Residential Energy Modeling for the Public Sector

Thursday, July 11, 2019
2:00 PM – 3:30 PM
Speakers

- **Eric Wilson**, National Renewable Energy Lab (NREL)
- **Deborah Philbrick**, Elevate Energy
- **Moderator**: Madeline Salzman, DOE
Residential Building Energy Modeling for Public Sector Partners

Madeline Salzman
US Department of Energy Building Technologies Office
Why Focus Public Efforts on Residential Efficiency?

- 95% of U.S. buildings
- 70% of U.S. building stock square footage
- 50% of peak demand on electricity grids
- 21% of U.S. energy use
Efficiency Makes Homes Better Places to Live

**Improves Quality of Life**
- **Increase comfort.**
- **Reduce environmental impact.**
- **Improved health outcomes.**
- **Less draftiness.**
- **Increased control.**
- **Peace of mind.**

**Helps Reduce Costs.**
Energy burdens average higher than both property taxes and home insurance.

**Smart Investment.**
Efficiency features payback via energy savings over time.
Problems Residents Face to Accessing Efficiency

- Residents are not well informed on which upgrades are best-fit for their home or associated benefits.
- Efficiency is persistently undervalued in residential real estate.
- Most consumers lack access to capital for efficiency upgrades.
Yet, Energy Burdens Are High

Nearly **one-third** of U.S. households reported facing a challenge in paying energy bills or sustaining adequate heating and cooling in their homes in 2015.

About **one in five** households reported reducing or foregoing necessities such as food and medicine to pay an energy bill.

The most common reason reported for individuals seeking payday loan products is to pay their utility bills.

Sources: EIA 2015 & FDIC 2012
A Resource to Help

Residential Energy Efficiency for Local Governments

» Easy to find under “Communities” Tab of Better Buildings Website

In the U.S., residential buildings account for 21% of total energy consumption. Household expenditures for energy exceed $219 billion per year, with annual household costs averaging $1,856 per year ($2,137/year for single family homes and $1,132 for multifamily units). Local governments that have established energy savings goals can develop and implement a range of programs and strategies to reduce residential energy use in their communities. Furthermore, lowering residential energy costs can contribute to other local government objectives, including housing affordability, energy reliability, improvements in health outcomes, updated aging housing infrastructure, investments in clean energy, and workforce and economic development.
Residential Energy Efficiency for Local Governments

» Click on “Communities” Tab of Better Buildings Website

» Click on resource name to far right of drop-down menu

» Home page: https://betterbuildingsinitiative.energy.gov/bca/residential-energy-efficiency-resources-local-governments

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Six Primary Strategies Highlighted

Each strategy includes dozens of resources:

» Introduction
» Stakeholders & potential collaborators
» U.S. DOE tools & resources
» Other helpful resources
» Examples from local governments where strategies are in action
Links to Other Resources on Residential Efficiency

Additional Resources:

- **DOE’s Better Buildings Residential Network**: Connects energy efficiency programs and partners to share best practices and learn from one another to increase the number of homes that are energy efficient. Local governments can learn from the experiences of their peers through peer exchange calls and other forums for sharing information on topics of interest. Contact: bbresidentialnetwork@ee.doe.gov
- **DOE’s Residential Program Solution Center**: A repository for lessons learned, resources, and knowledge from program administrators and industry experts across the country. Find information to help plan, operate, and evaluate residential energy efficiency programs.
Example with Strategy 3: Home Energy Labeling

- Address Residential Energy Use in Local Planning
- Adopt Residential Building Energy Codes and Standards
- Start a Home Energy Labeling Program
- Enable Financing for Residential Efficiency Upgrades
- Offer Incentives to Make Efficiency More Affordable
- Upgrade the Efficiency of Affordable Housing in Your Community
START A HOME ENERGY LABELING PROGRAM

Home energy labeling programs and policies allow local governments to provide reliable, standardized information to residents about homes’ estimated energy use. In addition to energy use estimates, home energy labels can provide an estimate of a home’s energy costs, as well as recommendations for energy-saving improvements that can make the home more comfortable and less expensive to run. This information helps homeowners, buyers, sellers, and renters make informed decisions about home purchases, rentals, or upgrades they can make. Local governments can use home energy labels to promote transparency of energy information in the real estate market, requiring a label to be provided in real estate listings, at time of sale/rental, or when upgrades are made. Additionally, the home energy information that is typically collected in order to generate a home energy label can provide local governments with a better understanding of the conditions of local housing stock, helping to target resources where most needed.  

