

# Home Energy Score Interactive Dashboard

Mckenzie Rhone, Roderick Tyler, Sarah Tinsley, Varun Gupta

## Problem Statement and Our Solution

Energy efficiency is difficult to observe. As a result, it is hard to value. According to the Shelton Group, 89% of people who expect to buy a new home in the next two years indicated higher energy efficiency would factor into their decision making (Shelton Group Energy Pulse, 2017). Yet, many homeowners do not know how to communicate energy efficiency and 84% have little knowledge about how to make a home more energy efficient.

The Department of Energy's (DOE) Home Energy Score (HES) System seeks to solve this problem by creating a standardized energy assessment score that can credibly signal the value of a home's energy assets. However, the HES system can be improved—the DOE faces a lack of data collection concerning the effects of the HES on homeowners' perceptions, understanding, and interaction with the HES. Providing a score is not enough to encourage its use. The score must be effectively communicated, and homeowners' responses need to be evaluated to monitor its effectiveness. The more engaged and knowledgeable homeowners are about their score, the better they can communicate it to potential buyers and the more they will value it when purchasing a home.

Our proposal is to present the HES in an interpretable and interactive manner to homeowners through an online dashboard with two features: 1) contextualizing the HES by incorporating messaging techniques, and 2) helping users understand how to improve their score via goal setting and progress tracking. Our intervention will help the DOE track this information and aid the homeowner in understanding the HES. We propose to leverage the HES data more effectively and help the DOE collect more useful data. Our intervention involves multiple features to provide the homeowners with a comprehensive understanding of the HES. In the long run, our dashboard will reduce information asymmetry in the real estate market by educating homeowners on their score, and consequently, household energy efficiency in general. This will help formalize the HES as a variable that influences prices in the real estate market.

## Background

Studies that attempt to reduce energy consumption in residential households make it clear that sustainably changing human behavior is difficult (Alcott & Rogers, 2014). Long-term daily behavioral interventions are even more

difficult to induce. However, demonstrated plasticity of certain behaviors such as appliance maintenance and purchasing decisions indicate that homeowners often adopt non-invasive interventions, which may still yield significant energy savings (Dietz et al., 2009). Consequently, focusing interventions on changing homeowners' household assets might be the best use of resources, as this involves a one-time investment decision; thus, we chose to expand upon the HES system, which focuses on home energy assets.

The HES seeks to provide a label for household energy efficiency to serve as a credible signal in the real estate market. The potential impact of the HES rating system is huge, as is illustrated by the success of the EnergyStar<sup>®</sup> program labels in the market for appliances, which annually saves as much electricity as used by 30 million homes (ACEEE, 2018). However, the HES system could improve by utilizing messaging and goal-setting to allow homeowners to interact with their scores. Studies have demonstrated that distinct types of behavioral messaging are critical to fully realize the value of providing people with additional information (Crosbie and Baker, 2010). Evidence also suggests that interest in energy-saving programs is driven by consumers' recognition of their present bias and that goal setting effectively reducing energy consumption when goals are achievable (Harding and Hsiaw, 2014). When their goals are achievable, consumers reach savings of nearly 11%, which are substantially higher than those choosing very low or unrealistically high goals. Our proposal highlights the potential for growth that will come from combining the HES with an interactive dashboard that incorporates messaging and goal-setting methods.

## Dashboard

The dashboard we propose has three sections. The topmost section is a visualization of the user's HES with a link to view and share (via email, real estate listing website, etc.) their HES report. This section provides no additional information from what the DOE provides.

The first treatment for the experimental design is located on the left side of the dashboard and focuses on messaging to contextualize the user's HES score. In this section, we have three messaging types to interpret energy efficiency in terms of: 1) environmental and health concerns, 2) economic impact, and 3) global normative comparison.

