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U.S. DEPARTMENT OF ENERGY

Improving Building Envelope and Duct Airtightness of US Dwellings – The Current State of Energy Retrofits

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AIVC Workshop on Building and Ductwork Airtightness
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Air-sealing of building envelope and duct is a common efficiency measure to reduce residential heating and cooling energy use

- How much does airtightness improve from air-sealing?
- Are there differences between energy efficiency programs?
- What are the levels of airtightness post-retrofit?

Weatherization Works

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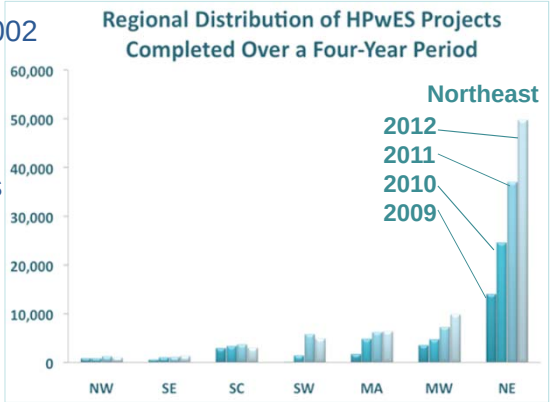
HOME PERFORMANCE WITH ENERGY STAR

- HPwES is administered by DOE in conjunction with USEPA
  - 250,000 homes participated since 2002
  - Whole-house approach on energy and comfort
  - Qualified contractors
  - Program sponsor financing to provide incentives
  - Typical utility bill savings of 20% or more*



* http://www.energystar.gov/index.cfm?c=home_improvement.hpwes_for_homeowners

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Income-qualified Weatherization Assistance Program (WAP)

RECOVERY.GOV

- WAP received $5 billion under Recovery Act
  - 1m homes weatherized Apr 2009–Sep 2012
- Energy savings average 35% of consumption*
- 900 local agencies, e.g. community action agencies, local governments
- Air-sealing
  - Maintain minimum ventilation requirement, depends on occupancy, combustion appliances, etc.
  - Demonstrate favorable savings-to-investment ratio by repeating blower door tests during work

* http://www1.eere.energy.gov/library/pdfs/48098_weatherization_assisprog_fsr4.pdf

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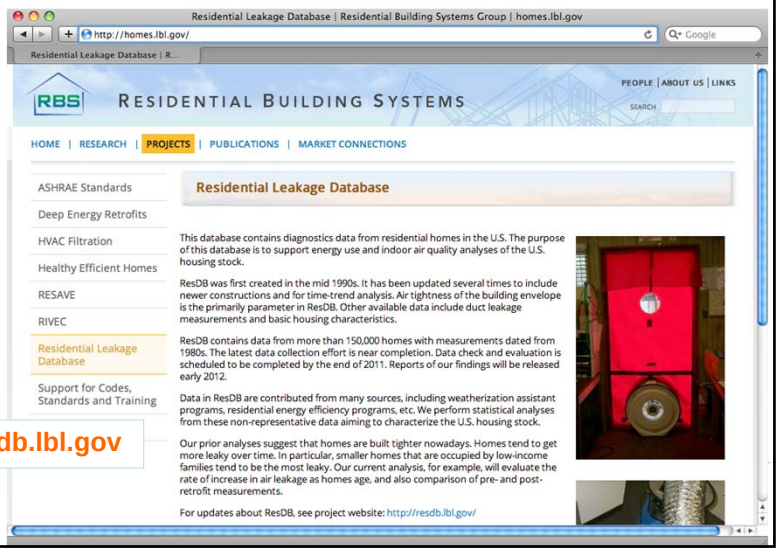
Data source: ResDB contains air leakage and other diagnostic data from 150,000 homes dated from 1980s

http://homes.lbl.gov



http://resdb.lbl.gov

ResDB has blower door data, and some duct blaster data, before and after energy retrofits

- 21,140 WAP homes
  - 13,090 single-family
  - 6,710 manufactured homes
  - 1,340 multi-family homes
- 10,000 HPwES/utility program single-family homes
- Fewer duct blaster measurements
  - 271 WAP homes, 170 HPwES/utility program homes
- Define reduction in air leakage as:

$$\%\ \text{Reduction} = \left(1 - \frac{X_{\text{post}}}{X_{\text{pre}}}\right) \times 100\%$$

