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### How well do home energy audits serve the homeowner?

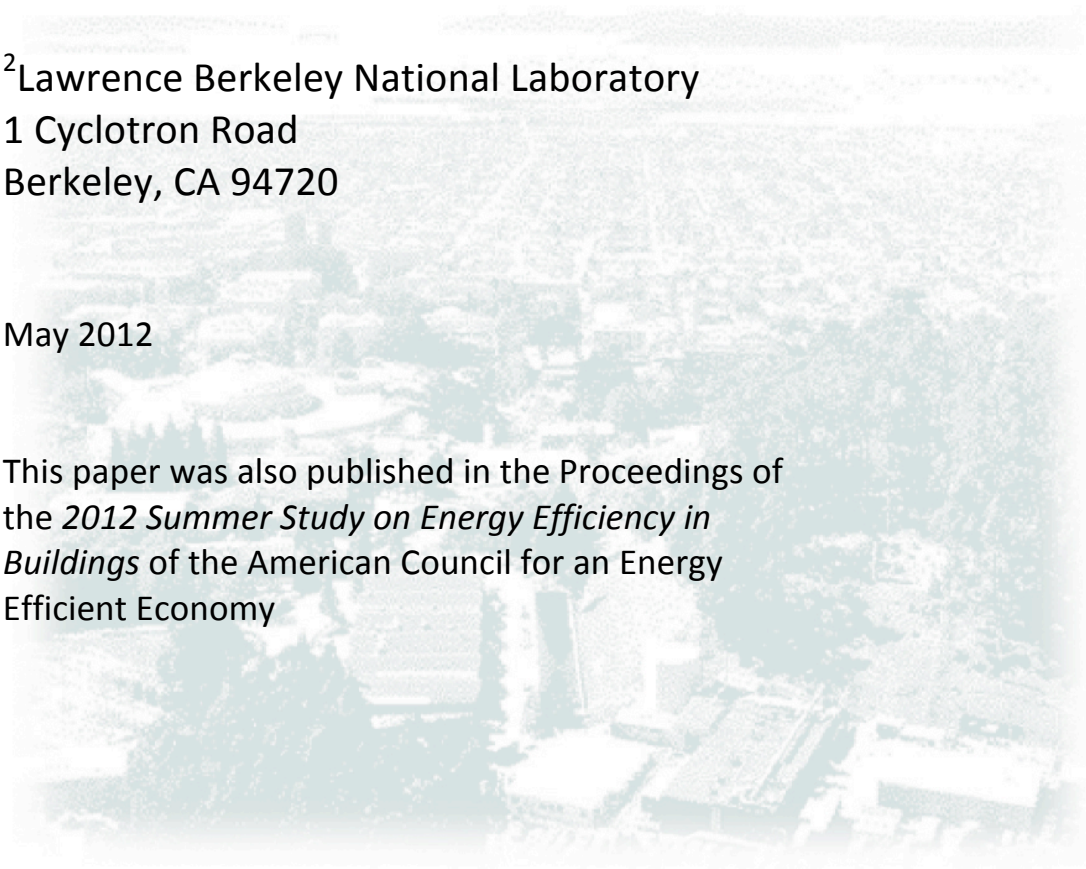
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May 2012

This paper was also published in the Proceedings of  
the *2012 Summer Study on Energy Efficiency in  
Buildings* of the American Council for an Energy  
Efficient Economy



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## **Acknowledgements**

The authors would like to thank Rafael Friedman, PG&E, for his thoughtful guidance on an earlier draft of this report, as well as two anonymous reviewers who sharpened our wits and pencils with their provocative comments. We also want to acknowledge our colleagues who contributed to the larger study of which this paper is a small part. They include Susan Lutzenhiser, Joe Van Clock, Jane Peters, *Research into Action*, and Rebecca Smith and David Heslam, *Earth Advantage Institute*.

