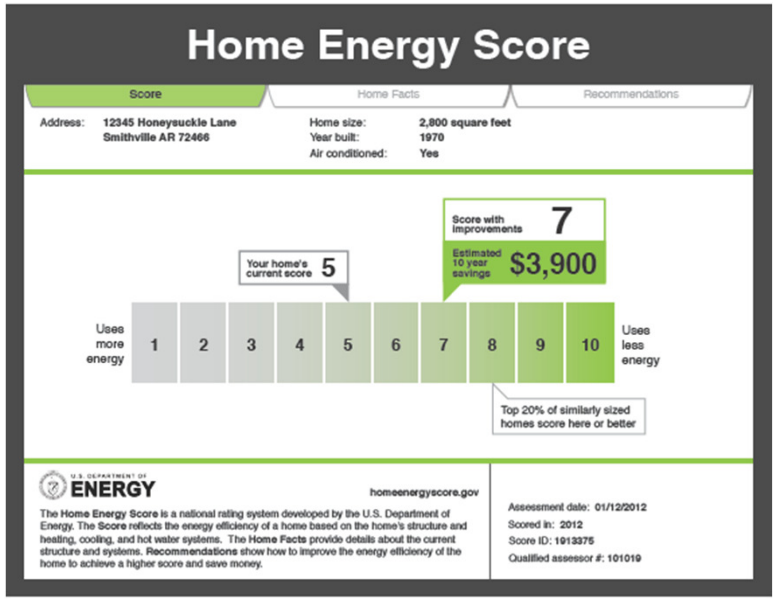
Home Energy Score:
Analysis & Improvements to Date



Joan Glickman
Senior Advisor/Program Manager
U.S. Department of Energy
July 24, 2012

Presentation Overview

1) Background
2) Program Improvements
3) Analysis: Efficacy of Tool & Program
   - Asset Perturbations
   - Behavior Perturbations
   - Estimated Energy Use vs. Actual Energy Use (from utility bills)
   - Time Required for Assessment and Scoring
   - Blower Door Test Analysis
4) Next Steps & Ongoing Analysis

1. Background

Guiding Principles

- Information must be credible, reliable, and replicable.
- Information must be transparent and easy to understand.
- Implementation costs must be affordable.
- Program must include effective quality assurance.

Scoring Methodology

- Basis for a Home's Score
  - Requires approximately 40 data points about the home's major energy systems, envelope, and general conditions
  - The tool estimates total energy use for the home and translates that into a score on a 10 point scale
    - Standard operating assumptions applied (e.g., thermostat settings, number of adults and children (based on number of bedrooms))
  - The score is an "asset" score; it does not take into account the homeowner's behavior or utility bills.
- Size of Home
  - The scoring tool calculates load requirements based on the home's conditioned square footage.
  - The 10 point scale is not adjusted for size.
    - If all things are otherwise equivalent, a large house will score worse than a small one.
- Climate
  - The 10 point scale corresponds to different energy values, depending on the local climate.
    - Two equivalent homes in different climates will get the same numerical score even though they use different amounts of energy.

Analysis to Date

- Pre-White House Announcement
  - Asset energy simulations
  - Focus groups
  - Review of social science research
- 2011 – present
  - Pilot homes analysis
  - Assessor feedback
  - Homeowner feedback
  - Comparison of actual energy use and modeled energy use
  - Additional simulations

Summary of Findings (Pre-Pilots)

- Simulations identified the impact of different home characteristics in estimating overall energy use.
  - The scoring tool requires assessor input for all "asset" variables that contribute 2% or more to a home's overall energy use.
- Consumers respond to simple, easy to understand information.
  - Savings estimates capture consumers' attention and can be a starting point for discussing why to improve their home's energy performance.
- People are motivated by their peers.
  - Effective scoring systems allow comparison to other homes and include aspirational reference points to encourage investment in energy efficiency.

Summary of Findings (Pilots to present)

The score is credible, reliable, & replicable.

