The Resource Value of Whole House Retrofit

Evaluated Experience of Established Programs

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Mitchell Rosenberg
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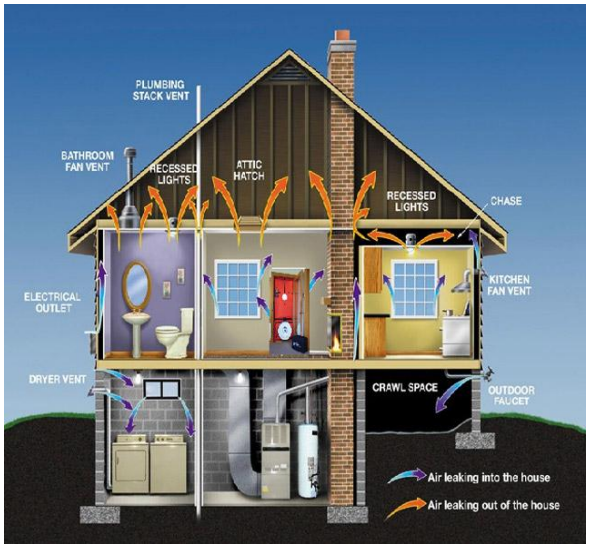
Overview of Today's Presentation

- Definition of Whole House and Home Performance Services
- Importance in energy efficiency program portfolios
- Diversity of program designs
- Review of Evaluation Results
  - Participation
  - Gross energy savings and savings versus plans (gross realization)
  - Measure-level gross savings
  - Net-to-Gross and Market Effects
- Implications for program design and evaluation

Definitions

- **Whole House Retrofit (WH) Programs:** eligibility and incentive structure encourage homeowners to implement multiple measures affecting one or more home energy systems.

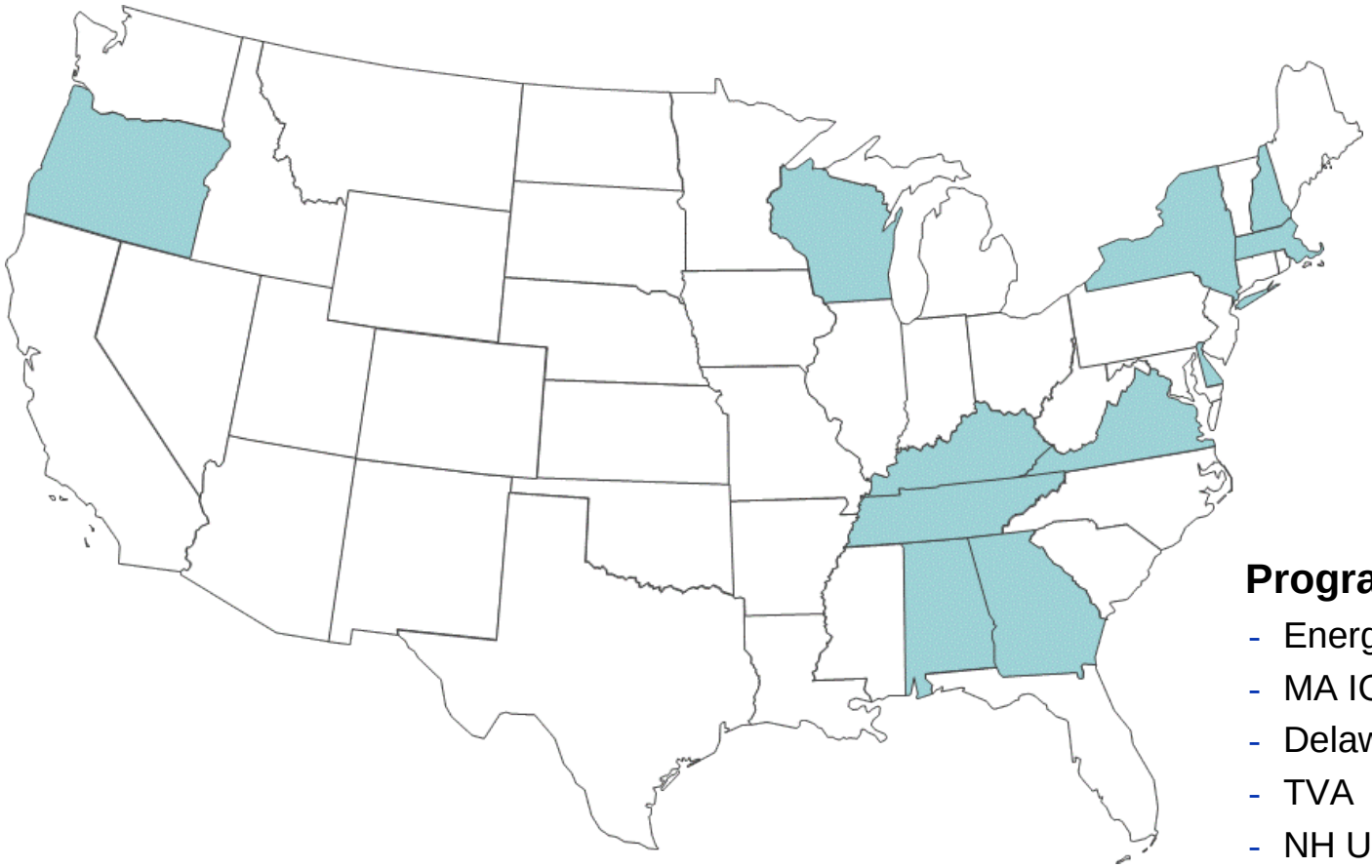
- **Home Performance (HP) Programs:** require opportunity assessment (audit) using building science methods, principles and diagnostics, as well as quality control of installed projects.