This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Building Technologies Program of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

# **How Well Do Home Energy Audits Serve the Homeowner?**

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## **ABSTRACT**

Home energy audits administered by utilities and government typically provide homeowners with lists of technical upgrade recommendations intended to increase the technical energy efficiency of the house. Audits proceed with assessment of physical characteristics, subsequently processed with a computational model and transformed into a report, sometimes customized by the auditor. While the design of an energy audit reflects program and policy points of view – balancing program cost with expected program savings, educating people about the value of energy efficiency, etc. – it is crucial to consider the criteria for a good home energy audit and recommendations from homeowners' points of view. How well do home energy audits currently meet these criteria? How well do asset-based assessments match what homeowners seem to want? We consider these questions based on a study of 286 homeowners who participated in a Seattle City Light home energy audit program. Findings suggest that there is substantial opportunity to reorient audit programs to better fit the realities of why homeowners undertake energy audits and retrofits. In the Seattle City Light program, participating homeowners found certain elements of the audit they received – interaction with professional auditors, blower door testing, and customized, specific upgrade recommendations – to be more compelling than the standardized and quantitative elements. Rather than being engaged with increasing energy efficiency, as invited by an asset perspective and asset-based efficiency scores, homeowners wanted to build better understanding of their home's energy use and to learn how to solve specific problems, especially reflecting their household's actual energy use practices.

## **Introduction: Seeking Homeowners' Points of View**

Most home energy audit and retrofit programs are rooted in a physical-technical-economic model (PTEM) of energy consumption (Lutzenhiser 1993). The house is a physical system, the envisioned solution of increased energy efficiency is technical, and the chief criteria for the worthiness of these solutions are economic. Humans tend to enter in the home energy audit and retrofit vision as economic actors and enablers of these technical solutions. This framing is natural given that home energy audit programs run by utilities and government are almost always designed to accountably increase energy efficiency. To the people who live in them, however, homes are not neutral technological settings, and increasing the home's technical energy efficiency may rarely be of much fundamental interest.

Over thirty years, home energy audits programs have learned about how to market audits to homeowners and how to set audit prices, and have developed various strategies to encourage homeowners to invest in energy-specific home improvements. Yet uptake of home energy audits remains low (Fuller et al. 2010; Palmer et al. 2011), and investment in home energy efficiency is considerably below levels considered reasonable from a technological-economic perspective (Alcott and Greenstone, 2012). Energy efficiency rating systems for existing homes have been in operation for over a decade, for example in conjunction with Energy Efficient Mortgages, but recently, there has been increasing interest in better establishing ratings for existing homes as a

means of building a stronger market for residential energy efficiency. In theory, such ratings could be a means of representing a home's relative energy efficiency in real estate transactions, and – under the adage that “you can't manage what you can't measure” – could serve as a comparison that motivates homeowners to invest in energy efficiency. The DOE's Home Energy Score program (Home Energy Score 2012) is one such example. The question remains how effective any such rating system will be, and more generally, how well current home energy audits actually provide what homeowners want. There is no assurance that what any audit program aims to provide necessarily coincides with what homeowners, in all their heterogeneity, might be seeking, or could be convinced to seek.

Recognizing a potential mismatch between programs and homeowners, we developed a research study to help better uncover homeowners' perspectives in the home energy audit process.<sup>1</sup> We did so by examining one particular home energy audit program managed by Seattle City Light. This program, launched in 2010, provided an asset-based home energy rating<sup>2</sup> and upgrade recommendations to single-family homeowners. The research was designed to take advantage of a program that had already been conceived and planned, with natural limits to experimental design and to how much we could ask of participants. One of the strengths of our research was that it collected a wide-ranging set of data: surveys and interviews with homeowners about what they thought about their audits, what they subsequently did within the study period, and why; self-reports on energy behavior; utility data; detailed technical characteristics of the home; and test-out audit data for some homes. Of the 1,355 audits completed during the study period (June 2010 through October 2011) we talked to 286 participating households to understand what homeowners thought about the audit they received, the upgrades they did, and what they might like differently or in addition. Methodological details and additional results are available in the full report (Ingle et al. 2012).

We present a portion of these results here, focusing on drawing out homeowners' perspectives and how well these perspectives aligned with what their home energy audit provided. The program and study were limited to one geographic area and to the households that had chosen to participate in the program offered by the utility, though we point out similarities to past efforts. Our research was not a program evaluation, and was not intended to estimate total energy savings impact or longer-term transformation. The study was conducted over a short period of time, and the follow-up period varied. Only rarely did more than one year elapse between the audit and our final contact with the homeowner. The research was not designed to speak directly to how to get more homeowners to invest in audits or to complete more upgrades. Rather we looked, as openly as possible, at how homeowners reacted to the audit that they received, within the limits of what could be observed.

