

# CONSULTANT REPORT

## Summary of Needs for Improving the Energy Efficiency of California's Existing Residential Buildings

*- Findings from interviews with industry experts*

Prepared for: California Energy Commission

Prepared by: PECl and Benningfield Group, Inc.



BenningfieldGroupinc

DECEMBER 2013

CEC-400-2013-016

**Prepared by:**

**Primary Authors:**

Eliot Crowe, PECI  
Emily Kemper, PECI  
Kirstin Pinit, PECI  
Nehemiah Stone, Benningfield Group, Inc.  
Garth Torvestad, Benningfield Group, Inc.  
Lynn Benningfield, Benningfield Group, Inc.

PECI  
1 Sansome Street, Suite 3500  
San Francisco, CA, 94104  
www.peci.org

Benningfield Group, Inc.  
400 Plaza Drive, #120  
Folsom, CA, 95630  
www.benningfieldgroup.com

**Contract Number: 400-10-002**

**Prepared for:**

**California Energy Commission**

Samuel Lerman  
**Contract Manager**

Christine Collopy  
**Project Manager**

Bill Pennington  
**Deputy Division Chief,  
Efficiency and Renewable Energy Division**

Dave Ashuckian  
**Deputy Director  
Efficiency and Renewable Energy Division**

Rob Oglesby  
**Executive Director**

**DISCLAIMER**

This report was prepared as the result of work sponsored by the California Energy Commission (Energy Commission). It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the Energy Commission nor has the Energy Commission passed upon the accuracy or adequacy of the information in this report.

## PREFACE

This Needs Assessment Report for Existing Residential Buildings is a deliverable under Task 1.2 of Agreement 400-10-002. This report summarizes findings from interviews of 27 industry experts to assess the current state of existing energy efficiency efforts in California's residential building sector. The scope of this report encompasses energy efficiency programs, rating systems, financing, workforce development, and outreach.

Please use the following citation for this report:

Crowe, Eliot, Emily Kemper, Kirstin Pinit (PECI), Nehemiah Stone, Garth Torvestad, Lynn Benningfield (Benningfield Group, Inc.). 2012. *Summary of Needs for Improving the Energy Efficiency of California's Existing Residential Buildings*.

# TABLE OF CONTENTS

<b>Introduction .....</b>	<b>1</b>
<b>Purpose.....</b>	<b>3</b>
<b>Research Methodology .....</b>	<b>4</b>
Industry Expert Selection and Recruitment .....	4
Survey Instrument and Interviews.....	4
Analysis of Interview Data .....	4
Rating Systems Research.....	5
<b>Background .....</b>	<b>6</b>
Home Ratings and Assessments under the California Whole-House Program .....	6
Whole-House Energy Efficiency Upgrade Programs .....	7
<b>Needs Assessment Interview Findings.....</b>	<b>9</b>
Investing in Energy Efficiency Upgrades .....	9
Homeowners’ ability and willingness to obtain financing for energy efficiency upgrades....	9
Lenders’ increased risk sensitivity.....	10
The value of energy efficiency at time of sale .....	11
Loan product options .....	12
Communicating financing options to market stakeholders.....	13
Workforce Development.....	14
Coordination of training and certification programs.....	14
Unmet training needs for raters, assessors, and contractors .....	14
Appraisers, real estate agents, mortgage brokers and lenders .....	15
Consumer demand and awareness for certification of professionals.....	15
Ratings and Assessments.....	15
Timing of ratings and assessments.....	16
CA Whole-House Rating / Energy Assessment software .....	16
Market delivery approach .....	16
Quality control for ratings and assessments .....	18
Whole-House Energy Upgrade Programs.....	19

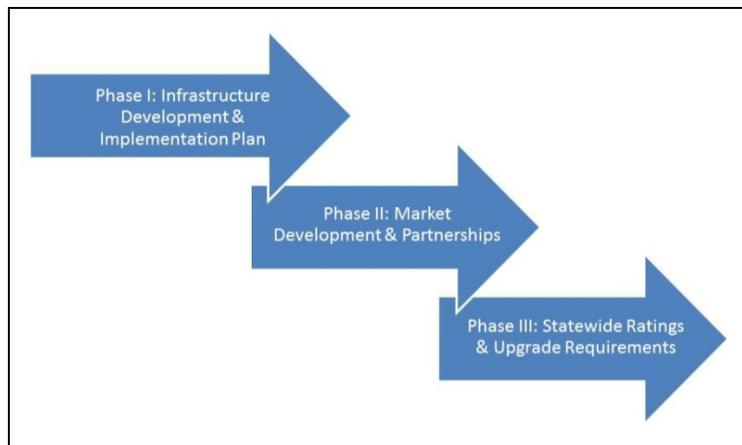
Depth of energy efficiency upgrade projects .....	19
Conversion rate from assessments to completed projects.....	20
Homeowner Demand for Energy Efficiency .....	20
Public awareness of, and demand for, energy efficiency .....	20
Regional variations in public awareness and demand for energy efficiency .....	22
<b>Summary.....</b>	<b>24</b>
Investing in Energy Efficiency Improvements.....	24
Workforce Development.....	24
Energy Efficiency Rating Systems .....	25
Whole-House Upgrade Programs .....	25
Homeowner Demand for Energy Efficiency .....	26
<b>References.....</b>	<b>25</b>
<b>Appendix A: Acronyms and Abbreviations.....</b>	<b>27</b>
<b>Appendix B: Glossary .....</b>	<b>29</b>
<b>Appendix C: Interview Instrument .....</b>	<b>30</b>
<b>Appendix D: Overview of California HERS, Home Energy Score (HEScore), and the Energy Performance Score (EPS) .....</b>	<b>32</b>

## Introduction

Assembly Bill (AB) 758 (Skinner, Statutes of 2009) requires the California Energy Commission (Energy Commission) to develop a comprehensive statewide program (AB 758 Program) to achieve greater energy efficiency in California’s existing residential and nonresidential buildings.

The bill states that the AB 758 Program may include, but need not be limited to, a broad range of strategies, including energy assessments, building benchmarking, energy ratings, cost-effective energy efficiency improvements, public and private sector financing options, public outreach efforts, and green workforce training (key AB 758 Program topic areas).

The development of the AB 758 Program is currently in Phase I of a three-phase plan, which is illustrated in Figure 1. The Energy Commission selected PECI to lead a team of firms to provide technical support (Technical Support Team) to aid in the development of the AB 758 Program. This team is comprised of 12 firms with expertise in all aspects of the residential and nonresidential building markets, as well as subject matter expertise on key AB 758 Program topic areas.



**Figure 1: AB 758 Planning and Implementation Phases**

Given the broad set of topic areas, a highly diverse set of building types, and a vast multi-climate state, developing a comprehensive energy efficiency program is a highly complex undertaking. However, given the state’s aggressive energy and carbon reduction goals and the opportunity to stimulate the state’s economy, there is a high level of urgency in developing the AB 758 Program. In response, the Energy Commission designed a needs assessment approach to gather industry perspectives on energy efficiency in California, to support Phase I activities.

This needs assessment report draws upon the expertise of industry experts to identify some of the significant issues, barriers and potential solutions for achieving greater energy efficiency in existing residential buildings (a separate needs assessment was conducted for the nonresidential market). The outcomes of this research fed into the development of the Comprehensive Energy Efficiency Program for Existing Buildings Scoping Report (Brook, Martha, et al. 2012) (Scoping Report), created by the Energy Commission. The Scoping Report combines the needs assessment interview outcomes with the expertise and experience of staff at

the Energy Commission and the California Public Utilities Commission (CPUC), supplemented with research reports and other industry resources. The Energy Commission also incorporated lessons learned from the AB 758 pilots conducted between 2010 and 2012,<sup>1</sup> funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

The Scoping Report was the subject of a two-day public workshop in October 2012, which was followed by an open period for submission of written public comments. The needs assessment, Scoping Report, and public consultation all contribute to the Energy Commission's ongoing development of a comprehensive AB 758 Action Plan (which will be the subject of further public workshops in 2013).

The findings in this report are the product of in-depth phone interviews conducted by Benningfield Group with residential building sector experts. These interviews were designed to ascertain the level of awareness of and concern for energy-related aspects of building performance as well as capturing market actors' articulation of the market needs and potential solutions for improving the energy efficiency of existing buildings.

In addition to soliciting input from industry experts, the Energy Commission also sought technical information on home energy rating systems used outside of California. This was considered potentially valuable in providing ideas and options for improving California's whole-house rating system in support of the AB 758 Program.

---

<sup>1</sup> See <http://www.energy.ca.gov/ab758/pilot-programs.html> for more details on AB 758 pilots.

## Purpose

Benningfield Group conducted this needs assessment to support the Energy Commission's implementation of Phase I of the AB 758 Program. To complete this phase, Energy Commission staff will draw on their own deep expertise and experience across the key program topic areas, as well as the expertise of the staff of the CPUC, and on published research and other resources. In addition, Energy Commission staff can incorporate the lessons learned from the AB 758 pilots conducted between 2010 and 2012 under the *Energy Upgrade California* program, conducted in collaboration with the CPUC, utilities, and regional and local governments.

Energy Commission staff recognize the efforts of home performance contractors, utility and local and regional government energy efficiency program implementers, home energy raters, energy assessors, policy analysts and representatives of industry associations in maintaining California's leadership position on energy efficiency. Through this needs assessment, Benningfield Group gathered valuable insights from experts in these disciplines that would provide fresh perspectives on the issues that Energy Commission staff are looking to address.

Given the breadth and maturity of the energy efficiency industry in California, there are many thousands of industry actors who could provide useful insights for development of the AB 758 Program. However, the need to move rapidly and cost-effectively through Phase I of the program necessitated a streamlined method of collecting industry input. Thus, Energy Commission staff determined that interviews with a small group of industry experts and opinion leaders would provide deep insights and perspectives to help in developing the Scoping Report and Action Plan, with broader input coming through public workshops.

The primary purpose of the needs assessment was to explore market needs related to the key AB 758 Program topic areas. The result of the needs assessment (this report) is a broad picture of the state of the existing residential buildings market in California, as seen through the observations and experiences of selected industry experts and opinion leaders. The research was also intended to ascertain the level of public awareness of and concern for energy-related aspects of building performance.

In addition to soliciting input from industry experts, the Energy Commission also sought technical information on home energy rating systems used outside of California. This was considered potentially valuable in providing ideas and options for improving California's rating system in support of the AB 758 Program.