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Home Energy Labeling: U.S. DOE Tools

List of Tools

» U.S. DOE software, plug-and-play programs, and data management systems that enable public sector programs to begin without reinventing the wheel
List of Resources

» U.S. DOE toolkits, published guides, and written resources that help communities walk through the steps of implementing this strategy.
Home Energy Labeling: Other Helpful Resources

LOCAL GOVERNMENT EXAMPLES

- Berkeley, California: Berkeley’s Building Energy Saving Ordinance (BESO) requires building owners and homeowners to complete and publicly report comprehensive energy assessments to uncover energy saving opportunities. Single family homes are required to get a Home Energy Score prior to sale, but may be deferred to the buyer for up to 12 months at time of sale. Home Energy Score data from the first year of implementation showed that the majority of homes scored were poorly insulated, and very few had insulation up to code. The city also found that the majority of homes scored had single pane windows. The three most common recommendations included in Berkeley Home Energy Score reports to date have been floor insulation, attic insulation and air sealing, and installing a central gas furnace. The city’s home energy disclosure policy not only provides consumer protections and critical information to residents about home energy use and costs, but is also helping the city identify where the greatest energy efficiency needs are in its housing stock.

- Columbia, MO: The City of Columbia, MO’s municipal utility, Columbia Water & Light, offers the Home Energy Score at no cost to customers in its Home Performance with ENERGY STAR program and provides the Score both before and after energy improvements are made. Homes that achieve a Home Energy Score of 8 or higher (on a 10-point scale with 10 being best), a Columbia Water & Light Efficiency Score (which is based on the Home Energy Score) backed by a Home Energy Score of 8 or higher, or a HERS rating of 65 or lower are eligible to receive a Gold Certificate from the Missouri Home Energy Certification program. Homes that can’t reach that threshold cost effectively, but can significantly reduce their energy consumption can qualify for a Silver Certificate. The Missouri Green Building Registry (GBR) was designed to automatically pull home energy data through an application programming interface (API) connection which can then generate the Missouri Home Energy Certificate. The GBR pulls Home Energy Score data from Columbia Water & Light (as well as HERS and other energy efficiency data from others in the state) and offers the potential to auto-populate home energy data into real estate Multiple Listing Services.

Other Resources

» Catch-call for infographics, and other written supporting documents.
Home Energy Labeling: Local Government Examples

Local Government Examples

» Short descriptions of local governments having implemented this strategy already.

» Usually 3-5 local government examples per strategy

More
How to Use This Resource

- Address Residential Energy Use in Local Planning
- Adopt Residential Building Energy Codes and Standards
- Start a Home Energy Labeling Program
- Enable Financing for Residential Efficiency Upgrades
- Offer Incentives to Make Efficiency More Affordable
- Upgrade the Efficiency of Affordable Housing in Your Community
Visit Our Website!

