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The Next Step Toward Widespread Residential Deep Energy Retrofits

J. McIlvaine, S. Saunders, E. Bordelon, S. Baden, L. Elam, and E. Martin

Building America Partnership for Improved Residential Construction

July 2013

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Definitions

ACCA	Air Conditioning Contractors of America
DOE	U.S. Department of Energy
HERS	Home Energy Rating System
HVAC	Heating, ventilation, and air conditioning
IAQ	Indoor air quality
JCHS	Joint Center for Housing Studies
QA	Quality assurance
QC	Quality control
RESNET	Residential Energy Services Network
SWOT	Strengths, weaknesses, opportunities, and threats

Executive Summary

The Building America Partnership for Improved Residential Construction (BA-PIRC) has been working with affordable housing entities to identify cost-effective *technical* pathways to achieve energy savings levels of 30% and safeguard or enhance indoor air quality (IAQ), durability, and comfort (McIlvaine et al. 2012; Fairey and Parker 2012).

The next step is to find *practical* pathways within the current home improvement industry of delivering those technical solutions to homeowners. Focusing Building America activities on provider types with a high chance of successfully pursuing whole-house retrofits will likely increase industry impact.

Approximately 70% of America's 132 million existing homes were constructed before the 1990s (U.S. Census Bureau 2011), when states began adopting residential energy codes. Although older homes tend to have higher energy use intensity, vintage is not an adequate indicator of efficiency for a particular house. Side-by-side homes of the same age and design can vary significantly in whole-house efficiency because of energy improvements, envelope conditions, and maintenance history. The availability of incentives, high utility bills, comfort, or IAQ problems may drive consumers to consider a multifaceted energy retrofit project. This creates opportunities for home energy auditors, general remodelers, and trade contractors.

In 2009, the American remodeling industry (excluding do-it-yourself projects) amounted to $147 billion. About 40% of remodeling spending in single-family detached homes involved a home built before 1980 (U.S. Census Bureau undated). About 25% of this volume involved improvements with energy implications (JCHS 2011). Each of those points of contact could provide a platform for selling deep energy retrofits, but the current remodeling industry structure is not set up to capitalize on those opportunities. The complexity of deep energy retrofits warrants additional training to successfully manage multiple improvements that will change whole-house air, heat, and moisture flow dynamics. The home performance contracting industry has responded to these challenges by aggregating skilled labor for assessment and implementation under one umbrella.

All the models share certain challenges associated with deep retrofits. These relate to recovering the cost of initial assessments that do not convert into sales; audit findings that point away from main line, incentivized, or high profit margin improvements; developing and retaining knowledgeable team members; and the heightened risk of adversely affecting air, heat, and moisture flow dynamics. Confusion in the marketplace over the relative merits of one improvement over another can lengthen the sales cycle to periods of many months.

The report provides a matrix of basic strengths, weaknesses, opportunities, and threats (SWOT) inherent in each model as a way of thinking about the transition from traditional business models into a viable model for delivering deep energy retrofits (Panagiotou and van Wijnen 2005). The report describes the strengths for facing these challenges as well as the potential weaknesses, opportunities, and threats inherent in each model.

Two emerging business models are profiled that seek to resolve many of the challenges, weaknesses, opportunities, and threats described for the conventional business models:

- **An "alliance" business model.** A group of contractors with building science training agree to work as a team to assess, implement, and manage the project. The contractors maintain independent businesses and interface with the client individually; however, one contractor acts as the project manager and takes responsibility for verifying whole-house performance metrics. This is an important distinction from the concept of a homeowner acting as general contractor. There is lower bias potential because an independent auditor formulates the recommendations, but has the benefit of real quotes for cost-effectiveness projections.
- **An "expansion" model.** An energy-related trade contractor continues the main line of business, but expands in-house knowledge and capabilities to assess and implement common deep retrofit elements. The scope of activity may warrant hiring a trade contractor with more expertise in a specific area, but the client interfaces with a single contractor who manages the entire project. All work is driven by performance specifications that the in-house project manager develops. A final audit is used to verify the achievement of whole-house performance metrics. The deep retrofit business line provides "off season" activity for the main line of business, and the main line of business ensures the lag time between audit and deep retrofit sale is not idle.

The Residential Energy Services Network (RESNET) EnergySmart Home Performance Team program is an example of the "alliance" approach. TexEnergy Solutions, Inc. of Irving, Texas, is an example of the "expansion" model. This report delineates how each concept responds to nontechnical barriers to deep energy retrofits.

Widespread business development in the deep energy retrofit sector of the remodeling industry could benefit from improved clarity in the marketplace and increased accuracy of savings predictions. Developing standard finance options would pave the way for broader industry participation, but that must be matched by increasing industry-wide technical capabilities through building science training and credentialing. The current business models compartmentalize trade activities and do not significantly consider whole-house performance, a potentially dire omission for occupants and structures. Perhaps the most important distinguishing characteristic of the emerging business models profiled here is that they include assurance of whole-house performance metrics for the contractors and the homeowners that foreseeable risks have been addressed.

1 Introduction

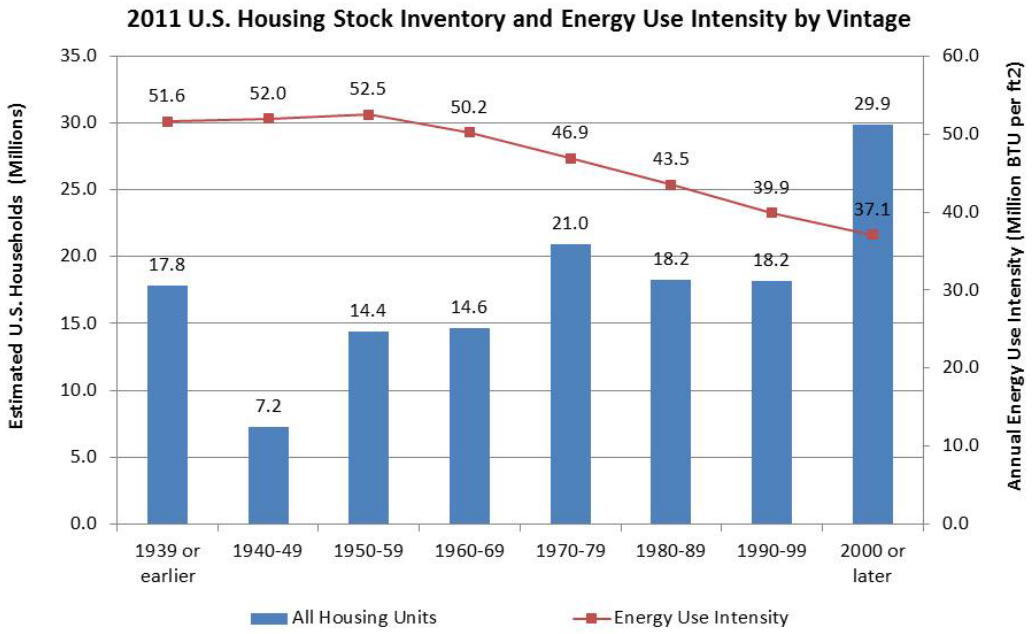
In recent years, consumer demand for home efficiency improvements has risen, likely in response to a number of stimuli including higher utility costs and availability of federal, state, and local incentive programs aimed at helping homeowners manage those utility costs (JCHS National Green Remodeling Surveys 2009-2011 (as cited in Baker 2012; Chung 2011); Joint Center for Housing Studies of Harvard University 2011). Since 2005, the remodeling industry share of total residential construction investment has steadily risen (JCHS 2011). In fact, the value of private remodeling activity exceeded that of private single-family new construction by 1% in 2009 and 2010 (U.S. Census Bureau 2012).

BA-PIRC has been working with affordable housing entities to identify cost-effective *technical* pathways to achieve energy savings levels of 30% and to safeguard or enhance IAQ, durability, and comfort (McIlvaine et al. 2012; Fairey and Parker 2012).

The next step is to find *practical* pathways of delivering those technical solutions to homeowners within the current home improvement industry. We are turning our attention to identifying provider types with a high chance of successfully pursuing whole-house retrofits based on the strengths of the current operating environment.

Home improvement varies significantly from new construction, which proceeds predictably from design, permitting, and construction processes to sales. Technical solutions for new construction are adopted through a systems engineering process. Without the framework of a consistent process, anticipating and resolving conflicts in advance becomes much more complex, though it remains essential for delivering high performance. Any major home improvement provider could serve as the entry point for a whole-house deep retrofit project. However, each also faces challenges and weaknesses currently inherent in the fragmented remodeling industry. Building America has a wealth of pertinent information on high performance housing, but determining an appropriate amount and scope of information for each provider type is an important step in speeding and broadening adoption of deep retrofit technical solutions.

Successfully engaging the home improvement process to include deep energy retrofits could have a significantly positive impact on climate change and energy supply based on the sheer magnitude of the opportunity. Approximately 70% of America's 132 million existing homes were constructed before the 1990s (U.S. Census Bureau 2011), when states began adopting residential energy codes. Based on estimates of the U.S. Department of Energy's (DOE) Energy Information Administration, energy use intensity has an inverse relationship with vintage (Figure 1) (EIA 2012). Retrofitting older homes with the energy-saving measures that are incorporated into today's new homes could significantly reduce residential energy use, which currently accounts for 22% of nationwide energy consumption (JCHS 2012; DOE 2011a).



Sources: U.S. Census Bureau, 2011 American Community Survey. Selected Housing Characteristics, Product ID DP04. U.S. Energy Information Administration. 2009 Residential Energy Consumption Survey (RECS). Consumption and Expenditures Data, Summary Statistics (Updated October 16, 2012), Totals and Intensities, U.S. Homes, Table CE1.1.

Figure 1. An estimated 93 million America homes still in service were built before residential energy codes were widely adopted in the 1990s

Census data indicate that in 2007, total remodeling and maintenance expenditures in the United States were roughly $168 billion. Of that, about $74 billion was expended for improvements in owner-occupied single-family detached homes built before 1980 (U.S. Census Bureau undated). The Harvard Joint Center for Housing Studies (JCHS) tabulated data from the U.S. Department of Housing and Urban Development for 2009, which show total home improvement expenditures were about $185 billion. Of this, $147 billion involved paid remodeling industry contractors, and the rest was expended in the do-it-yourself market. According to the data, $39 billion, about 25% of the total market, was spent on major energy-related improvements. These are split among roofing (39%); heating, ventilation, and air conditioning (HVAC) (30%); windows and doors (24%); water heaters (8%); and insulation (3%) (JCHS 2011). The data suggest that a substantial amount of remodeling industry activity involves a trade contractor in an energy-related field. Each point of contact could provide a platform for selling deep energy retrofits, but the current remodeling industry structure is not set up to capitalize on those opportunities.

1.1 Deep Retrofit Delivery

The DOE Building America program's deep energy retrofit goals are to cost-effectively achieve 30%–50% energy savings (comparing pre- to post-retrofit energy use) and to safeguard IAQ, building durability, and comfort. Although there is a general correlation between age and energy use intensity (Figure 1), it cannot be applied to specific homes. Existing home efficiency can vary considerably among houses of the same age, depending on construction characteristics and maintenance history. Even homes of the same design can vary dramatically because of energy improvements completed over the life of the house. In a recent Florida Solar Energy Center field

study of 70 deep energy retrofits in central Florida, whole-house efficiency, as gauged by the Home Energy Rating System (HERS) Index (RESNET 2012), varied dramatically even among homes of similar age (Figure 2) (McIlvaine et al. 2012)

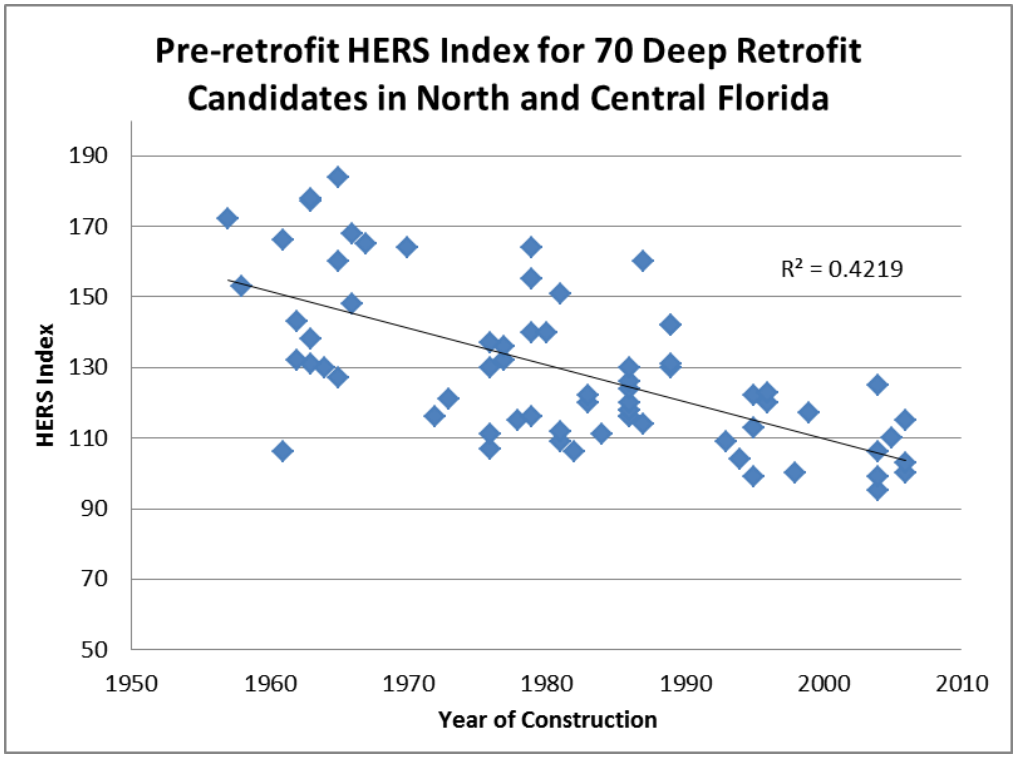


Figure 2. Florida Solar Energy Center field study of 70 deep retrofit candidates. Pre-retrofit HERS Index did not correlate with house age.

Similarly, strategies to deliver and implement those retrofit packages to achieve the target savings differ drastically from house to house depending on pre-retrofit envelope and equipment characteristics. Given a list of common efficiency improvements, not all will apply to every house. In this field study, the post-retrofit analysis showed, not surprisingly, that HERS Index improvement from a similar list of improvements was most directly correlated with pre-retrofit whole-house efficiency (Figure 3), HERS Index in this case. Although older homes tend to have higher HERS Index scores, age is not necessarily a determining factor, as shown in Figure 2 (McIlvaine et al. 2012).