The second treatment is located on the right side of the dashboard. It is designed to encourage homeowners to invest in their home and help them set goals for doing so. This allows users to track progress in their score without

needing repeated assessments. Users are guided to set goals for their score and track subsequent changes in their home's energy efficiency. Once a user inputs a goal, they are given information about which areas of their home can be improved to help achieve their goal. The guidance is divided into sections similar to the HES report: Roof/Attic, Foundation, Walls, etc. The user can personalize their plan by inputting specific "what if" upgrades to see how their score will change with specific improvements (**Figure 2**). Resources are also provided to guide the user to companies and websites offering additional information or services. For more information about our dashboard and its functionalities, refer to the **Appendix**.

## Methodology

To evaluate our intervention, we propose a matched pairs experiment. The control group receives the HES as is currently presented. Because our dashboard incorporates multiple interventions, we want to test each intervention. Consequently, our treatment group is divided into three sections: one with access to the full dashboard (**Figure 1**), one with access to the messaging (**Figure 3**), and one with access to the goal setting (**Figure 4**).

We propose conducting the study in Portland, Oregon, because in January 2018, Portland adopted a policy making the HES mandatory for sellers of single-family homes. Targeting cities with mandatory policies means our study has a larger, more easily accessible sample. Once the pilot study is completed, the study can expand to Berkeley, California, Austin, Texas, and Boulder, Colorado, which have similar policies.

As the program expands, homeowners will be randomly assigned to a control or treatment group. Every three months for a year following the assessment, participants will take a survey to assess the homeowner's: a) understanding of, b) opinions of, and c) behavioral changes in response to the HES (**Figure 5**). From the survey, a composite score will be calculated to reflect the user's overall "interaction" with the HES. The interaction scores and dashboard engagement analytics will be compared between the control and treatment groups across households with the same initial HES. A threat to this method is the risk of non-response. Potential solutions to address this include email reminders about the survey and possibly for the DOE to subsidize the HES to study participants, conditional on their completion of the surveys.

According to the Portland Tribune, 2,036 homes have been scores since implementation of the HES policy. We use this to estimate the size of our sample population:

Control: 1018

Messaging Treatment: 339

Goal Setting Treatment: 339

Full Dashboard Treatment: 340

## Data

The primary data in our dashboard comes from the HES report and information from the DOE on specific products and appliances. Our dashboard will collect a range of data, including demographic and investment/upgrade information, from homeowner inputs. The survey will provide feedback on upgrades and qualitative data on participants' opinions of the HES. With this information, the DOE can study general receptiveness to the score and track patterns in investment behavior across demographic groups. Lastly, dashboard analytics will be collected to track user engagement, which serves as a metric to measure how often users actually interact with the intervention.

## Impact

In the short run, the dashboard will help homeowners understand their score. This will help legitimize the score to homeowners, which is a crucial step in making the HES relevant in the real estate market. The dashboard will also help homeowners identify specific improvements and investments to increase their score. We expect that this access to easily digestible and interactive information will alter the habits of homeowners while educating them on the specifics of the HES.

In the long run, the dashboard will help reduce information asymmetry in the real estate market by educating homeowners. The more engaged and knowledgeable homeowners are about the HES, the more useful it will become for both parties in the real estate market. This will aid in expanding the HES program and formalizing the HES as a variable that influences prices in the real estate market. Lastly, our intervention has the potential to significantly reduce carbon emissions. We project that if the Portland homeowners in the treatment groups of our study, on average, reduce their HES

by two points, this will lead to a monthly CO2 emissions reduction of 424,000 pounds. As the HES initiative expands, this could potentially generate a monthly reduction of almost 7,000,000,000 pounds of CO2 (EPA Household Carbon Footprint Calculator).

