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U.S. DEPARTMENT OF ENERGY

ENERGY IMPACTS OF ENVELOPE TIGHTENING AND MECHANICAL VENTILATION FOR THE U.S. RESIDENTIAL SECTOR

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AIVC-Airtightness Workshop April 18–19, 2013
Washington DC

Context: Residential Buildings Energy

- ▶ Residential sector uses 21.6 quads of source energy
 - ▶ 22% of US source energy
- ▶ Residential sector uses 10.2 quads of site energy
 - ▶ Heating and cooling accounts for 5 quads
- ▶ National and state commitments to reducing residential energy use
 - ▶ Reduce costs
 - ▶ Mitigate climate change
 - ▶ Improve energy security

Envelope tightening has been a focus of energy efficiency

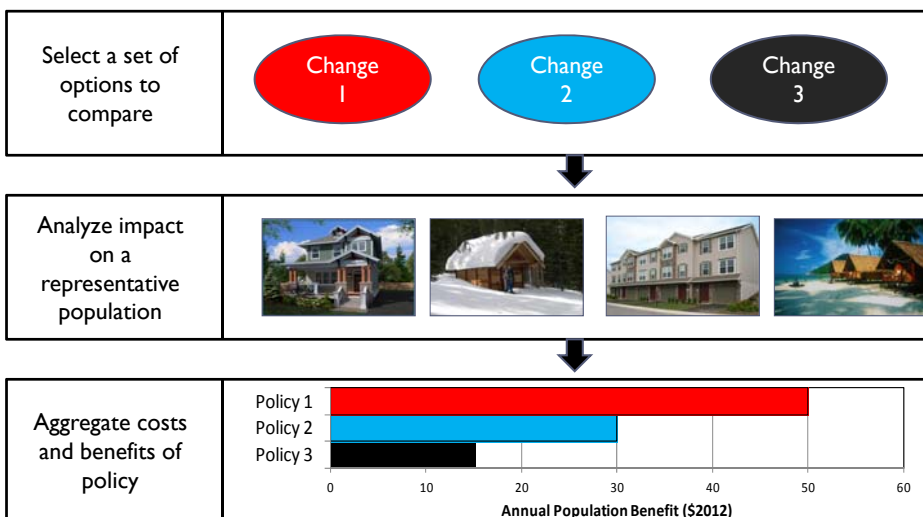
- ▶ Effective envelope air sealing reduces:
 - ▶ Uncontrolled infiltration
 - ▶ Annual energy costs for thermal conditioning

- ▶ Federal, state and local programs have focused on envelope tightening to reduce housing stock energy use while reducing occupant bills and improving comfort

- ▶ Ventilation standards present a lower bound on the minimum airflow allowed through a home for good indoor air quality

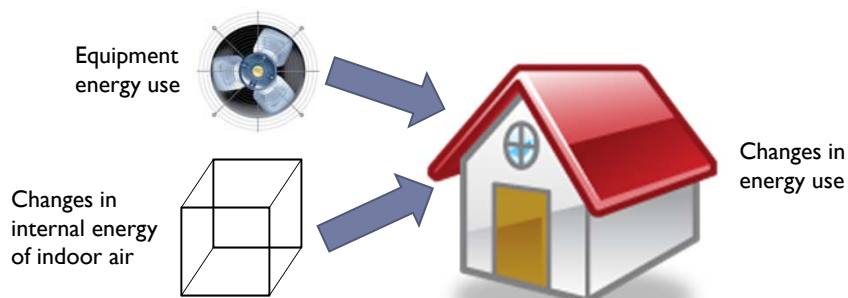
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How much does ventilation cost? How much energy can tightening save?



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Incremental Ventilation Energy (IVE) model predicts energy changes related to changes in airflow

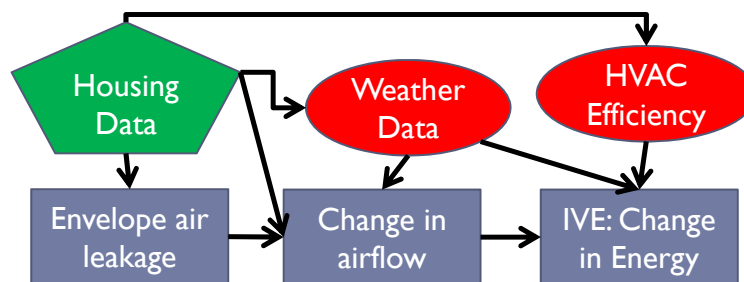


$$\Delta E_{\text{home}} \sim \Delta U_{\Delta \text{air}} / \text{efficiency} + \Delta E_{\text{equipment}}$$

- Logue et al. (2012) Evaluation of an Incremental Ventilation Energy Model for Estimating Impacts of Air Sealing and Mechanical Ventilation. LBNL-5796E.