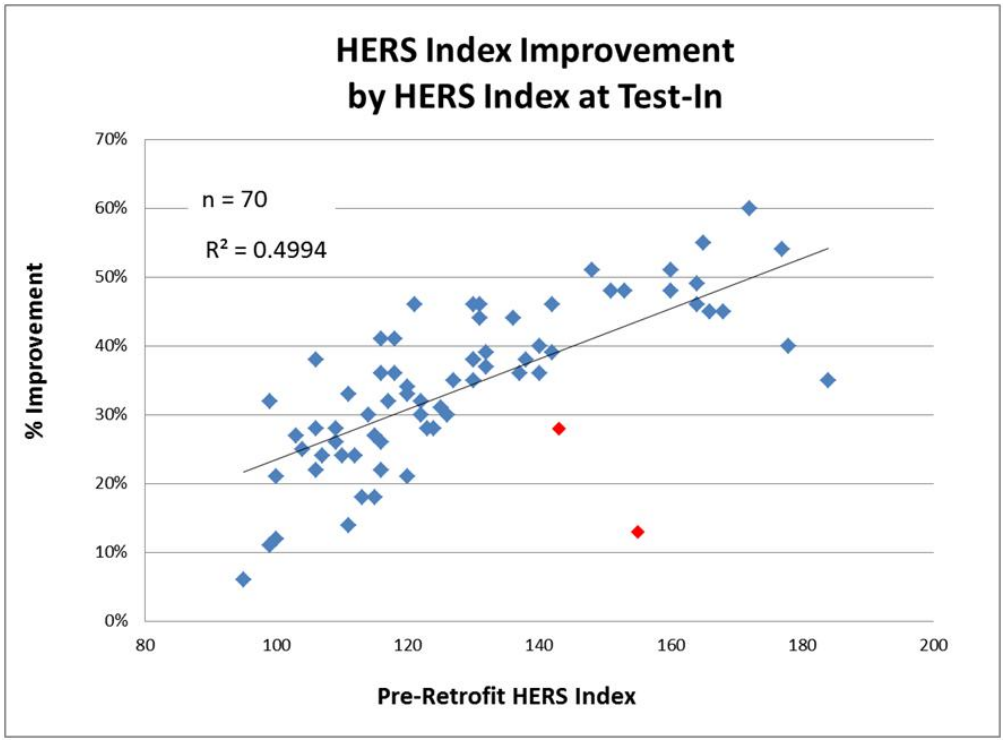


Figure 3. Whole-house efficiency improvement for 70 homes

Aside from technical achievement of the 30% savings goal, pre-retrofit conditions affect the cost effectiveness of individual improvements. Accurately assessing existing efficiency facilitates correctly projecting the savings potential of improvements. Miscalculations or false assumptions about existing conditions can dramatically affect the financial proposition of a deep energy retrofit. Pre-retrofit assessment and cost analysis for an array of appropriate improvements appear to be fundamental to achieving cost-effective deep retrofits, so a fundamental capability of business models is aimed at delivering deep retrofits.

Conditions in existing homes are unpredictable, which further adds to the complexity of cost-effective deep energy retrofits. Some important factors, such as drainage planes, are not visible during a pre-retrofit assessment without invasive action. Once renovation is underway, unexpected paths of heat, air, and moisture flow may occur, which may lead to health, safety, building durability, and comfort issues (Cummings et al. 2012). Changes made during renovation may unintentionally create new risks. The ability to foresee common risks and mitigate them with quality control (QC) procedures that cut across trades significantly enhances the ability to correctly predict renovation cost. Practitioners need to address whole-house performance metrics, and possibly commissioning, to ensure that retrofit work has not inadvertently created adverse conditions by . The conventional management paradigm focuses instead on individual trades or systems. Addressing these risks requires knowledge of building science principles, practical construction processes, and overall coordination that do not fall neatly into the responsibility or skill set of any one party conventionally involved in the remodeling industry (Goldman et al. 2010).

To capitalize on the rising interest in energy efficiency improvements, the remodeling industry will need to either expand conventional business models or create new ones. Goldman et al. (2010) identified the following conventional occupations already engaged in energy efficiency related retrofit services:

- Building and remodeling general contractors
- Trade contractors (mechanical, electrical, plumbing, insulation, etc.)
- Architects
- Marketing and training (workforce)
- Equipment firms (appliances, home electronics, windows, electrical/lighting, insulation, mechanical).

Bianchi (2011) consolidates these into four conventional remodeling industry business models for deep energy retrofit delivery that have broad recognition among industry stakeholders:

- Independent assessor or consultant
- General contractor
- Trade contractor
- Whole-house energy upgrade contractor.

The ability of any of these conventional providers to deliver deep energy retrofits depends on their ability to correctly assess existing conditions, reasonably predict expected savings, and carefully manage the work of multiple contractors to minimize the risk of building failure. This report discusses the capability inherent in each of these four conventional business models (Section 2) and two emerging models (Section 3) to meet the challenges associated with deep retrofits.

1.2 Business Challenges Faced by Deep Retrofit Providers

The team identified the following business challenges specific to deep retrofit providers with input from various industry stakeholders. All the business models discussed in this report face these challenges regardless of the level of integration between assessment, implementation, and whole-house QC:

1. **Cost of pre-retrofit assessment and conversion of an audit into a job.** Converting leads into sales is a common business challenge. Many people who are interested in saving energy in their homes are not seriously interested in a major remodeling effort or post-retrofit assessment. Some audits will never be converted into deep retrofits, bringing two penalties—the cost of the audit and the lost opportunity of working with a different, potentially more promising, client.
2. **Ethics.** Contractors who are familiar with individual energy efficiency home improvements, such as mechanical system or replacements, insulation, and duct sealing, may have an advantage in pursuing deep energy retrofits; however, they face an ethical question when an energy audit reveals that other improvements would be more cost effective than their primary line of business. Contractors must decide how to structure

their businesses around the work they prefer to do without misleading clients toward less appropriate measures.

3. **Expertise.** Protecting the business and the clients from risks related to technical implementation practices will likely require building science training, which may be expensive, limited locally, and have a long learning curve. Interest and availability of qualified candidates may be limited.
4. **Human resources.** Trained employees may leave the company, short circuiting an integrated process and taking away valuable institutional knowledge. Highly trained employees may require higher compensation and benefits, increasing overhead costs.
5. **Liability.** Work in one trade area may adversely affect whole-house performance. House-level coordination and a clear chain of responsibility for whole-house performance are difficult to achieve in a fragmented market where "house as a system" thinking is not the norm.

2 Conventional Remodeling Industry Business Models

Industry stakeholders recognize the following four business models (Section 2.1 through Section 2.4) as having the potential to deliver or participate in the delivery of deep retrofits (Bianchi 2011). The capabilities of practitioners in each model to assess conditions, project savings, and manage implementation are discussed here in terms of SWOT. The SWOT analysis shown here is intended to provide a way of thinking about the transition from these traditional business models into a viable model for delivering deep energy retrofits. More in-depth SWOT analysis or another strategic planning process would likely be needed to assess the potential of a particular company operating in these modes to move into a deep retrofit model (Panagiotou and van Wijnen 2005).

2.1 Independent Assessor or Consultant

In this model, an individual or small group conducts an evaluation of existing conditions and recommends improvements based on findings, homeowner input, and cost calculations. Traditionally, these service providers are not involved with implementation. The homeowner selects and works directly with necessary contractors. Offering additional services, such as monitoring energy savings or providing QC, may result in further business lines for assessors. This is shown in Table 1 as an opportunity to enhance the likelihood of business success for independent assessors pursuing deep energy retrofits.

Table 1. SWOTs Associated With Two Variations of the Independent Assessor Model

STRENGTHS	WEAKNESSES
1. Audit can be impartial and not biased toward any specific improvement (ethics) 2. Third-party credentials enhance consumer confidence 3. Investment in equipment and tools is small relative to implementation	• Auditors generally do not have accurate, up-to-date pricing on services they recommend, diluting the accuracy of cost-effectiveness calculations • Auditor training does not normally cover detailed trade knowledge; for example, trade-specific knowledge is required to assess if HVAC equipment is installed and functioning properly. • There is no clear method of staying engaged after pre-retrofit audit, so a post-retrofit opportunity may be lost
OPPORTUNITIES	**THREATS**
• Target early adopters • Offer follow-on services such as energy monitoring; could provide opportunity for additional analysis and client interface • Bundle with related services such as home inspectors • Team with contractors to participate in implementation and quality assurance (QA) • Work with many programs, neighborhood groups, etc. • Leads could develop for other related ventures such as detailed thermography, IAQ testing, and whole-house energy use monitoring with Web-based dashboards.	• Limited opportunity to influence implementation; may result in consumer dissatisfaction with actual versus projected savings • Price for thorough audit may exceed what the market will bear in a quantity sufficient to support a viable business • Limited consumer knowledge may translate into low value in the marketplace. • Repeat business is unlikely • Lack of licensing requirements may lead to untrained or undertrained auditors that erode consumer confidence

Assessors may have strategic, sometimes exclusive, alliances with contractors to implement the recommended improvements and may receive commissions based on those referrals. Even in this model, the homeowner works directly with the necessary contractors. This model addresses some of the weaknesses and threats facing independent assessors, but not without additional challenges. A SWOT chart for this variation is shown in Table 2. This approach could improve the conversion rate from audit to retrofit. Assessors and contractors can work together to present a unified proposal based on savings predictions from real estimates and co-conduct critical QA tasks that minimize risks. This type of alliance is discussed further in Section 3.

Table 2. Independent Assessor With Strategic Implementation Partners Model

STRENGTHS	WEAKNESSES
• Easier to obtain accurate quotes and improve financial forecasting • Auditor has access to higher trade-related knowledge held by partners • Keeps auditor plugged into the project, QA tasks and post-retrofit assessment more likely • Financial arrangements with partners (such as commissions) can keep audit costs to client down, increasing potential market for services • Business leads can flow in both directions	• Audits underwritten by partners may not lead to contracts, creating friction between the two operations • High potential for bias in assessment to favor partners' preferred types of work. • Exclusive relationships might limit opportunity to work with others
OPPORTUNITIES	**THREATS**
• Strategic partners can funnel leads	• Insufficient conversions of audit to implementation • Job urgency, consumer impatience, or consumer lack of knowledge may lead to skipping audit

2.2 Subcontractors in Energy-Related Trades

Trade contractors in energy-related industries (e.g., HVAC, window, and insulation contractors) control implementation. Thus, they may have an edge over independent audit-only organizations in delivering deep retrofits. Expanding capabilities to include energy audits and minor measures related to other trades, as additional lines of business, may enable them to offer increased value to clients; however, there are stumbling blocks to this approach.

For example, an insulation contractor needs to determine an appropriate level of insulation to add, which will require an evaluation of what is already in place, essentially an "audit in advance." Conducting a whole-house energy audit in advance, rather than just evaluating the insulation, could slow sales in the main line of business or result in loss of sale if the audit reveals other, higher priority needs beyond the contractor's capabilities. Also, pre-retrofit whole-house evaluation might not be feasible in the face of urgent demand such as a water heater failure.

Offering whole-house energy audits after the primary sale may not result in further sales. In either scenario (audit in advance or after primary trade work), the energy audit alone would need to be a net financial gain to be justifiable. The net profit from an energy audit would not likely be adequate compensation, though, if the audit does not result in additional sales.

Another consideration is that trade contractors do not generally have ongoing relationships with clients that can serve as a platform to offer audits at another time. Most have "one and done" business models, meaning that they are involved with each house only once, and then their services are no longer needed. If a contractor could expand to offer additional minor measures

from other trades; for example, water heater wrap or lighting improvements, it might draw staff away from main line, higher profit work.

One possible exception to this is found in the HVAC business. HVAC contractors often have service contracts with clients that provide an opportunity for sale-of-audit services. Further possibilities arise for this trade when mechanical equipment fails. A whole-house audit, either before or after replacement, may reveal additional trade-related issues such as duct leakage that could result in further work. However, if an HVAC contractor incorporates a comprehensive audit approach, ethical standards may require disclosure of other, more beneficial improvements, which again may not result in additional sales for the contractor. A less comprehensive evaluation restricted to the HVAC system, possibly including whole-house pressure balance and return air pathways, would probably have a higher likelihood of additional sales than would a full audit.

A matrix of strengths and weaknesses is presented in Table 3, including opportunities for and threats to success as deep retrofit providers.

Table 3. Energy-Related Trade Contractors With Audits as a Secondary Business Line

STRENGTHS	WEAKNESSES
• Communication likely initiated by clients. • Face-to-face meeting with client is part of the initial trade-related visit • Clients may already be interested in energy efficiency (e.g., adding insulation, non-urgent HVAC replacement) and be willing to make an investment • An audit could lend credence to the importance of the contractor's trade *HVAC Contractor-Specific Strengths* • HVAC system has multiple, discrete opportunities for improvement: duct sealing, duct insulating, passive return air pathways, zoning, etc. • Engineering-HVAC Manual J requires basic building science assessment and knowledge as well as awareness of other systems and components • Often, but not always, HVAC is a major component of a deep retrofit	• Front-end audit may slow the sale of main line trade or result in loss of sale • Client may choose a different contractor if the cost of the audit raises the price above the competition • Cost of audit may be an additional financial burden at time of replacement of expensive equipment • Trade work is usually a one-time sell—the contractor must be very aggressive on customer acquisition and on closing to gain follow-on work. May be less of an issue for HVAC contractors with ongoing service contracts • Potential conflict of interest—vested interest in selling specific measure

OPPORTUNITIES	THREATS
• All energy-related trades likely offer measures applicable to a large portion of existing homes • Use of in-house customer databases to promote "follow up" services • Close to customers—contractor is already on site with client's attention • Additional, minor efficiency measures could be accomplished by in-house staff. • Partner with independent assessor or other like-minded general or trade contractors *HVAC-Specific Opportunities* • Follow-on audit as part of service agreement • Complimentary audit as part of replacement could reveal other HVAC-related improvement opportunities and result in additional sales (less likely for insulation, window, water heating systems without multiple system opportunities)	• Client does not understand value of trained contractor • Good analysis may point away from core business • Lack of knowledge about other trades may result in bias, missed opportunities, or inaccurate cost estimates • Urgency of much trade work could preclude doing an energy audit before attending to main line business • Fluctuation in incentive programs limits window of opportunity to sell higher efficiency options • More/different insurance may be needed to cover audit activity • Offering audits may require cross training of staff, higher aptitude staff, or hiring an auditor—this may push staffing costs beyond benefit of secondary line of business

Trade contractors conventionally conduct QA and QC only within the systems they install. Though a single trade may play a large role in a deep energy retrofit in any given house, it may also raise risks that are not apparent in the absence of a whole-house assessment. For example, new windows may significantly reduce heat gain or loss, and reduce infiltration. Changing infiltration may adversely affect airflow and pressure dynamics, which are generally outside the realm of window replacement QC. Nonenergy-related trades can have a similar impact; for example, when drywall penetrations are created for new plumbing or lighting fixtures, it may alter infiltration rates or air pressure dynamics. Conducting even an abbreviated energy audit as part of QC among all energy-related trades may reduce the risk of inadvertently degrading whole-house performance. Trade-specific building science courses for continuing education may help usher in a broader industry awareness of system interaction necessary for wide implementation of deep energy retrofits.

Another challenge arises when a homeowner pursues a deep energy retrofit by implementing a series of energy-related improvements, essentially acting as the general contractor. The order of improvement could have a dramatic impact on whole-house performance opportunities. For example, replacement HVAC equipment could be smaller if it were installed after envelope improvements such as new windows and additional ceiling insulation, which reduce heating and cooling loads. However, if it is installed first with the capacity to meet the initial heating and cooling loads, it may be oversized when subsequent envelope improvements are made.

