Behavioral Perspectives on Home Energy Audits: Executive Summary

The Role of Auditors, Labels, Reports, and Audit Tools on Homeowner Decision-Making

Aaron Ingle, Mithra Moezzi, Loren Lutzenhiser, and Zac Hathaway
Portland State University

Susan Lutzenhiser, Joe Van Clock, and Jane Peters
Research Into Action

Rebecca Smith and David Heslam
Earth Advantage Institute

Rick Diamond
Lawrence Berkeley National Laboratory

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DISCLAIMER

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Executive Summary

Overview

During 2010 and 2011, thousands of news articles promoted the potential benefits of home energy audits and of subsequent energy efficiency improvements, signaling a resurgence of interest in motivating homeowners to assess and upgrade their homes. An increasing number of home energy audit programs were already underway in the United States, and auditors, utilities, and others learn from these experiences, and continue to try to design more effective audits, pitches, and programs, as they have for more than thirty years (e.g., Hirst et al. 1981; Van de Grift and Schauer 2010)—since the advent of home energy audits in the 1970s.

These home energy audits have generally been designed to overcome what the industry commonly considers "barriers" to increasing home energy efficiency, in particular the perception that homeowners do not have enough information about what to do to increase the energy efficiency of their homes or to solve performance problems, nor about the prospective advantages of these actions. Home energy audits are furthermore sometimes used to generate an energy score to inform potential home buyers about energy efficiency and thereby influence the overall housing stock, to qualify homes for energy efficiency financing, mortgages, loans, or incentives, and to diagnose home energy performance problems.

Despite success stories (e.g., Van de Grift and Schauer 2010), the results of home energy audit programs overall have often been considered disappointing: relatively few households undertake audits, and when they do, upgrade recommendations are often not acted upon (Frondel and Vance 2011; Fuller et al. 2010; Palmer et al. 2011). And though there is clearly remaining technical potential, little has been proven about the overall energy savings that result from audits and resulting upgrades, nor the extent to which actual social potential can reach technical potential. Rather than continue to ask why homeowners do not act as theory suggests they should, this research turns the lens more toward homeowners' views and experiences. A clearer, more open understanding of these views and experiences may help expectations for home energy audits better align with what is likely to be achieved.

Our study focused on the perspective of homeowner decision-making in response to home energy audits, *combined with* attention to the quality of the recommendations that homeowners receive, as well as the perspectives of some key industry actors on auditing and home energy labels. Unlike a program evaluation, the research was not designed to answer detailed questions about program effectiveness in terms of costs, savings, or process, nor was it designed to provide direct answers to questions of how to get people to do more audits or more retrofits. Rather it "steps back" toward a better understanding of more basic questions about what audits provide and what homeowners seem to want, for the case of one particular program that we expect has parallels to many others.

In this report, we present the results of a study for the U.S. Department of Energy, applied to an existing home energy audit program and pilot offered by Seattle City Light, the electric utility for the City of Seattle. Portland State University, Research Into Action,

and Earth Advantage Institute worked together with Seattle City Light and the Lawrence Berkeley National Laboratory to complete the research project. From mid-2010 to late 2011, approximately 1,350 home energy audits were completed in Seattle as part of Seattle City Light's program. These audits, and the homeowners who received them, are the subject of our report.

The research reported here was designed to advance the field's knowledge on what homeowners want and get from home energy audits. It did so by simultaneously studying multiple dimensions of these audits, including: physical characteristics of the houses audited, the energy use estimates and upgrade recommendations these audits offered to homeowners, actual energy use data, self-reported retrofit activity and energy use behaviors, physical assessment of the quality of the retrofits undertaken, viewpoints of both auditors and realtors on various key program elements, and—centrally in tying these streams together—homeowner motivations and reactions to the audits, what they consequently changed, and what they thought about the results. These data were used to address gaps in knowledge about home energy efficiency upgrades and audits, including:

- Homeowner decision-making processes in planning and undertaking energy retrofits, reactions to home energy performance scores, and satisfaction with the audits performed;
- Differences and similarities between home energy assessment and retrofit recommendation tools;
- Importance of household energy behaviors relative to house- and equipment-based assessments of home energy performance and upgrade recommendations; and
- Industry views on the current and potential future use, and usefulness, of home energy performance ratings in general.

