

Beyond Fossil Fuel Buildings



Marc Rosenbaum, P.E., CPHC

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?



Farmhouse



Coldham&Hartman Architects

www.coldhamandhartman.com 155 Pine Street Amherst, MA 01002 t. 413.549.3618 f. 413.549.6602

Inspired by Marc Rosenbaum, Energysmiths

Cocoon

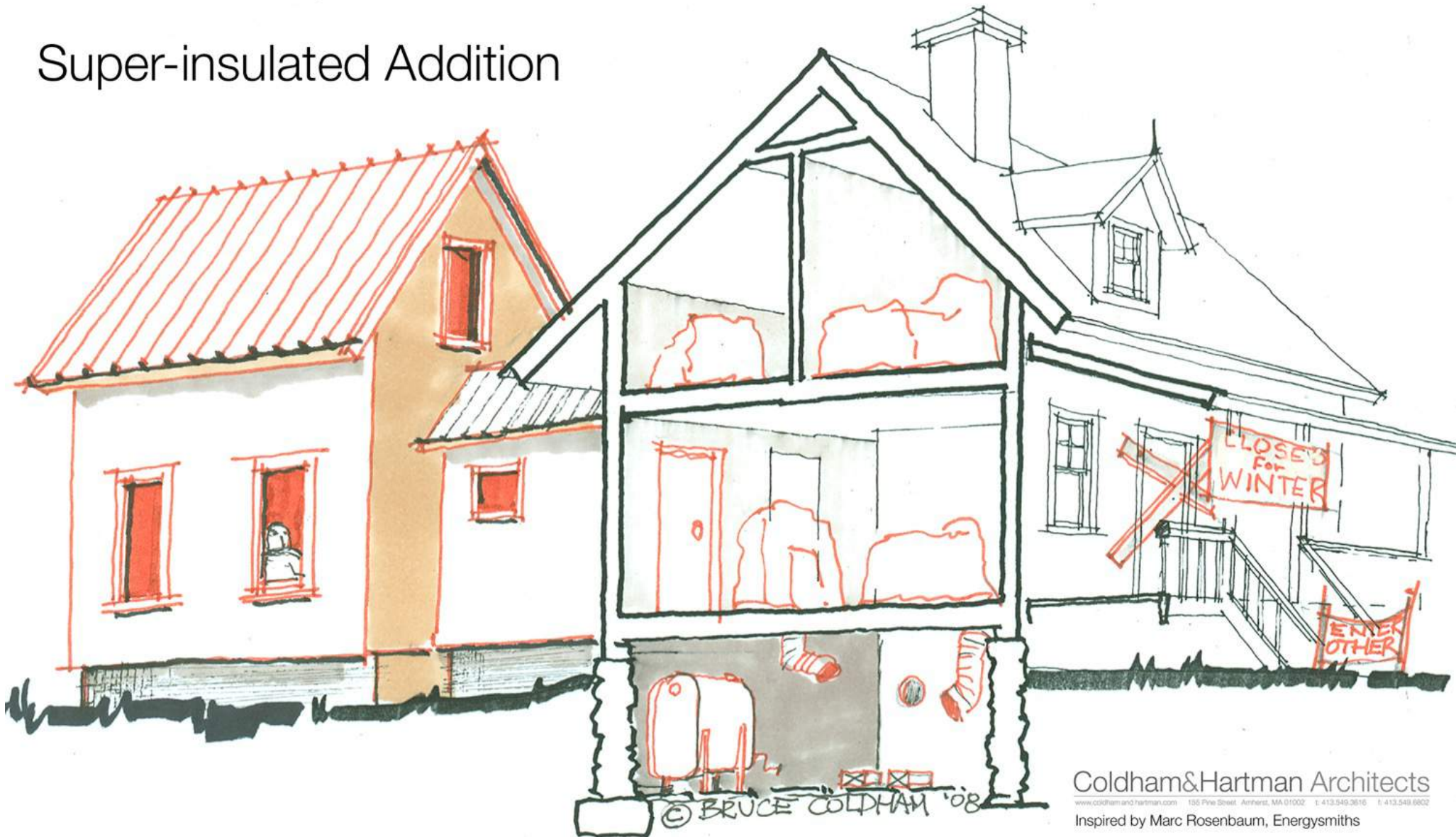


Coldham&Hartman Architects

www.coldhamandhartman.com 155 Pine Street Amherst, MA 01002 T: 413.540.3610 F: 413.540.6902

