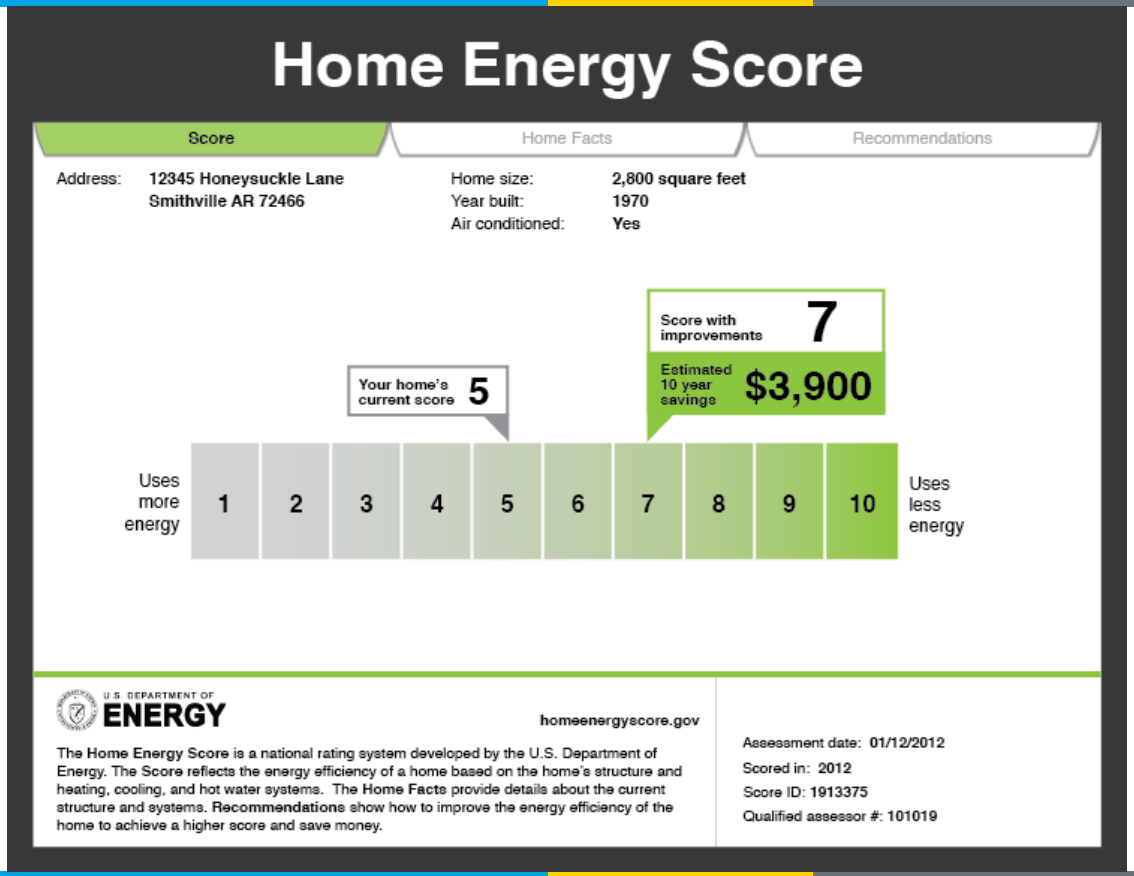


Home Energy Score Program

Peer Review

April 3, 2013

Joan Glickman, US DOE

Norm Bourassa, LBNL

joan.glickman@ee.doe.gov, 202-586-5607

njbourassa@lbl.gov, 510-495-2677

Purpose & Objectives

Problem Statement:

- Significant underinvestment in energy efficiency in residential sector
- High costs of traditional energy audits and ratings
- No standard method for understanding and comparing the energy efficiency of homes at point of sale

Impact of Project:

- Encourage investment in home energy efficiency improvements
- Provide consistent method for assessing the efficiency of all homes nationwide
- Highlight value of energy efficiency at point of sale

Project Focus:

- Support BTO energy reduction goal in new and existing homes
- Focus on market stimulation: speed and scale adoption
- Collaborate with industry partners to improve market adoption
  - e.g., 3rd-party software developers
- Communicate the importance and value of energy efficiency

Purpose & Objectives

Home Energy Score: A key product of the Vice President's "Recovery through Retrofit" initiative*

- Create a nationally standardized "miles-per-gallon" home score
  - ✓ Standardized Software Tool, free to users
  - ✓ Scoring services by existing market players
  - ✓ Nationally supported program to achieve scale and maintain quality

Council on Environmental Quality - http://www.whitehouse.gov/administration/eop/ceq/initiatives/retrofit

Home Energy Score web site - www.homeenergyscore.gov

Approach

Approach:

- Develop, improve and maintain standard scoring tool
- Recruit partners to oversee qualified assessors and scoring of homes
- Test impact of score and supplemental information on homeowners, homebuyers
- Devise methods to allow scale up of program beyond initial partners

Key Issues:

- Home size
  - Plug load effect on score
  - New homes
- Mobility along 10 point scale (addressed further in later slide)
- Uptake of score
  - Participation by individual assessors
  - Certification requirements
  - Quality assurance requirements and implementation

Distinctive Characteristics:

- Allow customization while maintaining consistent approach across all types of homes nationwide
- Data repository
  - No reporting requirements
- Ease of use
- Free non-proprietary tool with licensing available to encourage greater private sector development

Accomplishments and Progress

Accomplishments:

- 2800+ homes scored since June 2012
- 133 assessors qualified to score homes
- 29 partners
- 6 third-party licensees of Scoring Tool Application Programming Interface

Progress on Goals:

- Number of homes:
  - Surpassed winter 2013 goal of 1000 homes scored
  - On track to meet or exceed Spring/Summer 2013 goal of 2000-3000 homes scored
- Number of assessors:
  - Surpassed Fall 2012 goal of 100 qualified assessors
  - Unclear whether goal of 200 qualified assessors will be met by summer 2013
- Number of partners:
  - Surpassed Summer 2012 goal of 20 partners
  - Unlikely to meet Summer 2013 goal of 50 partners; greater recruitment emphasis post June 2013 after new Scoring Tool release
- Scoring Tool Version 2013
  - Originally planned for early 2013; now expected in June 2013

Recognition:

- CT and potentially other states interested in statewide adoption
- Adoption of scoring tool (via application programming interface) by numerous private companies

Project Plan & Schedule – FY10 thru mid-FY12

2010 | **2011** | **2012 (thru Spring)**

Researched scoring programs and audit tools

Conducted 12 focus groups

VP Biden announces Home Energy Score Pilot

Recruited pilot participants

Conducted 10 pilots

Developed Partner Materials & Program Requirements

Began Scoring Tool development

Modified tool based on pilot and analysis findings

Finalized Scoring Tool Version 2012

Developed Assessor Training and Testing

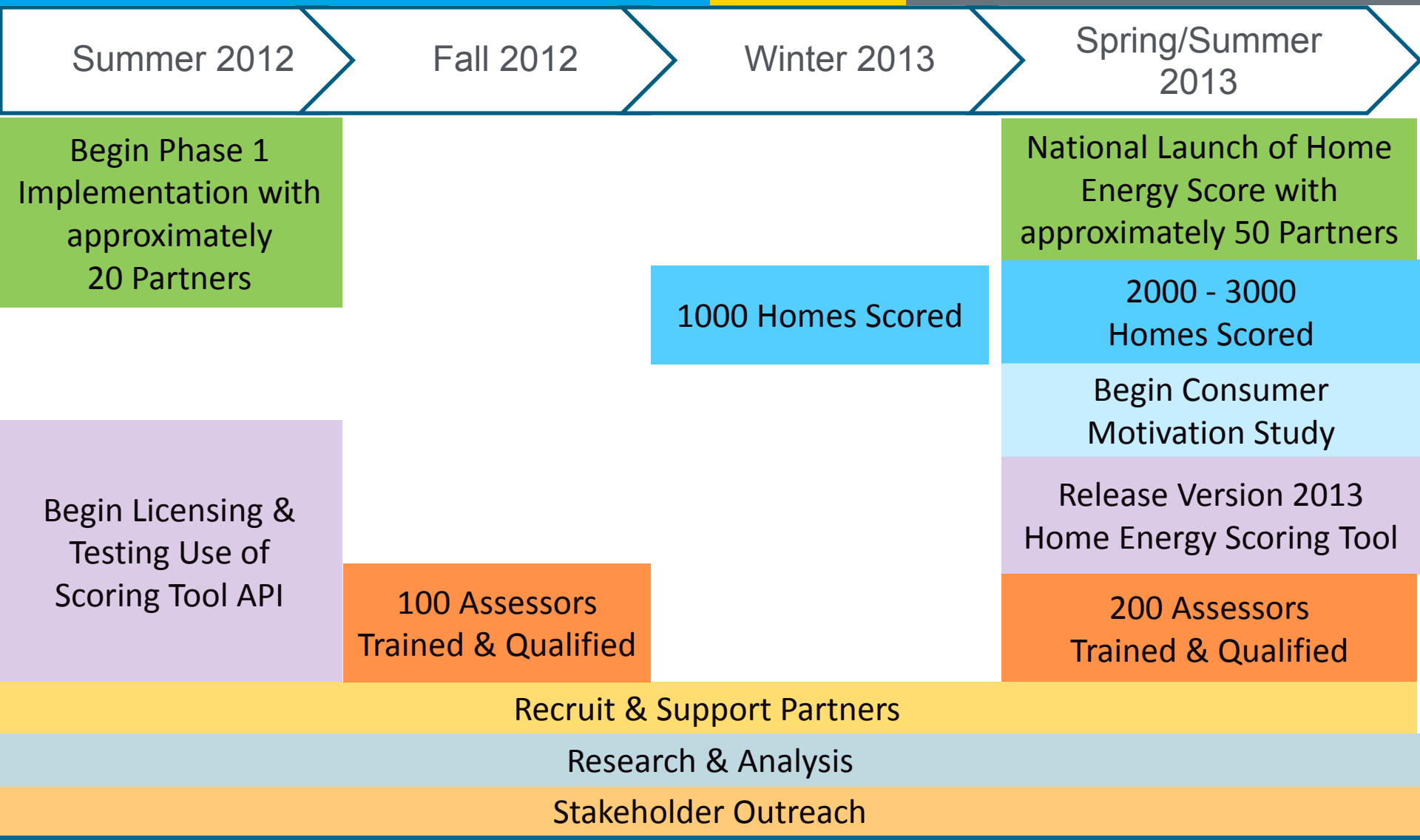
Modified training, testing, and homeowner report based on pilot findings