## **Research Methodology**

Benningfield Group collected data for this needs assessment through guided interviews with industry experts and opinion leaders on the key AB 758 Program topic areas.

### ***Industry Expert Selection and Recruitment***

Needs assessment interviewees were selected based on their experience with energy efficiency in general, as well as very specific expertise in the key AB 758 Program topic areas. Of the final 27 experts interviewed, 25 were based in California, and two represented national organizations, which are very active in the energy efficiency industry in California.

Interviewees were highly experienced and/or held a senior position within their organization.

Interviewees represented the following roles: utilities, local governments, home performance contractors, utility and local and regional government energy efficiency program implementers, home energy raters, energy assessors, policy analysts, and representatives of industry associations.

### ***Survey Instrument and Interviews***

Benningfield Group developed an interview guide for use in collecting information from interviewees that covered the following areas:

- Investing in energy efficiency upgrades
- Workforce development
- Energy ratings and assessments
- Whole-house energy upgrade programs
- Homeowner demand for energy efficiency

Within each of the main topic areas, primary questions and subtopics provided for detailed questioning of each interviewee on their area of expertise. The interview guide was approved for use by Energy Commission staff, and is included in Appendix C.

Benningfield Group conducted guided interviews using one interview guide for all interviewees, though not all subjects answered all questions at the same level of depth or completeness due to their differing perspectives and areas of experience. Interviews were conducted by asking open-ended questions, and the interview guide provided additional prompts in case interviewees needed clarification on the question or requested options from which to select.

Interviews were conducted between October and December 2011. In some cases, Benningfield Group requested additional information by email and phone if clarification was needed on interview responses.

### ***Analysis of Interview Data***

Individual interview data was transcribed and organized by topic area. Benningfield Group and PEGI reviewed data for each topic area to identify common themes relating to market needs, as well as statements that indicated commonly held perceptions regarding energy-related aspects of building performance.

Although each interviewee had “primary” areas of expertise (e.g., workforce development), the guided interview format allowed freedom for discussion across a range of topic areas. In analyzing each interviewee’s comments, Benningfield Group and PECI gave appropriate consideration and weighting for comments made within each interviewee’s primary area of expertise.

For each topic area, Benningfield Group and PECI derived a summary of key needs and recommendations from a combination of direct comments from interviews and inferences made by synthesizing statements from multiple interviewees. In developing this report Benningfield Group and PECI have not prioritized needs and recommendations, but in some cases it is noted where interviewees themselves held a strong personal belief of what was most needed.

### ***Rating Systems Technical Information***

To complement the needs assessment interviews, Benningfield and PECI conducted secondary research on two residential rating systems, the Home Energy Score (HEScore) developed by U.S. Department of Energy (U.S. DOE), and the Energy Performance Score (EPS) developed by the Energy Trust of Oregon (ETO). HEScore and EPS are the subjects of several studies, pilots, and reports, which formed the basis of this secondary research. Additional primary research was conducted to gather more detail on the technical specifications and methodologies of both rating systems for comparison to the California whole-house rating system. Primary research was conducted through informal interviews of representatives of both rating systems and assessments of calculation methodologies by technical staff at Benningfield and PECI.

## Background

The past three years have seen major changes in the residential energy efficiency industry in California, shifting emphasis from single efficiency upgrades to “whole-house” approaches, affecting the *Energy Upgrade California* program collaboration of utility, local, regional and statewide governmental programs, home energy ratings, energy assessments, and workforce training. To support understanding of the findings from the needs assessment interviews, background information on whole-house approaches is summarized below.

### ***California Whole-House Rating System Program***

AB 758 (Public Resources Code 25943(j)) defines an energy assessment as a “determination of an energy user’s energy consumption level, relative energy efficiency compared to other users, and opportunities to achieve greater energy efficiency or improve energy resource use.” Separately Public Resources Code 25942(a)(2) requires home energy ratings under the California Home Energy Rating System (HERS) Program to provide “reasonable estimates of potential utility bill savings, and reliable recommendations on cost-effective measures to improve energy efficiency,” which corresponds to the key features of the AB 758 definition of energy assessments. The California Home Energy Rating System Program (PRC 25942(a)(1)) is also required to provide “consistent, accurate and uniform ratings based on a statewide rating scale.”

The California Home Energy Rating System Program statute (PRC 25942(c)) requires that “... no home energy rating services may be provided in this state unless the services have been certified ... by the Commission to be in compliance with the program criteria ... and are in conformity with any other applicable element of the program.” The Commission adopted regulations and a HERS Technical Manual (HTM) in August 2009 that extended the California Home Energy Rating System Program to cover whole-house home energy ratings.<sup>2</sup> The regulations and HTM cover a range of requirements for the conduct of whole-house HERS ratings, including requirements for ratings, energy assessments, rater training, quality assurance, and software. Whether or not a home receives a whole-house rating is voluntary, although some programs under ARRA provided rebates, other incentives or financing for homes that were rated.

The California whole-house rating is an energy asset rating, which rates the energy efficiency of a home’s energy assets (its equipment, design, and construction); it is not a rating of the energy used by the occupants of the home as reported on energy bills. The California Home Energy Rating System Program defines procedures for determining a whole-house rating, and also for performing an energy assessment. The energy assessment is intended to provide a homeowner

---

<sup>2</sup> The California Home Energy Rating System Program was first adopted in 1999 to provide third party field verification ratings for demonstrating compliance of certain features in newly constructed residential buildings to meet the requirements of the California Building Energy Efficiency Standards (Title 24, Part 6) (for example, to provide field verification and diagnostic testing of duct sealing for showing compliance).

with a list of prioritized, cost-effective energy efficiency upgrade opportunities. The energy assessment includes analysis of a home's historical energy use.

A California whole-house rating is required to use software that is approved by the Energy Commission, to meet the technical requirements in the HTM. Currently, CalRatePro, which is a module built on the *EnergyPro* building simulation software<sup>3</sup>, is the only software that has applied and been approved for providing a California whole-house rating.

A California Home Energy Rating System Program requires that a HERS Provider test and certify HERS raters, and provide oversight over HERS ratings. Currently, CalCERTS is the only organization that has applied and been approved by the Commission as a HERS Provider for whole-house ratings.

The California Home Energy Rating System Program establishes a "dual-path" approach to providing whole-house ratings in the state:

- Under the "Independent Rater" path the rater must be an independent entity from any firm or person who performs upgrade work on the home. The rating procedures call for a rater to recommend a list of upgrades for the home. The homeowner will work with contracting firms to make those upgrades, or possibly other upgrades recommended by the contractor. The rater can come back to verify the installation after upgrades are performed, and provide a post-upgrade rating.
- Under the "Building Performance Contractor" (BPC) path the whole-house rating can be integrated with the upgrade project, and be completed by an employee of the contracting firm that is installing the upgrades. The BPC rater and the BPC contractor firm that employs the BPC rater have additional requirements to ensure consistent quality installation for all of the firm's projects. The BPC firm and rater must disclose to the homeowner that the rating is not being provided by an independent entity. The Energy Commission endeavored to align the BPC approach with the Building Performance Institute (BPI) expectations, calling for BPC contracting firms and BPC raters to obtain training and certification consistent with the BPI accreditation standards, and for HERS Provider quality assurance to be designed to align with BPI quality assurance for accredited contracting firms.<sup>4</sup>

### ***Whole-House Energy Efficiency Upgrade Programs***

Until recently, California's residential utility programs have offered rebates only for single measures, such as installing a more efficient furnace or air conditioner or attic insulation. At the CPUC's direction, California's IOUs began piloting the Whole-House Performance Program (WHPP) in 2010, to move away from a "widget" based incentives to deeper, more comprehensive energy upgrades. In parallel, the Energy Commission also launched regional pilots of whole-house upgrade programs (AB 758 Pilots) in 2010, using funds, which the

---

<sup>3</sup> More details on *EnergyPro* and CalRatePro available at: [http://www.energysoft.com/main/page\\_EnergyPro\\_residential\\_modules.html](http://www.energysoft.com/main/page_EnergyPro_residential_modules.html)

<sup>4</sup> More information about BPI standards, certification and accreditation can be found at: <http://www.bpi.org/home.aspx>

Commission was directed to administer, that were provided through the American Recovery and Reinvestment Act of 2009<sup>5</sup>. Examples of measures that might be combined into a comprehensive whole-house upgrade package include: attic insulation, air sealing, duct sealing, and efficient central furnace/air conditioner upgrades. Several regions of local governments also used ARRA funds that were allocated directly to them by the Department of Energy to pursue whole-house upgrade programs.

At the outset of these new whole-house programs, the Energy Commission, CPUC, utilities, and regional and local governments came together to coordinate these programs under a single statewide brand to avoid consumer confusion, and leverage all the resources for the good of all of the partners in the effort. *Energy Upgrade California* was launched as the statewide brand for whole-house programs, including a web portal to provide a call for action and a one-stop information source for homeowners to pursue energy efficiency upgrades<sup>6</sup>. The *Energy Upgrade California* is a resource for homeowners to find qualified home performance contractors and California whole-house raters, and identify available rebates from utility and local governments and available financing for upgrade projects. The regional pilot programs administered by the Energy Commission have provided incentives and financing to support the completion of whole-house HERS ratings; both the Independent Rater and BPC paths have been used to complete these ratings.

Given this major focus within California to achieve deep energy savings through whole-house approaches to energy efficiency upgrades, the findings from the needs assessment interviews are predominantly focused on the current status and needs relating to whole-house approaches.

---

<sup>5</sup> Program details can be found at: <http://www.energy.ca.gov/ab758/pilot-programs.html>

<sup>6</sup> *Energy Upgrade California* is the statewide energy efficiency brand for residential and small commercial properties, launched in 2010. *Energy Upgrade California* is an alliance between state agencies, local governments, and utilities, with each of these entities offering programs through a single online portal. More details at <https://energyupgradeca.org/overview>

## Needs Assessment Interview Findings

Benningfield Group's interviews covered the current market status, definition of needs, and potential means of addressing barriers to greater energy efficiency for existing residential properties. The summaries below provide an overview of the interview findings, divided into the following key AB 758 topic areas:

- Investing in energy efficiency upgrades
- Workforce development
- Ratings and assessments
- Whole-house energy upgrade programs
- Homeowner demand for energy efficiency

Interviewees highlighted many encouraging initiatives that are ongoing, along with highlighting market needs and barriers that could be addressed to achieve greater energy efficiency.