Examples of WH/HP in Energy Efficiency Portfolios

- **Long-Established Programs: Mass. IOUs**
  - Budget: $220 million; 45% of residential; 15% of portfolio
  - Ex ante kWh Savings: 15% of residential; 4% of portfolio
  - Ex ante Therm Savings: 45% of portfolio
  - Over 149,428 participants over period 2013 - 2015
- **Newer Programs: Tennessee Valley Authority**
  - Ex ante kWh Savings: 34% of residential; 7% of portfolio
  - 9,184 participants in first program year
- **Federal Stimulus Programs**
  - WH programs account for over 1/3 the budget of the Better Buildings Challenge, funded at $485 million nationwide for 24 areas.
  - WH programs also figure in the ARRA SEP portfolio

Evaluations Reviewed



Program Sponsors

- Energy Trust of Oregon
- MA IOUs
- Delaware Natural Resources
- TVA
- NH Utilities
- Wisconsin Focus on Energy
- NYSERDA
- LIPA

Overview of Programs

		Participants		Eligible Measures				Incentives		
Sponsor	Years	Assess-ments	Measures	Shell	HVAC	DHW	Other	Re-bate	Fi-nance	Assess-ment
NH Utilities	'09 – '10	n/a	1,628	◆			◆		◆	Refund
MA Utilities	'10 – '11	~68,000	~27,000	◆	◆	◆	◆	◆		Free
Delaware NREC	'10 – '11	n/a	3,887[1]	◆	◆	◆	◆	◆	◆	Free
WI Focus	'01 – '09	n/a	7,286	◆		◆	◆	◆		Free
LIPA	'10 – '11	n/a	1,710	◆	◆	◆	◆	◆		Free
NYSERDA	'01 – '13	n/a	42,457[2]	◆	◆	◆	◆	◆	◆	Free[3]
En. Trust of OR	'10 – '11	582	513	◆	◆	◆		◆	◆	Rebate
TVA	'10 – '11	n/a	9,148	◆	◆	◆	◆	◆	◆	No

[1] Most projects were for HVAC only. 1,055 "Performance Track" projects addressing multiple systems.