Sensitivity Analysis: Identify key data inputs

Utility bill and tool comparison analysis

Stakeholder Outreach

Project Plan & Schedule (current year)



Project Budget

Budget History							
FY2010		FY2011		FY2012		FY2013	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$1.8 million	None	$1.4 million	None	$1.6 million	Partner Implementation Costs	$1.2 million	Partner Implementation Costs

Primary Performers

- Scoring Tool: Lawrence Berkeley National Laboratory, EES
- Program support: SRA/Sentech
- Research and analysis: National Renewable Energy Laboratory
- Additional efforts: Navigant, Energy Savvy, ICF

Project Integration, Collaboration & Market Impact

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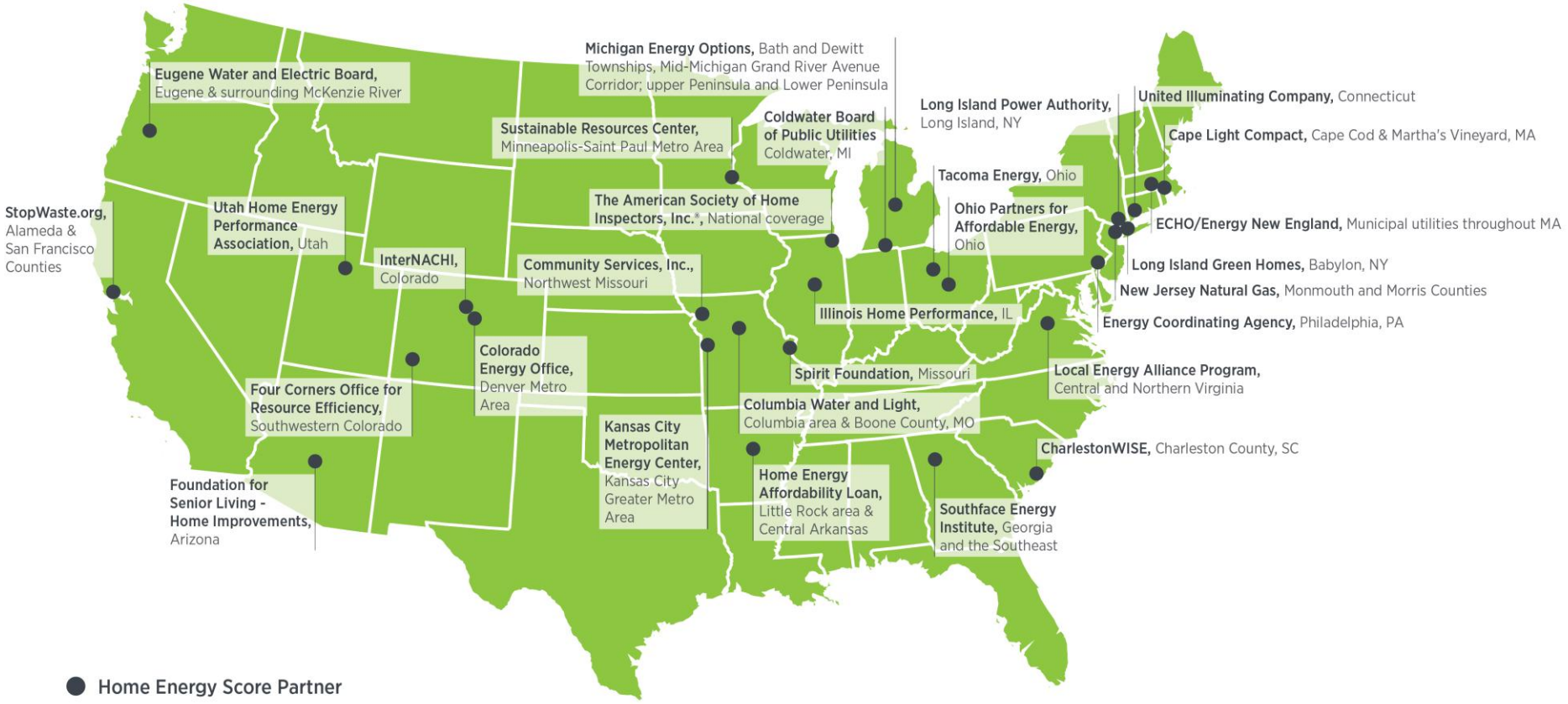
Partners, Subcontractors, and Collaborators