X = ACH50 for envelope leakage, CFM25 per 100 ft^2 floor area for duct leakage

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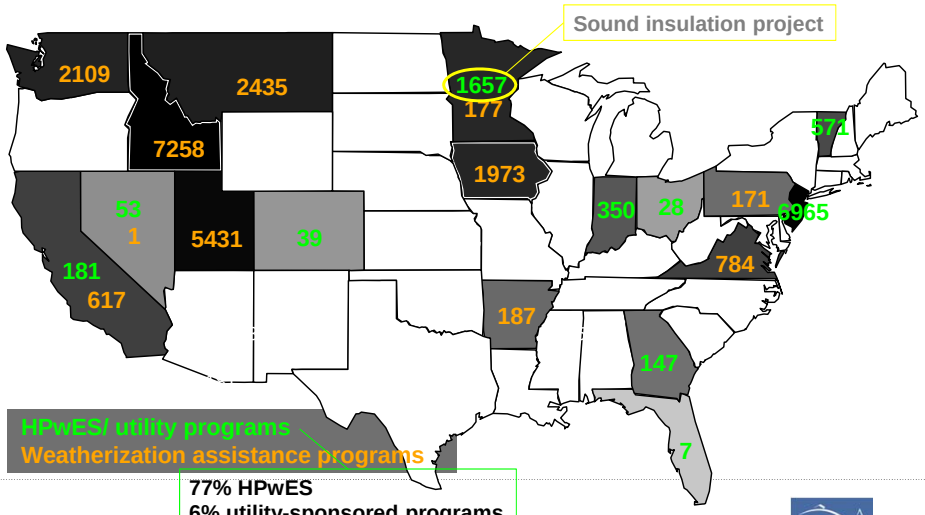
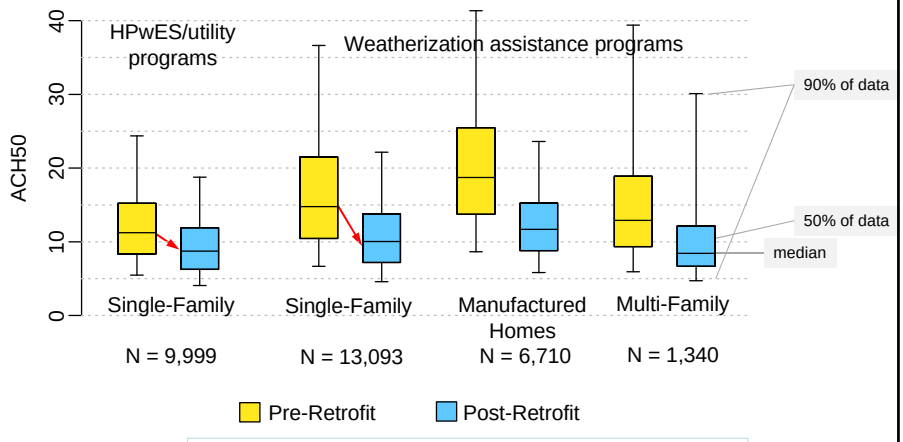
Number of homes in ResB with pre- and post-retrofit blower door data



77% HPwES
6% utility-sponsored programs
17% others

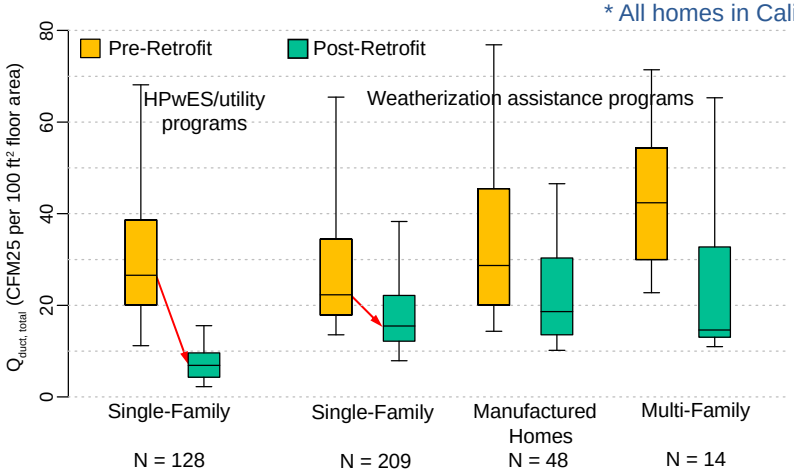
Pre- and post-retrofit blower door data show greater % reduction by WAP than HPwES/utility efficiency programs



For reference, IECC (2012) building envelope airtightness guideline for new homes is <3 or <5 ACH50, depending on US climates.

Limited data* of total duct leakage show greater % reduction by HPwES/utility efficiency programs than WAP

* All homes in California



For reference, IECC (2012) duct leakage airtightness guideline for new homes is <4 CFM25 per 100 ft² floor area.

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How much does airtightness improve from air-sealing?