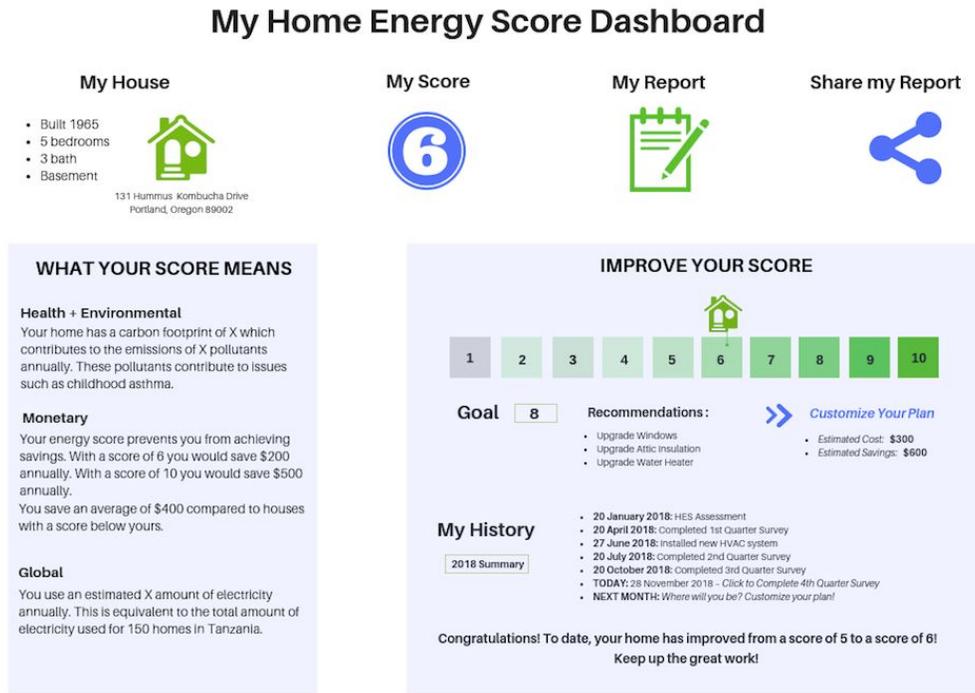
## Sources:

- American Council for Energy-Efficient Economy (ACEEE). “The Impact of Federal Energy Efficiency Programs.” 2018. <https://aceee.org/sites/default/files/pdf/fact-sheet/impact-federal-ee-programs.pdf>.
- Asensio, Omar Isaac and Magali A. Delmas. “The effectiveness of US energy efficiency building labels.” Nature Energy, 2017. <http://www.asensioresearch.com/uploads/1/2/8/8/12883280/nenergy201733.pdf>.
- Brounen, Dirk, and Nils Kok. “On the economics of energy labels in the housing market.” Journal of Environmental Economics and Management, 62, 166–179, 15 April 2011. [https://ac.els-cdn.com/S0095069611000337/1-s2.0-S0095069611000337-main.pdf?\\_tid=ca647fa6-7f35-4ddd-b088-f5e3d1cd1742&acdnat=1543345704\\_6a474fd2d0e3692c6fb608ddef3c8aa5](https://ac.els-cdn.com/S0095069611000337/1-s2.0-S0095069611000337-main.pdf?_tid=ca647fa6-7f35-4ddd-b088-f5e3d1cd1742&acdnat=1543345704_6a474fd2d0e3692c6fb608ddef3c8aa5).
- Dietz, Thomas, Gerald T. Gardner, Jonathan Gilligan, Paul C. Stern, and Michael P. Vandenbergh. “Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions.” Proceedings of the National Academy of Sciences of the United States of America, 106(44), 18452–18456, November 2009. <http://doi.org/10.1073/pnas.0908738106>.
- Delmas, Magali and William Kaiser. “Behavioral responses to real-time individual energy usage information: A large scale experiment.” March 2014. <https://www.arb.ca.gov/research/apr/past/10-332.pdf>.
- Harding, Matthew and Alice Hsiaw. “Goal setting and energy conservation.” Journal of Economic Behavior & Organization, Volume 107, Part A, November 2014. [https://ac.els-cdn.com/S0167268114001176/1-s2.0-S0167268114001176-main.pdf?\\_tid=c395aaa0-ed3e-45be-861a-00bbe103617b&acdnat=1543278521\\_5bbf26d23c15abe126fae3d53fc0fed8](https://ac.els-cdn.com/S0167268114001176/1-s2.0-S0167268114001176-main.pdf?_tid=c395aaa0-ed3e-45be-861a-00bbe103617b&acdnat=1543278521_5bbf26d23c15abe126fae3d53fc0fed8).
- Kahn, Matthew E. and Nils Kok. The capitalization of green labels in the California housing market. Regional Science and Urban Economics (47), 25-34, July 2014. <https://doi.org/10.1016/j.regsciurbeco.2013.07.001>.
- Shelton Group. Energy Pulse 2017. Jump into STEM Round 1 Webinar 2, 2018. <https://sheltongrp.com/>.
- Zheng, Siqi, Jing Wu, Matthew E. Kahn, and Yongheng Deng. “The nascent market for “green” real estate in Beijing.” European Economic Review, 56, 974–984, 3 April 2012. [https://ac.els-cdn.com/S001429211200030X/1-s2.0-S001429211200030X-main.pdf?\\_tid=74c5b877-1589-42d3-8c0e-837b2d8e5b78&acdnat=1543345706\\_525cbeea81dee8f5f7b781c46a735385](https://ac.els-cdn.com/S001429211200030X/1-s2.0-S001429211200030X-main.pdf?_tid=74c5b877-1589-42d3-8c0e-837b2d8e5b78&acdnat=1543345706_525cbeea81dee8f5f7b781c46a735385).

