

Cape Cod Regional Housing Strategy Retrofit Guidelines



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COMMISSION

utile



ACKNOWLEDGEMENTS

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INTRODUCTION

These guidelines include energy efficiency and electrification recommendations for existing residential buildings in Barnstable County. The measures align with the decarbonization goals of the Cape Cod Climate Action Plan and the Commonwealth's Next Generation Roadmap for Climate Policy, which sets a goal of carbon neutral emissions by 2050.

Building envelope upgrades, often referred to as “weatherization”, reduce the demand for heating and cooling by minimizing energy loss through components such as walls, windows, and roofs. Systems electrification recommendations involve replacing fossil-fuel combustion equipment with high-efficiency electric equipment such as heat pumps. These upgrades provide multiple benefits beyond greenhouse gas emissions reductions, including improving thermal comfort and air quality.

The document also identifies possible financial incentives through state, utility, and federal programs to offset the upfront costs associated with efficiency improvements. Case studies of hypothetical retrofits to existing multifamily typologies on Cape Cod are presented to illustrate possible combinations of applicable improvements and financial incentives.

The reuse of existing structures plays a critical role in meeting larger carbon reduction goals. By keeping the foundation and other elements of the structure in place, a great deal of upfront carbon emissions associated with the production and transportation of building materials are avoided. Additionally, retrofitting historic structures can also meet both housing and cultural resource goals, particularly when existing affordable housing is being preserved or repaired.

OPERATIONAL COSTS AND CARBON EMISSIONS

The retrofit upgrades shown in these guidelines are ways to reduce greenhouse gas emissions, especially for home heating. Specifically, switching to heat pumps can significantly reduce a household's emissions.

Upgrades may also represent an operational cost savings, depending on the fuel being replaced and level of envelope efficiency of the home. A recent study by the MA Department of Energy Resources (DOER) estimated that the average household cost to produce heat using air source heat pumps was about 25% less than heating oil or propane and 66% less than electric resistance. A similar study on heat pumps in Massachusetts by the Conservation Law Foundation found that the estimated annual operating cost for air source heat pumps (heating and cooling) were on par with a gas-fired furnace plus air conditioning (learn more [here](#)).

RELATIONSHIP TO ENERGY CODE

Massachusetts adopted the new Stretch Energy Code on January 1, 2023. The updated code includes increased energy efficiency requirements for new residential buildings and retrofits to existing buildings located within Stretch Code communities. For renovations, there are different requirements depending on the scope of work, including major alteration projects, additions, and retrofit projects where individual aspects of the building envelope or systems are being replaced or upgraded. Many of the recommendations in these guidelines align with the intent of the energy code, but homeowners should consult a qualified professional early in the retrofit planning process to fully understand what specific code requirements apply to their project.

In addition to the Stretch Energy Code, municipalities can vote to adopt more stringent, net-zero ready standards through the Opt-in Specialized Code. These additional requirements, however, only apply to new construction, and do not affect existing buildings undergoing renovations.

A recent study by the Massachusetts Clean Energy Center (MassCEC) showed that an average household can reduce its greenhouse gas emissions associated with heating by over a half when switching from fossil-fuel combustion equipment to air or ground source heat pumps. Learn more [here](#).

A recent study by the MA Department of Energy Resources (DOER) estimated that the average household cost to produce heat using air source heat pumps was about 25% less than heating oil or propane and 66% less than electric resistance. Learn more [here](#).

For definitions of certain technical terms, please refer to the Cape Cod Regional Housing Strategy Design Guidelines Visual Glossary.

GUIDELINES

RECOMMENDATIONS

ENERGY AUDIT

Before starting a retrofit, home owners should conduct an Energy Audit to assess current energy performance and identify cost-effective retrofit measures to make the building more energy efficient and comfortable. Utility supported incentive programs such as Mass Save offer no-cost home energy assessments that also provide information on rebates and other financial incentives for upgrades.

