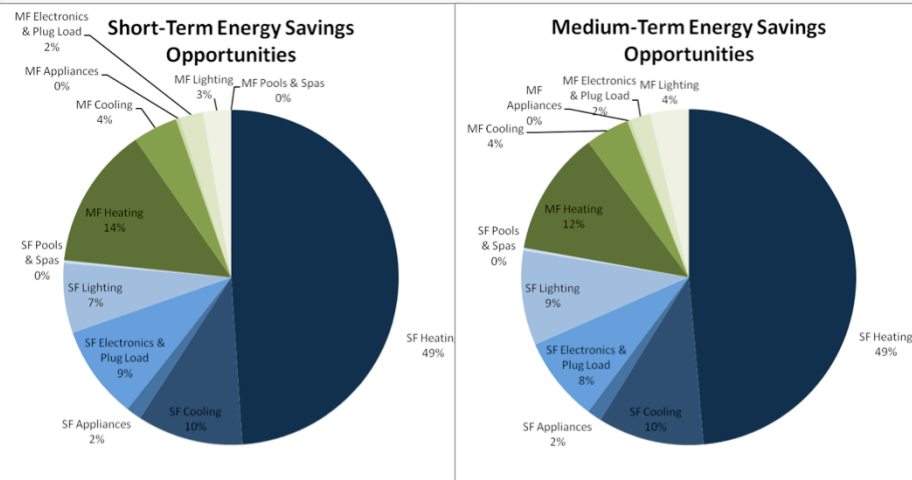
GARRISON INSTITUTE

The right side of this same chart answers the same set of questions for the medium term.

As shown here, estimates of Baltimore's *achievable medium-term* savings suggest that the city could help residents reduce current levels of residential energy consumption by a total of roughly 12% in the next 8 years. Similar to the findings for the short-term, the majority of those savings opportunities are associated with single-family homes and are likely to come from four specific energy end uses.

Both the short-term and medium-term findings reflect Baltimore's cold climate, old housing stock, and a growing reliance on air conditioning in the summer among other important factors that shape the unique patterns of Baltimore's energy demand.

Comparison of Short and Medium-Term Opportunities

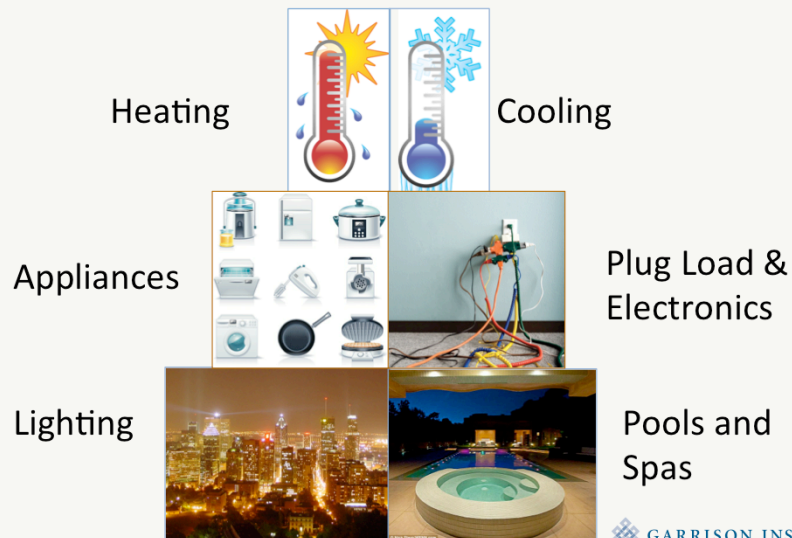


Note: Multi-Family Pools and Spa data was Not Attainable for short or medium term

GARRISON INSTITUTE

These pie charts – which are not currently part of the sample profile – show the same data in a slightly different way. Here the sum of short-term savings are represented as a single pie – the one on the left. Each of the slices illustrates the relative size of the savings opportunities associated with different end uses. This format makes it easy to see the very large opportunity associated with heating end-uses in single-family homes which represent nearly 50% of all savings opportunities in the short term.