### ***Investing in Energy Efficiency Upgrades***

Several interviewees noted that the 2008 housing market collapse had a major impact in California on financing of energy efficiency projects, including reduced availability of financing as well as reduced homeowner ability to take advantage of financing. Interviewees anticipate improvement as the economy recovers, and highlighted important actions that would contribute to increased investment in energy efficiency upgrades, including changes to the property valuation process to incorporate energy efficiency, and gathering of data to quantify the long term financial impacts of energy efficiency. More than one expert stated that the two most important factors affecting the decisions of major lenders about lending for residential upgrades are the size of the market (they need to be able to offer essentially the same financing package across the state), and their ability to understand and be able to mitigate their risks. Experts also identified examples of financing programs that have shown promise even during the recession. Many of the points discussed through the needs assessment interviews were also raised in *Energy Efficiency Financing in California – Needs and Gaps*, a major report released by the CPUC in 2011 (Harcourt Brown & Carey, Inc. 2011).

### **Homeowners' ability and willingness to obtain financing for energy efficiency upgrades**

The housing market collapse and the ensuing economic recession have had a major impact on homeowners' access to financing. Among the interviewees, contractors, lenders, real estate agents and others pointed to the continuing lack of home equity as being a key contributing factor limiting the uptake of financing for energy efficiency upgrades. One interviewee estimated that over 25 percent of California's homeowners are "underwater" (the value of their property is less than the amount of their outstanding mortgage debt), and that perhaps 50 percent of the remaining homeowners are concerned about their jobs and therefore reluctant to take on any more debt. Without a sizeable market, interviewees noted that offering loans for energy efficiency upgrades would not be an attractive business proposition for larger national lenders.

Utility program managers (particularly in California’s Central Valley) reported that many potential program participants currently do not have the income to cover any additional debt. Even if homeowners are not underwater and feel secure in their jobs, they need sufficient income to repay loans for energy efficiency upgrades (especially whole-house upgrades which can cost in excess of \$10,000). Based on the interviewees’ responses, there is a general need for the economy to improve (in terms of raising home equity and job security) in order to increase the pool of homes that can be considered targets for energy efficiency upgrades.

### **Lenders’ increased risk sensitivity**

Industry experts repeatedly mentioned that one of the impacts of the housing market collapse was a reactionary contraction of the lending industry. Interviewees stated that lenders are less willing to take risks on financing energy efficiency upgrades and are looking in some instances for others to share a greater portion of the risk. This sharing of the risk can take the form of higher cost of capital to the homeowner or the need for third party programs to provide risk mitigation incentives, such as loan-loss reserves (LLRs)<sup>7</sup>.

Statements from financial experts strongly suggest that lenders are dominantly focused on traditional risk factors, such as available equity in the home, and are willing to give only limited consideration of the benefits of energy efficiency upgrades in their assessment of lending risk. Interviewees suggested that evidence that savings from an energy efficiency upgrade will cover loan repayments were not currently considered compelling risk mitigation factors by lenders.

Interviewees believed that in order for energy efficiency to be factored into lenders’ risk calculations, more data is needed to demonstrate a clear relationship between energy efficiency upgrades and a borrower’s performance to repay a loan without default, resulting in low loan default rates for energy efficiency upgrades. None of the interviewees felt that there was currently strong enough evidence to demonstrate that relationship. Interviewees also raised three additional concerns:

- It was suggested that energy savings that are not correlated to actual energy use do not provide adequate estimates of energy savings to support upgrade recommendations<sup>8</sup>.
- There is substantial potential for energy use “rebound,” especially for households that have a limited budget that can be spent on energy bills, and therefore limit their comfort when living in homes that have need for energy efficiency upgrades. This energy use “rebound” occurs after an energy efficiency upgrade is completed, when a homeowner recognizes that they can have an improved level of comfort after the upgrade and still

---

<sup>7</sup> LLRs are designed to lower lending risk for lenders by offering to cover some or all debts in the case of a loan default. The goal is to free up private capital for energy efficiency projects at a reasonable interest rate. LLRs are being piloted in the Counties of Los Angeles and Santa Barbara, the Cities of San Diego, Los Angeles, and San Francisco.

<sup>8</sup> The building energy simulation software used for the *Energy Upgrade California* program used default values for ‘operational’ factors, such as number of occupants and energy use from plug loads; and although it was capable of making a detailed comparison of estimated energy use to actual energy in pre-retrofit bills, these default values were not able to be changed to calibrate the estimated energy use to match the actual energy use.

not exceed their budget limit for energy bills that they have set for themselves. The possibility of this occurring relatively frequently correlates with the finding that homeowners are usually more motivated to make energy upgrades to accomplish increased comfort and healthier homes than to achieve the potential energy bill reductions. As a result of the rebound effect, the realized savings for an upgrade may be less than expected. There is currently no reliable way of gauging the extent of the rebound effect.

- Creating an expectation among lenders that financed upgrade projects will have low default rates, since the savings from an upgrade will cover monthly loan payments, and then find that expectation to not be realized, could have a negative long-term impact on availability of financing for energy efficiency.

Respondents with financial industry expertise believed that lenders have low or no awareness of home energy ratings. One expert said this was because many other market actors (e.g. appraisers, real estate agents, etc.) don't yet recognize a significant value to energy efficiency nor attach any financial value to an energy efficiency rating.

### **The value of energy efficiency at time of sale**

Several interviewees suggested that a home energy rating would be most useful at time of sale, so that it could be considered as part of the property value determination. One interviewee stated, that home appraisers currently don't recognize ratings as an input for property valuation because there is insufficient data within the market database of comparative information for homes, to allow for easy correlation to sale prices for homes with higher energy efficiency. There is some published research on the relationship between energy efficiency ratings and home prices in California (Kahn, Matthew E., Nils Kok. 2013), but such data is perceived as being relevant to only that point-in-time and to the circumstances of the particular study, and is outside the market data system that is used by the industry to establish property values.

Interviewees indicated that it could take several influences working together before appraisers pay attention to energy efficiency. Some pointed to a lack of training for appraisers on the impact of energy efficiency measures. Another felt that the primary issue was the small size of the market for energy efficient homes; that when there are enough energy efficiency upgrades and ratings occurring and there are enough home buyers asking about energy efficiency, then the appraisal industry will be willing to address energy efficiency in property valuation. Most interviewees agreed that there is currently no systematic impact of energy efficiency on property valuation, and no consensus on how energy efficiency can be incorporated into appraisal standards. The recently released *Residential Green and Energy Efficient Addendum* from the Appraisal Institute provides three different ways to consider energy: check-boxes for specific nominally efficient equipment and measures; an energy rating or certification; and historical utility bill data.<sup>9</sup>

Several interviewees within the appraisal and real estate communities expected the *Residential Green and Energy Efficient Addendum* to be effective at advancing energy efficiency, but they

---

<sup>9</sup> More details available at: [http://www.appraisalinstitute.org/education/green\\_energy\\_addendum.aspx](http://www.appraisalinstitute.org/education/green_energy_addendum.aspx)

could not say how long that would take, nor how the means of accounting for a home's energy efficiency might change. The Appraisal Institute is providing training on the Addendum to its members and conducting outreach to help the real estate community understand it, and to help its own members understand how to use it. As a general comment, there is an overarching need to work with the groups that set appraisal standards and guidelines, and appraisers themselves, in order to incorporate energy efficiency into property valuation procedures.

## **Loan product options**

There are a number of loan options specifically targeted at energy efficiency upgrades; interviewees discussed some of these options: energy efficient mortgages (EEMs), on-bill financing (OBF), on-bill repayment (OBR), Property Assessed Clean Energy (PACE), and the California Rural Homes Municipal Financing Authority's (CRHMFA) Homebuyers Fund (CHF)<sup>10</sup>.

An EEM is a mortgage that gives borrowers the opportunity to finance cost-effective, energy-saving measures as part of a single mortgage and stretch debt-to-income qualifying ratios on loans, thereby allowing borrowers to qualify for a larger loan amount and a better, more energy-efficient home.<sup>11</sup> Reports from the subject matter experts on the viability and uptake of EEMs was mixed. One California whole-house rater said an EEM provides the greatest value available for financing energy efficiency upgrades. Another interviewee said that there are smaller lenders that are using EEMs as a way of gaining new customers. Other experts felt that EEMs are perceived as being slower and more complicated than conventional mortgages.

With few exceptions, the subject matter experts believed that EEMs can be valuable to the State's efforts to increase energy efficiency, but they voiced a need for improved methods of calculating energy savings from proposed energy efficiency upgrades to facilitate a more meaningful evaluation of costs versus benefits, including a means for calculated energy use to be calibrated to bills.

Many interviewees noted that OBF has been tried both inside and outside of California, and are perceived to have worked well, particularly for commercial buildings. The California IOUs have piloted OBF programs for the commercial sector, and the CPUC is looking to expand commercial OBF programs and also to introduce commercial, on-bill repayment (OBR) programs<sup>12</sup>. The CPUC currently has no plans to introduce OBF or OBR for residential properties. One interviewee mentioned the On-Bill Recovery Financing Program offered by the New York State Energy Research and Development Agency (NYSERDA) as a best practice

---

<sup>10</sup> CHF's Moderate Income Sustainable Technology (MIST) program offered zero to three percent financing with 30-year terms for energy efficiency projects in participating counties. The program ran from 2010 to 2012, with \$16.5m funding from the Energy Commission and \$2m from CRHMFA, a joint powers authority comprised of the majority of counties in California.

<sup>11</sup> More details on EEMs can be found at: [http://www.energystar.gov/index.cfm?c=mortgages.energy\\_efficient\\_mortgages](http://www.energystar.gov/index.cfm?c=mortgages.energy_efficient_mortgages)

<sup>12</sup> With OBF programs, utilities offer loans to customers, with repayments made through utility bills. For OBR programs, capital is provided by private lenders rather than the utility. The utility collects loan repayments on the customer's utility bill and passes them on to the private lender.

example that could be followed in California. Under this program, the state of New York set up a revolving loan program<sup>13</sup>, which is partly funded by proceeds from the sale of carbon allowances under the *Regional Greenhouse Gas Initiative*. NYSERDA is required by the enabling law to file a mortgage on the property receiving the upgrades, and loan repayment is made through customers' utility bills. The NYSERDA mortgage is subordinate to any existing or future mortgage. It continues beyond the sale of the property, remaining as an obligation of the property. If any arrearages occur and remain at the time of sale, the selling party is responsible for those, and NYSERDA is responsible for collecting arrearages (not the utility).