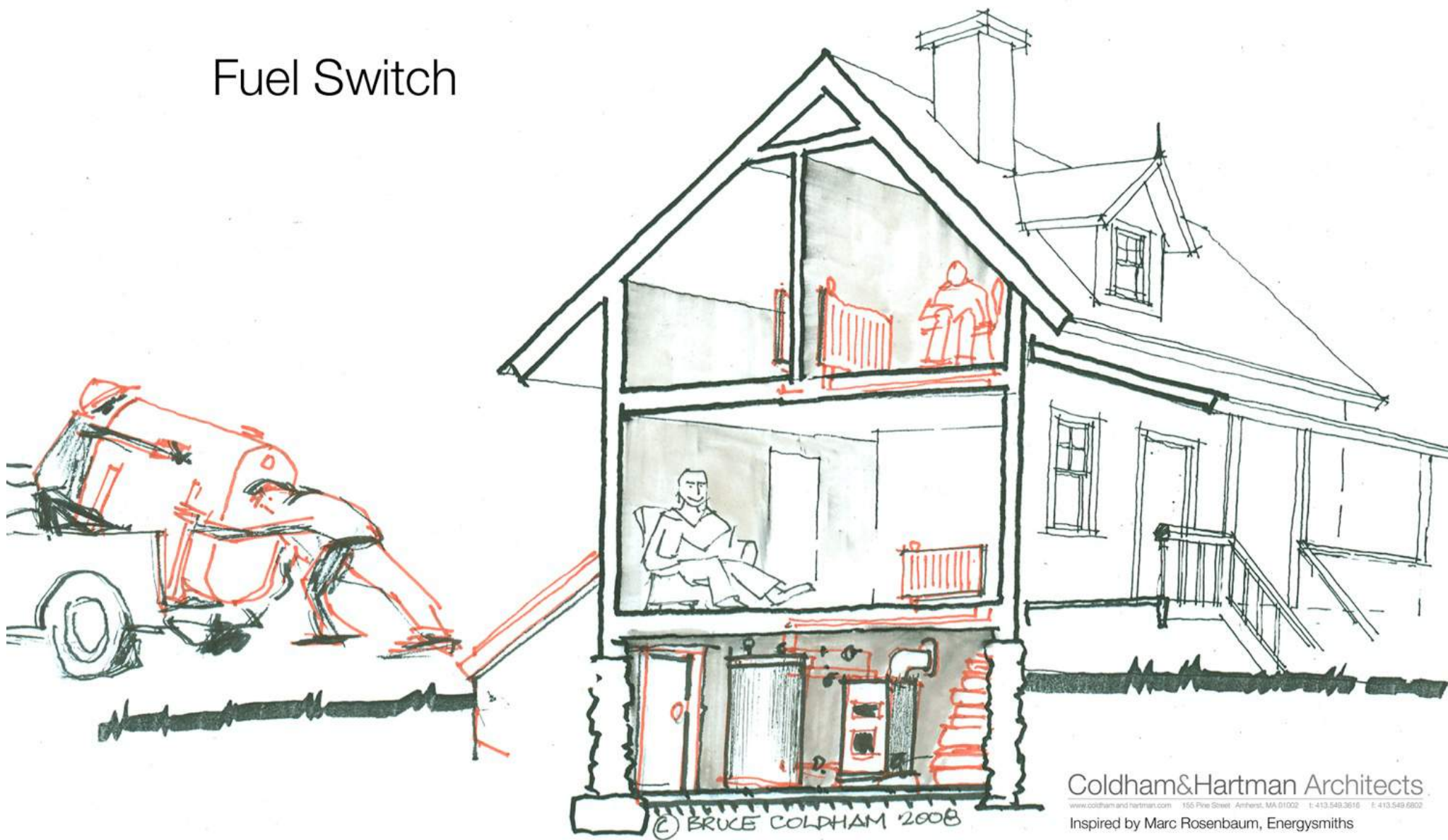
Inspired by Marc Rosenbaum, Energysmiths