# Appendix

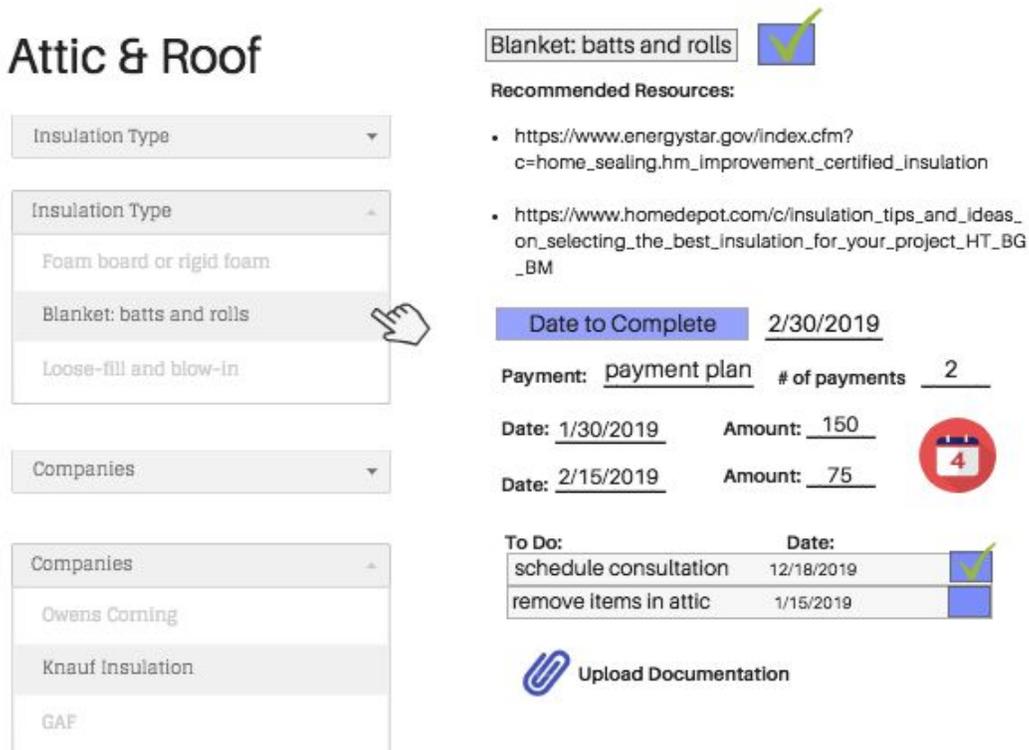
**Figure 1. Treatment Group 3 HES Dashboard.**

Below is a sample layout of the dashboard given to treatment group 3 of our experimental design. This dashboard includes both intervention types (messaging and goal setting via progress tracking).