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<sup>1</sup> This study was completed by researchers from Portland State University, Research Into Action, and Earth Advantage Institute, working together with Seattle City Light, Lawrence Berkeley National Laboratory, and Home Performance Collaborative. Research Into Action researchers contributed homeowner interview results important for the findings presented here.

<sup>2</sup> Asset ratings use assumptions about occupancy and occupant behavior to model the home under standardized weather and operating conditions. An operational orientation, in contrast, focuses on how the home is actually used. Operational models may therefore consider the actual historical billing data for the home and use this to calibrate or bound recommendations and savings estimates (BPI 2011; Khawaja & Koss 2007)—or they may include operational variables such as energy use behaviors as model inputs, e.g., Home Energy Saver™ Pro (<http://hespro.lbl.gov/pro/>).

## **The Seattle City Light Home Energy Audit Program and Process**

Starting in 2010, Seattle City Light offered single-family home residents a \$400 home energy audit for a discounted price of \$95. The audits included an asset-based home energy performance rating, details on the condition of the house, and a set of energy efficiency upgrade recommendations, based on asset assumptions. Earth Advantage Institute's EPS Auditor modeling and reporting software tool was used for these audits. Homeowners selected an auditor from a list of approved auditors, all of whom were Building Performance Institute (BPI) certified and trained in the use of the software. The audits included assessment of the whole house, including attic, walls, windows, foundations, ducts, and heating and cooling system(s), as well as measurements of air infiltration and combustion safety checks. The in-home portion of these audits took three to four hours, 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 emailed Scorecard and a detailed report. The scorecard included asset-based energy and carbon scores reflecting the efficiency of the house envelope and systems. The report provided "standardized" upgrade recommendations, selected by the auditor from a list provided in the EPS Auditor tool. These standardized recommendations addressed upgrades to the major elements of the home envelope and to energy-using systems. The EPS Auditor tool automatically provided an estimate of the cost range and savings range for each of the upgrades selected, with the savings estimates generated from the asset-based model of the home. Standardized recommendations were not prioritized, and the savings and cost estimate ranges were often very wide. Additionally, Seattle City Light encouraged auditors to customize the report with personalized messages, detailed information on the current conditions of the home, and with specific, often prioritized, recommendations for the homeowner. Most (75%) reports contained auditor-customized recommendations in addition to the standardized recommendations. These written recommendations from the auditor had greatly varying degree of detail and spoke to a wide range of specific issues, not always strictly related to energy use, for example addressing humidity or moisture in the home, reduction of spa energy use, staging or prioritizing upgrades, and even one homeowner's concern about excessive dryer lint. However, these written recommendations did not often include suggestions for changing operations or behavior, though some auditors made such recommendations in talking with the homeowner. Finally, the reports also routinely suggested "no-cost and low-cost strategies," such as closing the fireplace damper when the fireplace was not in use, or putting the bathroom ventilation fan on a timer.

The Seattle City Light Home Energy Audit program was designed as an information program, and was not intended to provide wrap-around elements such as linked incentives for upgrades or facilitation of the step between audit and upgrades, as incorporated in some recent programs (e.g., Van de Grift and Schauer 2010). The auditor role ended with the delivery of the audit report and the auditor answering any follow-up homeowner questions. Connecting homeowners to contractors was not part of the program.<sup>3</sup>

Our study included only the program participants, who as a group appeared to be more interested in energy efficiency and home upgrades in general than the average homeowner, as

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<sup>3</sup> While some auditors worked for companies that also performed upgrades, we did not study whether this made a difference in what homeowners said or did.

they had voluntarily pursued the audit program. Survey respondents were overall wealthier, more educated, and older than typical for Seattle, reflecting a pattern that has been found with other homeowner-paid home energy audit programs (Sanquist et al. 2012). As for most program-based studies, we have little basis to guess what the vast “non-participant” population finds appealing or not appealing about home energy audits or retrofits – a key set of questions if home energy auditing is to substantially expand from current levels.