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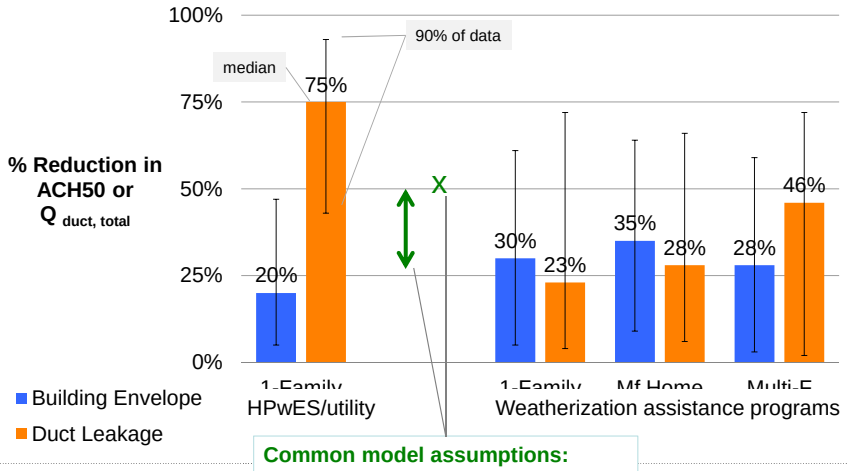
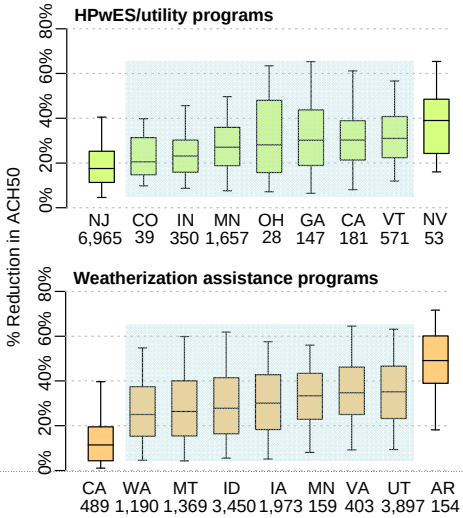
ResDB data show median reduction of ~25% for building envelope, and 25% (WAPs) to 75% (HPwES/utility programs) for total duct leakage



Common model assumptions:
25% to 50% for building envelope;
50% for total duct leakage

Are there differences between energy efficiency programs?

Substantial differences in % reduction by programs and states



- Differences between how HPwES/utility programs and WAPs approach air-sealing and blower door testing
- Differences in the range of other energy efficiency measures that are assessable to homeowners

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What are the levels of airtightness post-retrofit?

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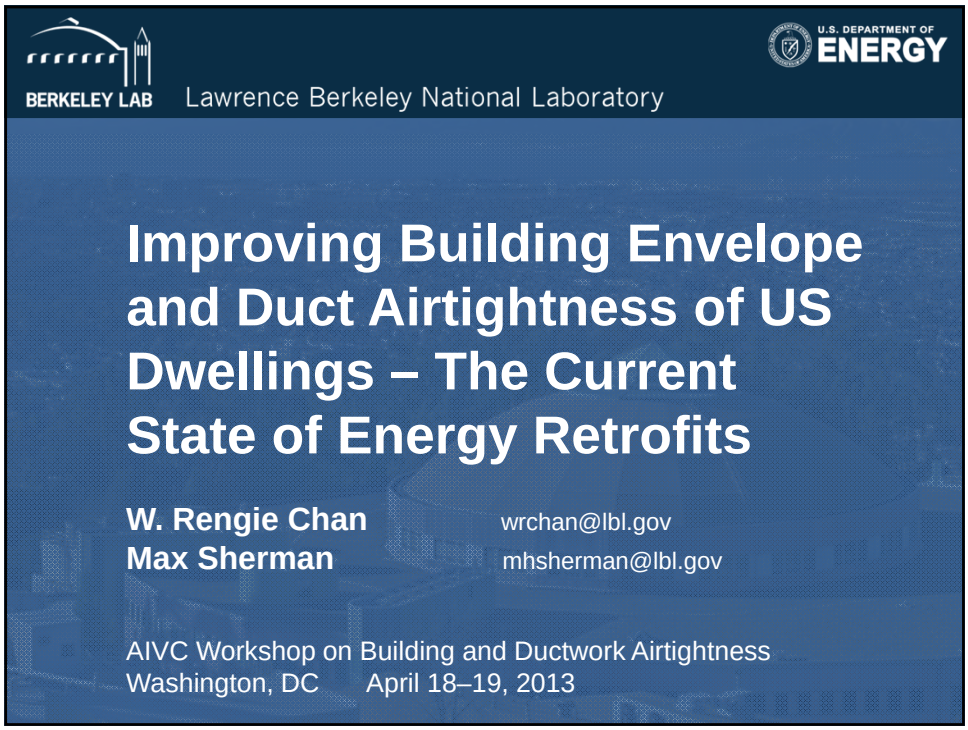
ResDB post-retrofit data show 40% of homes with building envelope airtightness >10 ACH50 or total duct leakage >8 CFM25 per 100 ft^2

	HPwES-type residential efficiency programs	Weatherization assistance programs
Building envelope		
(I) >10 ACH50	39%	50%
(II) >15 ACH50	12%	20%
Total duct leakage		
(I) >8 CFM25 per 100 ft^2	39%	95%
(II) >12 CFM25 per 100 ft^2	15%	77%

- Approximately 40% of the homes exceeded level (I) airtightness
- Level (II) is a target that most homes (80%+) can meet
- Total duct leakage in most homes remain high after weatherization

Summary

- Median reduction in ACH50 ranges between 20% to 35% by HPwES/utility-sponsored efficiency programs and weatherization assistance programs (N = 31,140)
- Limited data from California (N = 400) show median reduction in total duct leakage is 75% by HPwES/utility programs, and 25% by WAPs
- 40% of homes did not reach these airtightness levels post-retrofit: <10 ACH50 or <8 CFM25 per 100 ft^2 (about twice the IECC (2012) guidelines)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