- Homes, rescored by different assessors, resulted in energy estimates within 10 percent of each another, and scores within 1 point of each other, in all but one case.

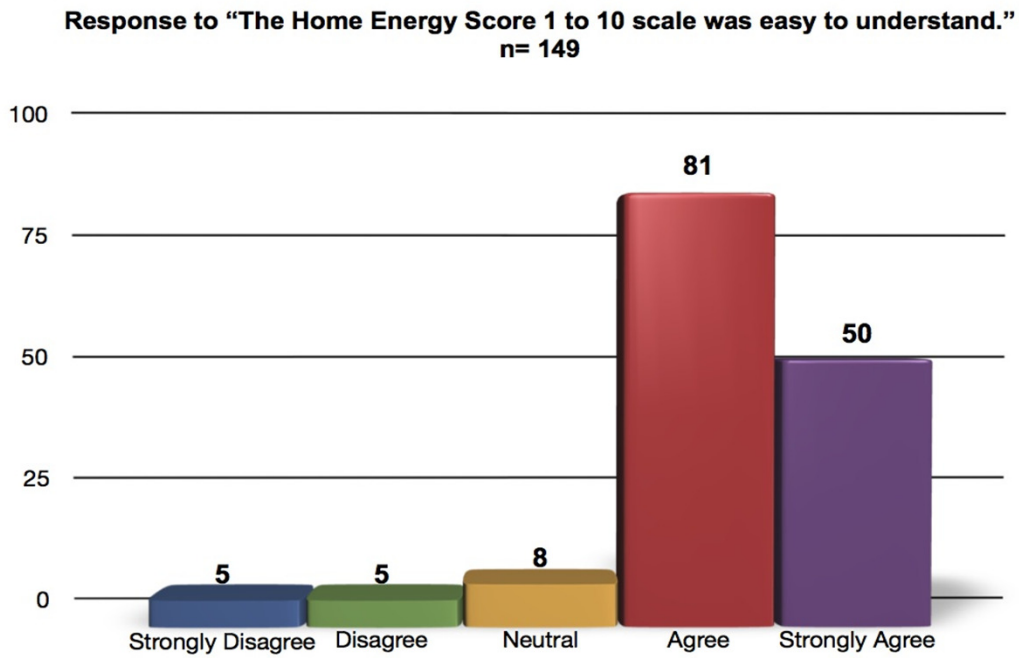
- The scoring tool consistently and correctly characterizes a home's energy performance on a 10 point scale.
  - Asset perturbation analysis showed that 90% of the time, a home will score within 1 point of its expected score (based on assigned normative values), given likely uncertainty and imprecision concerning a home's energy features.
  - The 10 point scoring scale is designed to a level of granularity consistent with the specificity of data required to calculate a score.

- The scoring tool was sufficiently accurate in estimating energy use when compared to actual energy use.

Summary of Findings (Pilots to present, continued)

The score is transparent and easy to understand.

- The majority of homeowners queried during pilots understood the 10-point scale.