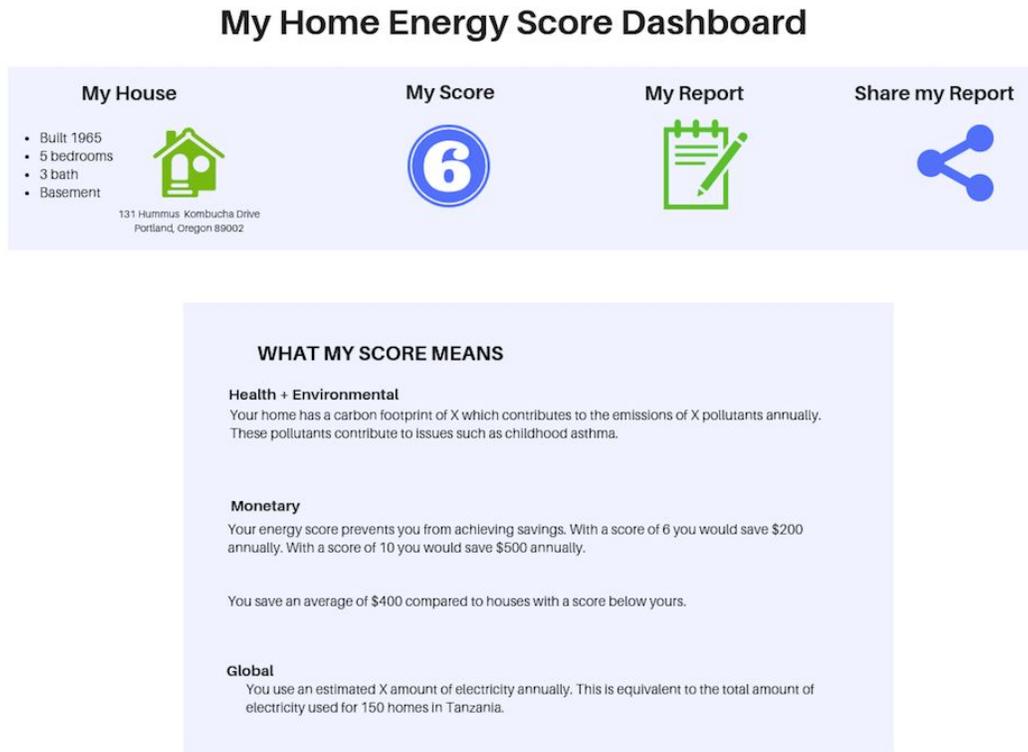
**Figure 2. Sample “What If” Tool.**

Below is an example of the “what if” tool for improvements, which is part of the goal setting feature of our dashboard. This allows homeowners both to see potential gains from upgrades and to set concrete goals for home improvements.