Super-insulated Addition



Coldham&Hartman Architects
www.coldhamandhartman.com 155 Pine Street, Amherst, MA 01002 t: 413.549.3616 f: 413.549.6802
Inspired by Marc Rosenbaum, Energysmiths

Fuel Switch



Coldham&Hartman Architects
www.coldhamandhartman.com 155 Pine Street, Amherst, MA 01002 t: 413.549.3616 f: 413.549.6802
Inspired by Marc Rosenbaum, Energysmiths

Tear Down and Build New



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

Coldham&Hartman Architects
www.coldhamandhartman.com 156 Pine Street, Amherst, MA 01002 t: 413.549.3616 f: 413.549.6802
Inspired by Marc Rosenbaum, Energysmiths

Extended Family

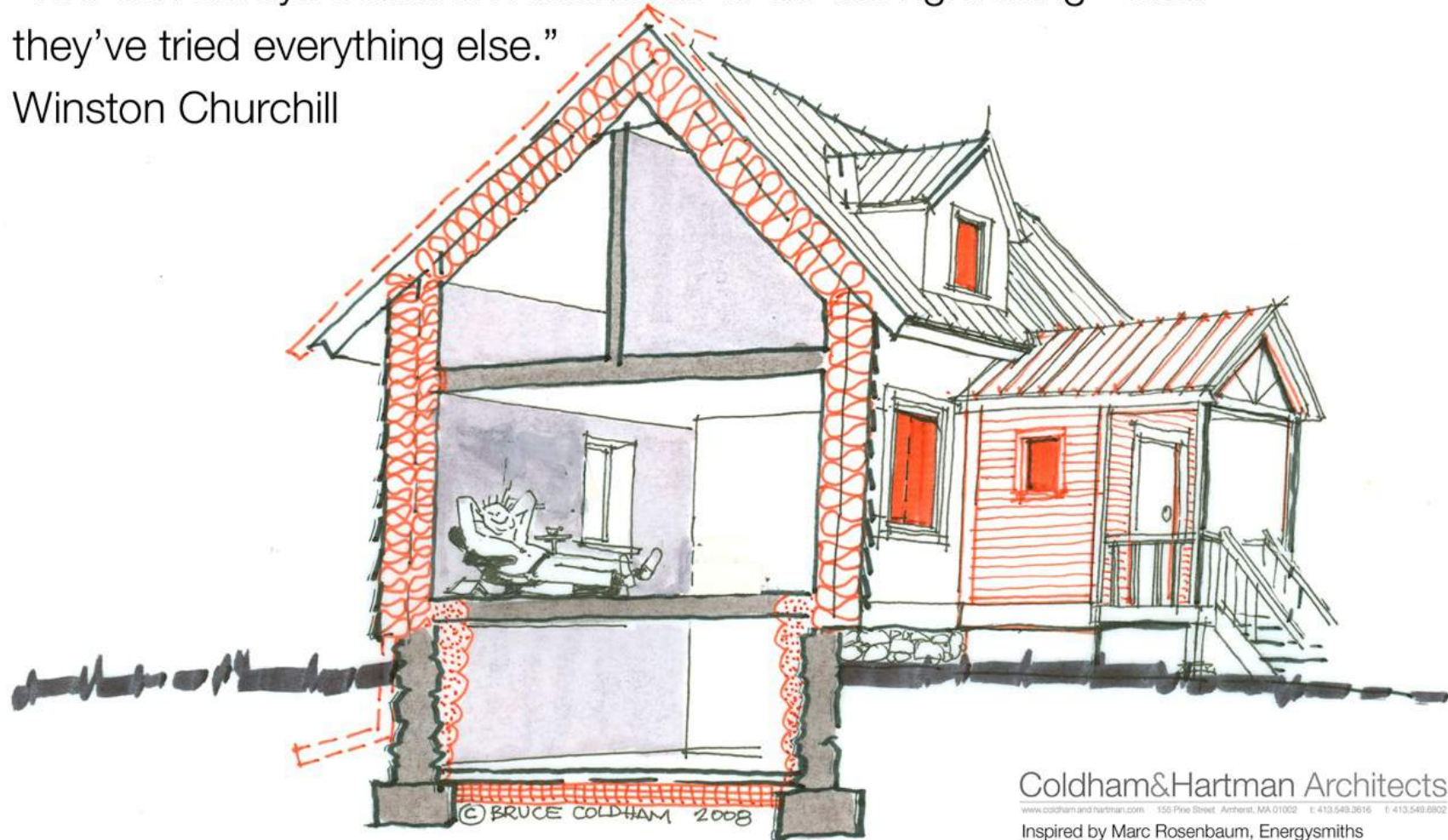