While we collected as much as 18 months utility consumption data for these households, the post-retrofit period was typically only 6 months, which was not sufficient to statistically test the degree of energy savings associated with audits and upgrades.

Seattle City Light's Home Energy Audit Program

In 2010, Seattle City Light began a program offering Seattle City Light customers owning single-family homes a $400 home energy audit for a discounted rate of $95, with an objective of reaching 5,000 households. These home energy audits used BPI-certified auditors, diagnostic testing, asset-based energy modeling, and an auditor-customizable report featuring an asset rating of the house's energy and carbon use, upgrade recommendations, and the energy performance details of the house. Earth Advantage Institute's EPS Auditor modeling and reporting software tool was used for these audits.

The Seattle City Light program provided an assessment of the whole house, including attic, walls, windows, foundations, water heating, ducts, and heating and cooling system(s), as well as measurements of air leakage, combustion safety checks, and, when

feasible, infrared thermal imaging. The in-home portion of these audits took 3-4 hours,[1] during which time the audit recipient had to be at home. Upon completing the technical measurements, auditors typically talked with homeowners about initial findings, following up later with an e-mailed Energy Performance Score (EPS) Energy and Carbon use Scorecard, and a report with detailed findings from the audit. The report included a standardized set of recommendations, selected by the auditor from a list provided in the EPS Auditor tool, which provided homeowners with a range of estimated costs and savings, and covered a fixed set of categories including air sealing, duct sealing, insulation (ceiling/attic, floor, wall, and ducts), appliances and lighting, heating and cooling systems, water heating, windows, and others. Additionally, Seattle City Light encouraged auditors to customize the report with information on the current conditions of the home and with customized recommendations for the homeowner; 75% of reports contained these auditor customized recommendations, and in most of these, the recommendations were prioritized.

The Seattle City Light Home Energy Audit Program was not designed to maximize participation, was not heavily marketed, and was not intended to closely tie in various wrap-around elements that are known to help boost upgrade completion, such as financial incentives, direct links to contractors, or providing "energy advisors" or "energy advocates" to help homeowners through the process (see, for example, Van de Grift and Schauer 2010). Rather, the Seattle City Light program represents a fairly evolved home energy audit program that provides homeowners with a lot of information, a detailed assessment of the energy characteristics of their home from an asset perspective, and high quality, well-trained, and often quite experienced auditors. Thus the research goals and the program itself complement each other quite well.

Description of Research Methods

To inform this research, we talked to nearly 300 different households that had received the Seattle City Light home energy audits. We collected 12-18 months of utility data, both gas and electric, for approximately 250 homes, extensive data on the technical characteristics for all 1,355 houses receiving an audit between June 2010 and October 2011, and self-reported data on energy behavior from 346 homes. We also obtained a follow-up set of data on the technical characteristics and upgrade measures for 50 homes where upgrades had been completed. In addition, we completed in-depth interviews with two key groups of stakeholders: home energy auditors and real estate professionals in Seattle. These data streams are detailed in Table 1 below.

[1] It typically takes the auditor about an hour to collect the measurements, other than the blower door test results, that are needed for the EPS score calculation (Earth Advantage Institute and Conservation Services Group 2009).

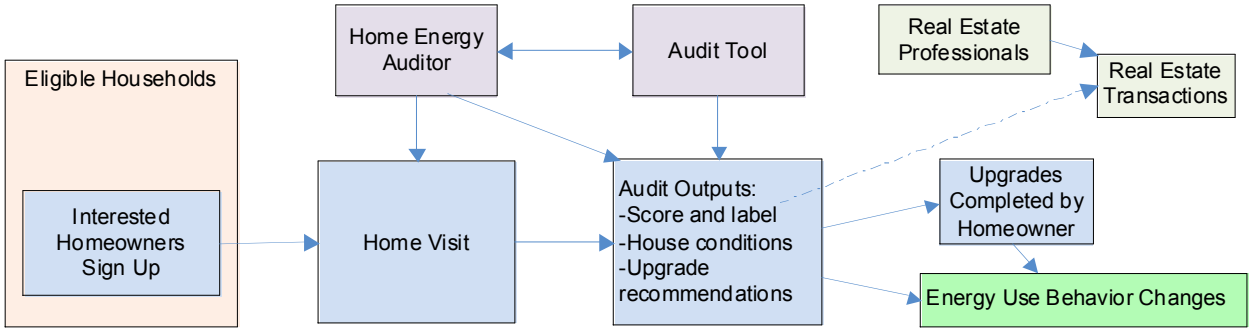
Table 1: Overview of research data streams