Residential PACE programs are administered by local governments that use their authority to issue bonds to back financing for energy upgrades to privately owned buildings in their jurisdiction. Property assessments are made as a lien on the buildings, and repayment is collected through property tax billing. PACE financing was disrupted in 2010 by a Federal Housing Financing Authority (FHFA)<sup>14</sup> letter to lenders, which raised concern that PACE financing takes a first position on liens to the property. In the event of a default, the repayment of PACE financing arrearages is in a first priority ahead of mortgages and loans, which come fully due at that time<sup>15</sup>. The obligation to fully repay the PACE financing assessment does not come fully due at the time of change of ownership, but transfers to the new owner for continuation throughout the 10 to 20 year term of the financing. According to an experienced financial policy expert, PACE advocates are expecting residential PACE programs to become more viable again in the future, but it is not clear when this will happen or how the program designs will need to be revised to address FHFA concerns.

Multiple parties in the interviews noted that the financing that publicly-funded CHF offers plays an important role in many of the most successful programs offered through *Energy Upgrade California*. One contractor stated that he had seen that financing whole-house upgrades through CHF could be cash flow neutral for homeowners.

It is assumed that improving the energy efficiency of California's existing buildings will require a combination of financing approaches, and so there is a general need to understand the optimal mix of options that will gain the greatest benefit with the least input of taxpayer funds.

## **Communicating financing options to market stakeholders**

A major barrier voiced by several interviewees was a lack of communication between implementers of loan programs and utility energy efficiency programs. It was suggested that there is a need for more coordination to achieve greater market penetration for energy efficiency

---

<sup>13</sup> More details available at: <http://www.nyserda.ny.gov/Programs/Statewide%20Initiatives/On%20Bill%20Recovery%20Financing%20Program.aspx?=21>

<sup>14</sup> FHFA regulates the secondary residential mortgage market by overseeing the activities of Fannie Mae and Freddie Mac and the 12 federal home loan banks. For mortgage lenders to be able to sell mortgages into the secondary market, they need to be mindful of FHFA policies.

<sup>15</sup> Some jurisdictions, such as Sonoma County, have continued to pilot residential PACE programs with support from ARRA funds administered by the Energy Commission. PACE programs are also ongoing for the nonresidential market sector, as commercial loans are not governed by FHFA

upgrades. Improved coordination can result in a more comprehensive offering for homeowners that includes both the upgrade proposal and a suitable financing package. This combination is one of the central features of the *Energy Upgrade California*, although the interviewees' comments indicate that there is still progress to be made in meeting market needs.

## ***Workforce Development***

There is a wide variety of residential energy-related training programs in California offered through utilities, nonprofits, private organizations, traditional educational institutions, and (between 2010 and 2012) the Energy Commission administered, ARRA-funded programs. These programs target home performance contractors who install energy efficiency upgrades, and whole-house HERS raters. Interviewees acknowledged the wide array of available training options and provided suggestions for improving both the training and coordination between the training programs. Also discussed were specific skills gaps for contractors, raters and real estate professionals. Interviewees suggested that homeowners generally prefer to hire certified professionals, but are currently unfamiliar with energy-related certifications.

### **Coordination of training and certification programs**

The Building Performance Institute (BPI) and the California whole-house HERS Program are the two most commonly referenced training certification programs related to residential energy efficiency. Several interviewees suggested further coordination between these two training and certification programs. Respondents stressed the importance of the health and safety measures included in BPI protocols, and expressed a need to include these into future upgrades of the California whole-house HERS program.

Several of the interviewees mentioned community colleges as an established training provider, and suggested a need for them to coordinate more closely with businesses and energy efficiency programs. One interviewee suggested that community colleges provide training for contractors, which includes hands-on field work. Another interviewee identified community colleges as a valuable training provider, but noted the need to coordinate with energy efficiency programs to ensure that skills are matched to the program needs. One barrier highlighted by the interviewee was that some energy efficiency programs may only be temporary, and there is reluctance to developing community college training to support energy efficiency programs that aren't assured of long term stability.

### **Unmet training needs for contractors, raters, and energy assessors**

Several interviewees stressed the need for business skills training for home performance contractors, HERS raters and energy assessors, such as sales, marketing and business development training. One interviewee from the local government sector said that they are already working to meet this need with basic business and marketing training for contractors, subsidies for advertising, and scholarships for business courses. The interviewee noted that given the high level of funding devoted to training and the variety of training programs underway at this time, it is hard to identify where the skills gaps might be, but there is a clear need for better coordination of workforce development efforts. One interviewee suggested that there needs to be a comprehensive training program that includes building science, hands-on experience, and business skills development, which culminates in one certification; this unified approach could meet a need for improved market clarity regarding training and certifications.

Several interviewees expressed the need for more field training to support energy efficiency work. One expert cited a five-day training course on auditing, modeling, and verifying multifamily energy efficiency upgrades as an example to follow. It was noted that even after that five days of training, there was a need to provide one-on-one training for individual projects (the respondent highlighted challenges with modeling a home with building simulation software as a particular issue).

One expert noted that there is a high amount of training focused on energy assessments and ratings, but a need for more training and certification for home performance contractors on quality installation of energy efficiency upgrades. Another expert offered a differing view, based on experience with a Home Performance with ENERGY STAR (HPwES) program in another state<sup>16</sup>. The HPwES approach includes independent verification of upgrades; the interviewee felt that this verification can assure quality for homeowners and negate the need to focus on certifying installing contractors.

### **Real estate agents, appraisers and lenders**

Training for real estate professionals was considered a significant need by one interviewee, and several others noted that real estate agents, appraisers, and lenders in their roles of advising homeowners can help to promote energy efficiency. One respondent suggested that many real estate agents are interested in sustainability, and several experts noted the need to increase the number of workshops offered for those in the real estate industry. As noted earlier in this report, home appraisers do not currently factor energy efficiency into home valuation procedures. Once standardized appraisal procedures have been developed that incorporate energy efficiency data, training will be needed for appraisers.

### **Consumer demand and awareness for certification of professionals**

While several respondents said that consumers generally prefer to hire professionals with certifications, nearly all indicated that consumers weren't familiar with specific certifications related to energy efficiency, such as BPI's numerous certifications, certified California Whole-House Raters, and Build It Green's GreenPoint Rater<sup>17</sup>. Usually, the requirement for one or more professional certifications is established by an incentive program, rather than by consumer demand. Interviewees expressed the need to simplify the range of professional certifications, to help drive consumer demand and reduce consumer confusion.

### ***HERS Ratings and Energy Assessments***

Interviewee responses on the topic of California whole-house HERS ratings and energy assessments covered three general themes: determining the timing of ratings and assessments, the software tool used, and the market delivery approach.

---

<sup>16</sup> More details on HPwES available at: [http://www.energystar.gov/index.cfm?fuseaction=hpwes\\_profiles.showsplash](http://www.energystar.gov/index.cfm?fuseaction=hpwes_profiles.showsplash)

<sup>17</sup> More details on Build It Green available at: <http://builditgreen.org/become-a-certified-greenpoint-rater/>

## **Timing of HERS ratings and energy assessments**

Among the interviewees there was some discussion of when a HERS rating is most valuable, and perspectives varied. Several experts (other than real estate professionals) indicated that the value of a rating is most likely to be realized at the time a property is sold. They asserted that if ratings become available at the time of home purchase, then this would be useful for potential buyers to assess the relative energy efficiency of several properties.

One interviewee suggested that there could also be value in obtaining a rating after energy efficiency upgrades have been carried out. This would provide an opportunity for a homeowner to validate the enhanced rating that was achieved following the upgrades, and also the rating would be available to demonstrate the increased energy efficiency to potential buyers at a later date.

There is a general need for further research to evaluate the potential benefits and drawbacks of performing a whole-house rating at different trigger points in the life of a building, such as prior to upgrades, after upgrades, and at time of sale.

## **California whole-house rating and energy assessment software**

Among the interviewees there was a range of opinion on the *EnergyPro* based software used by the *Energy Upgrade California* program and for California whole-house HERS ratings. Some contractors noted that this energy software works well as an assessment tool for *Energy Upgrade California*, and several of the interviewees suggested potential improvements to the software. It was suggested that the software should be easier to use, to reduce the time spent on data entry and to make the output reports more “customer-friendly.” One interviewee expressed a desire for a streamlined version of the *EnergyPro* software so that all of the required data could be entered in no more than one hour. Others have reported that it takes an experienced *EnergyPro* user about ½ hour to enter the inputs for a typical home.

One interviewee indicated that they know of contractors who use *EnergyPro* software to meet *Energy Upgrade California* program requirements, but that they will use other software tools to support energy assessments because they are considered better for developing packages of recommended measures and providing better estimates of energy savings. The expert suggested improving *EnergyPro* to allow for multiple upgrade packages when presenting options to a homeowner as part of an assessment. In the context of the AB 758 Program, the interviewee comments indicate a need for the Energy Commission to review the software specifications for the California whole-house HERS Program.

## **Market delivery approach**

Among the interviewees there were varying perspectives on the relative benefits of energy assessments being performed by a home performance contractor or by a HERS rater. Several respondents noted that if a HERS rater is the person who completes the energy assessment; this can increase the complexity of the upgrade process because the homeowner has to deal separately with the rater and the contractors performing upgrades. Two of the home performance contractors interviewed suggested that this makes it more difficult for homeowners to reach a decision to make upgrades. Several interviewees offered a contrasting opinion, that many homeowners value the objectivity of an independent rater providing an energy assessment because the independent rater does not stand to financially gain from the upgrades that a homeowner might select.

An interviewee who is primarily focused on the multifamily market sector indicated that use of an independent rater is standard in that market primarily because property owners want to use specialty contractors with whom they are already familiar to do work on their buildings. Multifamily property owners are typically comfortable with coordinating projects with multiple contractors, each working in their license specialty.

Virtually all interviewees noted that homeowners participating in whole-house programs typically have little or no knowledge that would allow them to judge the value of recommendations made during an energy assessment, yet there is a need for homeowners to be confident in the assessment process and in the expected results if they are to take action.

Two of the interviewees shared examples of meeting the need for homeowner confidence in the program process. One city program manager said that he has accompanied home performance contractors on home visits to review energy assessment results. This interviewee stated that this reduces the likelihood that homeowners will view the performance contractor as being biased in offering upgrade recommendations focused on maximizing the performance contractor's profits. One independent rater described how they conduct the energy assessment, create scopes of work for upgrades, help locate contractors, help arrange financing and rebates, and at the homeowner's request oversee the upgrades. This approach positions the rater as a trusted advisor, as opposed to just one of the many people a homeowner must deal with in a confusing process.

