Driving Sustainable Behavior in the Mainstream Consumer:
Leveraging Behavioral Economics to Minimize Household Energy Consumption

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# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>3</td>
</tr>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Objective</td>
<td>5</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>6</td>
</tr>
<tr>
<td>Literature Review</td>
<td>7</td>
</tr>
<tr>
<td>Summary of Literature Reviewed</td>
<td>7</td>
</tr>
<tr>
<td>Awareness</td>
<td>8</td>
</tr>
<tr>
<td>Concept</td>
<td>8</td>
</tr>
<tr>
<td>Application</td>
<td>11</td>
</tr>
<tr>
<td>Learning</td>
<td>11</td>
</tr>
<tr>
<td>Concept</td>
<td>11</td>
</tr>
<tr>
<td>Application</td>
<td>13</td>
</tr>
<tr>
<td>Social Norms</td>
<td>14</td>
</tr>
<tr>
<td>Concept</td>
<td>14</td>
</tr>
<tr>
<td>Application</td>
<td>15</td>
</tr>
<tr>
<td>Goal Setting</td>
<td>16</td>
</tr>
<tr>
<td>Concept</td>
<td>16</td>
</tr>
<tr>
<td>Application</td>
<td>18</td>
</tr>
<tr>
<td>Framing</td>
<td>19</td>
</tr>
<tr>
<td>Concept</td>
<td>19</td>
</tr>
<tr>
<td>Application</td>
<td>21</td>
</tr>
<tr>
<td>Energy Efficiency Company Case Studies</td>
<td>21</td>
</tr>
<tr>
<td>Opower</td>
<td>24</td>
</tr>
<tr>
<td>Background</td>
<td>24</td>
</tr>
<tr>
<td>Current Approaches</td>
<td>24</td>
</tr>
<tr>
<td>Key Observations</td>
<td>25</td>
</tr>
<tr>
<td>Earth Aid</td>
<td>26</td>
</tr>
<tr>
<td>Background</td>
<td>26</td>
</tr>
<tr>
<td>Current Approaches</td>
<td>26</td>
</tr>
<tr>
<td>Key Observations</td>
<td>28</td>
</tr>
<tr>
<td>Microsoft Hohm</td>
<td>29</td>
</tr>
<tr>
<td>Background</td>
<td>29</td>
</tr>
<tr>
<td>Current Approaches</td>
<td>29</td>
</tr>
<tr>
<td>Key Observations</td>
<td>30</td>
</tr>
<tr>
<td>Google PowerMeter</td>
<td>31</td>
</tr>
<tr>
<td>Background</td>
<td>31</td>
</tr>
<tr>
<td>Current Approaches</td>
<td>32</td>
</tr>
<tr>
<td>Key Observations</td>
<td>32</td>
</tr>
<tr>
<td>Wattvision</td>
<td>33</td>
</tr>
<tr>
<td>Background</td>
<td>33</td>
</tr>
<tr>
<td>Current Approaches</td>
<td>33</td>
</tr>
<tr>
<td>Key Observations</td>
<td>34</td>
</tr>
<tr>
<td>Green Lite Dartmouth &amp; Tellemotion</td>
<td>35</td>
</tr>
<tr>
<td>Background</td>
<td>35</td>
</tr>
<tr>
<td>Current Approaches</td>
<td>36</td>
</tr>
<tr>
<td>Key Observations</td>
<td>37</td>
</tr>
<tr>
<td>Plotwatt</td>
<td>38</td>
</tr>
<tr>
<td>Background</td>
<td>38</td>
</tr>
<tr>
<td>Recommendations</td>
<td>39</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>43</td>
</tr>
<tr>
<td>Works Cited</td>
<td>44</td>
</tr>
</tbody>
</table>
ABSTRACT

This project reviews and evaluates the effectiveness of behavioral economic interventions on household energy consumption, as utilized by non-intrusive energy monitoring services such as our client company, PlotWatt. Through our assessment of the landscape of relevant academic literature and interviews with experts within the fields of behavioral economics and environmental psychology, we identify five principles of behavioral economics that are most salient for this sector: awareness, learning, social norms, goal setting, and framing. These five principles are examined through six case studies of companies within the client’s peer group: OPOWER, Earth Aid, Microsoft Hohm, Google PowerMeter, Wattvision and GreenLite Dartmouth/TELEMOTION. In each case study, particular attention is paid to how effectively the behavioral economic intervention is implemented and best practices are highlighted. The paper concludes with tailored recommendations for PlotWatt. Our research suggests that a few behavioral economic tweaks to the user interface and reporting systems could lead to unique, measurable and significant behavior change that not only saves money for the household but also, in some case, motivates a deeper interest in conservation and curtailment of energy consumption.

INTRODUCTION

We propose that two distinct forces will drive the shift to patterns of more sustainable consumption: technological innovation and behavior change. Currently, on the behavioral side, green marketing and outreach are primarily reaching environmentally enlightened consumers. To have a greater impact on the mainstream consumer, new interventions must focus on educating and influencing the mainstream consumer to make more sustainable choices. To this end, our research will explore how behavioral economics can be applied to environmental sustainability, specifically the field of household energy efficiency, and will be used to guide an energy efficiency startup, PlotWatt, in enhancing their business model to create more lasting consumer behavior change.

Presently, households are accountable for a large portion of greenhouse gas (GHG) emissions. Energy use at the household level is a combination of direct and indirect energy usage. Direct usage includes resources for heating, cooling and running electric appliances, namely gas, electricity and fuel. Indirect usage refers to the embedded energy in the products and services that households use to produce,
transport and dispose of consumable goods. (265)\(^1\) In the United States, household direct energy use alone accounted for 26.3 percent of energy-related carbon dioxide (CO\(_2\)) emissions in 2008 and a smaller percentage of non-CO\(_2\) GHG emissions.\(^2\) Regardless of the exact GHG emissions volume, it is clear that households contribute substantially to emissions and this is costly for both the environment and the consumer.

Parks Associates, a market research and consulting company, conducted a survey on residential energy management in 2009. They found that the “average expenditures for electricity among US households are over $170 per month during high-cost periods and over $75 per month during low-cost periods” and “that more than 80 percent of consumers are very interested in learning about ways to cut energy expenditures (1)”.\(^3\) The monthly expenditure might be enough to motivate consumers to reduce usage but this is unlikely because energy is typically a lower percentage of fixed monthly expenses (e.g. when compared to mortgage, insurance, gasoline). Whether it is the carbon emissions, the monthly expense or some other motivation, consumers need to have awareness of their consumption before they can begin to reduce or curtail usage. Once awareness exists, there are a number of behavioral techniques that have successfully been employed by a range of companies to change behavior. We want to explore these techniques and determine which approaches are most relevant to energy efficiency and mainstream consumer behavior change.

Figure 1: PlotWatt’s Customer Interface

Luke Fishback, a Durham-based entrepreneur, launched PlotWatt several years ago. Frustrated with the limited opportunities for consumers to lower their monthly utility bills, Luke decided to create a company that could help. Using a sophisticated and proprietary algorithm, PlotWatt disaggregates household energy data from a smart metering device to supply the customer with appliance-specific energy use information. This specific and

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actionable information is already helping customers better understand their energy consumption. There are a number of features available on the PlotWatt interface, shown above.

The user can view their real-time energy usage in a unit of their choosing, see tailored tips for energy use reduction, interact with a timeline of their consumption over a set of days, weeks or months and view a breakdown of their energy bill by appliance – a unique feature driven by the company’s algorithm. While these features are compelling to the active consumer of energy data, we were curious if there were different approaches that PlotWatt could experiment with on their interface to make their service more effective for the average consumer.

**OBJECTIVE**

In order to develop recommendations for Luke Fishback and PlotWatt, we conducted a comprehensive literature review of behavioral economics, as applied to household energy efficiency, and explored techniques utilized by a group of PlotWatt’s peer companies. Behavioral economics is a field of study that combines traditional economics and psychology to study consumer decision-making and motivations. It turns out that, in reality, consumer are quite irrational and do not approach decision making as an optimization problem. Behavioral economists have identified some patterns and trends in consumers’ irrational behaviors.

A qualitative and quantitative assessment of our literature review findings, enabled us to discern which of the behavioral interventions were being utilized most effectively by six of PlotWatt’s peer companies. This peer group included OPOWER, Microsoft Hohm, Google PowerMeter, TELLEMOTION, Wattvision and Earth Aid, all of whom are similar in scope to PlotWatt and are considered leaders and innovators in the space of non-intrusive energy monitoring services. Additionally, we were able to sign up for each of the services, except TELLEMOTION and OPOWER, for whom we reached out to the companies to get a detailed sense of their service offerings.