Source	Method(s) of data collection	Contribution
Homeowners and households	Phone interviews and surveys Mail and web-based energy use behavior surveys Electric and natural gas billing data provided by utilities	Homeowner perspectives on audits and upgrades Self-reported energy use behavior data, used in combination with house technical data to evaluate the importance of behavior relative to house and equipment factors in home energy performance Utility-reported energy use data for many homes
House	Technical house data collected by home energy auditors during the site visit Re-measurement (after upgrades were completed) of technical house data, and inspection of completed upgrades	Technical characteristics of the house Re-measurement of many technical characteristics of the house Details on the quality of completed upgrades
Home energy auditors	Phone interviews	Auditor perspective on homeowner decision-making, audit process, audit modeling tool, and program
Real estate professionals	Phone interviews	Real estate professional perspective on how home energy performance currently fits into the buying/selling process and how it could fit in the future
Home energy modeling tools	Model runs for a subset of audited Seattle homes, using the Home Energy Scoring Tool and Home Energy Saver-Pro, as well as emulators replicating these tools Results from the original EPS Auditor modeling that was completed for the audit reports	Scores, energy use estimates (total, by utility, and by end use), and upgrade recommendations from each of the tools

Summary of Major Findings

Figure 1 diagrams the home energy audit process and actors as involved in this program and in our research.[2]

Figure 1: Overview of the home energy audit process and associated actors included in the research



Major findings are presented topically below, approximately following the organization in the diagram.

Homeowner Circumstances and Motivation

Survey respondents included a variety of different demographic circumstances, but overall were wealthier, more educated, and older than typical for Seattle. The program was not widely advertised; less than 1% of eligible customers completed an audit. This underscores our overall impression, from talking to homeowners and auditors, that participants were often particularly interested in energy consumption or energy efficiency. The characteristics of the homeowners that were surveyed are consistent with reported participation in previous home energy audit programs (Sanquist et al. 2010). The extent to which results from studying participant populations should be extrapolated to apply to non-participants is a typical challenge of program-oriented research.

Overall, these homeowners appeared to be quite motivated and oriented towards completing upgrades when entering the program, though some may have been more "curious" than predisposed to complete upgrades. When asked, after their audits, about their motivation for signing up for the audit, homeowners expressed a variety of reasons for undertaking the audit that indicated a predisposition to upgrade, including a desire to reduce energy costs (26%), improve energy efficiency (23%), address comfort problems (13%), or contribute to environmental sustainability (10%). However, a substantial portion of homeowners (23%) appeared to be largely motivated by curiosity about how their home worked or by the discount on the audit cost; these homeowners may not have been oriented to making a big investment. Nearly three-fourths of the homeowners had already done some energy upgrades to their home; many of these were looking for what to do next, though some wanted to figure out why they were not saving as much from those upgrades as they expected.

[2] We did not investigate real estate transactions directly; rather, we asked real estate professionals about their views on the current and prospective roles of energy and carbon scores, and energy efficiency more generally, in the residential real estate transactions.

For the mostly middle-to-upper income households receiving these audits, "financing" was not stated as a major consideration. Interviews early in the audit process indicated that most households would pay out of pocket for any upgrades they would complete. Surveys after retrofits had been completed bore this out: few respondents reported taking out a loan to pay for the energy upgrades they had completed. Rather, most (83%) said they used cash or savings, and most of the rest said they paid for the work with credit. Those who took out a loan said that they had spent at least $10,000, some much more, while some paid cash even for jobs over $10,000.