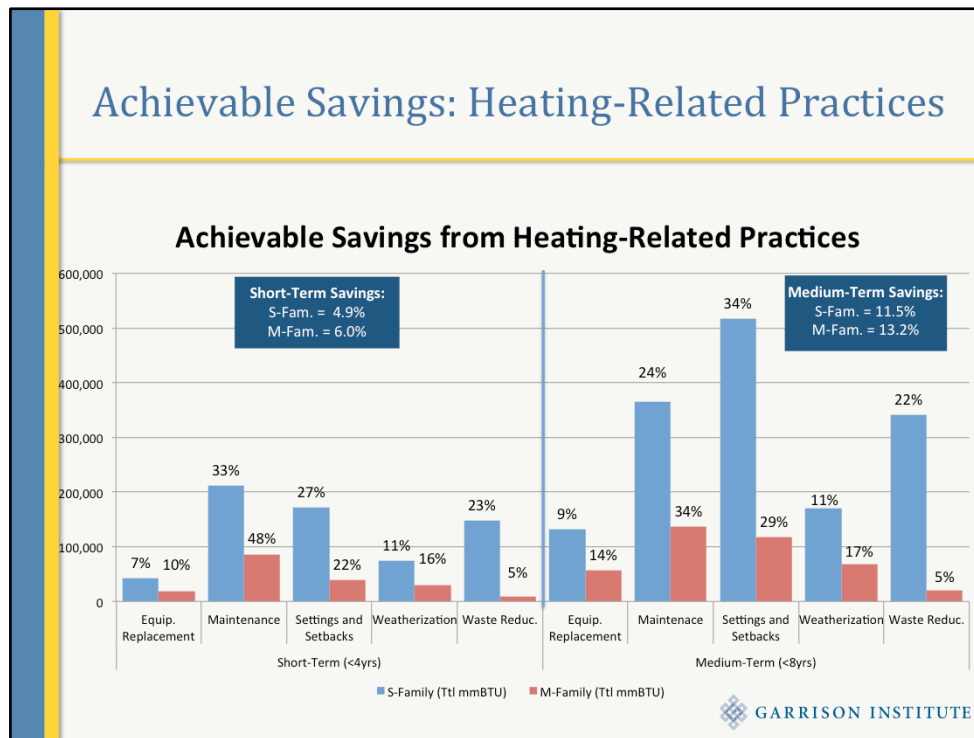
End-Use Categories and Target Behaviors



Following the overview section of the profile, subsequent sections look more closely at the savings opportunities associated with each of the 6 specific end-use categories.

Next we will look at the assessment of practices associated with heating-related end uses as an example of what each of the six end-use sections looks like.

Achievable Savings: Heating-Related Practices



This slide and those to follow are consistent in their formatting with the **Overview of Savings** slides: The Single-Family data is blue, Multi-Family is red, The left side represents Short-Term savings, the right represents Medium-term savings.

An important difference, however, is that this chart is exclusively focused on heating-related practices. Here the X-axis categories provide information on 5 specific heating-related behaviors.

In subsequent slides, the X-axis categories reflect other sets of behaviors associated with the particular end-use category being examined.

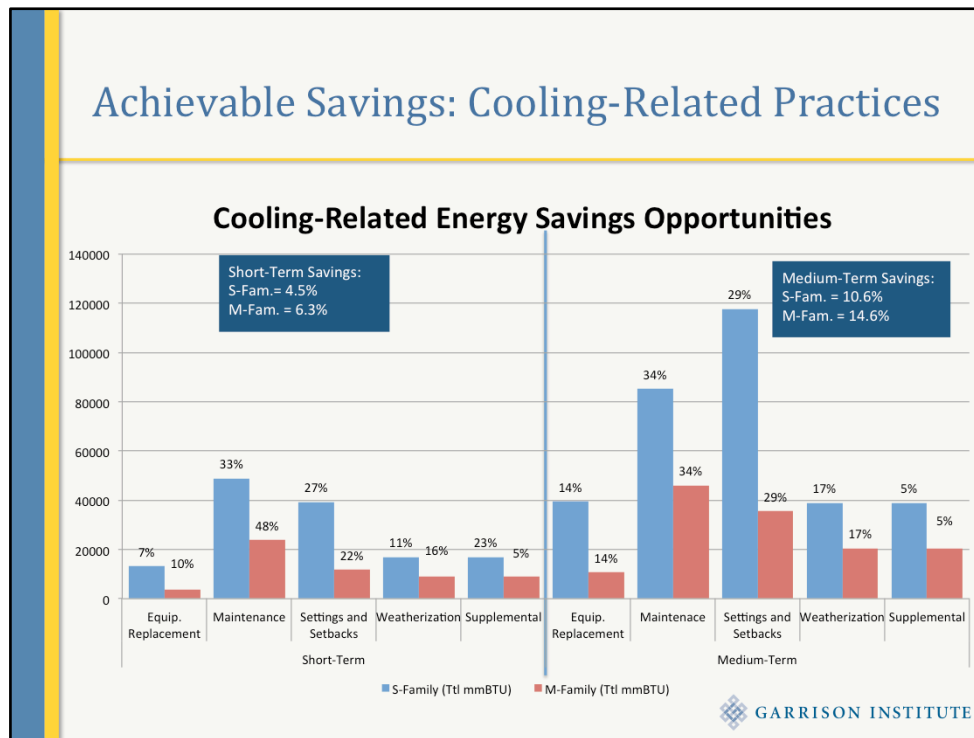
For brevity, let's focus on medium-term savings on the right side of the chart. As shown in the blue box:

Total achievable single-family savings = 11.5% of total single-family residential heating demand.
Total achievable multi-family savings = 13.2% of total multi-family residential heating demand.

If we look at the different sets of behaviors specified on the X axis, we can see that **achievable savings are greatest for thermostat settings and setbacks and for furnace maintenance.**

The greatest multi-family savings can be achieved through furnace maintenance followed by programs to reduce heat-related thermostat settings. Together, such programs account for 58% of achievable heating-related savings in single-family homes and 63% of achievable savings in multi-family homes.

Achievable Savings: Cooling-Related Practices



Although we don't have time to explore this chart in detail, this chart shows similar results for cooling-related activities.

Cooling-Related Savings Highlights

Total Achievable Energy Savings from Cooling – Single Family

Achievable short-term savings = 4.5% of total S-F residential cooling demand.

Achievable medium-term savings = 10.6% of total S-F residential cooling demand.

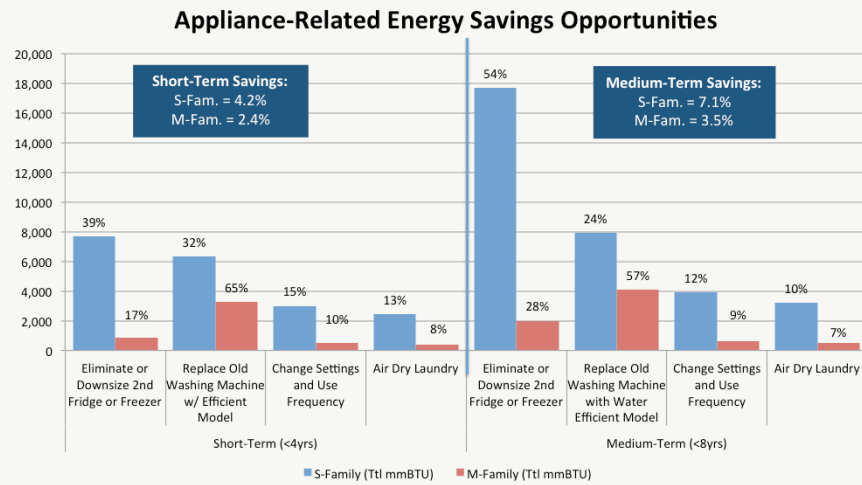
Total Achievable Energy Savings from Heating – Multi-Family

Achievable short-term savings = 6.3% of total M-F residential cooling demand.

Achievable medium-term savings = 14.6% of total M-F residential cooling demand.

Achievable Savings are Greatest for Thermostat Settings and Setbacks and AC Maintenance. The greatest cooling-related savings can be achieved through AC maintenance followed by programs to increase cooling-related thermostat settings. Together, such programs account for 64% of achievable cooling-related savings in single-family homes and 61% of achievable savings in multi-family homes.