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Applying IVE to a cohort of 50,000 RECS homes



- ▶ Residential Energy Consumption Survey (2009)
- ▶ Residential Diagnostics Database (Chan et al. 2012)
- ▶ Mechanical and natural ventilation calculations (Walker and Wilson 1998, ASHRAE)
- ▶ Home HVAC conditions (Mills et al. 2005)
- ▶ National Solar Radiation Data Base-TMY3

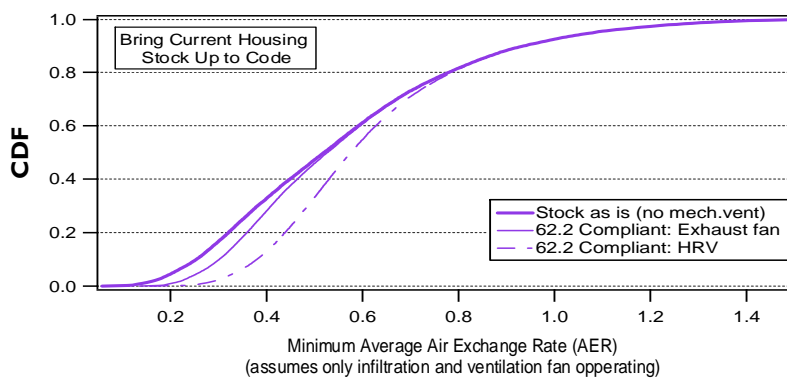
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Building envelope airtightness levels modeled

- ▶ **Base case: housing stock as-is**
 - ▶ Provide ventilation meeting ASHRAE 62.2
 - ▶ **Average tightening (average improvement)**
 - ▶ **Advanced tightening (10% tightest home with similar characteristics)**
- Retrofitting Existing Stock**
- ▶ **IECC 2012 Standard (3 or 5 ACH50)**
 - ▶ **R2000 Standard (1.5 ACH50)**
 - ▶ **Passive House (0.6 ACH50)**
- Energy Saving Potential of Airtightness Standards**

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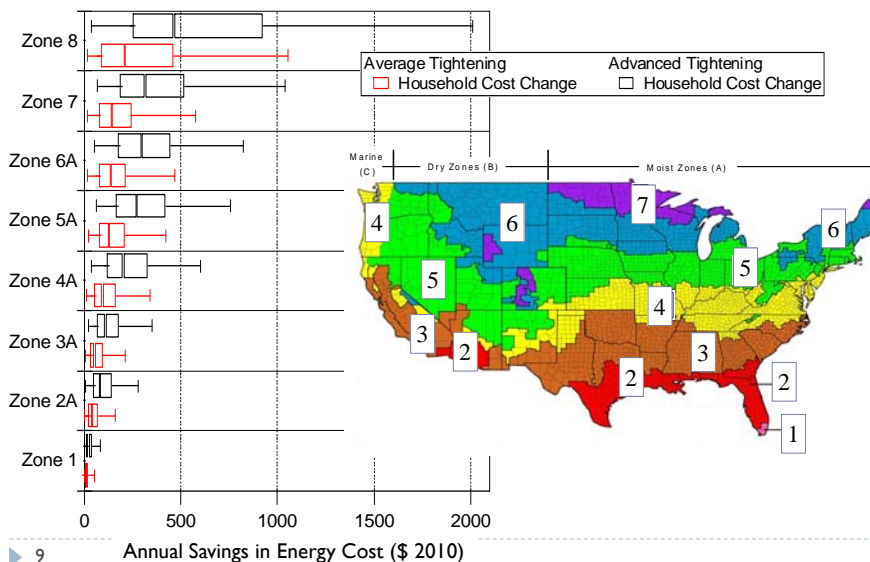
Complying with ASHRAE 62.2 in current housing stock is relatively inexpensive



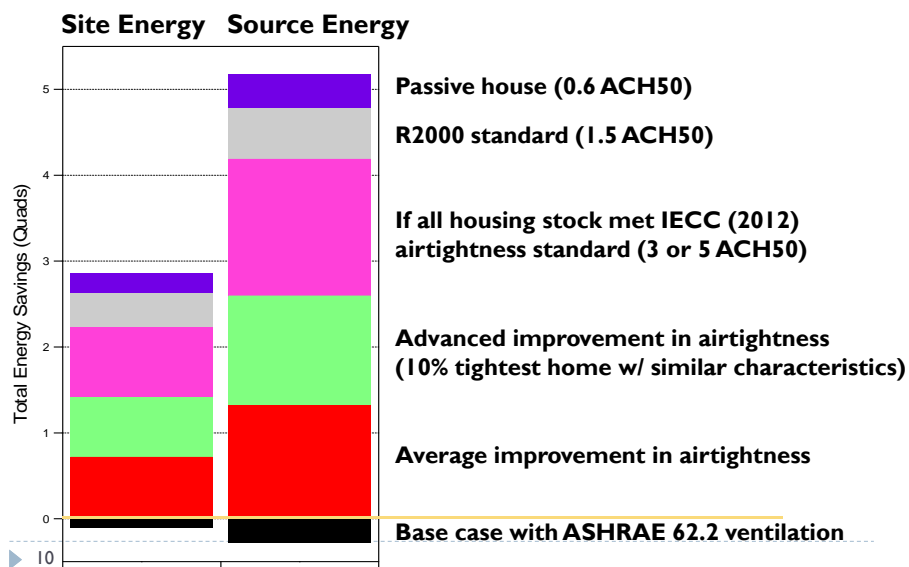
	Site Energy Demand (Quads)	Energy Cost (billion\$ 2010)	Source Energy Demand (Quads)
Baseline: Making Stock Comply with 62.2			
Exhaust	0.07	\$1.60	0.18
HRV	0.1	\$2.60	0.27

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IVE estimated distributions of cost savings by airtightening in different climate zones



Projected annual energy savings



Conclusions

- ▶ Incremental Ventilation Energy (IVE) model to assess the energy savings by envelope tightening of US homes
 - ▶ Providing ventilation to meet ASHRAE 62.2 would increase the annual site energy by 1% (0.1 quads)
 - ▶ Current levels of envelope tightening achieved by weatherization and energy efficiency programs can reduce annual site energy by 0.7 quads
 - ▶ Meeting IECC (2012) would capture most of the energy savings of 2.2 quads (about 40% of heating and cooling energy)

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Thank you

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