Through this assessment, first of the landscape of existing research and expert interviews with behavioral economists and second of the use of these behavioral economic principles among peer companies, we identified the most salient approaches for consumer behavior change at the household level that could be turned into actionable recommendations for PlotWatt. In summary, our objective
was to answer the following research question: Which behavioral economic interventions should PlotWatt utilize to lower its customers’ utility bills?

MATERIALS AND METHODS

This paper is organized into three sections. First, we present our literature review. We then look at PlotWatt’s peer companies in detail. In the final section, we blend the literature review and the findings from the case studies to develop recommendations for PlotWatt.

In the literature review, we focus on identifying key behavior change interventions\(^4\) that are relevant to energy efficiency companies. We compiled an accounting of all interventions listed in the most comprehensive review papers. From this list, we used both quantitative and qualitative sorting methods to identify the most salient interventions. We first counted the number of times a given intervention is mentioned in the reviewed papers and then assessed the effectiveness of the intervention, as described in each paper. A summary of this quantitative sorting approach is below:

**Figure 2: Literature Review Topic Frequency (by lead author)**

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<td>Learning/Feedback</td>
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<td>Goal Setting/Commitment</td>
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<td>Framing (Attribute Scales, Defaults)</td>
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<td>Choice architecture and heuristics</td>
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<td>Time: hyperbolic discounting</td>
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<td>Bounded rationality and decision heuristics</td>
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</tr>
</tbody>
</table>

Once we identified the most common approaches, we then determined whether or not the intervention was applicable to household energy efficiency services like PlotWatt. We found that while effective in some areas, not all interventions were immediately relevant to our research area of interest. Additionally, we discussed and further filtered our list with the assistance of Duke’s Behavioral Economics faculty, who served as advisors on this project. The combination of counting, assessing and

\(^4\) Intervention, principle and lever are used interchangeably throughout this paper.
filtering enabled us to select the most relevant interventions and to dig deeper and understand the underlying theory beneath each intervention.

To further filter these interventions to determine which would be most useful to PlotWatt, we selected a number of peer companies and studied how they were implementing behavioral interventions in their business models. With each case study, we explored how the company currently utilizes the five identified behavioral interventions and highlighted any particularly innovative or effective approaches. Through our literature review, we developed an evaluation rubric with which we could evaluate each case study (see Figure 3).

Through this analysis and conversations with our advisors and Luke Fishback, CEO of PlotWatt, we determined which of the peer group approaches were most relevant to PlotWatt. Using a similar methodology to the one implemented with the peer group case studies, we identified where PlotWatt is currently in terms of its engagement with behavioral economics, highlighting both innovation and opportunities. We then developed a set of recommendations for the company.

**LITERATURE REVIEW**

**SUMMARY OF LITERATURE REVIEWED**

Within the existing academic literature, multiple journal articles review past studies of behavioral economic interventions and their success as applied to residential energy consumption. As a starting point for our literature review, we assessed five of these review studies to draw out the most relevant principles of behavioral economics. The high-level summary of this analysis is depicted in the Methods section (see Figure 2).
As shown in Figure 2, multiple principles of behavioral economics consistently appeared in the review studies. Based on a qualitative and quantitative assessment of the literature and subsequent conversations with academic advisors, we focused our attention on five principles: awareness, learning, social norms, goal setting, and framing. With each of these five principles, we identified three of the most relevant characteristics to the energy efficiency behavior change problem. A summary of these 15 characteristics is shown in Figure 4.

We will explain each of these characteristics in detail below. Each intervention is presented in a similar fashion: the first section describes the general concept of the intervention and the second section describes how the intervention has been applied to a behavior change problem previously.

**AWARENESS**

**CONCEPT**

Theoretically, if a consumer was aware that their individual household energy inefficiency when taken in aggregate with other households had a significant impact on the environment and they were educated about energy saving behaviors, they would immediately alter their behavior to save. However, information alone does little to change behavior, no matter how viable the new behaviors may be. Yet millions of dollars and thousands of hours of time are dedicated to interventions that disseminate this very type of information to consumers around the country. Although realistically quite futile, the assumption driving the investment in information dissemination is that once people are made aware of the energy inefficiency problem and receive information on how to change their behavior, they will be willing to change their behavior. (83)¹

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Unfortunately, information alone is not enough to make people change. However, investment in information can make sense, because information often raises awareness, which is a critical first step in behavior change. An energy efficiency workshop was reported to have led to “higher levels of concern about the energy crisis, to an increase in knowledge about energy conservation, and stronger intentions to adopt energy-saving measures”. However, when the participants were visited at home, no behavioral difference was visible between attendees and non-attendees of the workshop, in terms of adaptation of energy-saving measures. (276) This scenario suggests that investments in information can raise awareness but need to be coupled with additional behavioral interventions to make the behavior change lasting. One possibility for a complementary intervention is to make sure that the information disseminated is tailored to the specific customer receiving the information.

Home energy audits can be an excellent method for collecting data that can help tailor information. Multiple studies suggest that these audits “result in significant energy savings through behavioral changes and increased knowledge about energy conservation”. (266) In addition to home audits, there are several general tailoring approaches that can help make information more relevant to a broad subset of consumers and be applied to our focus area, energy monitoring interfaces. Research suggests that the following features of information can improve usefulness and ability of the information to raise awareness: units, format, disaggregation and relevancy.

Scientific units are confusing to most consumers; the more effective utility bills and information sources examined used scientific units sparingly. The sources that do use scientific units used kilowatt-hours (kWh) because they are most common unit on utility bills and most familiar to customers. Monetary units are even more familiar to consumers.

For many consumers, energy efficiency is about saving money; therefore seeing consumption in monetary units often connects usage more directly to financial expense, which enhances awareness. This may be less effective in those households where energy expenses are lower than other household expenses because the dollar amount might seem trivial and the consumer could be disinclined to change

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their behavior. (460) Additionally, money is not entirely fungible so it might be worth using multiple units or equivalent measures of “cost” or consumption (i.e. a cup of coffee, a planted tree) to help consumers compare the expenses. In addition to scientific units and monetary equivalents, some consumers may respond to environmental impact measures, yet these should be used sparingly because most consumers are unfamiliar with these measures. If environmental impact information is essential, it should be presented along with additional or comparative data. (460) Each unit type adds a unique value to the consumer and as such, it will likely be beneficial to offer all unit types to the consumer and let them identify in which unit they prefer to view the information.

The format of the information is also very important to the consumer. The most common type of energy efficiency information is a monthly utility bill. A focus group asked to discuss utility bill design suggested the following approaches for effective interfaces for raising consumer awareness (460). First, information should be simple, but not simplistic. There is no need to overwhelm the consumer with a tremendous amount of complex data or visuals, the more streamlined and succinct the better. Additionally, the focus group suggests that a combination of text, diagrams and tables is more effective than a single-format presentation. If graphs are used, consumers need labels to understand each axis. Lastly, the group found that excess paper detracted from the message of conservation. If paper reports are used, the reports should be double-sided and use only the necessary volume of paper.

Another feature of information that is particularly useful for awareness-raising is disaggregation. Historically, energy usage information has been presented in the aggregate (i.e. energy used by the entire household). Research suggests that appliance-specific feedback is the ideal level of detail to influence the consumer to change their behavior. When energy usage is disaggregated, consumers can identify which appliances or behaviors are contributing to a specific outcome, which raises awareness and consciousness of problematic behaviors. (82) Any disaggregation (i.e. specific rooms, appliances, or time of the day) could raise awareness of the relevance of individual actions. (85)

Relevance of information is an additional feature of information that is important to consumers.

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10 Dan Ariely’s Class, April 4, 2011
Depending on the particular billing pattern that the customer is in (i.e. time of use), different tranches of information may be more important to see. Time of use customers will be very interested in consumption by hour of day; yet this information would likely be irrelevant to non-time of use customers. Condominium, dormitory and other multi-unit household customers might benefit from information that is specific to their room or particular living situation. Sending irrelevant information to disinterested parties could alienate them from future behavior change (i.e. sending a coupon for a new water heater to a person who is renting their home).

In summary, there are a number of approaches to information dissemination that positively influence awareness and lead to potential behavior change. It is important that these features be accounted for when deciding whether to or how to disseminate awareness-raising information to customers.