Inspired by Marc Rosenbaum, Energysmiths
Coldham&Hartman Architects
www.coldhamandhartman.com 155 Pine Street Amherst, MA 01002 t: 413.549.3616 f: 413.549.6802

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



Coldham&Hartman Architects

www.coldhamandhartman.com 150 Pine Street Amherst, MA 01002 T: 413.549.3616 F: 413.549.6902

Inspired by Marc Rosenbaum, Energysmiths

Fossil Fuels in MV Buildings

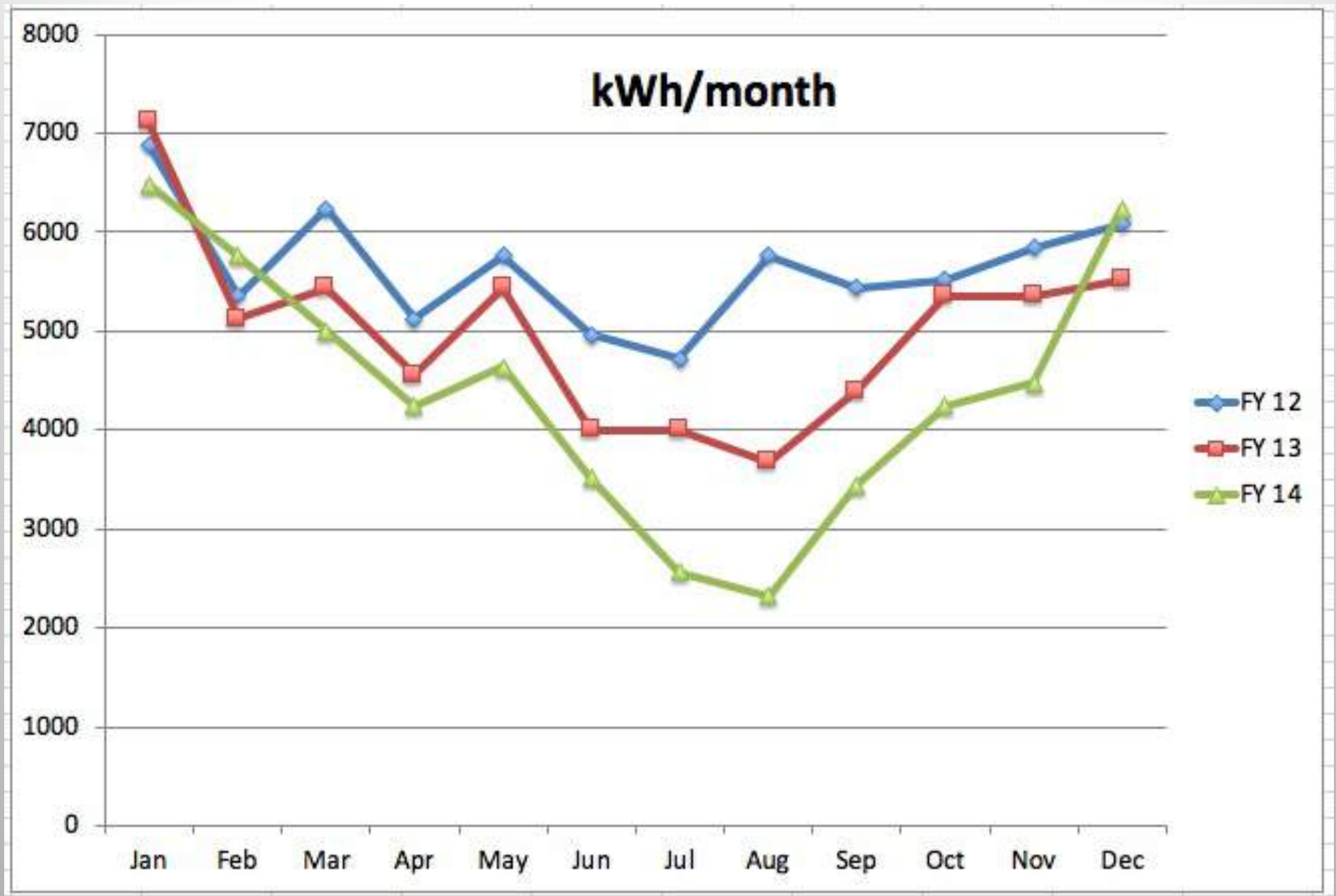
- Space heating, water heating, pool heating
- Appliances - cooking and dryers
- 1/3 fuel oil; 2/3 propane
- Boilers heat water, furnaces heat air
- Water heaters can be direct-fired or heated by a boiler



