Beyond Fossil Fuel Buildings
Why Bother?

- Most of the buildings that we will be using in 2050 already exist
- These buildings can be much better for their occupants
- Mitigate climate change
- So, what are the strategies with an existing house?
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Cocoon
Super-insulated Addition

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Fuel Switch

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Tear Down and Build New
Extended Family

Inspired by Marc Rosenbaum, Energysmiths

Coldham&Hartman Architects

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Deep Energy Retrofit, aka Fix It

“You can always count on Americans to do the right thing - after they’ve tried everything else.”

Winston Churchill

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Fossil Fuels in MV Buildings

- Space heating, water heating, pool heating
- Appliances - cooking and dryers
- 1/3 fuel oil; 2/3 propane
- Boilers heat water, furnaces heat air
- Water heaters can be direct-fired or heated by a boiler

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Decarbonization Strategies

- Upgrade the thermal enclosure and reduce losses
  - Weatherization
  - Deep Energy Retrofit
- Upgrade mechanical systems
  - More efficient, right-sized, sealed combustion
  - Insulate pipes and ducts; seal ducts
  - Better controls
- Switch to electric heat pumps
  - Space heating and cooling
  - Water heating
  - Pool heating
- Generate renewable electricity

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Weatherization

- Air leakage reduction
  - Basement, crawl space, attic, kneewalls
  - Blower door and infrared scanner
Weatherization

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Deep Energy Retrofits – A Definition

A Deep Energy Retrofit (DER) means taking an existing building to a condition equivalent to a modern superinsulated building, in terms of its enclosure and systems.

Photos courtesy Tad Everhart

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Why Do A DER?

• The building has significant *deficiencies* that must be addressed - these may include structural defects; finishes either interior or exterior at the end of their service lives; comfort issues; mechanical systems at the end of their service lives; infestations of insects and/or rodents; other health hazards including asbestos, mold, radon; water leaks in foundation spaces; ice dams and consequent damage. Other related drivers may be poor spatial layout or other architectural shortcomings that the Owner wants to remedy.

• The buildings available on the market in the desired location don’t meet the Owner’s requirements for comfort, health and safety, durability, and energy performance, so the options are either build new or substantially renovate an existing building...
DER Benefits

• The outcome of a DER is a building that is healthy and safe, comfortable, durable and low maintenance, and resource efficient
• The greatly improved energy performance is often an appreciated byproduct of solutions to the other issues, and the cost-effectiveness of the energy improvements is boosted by the fact that much of the associated work would have been performed in any case
Benefits of Deep Energy Retrofits

Adapted from: Moving Existing Homes Toward Carbon Neutrality
ACI July 2007 Summit White Paper

- Reduces GHG emissions
- Energy cost savings
- Increases long term affordability
- Increases passive survivability
- Maintains embodied energy
- Improves durability, IAQ, comfort, health and safety
- Increases the impact of investment in renewables
- Builds local economies
- Creates good jobs that cannot be out-sourced
- Stimulates product development
- Builds energy independence for US/Canada


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What Makes a Good DER Candidate?

- A building in a good location
- A building the owner is committed to staying in for the foreseeable future
- A building of relatively simple form
What Makes a Good DER Candidate?

• A building whose exterior claddings, and often windows, need replacement
What Makes a Good DER Candidate?

• A building whose interior finishes need replacement, especially if floor plan changes are desired
What Makes a Good DER Candidate?

• A building that has major deficiencies that the owner is committed to address anyway
DER Principles

• Envelope and load reduction first
• Don’t spend the money on costly mechanicals
• It’s OK to phase these improvements within a master plan
• The energy improvements become a marginal additional cost when siding, windows, roofs are replaced
• Solar can be planned for and arrive later
• Reducing electrical loads is crucial – occupant choices predominate
• Exterior retrofit is almost always easier to achieve significant reductions, and often can be done while the building is occupied
Extreme Makeover – Plainfield, NH School

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Deep Energy Retrofit (DER) Wall Section

3” Polyiso beneath 3-1/2” Nudura EPS panels with integral 1x nailers

3” PerformGuard

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Enclosure Retrofit Sequence

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Martha’s Vineyard Cottage

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Union Mill, West Peterborough, NH

• This 25,000 sf mill was built in 1824. It has been rehabilitated into 10 housing units and several thousand sf of commercial space.
• Windows were replaced and the walls and roof were fully insulated with soy-based foam products.
Before

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Heat and Hot Water

- Silo stores wood pellets (produced locally) for heating and DHW
- Heat and DHW are produced by two residential pellet boilers
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Air Source Heat Pumps

- Japanese inverter-driven, variable speed, air-to-air heat pumps
- They provide heating and cooling
- Rated outdoor air temperatures as low as -18°F
- Best choice for a low energy building – no combustion, and compatible with zero net energy performance
- CO₂ emissions 50% of propane, 40% of fuel oil
- Lower operating cost (~2/3 propane)
- A high % of installations in the Northeast are single zone wall cassette systems, supplemental to existing fossil fuel equipment, and properly operated can displace as much as 80% of the fossil fuel usage
Cold Climate Heat Pumps

• No electric back-up heat needed

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Multiple indoor unit types –
Wall cassette
Floor cassette
Recessed ceiling cassette
Ducted
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Heat Pump Water Heaters

• HPWHs pull air from the space they are in, and extract heat which is deposited to the water in the storage tank
• Electric resistance back-up elements are included for periods of high demand, as the heat pump recovery rate is slow
• HPWHs usually move 300-400 CFM, need to be in a space large enough to extract heat without excessive cooling off (100 sf minimum spec is common)
• Dehumidification is a welcome byproduct
Heat Pump Water Heaters

• There are models that can be ducted a short distance
• During the heating season, they pull heat from the space which must be made up by the heating system
• HPWHs are available in 50 to 80 gallon capacity, larger is better for family sized applications
• Cost per gallon of hot water is ~ 50% of propane
Heat Pump Water Heaters

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OTHER AVAILABLE PROGRAMS:

New Construction/Renovations & Additions
Incentives to build, renovate, or add an addition, using higher than the average efficiency standards for home building in Massachusetts. Call 1-800-628-8413 to learn more.

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$400 rebate* for oil or Propane Indirect Water Heater
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