## **Findings from Analysis of Seattle Home Energy Audits**

We were interested in seeing whether homeowners perceived an asset-based home energy rating to be important to their decision to pursue energy upgrades for their home. For the Seattle homeowners we spoke to, the rating often seemed to be of moderate interest, though participants did not necessarily know before the audit that they would be receiving such a rating. Almost every homeowner surveyed agreed it was something that they would want to see when buying a home (95%), and the majority (82%) also agreed that they would be willing to reveal the score if they were selling their home. But only six percent said that they were planning on remaining in the audited house for two years or less. We did not see evidence that the asset rating was a compelling motivator for pursuing energy efficiency upgrades. Rather, we found that the reasons that participants pursued upgrades had much more to do with addressing specific aspects of their own experience in the house: their bills, comfort and home performance problems such as inadequate heat, condensation, etc.

By focusing on the “asset” aspects of the home, audits utilizing asset-based modeling and ratings may have an unnecessarily limited scope, mismatching homeowners’ perspectives and possibly resulting in missed opportunities. For example, some homeowners expressed surprise that these audits did not systematically address energy use behaviors, small electronics, or unusual energy-using equipment.<sup>4</sup> On the one hand, any given home energy audit program, in attending to the bottom line, may choose to concentrate on more standard equipment, rather than invest in addressing in rarer or non-standard equipment for which there is no straightforward efficiency recommendation, no savings potentially attributable to program, and no relevance to an asset energy efficiency rating. But many households are not typical or average in their equipment holdings.

Asked if they had changed behaviors in response to the audit, one quarter (25%) of homeowners said they did – despite the fact that these audits were designed to focus on hardware efficiency. And, of those who had completed some upgrades, 41% said that they had changed some behaviors in response to the changes in their home. Probing how homeowners spoke about both post-audit and post-upgrade behavior changes, we found evidence of a shift in understanding of energy use for some households. For example, some households mentioned closing interior doors to reduce heat loss to unheated areas. Others mentioned that the investment in energy efficiency helped instigate a parallel degree of attention to energy-use behavior. Overall, our impression was that many homeowners did seem interested in learning about

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<sup>4</sup> Examples of energy uses often not included in asset-based assessments include electric vehicle charging, kilns, saunas, air compressors, medical equipment, shop tools, hot tubs, dehumidifiers, heated greenhouses, pool pumps, pool heating systems, air filtration systems, sewage and well pumps, and elevators. According to audit data and survey responses, approximately 24% of 322 responding Seattle households had one or more of these miscellaneous energy uses.

effective ways to reduce energy use and improve comfort by behavior change, even though behavior was not emphasized in the audit. If home energy audits were to pay greater attention to behavior, they could potentially provide customized guidance on behavioral conservation that is more useful and more salient than traditional energy conservation tips.

The Seattle homeowners we spoke to often appeared to want accurate cost and savings estimates for upgrades recommended by their auditor. But this is not easily done. For 101 program participants, we compared the home energy audit model's asset-based estimates of total site energy use to actual bills, and found that they did not match very well. Modeled estimates of total site energy use were more than 25% different from billed energy use for 45% of households – usually an overestimation rather than underestimation – and were more than 50% different than energy bills for 20% of homes (Ingle et al. 2012). Fuel-specific estimates were even further off. Accordingly, savings estimates from such modeling are unlikely to be very accurate. To reduce the potential of being inaccurate and to convey uncertainty, estimated savings from recommended upgrades may be provided with wide ranges, as they were for the Seattle City Light home energy audits. For example, while for some end uses savings estimates were reported as a single point estimate, in other cases savings estimates could range by a factor of nearly two, and cost estimates by more than a factor of two. The large ranges might readily be technically justified, as seems fair to the homeowner, but they do not give precise guidance. Could these ranges be justifiably reduced?

Toward gauging the degree to which incorporating basic operational characteristics into the energy modeling might increase the accuracy of modeling estimates, we conducted a second modeling analysis. In this analysis, we used basic operational characteristics – as reported by the homeowner on written and web-based surveys – along with house and major systems characteristics, to model the home. We used an alternate modeling tool where actual reported weather conditions could be included in the simulation. Compared to model estimates that did not incorporate occupancy and energy use behavior characteristics, modeled usage estimates that included these basic operational characteristics matched actual utility bills better, cutting in half the number of homes where model estimated total site energy use was more than 50% different than utility bills (Ingle et al. 2012). This improved ability to estimate actual energy use should also lead to recommendations and savings estimates that are better tailored to the homeowner, though clearly there is still room for improvement, and accurate estimates of total energy use do not necessarily ensure that end-use estimates are correct. Whether or not a homeowner trusts savings estimates they receive in a home energy audit, there is a parallel question of whether the estimates should be trusted: investments in energy efficiency may involve substantial risk for the homeowner. In any case, as others have argued (Khawaja and Koss 2007), better incorporating actual use may be an important avenue for developing improved home energy audits. There are different ways to incorporate actual energy use into model results; this study only tested modeling of self-reported energy use behaviors.