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

Turn It Off

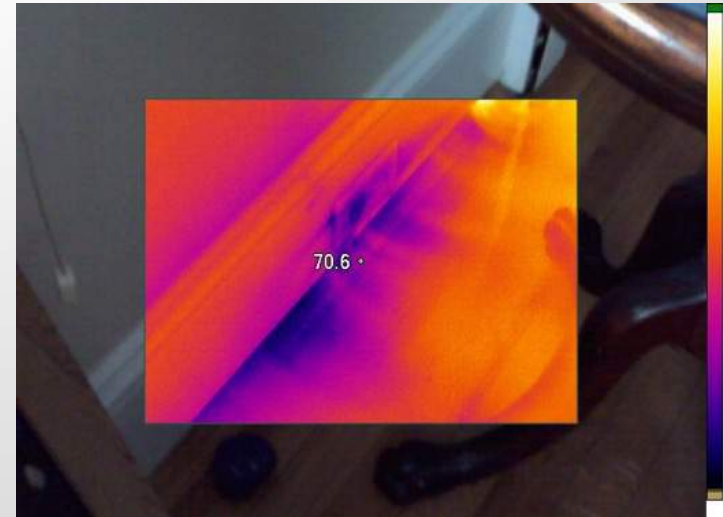


Weatherization

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



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.



Weatherization



Weatherization



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

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

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

http://www.thousandhomechallenge.com/sites/default/files/user-files/aci_white_paper_october1_025616.pdf