[2] Does not include 2 – 4 unit projects and highly subsidized projects for low-income customers.

[3] For income-eligible customers; otherwise variable charges per contractor.

- Annual participation levels relatively small in all states but MA, which built on a long-established audit and retrofit program.
- Significant variation in eligible measures, customer charges for the assessment, structure and level of rebates, access to dedicated financing

Savings: Performance v. Standard Tracks

Sponsor	Standard Track	HP Track
Measures installed/project		
Energy Trust of OR	**1.3**	**3.4**
Delaware NREC	**3.2**	**8.1**
Average Savings per Project		
Energy Trust of OR	**73 Th/Year**	**148 Th/Year**
Delaware NREC	**9.0 MMBtu/Year**	**46.3 MMBtu/Year**

- Assessment and bundling elements associated with larger number of measures installed, higher savings
- Most programs experience higher enrollments in performance tracks than in standard. This is the pattern in CA, but gross savings evaluation not complete.

Gross Savings: Summary of Evaluated Results

	MMBtu Savings		Gas Savings		Method		
Sponsor	MMBtu/ Year	% of Baseline	Th/Year	% of Baseline	BA	M&V	Sim
NH Utilities	24.1	19%*	114	12%*	◆	◆	
MA Utilities	n/a	n/a	96	9%	◆	◆	◆
Delaware NREC	35.1	35%*	78	15%*		◆	
WI Focus	33.4	26%*	319	31%*		◆	
LIPA	4.1[1]	12%*	n/a	n/a	◆	◆	
NYSERDA	12.1	9%*	117	12%*	◆		
En. Trust of OR	n/a	n/a	148	19%	◆		
TVA	4.4[1]	9%	n/a	n/a		◆	◆

[1] **Program targets electric measures only. % savings reflect average electric consumption.**

*** Using RECS averages for baseline. Average pre-program consumption not reported**

- High variability of savings estimates depending on program design and gross savings estimation method: high outliers used TRM with M&V only.
- To estimate aggregate savings, billing analysis preferred. Captures trends over time and can be used to control for other non-program influences.

Gross Savings: Summary of Realization Rates

	Gross Savings Realization Rate	
Sponsor	**Electricity**	**Heating Fuels**
NH Utilities	53%	92%
MA Utilities	n/a	57% - 86%[1]
Delaware NREC	34%	47% - 101%[1]
WI Focus	98%	99%
LIPA	62%	67%[2]
NYSERDA	35%	65%
En. Trust of OR	n/a	47%

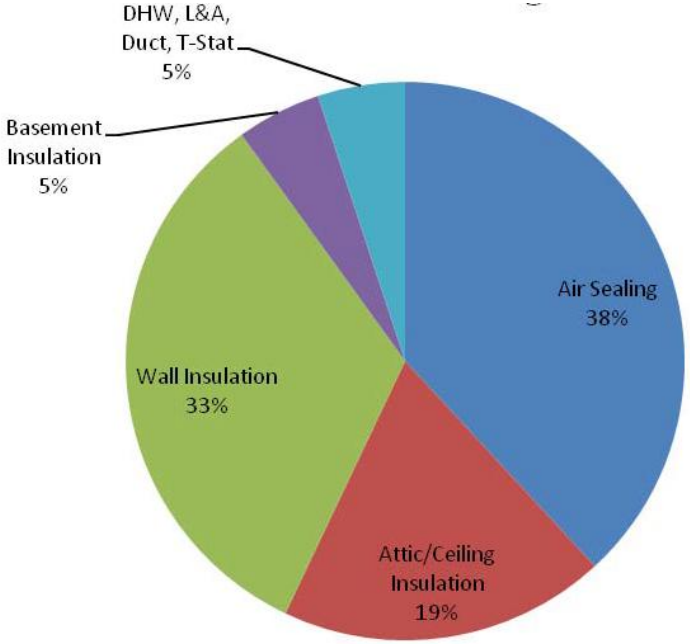
[1] Different realization rates found for gas, electric, and delivered fuel measures.