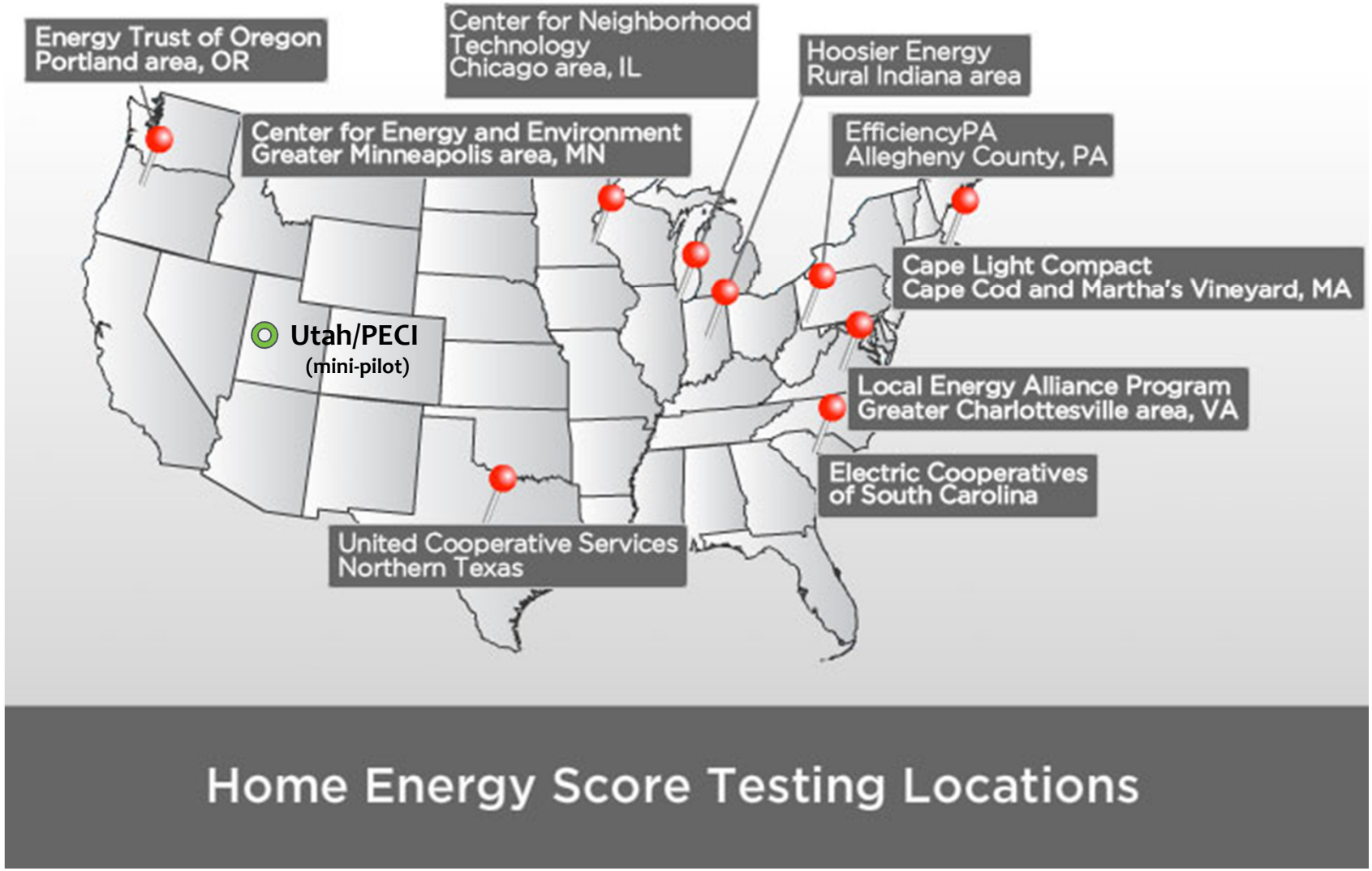


The score is affordable.

- Score can be completed in ~ 15 minutes if done as part of a home energy audit and in < one hour if done as a stand-alone assessment.
- Inclusion of blower door result does not significantly affect the score and therefore will not be required.

2. Program Improvements to Date

Home Energy Score Pilots



Pilot Feedback Led to Program Improvements

Homeowner information and education

- Program now provides information regarding the existing conditions of the home
- Developing additional materials for assessors to provide to homeowners

Graphic Score

- Simplified graphic
- Includes 10-year savings estimate (previously 1 year estimate)
- Working with partners to allow some customization of information

Energy improvement recommendations

- Recommendations consider the current home's energy systems as baseline for savings estimates

Low Scoring Homes

- Developing materials to emphasize importance of movement along the scale, rather than ultimate score (particularly for older homes)

Improved Assessor Training & Testing

- Added guidance and helpful tips in each data entry field of the scoring tool
- Expanded assessor training and materials
  - New recorded data entry session to show assessors how to use the Tool
  - Training available on DOE's National Training & Education Resource
- Enhanced assessor testing
  - Increased number of multiple choice questions on test from 20 to 50
  - Test now includes questions on building science
  - Added a second part to the test that requires calculations and data entry into the tool