Oversized equipment can lead to comfort issues during the cooling season. Another potential downfall in this single, trade-focused model for deep retrofits occurs when contractors are not mindful—or even aware—of critical performance elements of other trades. A contractor who cuts a hole in an interior duct chase for electrical or plumbing runs may unintentionally compromise the performance of the mechanical system. This may result in greater duct leakage to the outside, eroding whole-house performance (McIlvaine et al. 2002).

2.3 General Remodeling Contractor

A general remodeling contractor traditionally assesses client goals, existing conditions, and risks, and then manages a multifaceted remodeling project that often involves multiple trades. The general and the trade contractors conduct QC. With adequate building science training, general remodeling contractors could conduct whole-house audits and supervise implementation with QC to address potential risks. This requires, however, a major shift to thinking of systems as interdependent rather than independent. Even if audit and analysis capabilities were subcontracted or developed in house, a change in management culture would likely be needed to consistently achieve whole-house metrics. Under this scenario, the client receives invoices only from the general contractor who supervises all phases of the work to ensure that the specifications are met. This may significantly reduce the hassle factor for the homeowner.

In this model, energy efficiency could be addressed in the context of a broader remodeling scope. A general contractor, with training, is in a better position than trade subcontractors to conduct whole-house QA and to oversee system interactions. General contractors with experience in high performance new construction may be able to parlay that into remodeling with high performance features. The SWOT matrix in Table 4 shows other opportunities for this business model.

Table 4. General Remodeling Contractor Expanding To Offer Deep Retrofits

STRENGTHS	WEAKNESSES
• Clear chain of responsibility for whole-house performance • Offer as many trades as necessary to meet goals • Experience with coordination of trade contractors	• General construction knowledge may be insufficient to identify trade-specific opportunities • Vested interest in selling higher profit margin improvements
OPPORTUNITIES	**THREATS**
• Partner with independent assessor • Add deep retrofit goals to comprehensive renovations • Add deep retrofit as a specialty line of business, independent of general remodeling or new construction activity	• Lack of building science knowledge adequate to prevent/correct whole-house performance issues • Retention of more highly trained site supervisors may require higher salaries

2.4 Home Performance Contractor

Rising utility costs coupled with federal, state, and utility incentives have created a demand for home performance contractors in some areas of the country where whole-house, performance-based metrics serve as the basis for retrofit evaluation. Similar to general remodeling contractors, home performance contractors work at the whole-house level, coordinating all aspects of

implementation. They do not routinely deal with general remodeling (e.g., kitchens and additions); however, they do provide pre-retrofit assessment and recommendations as well as QA whole-house performance.

Home performance contractors are ideally suited for deep retrofit delivery. They can focus on efficiency improvements without distraction of general remodeling and, usually, the building science training necessary for risk avoidance. Implementation is generally completed by in-house staff. But this model is not without drawbacks.

One challenge of this business model is assembling a staff that can achieve whole-house performance goals and keep them engaged. For example, an in-house air sealing crew may not have the credentials to do the mechanical work, and it may be too expensive to pay a mechanical crew to do air sealing tasks. Crews that are tailored to specific tasks may have excessive idle time. Conversely, if crews are cross-trained for multiple tasks, salaries may need to increase. Additionally, depth of knowledge for cross-trained crews may be sufficient to carry out common tasks, but not deep enough to identify and resolve trade risks on the job.

When training or sales are tied to specific efficiency incentive programs, important opportunities not included in the program may be overlooked or omitted because of financing issues. Although home performance contractors who participate in a third-party credential program may provide clients with conflict-of-interest disclosures and other transparency measures, consumers may believe the contractors have a vested interest in selling higher profit improvements or improvements targeted by incentive programs (Griffiths 2011). This is a major weakness of this business model (see Table 5). Both emerging business models address this barrier.

Table 5. Home Performance Contractor

STRENGTHS	WEAKNESSES
• Expertise specifically in building science and home performance metrics • Offer as many trades as necessary to meet goals • Clear chain of responsibility for whole-house performance • One-stop shopping • Third-party credentials	• Conflict of interest (perceived or real) between assessment and sales • Lack of general, nonenergy-related construction knowledge
OPPORTUNITIES	**THREATS**
• Grouping incentives from several programs and simplifying homeowner decision-making process and submission of paperwork • Respond to needs of early adopters	• Overhead on multifaceted, in-house team. • Inadequate work load to keep in-house staff busy

3 Emerging Business Models for Delivering Deep Energy Retrofits

The threats and weaknesses identified in Section 2 for conventional remodeling industry business models do not necessarily keep those providers from conducting deep energy retrofits. However, business models may emerge that answer these and create new paths for deep retrofit delivery. Two such emerging models are described here:

- **An "alliance" approach that is championed by RESNET.** This strategy brings together assessors and subcontractors in teams that work together to deliver deep retrofits, but maintain independent businesses.
- **An "expansion" approach that has appeared in the remodeling industry over the past few years.** Specifically, the profile here looks at an HVAC contractor who has expanded capabilities to include whole-house assessment and implementation of improvements outside the HVAC trade, some of which are subcontracted.

A SWOT table is provided for each model, including a discussion of the deep retrofit barriers that each emerging model addresses.

3.1 Contractor "Alliance" Business Model for Deep Retrofits

Deep retrofits could be delivered through an alliance of energy-related trade contractors, including an independent assessor, working together to promote and conduct a coordinated effort. Homeowners could still work directly with each contractor individually and implement the retrofits in series, but with more thought given to system interactions. Trust among team members could be fostered through third-party or trade-specific credentialing.

A challenge to the success of this model might originate from competition within the alliance. Each contractor would have a vested interest in their trade being among the most important recommendations. Ethical evaluation standards would need to be established about how to handle audit results that point away from the trades represented in the alliance. This model would not automatically deal with whole-house quality issues, such as pressure balancing, that exceed the conventional QA practices of trade contractors. Credentialing through building science training channels could build awareness among trades, and teams could collectively agree to meet whole-house performance specifications. In the event of poor whole-house performance, it may be difficult (but not impossible) to assign responsibility for correction. Table 6 shows a SWOT characterization of this model followed by an example program that seeks to resolve the weaknesses and threats.

Table 6. Alliances of Energy-Related Trade Contractors for Deep Retrofits

STRENGTHS	WEAKNESSES
• Coordination of assessment and implementation reduces risk of whole-house durability, IAQ, and comfort issues • Additional leads from others in alliance • Clients contacting one energy-related trade may be interested in other energy efficiency work • A single audit could inform work of multiple contractors • Project initiation could begin with any of the allied contractors • Agreements among team members could build confidence and trust across trades • Credentialing of individual partners may build consumer confidence	• Unclear chain of responsibility for whole-house performance • Cost of audit may be an additional financial burden at time of replacement of expensive equipment • Disproportional profit margins among allied contractors may cause friction
OPPORTUNITIES	**THREATS**
• Tap into partners' databases of past clients • Each member promotes the whole team	• Untrained competitors offer lower bids • Client may want a contractor outside the alliance for specific trades • Client does not value integrated approach • Analysis may point to trades outside the alliance • Competition within alliance for limited funds in each house

3.1.1 RESNET EnergySmart Home Performance Teams—Example Alliance Approach for Deep Energy Retrofits

RESNET is a standard-making body concerned with the home energy rating and finance industries. RESNET standards are widely embraced within the home energy rater professional community and recognized by national programs such as the ENERGY STAR for Homes program and DOE's Challenge Home program. RESNET certifies HERS raters and qualifies other construction and remodeling industry professionals.

RESNET has developed a program called the EnergySmart Home Performance Team (RESNET 2012) to capitalize on the strengths and opportunities shown in Table 6, as well as those shown for independent assessors in Tables 1 and 2. The RESNET EnergySmart Team approach also addresses many of the weaknesses and threats for the contractor alliance business model shown in Table 6.

The EnergySmart Team program involves a formal agreement among allied contractors engaged in high performance retrofits. Program parameters were guided in part by a RESNET survey of 702 industry stakeholders. The response sample was composed of HERS raters (77.5%), trade contractors (12.9%), and general contractors (9.6%). Nearly 75% of the respondents were

already involved in retrofit activity with 1–9 jobs per month. Respondents reported that roughly 75% of the jobs valued below $6,000.

Of the remaining respondents, about half indicated that they were interested in getting involved in retrofits. Many cited a high priority for maintaining a business model distinct from the implementation side of deep retrofits, thereby preserving the third-party, independent character of assessments. Respondents indicated that finding and coordinating trade contractors was outside their core business model. The complete results of this survey are included in the Appendix.

Bianchi (2011) identifies lack of familiarity among trades as a barrier to deep retrofits. Under this allied team approach, members pool their expertise and relieve subcontractors of the burden of becoming experts in other trades. Team members may provide each other with referrals, and partnering could also provide co-marketing opportunities. EnergySmart Teams collectively develop, complete, and verify deep retrofit jobs. Each EnergySmart Team must meet the following criteria:

- At least one certified HERS rater to assess existing conditions and recommend energy improvement strategies and to independently verify the quality and effectiveness of the completed work.
- At least one state-licensed heating and air conditioning contractor (if that state requires a license) who is a recognized participant in the Air Conditioning Contractors of America (ACCA) QA Program.
- At least one RESNET EnergySmart contractor who specializes in air sealing and insulation and who employs at least one senior technician who is an Insulation Contractors Association of America certified insulation installer or has received a completion certificate for another RESNET-recognized, quality-installation training program.
- Any number of other home improvement contractor companies that have their RESNET EnergySmart contractor designation.

Under the EnergySmart Team business model, any of the EnergySmart contractors or the HERS rater on the team may act as the project manager. Team members may work with multiple teams. For each project, the project manager assembles the team to provide assessment, implementation, and a final inspection to ensure the quality of the work. The team also measures the projected energy savings and verifies that those savings meet the prescribed target.

Contractors and raters working on home performance teams can simplify the deep retrofit process for homeowners. The homeowner will have some assurance (based on third-party qualifying procedures) that the contractors understand more than just their specialty. Required training ensures that all team members are aware of trade-specific performance factors as well as their roles in meeting whole-house performance targets. Consumer confidence in the contracting team may be bolstered by the EnergySmart credentialing and QA training among the team members.

3.1.2 Barriers Addressed by the RESNET EnergySmart Home Performance Team Alliance Model

The EnergySmart Team model was developed specifically to address nontechnical barriers that impede the development of a national retrofit infrastructure.

Barrier: Energy audits often are not converted into retrofit sales and energy savings.

Without an integrated approach (RESNET teams or other allied partners) after the independent assessor evaluates a home and provides recommendations, the homeowners must find and coordinate qualified contractors to do the work. Determining which contractors are qualified and then acquiring and evaluating quotes takes a sustained and diligent effort—all before the actual work begins. In the end, retrofits are often tabled because the scope of activities is unfamiliar and daunting to clients. Bianchi (2011) reports this as a nontechnical barrier and suggests creating a "hand-off" process between the pre-retrofit evaluation and the implementation phases of a deep retrofit. A team approach that creates a standard process for moving from audit into implementation could bridge this gap.

Referring specifically to the RESNET EnergySmart Team model, the energy auditor works closely with the EnergySmart contractors. This ensures a seamless transition between the energy audit and installation of the recommended upgrades. The designation of a project manager clearly identifies who is responsible for QC to achieve the whole-house performance targets. During this process, the energy auditor works independently (maintaining impartiality) from the contractors completing the retrofit. The homeowner is relieved of finding, evaluating, and coordinating qualified contractors. Assessments, recommendations, and quotes can be produced collaboratively. This provides the homeowner with clearer decision points and can reduce the time lapse between audit and action. Quotes and energy cost savings projections are also more likely to be accurate because they would be based on specific contractors' input rather than an assessor's estimates.

Barrier: Single-trade contractors are required to change their business model to offer deep retrofit services.

In the traditional home performance contractor business model, a single company conducts the initial audit and testing, develops a scope of work, installs all the energy improvements, and conducts the final evaluation. This process requires traditional HVAC, insulation, and air sealing contractors to change their business models and become "one-stop shops," which is an expensive and time-consuming transition. Insufficient knowledge about new lines of work may also introduce greater risks.

In the EnergySmart Home Performance Team model, an individual trade contractor does not have to change its business model to participate in the comprehensive energy upgrade. Instead, the trades work as a team in conjunction with a certified independent home energy rater. This mitigates the entry barrier for trade contractors. The EnergySmart guidelines were written in cooperation with the contractor associations to meet the needs of their contractors.

Barrier: Performance targets and standard methods of calculating energy savings from home energy upgrades are lacking.

Traditional home performance efforts have largely been a process and not a product. The certification and procedures were explained; however, no energy-saving goals were established. In addition, energy modeling was not required, and no savings estimates were calculated based on the installed improvements. This provided little incentive for a homeowner to improve the home. It also made it difficult to recover the investment when selling the improved home.

The EnergySmart Home Performance Team procedures require that the rater undertake an energy modeling analysis using RESNET-accredited software to calculate the energy savings of the upgrades. This takes place as part of the initial inspection, testing, and development of the scope of work as well as final inspection testing and QA inspection. The RESNET EnergySmart Contractor Standard recognizes RESNET EnergySmart projects that meet a minimum level of improvement and issue a label for the home.

Barrier: Consumer trust in contractors is lacking.

Conventional wisdom and periodic consumer polls show a general consumer skepticism of home improvement contractors, who are perceived to have a vested interest in selling higher profit equipment and services when lower cost options are available. This has been an impediment of the traditional home performance contractor model because all the services, including development of the work scope and the test-out, were conducted by the contractor. Consumers may be wary that such contractors have an incentive to promote the most profitable—rather than the most prudent—improvements.

The RESNET HERS rating standard requires raters to disclose potential conflicts of interest, fostering consumer confidence. In the EnergySmart model, the HERS rater maintains a business separate from the EnergySmart contractors and answers to the homeowner, not to the contractors.

Bianchi (2011) reported that stakeholders identified difficulty for homeowners in understanding building science as a nontechnical barrier to deep retrofits. Under this business model, the HERS rater acts, to some degree, as the homeowner's agent to ensure that the improvements chosen are prudent and that the job is completed according to the specifications. This provides the client peace of mind that the work was needed and completed according to the work scope.

Barrier: QA required by government- and utility-sponsored home performance programs carries an additional cost.

When incentives are involved in deep retrofits, sponsors need assurance that the measures they are subsidizing are installed properly. The traditional home performance contracting model, where all the work is completed by a single contractor, requires sponsoring programs to invest in third-party QA reviews. This adds an administrative burden to program sponsors and ensures that only sponsors with large resources (generally government agencies or large investor-owned utilities) can participate.

Under the EnergySmart model, independent QA inspection and testing by a certified HERS rater, bound by the ethical requirements of the RESNET rating standards, is integral to the process. This may satisfy program sponsor needs and save them from investing scarce resources for QA. In turn, smaller organizations can become program sponsors, and traditional sponsors can allocate more resources for actual installation of upgrades or marketing. This also helps build a market-driven program that does not rely on utility or government incentives.

3.1.3 Status of RESNET EnergySmart Home Performance Team Standards

RESNET's EnergySmart guidelines were adopted by the RESNET board of directors as interim guidelines until they could be made an official Chapter 10 of the RESNET standards.