[2] Electric heating customers.

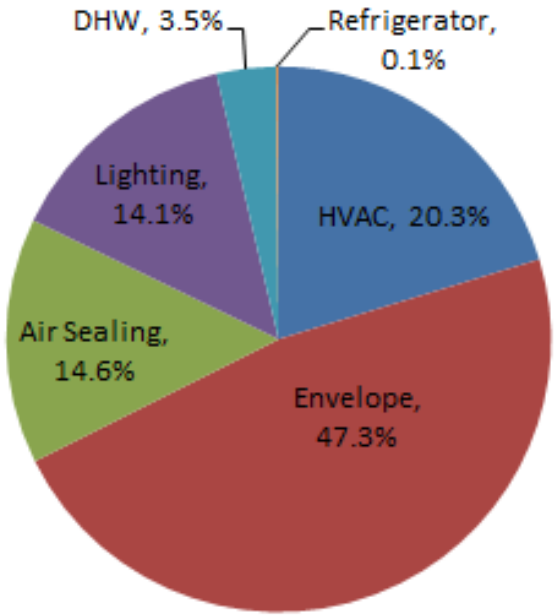
Factors contributing to low realization rates

- Misspecification of home audit or tracking system savings models
- Misapplication of audit models in the field
- Poor quality installation or lack of quality control
- Low installation rates for electric measures

Gross Savings: Distribution by Measure



New Hampshire, Fossil Fuel



LIPA, Electric Only

- Distribution of savings among measures is related to the program design and sponsorship: NYSERDA – 26% in heating system improvements
- Distribution among measures will also be related to climate and housing stock characteristics

Net Savings: Summary of Evaluated Results

				Method		
Sponsor	FR	SO	NTG	Cust	Cont	TRM
NH Utilities	n/a	n/a	n/a			
MA Utilities	14% - 29%[1]	28%	113%[2]	◆		
Delaware NREC	22%	n/a	78%	◆		
WI Focus	n/a	n/a	85%			◆
LIPA	23%	n/a	77%			◆
NYSERDA	20%	94%[3]	174%	◆	◆	
En. Trust of OR	n/a	n/a[4]				
TVA	43%	~47%[5]	~100%	◆		

[1] Varies by measure type.
[2] Weighted average of all measures.
[3] 14% participant in-house; 14% participant influencing others; 66% contractor-driven.
[4] Taken into account by billing analysis
[5] Interpret a portion of unreported 'take rates' as spillover

- Relatively high realization rates driven by cost, low baseline level awareness of major air sealing and HVAC measures
- Program theory draws attention to contractors as a channel for spillover – so far only one study has explored this systematically.

Cost-Effectiveness

Sponsor	Cost-Effectiveness Metrics	C/E Score
NH Utilities	n/a	
MA Utilities	TRC – prospective 2013 – 2015	4.7
Delaware NREC	n/a	
WI Focus	Not reported at program level	n/a
LIPA	TRC – retrospective	1.0
NYSERDA	TRC – energy savings only	0.7
NYSERDA	TRC – including NEIs	1.0
En. Trust of OR	TRC	0.4
TVA	n/a	

- Due to relatively high program and measure costs, TRCs generally cluster around 1.0 for mature programs
- Very low Energy Trust of Oregon score may have to do with low volume in HP track.
- Similarly, very high MA score likely have to do with high volume and anticipated continued high per project savings

Implications for Program Design and Evaluation

- Program Design
  - Volume is clearly a key to cost-effectiveness
  - Steps to increase volume
    - Simplify the participation process
    - Offer cash incentives
    - Use both program administrator and contractor channels to push program
  - Target to areas with high heating and/or cooling loads
  - Quality control also key to gross savings
- Program Evaluation
  - Develop reporting standards that fit the program
  - To the extent possible, use billing analysis for aggregate savings
  - Address the spillover issue comprehensively

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