- Utilities
- State and local governments
- Non-governmental organizations
- Home inspectors



Project Integration, Collaboration & Market Impact

Technology Transfer, Deployment, Market Impact

- Score adopted by state, local and utility efficiency programs
- Marketing tool for home performance contractors
- Single, standardized scoring method for national implementation
- Application Programming Interface (addressed in later slide)

Communications & Reports

- *Home Energy Score: Findings from 2011 Pilot Program and Analysis* (DOE)
- *Assessment of the U.S. Department of Energy's Home Energy Scoring Tool* (National Renewable Energy Laboratory)
- *Home Energy Score: Qualified Assessor Analysis* (SRA)
- *2011 Home Energy Score Pilot Program: Homeowner Understanding and Interest* (DOE)
- *Motivating Home Energy Improvements* (Navigant Consulting)
- *Home Energy Scoring Tool: A Simplified Asset Rating for Single Family Homes* (Lawrence Berkeley National Laboratory)
- Regular webinars and presentations to update stakeholders on the status of the program and analysis conducted to date (many recorded and posted on web site)

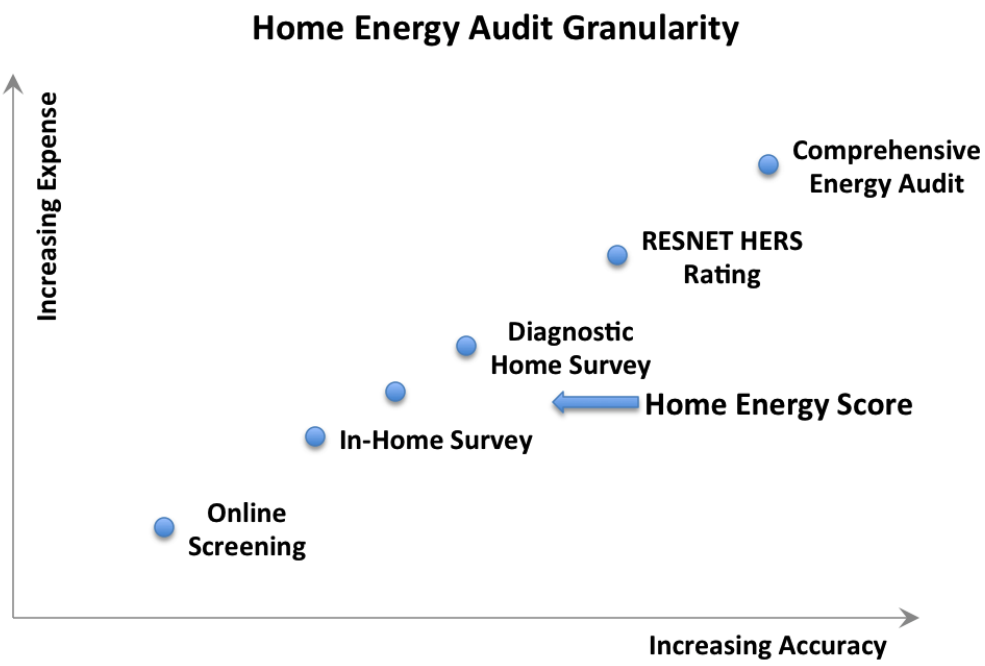
Next Steps and Future Plans

- Develop new 10 point scales for 1000+ weather stations
- Recruit additional partners
- Modify assessor qualifications and enhance testing
- Assess quality assurance requirements
- Incorporate additional enhancements to tool and customization features
  - Greater applicability to diverse housing stock
- Continue to improve calculation methods

Home Energy Scoring Tool

Purpose and Objectives

- General Objectives
  - Accuracy
  - Transparency
  - Innovation
- 1 hour assessment time
  - Affordable price point
  - "Opportunity Assessment" vs. investment-grade audit
- Support (not compete with) existing marketplace of tools & services
  - Stimulate retrofit market
  - Private tool development & innovation (Web Services)
  - Help with reduced up-front assessment cost
  - Nationally applicable
  - Responsive to public and industry input



Approach - Asset Score Methodology

- An asset rating seeks to evaluate a home's fixed characteristics, while holding occupant-determined factors and behaviors constant.
  - There are various opinions on which energy-using components are assets.
- Home Energy Scoring Tool includes the following to generate an asset score
  - HVAC
  - Water heaters
  - All envelope components
- Not included in asset assessment
  - Lighting
  - Appliances
  - Other equipment
  - Behavioral factors (e.g., thermostat and DHW settings)
- Advanced models and data (drawing on multiple National Lab and public resources)
  - Leverages DOE-2.1E, other algorithms & data: Sherman Air-leakage database, FSEC, RECS, Building America, NREL, ASHRAE duct method

Approach – Key Issues

- Tension between audit cost and precision
  - Approximately 40 required inputs, no required diagnostics
  - Granularity of 10-point scoring scale
  - Comparability – a “5” in FL versus a “5” in AK
- Default values
  - Referenced sources (e.g.. Building America simulation protocols)
- Market receptivity
  - Score must be positioned as “foot in the door” rather than end point in business transactions
  - Tool should not compete with private sector offerings but enhance them