The RESNET board created a RESNET EnergySmart contractor standard task force to convert the guidelines into a standard amendment. The task force made significant enhancements to the interim guidelines, which have become part of the proposed amendment, including:

- EnergySmart contractors must carry insurance.
- QA procedures must be definedfor EnergySmart contractors.
- An EnergySmart project must be created where the homeowner receives a label for a home whose energy consumption is modeled to be 30% more efficient after the whole-house retrofit.
- The Existing Homes Evaluation and Performance Improvement Standard must be incorporated. This is the first American National Standards Institute (ANSI) consensus standard on energy audits and retrofit of existing homes. (ANSI/ACCA Standard 12 QH-2011).

The proposed amendment to the RESNET standards (RESNET 2012) underwent the RESNET standard public review and comment process ending on June 1, 2012.

A standard has greater weight in the marketplace than a set of guidelines because it reflects stakeholder input and approval by a committee with broad industry representation. A formal standard can be referenced by legislation and programs to maintain an even playing field. Two pieces of bipartisan legislation (Snowe et al. 2011; McKinley and Welch 2012) were introduced in Congress to provide performance-based incentives for homeowners to make whole-house energy upgrades to their homes. Both reference the RESNET EnergySmart Home Performance Teams and Contractors certified through the Building Performance Institute.

Buy-in from trade associations could foster training and participation of individual trade contractors in the EnergySmart Team or other alliance approach to deep retrofits. Trade associations are poised to deliver deep retrofit concepts and training in the language of the trade contractor and to establish quality installation standards for their industry.

RESNET has entered into Memorandums of Understanding with a wide array of organizations to draw multiple pools of stakeholders into the alliance concept for delivering deep retrofits. Partnering trade contractor associations have committed to educate their member contractors and

to provide support to their members in joining EnergySmart Home Performance Teams. Additional partners include training providers, product manufacturers, and distributors.

3.2 Contractor "Expansion" Business Model for Deep Retrofits

Under this emerging business model, a general remodeling or energy-related trade contractor expands in-house capabilities rather than collaborating with other independently operated businesses. Under this model, a trade contractor expands building science knowledge to cover whole-house assessment, savings calculations, and work by other trades needed to meet deep retrofit goals. Section 2.2 discusses several challenges associated with incorporating a whole-house assessment into a trade contractor business. These included the potential for delayed or lost sales if the whole-house assessment identified higher priority efficiency improvements than the company's main line of business. Under this emerging model, a company develops the capability to capture the sales of other trade improvements, in addition to the whole-house assessment capability.

Thomas (2006) indicates that common deep retrofit opportunities and challenges at the local level can be anticipated and can guide contractors in identifying which capabilities to add. By developing in-house expertise in those areas, trade contractors can offer whole-house audits with confidence that they can implement the key recommendations.

As mentioned in Section 2.2, HVAC contractors may have an advantage over other trade contractors for adopting an expansion business approach because the system involves multiple opportunities to improve efficiency. This means that after a replacement or service call, other issues may still persist. Furthermore, service contracts are most common in the HVAC trade. It would be unusual for a service contract to accompany window replacement, insulation, or water heater replacement work. Service calls provide HVAC contractors with an opportunity to offer a whole-house assessment with an implementation proposal that includes non-HVAC improvements. This is a substantial reduction in hassle factor for the client, who thus has the opportunity to work with a trusted contractor who can accomplish all the work. The client's burden of sorting through priorities and identifying qualified (trained) contractors is diminished.

This model addresses many of the weaknesses, opportunities, and threats identified in Table 7 for trade contractors offering audits as a secondary service. Table 7 shows a SWOT characterization of this emerging model and is followed by a profile of one successful expanded HVAC contracting business that has further addressed some of the weaknesses and threats of this model. Much of the material would apply equally to other types of contractors who expand capabilities, although some are specific to the HVAC industry. A profile of a successful expanded HVAC business follows the table.

Table 7. HVAC Contractor With In-House Assessment and Additional Trade Capabilities To Address Common Deep Retrofit Measures

STRENGTHS	WEAKNESSES
• If clients are motivated by high energy bills or discomfort resulting from non-HVAC issues, expanded capabilities may net additional revenue from insulation, air sealing, window tinting, etc. • If audit identifies other common deep retrofit measures, the contractor is prepared to address those • Audit may result in client purchasing other HVAC system improvements such as duct sealing, duct insulating, passive return air pathways, zoning, etc. • HVAC is often a major component of a deep retrofit • Manual J calculations require basic building science assessment and knowledge including awareness of other systems and components—a good foundation for expanding knowledge • Less conflict of interest—multiple areas of sales are beneficial to contractor	• Client may choose a different contractor if cost of audit raises price above competition • Cost of audit may be an additional financial burden when expensive equipment is replaced • If audit costs are not passed on to clients and conversion rates are low, the gains from additional work may not cover the losses
OPPORTUNITIES	**THREATS**
• Use of existing customer databases to promote "follow up" services • Contractor already on site with client's attention at replacement/service • Follow-on audit could be part of service agreement or offered as an option to service that could be paid for later, reducing immediate financial burden • Audits could increase off-peak work load	• Client does not understand value of trained contractor • More or different insurance may be needed to cover audit and other trade activities • Offering audits may require cross training of staff, higher aptitude staff, or hiring an auditor—this may push staffing costs beyond benefit of secondary line of business

3.2.1 TexEnergy Solutions, Inc.—Example of an Expanded Contractor Approach to Deep Energy Retrofits

Responding to changes in consumer demand, codes, and program requirements (brought about primarily by the ENERGY STAR for Homes program in the early 2000s), TexEnergy Solutions was established to offer home energy ratings as a secondary line of business for Tempo Mechanical. This arrangement is a manifestation of the "trade contractor offering audit" business model discussed in Section 2.2, except that initially, TexEnergy focused on new construction while staff members developed the relevant skills for assessing existing homes. As the new construction market cooled, work in existing homes grew. The company leveraged the building

science knowledge garnered under new construction programs to expand its work in HVAC replacement and service to include whole-house audits.

Knowing that, in addition to HVAC improvements, the audits in existing homes would likely identify non-HVAC improvements, TexEnergy expanded its capability to implement common measures in other trades by expanding staff knowledge and capabilities. Training costs and the cost of retaining higher value employees must be factored into the financial proposition of expanding capabilities.

Several risks are still in play under this emerging model. An audit may not result in a sale, resulting in both lost opportunity for other sales and lost investment of labor. There may be a conflict of interest, real or perceived, in selling both an impartial audit and implementation.

TexEnergy has created an interesting solution to the conflict of interest and audit conversion challenges. Clients pay an upfront fee of $500 for an independent audit performed by TexEnergy. This separates the curious owners from the serious ones and sets the tone for a more serious financial commitment that is likely necessary to achieve a deep energy retrofit.

The recommendations from the audit are presented to the client with recommendations and an economic analysis based on a complete price proposal. There is no further obligation to work with TexEnergy; however, the cost of the audit can be applied toward the cost of implementation. Thus, the cost of the audit is underwritten, and the recommendations do not necessarily result in a direct benefit to TexEnergy.

Many people are interested in saving money. In the marketplace, consumers have access to free but less comprehensive audits. Selling a more comprehensive audit requires a motivated client who is willing to invest and make changes.

A comprehensive audit differentiates the provider from others providing free audits. Clients sometimes come to TexEnergy because of high energy costs, poor IAQ, or comfort issues. TexEnergy uses the audit to build client confidence by explaining the diagnostic procedures and the building science principles driving their complaints. This results in a higher conversion rate. The audit procedure has evolved over time. Key business goals are to balance the time necessary to adequately model the house and complete economic analysis against the need to respond to the client quickly with recommendations.

TexEnergy's comprehensive home energy audit template and inspection strategy includes duct system testing, which is a common element of energy audits and HVAC performance testing, which is uncommon but takes advantage of expertise within sister company Tempo Mechanical. Performance factors, such as temperature drop, fan speed, charge, and coil condition have real impacts on whole-house performance. However, assessing these characteristics generally falls outside the capability of auditors who are not HVAC contractors.

These improvement opportunities are available in many systems regardless of age, thus providing an opportunity for HVAC service even when the major components do not need replacement. This and similar system optimization tasks, such as improving duct insulation and layout (kinked runs, closed dampers, etc.), enhance comfort and may carry building durability benefits. Whereas an equipment change-out may satisfy the client's initial need, a whole system

assessment in the context of a comprehensive audit reveals opportunities that could result in higher client satisfaction and an increase in referral business.

In addition to HVAC performance measures, TexEnergy staff handle several deep retrofit improvements that commonly show a positive return on investment. These include repairing thermal bypasses (usually in attics), additional attic insulation, moderate air sealing, lighting, and appliances. TexEnergy subcontracts window replacement, which is another large component of the cooling load in Texas' hot humid climate. In this area and in a few others, TexEnergy has developed solid relationships with local specialists who are recognized experts. This is a win-win-win arrangement. TexEnergy gets reliable work without having to build and retain in-house expertise in these areas. The subcontracted trade specialist gets a sale without marketing or customer interface. And the homeowner does not need to coordinate with an additional contractor.

In the TexEnergy model, the initial sales call and audit with a project manager and one or two field auditors take two to four hours. The modeling and analysis by a member of engineering team and the project manager takes two to four hours, and the final sales call by the project manager takes approximately one hour. Throughout the process, there is an effort to educate the homeowner. This time investment is a gamble that it will result in an implementation contract. But it is a calculated risk because a client who is willing to spend $500 on an audit is likely more motivated than one who is not. The motivation commonly stems from either (1) a belief that a serious problem exists; or (2) an interest in long-term affordability. If no sale results, though, the audit is actually a loss because the $500 fee does not fully underwrite the labor. The conversion rate, however, is high enough to keep the model in place.

Most of the company's deep retrofits are in houses that are typical of the region, allowing staff to build expertise with specific building types. Commonly, homes were built between 1970 and 1985 and valued at $125,000 or more with high utility bills, comfort issues, or an IAQ problem significant enough to merit seeking assistance. Clients typically have the financial means to resolve the problems. This age home is very common in the area, whereas homes built before 1955 are in the minority. The small homes built in the 1950s and earlier are often replaced rather than remodeled.

TexEnergy leads come primarily from word of mouth. This business line helps to keep employees working during winter months (off peak for cooling climates). As such, the company's capacity for energy audits varies with staff availability, so its audit and deep retrofit line did not expand rapidly. Growth must be handled carefully to prioritize business goals. Promoting audits through the Tempo Mechanical service department might create higher demand. But this could overcommit staff or draw staff away from higher profit margin work. TexEnergy points out that, in its case, the assessment process runs at a slight deficit, so it makes the most business sense to conduct audits for highly qualified clients who are likely to convert the audit into implementation work in the winter.

3.2.2 Barriers Addressed by the TexEnergy "Expansion" Model

Barrier: Launching a second line of business in deep retrofits may strain resources for both lines and create a range of human resources issues.

Considering the business model of a trade or general remodeling contractor expanding into home performance, new experts must be hired or developed within the current staff. This may mean that some human and financial resources usually spent on the primary line of business are lost to training and development for the second line. In an effort to limit this effect, training and development may be invested in one person, or a new employee may be hired.

Centering a home performance business on one key retrofit leader carries several risks. This key staff member may necessarily function as the retrofit salesman, rater, analyst, project manager, and certification agent. If that person is still involved in the main business line, attention becomes divided, which may compromise quality on both fronts. The company risks losing institutional knowledge and the potential return on investment in training and development if the person leaves the company. And the whole process may come to a halt in that event.

With the multiple roles this person plays, the potential for additional sales becomes strained while he or she implements and verifies earlier sales. To scale up business, a new point person needs to be created, or the responsibilities need to be divided to allow the point person to concentrate on a smaller set of activities.

The TexEnergy model deals with these challenges by diversifying skills and spreading training, responsibility, and project management over a small staff who share the retrofit work load and collectively resolve problems. The home performance work is divided among three work functions: sales (one manager per project), energy engineering (team), and field audits (team).

The project manager meets the client at an initial visit to document the client's wants, desires, thoughts, and issues for incorporation into the audit study. Like other sales positions, those with good interpersonal skills and business sense excel in this role. The accompanying field audit team (generally one or two individuals for each audit) conducts a thorough energy audit, including inspections of envelope and equipment characteristics along with whole-house and duct airtightness testing and observations. They also perform any energy code and above code program inspections needed for the job. Staff in this position prefer hands-on work to office work and are committed to applied knowledge and on-the-job problem solving.

The energy engineering team partners take data collected in the field from both the project manager and field auditor team to complete the HVAC load calculation and the energy model for the home. Team members have the skills and capacity to perform the work of both the project manager and the field auditor, but have chosen to focus on energy modeling and building performance simulation. Ideal candidates for this role are very detail oriented with a deep first-hand understanding of construction and performance factors. The team models the house and provides results to the project manager, who then uses an internally developed template to build several improvement options with associated costs. These are presented to the client as part of the audit presentation.

In all three job roles, employees specialize in one task area rather than taking on responsibility for sales, audits, and modeling. The project manager focuses on client satisfaction, field auditors concentrate on thoroughly applying a standard process for characterizing each unique house, and the engineering team can build expertise in modeling existing homes, which are often more

complex than new houses having undergone periodic modifications. If a person needs to be replaced, training is required for only one area of responsibility.

Barrier: Pricing a comprehensive assessment low enough to be affordable may not cover costs, but without accurate assessments and cost estimates, it is difficult to make a case for major improvements and investments.

Essentially, in the TexEnergy model, the initial assessment is conducted in hopes of converting the audit into a sale for the sister company, Tempo Mechanical, which handles the mechanical system improvements and acts as the general contractor for in-house crews and subcontractors to complete the full scope of work. Whether split up in this manner or consolidated into one company, time spent conducting audits that do not convert into contracts can drain financial resources. That happens if the price is too low to filter out merely curious clients. Conversely, if the price is too high, no one will be interested. The challenge is to find a balance point that will cover costs, discourage uncommitted clients, and provide enough value to warrant investment. The barrier manifests when the market will not bear the actual cost of the audit.

TexEnergy reports that this is the case in its market; however, it continues to offer comprehensive evaluations when staff members are available, meaning they are not drawn away from other revenue-generating activities, and at a price that attracts a wide audience and discourages "tire kickers." The $500 fee was decided after lower prices generated too many dead leads, and higher prices produced limited market response. TexEnergy concludes that this is a reasonable fee for clients who are serious about making improvements. It does not, however, cover actual costs.

In essence, the strategy competes with free audits because the $500 upfront is applied to the total cost of the retrofit if the client chooses Tempo Mechanical to coordinate the work. If clients choose to work with a different contractor, they still have a high quality audit report and recommendations useful for soliciting bids. At this price point, the conversion rate of assessments into implementation contracts is sufficient to risk conducting the assessment at a loss. The assessment process works to establish credibility and opens dialog about whole-house performance that often exceeds the client's initial interest.

For TexEnergy, reducing assessment costs and increasing the efficacy of implementation contracts are primary business objectives pursued through several paths. These include refining lead generation and qualification, improving modeling procedures, and reducing the overhead and effort required for assessments. The field audit team uses a standard procedure day in and day out, outlined in an audit handbook, that builds familiarity and improves speed. Increasing assessment speed reduces the company's financial burden if the lead is not converted into a contract. It also allows staff to conduct more assessments, if qualifying leads are available, raising the odds of netting a contract.