One interviewee commented that they have seen a lot of pressure on pricing for energy assessments and initial ratings, as some firms are offering energy assessments and initial ratings at a very low price or sometimes free of charge. It was suggested that home performance contractors sometimes offer the energy assessment at no cost as a sales tool to help with gaining work to install upgrades, and that this puts independent raters at a competitive disadvantage because they do not offer other services where the cost of the energy assessment/rating can be recouped. BPI websites list contractors who offer free assessments, and one energy assessor suggested that many homeowners are expecting an energy assessment to be free or very low cost. Given that energy assessors need to invest in their own training, purchase special equipment, and spend time to do the assessment, offering energy assessments at low or no cost is infeasible for many firms, if the cost of the assessment cannot be covered in the cost of the upgrade installation.

One general point voiced by some interviewees across several professions was uncertainty over the future of *Energy Upgrade California* and the California whole-house rating program beyond the ARRA funding period (interviews were conducted in late 2011 and ARRA funding ended on April 30, 2012). The interviewees suggested that, as a result of the uncertainty, some industry stakeholders (particularly home performance contractors) were not prioritizing their efforts to participate in the *Energy Upgrade California*. One interviewee voiced a need for the Energy Commission to work with the CPUC to continue the *Energy Upgrade California* Program beyond the ARRA funding period.<sup>18</sup>

---

<sup>18</sup> The CPUC's Guidance Decision on the 2013-2014 utility programs transition period acknowledges the need for, and value of, continuing *Energy Upgrade California*, and directs the utilities to continue the use of

Given the range of opinions expressed by interviewees regarding the market delivery approach for energy assessments and ratings, there is a need for the Energy Commission to further explore the experiences of performance contractors, independent HERS raters, and homeowners, and to review program data to understand the relative value of the completion of energy assessments by either a home performance contractor or an independent rater in the context of future program design.

### **Quality assurance for ratings and assessments**

There are many industry entities involved in designing and conducting quality assurance (QA) for energy assessments and California whole-house ratings, including utility program implementers<sup>19</sup>, local governments<sup>20</sup>, and BPI<sup>21</sup> regarding energy assessments, and the Energy Commission and the HERS Provider<sup>22</sup> regarding energy assessments/ratings.

One interviewee noted that the utility programs conduct a high rate of QA sampling, both before and after the upgrade project, and that there is the potential for multiple additional QA inspections at a home (such as a separate QA review by a local government program administrator, another QA review by BPI, and a QA review by the California HERS Provider). Although the non-utility program QA covers only a small subset of the total upgraded homes, and has much smaller sampling rates, some limited overlap is possible, and could cause a high level of inconvenience for the homeowner. The interviewee also commented that multiple quality assurance inspections add cost that is sometimes unnecessary. Multiple interviewees commented that increased focus on training of home performance contractors should result in a reduced need for quality assurance inspections.

An interviewee stated there is a need to be clear about what QA inspectors will be looking for during inspections and provide this information to performance contractors, and independent raters as early as possible in the program launch phase. Other interviewees involved in *Energy Upgrade California* program QA believed that contractors perform better when they know their work might be reviewed, that the review will be meaningful, and they are aware that there are consequences from a “failed” QC inspection.

---

the *Energy Upgrade California* as an umbrella brand for residential and small commercial energy efficiency programs.

<sup>19</sup> Utility program administrators conduct a sliding scale of quality assurance reviews for each participating performance contractor depending on the performance of each contractor on prior reviews. Quality assurance sampling rates of the utilities can be 20% or higher when they find that necessary to achieve acceptable contractor performance in their programs.

<sup>20</sup> Local government programs commonly rely on the quality assurance of the utility *Energy Upgrade California* program rather than conducting their own quality assurance reviews.

<sup>21</sup> BPI conducts quality assurance reviews of a minimum of five percent of projects completed by the limited number of BPI accredited firms in California.

<sup>22</sup> The HERS Provider is expected to provide quality assurance reviews at a sampling rate of 1-2% for homes that receive ratings.

An interviewee voiced a need for more education of homeowners, to help them have an accurate understanding of what is involved in energy assessments and ratings, and to provide guidance if they have quality concerns related to work on their home.

## ***Whole-House Energy Upgrade Programs***

This section includes interviewee comments on whole-house upgrade programs, which has not been covered previously.

### **Depth of energy efficiency upgrade projects**

Most whole-house upgrade programs target at least a 15% improvement in energy use, although there is variation between programs. Eight interviewees with whole-house program experience discussed typical energy savings for projects, with estimates ranging from 20 percent to 30 percent.

None of the interviewees was able to report what percentage of the estimated savings identified through an energy assessment was being realized through implementation of the recommendations by homeowners. One interviewee said that at least five percent of the identified savings was not being achieved because the recommendations were not implemented, and another suggested that this number was much higher. The latter interviewee suggested that homeowners often plan to implement measures in phases based on finances and their desire to build confidence in the upgrade process step by step. Another interviewee stated that, for the multifamily sector, a multi-phase upgrade approach is much more likely than for the single family sector, due to financial constraints and the logistical difficulty of coordinating upgrade timing with multiple tenants.

Two interviewees discussed the challenges in persuading homeowners to implement a comprehensive (and often expensive) package of measures as a single project; however, most interviewees expressed support for continuing to pursue the comprehensive upgrade approach. One contractor noted that each phase of a multi-phase approach requires the homeowner to identify a contractor; obtain a bid (or multiple bids); work out how to pay for the upgrade; potentially deal with disruption during the upgrade; and potentially deal with utility rebate paperwork. The contractor made the point that with a phased approach, the homeowner's level of inconvenience is far higher overall, and there is a risk of the homeowner losing interest before all potential measures have been implemented. Another interviewee voiced a similar concern, saying that with a phased approach, a homeowner might start with the most cost-effective measures and later lack the motivation to continue with less cost-effective measures in subsequent phases.

Interviewees' estimates of the amount of time it takes to complete a typical energy upgrade project ranged from 4-5 days to 2-4 weeks. Additionally, both contractors and program managers pointed out that these estimates do not include the amount of time it takes from an initial expression of interest by the homeowner to the point at which upgrades actually commence. One interviewee suggested the process involved in getting the upgrade started adds one month, and another interviewee suggested it takes between one and four months.

There is a general need for more quantitative data on whole-house program results to gain a better understanding of how homeowners are choosing to implement upgrades, and to research

the relative benefits and drawbacks of implementing a package of measures at one time compared with a phased approach.

### **Conversion rate from assessments to completed projects**

A useful metric for assessing the success of whole-house upgrade programs is the percentage of energy assessments that resulted in completed upgrades (referred to here as the “conversion rate”). Among the experts interviewed, home performance contractors, raters and program managers provided a range of estimated conversion rates for programs in which they had worked, generally between 25 percent and 50 percent. One independent rater reported that his conversion rate was near 100 percent, and explained that he offers a comprehensive package of services beyond what would normally be provided by independent raters. He markets a partnership with his firm to home performance contractors, and then trains and qualifies them. He acts on behalf of the homeowner to explain the scope of work to interested contractors, and then conducts a home visit with them to make sure upgrade requirements are clear. He has what he considers a mature marketing package, business plan, and relationships with all of the relevant parties, including lenders.

As reported previously, however, many home performance contractors find that the involvement of an independent rater in projects can be a hindrance to achieving a high conversion rate with their customers.

As with the above section on depth of whole-house upgrades, there is a need for more data on conversion rates, and also research on some of the factors that contribute to low or high conversion rates.

### ***Homeowner Demand for Energy Efficiency***

Interviewees generally believed that homeowners are becoming more aware of energy and sustainability issues, but that there is a low level of awareness of what practical steps can be taken to improve energy efficiency. Energy efficiency has been promoted through many approaches and programs in California for decades, but only since 2010 has there been a concerted statewide effort to encourage whole-house upgrades to achieve greater energy efficiency. Based on interviewee responses the public has not yet fully embraced a whole-house approach to energy efficiency upgrades (unsurprising given that it is still a relatively new program concept).

### **Public awareness of, and demand for, energy efficiency**

Most of the interviewees asserted that while the public is generally aware of energy and sustainability issues, this does not necessarily drive a strong motivation to upgrade the energy efficiency of their own homes. Experts also indicated that even when homeowners are motivated, there is typically a low level of awareness of the options available to support energy efficiency upgrades. Interviewees also noted that there is a low level of compliance with code permitting requirements for upgrades. One interviewee stated that during the California energy crisis of 2000/2001, there was a strong sense of urgency around reducing energy use, but that the general public no longer feels that urgency. A home performance contractor indicated that he doesn't feel any sense of urgency from the homeowners he deals with on a daily basis, and

there is a need to review marketing efforts and establish outreach messages that can generate a sense of urgency.

One interviewee suggested a need to target homeowners with the greatest opportunity for savings over the next two years, ensure they have a positive experience with whole-house upgrades, and then expand further into the residential market from there. The intent of this strategy is to create success stories that can help make a compelling case for other homeowners to upgrade.

One interviewee noted that one factor in homeowners' lack of motivation to upgrade their homes is that energy waste is often inconspicuous, and high energy bills are often attributed to high utility rates. Homeowners are typically unaware of the energy efficiency of their heating, air conditioning, and lighting, or the potential favorable impacts of upgrades. Another interviewee believed that many homeowners do have an understanding that changing light bulbs and thermostat settings will reduce energy use, but that few understand whole-house approaches for improving energy efficiency. Two of the interviewees indicated that sometimes it is harder to motivate homeowners who have implemented some energy efficiency upgrades in the past, as they may feel they have "done their part already."

One program manager stated that homeowners are confused about the relative benefits of energy efficiency compared to installing photovoltaic (PV) systems, and that many choose PV because it is more "visible." Some respondents stated that they are working to leverage consumer interest in PV to promote energy efficiency. One program manager said that their program provided outreach on energy efficiency to homeowners who express an interest in PV. One of the independent energy assessors interviewed works closely with PV contractors so as to encourage homeowners to pursue both solar and energy efficiency. However, another said that PV contractors are not interested in talking with potential customers about energy efficiency because it complicates their sales process and can slow down the PV installation. There is a need to educate the public on the relative benefits of PV and energy efficiency, and to explore ways of better coordinating efforts between PV and energy efficiency programs.