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

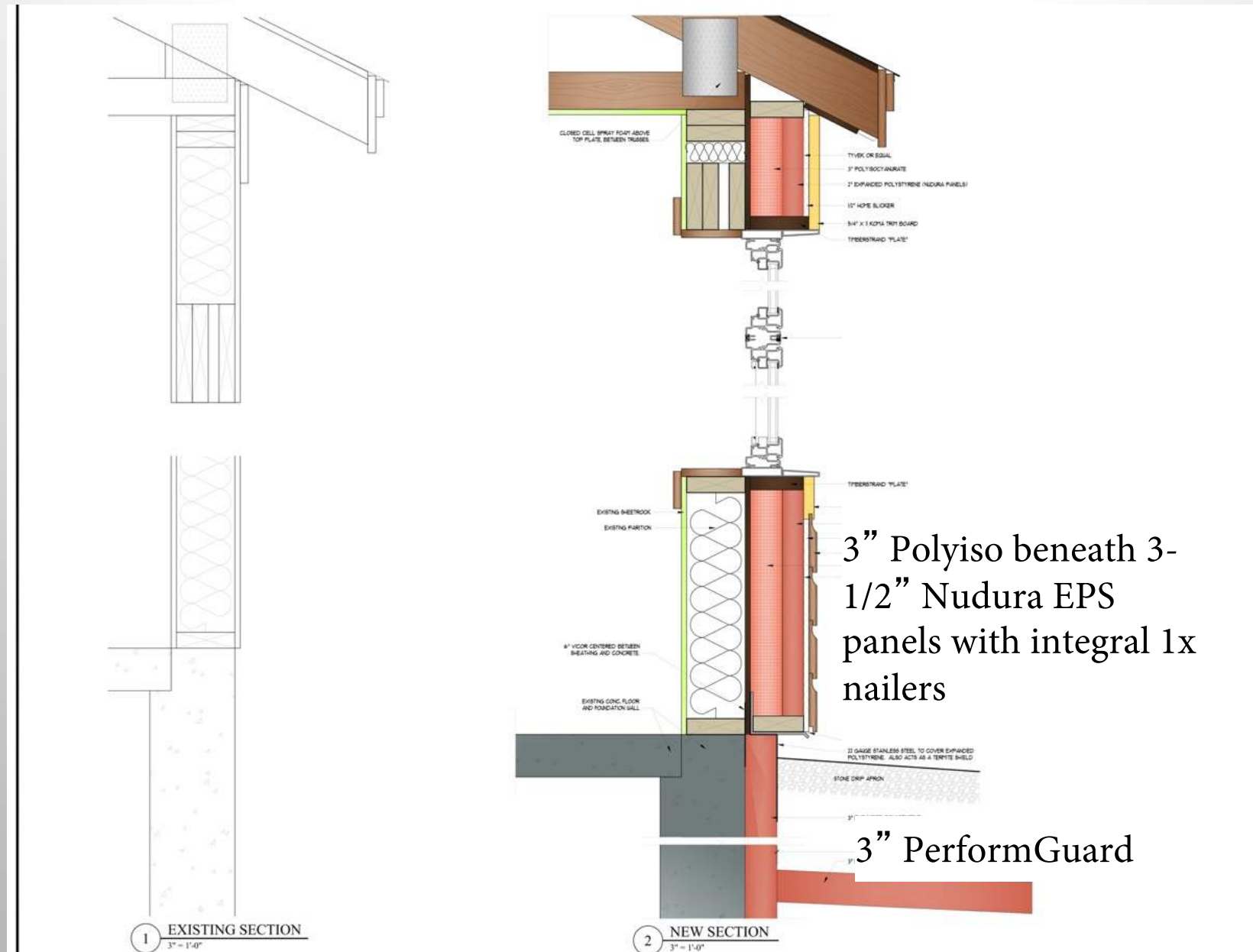
- Envelope and load reduction first
- Don't spend the money on costly mechanicals
- It's OK to phase these improvements within a master plan
- The energy improvements become a marginal additional cost when siding, windows, roofs are replaced
- Solar can be planned for and arrive later
- Reducing electrical 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



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

Deep Energy Retrofit (DER) Wall Section



Enclosure Retrofit Sequence



Enclosure Retrofit Sequence



Enclosure Retrofit Sequence



Enclosure Retrofit Sequence



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

Enclosure Retrofit Sequence



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

Enclosure Retrofit Sequence



Enclosure Retrofit Sequence



Enclosure Retrofit Sequence



Martha's Vineyard Cottage



Martha's Vineyard Cottage



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

Union Mill, West Peterborough, NH



Luc Monzies and friends

- 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



Interior Framing



Heat and Hot Water



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

Commercial Space



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

Residential Space



Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

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 -18F
- 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

Multiple indoor unit types –

- Wall cassette
- Floor cassette
- Recessed ceiling cassette
- Ducted



Indoor Units



MSZ-FH09, 12, 15NA

New sleek design offers many new features including new multi-functional wireless remote controller.

- Triple-action filtration including anti-allergen enzyme filter.
- Double-vane air delivery for enhanced circulation.
- i-see Sensor™ 3D senses human heat signatures.



MFZ-KA09, 12, 18NA

Floor-mounted indoor units are perfect for difficult areas that may be smaller or don't have usable wall space.

- Top and bottom discharge vanes.
- Wireless remote control with smart set feature.
- Front panel filter access for ease of cleaning.



SLZ-KA09, 12, 15NA

Ceiling-recessed indoor units offer a wide airflow pattern for better air distribution in a less obtrusive style.

- Ventilation air knockouts available.
- Offers a 2, 3, or 4 way airflow pattern.
- Built-in condensate lift mechanism (up to 20").



MSZ-GE09, 12, 15, 18, 24NA

Slim, wall-mounted units provide individual room control in a variety of applications.

- Offers wide angle of airflow, 150 degrees from left to right.
- Quiet operation as low as 19 dB(A).
- Provides cooling and heating in a wide range of capacities.



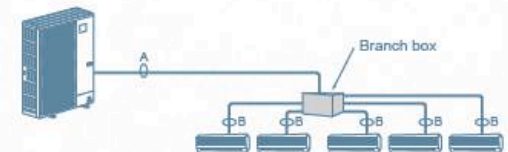
SEZ-KD09, 12, 15, 18NA

Horizontal-ducted indoor units provide comfort and efficiency while staying hidden in ceiling or beneath the floor.