An opportunity to increase the value—and possibly the fee—associated with initial site visits may be found in implementing low-hanging fruit improvements such as lighting replacements, water savers, cleaning of refrigerator coils and exhaust fan housing, insulating accessible hot water pipes, and airflow control recommendations. Leaving behind a tip sheet to accompany the recommendations and a tangible reminder, such as a digital temperature and relative humidity

meter, may build awareness of comfort conditions uncovered by the audit. A mechanical system tune-up that produces a palpable improvement in household comfort may give the client a lasting reminder of the company's capabilities.

A real threat in this area comes from insufficient knowledge about other trades and lack of reliable cost data. If the price proposal reflects poor estimates because of misinterpretation or incorrect assumptions, the final bill may be off by orders of magnitude. The company is then faced with the dilemma of absorbing the overrun or passing the cost to the client. The former reduces the profit margin; the latter jeopardizes customer satisfaction.

Barrier: In the absence of incentives, the sales cycle for deep retrofits is slow.

Addressing whole-house performance often requires addressing complex, multifaceted issues. These can be difficult for homeowners to understand and digest. It is difficult to sell a solution to someone who does not understand the problems. Government, utility, or other sponsored incentives and programs add credence to contractor recommendations and build consumer confidence. The incentives take some or all of the financial burden off the client. Sponsored incentive programs usually have time limits.

In the absence of these factors, clients face spending considerable sums, perhaps tens of thousands of dollars, on a deep retrofit. Upon receiving such a price proposal, even serious clients may take a considerable amount of time to review technical recommendations and economic analysis, explore possible alternatives, and gauge the importance of the work against competing priorities. TexEnergy reports that the time lapse from initial assessment to retrofit completion commonly exceeds one year. During that time, the company absorbs the cost of the assessment and must have the internal capacity to respond if and when the client decides to proceed. If the company cannot respond in a timely manner, the opportunity is likely lost. Further complicating the situation, sales staff may be personally frustrated by the slow pace of sales. Consequently, they may request other assignments with more immediate gratification or leave the company. If they are key leaders in the retrofit business, investment in training and development along with institutional knowledge are lost. When audit and retrofit work are positioned in the context of a main line of business that does not depend on these delays, some of the downtime is absorbed by other activities, reducing the overall idle time of staff.

3.3 Overall Business Model Challenges

In Section 1, we introduced five challenges that face all deep retrofit operations regardless of the level of integration between assessment, implementation, and whole-house QC. The following summary explains how two emerging business models—contractor alliances and contractor expansions—address these five challenges.

1. **Cost of pre-retrofit assessment and conversion of audit into a job.** In both the alliance and expansion models, a price proposal based on an actual quote for implementation can be presented with audit recommendations. This reduces the client's burden of finding and coordinating multiple contractors. Simplifying the decision-making and implementation processes eliminates some of the hassle factor that sometimes prevents a homeowner from moving forward with a comprehensive retrofit.

Third-party credentialing in the RESNET EnergySmart Home Performance Team model may also raise client confidence and facilitate a higher conversion rate.

In the TexEnergy example of contractor expansion, the client pays a $500 fee for the audit that is separate from the implementation. This partially offsets losses if the audit is not converted into a sale. It also ensures that audits are conducted for highly qualified and motivated clients who are ready to make an investment. This contractor places an emphasis on client involvement and education during the audit, particularly if the client has a high bill, IAQ, or comfort issue. Although the extra time increases the potential for loss, it builds client confidence and enhances the likelihood of a sale.

2. **Ethics.** A contractor must decide how to handle situations when the best interest of the client is at odds with the company's interests.

   In the alliance model, the assessor maintains an independent relationship with the client. Contractors work together with the full knowledge that jobs will require different trades that are determined based on an independent audit. In the RESNET EnergySmart Team model specifically, assessors conduct business within the framework of RESNET's National Standard for Home Energy Audits, which requires assessors to disclose to clients in writing potential conflicts of interest (RESNET 2013).

   In the expansion model, the contractor develops in-house capability beyond the original area of expertise. This is no longer a business threat (as it would be if only one trade were being offered), because the expansion model makes provisions for capturing the sales of multiple trades under one umbrella. Ideally, such a contractor would be able to accomplish all the work identified in an audit, thereby reducing the chance of an audit directing work away from the contractor. In the TexEnergy model specifically, a menu of core high performance improvements are handled in-house, or with subcontracted work in a few areas. The contractor still profits from the subcontracted work, so it is a net gain. The client is not tasked with selecting, coordinating, and supervising subcontractors. Additionally, TexEnergy assessors also abide by the RESNET audit standard and provide conflict-of-interest disclosures, adding another layer of client protection.

   Also working in favor of the client's best interest is that in both models, the economic calculations are based on actual price quotes on which the contract will be based. Thus, it is in the interest of all that the costs and benefits be accurately portrayed.

3. **Expertise.** Mitigating risk will likely require building science expertise.

   Building science training that teaches "house as a system" thinking will help prepare contractors for on-the-job problem solving and their roles in meeting whole-house performance targets.

   In the alliance model, training required for trade-specific certifications and credentials help to develop a common body of knowledge, understanding of system interactions, and trade crossovers. The RESNET model has a formal set of training requirements for EnergySmart Team members.

In TexEnergy's expansion model, depth of knowledge varies among staff members according to responsibilities, but managers report striving to develop a company-wide culture of high performance housing that fosters awareness of system interactions. This enables in-house staff to better recognize risks in on-the-job situations, even if the issue is outside their specialty.

4. **Human resources.** Retaining highly trained staff may increase the labor costs of deep retrofit providers. In a slow sales cycle, talented employees may grow frustrated and move in other directions.

   In both the alliance and expansion models, clients still may not value the benefit of knowledgeable and capable contractors. In the RESNET team model, this is addressed to some degree by promoting the team concept (by all members) as a different way of dealing with homes, essentially differentiating the approach from business as usual. The national branding of a program such as the RESNET EnergySmart Team may differentiate the additional services from other contractors. All these things raise the chances of sales success, which is paramount to staff retention.

   In the TexEnergy model, investing in the development of multiple key employees reduces the risk of shutting down the process if one trained employee leaves the company. Concurrently, cross training of in-house staff reduces the number of people needed to complete a project, lowering the labor burden when sales lag. Retaining a focus on a main line of business to keep most employees engaged reduces the pressure to sell expanded services. Ideally, the expansion of services would reduce idle time in the main line of business but not overburden the staff in the event of high sales of deep retrofits. Striking that balance is a challenge.

5. **Liability.** A lack of building science knowledge can place contractors at risk when retrofits produce unintentional results that endanger a house or its occupants.

   The potential risks in whole-house retrofits are serious, with implications that involve fatality, quality of life degradation, building durability, and occupant comfort. The work of any single crew may unintentionally affect the performance of the whole house. To minimize liability, QC procedures and performance metrics are needed at the whole-house level, not just the system level.

   The RESNET EnergySmart alliance model addresses these issues:

   a. It requires participating members to acquire certifications so they can perform adequate QC within their trades and understand the relationships of their work to the other trades.

   b. The team designates a project manager for each job who is ultimately responsible for whole-house performance metrics.

   In the TexEnergy expansion model, an in-house project manager plays the same role—and ultimately has responsibility—for the whole-house metrics. Having multiple people

on each job who are trained in building science raises the chance that risks will be identified and addressed early in the process before they become problems.

4 Future Needs

4.1 Spurring Consumer Demand

For widespread deep retrofit activities to occur, consumers need clear guidance. Information provided by manufacturers, utilities, government programs, etc. often present conflicting information and create confusion in the marketplace. This is understandable to some degree because the retrofit priorities for any given house can differ dramatically from those next door, even if they are of the same vintage and design. Regardless, consumers need a common frame of reference for understanding energy options and factors that influence priorities. With that in place, stakeholders in the deep retrofit value chain, from consumers to program managers, would have a common language and an advanced starting point for decision making.

Deep energy retrofits are complex; shallow retrofits are more straightforward. Instituting nationwide shallow retrofit guidelines could advance understanding and empower consumers to make low-risk, low-cost improvements with modest personal benefits but large collective benefits. The initial effort could consist of a do-it-yourself checklist of off-the-shelf improvements and a guided self-audit. The audit could help consumers identify and characterize the energy-related features of their homes and understand the improvement options. If this is done well in advance of urgent replacement needs, more efficient options may be more highly valued with less education effort by contractors. This increase in market pull could in turn drive contractors toward building science education. The free DOE Home Energy Saver online simulation tool (Home Energy Saver 2013) provides a simple way for consumers to explore priorities for their homes. This, coupled with a second tier of low-risk, low-hanging-fruit improvements with a modest investment ceiling (e.g., $500), could be a stepping stone to a third-party energy audit that has full whole-house performance metrics. Several projects with a tiered nature were explored in DOE's Better Buildings program (DOE 2011b).

Monetary incentives, such as the federal tax credits and utility rebates, create market pull, reduce the education burden on contractors, provide non-urgent work during off-peak seasons, and clarify acceptable product performance standards (from looking at the entire list of what level of products met the government-approved criteria). These programs also provide contractors, manufacturers, and retail outlets with a promotional foundation for higher performance options. These programs successfully spur the adoption of specific, system-level improvements. However, the complexity of providing program-level QA and management all but precludes conducting similar programs for whole-house improvements. Complexity of program management was cited at the Building America Expert Meeting on Utility Incentive Programs as a key barrier for whole-house retrofit incentives (Kerr and Kosar 2010).

4.2 Enhancing Technical Capacity Industry Wide

In addition to the actual sales of products and services, incentive programs play a role in the industry dialog on what is reasonable, achievable, and worthy of effort. For example, the proposed HOMESTAR program, which did not come to fruition, nonetheless incentivized contractors to think about how the proposed framework would impact the market and at what performance level they could compete. The proposal spurred discussion of the merits, the potential effects, and the effort required to compete in a market where there was significant client demand for higher performance products, systems, and implementation goals.

On a state level, the Texas State Energy Conservation Office developed an American Recovery and Reinvestment Act-funded program that granted redeemable certificates to consumers for the purchase of energy efficiency products. A "government seal" of approval on products that were considered energy efficient drove demand from consumers and positioning from retailers, manufacturers, and contractors. The program garnered 38 million website hits and nearly 39,000 rebate reservations. Leveraging this type of program experience into a deep retrofit paradigm would have challenges. The emerging alliance and expansion business models, however, provide a context for accomplishing a whole-house retrofit with limited client coordination that might hold true even if the clients were program managers.

A major impact of these government-backed programs is less obvious but important. Particularly under the HOMESTAR program, comprehensive audits were recognized by legislative bodies to be worth much more than walk-through audits. This was a wake-up call for many in energy-related contracting industries who were not technically able or qualified to deliver the higher value audits in accordance with the proposed program guidelines. Although this created pushback, it also increased enrollment in building science continuing education and certification courses, raising awareness even though the program was never implemented.

4.3 Whole-House Assessment Challenges

Interest in a lower cost audit is very high among all stakeholders. Risk avoidance must, however, remain the first priority in evaluated homes before, during, and after comprehensive retrofits, because the potential risks are dire, particularly when atmospheric combustion gas furnaces and water heaters are involved. Speed and reliability must be balanced.

A major impediment to consumer confidence lies in our ability to predict savings with greater accuracy. Several efforts related to this issue are underway in the Building America program. Results that reasonably match predictions would raise customer satisfaction and likely result in more word-of-mouth promotion. Recent reporting suggests there is much room for improvement in our ability to match or "true up" a simulation model to pre-retrofit utility data to predict savings (Chasar et al. 2012). We need, as an industry, to determine whether the accuracy improvement justifies the time required to do a calibrated modeling effort in comparison to an "asset" home energy rating that assumes standard operating conditions regardless of actual occupancy characteristics. Lower cost, whole-house monitoring devices are now available that could significantly increase the amount of data we have for actual retrofits. However, to be meaningful, these devices would need to be installed in advance of a retrofit to characterize pre-retrofit energy use partners. This could jeopardize sales by increasing the lag time between initial contact and retrofit.

4.4 Financial Language

The financial terminology used to discuss cost effectiveness varies widely from one stakeholder to another. However, one thing is certain: abundant misrepresentations of savings potential in the marketplace complicate the decision-making process for homeowners. Although some misrepresentations are honest misconceptions, others are deceitful. Efforts should be made to correct these marketplace discrepancies. In the way that standardized efficiency testing has defined a level playing field for appliances and equipment, a standardized format for presenting whole-house savings estimates is needed. For example, the savings for a particular strategy, such as reflective roofing, can vary widely depending on house type, climate, and other energy-related

characteristics. Product materials, however, will likely emphasize the higher end of the savings potential range, which will unlikely apply to all consumers. This is a complex issue that complicates decision making. Consumers do not know what to believe, because the conflicting information is probably all true for specific circumstances.

Regardless of decision making, financing deep retrofits remains a key business challenge in the absence of incentives for deep retrofits. Microloans, on-bill financing, local and utility incentive programs, and Property Assessed Clean Energy programs are potential paths for overcoming financing obstacles.

5 Conclusions

Deep energy retrofit solutions often involve complex building science and vary significantly from one house to another, even between those of the same size and vintage, because of differing levels of equipment efficiency and envelope conditions. A pervasive lack of building science awareness among conventional remodeling providers tends to compartmentalize trade activities. The influence of overlapping trade activities on whole-house performance falls outside traditional responsibilities. This is both a QC challenge and a risk to occupant health, durability, and comfort.

Building America has vast experience with gaps, barriers, failures, and successes in high performance new construction over the past decade. BA-PIRC and other Building America teams have been working with affordable housing entities (McIlvaine et al. 2012) to identify technical pathways, gaps, barriers, and solutions related to deep retrofits. Determining the appropriate amount and scope of information for each home improvement industry player is an important step in accelerating and broadening the adoption of deep retrofit technical solutions.

All the current home improvement business models have inherent strengths that may help contractors move toward whole-house retrofits. These strengths, along with weaknesses, opportunities, and threats, are different for each of the four conventional business models discussed: independent assessors, trade contractors, general remodeling contractors, and home performance contractors.

Two emerging business models, the contractor alliance approach and the contractor expansion approach, capitalize on many of these strengths and opportunities and overcome many of the weaknesses and threats. Two ventures representing these two approaches illustrate that creativity plays a role in overcoming the challenges that face all deep retrofit providers, ranging from limiting exposure to risk and conflicts of interest to training and retaining in-house experts.

The potential for reducing energy consumption among homes built before the 1990s (when state energy codes were being adopted) is vast and untapped. Recent incentive programs have raised awareness of efficiency options and generated industry-wide interest. Other market factors, aside from a contracting infrastructure, inhibit deep retrofit implementation. Consumer interest in energy efficiency is, in general, high. However, conflicting information in the marketplace paralyzes consumer decision making and action. The rate and market penetration of deep energy retrofits could be increased by improving clarity in energy savings claims among retrofit programs, sales literature, and consumer information sources. Increasing the accuracy of savings predictions may enhance consumer confidence. Developing reliable financial options would pave the way for broader industry participation. The resolution of all these challenges must be matched by increasing industry-wide technical capabilities.