This is Live & Living

» Visit the website today to see the first resources available
» We will continue to make updates – let us know what is missing or could be described better
» Be in touch: madeline.salzman@ee.doe.gov

» Home page: https://betterbuildingsinitiative.energy.gov/bca/residential-energy-efficiency-resources-local-governments
Our Next Speakers

Eric Wilson, National Renewable Energy Laboratory
» ResStock & its applications for public sector partners

Deborah Philbrick, Elevate Energy
» Use of home energy labeling in underserved markets

Followed by Discussion and Q&A
Residential energy modeling: ResStock, URBANopt, and EnergyPlus

Eric Wilson
2019 Better Buildings, Better Plants Summit
July 11, 2019
## NREL building energy modeling

<table>
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NREL building energy modeling

Tool:
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Districts, campuses

Building stocks (city, state, utility, national)
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URBANopt

- Analytics platform for communities and urban districts
- Built on top of OpenStudio® and EnergyPlus™ through new U.S. DOE investments in tools
- Modular, open source platform; “underlying analytics” that can be integrated into private sector tools
URBANopt Analysis Workflows

Geometry/Building Data Input and Detailed Building Energy Model Creation

District-Scale Annual Energy Scenario Analysis

Seek Answers to these and Other Questions

What efficiency and energy generation levels are required to achieve a Zero Energy District?

Should one central system or multiple smaller systems be used and which potential thermal network layout is best?

Grid-Interactive Analysis w/ REopt/OpenDSS

What impact does the efficiency, demand flexibility, and distributed generation/storage have on the electric distribution grid requirements?
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Highly granular analysis tools for national, regional, and local housing stocks
Housing stock characteristics database + Physics-based computer modeling + High-performance computing
Large public and private datasets

Census Data

Building Characteristics

Climate Locations

Costs

6000 probability distributions for 100 parameters structured in a dependency tree
Housing stock characteristics database + Physics-based computer modeling + High-performance computing

Large public and private datasets

Best-in-class models

OpenStudio + EnergyPlus

Detailed sub-hourly energy simulations

6000 probability distributions for 100 parameters structured in a dependency tree
Housing stock characteristics database + Physics-based computer modeling + High-performance computing

Large public and private datasets

Best-in-class models

10,000s to 100,000s of simulations

NREL’s supercomputer

Cloud computing

Big data technology stack

6000 probability distributions for 100 parameters structured in a dependency tree

Detailed sub-hourly energy simulations
Why ResStock?

Payback, in years, for wall insulation retrofit in Washington and Oregon single-family homes

Typical Approach

Annual savings modeled or measured in small sample

$120

$80

$75

$125
Why ResStock?

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Segmented by:
Heating fuel type
Weather station

3 5 10+

= 50,000 homes
Why ResStock?

Payback, in years, for wall insulation retrofit in Washington and Oregon single-family homes

Typical Approach

- Annual savings modeled or measured in small sample
- Segmented by:
  - Heating fuel type
  - Weather station

Annual savings modeled with sample of 10,000s–100,000s

- Heating fuel type
- Weather station
- Year built
- Home size
- Number of stories
- Foundation type
- Occupancy
e tc.
Why ResStock?

Payback, in years, for wall insulation retrofit in Washington and Oregon single-family homes

Annual savings modeled or measured in small sample

$120

$80

$75

$125

= 50,000 homes

Homes with less than 5-year payback

90,000

270,000

Segmented by:

- Heating fuel type
- Weather station

Heating fuel type
Weather station
Year built
Home size
Number of stories
Foundation type
Occupancy etc.
Applications

Utility companies and consultants
• Increase the cost-effectiveness of programs ($8B/yr)
• Defer distribution infrastructure spending ($20B/yr)

Manufacturers
• Prioritize R&D investments in emerging technologies
• Identify target markets to inform marketing and sales

Cities/States
• Identify the highest priority housing stock improvements
• Understand how buildings contribute to city/state energy or emissions targets

$49 billion potential utility bill savings identified to date
48 State Factsheets

Available at resstock.nrel.gov

State Fact Sheets

Click on a state to view a summary of the cost-effective residential savings potential and top priority improvements in that state.

New York

Residential Energy Efficiency Potential

- 3.4 billion dollars per year utility oil savings
- 149.7 billion 100s per year gas, propane, and fuel oil savings
- 5.3 billion dollars per year electricity savings
- 110,582 million cars of pollution reduction

Energy used by New York single-family homes that can be saved through cost-effective improvements.