Audit Site Visit—The Homeowner Experience

The auditor was integral to the homeowner's overall reaction to the audit. Many homeowners identified the importance of face-to-face discussions with the auditor, and appeared to be energized by the auditor's enthusiasm. Homeowners frequently reported that the discussion with the auditor at the end of their visit was the most informative part of the whole process. The audit site visit was designed to allow time for these interactions. Conversely, a few households felt that their auditor was not sufficiently oriented to their own circumstances. For many households, the home energy audit may be more about interactions with the auditor than the report or detailed calculations. However, the auditor's role typically ended with the delivery of the audit report and response to any follow-up questions—auditors reported limited post-audit follow-up, in line with the Seattle City Light program design.

Blower door testing and infrared thermography seemed particularly compelling to the homeowner, and may have motivated higher levels of weatherization and local air sealing, and possibly led some homeowners to think of energy use in their homes in a different and more sophisticated way. These diagnostic techniques make invisible energy flows and leakage problems tangible and offer a good spectacle. Also, after upgrades are completed, blower door and combustion safety testing provide useful checks to make sure that upgrades resolve—and do not create—health and safety problems.

How Scores Were Perceived

While program-participant Seattle homeowners found their home energy performance scores to be interesting, only a fraction of the audit participants appeared to be drawn by the opportunity to get an energy or carbon rating for their home. Less than half of the interview respondents said that they knew they would receive such a rating, and the rating may not have played a strong role in the *marketing* of these audits. The homeowners we talked to did not necessarily represent typical consumers of home ratings or scores, as the majority were not planning on selling their home in the near future. Instead, they tended to be more interested in how their home actually uses energy rather than seeing energy efficiency as a more abstract attribute of the house. Still, auditors thought the scores helped the homeowner make sense of their report. Seattle City Light's program design was a deliberate balance of providing a comparable asset-based home energy score with a report providing more tailored recommendations for upgrades.

When asked to imagine that they were buying or selling a home, Seattle respondents familiar with the scores, after receiving an audit, consistently expressed an interest in seeing the scores of homes they were thinking about buying (95%). Respondents also

indicated that they would be willing to share their home's score with potential buyers (82%). However, these homeowners were rarely currently involved in selling their home or buying a new one, so the real estate context for this use of the scores was hypothetical.

When asked about the home purchase or sales process, real estate professionals saw qualified potential for ratings to provide information useful for the home buying decision. The real estate professionals we interviewed expressed concern that efficiency is not generally an advantage for existing homes compared to new homes, and also distinguished between marketing the energy efficiency features of a home and marketing the efficiency of the home as a whole.

How Reports and Recommendations were Perceived by Homeowners

Auditors often provided extensively customized upgrade recommendations and other audit report content, and were encouraged to do so by Seattle City Light and by the audit report format. Homeowners appreciated the customization, and those who received the auditor customized recommendations were more likely to complete more upgrades than those who did not. Auditors frequently developed this separate list of recommendations, tailored to what they perceived as the needs of the homeowner, and also often including a personal note to the homeowners. 75% of respondents to one of the surveys received this type of list, and in two thirds of these lists the recommendations were prioritized.

Still, many homeowners expressed the desire for more information and guidance from the reports. Some homeowners expressed an interest in getting more recommendations, particularly achievable, low-cost suggestions, or a greater level of detail on their home's issues, such as inclusion of infrared photos and other testing results. Some homeowners asked for more practical support on how to complete recommended upgrades, or more information on what upgrade subsidies or other financing incentives are available. A few households felt that the recommendations they received were too standardized, or not actionable for various reasons. Conversely, some homeowners said that the report was too detailed—indicating that not all homeowners necessarily wanted the same information from their audit.

The audit reports that homeowners received often gave very broad ranges for cost and savings estimates, which led to frustration for some auditors and homeowners. On the other hand, broad ranges may be more reflective of real modeling uncertainty than point estimates would be. In some cases the ranges provided to Seattle homeowners may have been unnecessarily broad (e.g., encompassing saving nothing and saving all end use costs). Still, both auditors and homeowners often found the estimates useful as a starting point, and doing without them does not seem to be a credible option. Typically, the EPS audit report provides a single number for the estimated fuel use after upgrades and for the approximate annual savings in dollars. However, the audit report implemented for Seattle City Light provided ranges instead of a single number for estimated fuel costs after upgrades and for the approximate annual savings in dollars after upgrades.