**APPLICATION**

**Utility Bills in Oslo, Norway**

There is evidence from a three-year study of home energy bills in Oslo, Norway that suggests that tailored information that is disseminated to appropriate customer segments results in significant behavior change. The study revealed that “more informative bills resulted in energy savings of about 10 percent” between 1989 and 1992 (145 and 149)\(^{15}\). Specifically, the authors examined how the type of bill sent, the specificity of the message and the comparative context (previous consumption in a similar period, consumption of similar households) of the information affected the consumer (146)\(^{16}\). The status quo customer received a bill once a quarter with only financial data; the new bills provided succinct information that effectively raised consumer awareness of high consumption patterns. The group that received enhanced bills, with a simple, yet not simplistic set of consumption data in an array of units, was able to conserve substantial amounts of electricity.

**LEARNING**

**CONCEPT**

Learning, like awareness, is a behavioral objective that flows from information and works to change behavior by connecting, in the consumers’ head, cause and effect. Feedback, information in response to

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behavior, is a particularly important type of learning in the household energy efficiency space. Immediate feedback increases the awareness of the impact of individual behavior and builds a foundation for learning. (82)

When a small child touches a hot stovetop, he immediately pulls his hand away. The temperature of the coils is excessive and burns the child. A painful nerve response is the body’s response to this situation. His brain receives a specific type of information, or feedback, that lets the child know not to touch the surface because it is too hot. Similarly, feedback in the context of behavioral economics is information in response to some action or behavior. In the same way that touching a hot stove would encourage a child to never touch a stove again, it is possible that the ideal type of feedback could encourage a household to conserve energy over both the short and long-term.

There are two types of feedback: direct and indirect. The immediate response to usage is direct feedback. At the household level, direct feedback includes reading a meter or viewing a digital thermostat. Indirect feedback includes a range of responses, from inferring content from a detailed utility bill that includes normative and descriptive information to alerts from external meter readers (458). Several characteristics distinguish both direct and indirect feedback, namely frequency, content, and medium.

Frequency is the rate at which the feedback or learning occurs for the customer. In terms of lasting behavior change, higher frequency is shown to be more effective than feedback that is less frequent. (266) When learning is more frequent, a link is established between a specific behavior and its effect, which heightens awareness of the consequences of individual actions. (85) It is unclear from our research if there is an upper limit to frequency. It seems reasonable to think that too frequent feedback could alienate the recipient and have the opposite of the desired behavior change effect.

The content of the feedback, like the curriculum in a classroom, can also enhance the ability of the information to change behavior. Feedback should attract the consumer’s attention. The more

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interesting the content, the more likely the user will be able to increase their consciousness and draw links between their behavior and its effect. The challenge is that different individuals have different interests and the content must be adaptable to these differences (i.e. highlighting resource conservation and emissions reductions might be interesting to some, while competitions and couponing might be better for others). (85)

The medium by which feedback reaches the consumer is also important. Existing household energy efficiency feedback mechanisms include the monthly utility bill and in-home energy meters. PlotWatt and the peer companies we studied provided feedback in the form of either computer-based online media or written material. Both media can be effective if the frequency and content support that particular media. Yet, the presentation should not overwhelm the content. The online interface has to be robust enough for the customer to feel inclined to go to the site frequently. However, consumers are diverse and it is highly possible that familiarity with technological interfaces could vary greatly. A comprehensive review of five studies and twenty-one papers on the effects of feedback on electricity consumption, suggests that frequent and concise computerized feedback, given over a long period of time, that includes application-specific breakdowns is the most successful type of feedback. (79)

APPLICATION

Ambient Orb

Southern California Edison wanted to help consumers conserve energy; they tried sending emails with helpful hints and convenient text message reminders to conserve – but neither seemed to alter usage behaviors. Instead of reconfiguring the content of messages in these traditional channels, they got creative. The company distributed an Ambient Orb, “a little ball that glows red when a customer is using lots of energy but green when energy use is modest”. Within weeks the Orb owners significantly reduced energy usage during peak hours by 40 percent. The glowing red light made customer notice their energy usage in a way that informational pamphlets alone were incapable; energy consumption was no longer an invisible problem. (195-196) This demonstrates that the curriculum of energy efficiency can be creative and lead to significant, measurable behavior change.

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Nag-Baztag Device

The Nag-baztag rabbit is a device designed to reduce energy consumption in household kitchens. Wirelessly connected to the Internet, the device tracks water, gas and electricity usage and identifies usage patterns in the kitchen.

Once patterns are recognized, attention can be called to inefficient behaviors. For example, if a kitchen door is left ajar or the oven is left on or preheats for too long, the device would notice and the behavior would be addressed with a verbal warning and a color change. After the negative behavior is observed, the rabbit would nag the user when similar behaviors were close to happening, which would motivate the user, who does not like things that nag, to change their behavior. Since consumers are each unique, there may be someone who actually enjoys the nagging or likes watching the rabbit change colors. If this is the case and the feedback does not lead to the desired behavior, the feedback mechanism could evolve and do things that actually irritate the consumer. Changing feedback mechanisms are often the most successful.24

SOCIAL NORMS

CONCEPT

Behavioral psychologists argue for the use of social norms based on observations that the majority of individuals both overestimate socially undesirable behavior and use their misperceptions of average behavior as a reference point for their own behaviors. A common example of this phenomenon is alcohol consumption. Many college students perceive a higher level of drinking among their peers than is accurate and then use this misperception to evaluate their own alcohol consumption.25

Robert Cialdini, et al. assert that the most effect way to manage social norm messaging is to use both types of social norms: descriptive and injunctive.

**Descriptive norms** illustrate common or average behavior, whereas **injunctive norms** are used to inform behavior that is socially desirable or undesirable. According to the Focus Theory of Normative Conduct, the most potent combination of these two norms is when the average behavior is less than desirable is to “induce a normative focus, but only on the injunctive norm” (5). To continue the alcohol example, Cialdini would argue that you should bring focus to a particular behavior that you wish to influence, reporting the average alcohol consumption of college-age individuals. However, you should also praise positive behavior. Otherwise, individuals who were previously performing better than the average, in this case drinking less than the average, will change their behavior to become more in line with the average and increase their alcohol consumption. This outcome is referred to as the boomerang effect. Adding an injunctive message that praises positive behavior, less drinking, can counter this effect.

**Rewards** are often thought of in financial terms, whether direct monetary payments, reduced costs or rebates and coupons. However, behavioral economist Dan Ariely expressed concern about the use of financial rewards. During an April 7th interview, he said he was weary of financial rewards like the coupons used by EarthAid, one of the peer case study companies, because the reward is relatively small for a big behavior change. An ice cream coupon is not likely to do much to incentivize an individual to put on extra sweaters during the winter so that they can turn down the thermostat a few degrees. Inherently, this is a source of conflict for all types of financial rewards when it comes to energy efficiency because energy is so cheap and the household energy bill is so much smaller than other bills, occupying a smaller portion of household consciousness. Alternatively, social rewards can be more influential because individuals have a relatively higher concern about self-perception and how others perceive them. In this sense, social rewards can be used to tap into this ego-utility.\(^{27}\)

### APPLICATION

**Littering**

Cialdini first demonstrated the effect of social norms on environmental behaviors in the early 1970s with

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27 Ariely, Dan. Personal interview. 7 April 2011.
a study on littering. Set in a parking garage, the study used paper flyers left on cars to determine the affect of the presence of litter and whether or not others approved of littering (descriptive and injunctive norms, respectively). The results conclusively demonstrated that social norms do impact environmental behaviors, as predicted.  

**Hotel Towel Reuse**

In addition to the littering study, Cialdini’s team looked at the use of social norm messaging and individuals’ ability, or lack thereof, to predict the effectiveness of such messaging. Using signs in hotel rooms to encourage towel reuse and water conservation, the research team again found social norm messaging to be more successful than messages simply extoling the benefits towel reuse. Further, they conducted a survey to ask hotel guests what type of social identity factors (guests who stayed in the same room, fellow citizens, specific genders, etc.) would be most effective in producing positive results for the towel reuse program. Participants predicted that location-specific provincial norms (e.g. guests who stay in the same room) would be the least effective, whereas the associated study found these messages to be the most effective.  

**Smiley Faces**

Cialdini and a team of researchers also explored the application of descriptive and injunctive norms on residential energy consumption directly. For 290 households in San Marcos, CA, they studied energy consumption over two weeks and periodically provided descriptive feedback about their energy consumption relative to the average of their neighbor. For some participants, they also provided injunctive feedback in the form of a smiley face or a frowning face. As predicted from previous studies descriptive norm-only messages produced a boomerang effect for households that were more efficient than the average, but the injunctive feedback of the approving or disapproving faces eliminated this effect.  