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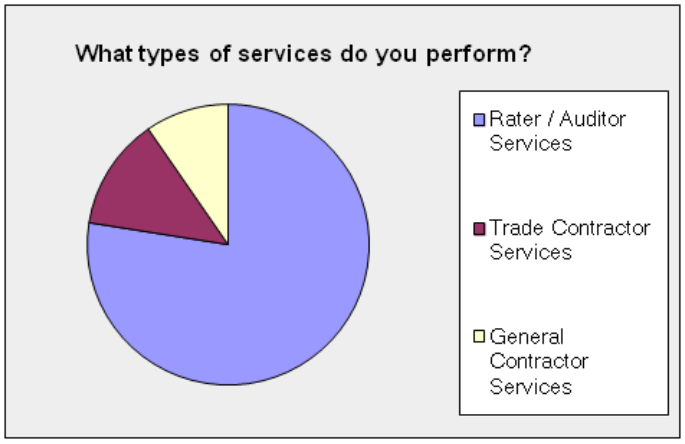
Appendix: RESNET Deep Retrofit Industry Stakeholder Survey Results

Shortly after the RESNET EnergySmart Home Performance Team program was launched, RESNET conducted a survey of EnergySmart Team members and other home energy raters, contractors, and stakeholders. The survey pertained to activities and attitudes surrounding retrofit projects, including barriers to working in existing homes, programs they participate in, and the nature of the work performed. The survey was taken by 702 respondents.

The individual questions are presented here with response summaries for each and specific responses for some.

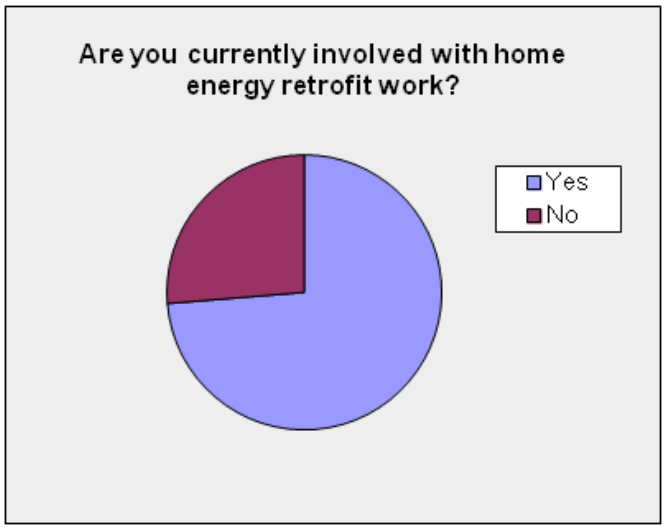
1. **What Types of Services Do You Perform?**

Answer Options	Response Percent
Rater/Auditor Services	77.5%
Trade Contractor Services	12.9%
General Contractor Services	9.6%



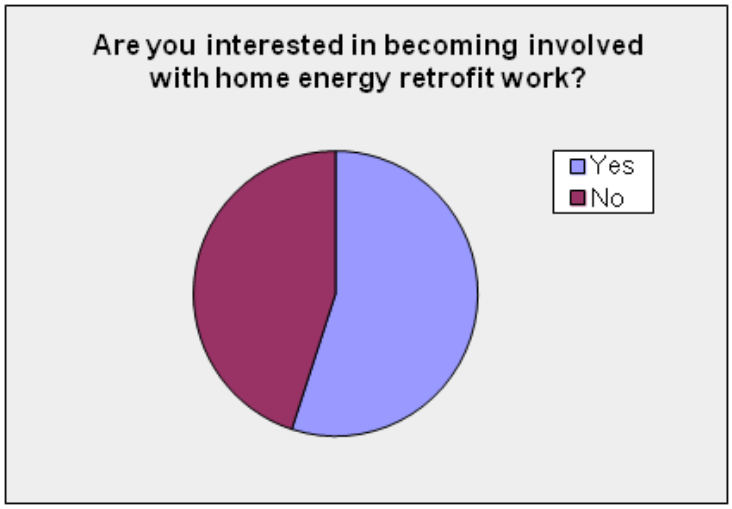
2. **Are You Currently Involved with Home Energy Retrofit Work?**

Answer Options	Response Percent
Yes	73.7%
No	26.3%



3. Are You Interested in Becoming Involved with Home Energy Retrofit Work?

Answer Options	Response Percent
Yes	55.0%
No	45.0%



4. (Given If Respondent Answered No to #3): Why Are You Not Interested in Home Energy Retrofit Work? (Open Ended Question)

- I am an 3rd party independent consultant not interested in assembling and managing crew(s).
- Low profits, hard work.
- Hard work, low profit

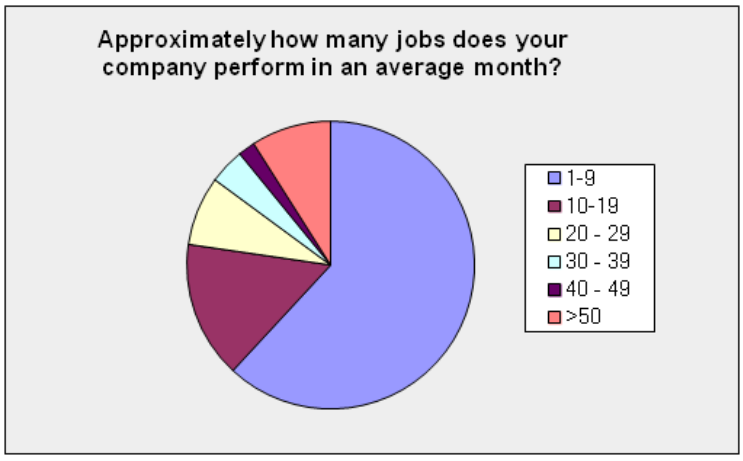
- I work for a utility and make recommendations. We do not compete w/people who are in the business.
- This company provides training, not retrofitting.
- I work for a utility that performs energy audit only. Although retrofit are great, our company does not actually complete the retro work, although we do offer incentive for the work to be completed. The way the questions are worded, it sounds like the survey is asking if I or my company actually do the retro work. We are just consultants.
- we like to be a neutral 3rd party to ensure trust in the evaluation of the home
- I only deal with new home stuff.
- Over regulated industry
- Retired
- I prefer to keep my business focused.
- I am slammed with all new home energy star inspections at this time
- I and my employees have done that in the past. I am now semi retired.
- Currently rate new construction
- Not my goal.
- We are a third party consulting organization and being directly involved with retrofit work is contrary to our mission.
- I have too much responsibility at the moment to take on more.
- Seems like too much investment in tools and licensing (gen contractor) for the potential profit margin.
- Because I am a solar installer as well, and have limited time to offer, plus I don't have equipment for foaming, which is possibly the most sought after retrofit solution. I don't have interest in being an insulating contractor or an HVAC contractor. Besides, I like to be able to give a non-biased opinion on upgrades without having an axe to grind so to speak.
- have other specialties of home inspections and green build consulting. Not interested in managing a construction crew. Plus we like to be an objective "3rd party" for the customer.
- There seems to be a lot of people involved in this industry and not that many homeowners currently looking for their services.
- To much time involved for very low return. In order to make money with retrofit–you need to also complete the work on the home. It is hard to do a home energy audit and then trust the trades to properly complete the work.
- we are primarily a architecture and engineering design company and do the rating work as a part of our professional services for builder/owner clients
- Tax credits have expired.
- too busy
- All of my work is commercial and/or new residential multi family construction–high rise, podium style (250-300 Units), park style–muti unit buildings in campus. I am not geared up for single family residential energy retrofits.
- Not part of the business model at this time.
- I work with new home builders
- Startup costs
- The company does not do installations.

- want to do audits
- Dirty, difficult work. Low pay.
- I don’t have the necessary building skills
- We don't find it to be profitable
- Our company has a separate division that handles retro-fit.
- Trade Conflicts
- one client, one home; and client has no money! And they are too involved in the process. Too much hassle.
- I wish to be a consultant only–conflict of interest to be an installer as well.
- Too old to crawl around attics and crawlspaces.
- Because there is a huge conflict of interest in evaluating home energy performance issues, performing the work and then verifying how well you completed the work. This is a weakness in the Energy Star program too.
- Not interested in dealing with home owners.
- I work for an electric cooperative full time, being a HERS rater means I give our members quality energy audits.
- Liability and lack of control of the improvement implemented.
- money
- Working with new construction builders
- We are a electric cooperative utility providing no cost home audits for our members.
- I am strictly new construction.
- I'm a HERS Rater, LEED Rater, and NGBS verifier so I don't do any retrofit work.
- We are homebuilders...
- As a home energy auditor my recommendations are more credible when I'm not selling services.
- Low fees
- disabled
- too many headaches
- Staying focused on auditing, diagnostics and assessments
- I personally like being a third party verifier of the work. I want to keep conflicts of interest to a minimum.
- busy with new homes
- We do ENERGY STAR ® for new construction this keeps us busy.
- We are strictly an independent third-party company and do not intend to sell any product line along with our audits/ratings.
- Only interested in new home residential construction.
- Finding qualified sub contractors and cost to homeowners.
- Very involved with new construction and Energy Star. Do not have the time or personnel to branch out at this time.
- resources
- I like being able to promote my company as 3rd party that has no financial stake in the proposed upgrades.
- I'm not a contractor. Content to do audits only and I oversee an auditor training program at our local community college

- I have been a builder for over thirty years and do not want to become a contractor with employees or sub contractors now.
- lame

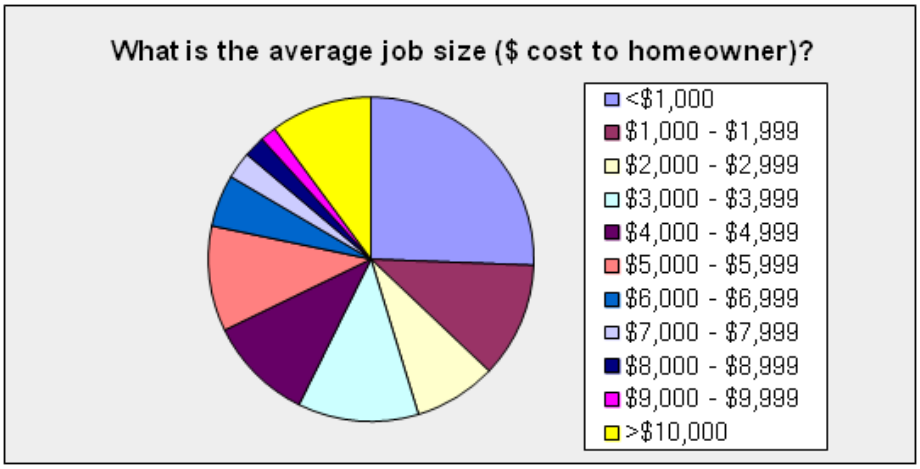
5. Approximately How Many Jobs Does Your Company Perform in an Average Month?

Answer Options	Response Percent
1–9	61.9%
10–19	15.4%
20–29	7.8%
30–39	4.0%
40–49	1.9%
> 50	9.0%



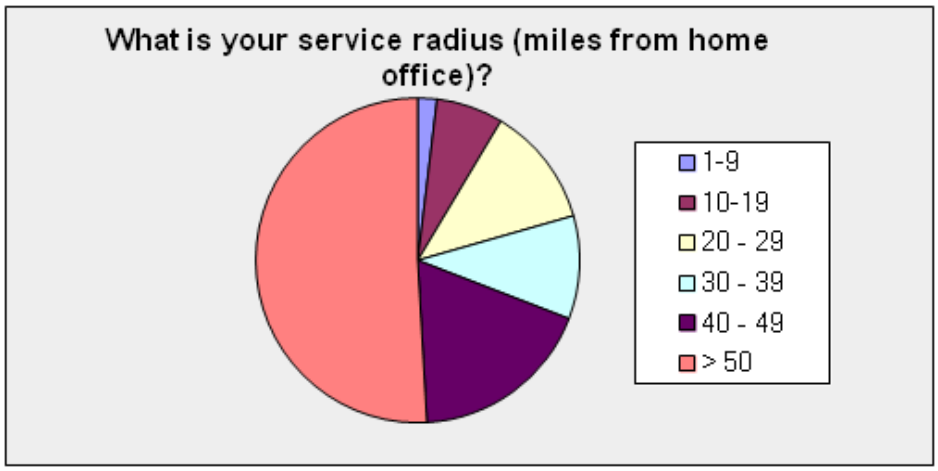
6. What is the Average Job Size ($ Cost to Homeowner)?

Answer Options	Response Percent
< $1,000	25.6%
$1,000–$1,999	11.5%
$2,000–$2,999	8.2%
$3,000–$3,999	12.0%
$4,000–$4,999	10.5%
$5,000–$5,999	10.5%
$6,000–$6,999	5.2%
$7,000–$7,999	2.7%
$8,000–$8,999	2.1%
$9,000–$9,999	1.6%
>$10,000	10.1%



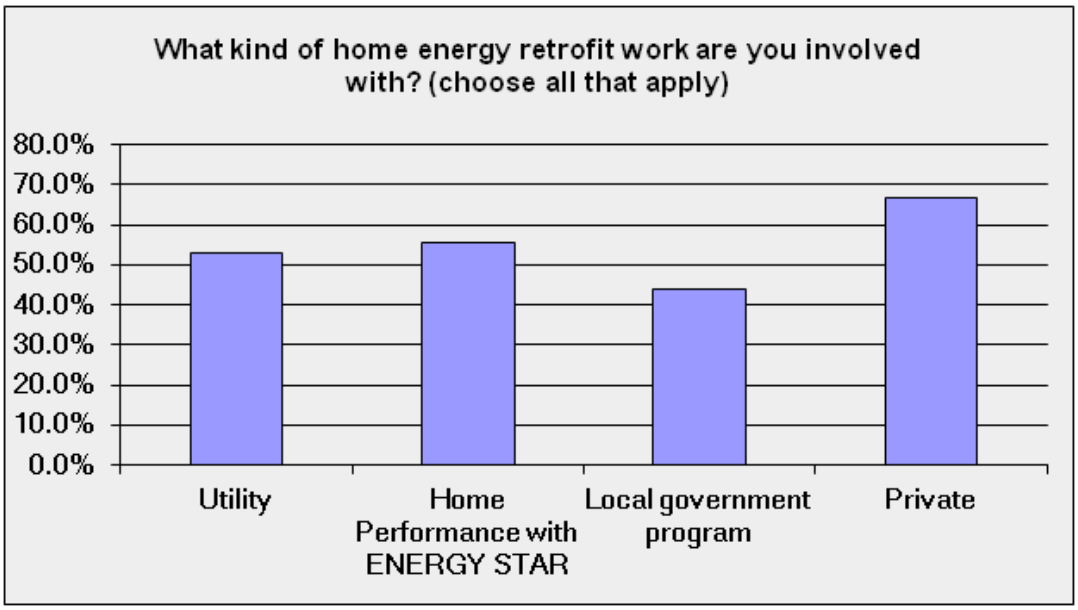
7. What is Your Service Radius (X Miles from Home Office)?