Tool Improvements

- Pilot testing led to the following changes --
  - Efficiency improvement recommendations
    - Adjusted Base House versus Recommendations energy calculation method
    - Adjusted Recommendation calculations to return highest energy efficient options
  - User Interface
    - Conducted a complete review and update of Tool Help language
    - Adjusted Scoring Tool user interface per relevant Pilot Tester comments (15 changes)
  - Modified Home Address validation method to accommodate non-USPS address locations
  - Added exterior wall and roof sheathing types
- LBNL and NREL analysis and testing resulted in the following changes --
  - Updated air conditioning & heat pump efficiencies model methods as well as furnace blower fan power calculation method
  - Adjusted the lighting and small appliance load calculations to scale by floor area
  - Standardized occupancy based on number of bedrooms
  - Adjusted DOE2.1E modeling defaults
    - e.g., thermostat set points, wind/terrain settings, seasonal shading schedules, neighboring house height
  - Updated defaults for building envelope and location, appliances and water heating
    - Building America House Simulation Protocols and Research Benchmark Definitions; RECS 2009 data
  - Created individual 10 point scales for 248 weather file locations
    - Previously used 10 point scales based on only 19 RECS zones

Improved Process for Defining 10 Point Scale

- Significantly enhanced sensitivity to climate differences by moving from 19 climate zones to 10 point scales calibrated to more than 240 weather stations.
- 10 point scale for each weather station location created by considering the following:
  - Range of Mbtu estimates generated by scoring tool given wide variety of home characteristics
  - Importance of reasonably sized "bins" – generally between 12 Mbtu and 30 Mbtu
- Looked at heating degree days
- Fit scales so that same home evaluated within a state scored equivalently regardless of weather station

Example of 10 Point Scales for One State (in MBtus)

State	Weather Station Name	City	Final Bin Size	1	2	3	4	5	6	7	8	9	10
NY	NYALBTM2	Albany	30	371	371	341	311	281	251	221	191	161	131
NY	NYBINTM2	Binghamton	30	372	372	342	312	282	252	222	192	162	132
NY	NYBUFTM2	Buffalo	30	371	371	341	311	281	251	221	191	161	131
NY	NYMASTM2	Massena	30	380	380	350	320	290	260	230	200	170	140
NY	NYNEWTM2	New York City	26	328	328	302	276	250	224	198	172	147	121
NY	NYROCTM2	Rochester	30	371	371	341	311	281	251	221	191	161	131
NY	NYSYRTM2	Syracuse	30	371	371	341	311	281	251	221	191	161	131

3. Analysis: Efficacy of Tool & Program

Effect of Asset Uncertainty on Score

- Monte carlo analysis estimated likely variability in predicted energy usage given imprecise* characterization of a home's energy features.
  - Data points for key energy assets were varied to represent likely range of uncertainty.
- 90% of the time the homes scored within +/-1 point of actual score given asset uncertainty.

Tested Location	Likelihood of ≤1 Point Variance
Minneapolis	85%
San Diego	88%
Tampa	93%
Boston	91%
Seattle	95%
Golden	91%
City Average	**90%**

* Imprecision here is defined as assessor measurement error as well as uncertainty about various home characteristics (e.g., wall insulation).

Comparative Study: Effect of Behavior on Energy Use

- For comparison purposes, monte carlo analysis estimated likely variability in energy usage given common behavioral differences.
  - Data points for key behavioral inputs were varied to represent likely range of uncertainty.
  - Extreme behavior was not included as part of the analysis to generate a conservative estimate of the effect of behavior.
- On average, common behavioral differences account for +/-28% of energy use variability 95% of the time.
- 80% of the time, homes score within +/-1 point of typical homeowner's score given likely behavioral differences.
  - The analysis demonstrated that temperate climates (e.g., LA) are more sensitive to changes in behavior.
  - This analysis (as well as the asset perturbation study) illustrated that in mild climates, the energy difference between two consecutive points on the scale was too narrow.
  - The final scoring bins have been adjusted to allow for the fact that estimated energy use is unlikely to be precise enough to characterize a home within less than 10 Mbtus.