BUILDING ENVELOPE EFFICIENCY

AIR SEALING

- Air seal rim joists and adjacent areas
- For vented attics: Seal all ceiling penetrations (lights, hatches, vent stacks etc)
- Provide weather stripping at doors and windows, or replace windows/doors that are beyond service life (see specific guidelines below for buildings that are designated for historic preservation)
- Use sealing gaskets at electrical outlet covers
- If re-siding (older buildings without historic significance): install new air and weather-resistive barrier with rainscreen gap

INSULATION

- For unfinished basement and crawl spaces, insulate rim joist areas (and basement walls if feasible, with spray foam insulation)
- Wood frame walls
 - Install blown insulation (e.g., cellulose) in stud cavities, typically from the outside
 - If re-siding (older buildings without historic significance), consider exterior continuous rigid insulation, such as mineral wool board

- Masonry or historic buildings: insulation changes the drying dynamic of the masonry, so a specialist should be consulted. Also, the presence of any active knob and tube wiring should be determined and mitigated before conducting any insulation project.
- Attic or roof insulation
 - Buildings with unfinished and unheated (vented) attics should install insulation between the joists, such as blown-in or loose-fill insulation
 - Depending on the level of retrofitting, older, non-historic buildings with finished attics could install rigid insulation on top of sheathing (especially if re-roofing); other options include insulation on the underside of sheathing (such as spray foam) if the rafters will be exposed during the work
 - With flat roofs where roof replacement is part of the project, add rigid insulation on top of deck

WINDOWS + DOORS

- For windows in older buildings that are not designated as historic: if windows are at the end of their useful life (e.g., thermal comfort and condensation issues, broken seals, etc.), new, energy efficient windows with low-e coated glazing could be installed
- For windows in historic buildings: install storm windows on exterior or interior
- Doors in historic buildings and/or those that are in good condition can be weatherstripped and/or provided with storm doors
- For doors beyond their useful life, they can be replaced with high performance, insulated doors such as fiberglass

BUILDING SYSTEMS ELECTRIFICATION

HEATING, COOLING, AND VENTILATION

- Replace fossil-fuel based heating systems with cold-climate air source heat pumps, or ground source heat pumps
- Electric resistance baseboard heating is also a candidate for replacement with heat pumps, due to the inefficient use of electricity of baseboards. Heat pumps can also provide cooling.
- For renovation projects that allow for access to interior framing and ceilings, install a balanced energy recovery ventilation system

WATER HEATING

- Replace fossil-fuel based water heating systems with heat pump water heaters, which can be located in basements or in mechanical closets with adequate venting/ducting and acoustic isolation, or solar water heaters

APPLIANCES AND OTHER EQUIPMENT

- Replace gas cooking with induction
- Replace gas clothes dryer with electric heat-pump dryer
- Provide capability for electric vehicle (EV) charging station(s)
- Because older homes may have inadequate electrical service for the new loads described above, consult with a licensed electrician about the need for an electrical service upgrade

RENEWABLE ENERGY

- For buildings with favorable roof exposures (unshaded roof oriented between 110 degrees and 270 degrees of true north or low-slope roofs), install a solar photovoltaic system
- For sites with limited roof access, consider ground mounted solar arrays or solar carports
- Consider a battery storage system if the building experiences frequent power outages

WATER EFFICIENCY

- Encourage low-flow plumbing fixtures with the WaterSense label, including bathroom sink faucets and accessories, showerheads, toilets, and weather-based irrigation controllers
- Find and fix leaks, including dripping or trickling faucets, showerheads, and toilets
- For landscaped areas, plan and design green areas for efficient watering (e.g., plantings that are suited to sunny/hot vs. cool/shaded zones)
- Use low-water plants, and consider installing rain barrels for rainwater harvesting and conserving potable water for irrigation

INCENTIVES

Several incentives and rebates are available to homeowners and multifamily residential building owners engaging in energy efficiency and decarbonization retrofits through state, local, and federal programs. More information can be found on the Massachusetts Department of Energy Resources (DOER) [website](#).