**GOAL SETTING**

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According to cognitive psychology, Prospect Theory depicts a value function relative to a particular reference point. Larrick and Wu argue, “goals serve as reference points and systematically alter the value of outcomes as described by the psychological principles in Prospect Theory’s value function.” (79) On the Prospect Theory value function, gains to the right of the reference point increase in value at a slower rate than losses to the left of the reference point decrease in value. This phenomenon is commonly referred to as loss aversion. Framing conservation as preventing a loss, rather than incurring a gain is more motivating than a emphasizing a gain. For example, presenting “money saved” or “energy saved” on the Y-axis of a graph (instead of the X-axis) will visually suggest that the consumer is actually losing money instead of saving. Additionally, Prospect Theory explains that there is diminishing sensitivity along the value function further away from the reference point or goal.

Studies have explored the effectiveness of goals in reducing energy use according to different goal characteristics. Becker found that the difficulty level of a goal influenced the success of goal achievement. More difficult goals lead to higher energy savings, whereas easy goals (e.g. 2 percent savings) produce little or no savings. In contrast, McCalley and Midden found that goal attribution, whether the goal is set by the individual or assigned by some external entity (e.g. researcher or energy efficiency company), has no significant impact on the level of energy savings.

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Goal setting is commonly studied in combination with other behavioral psychology principles. In a survey of the effect of information, feedback, and goal setting on household energy use, Abrahamse and his team found that goal setting was effective when combined with a commitment to reduce energy use and/or feedback about savings performance. Further, studies have shown that goal setting is more effective in combination with feedback than goal setting alone.

In terms of relative comparisons using social norms, consumers tend to evaluate their position relative to a reference point, whether that be an expectation, a habit or a social norm. Further, the two main attributes of Prospect Theory, loss aversion and diminishing sensitivity, predict that upward comparisons will be more painful and motivating than downward comparisons. This suggests that the effect of goal setting in combination with social norms may make the boomerang effect even more potent for individuals performing better than the average, reinforcing the necessity for injunctive messaging.

APPLICATION

Goal Setting and Feedback

Lawrence Becker demonstrated the combined effect of goal setting and feedback for residential energy efficiency in a study in the late-1970s. One hundred households in New Jersey were divided into five groups: a control group, two groups that received goals of reducing their energy use by 20 percent (a difficult goal), and two groups with a goal of 2 percent reduction (an easy goal). Each of the goal groups was further divided based on whether they received feedback on their performance and goal attainment. Relative to the control group, the group without feedback and the easy goal actually performed worse, and the group without feedback and a difficult goal performed similarly to the group with feedback and an easy goal (4.5 percent and 5.7 percent savings, respectively). However, the group with both feedback and a difficult goal performed significantly better, reducing their consumption by 15.1 percent.

Based on this study, setting a difficult goal can have nearly the same effect as feedback,

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but combining the two behavioral interventions can dramatically amplify the effect and reduce energy consumption.

**FRAMING**

**CONCEPT**

Framing refers to the way in which decision options are presented and the context in which the decision is situated. For example, energy conservation could be framed as an environmental or a financial opportunity and the results of a decision made in the distinct frames would vary. Choice architecture, a subset of framing, is the art of designing how decision alternatives are presented. In the environmental opportunity example described above, the variables of choice architecture could include the organization of decision alternatives, the language used in the alternative descriptions, the diversity of alternatives and a number of other features. Several features of framing that are relevant to the energy efficiency space include financial costs, defaults and reference points.

It is often difficult to frame financial costs in the energy efficiency space because the paybacks on many of the investments occur in the future and customers struggle with discounting their investments over this long period of time. Additionally, consumers struggle with a sunk cost bias where they fail to replace antiquated appliances and equipment (e.g. washing machine, incandescent light bulbs) because they remember the time and money they invested in the initial purchase of that product. No matter how long ago they purchased these products, consumers feel more attached and invested in the purchase once it is made. Beyond sunk costs, there are opportunities in which positive framing of financial costs can actually benefit energy efficiency. Depending on whether the costs are a savings or expenditure to achieve energy efficiency, it can be effective to emphasized or de-emphasized financial costs. In general, you can present values independently to emphasize the savings or embed them to de-emphasize their cost. Consumers respond better when a small cost or savings opportunity is presented on its own rather than when it is integrated into a total cost that is much larger. For example, “You are currently loosing $5 every month by not consistently turning off your lights” is more effective than “You could reduce your $125 electricity bill to $120 if you consistently turned off your lights.” Consumers like large savings, so another effective framing message if the savings are relatively small is to aggregate:
“Save $100/year by buying an energy efficient refrigerator rather than saving $0.30 per day.”

One of the most powerful framing tools to be aware of is the idea of defaults, or the option that your system is set to automatically (i.e. default web browser). Defaults are everywhere and often go unnoticed by consumers. For example, they often appear as opt-in or opt-out options at the bottom of service agreements. When signing up for an online service, if the box is checked at the bottom on the sign-up page, that automatically opts the customer into receiving information from the service providers’ partners. This situation is an opt-out scenario because the customer has to pro-actively uncheck the box to not receive additional information from partners. Very few customers actually opt-out, so providing a default option that is opt-out means you are more likely to encourage participation.

A classic example of the opt-out bias is organ donation. Organs donation participation rates are 25-30% higher in countries that require citizens to opt-out of donations versus countries in which not donating is the default. Defaults could be useful in a number of energy efficiency settings, like with setting the default temperature on washing machines. Research suggests that setting the default temperature to cold could save 24% on energy costs. Energy efficiency companies should make the automatic (default) option the desired efficient behavior for the simple reason that people do not like to click boxes and will have to be very motivated to select the non-default.

A final relevant type of framing in the energy efficiency space is reference points. Customers have to compare themselves to some baseline (past performance, for example). Most energy efficiency programs do not offer customers a viable reference point. The big problem with reference points is that the typical assumption is that a baseline of energy use would be zero (no consumption); however, this is impossible for almost every type of consumer. It is important that the reference point against which customers compare their behavior be realistic. Dan Ariely suggests that one way to do this is by breaking out usage into total consumption and a controllable range. This frames the opportunity for action (controllable range) or overall spending by removing demotivating fixed costs. Fixed costs are basic

consumption requirements like keeping a refrigerator on at all times and keeping the thermostat at a livable temperature. By breaking out the controllable range, the consumer has a better sense of what scale of energy efficiency is achievable. A similar exercise has been successful in household budgeting: consumers break out discretionary spending from “fixed monthly costs,” like mortgage, gas, and insurance payments. Knowing the discretionary usage enables the customer to better visualize their opportunity for action.

APPLICATION

Ordering Vegetarian

Many environmentalists are aware of the tremendous energy usage that goes into meat production. The value of vegetarianism on energy consumption is not trivial and many in the energy efficiency space are eager to promote vegetarianism as a way to reduce energy consumption. Some are even leveraging the principles of framing to accelerate the switch to vegetarianism. At a recent meeting of the American Council for an Energy-Efficient Economy, the vegetarian meal option was set as the default. Attendees had to make an additional effort to opt-out of the default option and opt-into the meat meal option. As research suggests, the default option was quite powerful: in previous years most participants ordered the meat meal option; at this year’s meeting only 20 percent did. By setting the vegetarian option as the default option, the meeting organizers dramatically changed the behavior of the participants.

ENERGY EFFICIENCY COMPANY CASE STUDIES

While reading the studies highlighted in our literature review, we noticed a number of interesting applications of behavioral economics to energy efficiency cited. Some of these findings are described above and it is clear that there are dozens, if not hundreds, of additional examples of situations where behavioral economics has been utilized to alter household energy consumption. In fact, there are a handful of energy efficiency companies whose entire business models are based on the ability of these interventions to not only drive behavior change, but also make large amounts of money. Not only are these companies driving meaningful change in a unique and applicable way, but they are also becoming increasingly relevant in the larger national energy efficiency conversation.

46 http://danariely.com/tag/defaults/
A number of states already have working smart meter systems installed, even more are close to flipping the switch. With smart metering comes an extremely large volume of energy consumption information. The companies that are able to find useful ways to analyze, manipulate and leverage that information will emerge as significant players in the evolving electric grid. We think these companies are relevant to more than just our research question.

In order to develop the most salient set of recommendations possible for PlotWatt, it is necessary to study the company’s peer group to determine how they are using behavioral economics effectively, where they are falling short and which of their approaches are most relevant to PlotWatt. There are a number of companies we could have focused on. We decided to study those companies we could personally engage with. We signed up or reached out to six companies that, in some way, promised consumers that using their service would change behavior and drive energy conservation. We selected OPOWER, Google PowerMeter, Microsoft Hohm, Earth Aid, TELLEMOTION/GreenLite Dartmouth and Wattvision.