- Build-in condensate lift mechanism (up to 22").
- Static capability up to 0.20" WG.
- Optional filter box with MERV-8 filters.

BRANCH BOX CONNECTIONS

When Using One Branch Box
Flare Connection - Max. 5 indoor units





Beyond Fossil Fuel Buildings - Marc Rosenbaum, P.E.

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



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.

Income Eligible Households

Enhanced incentives for customers on Fuel Assistance, the Discount Rate, or those households with income at or below 60% of median income. Call 1-800-797-6699 for more information

Commercial & Industrial

Cape and Vineyard businesses can receive a no-cost Business Energy Assessment as well as a variety of rebates and incentives. For more information call 1-800-797-6699.

CONTACT INFO

Cape Light Compact JPE
261 Whites Path, Unit 4
South Yarmouth, MA 02664

1-800-797-6699

www.capelightcompact.org



2020 RESIDENTIAL REBATES

Step towards savings!



Aquinnah . Barnstable . Bourne . Brewster
Chatham . Chilmark . Dennis . Eastham
Edgartown . Falmouth . Harwich . Mashpee
Oak Bluffs . Orleans . Provincetown
Sandwich . Tisbury . Truro . Wellfleet
West Tisbury . Yarmouth . Dukes County

Oil and Propane Heating

Up to \$2,300 rebate* for oil & propane heating systems.

Oil and Propane Hot Water

\$400 rebate* for oil or Propane Indirect Water Heater

\$800 rebate* for Propane On-Demand Tankless Water Heater

\$400 rebate* for oil Indirect Water Heater

*Natural gas equipment related rebates are available at
<https://www.masssave.com/en/saving/residential-rebates/gas-heating-equipment>

Electric HVAC & Hot Water

\$1250/ton on Mini-Split or Central Heat Pump, Displacing Oil, Propane, and Electric Resistance

\$500/zone up to \$1500 on Integrated Controls for Mini-Split Heat Pump, Displacing Oil or Propane

\$50/ton for Central AC

\$350/ton for Central Heat Pump not displacing oil or propane

Up to \$600 on Heat Pump Water Heaters for qualified electric hot water replacements.

ENERGY STAR® Appliances

\$40 rebate on Room Air Cleaners

\$30 rebate on Dehumidifiers

\$50 rebate on Elec. Clothes Dryers

\$100 rebate on Smart Thermostats

Fridge and Freezer Recycling

Up to \$75 rebate* for recycling your working fridge or freezer. Call 1-877-889-4761 or visit the link below to schedule your pickup

Get instant rebates on LED bulbs, Smart Thermostats, Advanced Power Strips, and much more at
www.masssave.com/store

www.capelightcompact.org/ResRebates

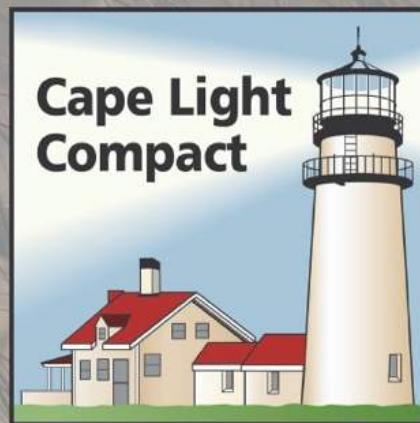
Home Energy Assessment

During an Assessment, our Home Performance Contractors offer:

- Free replacement of inefficient light bulbs
- Free air sealing
- Early clothes washer rebate
- Up to 100%* of the cost to install recommended insulation for eligible homes.

Please call (800) 797-6699 to schedule your free home energy assessment today!

*For income qualified customers.



Mass Save® HEAT Loan

The HEAT Loan Program provides loans up to **\$25,000 with 0% interest and terms up to 7 years** for approved measures.**

To view eligibility requirements, please visit
www.capelightcompact.org/heat.

**Subject to lender approval

Solar PV, Hot Water, and Battery Storage

Looking to learn more about Solar? Head to:
www.capelightcompact.org/solar