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Super-insulation retrofits:

Teaching old houses new tricks

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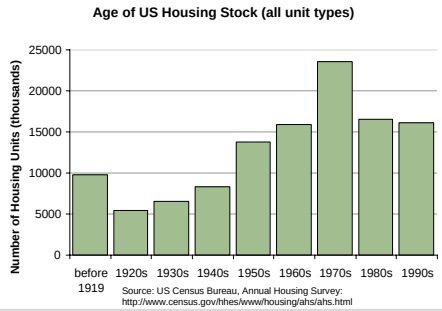
Background

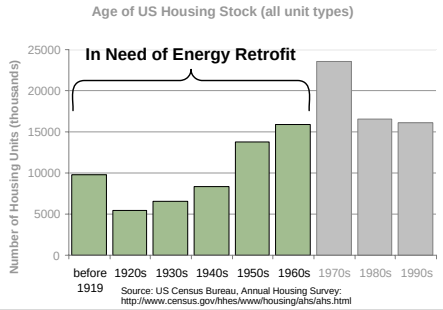
Deep Energy Retrofits

- Beyond weatherization retrofits—e.g., R-40 walls, triple glazing, major airtightness upgrades
- 1980's work: DuMont & Orr ("chainsaw retrofit"); Neal Carter
  - Larsen trusses on exterior; fiberglass insulation; addition of air barrier
  - Rosenbaum NESEA 2009 Keynote

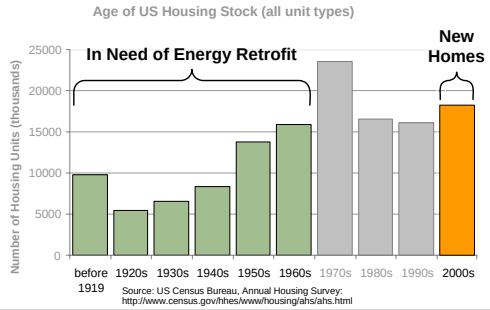
Existing Housing Stock



Existing Housing Stock



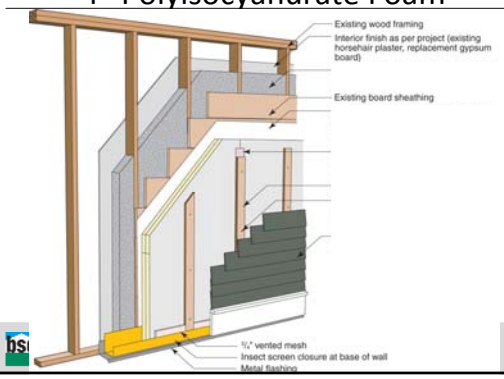
Existing Housing Stock



Deep Energy Retrofits

- Significant upgrades are incrementally less expensive
  - Small upgrades very cost effective, but small (10-25%) reductions
  - mid-range upgrades (15-50%) usually really expensive per energy saved
- Deep retrofits (>50%) secure buildings future
  - Allow for new styles, use, etc.
  - Leap frog current housing

4" Polyisocyanurate Foam



4" Polyisocyanurate Foam

4" Polyisocyanurate Foam

Retrofits and Water Intrusion

- Generally improves wall durability
  - Rebuilt drainage plane; redundant layers
  - Ventilated drainage gap (3/4" cavity)
  - Reduced risk of interstitial condensation
- Reduced vapor permeability due to foam
  - Reduced drying to exterior of bulk water events
  - Reduced airflow → reduced drying?
- Hygrothermal simulations of "survivable" leak in pre- & post-retrofit walls
  - Limited applicability—"bounding exercise"

Water Control: Pan Flashings

- Deep energy retrofits (addition of insulation at existing wall) can make the wall more vulnerable to water leakage
- Previously "survivable" leaks may no longer be able to dry out.

What We've Learned

Retrofitting Exterior Air Barriers



Concord, MA "Four Square"	Arlington, MA "Duplex"	Bedford, MA "Farmhouse"
3.1 ACH 50	5.0 ACH 50	6.2 ACH 50
Mechanical penetrations, porch attachments, replacement sash windows	Basement compartmentalized? (1000 CFM 50 vs. 2129 CFM 50 total)	No secondary air barrier (housewrap w. connections); mediocre roof-wall connections

Retrofitting Exterior Air Barriers



St. Agatha, ON	Utica, NY (NYSERDA)	Belmont, MA
~1 ACH 50	2.3 ACH 50	0.9 ACH 50
Spray foam on exterior; all windows well air sealed; casement/ awning typical	Rigid air barrier layer under foam/over board sheathing; spray foam roof-wall & bsmt rim joist (non-"chainsaw")	Rigid foam as air barrier, "chainsaw" retrofit of roof overhangs/eaves, meticulous air barrier, blower door tests in progress

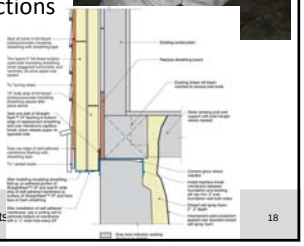
Utica (NYSERDA) Air Barrier


Exterior Spray Foam (St. Agatha)



Retrofitting Exterior Air Barriers

- Roof-wall connections
- Wall-foundation connections
- Wall-window connections
- Windows (actual units)— installation flaws?

•Provides for both heating & cooling; 11,000 BTU heating load
•Installed costs in the 1,818 square foot "Farmhouse" was $6,850
•Two 9,000 BTU heads upstairs, One 12,000 BTU head downstairs
•Electric heater back up, no heat production below zero degrees outside

Mitsubishi SEZ Ducted Indoor units

•Provides for both heating and cooling, 17,000 BTU peak heating load
•Installed costs in the 4 BR 2,612 square foot "Carlisle" model was $7,600
•One 15,000 BTU heads upstairs, One 18,000 BTU head downstairs
•20,000 BTU gas fireplace as back up heating system

Resources

- BSC Website
  - Concord House Case Study (Building Science Digest 139) http://www.buildingscience.com/documents/digests/bsd-139-deep-energy-retrofit-of-a-sears-roebuck-house-a-home-for-the-next-100-years
  - Rubble Foundations (Building Science Insight 041) http://www.buildingscience.com/documents/insights/bsi-041-rubble-foundations?topic=doctypes/insights
  - Details for Deep Energy Retrofit Expert Session, Boston, MA - March 12, 2010 http://www.buildingscienceconsulting.com/services/service.aspx?ServiceID=45
  - Designs That Work Case Studies (Several retrofit case studies) http://www.buildingscience.com/doctypes/designs-that-work/dtw-case-studies
- Marc Rosenbaum NESEA 2009 Keynote PPT: Deep Energy Retrofits: Less (energy) is More (better)
  - http://www.energysmiths.com/resources/keynote/BE%202009%20Keynote-s.pdf