Tested Location	Likelihood of ≤1 Point Variance
Atlanta	89%
Chicago	79%
Houston	81%
Los Angeles	58%
Phoenix	89%
Seattle	81%
City Average	**80%**

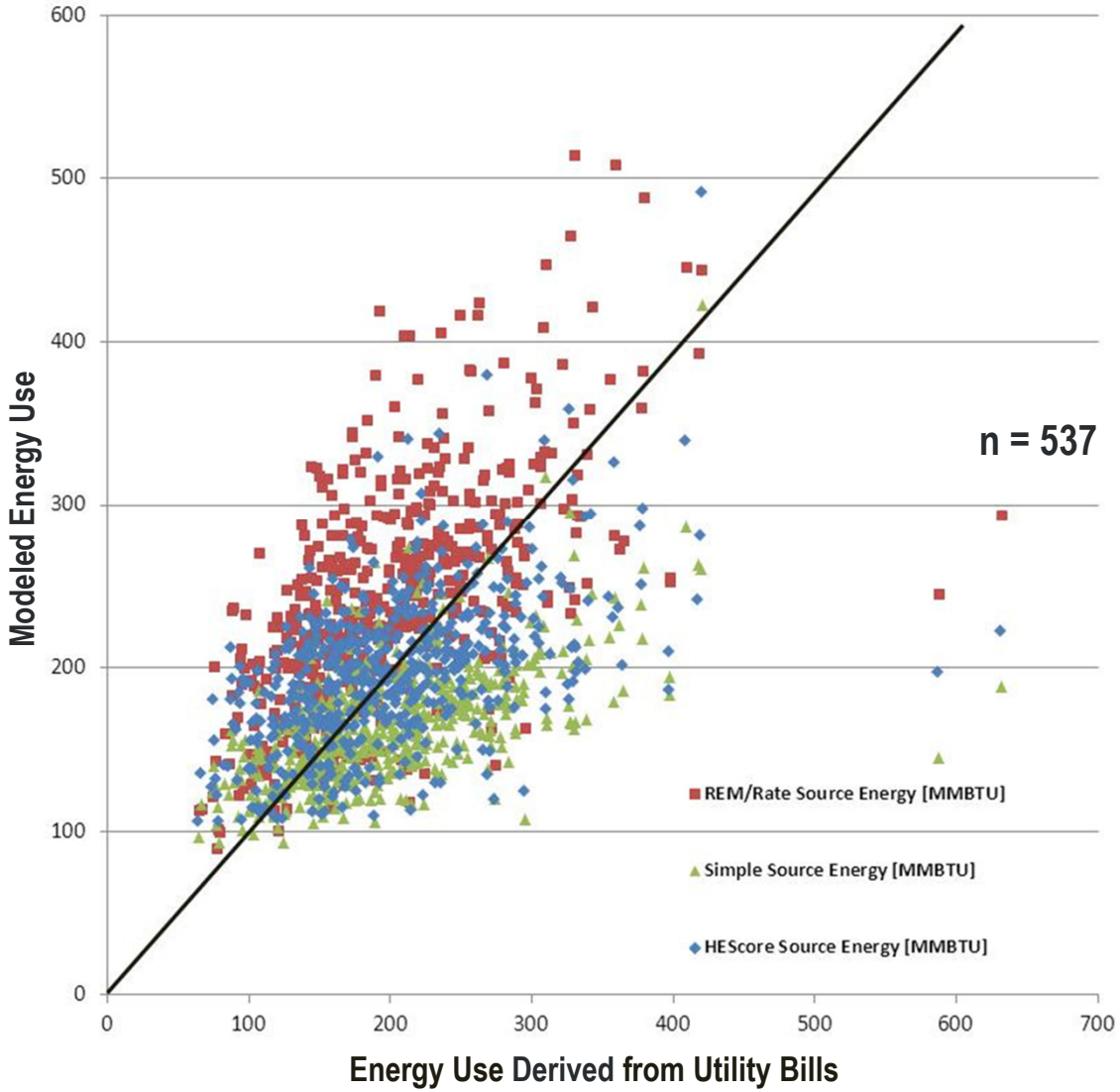
Utility Bill Analysis

- The Home Energy Score is NOT intended to predict utility bills.
- However, in the absence of an absolute method for estimating home energy use, utility bill data can serve as a helpful comparison point.
- In analysis of 537 homes (with electric and natural gas utility information as well as home characteristics data), Home Energy Scoring Tool performed similarly to other tested modeling tools.
  - Scoring Tool outperformed others in percent of homes where predicted energy is within 25% of actual energy use.
  - Scoring Tool appeared to be least biased given statistical review.

	Home Energy Scoring Tool (Version 2012)	SIMPLE	REM/Rate
Modeled Mean (MBtu)	196	165	244
Utility Bill Mean (MBtu)	200	200	200
Standard Deviation of Difference (MBtu)	62	58	64
Percent of Homes within 25% of Actual Energy Use	61%	58%	47%
Percent of Homes within 50% of Actual Energy Use	88%	96%	75%

Utility Bills Compared to 3 Models' Predicted Energy Use

- Improved tool resulted in fewer outliers and compared more consistently to utility bills and projections of other models.



Affordability: Time and Materials

- Home Energy Scoring Tool is free to qualifying partners and assessors
- No cost to participate in the program
- A home can be scored quickly compared to other rating systems.
  - Pilots confirmed that score can be completed in ~ 15 minutes if done as part of a home energy audit and in < one hour if done as a stand-alone assessment.
- Pilots confirmed that inclusion of blower door result does not significantly affect the score.
  - The scoring tool allows entry of blower door test result, but does not require this data point.

Blower Door Test

Based on the pilot analysis, blower door information is unlikely to change a home's energy score on the 10 point scale.

- 650+ pilot homes included blower door test
- These homes were rescored using both qualitative options (sealed, unsealed)