There are a few reasons that home energy audits, in general, shy away from trying to deal with actual behavior. First, behavior and “energy efficiency” have historically been considered separate tracks (aside from purchase or adoption of energy efficient technologies) and the strong preference has to been to technological definitions of energy efficiency, as outlined above. Second, program providers may view collecting information on energy use behaviors to be too time-consuming, costly, and possibly intrusive, and the quality of such self-reported behavior data may rarely match the precision with which technical data can be collected. But these reservations about behavior may deserve reconsideration. Any description of actual energy-

relevant behaviors is, of course, a simplification of actual behaviors. For example, occupants may actually change thermostat settings many times a day, and differently from one day to the next (Peffer et al. 2011). Neither may people accurately report their “average” or “typical” behaviors (Lutz and Wilcox 1990; Vine 1989). However, in most cases, self-reported energy use behaviors are likely to be a more accurate description of how a household uses their house, and a better gauge of how to best improve energy efficiency for the home as used, than are the standardized assumptions used in asset-based ratings. Data collection for energy use behaviors need not be a major burden on the homeowner or auditor. In our case, homeowners voluntarily completed a 10 to 15-minute self-administered paper or web-based survey. With further attention, it may be possible to both reduce the burden of data collection and increase the quality of resulting modeled estimates.

### **Homeowner Motivations for Seeking Audits**

When asked why they signed up for a home energy audit, most homeowners reported that they wanted to save energy or money (26%), increase energy efficiency (23%), diagnose or lower high bills (11%), or improve comfort (13%). Others were looking to inform planned home improvements (16%) – energy or otherwise, or to understand why their bills remained high even after past efforts to reduce their bills through conservation measures or efficiency upgrades. Some, given the relatively low cost of the audits, seemed to be mostly driven by curiosity (11%) and perhaps were also enticed by the offer of free CFLs. Homeowners were sometimes interested in the comparative rating they received, but as noted above, most seemed far more oriented to learning about specific improvements for their home. These motivations were more diverse than would be assumed if homeowners were to be characterized as simply seeking cost-effective energy-efficiency investments.

### **Role of the Auditor**

The auditor was a central actor in these Seattle City Light home energy audits, rather than an interchangeable technician. Audits were conducted along standardized protocols, but auditors added their own experience, expertise, and personality to the audits they undertook, adapting to the situation and to the homeowners they encountered. Many homeowners seemed to enjoy the process of the audit visit and found the ongoing conversations with the auditor useful and interesting. Homeowners often followed along with the auditor: nearly 60 percent said that they were with the auditor most or all of the time during the audit, and most of the rest (34%) said they followed along part of the time. Our impression was that homeowners often found personalized discussions with the auditor to have been particularly helpful in convincing household members – the instigator of the audit as well as others – of the value of completing energy upgrades.

We found that when auditors took the initiative to develop a list of customized recommendations, often prioritized or including a personal note, homeowners had a higher propensity to complete upgrades to equipment, appliances, or the envelope of the home (see Ingle et al. 2012 for details). Earlier research found that a prioritized list of upgrades helps homeowners more actively approach efficiency upgrades for their home (Earth Advantage Institute and Conservation Services Group 2009).