New York Top 10 Improvements

New York Utility Bill Savings (electricity, gas, propane, and fuel oil)

<table>
<thead>
<tr>
<th>Statewide Annual Consumer Savings</th>
<th>Average Annual Savings per Household</th>
</tr>
</thead>
<tbody>
<tr>
<td>States</td>
<td>Millions</td>
</tr>
<tr>
<td>Enclosure Drill-fill wall cavity insulation</td>
<td>80</td>
</tr>
<tr>
<td>Enclosure R-5 insulated wall sheathing (at siding replacement)</td>
<td>40</td>
</tr>
<tr>
<td>Enclosure R-10 basement wall insulation</td>
<td>20</td>
</tr>
<tr>
<td>HVAC Smart thermostat</td>
<td>10</td>
</tr>
<tr>
<td>HVAC Air sealing</td>
<td>5</td>
</tr>
<tr>
<td>HVAC R-60 attic insulation</td>
<td>2</td>
</tr>
<tr>
<td>Enclosure Low-E storm windows (DIY install)</td>
<td>1</td>
</tr>
<tr>
<td>Lighting LED lighting</td>
<td>1</td>
</tr>
<tr>
<td>HVAC Duct sealing &amp; insulating</td>
<td>1</td>
</tr>
<tr>
<td>HVAC Ductless heat pump (displaces electric baseboard)</td>
<td>1</td>
</tr>
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</table>
Putting the “E” in PITI(E)
DOE is working with Fannie Mae, Freddie Mac, and the Appraisal Institute to explore the possibility of using ResStock to estimate energy costs for appraisals
Targeting savings opportunities for low- and moderate-income households

Find article link at: resstock.nrel.gov/page/publications
Los Angeles 100% Renewable Energy Study

Building load modeling

First-of-its-kind analysis

What role do energy efficiency, electrification, and demand response play in achieving 100% renewable energy for a city AND utility?
First-of-its-kind analysis

What role do energy efficiency, electrification, and demand response play in achieving 100% renewable energy for a city AND utility?

Key study considerations

- Necessary infrastructure upgrades
- Critical transmission investments
- Maintaining system reliability
- Impact on equity, jobs, and local economy
Coming soon:
Case study on steps that cities can take to prepare for a detailed building stock analysis, using NYC as example
Thank you

www.nrel.gov
Eric.Wilson@nrel.gov
Residential Energy Labels across America

Deborah Philbrick
Senior Manager, Research & Innovation
July 11, 2019
Our Mission: Smarter Energy Use for All

We give people the resources they need to make informed energy choices.

Getting energy use right saves money, increases comfort, creates jobs, and protects the environment.

We ensure the benefits of clean and energy efficient energy use reach those who need them most.

©2018 Elevate Energy
What’s a Home Energy Label?

Typically includes one or both of the following:

- A list of a home’s physical assets, like insulation level or furnace efficiency

- An operational rating that compares the home’s operating costs to a “typical” home, or uses the home’s utility bills or modeling
Why a home energy label?

- It is a tool that can help homeowners make visible the typically invisible energy efficiency features of home, like insulation levels or operating costs.

- A well-designed label will create a straight-forward path for homeowners to follow, leading them to simple and effective home energy improvements.

- Because homeowners now have a path for moving forward, it can drive them to utility program incentives and rebates.

- The label can also jurisdictions get a better, more granular, and more standardized view of its housing stock.
Who did we talk to?

- City of Denver (Department of Public Health & Environment)
- State of Connecticut (Energize Connecticut)
- City of Austin (Austin Energy)
- State of Vermont (Efficiency Vermont)
- City of Berkeley (Office of Energy & Sustainable Development)
- City of Minneapolis (Center for Energy and Environment)
- City of Portland (Bureau of Planning and Sustainability)
- City of Holland (Community and Neighborhood Services)
But what does this really look like?