In the following section, we explain the background of each company, highlight how they are currently utilizing principles of behavioral economics that we have defined above, and we evaluate their performance against a common rubric. The rubric overlays each behavioral economic intervention on top of each company. Based on the key characteristics and descriptions identified in the literature, the companies utilization of each intervention is evaluated as either “Excelling”, “Trying” or not utilized (“No data”). This is a qualitative assessment and is nuanced based on the specific business model of each company. See below for a summary of the key characteristics for each of the five behavioral economic principles:

<table>
<thead>
<tr>
<th>Principle</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td><strong>Units</strong>: What are the units used to convey energy use? <strong>Format</strong>: What types and combinations of text and graphics are used and how dynamic is the presentation? <strong>Disaggregation</strong>: How is the information tailored to the customer, if applicable? Is information based on entire household energy use or is it broken down into smaller pieces (i.e. appliance-specific or room-specific feedback)?</td>
</tr>
<tr>
<td>Learning</td>
<td><strong>Frequency</strong>: Does feedback occur in a timely fashion? Is it closely linked in time with a specific action? <strong>Content</strong>: Does the content draw the user in? Is it compelling and fresh? <strong>Medium</strong>: What type of interface is used (paper, web-browser, standalone device)?</td>
</tr>
</tbody>
</table>
A company is “excelling” when they are using the intervention very effectively, as demonstrated by the use of all or nearly all Key Characteristics of the principle, or very innovatively, which implies that no other company is utilizing the intervention in the same way. If a company is excelling, they essentially have little to no room to improve and have integrated each characteristic of the intervention into their approach. A firm that is “trying” to implement an intervention is attempting to use the intervention but is only addressing a couple of the key characteristics or is not necessarily particularly innovative in their implementation.

If a company is not using the intervention or is doing so to an extremely minimal extent, we identify that there is “no data”. Figure 8 is a high level summary of our findings.
OPOWER

BACKGROUND

OPOWER uses behavioral science and data analytics to enable utilities to motivate changes in customer energy usage behavior. Six of the ten largest utilities in the United States are OPOWER customers.

From the early stages of the company, the founders understood the value of normative influences and realized that partnering with electrical and gas utility companies was the best way to gain access to consumers’ energy usage data so that normative trends could be identified and shared with the customers. Robert Cialdini serves at the company’s chief scientist.

CURRENT APPROACHES

There are two main channels through which OPOWER delivers content to utility customers: an energy mailer (Home Energy Report) and an online energy efficiency portal.

The Home Energy Report is sent several times per year and contains relevant and actionable energy data and feedback that is customized for each utility and its customers. Nearly one million households nationwide receive these reports and have subsequently cut annual gas and/or electricity usage by 1.5 to 3.5 percent. The reports offer energy use patterns and comparisons to previous performance in the household or against “neighborhood peers”. Unique to OPOWER is the use of smiley faces to visualize performance in a different way, which spurs consumer behavior change. The reports also offer targeted tips that are tailored by demographics and prior response patterns. Utilities and their partners can also add promotional offers.

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47 http://www.opower.com/Company/AboutUs.aspx
50 http://www.opower.com/Products/EnergyEfficiencyPortal.aspx
to the reports; evidence from OPOWER suggests that including promotions in their reports increases participation in the promotional program by more than 20 percent over the status quo.\(^{51}\)

**Figure 11: OPOWER Energy Insight Module**

The Energy Efficiency Portal\(^{52}\) complements the paper report and is accessible to customers at all times. The site contains a number of data-rich displays that are intuitive and simple. It contains additional tips that customers can provide feedback or comment on. Additionally, the site offers best practice sharing where a customer could suggest a particularly useful tip or one that was less influential on their energy bill. There is also a space where the utility can offer hints on how to better understand the bill. This helps customers further identify the drivers behind their usage. There is an “Online Energy Insight Module” on the portal that highlights trends and patterns in usage that can help highlight historical performance and normative influences.\(^{53}\)

**KEY OBSERVATIONS**

OPOWER is a leader in the energy efficiency space because of its unique approaches to social norms and framing consumption. The reports, although comprehensive in many ways, are infrequent and rather basic in terms of content. There is little motivation for the average customer to use the online portal because the information is not real-time. There is not an immediate connection between an efficient behavior and a savings in the bill (because of the month time lag).

<table>
<thead>
<tr>
<th>Principle</th>
<th>Assessment</th>
<th>Key Characteristics</th>
</tr>
</thead>
</table>
| Awareness | Trying     | **Units**: Customer can choose between dollars, kilowatt hours and therms  
**Format**: Interactive and attractive.  
**Disaggregation**: No appliance or room-specific disaggregation |
| Learning  | Trying     | **Frequency**: Mailing is infrequent but the portal is always on. There is the capacity for immediate feedback on several different devices but it is not clear if this feature is functional.  
**Content**: Clean presentation. Smiley Faces are unique, otherwise similar content to other energy information companies. Both the portal and the mailed report are very tailored to the customer and change based |

\(^{52}\) [http://www.opower.com/Products/EnergyEfficiencyPortal.aspx](http://www.opower.com/Products/EnergyEfficiencyPortal.aspx)  
on interaction and feedback.  
**Medium:** Web and paper report encourage customer interactivity but there is no additional driver for website visit

| Social Norms | Excelling | **Descriptive:** Clearly identifies average usage in creative ways  
**Injunctive:** Offers positive reinforcement (smiley face) for high-performing customers to encourage continued energy efficient behavior  
**Rewards:** Smiley face is a mild reward for customers with efficient practices |
|---|---|---|
| Goal Setting | No Data | **Loss Aversion:** N/A  
**Difficulty Level:** N/A  
**Attribution:** N/A |
| Framing | Excelling | **Financial Costs:** N/A because Durham utilities are not partners  
**Defaults:** Partnership with utilities is a distinct advantage because customers have to ask to be removed from the program  
**Reference Points:** Adjusted for weather and normal usage |

**EARTH AID**

**BACKGROUND**

Earth Aid launched its current energy savings program in September of 2009. Initially the service was only available in Washington, DC, Bethesda, MD, and Hawaii. While Earth Aid continues to activate compatibility with some smaller utilities such as the City of Durham Water, the program is largely available nationwide. The company characterizes its strategy as threefold: educating households about their energy and water use, helping those households reduce consumption, and rewarding more efficient energy and water use.

![Figure 12: Earth Aid Interface](http://www.earthaid.net/content/about)

**CURRENT APPROACHES**

Earth Aid provides households a free online interface to track energy and water use. Unlike other programs, Earth Aid draws data directly from user’s utilities and includes natural gas and water use in addition to electricity. When households sign-up for the service, they provide their log-in information for each of their utilities’ websites, which allows Earth Aid to pull the current and prior 12 months of data into their profile. In our home setup, we were able to connect 2 out of 3 utility bills, receiving a

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^54 [http://www.earthaid.net/content/about](http://www.earthaid.net/content/about)
message that Earth Aid was “currently working hard to activate compatibility” with our local municipal water provider.

Although it is evident that Earth Aid does not have all local utility relationships established, it is far more accessible to the average household than many other energy monitoring companies that require either a smart meter (either individually purchased or provided by the utility) or major utility relationships like those established by OPOWER.

The Earth Aid “dashboard” is the main user interface and displays a wealth of information including: usage by resource type over the past 12 months (electricity, gas, water), comparison to others (friends in the system, zip code, state, country), savings to date (dollars, reward points accumulated, environmental impact), and opportunities for improvement (local incentives/rebates, generic energy efficiency tips). While all interesting and relevant, we found this wealth of information overwhelming. Earth Aid is still in beta stage and in the past weeks has altered the look of their interface. While it appears that the site is still a work in progress, it is unclear how and which information will be presented in the new version.

Rewards points are a key feature of Earth Aid, which relies more on social norms and rewards than information and feedback that can be effective (in addition to being overwhelming, the information provided is not tailored or disaggregated). Earth Aid members accumulate reward points based their current energy and water use relative to usage in the past year. These reward points serve as both a financial and social incentive, as they can be redeemed for coupons from participating retailers and are visible to other users in the community. Additionally, Earth Aid provides “tips” for
energy efficiency improvements, but does not explain (or offer possible explanations) differences in energy efficiency performance between the user and other households.