Approach -- Scoring Method

Distinctive Characteristics:

- 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

Sample 10 Point Scale Values (in Mbtus)

State	Weather Station	Final Bin Size	1	2	3	4	5	6	7	8	9	10
CA	CAREBCTZ	26	324	324	298	271	245	219	192	166	140	113
CO	COEAGTM2	30	364	364	334	304	274	244	214	184	154	124
FL	FLTAMTM2	16	245	245	229	213	197	181	164	148	132	116
MD	MDBALTM2	23	306	306	283	259	236	212	189	166	142	119
NY	NYALBTM2	30	371	371	341	311	281	251	221	191	161	131
WA	WASEATM2	27	322	322	295	269	242	216	189	163	136	110

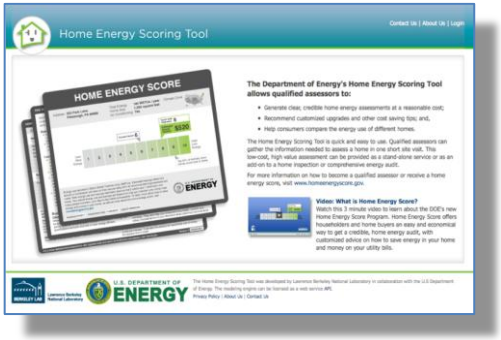
Built on Home Energy Saver Tool Suite

- DOE developed web-based residential energy tool
- Impact: ~8M cumulative visitors; 3000 contractors in Home Energy Pros social network
- Scoring session data interoperability with the Home Energy Saver tools
  - Allows operational energy simulation