Answer Options	Response Percent
1–9	1.9%
10-19	6.7%
20–29	12.0%
30–39	10.3%
40–49	18.3%
> 50	51.0%



8. What Kind of Home Energy Retrofit Work Are You Involved With?

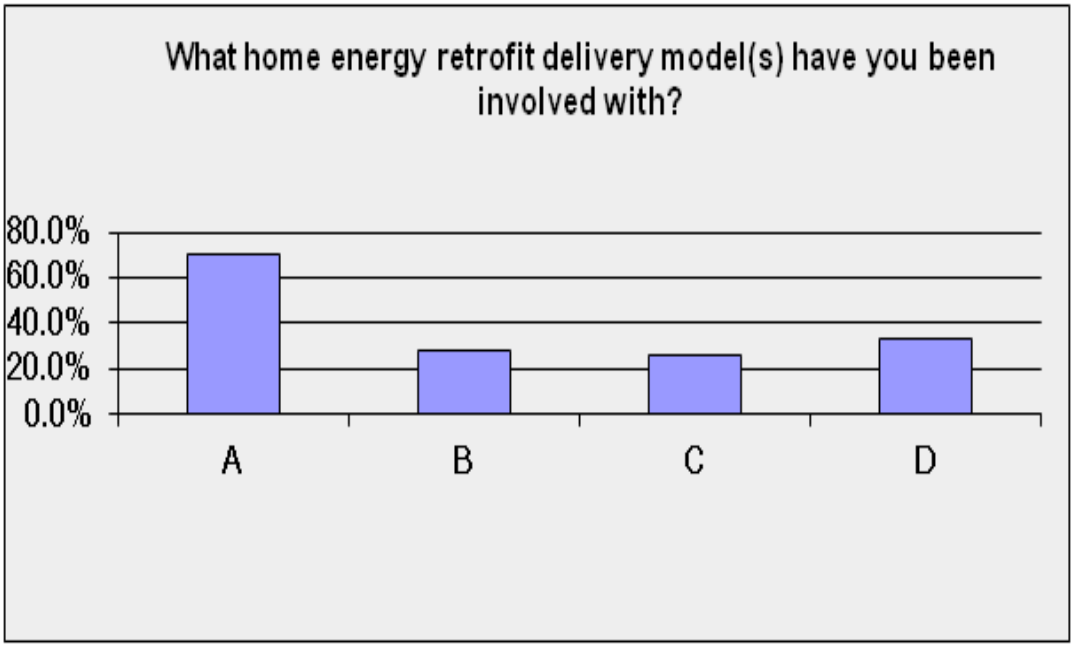
Answer Options	Response Percent
Utility	53.0%
Home Performance with ENERGY STAR	55.6%
Local Government Program	43.8%
Private	66.7%



9. What Home Energy Retrofit Delivery Model(s) Have You Been Involved With?

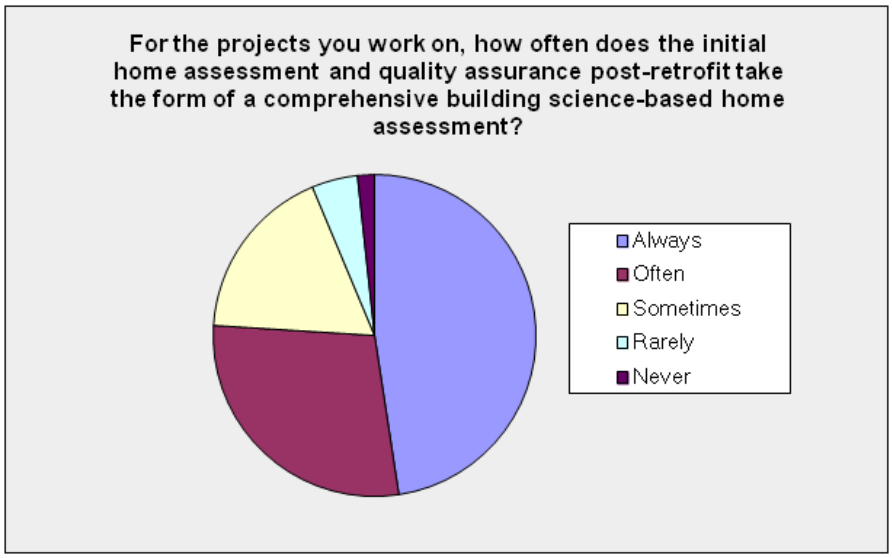
Answer Options	Response Percent
Consultant or Independent Assessor: You work directly for the homeowner (or program manager in case of a sponsored program). You arrange for or perform a home assessment. You develop a work scope to be conducted, possibly provide the homeowner with a list of recommended contractors to execute the work scope, arrange for or perform quality assurance for the project. You are not involved with the actual retrofit work. (on graph below as A)	69.9%
General Contractor: You arrange for or perform a home assessment, develop a work scope, and sell the job. You subcontract all the trades involved in the upgrade. If a program is involved, you process the paperwork involved. You arrange for or perform quality assurance for the project. (on graph below as B)	28.2%
Trade Contractor: You arrange for or perform a home assessment and develop the work scope. The work scope usually depends on your trade (HVAC, insulation, windows). If the work scope you develop goes beyond your trade, you may provide the homeowner with a list of recommended contractors to execute the other services. You arrange for or perform quality assurance for your part of the project only. (on graph below as C)	25.9%
Whole House Energy Upgrade Contractor: You work for a full-service, or home performance contractor. Your company performs a home assessment and develops a work scope. Services offered include	33.5%

insulation, air sealing, HVAC (and possibly window replacement) services, all with installers and technicians who are employees of your company. If a program is involved, your company processes the paperwork involved. Your company performs quality assurance for the project. (on graph below as D)	



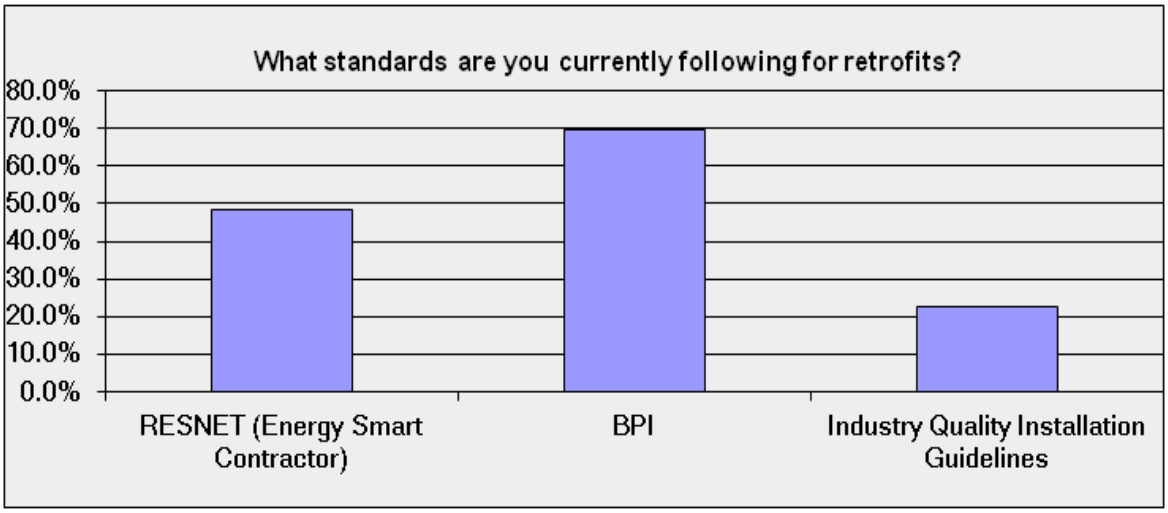
10. For the Projects You Work On, How Often Does the Initial Home Assessment and Quality Assurance Post-Retrofit Take the Form of a Comprehensive Building Science-Based Home Assessment?

Answer Options	Response Percent
Always	47.6%
Often	28.4%
Sometimes	17.7%
Rarely	4.6%
Never	1.7%



11. What Standards Are You Currently Following for Retrofits?

Answer Options	Response Percent
RESNET (Energy Smart Contractor)	48.4%
BPI	69.5%
Industry Quality Installation Guidelines	22.4%
Other (Responses Below)	



Responses to Other:

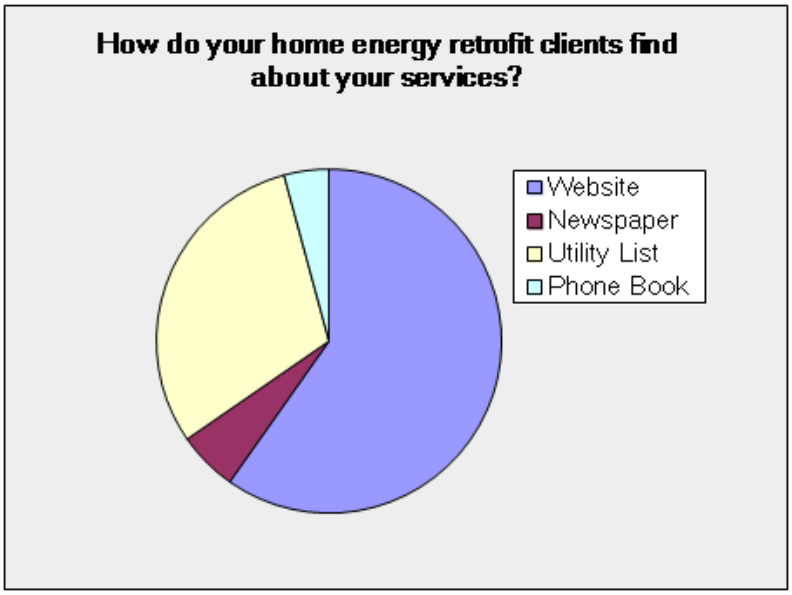
- comfort institute
- HERS II Whole House Rating and Energy Upgrade Recommendations
- ZEB Building–Achieve HERS Index 30
- ASHRAE 90.1, 2009 IECC-IRC-IMC, ASHRAE Handbooks (quasi standard)

- CEA, CEPE and ASHRAE, ACCA and LEED CBC
- energy wise structures
- ASHRAE, ACCA,
- Home Performance with Energy Star with Utility
- Home Performance with Energy Star
- California HERS II
- IHWAP installation standards are helpful
- earth craft green bldg leed
- LIUNA Worker Training Standards
- WAP/DOE
- none
- Depends on the job.
- none
- DOE WX specifications & standards
- ICC
- Beyond BPI
- HPwES
- Focus on Energy Materials and Installation Guidelines (by CSG)
- ACCA, LEED for HOMES, ASHRAE
- HPwES
- Build It Green, CalCERTS
- Puerto Rico
- Plus IAQ, Water Conservation, and Water/moisture management
- D.O.E. NEAT and MHEA audits
- DOE Weatherization
- Program guidelines, plus TXHERO standard
- HERS II (California Whole House Energy Rater)
- WAP ARRA
- And the classes with Calcerts (California)
- Modeling is RESNET, best practice for standards which excludes the top two
- Higher standards... Those that are sensitive to Moisture issues.
- Each home case by case
- DER, PH
- EarthCraft
- specific program guidelines
- Ma stretch code / Energy Star
- WAP
- NC energy code
- ASHRAE
- Department of Energy
- Utility Program standards
- EarthCraft House Virginia
- EarthCraft, Energy Star, ACCA
- State Regulations

- MN Green Communities
- Best Practices
- Best practice
- NARI, Green Advantage, LEED,
- NAHB, Enterprise Green Communities, Energy Star, BPI, RESNET, etc.
- California HERS II
- local utility standards
- New BPI certifications
- DVELOPED MY OWN
- NW Energy Star
- EPA Lead Safe; OSHA; Local Codes
- Program specific...include: BD,DB,Optimiser V2 report
- We have developed a quality program that exceeds many others.
- NGRID/NSTAR/ACI DER Guidelines
- Home Performance with Energy Star
- Building code standards
- NAHB National Green Standard
- RESNET Chapter 7, Measured HomePerformance-Chitwood
- Focus on Energy WI
- DOE
- for some programs, Weatherization Assistance Program Standards
- Depends on scope of work and client need

12. How Do Your Home Energy Retrofit Clients Find About Your Services?

Answer Options	Response Percent
Website	59.7%
Newspaper	5.6%
Utility List	30.4%
Phone Book	4.2%
Other (answers below)	



Responses to Other:

- all of the above
- Referrals
- Word of mouth
- Wx. Agencies
- Government agency website
- "Word of mouth"
- Energy House Marketing, Referrals from other customers
- door hangers, newspapers and website
- utility bill insert & direct mail
- BEST PICK,ANGIES LIST,CHECK BOOK.COM
- ocheep a government program
- Utility company
- program referral list
- facebook
- City based retrofit incentive projects
- Utility website, my own site, our marketing at events, etc.
- We receive 1/2 of pvt work due to 3-time Angie's Super Svc Award + funded program
- Word of mouth or recommendation from friends or other companies
- outreach
- industry website I am listed on
- media outreach-response to
- contact existing clients for which we performed home inspections
- In addition to utility listing.....Some website leads
- referenced by other clients
- Service Magic lead provider

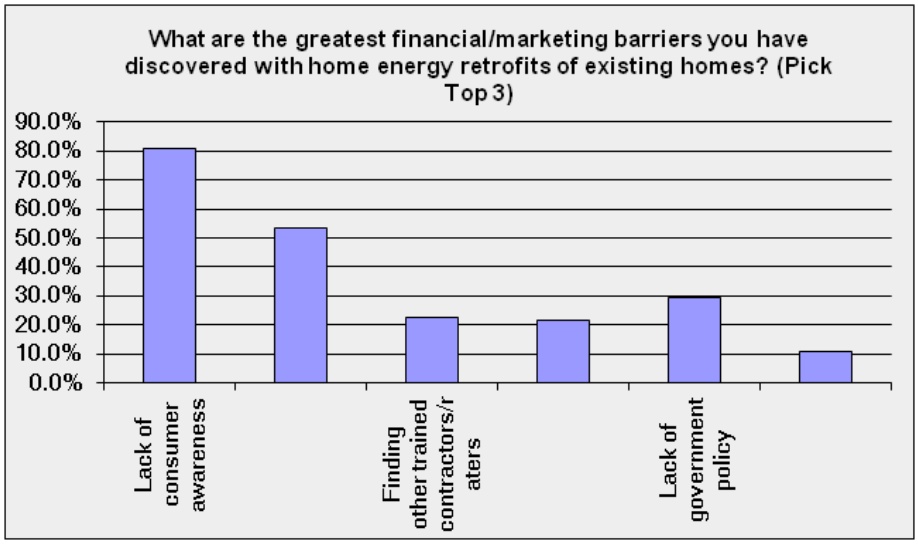
- Fliers, hand outs placed with charities/churches
- Independent marketing
- All the above plus cable TV and Referrals
- personal referral, Angies List rating
- door to door marketing
- other clients
- reputation
- Website
- intra-agency support
- recommendations
- mechanical contractors
- results from energy education presentations, referrals
- Marketing
- References
- 3rd Party agency in Phila. (ECA)
- Habitat for Humanity internal affiliate process
- Sales
- Word of mouth, credential registry
- we are a manufacturer clients use our products in performing these services
- referrals, radio, TV
- Special State Programs
- all of the above
- General Contractor reputation
- phone book, efficiency maine website
- Entirely word of mouth
- sales team
- doorhanger, word of mouth, newspaper
- Low Income Assistance
- Direct marketing
- Energy Programs
- Utility Co promotional info
- from our own clients
- Various ways
- Radio advertisement
- we are a statewide non-proff administering a Home Performance with ENERGY STAR
- Web Site under development.
- internet
- client of HVAC service unit of our parent company
- Presentations and training
- Agency advertising
- I do not advertise in any way. Word of mouth
- All above except paper, + TV
- Electric co-op newsletters, home shows, weatherization contractors
- Networking