Scenario	Change in Score
59% of Total Runs	No Change
34% of Total Runs	One Point Change
If Best Qualitative Option is Chosen in All Cases	0.25 Point Change
If Worst Qualitative Option is Chosen in All Cases	0.7 Point Change

4. Next Steps & Ongoing Analysis

Next Steps

- Implement program and recruit additional partners
- Conduct additional analysis & program evaluation
- Enhance scoring tool and release updated version annually
- Evaluate suitability of other certifications or testing options to allow broader array of contractors to score homes

Ongoing Analysis and Program Refinement

Reliability of Score

- Are there certain types of homes where uncertainty results in greater likelihood of more than ±1 point variation?
- Are there other home characteristics that warrant inclusion (e.g., on-site renewables)?
- Does additional home data and scores suggest a need to alter the 10 point scale for any of the 240+ weather station locations?

Effectiveness in Motivating Change

- How can the program maximize the Score's impact in getting consumers to invest in energy efficiency?
- Would adjustments to the scale or materials result in motivating greater investment in energy efficiency?

Ongoing Analysis and Program Refinement (continued)

Assessor Qualifications

- Can less technically trained individuals score homes effectively?
- Can we eliminate the need for specific certification levels and instead simply require a more extensive exam?
- Does the program need to establish a requirement for experience (e.g., # of homes audited or inspected)?

Program Scale-Up

- What aspects of the program need to remain under DOE's administration? What aspects could be administered by other entities?
- Can a Quality Assurance system be set up to broadly apply to a large number of diverse Home Energy Score providers, rather than having this requirement carried out by individual partners?
- Is the current process of testing software tools that use of the application programming interface (API) effective in ensuring consistent scoring of homes?