Upgrades Completed after the Home Energy Audit

Homeowners seemed to prefer actionable, do-it-yourself, problem-solving, interesting, and lower-cost upgrades, though some households did bigger upgrades, too. In

particular, homeowner action seemed focused on solving problems—such as plugging leaks or fixing safety problems—as compared to more abstract, less-visible, energy efficiency upgrades. In addition, these types of problem-solving upgrades may be easier to complete for many households. Of the homeowners we talked to at our latest survey point—an average of 8 months after the audit—43% said that they had not yet completed any recommendations, although many of these (67%) and many of those who had completed at least one recommendation (52%) still had plans to do upgrades in the future. Homeowners often cited costs, weather, family schedules, and waiting to bundle the job with other improvements as reasons for waiting, as well as, especially for white goods, waiting until appliance end of life. Nearly three in every four homeowners said that they had *already* completed upgrades prior to their audit—possibly leading to a reduced set of compelling retrofits remaining for auditors to recommend and homeowners to complete.

The blower door and infrared thermal imaging offered to participants seemed to make air sealing recommendations particularly appealing, based on our discussions with survey participants, while insulation upgrades, particularly wall insulation, were completed less, often due to expense, disruption, and technical challenges. Appliance upgrades appeared to be more a function of whether the appliance otherwise needed replacement. The most common recommendation provided to homeowners was air sealing (89%), and following that was attic insulation (71%). Sixty percent received a recommendation to replace their dishwasher, refrigerator, or washing machine. Over half of audited households also received recommendations to insulate walls (61%) or install a high efficiency or tankless water heater (54%). Less frequent, but still common, were recommendations to seal or insulate ducts, to replace the heating system, to insulate the floor, or to add storm windows or high efficiency windows.

We conducted a post-retrofit assessment of 50 households who had completed upgrades, in order to assess the quality of the upgrades that had been completed. Based on this sample, upgrades that homeowners completed generally appeared to be of good quality. Where quality issues were found, these mostly reflected a lack of attention to detail or missed opportunities in air sealing or insulation—some attributed to contractors and some attributed to do-it-yourself upgrades. For these homes, the potential benefits from upgrades—energy, comfort, or otherwise—do not appear to have been substantially degraded by implementation. Also, two safety issues were found after upgrades—one home where replacement of suspect equipment failed to resolve the combustion safety issue found in the original audit, and another home whose rate of air leakage dropped below 0.35 ACHn (natural air changes per hour) after upgrades. These two cases (4%), while unusual in this sample, highlight that there are risks inherent to completing energy upgrades that can potentially be mitigated by "test-out" diagnostic assessments (after retrofitting work has been completed).

The primary tangible short-term benefits homeowners received from completed upgrades may often differ from their stated motivations for completing upgrades. At the time of the Retrofit Survey, three-quarters of the homeowners who had completed upgrades expressed satisfaction with them, and reported improved comfort in their house along with the expectation of long-term cost and energy savings, a sense of accomplishment, and occasional co-benefits such as reduced street noise, reduced dust,

and improved protection against pests. Less than half of these households indicated that they had noticed some (30%) or a lot (10%) of energy savings, while others reported that it was too early to tell (11%). A few expressed disappointment with the lack of energy savings. This differs somewhat from the reasons homeowners gave for completing the upgrades they did—which focused first on cost and energy savings (67%), and secondarily on comfort (28%) and other motivations. For most households, the study period covered only 6 to 12 months after the audit, so we could assess only short-term rather than longer-term reactions to the audits and upgrades. Gathering follow-up utility data would enable assessment of the energy savings from these upgrades.

Changes in Energy Use Behaviors

Though the audits as formally designed addressed homeowner behavior only peripherally, a quarter of respondents reported that their household changed their energy use behaviors in reaction to the audits. For these asset-based audits, behavior change was not a major objective of the audit, though some recommendations for behavior change were included in "no or low-cost strategies" portions of the home energy audit report. In addition to conservation-oriented changes in household energy management, a second type of behavior change could potentially occur in response to technical changes in the home, e.g., increasing thermostat set-points once a more energy-efficient furnace is installed. Few homeowners mentioned this kind of behavior change, including take-back effects, though accurate tracking of behavior change is notoriously difficult to achieve.