Several interviewees indicated that there is a great deal of outreach messaging around "sustainability" and "green" issues, but that the public is confused about how energy efficiency relates to these themes. One respondent noted that multifamily owners are as interested in water efficiency and indoor air quality as they are in energy efficiency. A program manager suggested that U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) for Homes rating<sup>23</sup> has helped to raise public awareness of sustainability, although this does not address potential homeowner confusion between the terms sustainability and energy efficiency.

One interviewee, from an energy efficiency resource and training center, offers homeowner workshops to educate people on what they can do to improve the energy efficiency of their homes. Workshop attendees complete a questionnaire, which includes asking about

---

<sup>23</sup> LEED for Homes is a voluntary rating system for single and multifamily, affordable and market rate housing projects. LEED for Homes is a points-based rating system that promotes the design and construction of high-performance homes - energy efficient, resource efficient, and healthy for occupants. More details available at: <http://new.usgbc.org/leed/rating-systems/homes>

motivations for improving energy efficiency. High utility bills, concern for the environment, uncomfortable rooms, and indoor air quality are the top four cited reasons for taking action to improve energy efficiency. It should be noted that the sample population for this questionnaire only included people who voluntarily attended the workshop, as opposed to representing the general population of homeowners. However, the data can be helpful for identifying the motivations of those who are showing an interest in energy efficiency. There is a need to gather similar data from other jurisdictions that provide training and workshops.

Interviewees indicated there are several triggers when homeowners may be interested in exploring energy efficiency options, including when experiencing high energy bills; When wanting to qualify for incentives to install PV and there are “loading order” requirements to incorporate energy efficiency in the project; when there is a furnace or air conditioner failure, and they are alerted to utility incentives by their contractor; or when they receive an email or utility bill insert from the program administrator.

### **Regional variations in public awareness and demand for energy efficiency**

Two interviewees described the relative level of trust that homeowners have in utilities, contractors, and their city governments. One respondent stated that, in their region, focus groups had indicated a higher level of trust in the city because it is perceived as “not selling anything.” A program manager from another city said that their market research showed that the utilities are the first source that homeowners go to for energy efficiency advice, and that utilities are the most trusted source for energy efficiency information because they are the most visible. Both stated that there is a general distrust of contractors, since they are perceived as trying to sell their own services as opposed to offering independent advice.

Several experts indicated that regional climate variations need to be considered when conducting outreach to promote energy efficiency. For example, multiple interviewees noted that in very mild climates of California such as the south coast, heating and cooling costs are too small to motivate residents to upgrade energy efficiency based on cost savings alone. One program manager suggested that messages about safety, indoor air quality and health would create greater motivation among homeowners than energy efficiency will. He said that they are working with the American Lung Association and other health organizations to promote the health benefits of energy efficiency.

One local government program manager explained that they use home energy use data available from the utilities at the neighborhood level, along with economic and demographic data, to target those homes that have both higher than average utility bills and insufficient household income to tackle energy efficiency upgrades without assistance. That allows the program to very effectively focus its outreach messages to target those homes on health, comfort and utility cost savings benefits of efficiency upgrades.

Respondents who had experience with local government partnerships believed that their outreach efforts have been relatively successful because they are led by local entities whom homeowners trust, and because outreach is focused on drivers that align with local issues and attitudes. Messages that made a difference included comfort, health, reduced utility costs, increased home value, and the environment. Several program managers believed that messages would be most successful when they are focused just on the highest priority local concerns, such as energy costs or environmental concerns. There is a need for AB 758-related outreach to

account for regional drivers in addition to statewide policies and concerns, and to craft local campaigns that deliver effective local messages.

## Summary

The needs assessment interviews provided a broad perspective of California's needs relative to the key AB 758 topic areas, through the insights and perspectives of industry experts. Each interviewed expert recognized the high degree of complexity of the existing residential energy efficiency market, and the need for a comprehensive approach to increase the energy efficiency of California's existing building stock.

The guided interview format allowed deep exploration of the topic areas most relevant to each expert. This has provided valuable contextual information on the concerns and perceptions of different market actors, and provides many pointers to areas most in need of attention as the state seeks to increase the energy efficiency of California's existing buildings. These findings can help to guide the Energy Commission through Phase I of AB 758 Program development and to anticipate some of the obstacles that lay ahead.

The market needs stated by interviewees for each of the key AB 758 topic areas are summarized below.

### ***Investing in Energy Efficiency Improvements***

- There is a need for the general economy to improve, in terms of raising home equity and job security, in order to increase the demand for financing whole-house upgrades.
- More data is needed by lenders to demonstrate a relationship between energy efficiency upgrades and low borrower default rates.
- There is a need to work with the groups that set home appraisal standards and guidelines, and appraisers themselves, in order to incorporate energy efficiency features into property valuation procedures.
- There is a need for improved methods of calculating energy savings for proposed energy efficiency upgrades to facilitate a more meaningful comparison of financing costs and energy cost savings. Improvement is needed of building simulation software to better match actual energy use.
- There is a need to understand the optimal mix of lending product options that will gain the greatest benefit with the least subsidization of taxpayer funds.
- Greater coordination is needed between implementers of loan programs and utility energy efficiency programs to achieve greater market penetration for energy efficiency upgrades.

### ***Workforce Development***

- Further coordination is needed between the Building Performance Institute and the California whole-house rating Program, such as having the California whole-house rating Program including combustion testing and establishing better alignment with home performance contracting standards and practices in rater training programs).
- Community colleges need to improve coordination with businesses and energy efficiency programs, to better match training curricula to business needs.

- Community colleges need to increase the amount of hands-on technical training available for performance contractors and energy assessors working on energy efficiency upgrades.
- Business skills' training is needed for performance contractors and independent energy assessors and raters, including sales, marketing and business development training.
- There is a need for more training and certification for contractors on high quality installation of energy efficiency upgrades.
- There is a need to increase training for real estate professionals, such as real estate agents, appraisers, and mortgage lenders, to incorporate energy efficiency into the home sales process.
- There is a need to simplify the range of professional certifications for performance contractors and independent energy assessors and raters working on efficiency upgrade projects, to help reduce consumer confusion and increase demand for energy efficiency.

### ***Energy Efficiency Rating Systems***

- There is a need for further research to evaluate the most advantageous trigger points for performing California whole-house ratings, such as prior to upgrades, after upgrades, and at time of sale.
- Building simulation software used for energy assessments and ratings needs to be easier to use, have the ability to support recommendations for packages of measures, require reduced time spent on data entry, produce output reports that are more customer-friendly, and better match estimated energy savings to actual savings in energy bills.
- There is a need to further explore the experiences of performance contractors, independent energy assessors and raters, and homeowners, and review program data to better understand the benefits of energy assessments provided by either performance contractors or independent energy assessors and raters.
- Energy upgrade program managers need to be clearer about what Quality Assurance inspectors will be looking for during program Quality Assurance inspections, and provide this information to performance contractors, and independent energy assessors and raters, as early as possible in the program launch phase.
- There is a need for more education of homeowners, to help them understand what is involved in energy assessments and ratings, and provide guidance on what they should do if they have quality concerns related to work on their home.

### ***Whole-House Upgrade Programs***

- There is a need for further research into the benefits and drawbacks of implementing a package of upgrade measures at one time versus a phased approach with multiple interventions.

- There is a need for more data on the percentage of energy savings achieved in implementation of whole-house upgrade projects compared to the potential savings identified through energy assessments.

### ***Homeowner Demand for Energy Efficiency***

- There is a need to review marketing efforts and establish outreach messages that can generate a sense of urgency around energy efficiency.
- There is a need to target homeowners with the greatest opportunity for savings in the short term, ensure they have a positive experience with whole-house upgrades, and then extend further into the residential market based on these early successes.
- There is a need to educate the public on the relative benefits of combined energy efficiency and PV system projects, and to explore ways of coordinating both types of upgrades.
- Regional climate variations need to be considered when conducting outreach to promote energy efficiency, as this can affect the relative priority that homeowners placed on energy cost savings, environmental concerns, and health concerns.
- There is a need to account for regional drivers in addition to statewide policies and concerns, and to craft local campaigns that deliver effective local messages.

Over the last two years there has been a major shift in the residential energy efficiency market in California, driving towards whole-house approaches to energy efficiency as well as coordinating efforts statewide. Major factors in this shift have included the collaborative efforts to merge the IOU WHPP Programs, ARRA-funded AB 758 pilots, local and regional government funded whole-house programs and the California whole-house rating program under the single brand of *Energy Upgrade California* to establish a one-stop support process to promote whole-house upgrades statewide.

Given that the whole-house concept is still relatively new, it is understandable that market delivery mechanisms (upgrade programs, energy assessments, whole-house ratings) are not yet fully optimized, and that the efforts of all market actors are not fully coordinated. Similarly it is understandable that homeowner awareness of, and demand for, whole-house upgrades is relatively low. Many of the interviewee responses recognized the relative infancy of the whole-house upgrade industry, and provide valuable perspectives that can help guide the industry towards maturity.

## References

Harcourt Brown & Carey, Inc. 2011. *Energy Efficiency Financing in California: Needs and Gaps*.

Available at: [http://www.harcourtbrown.com/wp-content/uploads/CPUC\\_FinancingReport\\_HBC\\_Jul8v2.pdf](http://www.harcourtbrown.com/wp-content/uploads/CPUC_FinancingReport_HBC_Jul8v2.pdf)

Matthew E. Kahn (University of California, Los Angeles), Kok, Nils (Maastricht, University).

2013. *The Capitalization of Green Labels in the California Residential Housing Market*.

Available at: <http://www.corporate-engagement.com/files/publication/KK%20Green%20Homes%20021313.pdf>

## Appendix A: Acronyms and Abbreviations

ARRA	American Recovery and Reinvestment Act
BPC	Building Performance Contractor
BPI	Building Performance Institute
Btu	British thermal unit
CHF	CRHMFA's Homebuyers Fund
CPUC	California Public Utility Commission
CRHMFA	formerly the California Rural Homes Municipal Financing Authority
EEM	Energy Efficient Mortgage
EPS	Energy Performance Score
HERS	Home Energy Rating System
HEScore	Home Energy Score
HPwES	Home Performance with Energy Star
IOU	Investor-owned utility
LEED	Leadership in Energy and Environmental Design
LLR	Loan Loss Reserve
MBtu	Millions of Btus
OBF	On-bill financing
OBR	On-bill repayment
PACE	Property Assessed Clean Energy
TDV	Time-dependent valuation
U.S. DOE	United States Department of Energy
USGBC	United States Green Building Council

## **Appendix B: Glossary**

**Energy Assessment** of a building is the determination of an energy user's energy consumption level, relative energy efficiency compared to other users, and opportunities to achieve greater energy efficiency or improve energy resource use."