In talking with participating homeowners, it became clear that there were varying preferences about what information should be conveyed and how it should be delivered, and varying experiences with the auditor. Relating general impressions of their audit experience, many participants raved about the auditor or commented on his or her enthusiasm, while a few said that their auditor was too rushed, was unable to answer questions, or made mistakes. Overall, our discussions with homeowners about the auditor drew attention to three main points. First, auditors acted as more than technicians. They helped sell upgrades, and their enthusiasm appeared to readily rub off on homeowners – though certainly some homeowners were wary of sales jobs. Second, auditors added a critical layer of translation and interpretation of technical results to a homeowner’s situation, helping homeowners prioritize with respect to their budget and life plans (e.g., retirement, new babies), pointing out staging issues, hassle factors, and specific benefits. Third, auditors added suggestions missed by standardized recommendations, including highlighting lower cost or easy-to-do options, possibly compensating – to a fair extent, with Seattle City Light’s encouragement – for the asset focus of the audit. Clearly, a homeowner’s experience depended on the skill, personality, and work style of their auditor, as well as their own receptiveness.

### **Why Homeowners Completed Particular Upgrades**

As a gross indicator of retrofit activity, 57% of survey respondents reported completing at least one recommendation by the time they were surveyed, typically less than 12 months after their audit. Many of the recommendations reported as undertaken, however, were quite small. Data on expenditures, Table 1 below, may be a better indicator of degree of change.

The perspective evidenced by our Seattle homeowners focused on saving money and energy, but also appeared to often be geared towards doing upgrades that made sense in the context of other remodeling home improvements, the need for equipment replacement, or fixing obvious problems – high bills, comfort problems, and occasionally, health and safety concerns. The diagnostic nature of these audits may have accentuated the problem-solving motivation, as some homeowner responses indicate that the audit found problem areas that could be fixed at low cost. The ability of in-house measurements and diagnostics to find “quick fixes” has long been recognized (Socolow 1977). When asked if anything about the audit was especially helpful in convincing household members to complete energy upgrades, homeowners reported the testing – particularly the blower door test, but also the infrared (IR) imaging. This diagnostic testing seemed to bring energy issues to life, making otherwise invisible energy flows and performance problems tangible to the homeowner.

Just over half of households completing upgrades did some of the work themselves, and most of the DIY work was local air sealing such as caulking and weather-stripping – potentially spurred by the diagnostic testing. Earlier research found that these small projects are often outside of the comfort zone of homeowners, but too small to justify a contractor (Sanquist et al. 2012). Auditor guidance and diagnostics results may have helped mobilize this subset of homeowners. More extensive upgrades were also completed by a fraction of homes, with almost two-thirds of households that completed upgrades hiring contractors to do at least some of the work, and 25 percent of households that completed upgrades reporting having spent more than \$3,875, with some of these reporting spending much more (see Table 1).

**Table 1: Total Estimated Expenditures for All Energy Upgrades Performed for the Households Which Completed Some Upgrades (n=66)**

Percentile	Expenditure
25%	\$200
50%	\$1500
75%	\$3875

Sample includes only those respondents who reported their upgrade expenditure.

Asked why they undertook the retrofits they completed, the most common response was to save energy and resources, as shown in Table 2. Improving comfort, being more efficient, or reducing energy bills were each stated by about a quarter of respondents. Many also said that they did the retrofits because they were easy to do. Only one in ten mentioned increasing or preserving the home’s value as a reason for undertaking the retrofits.

**Table 2: Reasons Homeowners Gave for Choosing the Retrofits they Completed(n=109)**

Reason Provided	Percent Stating
Save energy and resources	44%
Improve home’s comfort	28%
To be more efficient	25%
Reduce utility bills	23%
Easy to do	17%
Replace older equipment	10%
Increase or preserve home value	9%
Provide fresh air or improve indoor air quality	5%
Improve safety	4%

Open-end responses recoded by the interviewer, to the question: “Why did you decide to do this/these upgrade(s)?”

Sixty percent (95 of 159) of the respondents we asked said they were planning to complete one or more of the recommended retrofits in the future, whether or not they had already completed some recommendations. Respondents who had not completed any recommendations were somewhat more likely to say they planned to complete recommendations in the future (67%) than were respondents who had already completed at least one upgrade (52%). The most common reason given for deciding to put off doing the “still planned” retrofits was the expense. Lack of time and other concerns – such as waiting for better weather, practical considerations of bundling with other home improvements, etc. – were also common reasons (Ingle et al. 2012). Given the relatively short time period between audit and surveys for most of these households (usually no more than a year), it is likely that at least some households went on to complete upgrades after our surveys.