**ENERGY AUDIT SUMMARY**

<table>
<thead>
<tr>
<th>Action Recommended?</th>
<th>Potential Annual Savings*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Windows and Shading</td>
<td>Yes</td>
</tr>
<tr>
<td>B. Attic Insulation</td>
<td>Yes</td>
</tr>
<tr>
<td>C. Air Infiltration and Duct Sealing</td>
<td>Yes</td>
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<tr>
<td>D. Heating and Cooling System Efficiency (HVAC)</td>
<td>Yes</td>
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<tr>
<td><strong>Total Annual Savings:</strong></td>
<td></td>
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**HOME IMPROVEMENT RECOMMENDATIONS:**

Austin Energy recommends the following actions based on the energy audit performed by Greenmon G. Greenburg of Gone Green Audits, Inc.

A. Adding shade to south-, east-, and west-facing windows reduces the heat that the Texas sun adds to your house.

B. Adding insulation to your attic can save you money. Look into insulating and sealing attic stairs and hatches, wall chases and openings between floors. This will prevent your house from heating up rapidly during summer and cooling down quickly during winter.

C. Weatherstrip your doors and seal places where pipes enter your home to prevent outdoor air leaking into your home, making it hot and humid during the summer and cold and drafty during the winter.

D. Sealing or replacing the air conditioning ductwork can reduce your electric bill and make your home more comfortable. The duct system must be properly sized and in good condition or the heating and cooling system will run longer and cool less efficiently.

We appreciate your support of the ECAD ordinance and your efforts to make Austin the most livable city in the country.
Beneficiaries

- Local government
- Utilities
- Real estate agents
- People selling their home
- People buying new homes
The Temporal Aspect

- When do people interact with the label?

- Time of Sale
- After Major Upgrades
- Time of Listing
Best Practices from Around the Country
Main Sections of a Label

- Basic home and assessor information
- The score itself
- Energy features and recommended upgrades
- Taking action and next steps
Clearly presented information about the home and the assessor

**HOME INFORMATION**

LOCATION: 123 Main Street, Anytown, VT 05000

YEAR BUILT: 2005

CONDITIONED FLOOR AREA: 3,029 sq. ft.
Includes all spaces that are intentionally heated or cooled. This value may differ from a home’s appraised square footage.

**REPORT INFORMATION**

PROFILE ISSUE DATE: 6/10/15

ASSESSOR: John Doe

ORGANIZATION: Sample A. Sample Contracting

PHONE: 802-555-1111
• There are many models for scores. However, programs report that consumers strongly value the potential to improve their score and a path for doing so
Score Section: Minneapolis

Improve your score by lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras quis neque pharetra, rhoncus lectus sit amet, metus.
Score Section: Eugene, OR

Your home's current score: 3

Score today: 3
Score with improvements: 8
Estimated energy savings with improvements: $545 per year
Estimated carbon reduction with improvements: 41%

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# Features/Recommendations Section: Minneapolis

### Completed at This Home

- **Wall Insulation**: Walls are the largest area of your home protecting you from the hot and cold of the outdoors. Once completed your house will be less drafty and you will be more comfortable in your home.

- **Windows**: Installing a storm window on the exterior of single-pane windows can cost-effectively reduce your energy usage. Although it is generally not justified by energy savings alone, replacing single-paned windows with double-paned, high efficiency, ENERGY STAR rated windows is another option.

### Recommended Upgrades

- **Attic Insulation and Air-Sealing**: Air leaks in your ceiling allow air from inside your house to enter the attic, causing ice dams and moisture issues. Sealing these leaks improves durability and saves energy. After air sealing is complete, insulation can be added to help keep your home warm in the winter and cool in the summer.

  - **Typical Cost**: $1,750 – $2,250
  - **Rebate Available**: $500

- **Heating System**: Replacing your old heating system with a new energy-efficient model will maximize your energy savings. We recommend a minimum 95% efficient (AFUE) furnace equipped with an ECM motor.