Awards and Recognition

- R&D 100 award/many other marketplace recognitions

Home Energy Scoring Tool



Home Energy Saver - Consumer

Home Energy Saver - Pro

Accomplishments: Development of Scoring Tool – A Very Quick Tour

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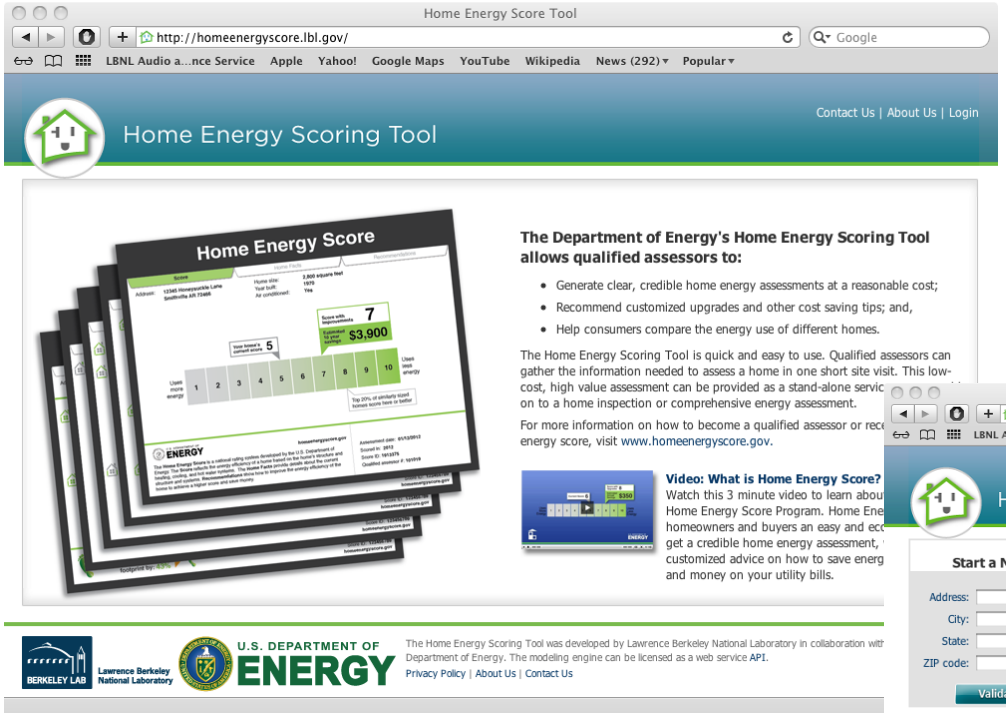
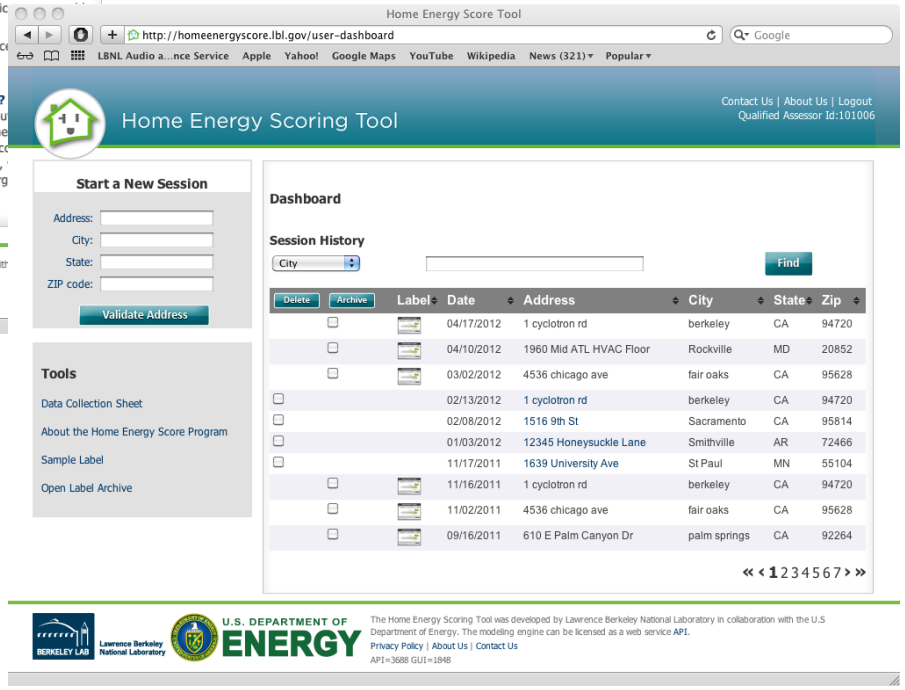
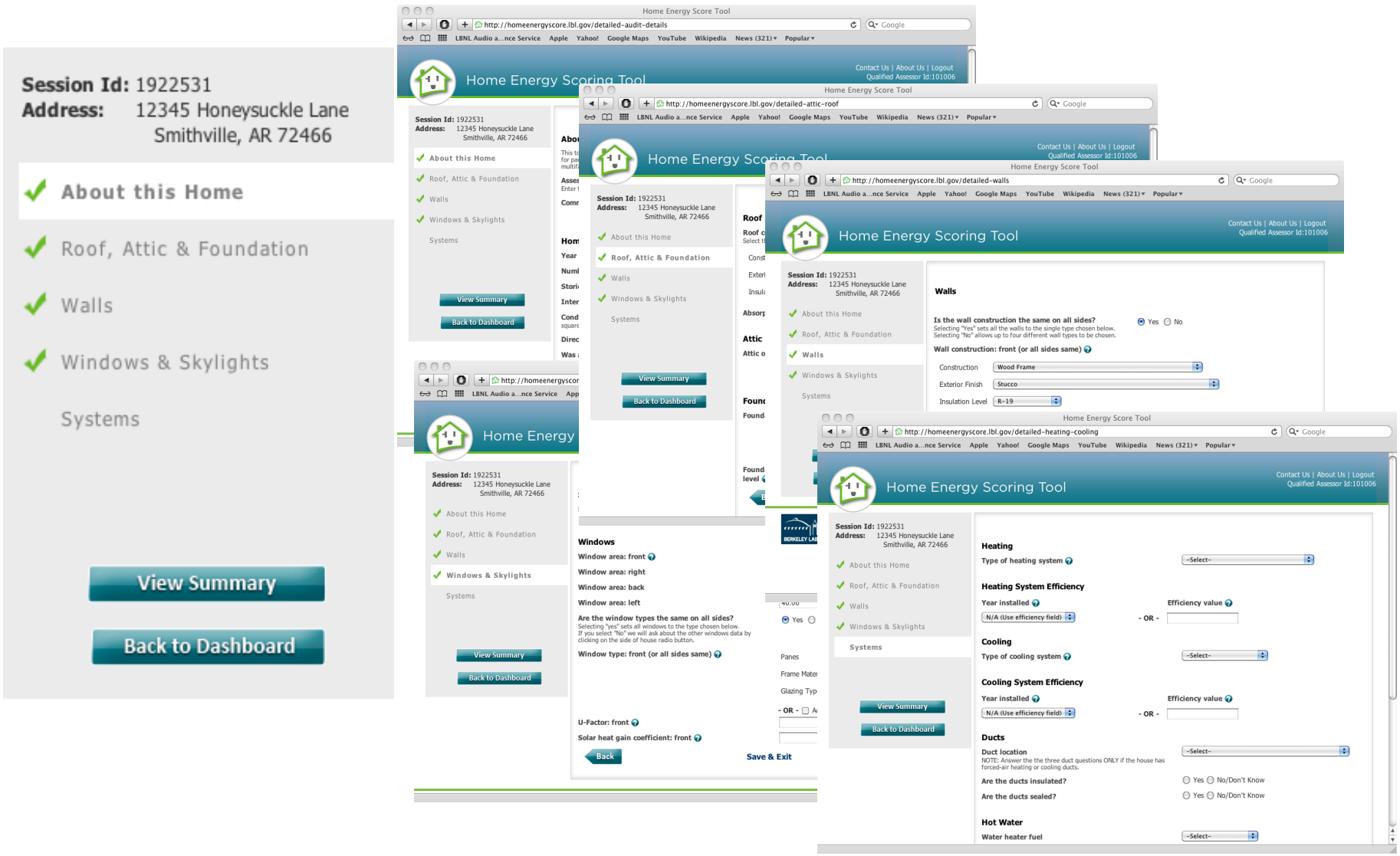