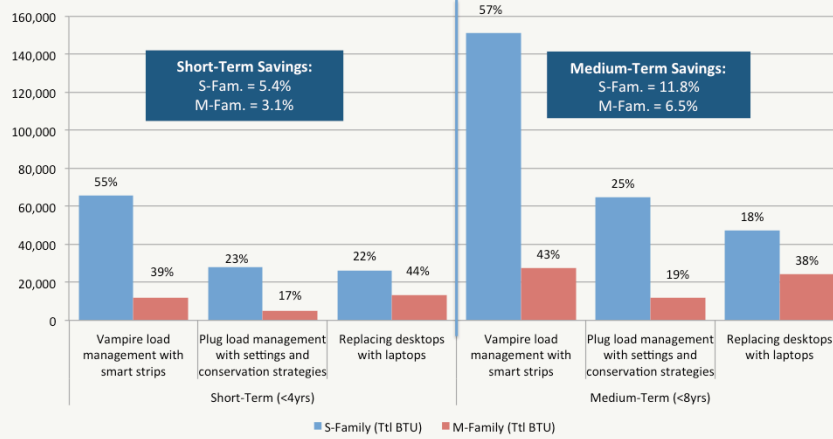
Achievable Savings: Appliance-Related Practices



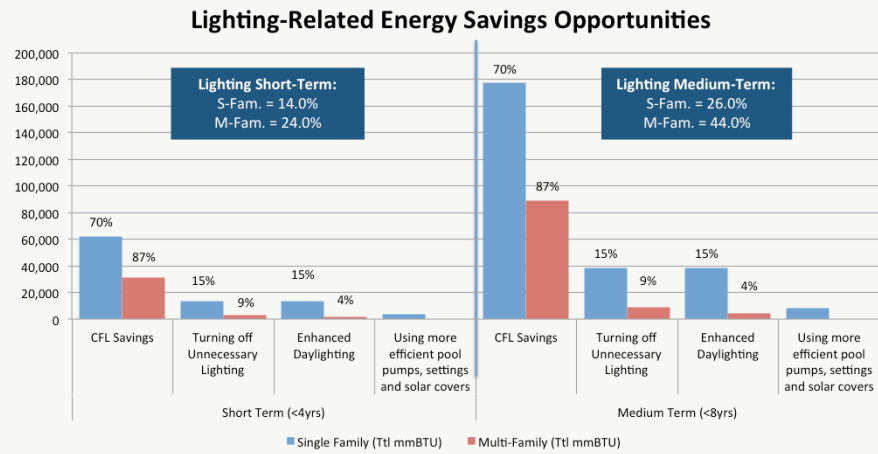
This chart shows similar results for appliance-related activities.

Achievable Savings: Plug load and Electronics

Electronics-Related Energy Savings Opportunities



Achievable Savings: Lighting & Pools and Spas



Top Ten Strategies: Single Family

	Savings
1 Heating & Cooling: Setbacks and programmable thermostats	3.20%
2 Heating: Furnace maintenance	1.84%
3 Heating: Reduce wasteful heating practices	1.72%
4 Plug load: Plug Load management	1.09%
5 Heating & Cooling: Weatherization	1.06%
6 Lighting: CFL bulb replacement	0.89%
7 Heating: Accelerated furnace replacement	0.67%
8 Cooling: AC maintenance	0.43%
9 Electronics: Accelerated replacement of desktops with laptops	0.26%
10 Cooling: Alternative technologies and reductions in solar heat gain	0.20%
Total Achievable Savings	11.36%



The final component of the behavior wedge profile that I want to talk about today is the listing of the **Top Ten Strategies for Reducing Energy Consumption in both Single-Family and Multi-Family Homes**.

On this slide, you'll see the top ten list for single-family homes. Here we look across the different end use categories to identify the top-ten sets of behaviors that offer the biggest savings opportunities for the specific city in question.

In the case of this sample profile for Baltimore, we found that the largest achievable savings are associated with heating and cooling setbacks and settings. Together, this set of behaviors held the opportunity for reducing current energy demand by 3.2%. Five other heating-related behaviors also made the top ten list, including items 2 and 3 – furnace maintenance and the reduction in wasteful heating practices. Number four on our list was plug-load management which represented the opportunity for reducing current energy demand by over 1%.

Altogether this set of top ten behaviors represent a savings opportunity of 11.4% for single-family homes.