  - **Typical Cost**: $3,000 – $6,000
  - **Rebate Available**: $400
**Features/Recommendations Section: Portland**

### *Priority Energy Improvements* | 10 Year Payback or Less

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<tr>
<th>FEATURE</th>
<th>Today's Condition</th>
<th>Recommended Improvements</th>
</tr>
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<tbody>
<tr>
<td>Duct Insulation</td>
<td>Un-insulated</td>
<td>Insulate to R-8</td>
</tr>
<tr>
<td>Envelope/Air Sealing</td>
<td>Not professionally air sealed</td>
<td>Professionally air seal</td>
</tr>
<tr>
<td>Heating Equipment</td>
<td>Oil furnace 60% AFUE</td>
<td>When replacing, upgrade to ENERGY STAR 1</td>
</tr>
<tr>
<td>Heating Equipment</td>
<td>Natural Gas/Propane Furnace</td>
<td>When replacing, upgrade to ENERGY STAR</td>
</tr>
<tr>
<td>Water Heater</td>
<td>Standard electric tank</td>
<td>When replacing, upgrade to ENERGY STAR, minimum 2.76 EF (Energy Factor)</td>
</tr>
</tbody>
</table>

**Score today:** 9  
**Score with priority improvements:** 10  
**Estimated energy savings with priority improvements:** $267 per year  
**Estimated carbon reduction with priority improvements:** 15% per year
Features/Recommendations Section

Includes:

- Energy efficiency feature
- Condition today
- Recommended upgrade (if any)
- Potential annual savings if upgrades
- Potential costs of the upgrade
- Incentives and rebates should be tied to recommendations
**ENERGY AUDIT SUMMARY**

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B. Adding insulation to your attic can save you money. Look into insulating and sealing attic stairs and hatches, wall chases and openings between floors. This will prevent your house from heating up rapidly during summer and cooling down quickly during winter.
C. Weatherstrip your doors and seal places where pipes enter your home to prevent outdoor air leaking into your home, making it hot and humid during the summer and cold and drafty during the winter.
Sealing or replacing the air conditioning ductwork can reduce your electric bill and make your home more comfortable. The duct system must be properly sized and in good condition or the heating and cooling system will run longer and cool less efficiently.
D. Consider replacing your HVAC system with an energy-efficient model. Show the audit results to an HVAC professional, who will ensure that your heating and cooling system is right-sized and operating efficiently.

We appreciate your support of the ECAD ordinance and your efforts to make Austin the most livable city in the country.
Take Action/Next Steps Section

- Consumers report that they value simple steps for moving forward.
  - Links to participating incentive and rebate information
  - Links to contractors
  - A third-party to contact with questions
TACKLE ENERGY WASTE TODAY!

Enjoy the rewards of a comfortable, energy efficient home that saves you money.

☑ Get your home energy assessment (Done!)

☐ Choose which energy upgrades to address first.

☐ Get a bid. Find an EWEB-participating contractor by visiting our list online at bit.ly/EWEBcontractor.

☐ Complete energy improvements. For eligible measures, EWEB may be able to offer a rebate or a 0% interest loan. For more details, visit eweb.org/saveenergy or call EWEB at 541-685-7088.
Interview Learnings

- Voluntary will only get you so far if your goal is market transformation

- Think about what ordinances or programs you already have
  - Minnesota & TISH

- You have to spend the money on marketing or outreach

- Reverse engineer from your goals
  - Climate Action Plan and GHG emission reduction?
  - Educated homebuyers?
  - Workforce development?
Resources

- EMPRESS: Final Report, Released by NASEO

- Bringing Home Energy Information to Real Estate: A Toolkit
  https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/HEIA%20TOOLKIT%20081318.pdf

- COMING SOON: Residential Energy Labels & Underserved Markets
Deborah Philbrick
Deborah.Philbrick@elevateenergy.org
214.536.3880
Thank You

Provide feedback on this session in the Summit App!

Download the app to your mobile device or go to event.crowdcompass.com/bbsummit19