Scoring Tool – A Very Quick Tour (continued)



Scoring Tool - Required Inputs

About this Home	Assessment date, Physical address, Year built, Conditioned floor area, Number bedrooms, Number Floors, Ceiling height, Orientation, Air leakage rate, Auditor comments
Roof, Attic & Foundation	Roof construction, Roof surface solar absorption, Attic or ceiling type, Attic floor insulation, Foundation type, Foundation insulation level, raised floor insulation level
Walls	Walls the same on all sides indicator, Wall construction(s) layers
Windows & Skylights	Skylights present, Skylight type, Skylight total area, Windows the same on all sides indicator, Window type(s) or custom input of U-Factor/Solar Heat Gain Coefficient
Systems	Heating system type & efficiency, Cooling system type & efficiency, Duct location, Duct insulation, Duct sealing status, Domestic hot water system type & efficiency, Combined space and water heating type

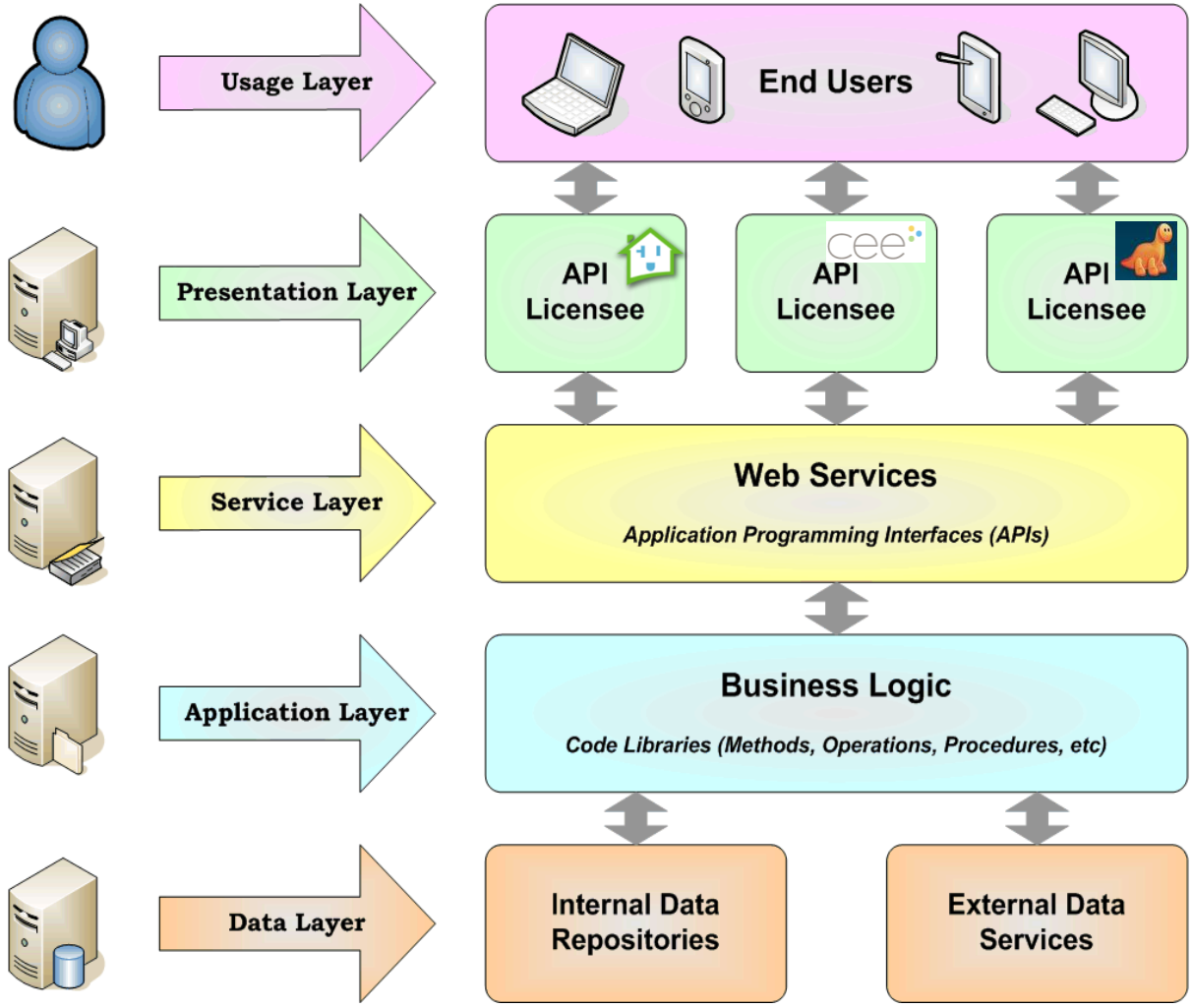
Progress: Demonstrated Accuracy

	Home Energy Scoring Tool (Version 2012)	SIMPLE	REM/ Rate
Mean Predicted (MBtu)	196	165	244
Mean Measured (MBtu)	200	200	200
Mean Difference (MBtu)	-4	-35	44
Median Difference (MBtu)	1	-30	44
Standard Deviation of Difference (MBtu)	62	38	64
Percent of Homes <± 25% Difference	61%	58%	47%
Percent of Homes <± 50% Difference	88%	96%	75%