### Benefits and Costs of Completed Upgrades

From the conventional top-down policy perspective, upgrades are typically valued based on their payback, or energy and cost savings compared to their financial cost. Benefits other than energy or cost savings are recognized, but they are difficult to quantitatively value and are not typically formally addressed within home energy audit programs. We find that most of the homeowners we spoke to said that they were satisfied with the upgrades they completed, with only 10 percent reporting that they were dissatisfied. But, as shown in Table 3, when asked how much they thought the recommended upgrades that they had completed had reduced their monthly energy bills, just one in ten said “a lot.” Some indicated disappointment in the energy

savings experienced, but overall, many households, given that our surveys were typically completed relatively soon after the audit, still implied that they expected long-term savings, even if they could not see them clearly or immediately on their bill.

An earlier study found that 69 percent of homeowners doing energy efficiency renovations did not know what to expect in terms of energy cost savings (Wilson 2010). So for some homeowners, cost-effectiveness estimates may serve as a rationale that creates its own truth, whether or not savings are actually observable. Other homeowners, however, were skeptical about cost-effectiveness claims, especially when the upgrades involved high investment and disruption, without other clear advantages in addition to estimates of energy savings. Of course, it may be very difficult for homeowners to see changes in their bills, since other factors – variations in occupancy, weather, equipment, habits, and utility rates – may easily swamp the savings expected from modest upgrades in energy efficiency (Shapiro 2011). As detailed in our main report (Ingle et al. 2012), most households we surveyed completed no more than modest upgrades during the study period.

**Table 3: Homeowner Perceptions of Savings from Recommended Upgrades they Undertook, and Median Total Reported Expenditures by Reported Level of Savings (n=109)**

<b>How much do you think the upgrades you did reduced your energy bills each month?</b>	<b>Percentage of Respondents Among Those Who Did Retrofits</b>	<b>Corresponding Median Expenditure</b>
Not much	46%	\$450
Some	30%	\$2,000
A lot	10%	\$3,250
Too early to tell	11%	\$9,000
Don't know	3%	n/a

We also looked at the median reported total expenditure on recommended upgrades for each level of reported savings (i.e., those who said that their energy bill reduction was “not much” had median expenditures across households of \$450). These results are reported in Table 3. The level of perceived savings increases with median expenditure on retrofits. There was a great deal of variation, however, with some who completed major upgrades reporting that they hadn’t seen much reduction in their bills or that it was “too early to tell.” Certainly those who did major upgrades might have higher expectations for savings or want a longer period of time (e.g., a full winter after adding insulation) to assess degree of savings. As noted earlier, the study period was too short for researchers to realistically evaluate energy savings.

Overall, increased comfort seemed to be the major palpable benefit of the retrofits completed. Asked directly how much they thought the changes they made had saved them on their monthly energy bills, almost half (46%) said “not much.” Though savings may become more apparent later, “more smiles than savings” was also the conclusion of a major Massachusetts home energy audit program (Cataldo 1998). The Seattle City Light program auditors appeared to be able to address specific benefits and downsides directly in their discussions with homeowners and the customized report recommendations. Home energy audit program designs that downplay the role of a skilled auditor or are more narrowly focused on delivering asset ratings and on achieving energy efficiency, may miss these key elements. The risk is that home energy audit elements that are most important to a homeowner and most relevant to how he or she makes decisions may be lost, or treated so incidentally that they are ineffective.

The energy efficiency industry often uses the term “non-energy benefits” (NEBs) to convey all benefits of energy efficiency other than energy and concomitant energy cost savings (e.g., Schweitzer and Tom 2004). This recognition that it is not just about energy is crucial, especially to marketing, evaluation, and technology assessment (Mills and Rosenfeld 1994). But the NEB terminology may also invite distortions. First, from the perspective of a homeowner considering upgrades, energy savings are not necessarily privileged, and the separation of benefits into energy and non-energy realms is artificial. Just “benefits” is more appropriate – be they improved safety, aesthetics, comfort, ergonomics, maintenance, pest control, property value, or something else. Second, non-energy benefits are often broadly assumed as concomitant with energy efficiency upgrades (e.g., in marketing material), even while there is no parallel concept of non-energy costs – such as the hassle of insulation, a noisy heat pump, a longer washing machine cycle, or trying to find the right contractor – all of which were mentioned by homeowners in our surveys. So while the concept of NEBs is useful in its place, it can be misleading for understanding homeowners’ perspectives. The distinction between the energy efficiency industry’s NEBs on the one hand, and a balanced and specific consideration of benefits, costs, and risks on the other, is a useful illustration of why we oriented this research to draw focus to the homeowner perspective in the first place.