**KEY OBSERVATIONS**

Earth Aid is unique in its approach to incentives, incorporating financial and social rewards. However, the program is does not appear to be robust enough to make a significant impact on the user’s behavior in terms of financial incentives. In our experience with the site, only one “local” retailer (25 miles away) offered rewards in our area along with ten national retailers. According to Dan Ariely\(^5\), the social rewards may actually be more effective in changing behavior than financial incentives. Again, the site is still in development with relatively few users, limiting this effectiveness as well.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Assessment*</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Awareness</strong></td>
<td>Trying</td>
<td><strong>Units</strong>: Mix of dollar, kilowatt and environmental impact information. <strong>Format</strong>: Overload of information, both types of feedback (use patterns, comparison to other users, tips for improvement) and flexibility to assess usage (change units and resources) <strong>Disaggregation</strong>: Resource use specific to household only to the extent possible from monthly bills; incentives and rebates are specific to user location. Environmental impact disaggregated by resource (e.g. electricity, gas, water). Includes current usage and past performance.</td>
</tr>
<tr>
<td><strong>Learning</strong></td>
<td>Trying</td>
<td><strong>Frequency</strong>: Updated monthly based on utility bills <strong>Content</strong>: Online portal is overwhelming with amount of information. “Tips,” “Community,” and “Rewards!” sections offer a high level of interactivity. For example, user has ability to create “Personal To-Do List” under “Tips” section for energy efficiency improvements <strong>Medium</strong>: Web browser-based only</td>
</tr>
<tr>
<td><strong>Social Norms</strong></td>
<td>Excelling</td>
<td><strong>Descriptive</strong>: Compares against peer group in zip code, state, and country <strong>Injunctive</strong>: Uses green and red background color to highlight positive and negative performance relative to the average <strong>Rewards</strong>: Reward points accumulate according to performance and can be redeemed for coupons from local and national retailers; these points also serve as a social incentive as they are visible to other users in the community</td>
</tr>
<tr>
<td><strong>Goal Setting</strong></td>
<td>Trying</td>
<td><strong>Loss Aversion</strong>: Messaging focuses on gains (dollars saved and reward points accumulated) <strong>Difficulty Level</strong>: N/A <strong>Attribution</strong>: N/A</td>
</tr>
<tr>
<td><strong>Framing</strong></td>
<td>Trying</td>
<td><strong>Financial Costs</strong>: Highlights available/relevant rebate programs in local area for energy efficiency improvements, which can alleviate concerns</td>
</tr>
</tbody>
</table>

\(^5\) Ariely, Dan. Personal Interview. 7 April 2011.
Microsoft Hohm is a free online application that is designed to help consumers save energy and money. Hohm users receive tailored recommendations that are based on their consumption, unique attributes of their home and household circumstances.

Microsoft Hohm envisions developing a system that integrates data from electric vehicles, homes and utilities into one cohesive “ecosystem”. They believe that this integrated view of resource consumption with help consumers manage consumption while supporting utilities as they manage the growing demands on the grid.

Like OPOWER, Microsoft Hohm uses both the combined offering of a report and an online portal. When a customer goes to the Hohm site, they are prompted to complete a comprehensive Home Profile\textsuperscript{56}, which in our experience took about 30 minutes and involved a number of cumbersome steps, including walking room to room in order to count light bulbs. If a customer is able to overcome the Home Profile step, they are set up to receive energy data (based on utility bills) and recommendations for potential savings.

Microsoft Hohm requires utility data and a customer cannot install a meter to get relevant data. The site

\textsuperscript{56} Microsoft Hohm Report of Jennifer Snook’s House (January 2010), © 2010 Microsoft Corp
estimate our energy breakdown and usage based on the profile we populated. Unfortunately, we received the following message after completing the profile: “There is no energy usage data available for your home. You can enter data manually on the energy usage page, or connect up to a provider in your area if automated feeds are available” – suggesting the pie chart was a complete approximation based on the characteristics of Jen’s house instead of actual consumption patterns.

This was very frustrating because we spent a significant amount of time entering data and were not given access to meaningful feedback. Therefore, we felt no real reason to return to the site because we could not gain access to all features. This is relevant to the company’s vision of a resource feedback ecosystem; if customers don’t have all information populated, they may get alienated from the site altogether, despite its potential to integrate all information and provide meaningful feedback to some consumers.

Despite our frustration with the feedback, we were impressed with the number of the features within “Your Savings Recommendations”. The information provided felt very specific to Jen’s house, and was presented in a fun, easy-to-manipulate chart (Figure 17). The chart allows customers to mark recommendations as complete, enter notes, set due dates, track cost information, and drill down for more details.

Figure 17: Microsoft Hohm "Ways to Save"

![Figure 17: Microsoft Hohm "Ways to Save"

KEY OBSERVATIONS

Microsoft Hohm is making an effort in each category except goal setting. Unfortunately, our experience with the site was mixed. We found the information to be comprehensive and tailored but we were not given access to all the features because our utility did not participate.
and based on the home profile. Tailoring requires inputs by the consumer and is not automatic

| Learning | Trying | **Frequency:** Based on monthly utility bills  
**Content:** Not real time but “Ways to Save” section offers a high level of interactivity  
**Medium:** Web browser-based only |
|----------|--------|--------------------------------------------------|
| Social Norms | Trying | **Descriptive:** Compares against peer group in the neighborhood  
**Injunctive:** The “Hohm Score” feature allows users to compare their usage to others in their neighborhood; good performance is illustrated in green, average performance in yellow and bad performance in red.  
**Rewards:** Offers ways to save and tools to track these recommendations and progress against them |
| Goal Setting | No Data | **Loss Aversion:** N/A  
**Difficulty Level:** N/A  
**Attribution:** N/A |
| Framing | Trying | **Financial Costs:** Annual savings are presented for all recommended actions next to do-it-yourself installation costs which provides context for the investment  
**Defaults:** This is an opt-in program and requires the customer’s utility be a participant for information to be easily inputted; otherwise the customer must input all information himself or herself, which is very tedious.  
**Reference Points:** Unable to assess because Durham utilities are not partners |

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**GOOGLE POWERMETER**

**BACKGROUND**

Google PowerMeter is a project of Google.org, the philanthropic arm of Google whose mission is to “use Google’s strengths in information and technology to build products and advocate for policies that address global challenges.” PowerMeter is one component of Google.org’s greater commitment to advancing the development of the smart grid. Along with other prominent NGO and private-sector companies, Google.org issued a statement at the Copenhagen climate conference that called on national governments to provide their citizens with real-time access to home energy use information. For households that already have utility-installed smart meters or energy monitoring devices like WattVision, Google PowerMeter provides a free interface to monitor home energy use from any web browser.

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57 [http://www.google.org/about.html](http://www.google.org/about.html)
CURRENT APPROACHES

Google PowerMeter has a relatively simple interface that one might expect from a free service. The site has three main pages: “Recent usage,” “Historical usage,” and “Take action.” The first page, “Recent usage,” shows usage in kWh or dollars over the course of the present day, disaggregating the “always-on” baseload from overall use, and comparing usage to past performance. “Historical usage” provides the same information over a week or month-long period.

The site offers some more tailored feedback and user interaction within the “Take action” page, which provides recommendations for energy efficiency improvements based on user performance. Users earn “badges” based on which recommendations they act upon. Further, the site employs social norms by comparing the users’ energy consumption to the average home that is similar in dwelling type and square footage. Users also have the option to opt-in to receiving weekly emails about usage patterns and can elect to track their recent energy use with an iGoogle PowerMeter gadget on their iGoogle home page (iGoogle home pages are another product of Google).

KEY OBSERVATIONS

Google PowerMeter is the most basic of the energy monitoring interfaces that we explored. This is somewhat surprising given the position of Google in the general marketplace. In all likelihood, Google is simply establishing a presence and basic infrastructure in the energy monitoring space in anticipation of larger changes in the smart grid development.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Assessment</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>Trying</td>
<td>Units: Mix of dollar and kW per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Format: Combination of text and graphs; limited dynamic content</td>
</tr>
<tr>
<td>Learning</td>
<td>Disaggregation: “Always on” baseload disaggregated from variable use; time of day disaggregated by 6-hour periods in weekly emails; current and historical (prior week or month) usage data available</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| Social Norms      | Trying Frequency: Live data, updated every 10 minutes via browser portal  
|                   | Content: Simple and simplistic. Limited user interactivity except for basic energy saving tips.  
|                   | Medium: Web browser-based, opt-in weekly email summaries, optional iGoogle home page gadget ties feedback to other common activity for iGoogle home page users  |
| Goal Setting      | Trying Loss Aversion: N/A  
|                   | Difficulty Level: “Budget tracker” option to change comparison of present use to 80 or 90% of past use.  
|                   | Attribution: Voluntary  |
| Framing           | Trying Financial Costs: N/A  
|                   | Defaults: Opt-in for “budget tracker” and weekly emails  
|                   | Reference Points: Baseline (y-axis) is zero energy use |

**WATTVISION**

**BACKGROUND**

Wattvision’s primary business is the sale of residential energy sensors direct to consumers. The devices can be set up by the homeowner and require no electrical expertise. Once installed, the sensor reads the home electric meter and transmits data through the home wireless network to the WattVision servers. Further, Wattvision has a web-based Application Programming Interface (API) that allows for other developers such as Google PowerMeter and PlotWatt to access the stream of energy use data.