Modeling Tools—Scores and Recommendations

Using a circumscribed set of model inputs, we found that EPS Auditor and the Home Energy Scoring Tool gave energy use estimates that were reasonably consistent with each other—for a set of homes modeled in both tools. This finding provides support for the idea that different asset tools can generate comparable asset scores or ratings for houses, especially when using a similar scope of inputs and similar assumptions regarding occupancy and energy use behaviors. There is no consensus on what energy uses are "in scope" or what occupancy and energy use behavior assumptions to use in asset modeling and scoring tools. While the assumptions used to represent "standard occupant behavior" differed somewhat between EPS Auditor and the Home Energy Scoring Tool at the time of the analysis, the model estimates still coincided reasonably well. Also, our analysis did not consider sources of variation in model results, such as auditor measurement and interpretation differences, while the limited model inputs we used likely caused model estimates to be somewhat more consistent with each other than they would otherwise have been if we had a full set of model inputs available for the Home Energy Scoring Tool.

For a small set of homes, we compared the upgrade recommendations generated by auditors using EPS Auditor with recommendations we generated for the same house using the Home Energy Scoring Tool. Despite the consistency in modeled energy use estimates noted above, the upgrade recommendations, costs, and savings estimates were quite different between these two asset-based tools. That is, a homeowner would

be likely to receive different recommendations from an audit using EPS Auditor than from an assessment using the Home Energy Scoring Tool. We have no basis to determine whether either approach gave "better" recommendations by any particular criteria, and assessing the source of these differences, e.g., cost-effectiveness criteria or cost assumptions, was beyond the scope of our analysis. The auditor-customized recommendations also provided with most Seattle City Lights audit reports were not included in this comparison.

For 101 homes, we compared audit modeling tool estimates of total energy use to utility-reported energy consumption. While the tools that we considered estimated group-average energy use moderately closely, we found large differences between individual model estimates and reported usage for many homes, with larger differences for asset-based model estimates than for estimates that included inputs on occupancy and basic energy use behaviors. Asset-based tools, e.g. EPS Auditor, used for these Seattle audits, and the Home Energy Scoring Tool, do not consider occupancy and household energy use behaviors beyond applying standardized assumptions, and are not necessarily intended to reliably predict actual energy usage. However, these tools do use model-generated usage estimates to select upgrade recommendations or to calculate upgrade savings estimates. Homeowners using these savings estimates for upgrade decisions risk being misinformed if models significantly over- or under-estimate the savings they would see from completing upgrades. For EPS audits, personal interactions with the auditor and their customization of the report may often overshadow, or qualify, this model-generated guidance.

Conclusions

Our research on home energy audits underscored the importance of a shift toward homeowner perspectives, requiring more than simple repackaging of energy efficiency, but rather fuller appreciation of the position of the homeowner and the personal nature of homes. We see the potential for policy makers and the home energy audit industry to better meet the needs and desires of homeowners for comfortable, healthy, and energy-efficient homes. This shift will not be easy, but based on the findings from this project, we have recommendations for going forward.

First, in the Seattle audits we examined, the auditor appeared to often function as an expert agent and advisor, and seemed to have an important influence on what homeowners did or did not do. Compared to presenting homeowners with standardized recommendations selected solely on estimated costs and energy savings, skilled auditors may provide critical additional value by being better able to judge the multi-dimensional nature of home energy upgrades—comfort, hassle, risk, safety, reliability of savings estimates, the present circumstances and plans of the homeowners, and so on—than software can, while perhaps offering inspiration and personal guidance to the homeowner.

Second, an asset orientation may not align with all existing homeowners' interests and positions. The majority of homeowners we surveyed and interviewed were not planning on selling their home in the near term and were seemingly more interested in making home improvements, wanting specific upgrade advice toward improving their own living conditions rather than for directly affecting the market value of their home. Interviews

indicate that people who are motivated to (or have already decided to make changes) but just want to know what to do, were less likely to be motivated by the EPS score itself than those seeking to compare their home to others. Seattle City Light anticipated as much and it is for this reason that they designed a program that tested homeowners' reception of an asset rating along providing an audit report with customized recommendations. The asset-based home rating was interesting enough to most homeowners, and is something that almost all claimed they would want to see when buying a home or reveal when selling a home.