## **Conclusions**

Our research on home energy audits underscores the importance of a shift toward homeowner perspectives. This requires more than simple repackaging of energy efficiency, but rather fuller appreciation of the position of the homeowner and the personal nature of homes. This proposed shift is in some ways subtle, but some conclusions and suggestions for further research stand out.

First, in the Seattle audits we examined, the auditor appeared to often function as an expert agent and advisor, and, we believe, often had an important influence on what homeowners did or did not do. Rather than repeating a set of recommendations ranked by uncertain costs and benefits, the auditor can make a personal assessment and recommendation on the multi-dimensional nature of the home energy upgrades—comfort, hassle, risk, safety, and reliability of savings estimates. Unlike a software report, an auditor may also be better able to respond to homeowners’ concerns and questions about their homes.

Second, an asset orientation may not align well with most homeowners’ interests and positions. The asset-based home rating was interesting enough to most homeowners, and something they might want to see when buying a home, but there was little evidence that it was a compelling motivator for energy efficiency upgrades. Few of the homeowners we spoke to were planning on selling their home anytime soon; upgrades appeared to be more geared towards improving household living conditions, rather than as an efficiency-specific investment in home value. 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. How energy is used in homes 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.

Third, as to the benefits of the retrofits they undertook, few households said that their bills were reduced “a lot”. Some expected to save in the long term, as promised in the cost-effectiveness calculations, but the most detectable benefits may have been increased comfort – especially for the many households who stuck to air sealing. This is interesting in that while a majority of homeowners indicated that they chose retrofits that would reduce energy use and/or bills, in practice comfort was the more palpable short-term benefit. Still, homeowners were largely satisfied with the completed upgrades.

Finally, home energy audits often promise to help homeowners with increasing the energy efficiency of their home.<sup>5</sup> Rather, the motivation for most participants for seeking an audit and for completing retrofits seemed to be about shaving off monthly costs, solving more concrete problems in living conditions (such as diagnosing high bills or making the home more comfortable), or defining reasonable strategies for incorporating energy efficiency into other changes they were planning for their home.

By many criteria, home energy audit programs, such as the one conducted in Seattle, have led to successful outcomes, with participants indicating that they are pleased with their involvement in the program. These audits have led in many instances to quality upgrades that improve the condition of participants’ homes, and they may have led to lower energy consumption in upgraded homes.

We suggest, however, that it is useful to consider how much of what is being offered makes good sense from the point of view of potential participants, in light of all the uncertainties in planning home energy audit programs. This requires stepping away from trying to convert households into “idealized energy consumers” who view energy efficiency as an intrinsic value and an investment option, and toward a more home- and owner-centered view. It may also mean a colder, harder look at the quality and uncertainty of savings estimates being offered. For some homeowners, home energy audits may never make sense or be appealing. For others, they will make the most sense and have the most value if they offer, and deliver, what is motivating and inspiring. Of course, homeowners do not necessarily know what is possible or what will inspire them, and certain elements – the auditor, or the blower door test – may sometimes be transformative.

Ultimately, respecting the participant point of view means recognizing that lifestyles, motivations, needs, and capacities vary from household to household – just as insulation levels and equipment efficiency varies from house to house. It means designing programs that not only appeal to a much more diverse range of households, but that also accommodate and serve those households on their own terms. Next generation home energy audit and feedback programs promise more targeted marketing, boast new schemes to motivate household action, and leverage detailed utility data. But questions remain as to whether these “new” tools will significantly broaden the appeal of home energy retrofits and conservation, and whether they will be applied in ways that will better meet household needs and expectations.

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<sup>5</sup> For example, a U.S. federal government website describes home energy audits to consumers as a “first step to assess how much energy your home consumes and to evaluate what measures you can take to make your home more energy efficient.” ([http://www.energysavers.gov/your\\_home/energy\\_audits/index.cfm/mytopic=11160](http://www.energysavers.gov/your_home/energy_audits/index.cfm/mytopic=11160))

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