**CURRENT APPROACHES**

In addition to selling sensor hardware, Wattvision provides an online user interface that shows the live and historical usage of energy, as well as relative ranking for all homes publicly reporting data. Although this interface is secondary to the sale of the sensors and does not provide a direct revenue stream to Wattvision (free for owners of the Wattvision sensor), it is well designed and provides the user
opportunities to not only track their data, but also compare their performance to other Wattvision users.

Within the “Live” usage reports, energy use is graphically represented for the trailing five-minutes or hour and translated into a current consumption rate for dollars and kWh. The site also provides an estimate for how much it will cost at the current rate in terms of per day, per occupant, and per 1,000 ft². This information is compared to other Wattvision users, invoking descriptive social norms. Further, Wattvision highlights the relative “savings” or “excess” in dollar terms using green and red font colors, respectively, as a means of utilizing injunctive norms to indicate preferred behavior. The “History” tab is much simpler than the “Live” tab, communicating only dollars spent per hour and consumption rate every fifteen minutes over the current day.

In addition to the use of social norms within the “Live” usage reports, Wattvision ranks users according to their current energy use per occupant and energy use in the preceding day. Again, green and red colors are used to indicate preferred behavior. By default, the live energy use of each users is publicly available, allowing for such rankings. Wattvision also sets the default for receiving weekly energy use emails as opt-out, although either of these settings can be changed by the user.

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**KEY OBSERVATIONS**

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<thead>
<tr>
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<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>Excelling</td>
<td><strong>Units:</strong> Watts and $/hour for live usage and cost per day based on current consumption</td>
</tr>
</tbody>
</table>
Launched in 2008 on the campus of Dartmouth College, the GreenLite Dartmouth project (which later evolved into TELLEMOTION) uses an animated polar bear to bring energy consumption data to life. Founded on the idea that behavior would change if the customer could visualize the impact of their consumption decisions, GreenLite Dartmouth has reduced energy usage from lighting and plug loads in dormitories between 5% and 34% per dorm\(^5\).

The premise of the system is that when energy use is low, the animated bear is happy; when usage is high the polar bear is unhappy.

\(^5\) http://www.tellemotion.com/about_history.php
bear’s health and habitat are endangered. TELLEMOTION motivates consumers to keep the bear alive with a mix of animations, competitions, graphics and historical data. Thousands of users have “fallen in love” with the bear; this affinity has reduced electricity use by an average of 10% over sustained periods of time.\(^{59}\)

**CURRENT APPROACHES**

Customers can access the TELLEMOTION data through an online portal or through display kiosks in dormitories. The website and the kiosks provide current power usage in traditional metrics but also present the user with a letter grade, a metric particularly relevant to college students. Information is presented in either hourly, daily, weekly or monthly increments. Most interestingly, this data is integrated into an animation system that adjusts the living conditions of a polar bear. When a dormitory is being energy efficiency, the bear happily frolics with a butterfly. When the building is being less efficient compared to typical behavior, the bear melts through ice and drowns until the energy usage returns to a more normal point.

The site and kiosks provide changing content, including comic strips and tailored tips, to keep interest in the site high. The polar bear’s constantly changing situation keeps students connected to the site, bringing them back consistently. In fact, over 80% of students look at the website or display on a regular basis.\(^{60}\)

The competition features are evolving and are displayed in easy-to-use formats. The information on the site is tailored, even in dormitories. The system is currently being installed in Tuck School of Business dorms and the GreenLite team has added cost-savings data that does not appear in undergraduate dorms because the business school students respond better to the polar bear when it is coupled with financial information.

\(^{59}\) http://www.tellemotion.com/about_history.php
\(^{60}\) http://www.tellemotion.com/info.php
\(^{61}\) Loeb, Lorie. Telephone Interview. 22 February 2011.
The emotionally engaging animations connect energy use with the well-being of the bear and helps students realize that their small actions, when combined with the small actions of others, create real environmental problems.\(^2\) Dartmouth research suggests that before the site launched, students did not self-identify as environmentalists. After the launch, students started joining eco-friendly groups on campus and taking significant actions to reduce energy (like using drying racks instead of dryers\(^3\)). These significant behavior changes suggest that the emotional connection to the bear drove larger psychological shifts.

### KEY OBSERVATIONS

<table>
<thead>
<tr>
<th>Principle</th>
<th>Assessment</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>Excelling</td>
<td><strong>Units</strong>: Flexible based on consumer preference</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Graphics</strong>: Interactive, streamlined, fun</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Disaggregation</strong>: Dorm specific but not appliance specific. Historical usage comparisons are available by day, week, month or year</td>
</tr>
<tr>
<td>Feedback</td>
<td>Excelling</td>
<td><strong>Frequency</strong>: Very real time, animation changes within minutes of behavior</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Content</strong>: Very unique and interactive. Changes frequently (animation), comic strips are unique feature, competition data is real-time, tips are easy to access</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Medium</strong>: Combination of kiosks and online displays</td>
</tr>
<tr>
<td>Social Norms</td>
<td>Excelling</td>
<td><strong>Descriptive</strong>: Identifies “normal” behavior (i.e. what is typical usage at this time of the day and display if current usage is atypical)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Injunctive</strong>: The “A” grade is the desired norm and also represents an energy use state where the polar bear is alive on a sheet of ice</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Rewards</strong>: Peer approval from keeping the polar bear alive.</td>
</tr>
<tr>
<td>Goal Setting</td>
<td>Trying</td>
<td><strong>Loss Aversion</strong>: Some Tuck (Dartmouth’s business school) monitors convey dollars lost, in addition to the polar bear on the displays but this is not linked to goal setting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Difficulty Level</strong>: Competitions can be designed to accommodate stretch goals. System administrator (i.e. Dorm Dean) can set targets in certain configurations but it is not a standard feature</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Attribution</strong>: Not assigned by TELLEMOTION</td>
</tr>
<tr>
<td>Framing</td>
<td>Excelling</td>
<td><strong>Financial Costs</strong>: Several financial cost statements are being tested in Tuck School of Business dormitories for their impact on MBA student behavior</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Defaults</strong>: The system is installed at nearly all Dartmouth dorms making it opt-out for most students</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Reference Points</strong>: Graphs present typical usage range, based on time of</td>
</tr>
</tbody>
</table>

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\(^2\) [http://greenlite.dartmouth.edu/portal/dartmouth#gotoDemo](http://greenlite.dartmouth.edu/portal/dartmouth#gotoDemo)

\(^3\) Loeb, Lorie. Telephone Interview. 22 February 2011.
PlotWatt uses a sophisticated algorithm to disaggregate total home energy consumption into appliance-specific usage data. Like many of the companies described above, the mission of PlotWatt is to help customers lower their monthly utility bill. While not intentionally utilizing behavioral economics in the design of the interface, Luke Fishback does admit that PlotWatt’s interface intends to present the most essential information to the customer. We believe that PlotWatt has the potential, by leveraging principles of behavioral economics, to do an even better job of conveying information to its customers to help them lower their monthly utility bills.

There are four main sections in PlotWatt’s current interface, as the above screenshot illustrates. In the upper left corner, the customer sees real time consumption data in a unit of their choosing. The center of the screen offers the customer an energy timeline that displays usage over a range of days, weeks or months. On the far right side of the screen, there is a set of tailored recommendations for the customer to try to further lower energy usage. A key differentiator of PlotWatt is the information that is displayed in the bottom left corner of the screen. This section provides the customer the cost of running each appliance without having to individually monitor them. Despite the value of these four elements, we see areas for improvement.