**Energy asset rating** is a rating where the home's energy efficiency performance is rated based on the home's energy assets (its equipment, design, and construction).

**Energy use rating** is a rating where the home's energy use history (energy use is a function of the home's energy using equipment and the occupant's usage behavior) is evaluated based on comparison to the energy use history of other homes.

**Energy Upgrades (or measures)** are the individual actions that can be taken to improve the energy efficiency of a building. Upgrades may be implemented individually or as a whole-house package of measures at one time.

# Appendix C: Interview Instrument

## *Residential Needs Assessment Guided Interview Topics*

### **1. Public Awareness**

- 1A Public awareness of and/or receptiveness to EE and EE marketing by state agencies, utilities, local governments, contractors, Independent Raters, consultants, realtors, appraisers, lenders
- 1B What is the current level of public awareness of certificates/labels and disclosure options?
- 1C Reliability of information sources—who/what does the public trust?
- 1D Privately sponsored energy efficiency initiatives

### **2. Financing Options**

- 2A Practices used to evaluate and implement capital and operational improvements
- 2B Issues for lenders to EE projects
- 2C ARRA Programs
- 2D Emerging State and National Finance Initiatives

### **3. Workforce Development**

- 3A Consistency of Energy Rater and energy assessment certification programs such as HERS and BPI
- 3B Integration of Workforce Development Infrastructure with Energy Industry Training and Certification Programs
- 3C Other workforce Development Programs for:

### **4. Building Science Research / Technology**

- 4A Use of building-specific benchmarks such as ENERGY STAR or California Climate Goals
- 4B Research on quality assurance and verification approaches for the residential component of the AB 758 Program
- 4C What is the most important building science research or research program that advances technologies and strategies in order to improve the cost-effectiveness of home energy ratings and comprehensive upgrades?
- 4D Market research

## **5. Rating and Labeling Tools**

- 5A Energy efficiency rating systems for new and existing homes
- 5B Survey of existing consumer facing SF/MF labeling tools
- 5C What do you see as the primary purpose for a building energy label?
- 5D Web-based Interfaces
- 5E HERS Whole-house program Feedback & Issues
- 5F Disclosure
- 5G Legislative Initiatives
- 5H Required Upgrades AB 758 incorporates the possibility of mandatory EE upgrades in the future for existing homes – how best can this be achieved
- 5I Easing the Impact on Home Purchasing and Renting

## **6. Energy Assessments**

- 6A What can be done to align assessments completed by HERS raters with those done by performance contractors?
- 6B What recommendations might you suggest to overcome present barriers?
- 6C Energy Upgrade CA recommendations and prioritizations
- 6D Assessor and Upgrade Market
- 6E Energy assessment research and research needs

## **7. Comprehensive Energy Upgrades**

- 7A State of Residential Energy Efficiency Upgrades in CA
- 7B Programs -- What are successful examples of each?
- 7C Numbers
- 7D Barriers to EE Upgrades
- 7E Comprehensive Energy Upgrades

## **8. International, National, Regional and Other State Energy Performance Improvement Programs**

- 8A Which Programs or Labeling initiatives have you heard of and what do you see as potentially offering benefits for CA market?

## **Appendix D: Review of California whole-house HERS rating, Home Energy Score (HEScore), and the Energy Performance Score (EPS) rating programs**

Benningfield Group and PECO conducted a technical review of HEScore and the EPS energy asset ratings in comparison with the California whole-house HERS ratings. The conclusions of this review are summarized below. It should be noted that the HEScore and the EPS were continuing to evolve at the time that Benningfield and PECO conducted this review.

### **HEScore and EPS overview**

While the California Home Energy Rating System Program provides the only legal home energy ratings in California, there are other rating systems available elsewhere in the U.S. Two such rating systems are the U.S. DOE's HEScore, and the EPS introduced in 2008 by the Energy Trust of Oregon (ETO):

#### *HEScore*

HEScore is a voluntary national home energy rating system under development by DOE. HEScore rates a home on a scale of one (worst) to ten (best), based on 40-50 data points collected on home characteristics. HEScore does not generate a list of recommended upgrades specific to the home. HEScore was piloted in nine states in 2010-2011,<sup>24</sup> updated based on pilot participant feedback, and is currently being implemented through pilot programs in 16 states.

#### *EPS*

The EPS, developed in 2009 to support ETO's energy efficiency programs, rates a building based on an estimate of energy use per year, quantified in millions of Btu (MBtu) per year.<sup>25</sup> The rating scale for the EPS starts at zero (denoting zero net energy use) and does not have a fixed high endpoint on the scale. An EPS rating is generated from a limited set of data points collected on the home.

### **Purpose of the rating**

HEScore is a rating that is available only for existing homes; it does not attempt to cover newly constructed homes, while the EPS was originally created for newly constructed homes and then evolved to include existing homes. The California whole-house ratings cover both newly constructed and existing homes.

DOE states that HEScore provides an initial indication of the relative efficiency of a home, and is intended to motivate homeowners to pursue a subsequent, deeper investigation of upgrade opportunities. The EPS was initially developed as a consumer education tool to differentiate the energy performance of newly constructed homes in Oregon, and later expanded to different geographic markets and to existing homes.

---

<sup>24</sup> See [http://www1.eere.energy.gov/buildings/residential/hes\\_summaries.html](http://www1.eere.energy.gov/buildings/residential/hes_summaries.html) for a summary of pilots

<sup>25</sup> More details at <http://energytrust.org/residential/new-home-solutions/eps.aspx>

The California whole-house rating is intended to differentiate homes based on relative energy efficiency and generates a list of prioritized upgrade recommendations.

### **Energy rating metric**

The California whole-house rating, HEScore, and the EPS are all generated from a building simulation model for the rated building. In all three cases, the simulation calculates energy use for the modeled home. All three rating systems are energy asset ratings. Asset ratings are similar to the familiar mile per gallon (MPG) ratings for vehicles. Energy asset ratings are focused on the building's permanent equipment, design and construction; defaults are used for inputs that are not related to the physical characteristics of the building, such as number of occupants, times of occupancy, and plug loads. Similar to the MPG ratings, the modeled energy for the rating is not expected to match the actual energy use of the home ("your actual mileage may vary").

Each rating system uses a different rating metric. Each rating system first determines the energy use for natural gas (measured in therms) and the energy use for electricity (measured in kWh). To evaluate the relative efficiency of homes, the energy use for natural gas and the energy use for electricity need to be converted into common units, British Thermal Units (Btus). Conversion factors or weights are applied to the therm and kWh use of the home to calculate total Btus.

The EPS uses a site energy conversion to determine Btus. Using a site energy conversion ignores the energy losses in the natural gas distribution system and the electricity generation, transmission and distribution system that occur in order to meet the energy demand caused by the home's physical features and occupant behavior and plug loads. This is equivalent to assuming that there is a natural gas well and a perfect efficiency electric powerplant in the home's backyard. In actuality there are modest losses in the natural gas distribution system (on the order of 5%) and major losses in the electricity generation and distribution system (on the order of 60-70%). Since the utilities must charge for their entire costs of serving the energy demands of the home, they cannot leave out the costs that are associated with natural gas distribution and electricity generation, transmission and distribution, when determining energy bills. For this reason a site energy conversion to Btus will give different signals about the importance to save energy than what energy bills will reflect, substantially deviating for electricity.

The HEScore uses a source energy conversion to determine Btus - in this case the conversion makes the assumption that the energy demands of the house must be met by the natural gas system and the electric generation, transmission and distribution system causing additional energy to be used due to the losses in those systems. Source energy conversion to Btus will provide signals about the importance to save energy that are much closer to what energy bills will reflect. Source energy makes the assumption that the impact of natural gas distribution and electricity generation, transmission and distribution does not vary by season for natural gas or by time of day and season for electricity. This ignores that the cost of getting the natural gas and electricity to the house to meet the demand is highly dependent on the season and time of use.

The California whole-house HERS rating uses the Time Dependent Valuation (TDV) method to determine a weighted value conversion to Btus that accounts for the season for natural gas use and the time of use and season for electricity use. The TDV method of conversion to total

energy use endeavors to capture the important time varying impacts of the home's energy demand on the California natural gas and electricity systems, aligning signals about the importance to save energy with maintaining reliable and low cost natural gas and electricity systems in the State.

## **Rating scale**

Each of the three ratings systems uses different rating scales.

The EPS "scale" provides essentially an "estimated energy use" rating based on modeling of the home's physical characteristics and default operating assumptions. The rating merely divides the calculated site energy Btus by 1,000 to produce a score in MBtus. The EPS rating is zero for zero net energy homes and increases indefinitely dependent on the size of the home and the energy efficiency features in the home. The scale is consistent with the goal of getting energy use as close to zero as possible – lower is clearly better. The EPS rating is driven just as hard by the size of the home as the energy efficiency measures that are installed in the home. In the EPS scale a small, relatively inefficient home (with potentially substantial opportunities for energy efficiency upgrades) can get a lower rating than a bigger, very efficient house (which has very limited additional energy efficiency measures that are feasible).

The HEScore scale is converted to a score of 1 to 10 based on a comparison of the home's simulated energy use (source energy Btus) to the distribution of simulated energy use for the range of homes and common upgrade measures in the home's climate. HEScore assigns a score of one to relatively high estimated energy use homes and ten to relatively low energy use homes – higher is better. HEScore makes no attempt to include onsite renewable energy in the rating, being indifferent to the goal of zero net energy homes. This deviates from California's loading order policy and emphasis on achieving both energy efficiency and onsite PV installation in homes as much as possible. HEScore does not enable homes that have both energy efficiency and PVs to be differentiated from homes that have similar levels of energy efficiency without PVs. Because all homes have to fall within HEScore's small ten-point scale established by ranges of common upgrade measures, there is limited room for differentiating highly efficient homes. This rules out the ability of the energy efficiency of newly constructed homes built to increasingly improving energy standards being able to be differentiated from the energy efficiency of existing homes. HEScore ratings are driven significantly by the size of the home, but not as directly as EPS. Given the relative large energy use categories in each bin, some variation in size can occur without moving the home to a different rating; however, clearly the size of the home can move a home with the same energy efficiency features as a smaller home to a different rating score, driven by size alone.