Data source: NREL Field Data Repository (Roberts, et al. 2012)

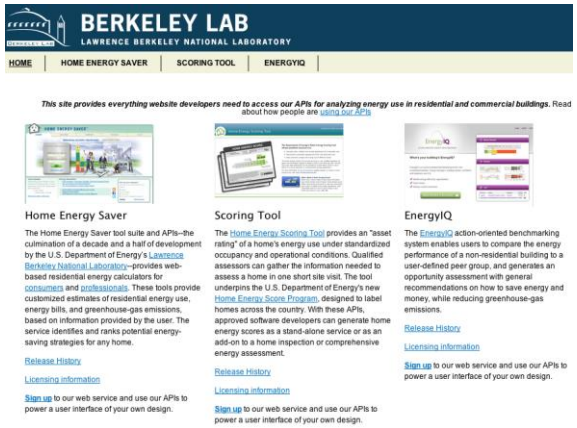
- Scoring Tool shows good agreement to measured source energy data
- Median difference between Scoring Tool predicted vs. measured energy use is estimated at -4 MBtu (-2%)
- When all conceivable modeling uncertainties are included, testing showed that the correct score is assigned within +/- 0.5 bin 67% of the time.

Collaboration, Market Impact: Leverage Market Players



Current Licensees

- Minnesota CEE
- EnergySavvy
- EnergySoft LLC
- Performance Systems Development (PSD)
- Conservation Services Group (CSG)
- InterNACHI
- Interest expressed (+N=51)



Sign-ups at "developers.buildingsapi.lbl.gov"

Collaboration, Market Impact: Leverage Market Players

Images courtesy Richard Szydlowski, MNCEE

Scoring Tool – Next Steps

- Annual update to standardized calculation methods & Scoring Tool user interface
- Future modeling features -- in development for 2013
  - TMY3 weather data (~1000 stations)
  - New DHW heater models - Heat pump & tankless water heater
  - Evaporative cooling models
  - Ground-source heat pump model
  - Hourly duct efficiency calculation with regain heat flows (ASHRAE Standard 152)
- Possible future modeling features (including but not limited to the following)
  - Multiple construction types (roofs, foundations, floors, etc.)
  - Solar (photovoltaic, thermal)
  - Pool equipment
- Long-term: Supply data to Building Performance Database

Backup Slides on Scoring Tool

Scoring Tool - Fixed Assumptions & Default Values

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- Occupancy and TV energy are scaled per the number of bedrooms as defined in the Building America House Simulation Protocols (Hendron & Engebrecht, Oct. 2010)
  - Up to 3 bedrooms the occupant/bedroom ratio equals 1, then gradually scales downward for 4 bedrooms and higher homes
  - TV kWh = -3 * (number Bedrooms)^2 + 89 * (number of Bedrooms) + 390
- Domestic hot water load dependent on occupancy level
- Misc. electric loads scaled by conditioned floor area (Hendron & Engebrecht, Oct. 2010)
  - Residual misc. elec. kWh = 0.91 * (conditioned floor area)
- Stove, oven, and clothes-drying fuels are set as electric
- Lighting
  - Interior lighting kWh = 455 + 0.8 * conditioned floor area
  - Exterior lighting kWh = 50 + 0.05 * conditioned floor area
- The building length and width are fixed at a 5:3 aspect ratio with actual conditioned floor area
- The thermostat set point is scheduled all year as:
  - 08:00-17:00 Heating 60^{o}F, Cooling 84^{o}F
  - 17:00-08:00 Heating 68^{o}F, Cooling 78^{o}F

Detailed engineering documentation located at https://sites.google.com/a/lbl.gov/hes-public

Scoring Tool – Recommending Upgrade Opportunities

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Repair Now:

These upgrades can help you save energy right away

- Attic floor insulation
- Basement wall or foundation slab edge insulation
- Floor insulation above a basement or crawlspace
- Crawlspace wall insulation
- Building air-sealing
- Exterior wall insulation
- Duct sealing
- Duct insulation

Replace Later:

Recommendations for when you replace the affected equipment at a later time when needed or desired.

- Central air conditioner
  - ENERGY STAR unit
- Boiler or Furnace or Heat pump
  - ENERGY STAR unit
- Room air conditioner
  - ENERGY STAR unit
- Roof
  - Cool roof
  - Insulated sheathing
- Skylights
  - ENERGY STAR units
- Siding
  - Insulated exterior sheathing
- Water heater
  - ENERGY STAR unit
- Windows
  - ENERGY STAR units