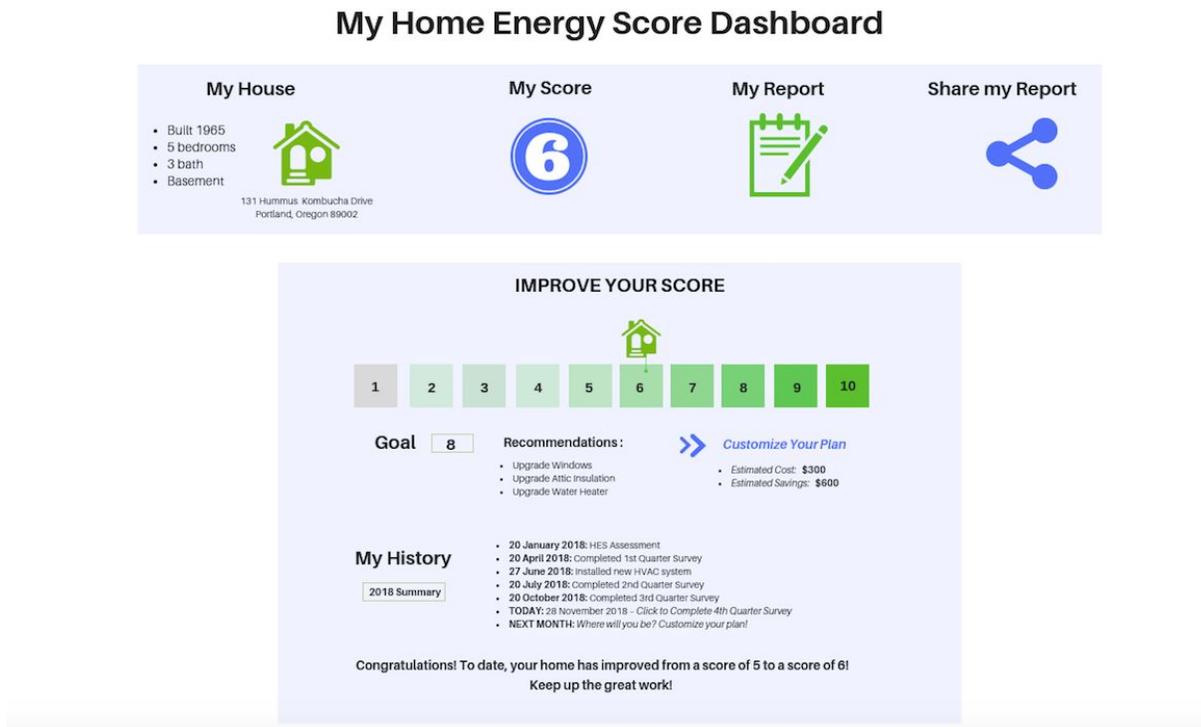
**Figure 3. Treatment Group 1 HES Dashboard.**

Below is a sample layout of the dashboard given to treatment group 1 of our experimental design. This dashboard includes only the messaging intervention.



**Figure 4. Treatment Group 2 HES Dashboard.**

Below is a sample layout of the dashboard given to treatment group 2 of our experimental design. This dashboard includes only the goal setting intervention.



**Figure 5. Quarterly Homeowner Feedback Survey.**

Below is a sample layout of the survey that will be distributed to all participants in our study. This survey will collect information on the level of understanding of the HES, opinions of the HES, and behavioral changes in response to the HES.

<p style="text-align: center;"><b>Home Energy Score Feedback Survey</b></p> <p>1. On a scale of 1 = "Very little understanding" to 10 = "Complete understanding," how well do you understand your Home Energy Score?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p> <p>2. Do you understand what the HES measures?</p> <p style="text-align: center;">Yes                      No</p> <p>3. On a scale of 1 = "Not useful" to 10 = "Extremely useful," how useful do you believe the HES is to your understanding of your home's energy efficiency?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p> <p>4. On a scale of 1 = "Not useful" to 10 = "Extremely useful," how useful do you believe the HES is to communicating your home's value?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p> <p>5. If/when you sell your house, will you disclose your HES in the listing process?</p> <p style="text-align: center;">Yes                      No</p> <p>6. Why or why not?</p> <p>A. Not important</p> <p>B. Unhappy with score</p> <p>C. Hard to explain score</p> <p>D. Other: (please specify)</p> <p>7. On a scale of 1 = "Little understanding" to 10 = "Complete understanding," how well do you understand changes you can make to improve your Home Energy Score?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p> <p>8. Has your Home Energy Assessment influenced your decision to make any investments to make your home more energy efficient?</p> <p style="text-align: center;">Yes                      No</p>	<p>9. If yes, how impactful, from 1 = "Not impactful" to 10 = "Very impactful," was the dashboard in helping you decide which changes to make?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p> <p>10. Since the past survey or the initial HES assessment how many changes/investments have you made to your house's assets/infrastructure? Number range from 0 plus.</p> <p><b>** FOR TREATMENT 3 ONLY</b></p> <p>11.. How useful, from 1 = "Not useful" to 10 = "Very useful," were each of the following components of your HES dashboard?</p> <p style="text-align: center;">What My Score Means?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p> <p style="text-align: center;">How Can I Change My Score?</p> <p style="text-align: center;">1   2   3   4   5   6   7   8   9   10</p>
---	---