The California whole-house rating scale is intended to support State policy to encourage maximum feasible levels of energy efficiency and the incorporation of PVs, striving towards zero net energy as is achievable for any give home. The scale uses a score of zero to correspond to zero net energy – clearly lower is better. The scale also benchmarks the energy efficiency of a home that complies with the Building Energy Efficiency Standards<sup>26</sup> at a score of 100.

---

<sup>26</sup> The score of 100 is assigned to a home that complies with the 2008 Building Energy Efficiency Standards. Setting the 100 score to those specific Standards avoids the rating scores for homes changing whenever there is change in the Standards.

Establishing the scores of zero and 100 in this manner enables the energy efficiency of any home to be compared and assigned a relative rating score. Homes that are less efficient than a code-compliant home will score higher than 100. The rating of the score for the home that is being rated is determined and displayed on the rating scale for comparison. For ease of display the rating scale on the certificate shows the scale from zero to 250. For homes that earn a score higher than 250, the score is displayed on the certificate to the side of the rating scale.

## **Recommendations for energy efficiency upgrades**

The three rating systems each provide recommendations for energy efficiency upgrades to the home that is being rated. Each rating system has a different approach for providing these recommendations.

In delivering the EPS, ETO evaluated the cost effectiveness of a list of measures for the program as a whole. The EPS recommended to each home that was being rated those measures in the list that went beyond the existing features of the home being rated.

For the first pilot of HEScore, the software used the energy calculated for the rating based on the default operating assumptions to determine what additional upgrades would be cost effective for each rated home. Based on feedback from the first pilot, DOE discontinued making recommendations for upgrades based on analysis for each home being rated. The current HEScore approach is to provide generalized recommendations for upgrades that have been determined to be cost effective for the program as a whole.

The California whole-house rating system established two approaches to providing recommendations for upgrades, the “standard” approach and the “custom” approach. The “standard” approach is intended to make recommendations regarding what upgrades to a home would be cost effective based on consistent operating assumptions for all homes, using the default building operating assumptions that are used for determining the rating. The recommendations that result from the “standard” approach establish a “loading order” of the recommendations, similar to the recommended approaches of Home Performance with Energy Star.

The rating program recognizes, however, that there is very large variation in how occupants operate their homes and in other circumstances that can cause any individual home’s actual energy use to deviate from the estimate made by the building simulation. The California rating system requires the rating software to compare the monthly estimated energy use to the monthly actual energy use from energy bills.

It also recognizes that part of the deviation in simulation estimates compared to actual energy use, arises from differences in the historic weather data for the climate zone that the home is in that is used in the simulation and the actual weather data that occurred when the actual energy bills took place. Rating software is required to compare the simulation weather with the actual weather to “weather normalize” the actual energy use to be take the weather driven variation out of the comparison of energy use.

The rating software must produce reports to show the homeowner how the simulation results compare to the weather normalized actual energy use. When there is a deviation of 30% or more between the building simulation estimates and the actual energy use, the rater is expected to adjust the recommendations to account for the deviation. The rater is expected to interview

the homeowner to understand how their energy use patterns may vary from the standard assumptions. Some reasons for deviation may include that the occupants use different thermostat settings than the simulation, there may be intermittent occupancy, there may be substantially different miscellaneous electricity consumption, there may be different levels of demand and use patterns for hot water, and the home may be shaded substantially by trees or other buildings.

## **Capturing climate differences**

California has a high diversity of climate regions. California climates vary from mild coastal summers (with gradually increasing severity of winter moving north up the coast), moderate inland valleys, hot summers in the central valley (combined with cold winters in the north – the climate in the middle of the valley is tempered somewhat by ocean influences through the San Francisco Bay delta), very hot summers of the low desert, hot summers and cold winters of the high desert, and the cold mountain winters. This climate diversity represents in one state nearly the full range of climate diversity of the whole U.S. No other state comes close to having as much climatic diversity. This climate diversity has critical implications for California energy use, the cost and reliability of California’s energy systems and the outdoor air quality in the state, and the ability of the state to mitigate the impacts of climate change. Ensuring that California’s buildings have climate appropriate levels of energy efficiency upgrades is very important to the State.

The EPS was developed by ETO to include weather data for the three climate regions in Oregon. The EPS rating scale produces an “energy use” rating that is directly dependent on how severe the climate is where the rated home is located. Homes in the mild Oregon coastal areas get lower (better) ratings than homes in the more severe climates, even if there are additional climate appropriate upgrades that can be made in those coastal homes.

The HEScore rating program that was first piloted established 19 climate regions nationwide. Ratings for homes were established by comparison to the range of national energy use data that was available for each of the 19 climate regions. California was assigned to 3 climate regions. One of those regions was for the Sierras and north coast area where there is a very limited population of homes – that climate mapping was satisfactory. The other two climate regions contained within them a large range of actual climate conditions. The northern California climate region included the diverse climates of the coast, Bay Area, and hot summer central valley including its variation in winter severity. The southern California climate region included the diverse climates of the coast, moderate Los Angeles area, hot Riverside area, the low desert and the high desert. HEScore ratings across the varying climates in the two DOE regions were substantially dependent on weather differences regardless of energy efficiency differences. After the first pilot DOE expanded its climate differentiation to 240 climate bins, 20 in California. Under the new approach ratings for homes are based on much more homogenous climates, with each home being assigned to one of the bins based on the “as the crow flies” distance to the nearest weather station.

The California whole-house rating approach endeavors to establish ratings for each home based on its energy efficiency compared to the climate appropriate energy efficiency upgrades for that climate that are adopted in the Building Energy Efficiency Standards for each of the State’s 16 established climate zones.

## Quantity of inputs

One of the important considerations for completing ratings of homes is the relative ease of collecting data at the home and entering the data into rating software to produce a rating. Both DOE and ETO actively have considered this in developing their rating systems. For the Standards compliance software the Energy Commission historically has focused on specifying the technical capabilities required for approval, leaving the design of the user interface up to the software developer. This was followed also when the California whole-house rating system was developed.

EnergySoft, the developer of the *EnergyPro* software engine, provided two modules of *EnergyPro* for existing single family residential building modeling in California, *CalRatePro* for use by certified California whole-house HERS raters and *Residential Performance* for use by performance contractors and energy assessors to support the *Energy Upgrade California* program. Both programs have a Residential Building Wizard approach for creating a model of the existing building.<sup>27</sup>

In terms of number of inputs, *HEScore* requires 40-50 inputs, while EPS requires 60-80. The residential modules of *EnergyPro* require 40-60 inputs to model the features that are commonly upgraded and the common alternative upgrades. DOE has widely reported its efforts to reduce to an absolute minimum the number of home features required for home data collection and modeling inputs. There is nearly a one-for-one comparison of the minimum required inputs for *HEScore* and *EnergyPro*. For any particular home feature, in some cases *HEScore* requires fewer inputs, and in other cases *EnergyPro* requires fewer inputs.<sup>28</sup>

The residential *EnergyPro* modules also allow additional measures and upgrades to be considered. Modeling of those features is voluntary, and not required for producing a rating or making upgrade recommendations. These include existing conditions and upgrades to significant energy using appliances, including refrigerators, dishwashers, clothes washers and dryers, and ranges/ovens, and to interior and exterior lighting.

---

<sup>27</sup> *EnergyPro* was developed to model a wide range of buildings for Standards compliance, including single family, multi-family and nonresidential buildings. The user interfaces for the residential modules have extraneous inputs that relate to the modeling of other types of buildings. Although these extraneous inputs have no impact and are ignored for modeling of single family buildings, they can be annoyingly confusing to the inexperienced user of the software.

<sup>28</sup> For example, *HEScore* allows wall insulation to be input for either the home as a whole or for each orientation separately; *EnergyPro* requires separate input for each orientation, an increase in 3 repeats of the same entry. *HEScore* assumes default uninsulated wood doors; *EnergyPro* requires the type of door to be selected from a menu, an increase typically of 2 inputs. On the other hand, *EnergyPro* provides library selection of ceiling, roof, wall and floor assembly types and insulation level combinations, window and skylight types and default U-factors and SHGC values, and HVAC and water heating models and efficiencies that populate inputs by clicking on the choice in the library. This can save 5-10 inputs per home. These libraries can be updated to include specific products that are repeatedly input by the software user. On the other hand larger and more complicated homes that have multiple HVAC systems require separate *EnergyPro* input of envelope characteristics for each HVAC zone; this can add 10 repeats of the same inputs for each HVAC system.

The three rating systems also are different in how they address diagnostically tested/field verified measures. *Home Performance with Energy Star* and *BPI* call for diagnostic testing to measure building envelope leakage and duct leakage in homes. However, this testing can be one of the most time consuming aspects of field data collection, so in-home field time can be significantly reduced if this diagnostic testing is omitted.

The *EPS* believes that this diagnostic testing is critical and requires it to be done and the tested values to be input into the software.

*HEScore* allows the rater to either select whether the home's building envelope has been sealed or not (relying on defaults for either case) or measure and input the tested air leakage. *HEScore* allows the rater to select whether the home's ducts have been sealed or not (relying on defaults for either case).

The California whole-house rating approach encourages raters to do building envelope testing and duct testing, but allows defaults to be used if the diagnostic testing is not done. This results in the same amount of time being devoted to building envelope testing and duct sealing testing and software input as *HEScore*.

California has actively researched common construction and contractor installation practice in the state, and has found that common practice results in a host of construction defects that degrade the energy savings potential of energy efficiency upgrades. The areas of common construction defects include duct and air handler sealing, location and insulation; proper air conditioner installation, including refrigerant charge, airflow, fan watt draw, sizing and high Energy Efficiency Ratio coil installation; building envelope air sealing and insulation quality; and proper PV system installation. California assumes that the performance of these building features and upgrades in the whole-house rating software is degraded unless the quality of the installation is diagnostically tested and verified using Energy Commission approved protocols. If the verification protocols have been conducted by raters, then the features and upgrades are modeled with full energy saving performance.

In this manner California encourages the correction of these common construction/installation defects, and rewards contractors who follow quality installation practices. Home performance contractors, trained in *BPI* standards and Energy Commission protocols, should correct these common defects as a normal part of their business, and be able to differentiate their quality work through the energy savings recognized in the California whole-house rating approach. These additional diagnostic testing options of the California whole-house rating approach is important to the State's energy system reliability and climate change goals, but are completely voluntary in the conduct of ratings, which can rely on default assumptions for these features if the diagnostic testing is not done. If the choice was made to not include these diagnostic testing measures for a particular home, no added in-home data collection time or software input time would be required for the California whole-house rating compared to the *HEScore* rating.