Using the same assessment methodology as we applied to PlotWatt’s peer companies, we analyzed where the company stands in terms of its utilization of behavioral economic interventions. Below is the

assessment of the current state:

<table>
<thead>
<tr>
<th>Principle</th>
<th>Assessment</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>Excelling</td>
<td><strong>Units:</strong> Flexible based on consumer preference</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Format:</strong> Simple and clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Disaggregation:</strong> Appliance specific</td>
</tr>
<tr>
<td>Learning</td>
<td>Trying</td>
<td><strong>Frequency:</strong> Live data</td>
</tr>
<tr>
<td>Social Norms</td>
<td>No data</td>
<td><strong>Descriptive:</strong> N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Injunctive:</strong> N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Rewards:</strong> N/A</td>
</tr>
<tr>
<td>Goal Setting</td>
<td>No data</td>
<td><strong>Loss Aversion:</strong> N/A</td>
</tr>
<tr>
<td>Framing</td>
<td>Trying</td>
<td><strong>Difficulty Level:</strong> N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Attribution:</strong> N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Financial Costs:</strong> “Low hanging fruit” presents savings as daily and monthly which make it seem like customer can save a lot with a small change</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Defaults:</strong> Customers have to opt-in to PlotWatt which vastly limits the number of active users</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Reference Points:</strong> The energy use timeline does not offer a controllable range as a reference point.</td>
</tr>
</tbody>
</table>

In general, we think the company is excelling at building awareness. However, there is room for improvement in these learning, framing and awareness. We see tremendous opportunity in both social norms and goal setting, which are not being utilized at all currently. Below is a detailed description of our recommendations for the company.

**RECOMMENDATIONS**

We see four main opportunities areas for PlotWatt to consider in the near term: (1) Enhance Awareness, Learning and Framing; (2) Introduce Goal Setting; (3) Leverage Social Norms; and (4) Develop Partnerships to Enable Opt-Out Opportunities.
Enhance Awareness, Learning and Framing

Awareness

The purpose of PlotWatt is two fold: 1) it is a learning tool 2) it reinforces, motivates and builds awareness or positive behaviors. Currently the two purposes are intertwined. We recommend splitting them within the interface. As a learning tool, we see PlotWatt helping inform the customer upon initial installation of the smart meter about their actual baseline energy usage. We recommend building a game around this learning tool premise, which teaches the PlotWatt user about the drivers of energy consumption in their household. One game option is to set the “base load” – where they turn everything off in their house and see what their house “zero consumption” level looks like, then gradually turn on appliances to see the effect in a very granular way. Each house will be different so this learning game will set the house zero, helping both the consumer and the company by refining the algorithm. Once the game has taken place, the second purpose of the site can take over and the existing interface can be tweaked to reinforce and motivate good behaviors.

The energy timeline that PlotWatt and many of the peer companies offer provides near-real time data. This information is highly likely to convey large amount of noise, like strange weather fluctuations and timing of switching on and off appliances, that might confuse the active user and not be beneficial for training good behaviors. PlotWatt’s disaggregation algorithm is one of its greatest assets and could allow the company to provide useful information without the potentially misleading energy timeline. Recognizing, however, that the timeline is a common focal feature of these types of monitoring services, PlotWatt could continue to offer this feature as optional, with the default set as opt-in. Regarding the disaggregation feature, we encourage the company to further refine the “other category” because even though, for example, hair drying does not require large amounts of energy, the vagueness of the other category encourages attention to the noise of the “other category” which could detract from the overall positive behaviors the company is trying to encourage.

Learning

As PlotWatt users, we found that our frequency of site visits diminished over time, which we expect to be representative of other PlotWatt users. After the excitement of the initial interaction with the site, there was limited reason to return to the site nor a reminder from the company to do so. There are several options for remedying this: the introduction of attention grabbing content like GreenLite
Dartmouth that inspire the user to return to the site frequently or more frequent user contact like the weekly emails sent by Wattvision and Google PowerMeter.

The interactive content of PlotWatt’s site is minimal, providing customers with an Energy Timeline and behavior change recommendations, and it does not necessarily inspire the customer to return to the site. Alternatively, the GreenLite Dartmouth site includes animation, comics, and competition sections that provide interesting and unique content, motivating the user to return to the website. Although it is likely unrealistic to replicate GreenLite Dartmouth’s content, PlotWatt could introduce competitions that would leverage the benefits of frequency, as well as social norms and goal setting.

Because PlotWatt is a website, there is not currently a physical in-home interface besides the computer for customers. It might be worth exploring a way to display PlotWatt information on a stand-alone device in the home. In our interviews with Luke Fishback, he mentioned that PlotWatt has considered the possibility of adding SMS alerts that would engage the user at various intervals. Additionally, we suggest introducing a smartphone application with push alerts.

**Framing**

The total consumption versus the controllable range reference point is missing from PlotWatt’s energy timeline. We encourage PlotWatt to use the findings from the game (described above) to build out a controllable range of consumption for users to reference. Ideally, the site would offer customers a range of views into their “discretionary” energy usage. For example, with the HVAC system, you could show that it costs a total of $5 per month to run the HVAC system, $1 of savings is possible from a more efficient HVAC systems, but 10 cents of savings are possible from changing thermostat setting. The 10-cent view should be the default, because it displays the savings from a minimal behavioral adjustment that requires no additional financial investment or tradeoff analysis, and therefore is more likely to result in sustained behavior change.

**Introduce Goal Setting**

Our research showed that it does not matter if goals are set by the individual or some external entity and that stretch goals with feedback are most effective in reducing energy use. Subsequently, we

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recommend that PlotWatt set stretch goals for their customers as the opt-out default. For example, the company could set the goal of a 20 percent reduction in washing and drying expense. The goal setting will be even more robust if you break out “discretionary use,” as it makes the customer’s gains (goals) look proportionally bigger than if they were aggregated into overall energy use (being drawn down by the uncontrollable baseload). Likewise, customer losses (higher bills) look worse in comparison and may be more motivating to change behavior.

**Leverage Social Norms**

There is opportunity for PlotWatt to introduce social norms into their interface. PlotWatt does not really compare customers to anyone else and we think some sort of peer-level comparison would be useful for the customer to gain a sense of context and leverage the power of social norms. However, PlotWatt introduces descriptive norms (that convey the average or typical behavior), they should also be sure to include injunctive norms (that convey what the customer should be doing). The injunctive norm is essential if PlotWatt wants to avoid the tendency of customers to regress to mean performance; without positive reinforcement, it is possible the energy efficient consumers might think they are performing sufficiently well and would become disinterested in staying above the average. A good example from the peer company group is Wattvision, which compares users to everyone else in the system and uses injunctive language and color schemes to show the customer their savings compared to others (savings are denoted in green and excess in red).

**Develop Partnerships to Enable Opt-Out Opportunities**

OPOWER is the only company that uses an opt-out enrollment feature to ensure higher levels of customer participation. TELLEMOTION customers are required to use the product based on their living situation but can physically opt-out of participating in conservation. All the other cases we looked at, including PlotWatt, require a customer be proactive and signup for the service, which in many cases involves purchasing a smart meter sensor, hiring an electrician to install the device or spending hours entering all the bits and pieces of energy data into the company’s interface. PlotWatt must consider how being an opt-in service affects its potential in the market. We strongly encourage the team at PlotWatt to look at ways to integrate their system into traditional utility channels or into emerging smart grid nodes. No matter how good the behavioral economic theory empowers your site to be, it is still a very high bar to jump if customers are required to volunteer for the program.
ACKNOWLEDGEMENTS

This project would not have been possible without the contributions of a number of people at the epicenter of behavioral economics and energy efficiency. We are indebted to Lorie Loeb of TellEmotion and Pete Curtice of OPOWER for their willingness to share information about their companies for our case studies. Dan Ariely, the James B. Duke Professor of Behavioral Economics at The Fuqua School of Business, not only inspired our interest in the field but also provided feedback on our research over an amusing dinner, which further deepened our love of the subject and irrational behavior.

Rick Larrick, Professor of Management at the Fuqua School of Business and Faculty Director of the Center for Energy, Development and the Global Environment (EDGE), served as our behavioral economics guru and sat with us many moons ago when our outline was little more than a few bullet points. Rick helped connect us with Luke Fishback, who together with Rick, several cups of coffee and smart metering jokes, helped us formulate our research question. We are inspired by Luke’s passion for PlotWatt, his sense of humor and his potential to change the energy efficiency landscape.

And finally, we are extremely grateful for our relationship with Deborah Gallagher, Assistant Professor of the Practice of Resource and Environmental Policy, Executive Director of the Duke Environmental Leadership Program and our advisor at the Nicholas School of the Environment. If it were not for her guidance, intellectual encouragement and compassion over many months, countless time zones and dozens of iterations, this project never would have come to fruition, as it did. She let us experiment with ideas, take time to digest and gave us the freedom to make mistakes, which deepened our engagement with the material and the quality of our end product.
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