Top Ten Strategies: Multi-Family

	Savings
1 Heating & Cooling: Setbacks and programmable thermostats	2.80%
2 Heating: Furnace maintenance	2.51%
3 Lighting: CFL bulb replacement	1.63%
4 Heating & Cooling: Weatherization	1.62%
5 Heating: Accelerated furnace replacement	1.05%
6 Cooling: AC maintenance	0.84%
7 Plug load: Plug Load management	0.67%
8 Electronics: Accelerated replacement of desktops with laptops	0.50%
9 Cooling: Alternative technologies and reductions in solar heat gain	0.38%
10 Heating: Reduce wasteful heating practices	0.36%
Total Achievable Savings	12.43%



Here is the list of top ten strategies for *Multi-Family* homes. This list also highlights the role of thermostat settings and setbacks and furnace maintenance but also recognizes the importance of CFL bulb replacement, accelerated furnace replacement, and AC maintenance.

Altogether this set of top ten behaviors represent a savings opportunity of 12.4% for multi-family homes.

Behavior Wedge Assessment Methodology

Primary Data Source

- The Energy Information Agency's Residential Energy Consumption Survey (**RECS**)



Behavior-Specific Algorithms

cooling conservation actions	$(\# \text{ of homes}) \times (\% \text{ of homes with central AC}) \times (\% \text{ of homes in which bedrooms} > \text{HH occupants}) \times (\text{short-term participation rate}) \times (\text{avg. BTUs for AC per HH}) \times (\text{est. \% savings per HH})$
------------------------------	--



Just a few words on our methodology.

First, all of our estimates rely on an estimation model that draws from several **existing data sources** – in this case RECS – (and Census data)

As noted earlier, our overall **methodologies** are very similar to those used for national-level behavior wedge assessments but also draw from the insights of subject-matter experts.

The complete residential sector model uses RECS data for urban areas which are then weighted using Census data with the purpose of reflecting some of the key characteristics of the city in question – in this case Baltimore. For example, we found that residential buildings in Baltimore tend to be much older than housing in much of the rest of the country and compared with urban Maryland in general. Because of this, housing in Baltimore tends to be smaller and is also unique in other ways that need to be accounted for in creating these estimates.

Once we had a good picture of the context for the city in question, we were able to develop a set of behavior-specific algorithms to calculate behavior-related savings opportunities for each of the behaviors in question, for each of the time periods, and for each of the two housing types. This slide provides an example of a behavior-specific algorithm for cooling conservation actions.

Vision for a Fully Developed Behavior Wedge Profile

In addition to residential sector energy, a fully developed profile could contain assessments for:

- Commercial Sector energy/carbon
- Transportation Sector energy/carbon
- Food Sector energy/carbon
- Water-Related energy/carbon
- Waste and Recycling
- Underlying attitudes and opinions that shape our resource use practices

As noted earlier, we hope to develop the behavior wedge profile for a variety of sectors including commercial buildings, transportation, food, water, waste and recycling.

Vision for a Fully Developed Behavior Wedge Profile

Report

- Behavior Wedge Profile: Model Development and Documentation

Refining the Residential sector model & developing the Commercial sector model

- Charlotte, NC
- Miami, FL
- Boston, MA
- Baltimore, MD
- Park City, UT



In terms of immediate next steps, we are planning to refine the residential model and to develop a similar model to estimate savings opportunities in commercial buildings.

We will be working collaboratively with the 5 cities listed here to apply these models and to develop city-specific profiles for these cities over the course of the next year.

Once these models have been fully developed, we hope to work with other cities as well.

Value and Application

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,



I would like to close the presentation with two final thoughts:

First, I'd like to remind everyone that the full report – which documents the process and the model components - has been posted on the USDN website and is available to USDN members for download.

•Second, I'd like to highlight a few of the many ways in which this tool may be useful to USDN members.

I look forward to your questions and would like to the call over to Alice Kennedy from the city of Baltimore who will talk more about the value and application of the profile for her work.

[Other ways in which the profile may be of use:]

•6. Prioritize investments in different types of projects and programs and focus limited resources on a more precise and promising set of interventions,

•7. Validate decisions to pursue a particular project focus or project design,

•8. Develop more targeted marketing and communications efforts, and

•9. Make better work plan decisions for personnel

Contact Information

Karen Ehrhardt-Martinez, Ph.D.
KarenE@GarrisonInstitute.org