Few of the homeowners we spoke to were planning on selling their home anytime soon; upgrades appeared to be mostly about improving their living conditions in their home. More important, in assuming standardized usage of the home, asset-based recommendations and cost and savings estimates may be quite different from what would be recommended if how the homeowner actually used the home were considered. Household use of energy is highly variable. Good recommendations for frugal users, for example, may be much different than for those of liberal users. Our modeling results indicated that taking actual use—whether through bills or through operational data—into account might lead to important changes in recommendations and savings estimates, as others have also noted (e.g., Khawaja and Koss 2007). Additionally, some homeowners seemed interested in receiving advice on their energy use behaviors and operation of the home. Operationally-focused audits could provide the opportunity for providing this type of specific advice, e.g., when to use a portable heater rather than the central heater, how much they could save by turning down the heat at night, or how much energy a given appliance uses.

Third, those who undertook upgrades seemed pleased with them, although the non-energy benefits seemed often more tangible and may outweigh energy- and money-saving benefits, at least in the short term. While reductions in utility bills due to upgrades are difficult to positively identify given the natural variability in utility bills, so are they difficult to disprove. Therefore, homeowner satisfaction is not necessarily an indicator that actual energy savings met homeowner, or program, expectations. The utility consumption data we collected was not sufficient to statistically test the degree of energy savings.

Fourth, the group of surveyed homeowners tended to be considerably higher-income and more highly educated than other homeowners in the area, but there were still substantial differences in household characteristics and in what various homeowners appeared to want from audits. While many expressed sentiments in alignment with typical program promotion, e.g., energy efficiency, many did not. Other participants seemed to be interested in diagnosing and solving concrete problems such as high bills or comfort issues, or in shaving off monthly costs. Many auditors appeared to tailor their discussions to the wants and needs of homeowners, as they perceived them.

Finally, this research drew upon a generally aware, enthusiastic, often highly-educated, and affluent slice of Seattle homeowners—those voluntarily seeking out a home energy audit and who were subsequently willing to talk to us at length. People who do not sign up for a home energy audit may behave quite differently. If home energy audits are to be expanded, there is a research need to look at the circumstances and expectations of

households who do not currently participate in home energy audit programs, and to understand their goals and decision-making rationales.

By many criteria, the home energy audit program conducted in Seattle led to successful outcomes, with participants indicating that they were pleased with their involvement in the program. In many instances, these audits have led to quality upgrades that improve the condition of participants' homes, and they may have led to lower energy consumption in upgraded homes.

What we do suggest, however, is that in planning home energy audit programs in general, it is useful to consider how much of what is being offered makes good sense to potential participants. This perspective requires taking a more home- and owner-centered view than programs appear to typically adopt. It may also mean a harder look at the influence of personal interactions with a trusted expert such as an auditor or energy advisor, the quality, accuracy, and customization of the guidance being offered, in what cases diagnostic testing is warranted, and when are asset or operational assessments most useful. Of course, homeowners do not necessarily know what is possible or what will inspire them, and certain elements—the auditors themselves, or the blower door test—may sometimes be transformative.

Our findings suggest several open questions that, if better understood, could help home energy audits and assessments better speak to households:

- How much energy are upgrades saving, and how does this compare to what energy models estimate and what households expect?
- Could research pursuing household segmentation with respect to home energy efficiency be used to refine home energy audits to better meet homeowner (and non-homeowner) needs? Are one-size-fits-all programs a suitable solution or are tailored programs more appropriate?
- Do home energy audits provide a viable opportunity for providing households with specific guidance on how to operate their home and optimize their energy use behaviors?
- How much effect does variability in auditor measurements and interpretation of homes, as well as data entry error, have on scores and on the tool-generated upgrade guidance provided to audit recipients, with what implications?

We are optimistic that research in these topics—and others—will strengthen policies and programs to help deliver the best home energy audits possible and to further support efforts to achieve homes that provide good indoor environments and reduced energy use.