- Primarily by referrals
- most of the above
- about evenly split between website, utility list, RESNET list, & word of mouth.
- networking
- multiple
- referrals from contractors and homeowners
- HPwES local sponsor
- Referrals from contractors, previous clients
- All of the above; we're a non-profit offering free services to those qualifying
- Word of mouth/website
- all the above and: referrals from previous clients, radio, flyers
- all traditional methods
- direct marketing
- various forms of advertising
- I work for utility, it is our outreach
- Most are customer referrals
- Website, direct mail and phone solicitations
- personal reference
- Our Service Techs
- ALL OF THE ABOVE PLUS MANY MORE
- Word of mouth and trade association
- HPwES program, referrals, mailings & Angie's List deals
- Focus on Energy–Wisconsin
- shows
- Mostly referral, but also several other ways
- Assigned by State sponsored program
- Through DOE funded county EE program
- Florida Solar Energy Center Web Site
- my data
- builders association
- Efficiency Vermont
- Product shows, word of mouth
- speaking engagements
- personal contacts
- well rounded marketing plan
- Direct Sales
- Community Services
- All of the above and many more. #1 is referrals.
- Word of mouth from many trades and real estate persons
- networking
- All of the above
- My efforts, other participating contractors, utility list
- DER Program ads
- Radio Commercials

- Website and on Utility List
- Media, contractors, bill boards, CEWO
- Contacts
- Website, Magazines
- Web, Referral, Press, Trade
- Direct mail
- trade partners
- political connections related to energy
- Weatherization Program-LIHEAP
- My Website and SM
- all but phonebook/newspaper. dead tech.
- All of the above. Primarily via utilities, local government, and web. Referral bonuses from other residential contracting trades or homeowners receiving assessments have been a driver in past audit/retrofit program delivery.
- Known entity
- Networking with remodeling contractors
- word of mouth is the main source, utility is #2

13. What Are the Greatest Financial/Marketing Barriers You Have Discovered with Home Energy Retrofits of Existing Homes? (Pick Top 3)

Answer Options	Response Percent
Lack of consumer awareness	81.0%
Lack of affordable financing for consumers	53.2%
Finding other trained contractors/raters	22.6%
My utility doesn't offer a program	21.6%
Lack of government policy	29.5%
Lack of cost effective components (i.e. windows)-enter component below	10.8%



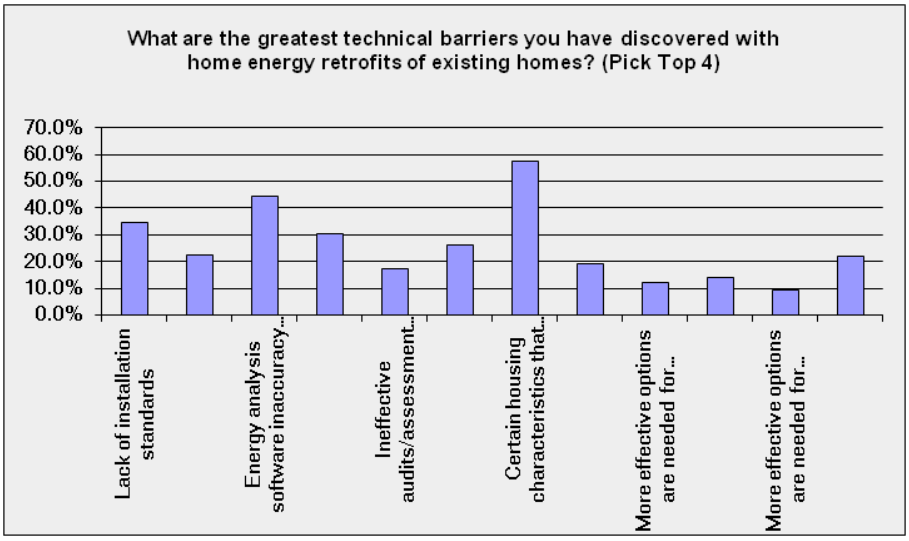
Lack of cost effective component responses:

- Consumer resistance to installation (incentive)
- our market is small, prices are high
- utility/ govt programs very limited and simplistic
- Energy in our area is still inexpensive; no great need.
- Funding, SIR, TRC does not work
- windows, radiant barrier
- Everyone thinks they need gaskets around outlets and windows thanks to government involvement
- no component but Control of State Program By ICFI–limited market
- work under utility programs,that produces limits on products
- Competing government programs
- No Marketing to the general public about the benefits of energy efficiency, no support from the building community, and no support from government or utilities.
- Lack of valuing of ee improvements
- Program regulations & paperwork slow process too much.
- Wrong guidelines from Government and Industry appropriate for my climate. Poor RESNET standards. Poor goals and poorer quality control by utility and government programs.
- People want shiny, curb-appeal components
- Customers following the recommendations.
- AC & Heat pumps don't qualify for financing or incentives because the EER requirements are too high
- to much reliance on government driven programs
- pay back is too long for the residence/instant gratification
- utility programs are lacking when it comes to remodel/renovation work
- Water Heaters, HVAC, Insulation, Air Sealing
- Insulation retrofit cost
- Prices are to high
- new renewable energy is expensive
- Foam Insulation Costs
- Uninformed consumers, lack of trust in an unfamiliar industry (elderly citizens), consumers wanting to do the minimum
- typically only cost-effective when replacing components at end of serviceable life
- windows and spray foam are not cheap
- Wall Insulation for old brick and plaster homes, windows
- Cannot see an immediate payback.
- Most consumers are only aware of energy costs during the 3 months of the year they are heating their home. Otherwise, they are apathetic.
- windows
- windows, foam insulation
- Solar
- We run into all of these regularly
- Total window replacement, total duct/HVAC replacement

- Homeowners do not have finances
- windows, controls, sensors
- windows
- Customer expectation: $2-3k. Our Avg. workscope: $7-10k
- windows are the biggest con-game in the energy retrofit world. RESNET and others need to get the word out to help consumers avoid other scams.
- Customer doesn't have the money/financial means
- PV and solar water
- warm winters make cost effectiveness low
- My utility only recognizes resnet not bpi

14. What are the greatest technical barriers you have discovered with home energy retrofits of existing homes? (Pick Top 4)

Answer Options	Response Percent
Lack of installation standards	34.6%
Lack of Quality Assurance procedures	22.5%
Energy analysis software inaccuracy or limitations	44.5%
Access to utility bills and combining them with energy analysis	30.3%
Ineffective audits/assessment procedures and tools	17.1%
Recently installed mechanical equipment	26.1%
Certain housing characteristics that prevent effective retrofit	57.3%
More effective options are needed for reducing energy used for Miscellaneous electric loads	19.1%
More effective options are needed for reducing energy used for Space Conditioning	11.9%
More effective options are needed for reducing energy used for Ventilation	13.9%
More effective options are needed for reducing energy used for Water Heating	9.2%
More effective options are needed for reducing energy used for Building Enclosure	21.8%
Other (Responses Below)	



Responses to Other:

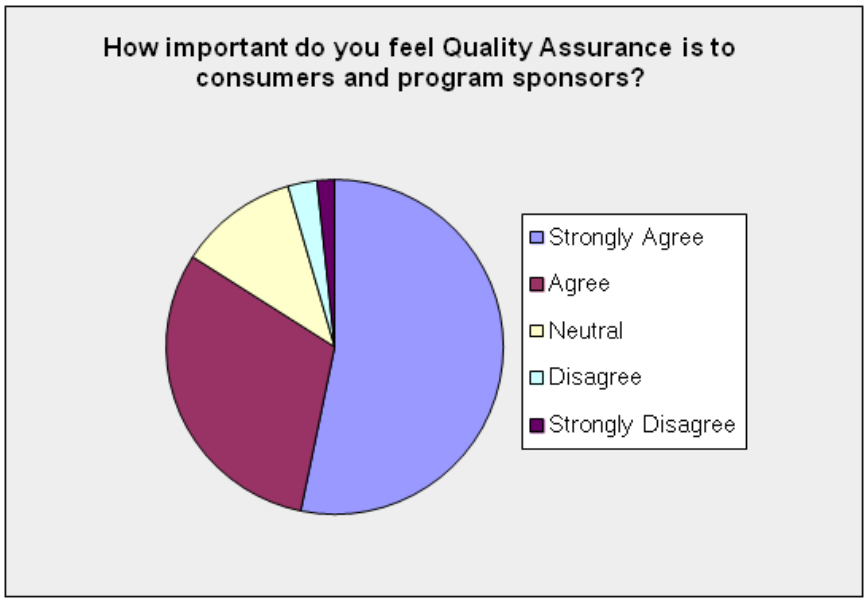
- there is a dramatic need to "simplify" the standards and to create an consensus on consistently between completing standards, especially BPI & RESNET.
- Improper HVAC sizing, lack of knowledge by the home builders and hvac contractors.
- to many programs and marketing not enough science

- lack of software tools that allow for quick building assessment, energy modeling and report generation used to sell the retrofit.
- Contractors lack training and experience with retrofit, and training focuses on basics only.
- lack of flexibility in programs
- cost to perform good audit
- Dehumidification
- Lack of building code adoption and enforcement.
- It's a Mess!
- State-sponsored reward system doesn't cover the key elements and misguides the consumer
- Everyone thinks they need gaskets around outlets and windows thanks to government involvement
- I do not have enough experience to share view
- Control of State Program By ICFI–limited market
- consumer awareness
- Contractors reading my scope of work and actually following it the first time
- State, Government and Utility programs that force duplication (required use of their system which duplicates ours and confuses our clients)
- Competition with only "a week's worth of training"
- Vermiculite removal cost no work allowed if found in home
- Lack of understanding, marketing, lender and real estate professional backing.
- Lack of evidence that predicted savings are actually realized
- explaining to them why all these other BPI, etc... "auditors" missed XYZ or why the fixes that were done, weren't done correctly
- Product sellers filling the market place with non-science based BS
- Poor, inconsistent and conflicting Retrofit Standards. Standards ignore moisture and overemphasize problems with heating.
- Lack of HVAC contractor's willingness to size right! Make these stone age idiots responsible!
- Most software is focused on being a science project and is either hard to use, confusing for the homeowner, or just a pain. Most of the current software available today needs some serious streamlining.
- Buyer education and salesman's limited focus on one product
- cost effective options to remove hazards such as asbestos, lead, radon and water from dirt crawlspaces, buried oil tank removal–these need to qualify for incentives and financing
- Business model is hard to make work... complicated and not very profitable.
- Contractors are slow to adopt home performance best practices.
- Other contractors who did not do proper installation
- ineffective costly measures previously used (windows)
- Dis-information by false energy saving claims
- I think the greatest technical barrier is these retrofits lack any type of visual appeal. We frequently see adequate windows replaced with tax credit windows. This retrofit does almost nothing for energy savings but the consumer is happy because he/she gets to see them every time they come home.

- homes that are newer and could have fixed during construction and now cost too much to fix.
- Confusion in the marketplace due to competing standards and models
- State licensing boards and officials that don't understand building science.
- Having to wait until the name is released from the State program.
- MOLD AND WATER PROBLEMS in 33% of homes
- builders, hvac, owners not knowledgeable and don't want to pay me to teach them.
- Invasive process and not sexy
- Limitations on customer budgets for analysis
- No adequate code enforcement for housing in past 10 years.
- No real technical barriers–the software is the weak link
- most software overstates savings and under evaluates the actual benefit of high ticket items. Few auditors and hardly any program administrators seem to be willing to go to our level of evaluating actual energy history and making sure the savings match the estimates more closely, with rebound effect taken into consideration.
- electronics and video electronic control guidelines (our specialty)
- Failed combustion test and other tech. don't test combustion other than visual
- Smaller furnaces
- Existing Building codes,
- Paperwork and tracking requirements
- Greenwashing media, and lack of public knowledge
- partnerships ie window, roofer, remodelers, all home improvers are not being rewarded for working together as programs now seem to push themselves the people in the program little concern for players in field
- Lack of belief in the actual savings to be gained!
- Special considerations for Hawaii's environment, climate, lack of mechanical heating and cooling, historical construction standards & lack of awareness.
- The industry is a disaster
- REMRate and other software is too time-consuming and produces a "cartoon" of existing conditions. Has to be an easier way of getting to the heart of the problem so they can be addressed.
- my own software is better at predicting savings than an efficiency utilities offered to many competitors- either I lose jobs or they over-predict savings that aren't achievable even if I get the job.
- Cost/Price point of efficiency measures

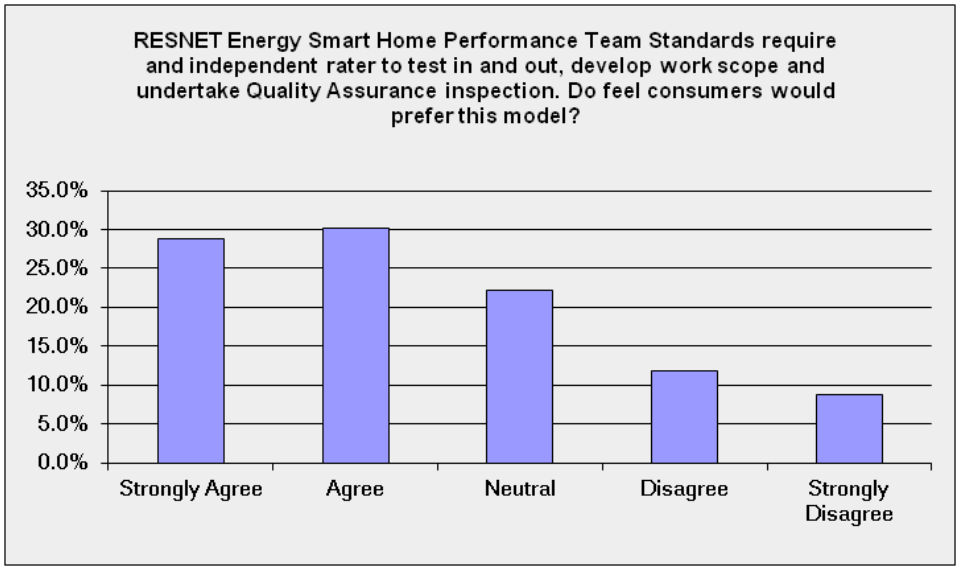
15. How important do you feel Quality Assurance is to consumers and program sponsors?

Answer Options	Response Percent
Strongly Agree	53.3%
Agree	30.8%
Neutral	11.5%
Disagree	2.8%
Strongly Disagree	1.7%



16. RESNET Energy Smart Home Performance Team Standards require and independent rater to test in and out, develop work scope and undertake Quality Assurance inspection. Do feel consumers would prefer this model?

Answer Options	Response Percent
Strongly Agree	28.8%
Agree	30.1%
Neutral	22.2%
Disagree	11.9%
Strongly Disagree	8.7%



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