MASS SAVE INCENTIVES

Mass Save is a statewide energy efficiency program provider. Rebates and incentives for homeowners and multifamily programs include:

- Air source heat pump rebates
- Ground source heat pump rebates
- Efficient electric appliance rebates
- Heat pump water heater rebates
- Induction cooking rebates
- Weatherization rebates
- Mass Save HEAT Loan
- Multifamily program
- Air Source Variable Refrigerant Flow Heat Pump rebate

STATE TAX INCENTIVES

Residents in Massachusetts can claim a solar energy tax credit against personal income tax.

- 830 CMR 62.6.1: Residential Energy Credit: 15% of the system cost, up to \$1,000

MA DOER INCENTIVES

The Solar Massachusetts Renewable Target (SMART) program is an incentive to support the development of solar PV installations. It is only open to utility customers of National Grid, Eversource, and Unitil. Additional incentives can be obtained through this program for battery storage and affordable housing. Additionally, DOER offers financial incentives called Alternative Energy Certificates (AEC's) for air and ground source heat pumps and other clean energy technologies. More information can be found on the DOER [website](#).

FEDERAL TAX CREDITS

Through the Inflation Reduction Act of 2022, Federal income tax credits have been expanded and are available to home and building owners making energy efficiency and clean energy upgrades through 2032. These incentives range from tax credits for electrical service and heating system upgrades, to clean energy tax credits and incentives for weatherization. More information is available on the Department of Energy's [website](#).

Disclaimer: The incentive values shown in the case studies beginning on page 10 are estimates based on illustrative examples and available incentives at the time of the development of this document.

ADDITIONAL RESOURCES

WEATHERIZATION AND CLEAN ENERGY

- <https://goclean.masscec.com/clean-energy-solutions/>

AIR SOURCE HEAT PUMPS

- https://neep.org/sites/default/files/resources/ASHP_buyingguide_5.pdf

WATER EFFICIENCY

- <https://www.mwra.com/comsupport/conservation/hometips.htm>
- <https://www.epa.gov/watersense/watersense-homes-save-water-and-energy-infographic>
- https://19january2017snapshot.epa.gov/www3/watersense/our_water/why_water_efficiency.html

HISTORIC BUILDINGS

- <https://www.nps.gov/orgs/1739/upload/preservation-brief-03-energy-efficiency.pdf>
- <https://archive.epa.gov/region5/sustainable/web/pdf/energy-advice-for-owners-of-older-homes.pdf>
- <https://www.historicithaca.org/toolkit>

INCENTIVES

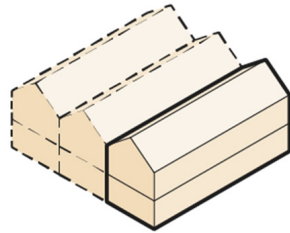
- <https://goclean.masscec.com/benefits-savings/>
- <https://www.rewiringamerica.org/app/ira-calculator>

DEEP ENERGY RETROFIT STANDARDS

- Passive House REVIVE standard <https://www.phius.org/standards/retrofit/phius-core-revive>
- PHI EnerPhit standard

CASE STUDIES

TOWNHOUSE



This case study illustrates a two-and-a-half story attached townhouse renovation that has all individual systems and a ~30 year old enclosure. The heating, water heating, and stove run on electric resistance. While no on-site fossil-fuel combustion is present, the inefficiency of the electric resistance heating and appliances and older building envelope make this a good candidate for upgrades.

EXISTING CONDITIONS

- Envelope: fiberglass batt insulation in walls and attic floor, 1990s vinyl windows
- Heating system: electric baseboard
- Water heating: electric tank water heater in basement
- Appliances: electric resistance range

UPGRADES

ENVELOPE

- Roof: Retrofit loose fill cellulose insulation at the attic floor, with air sealing at the ceiling plane
- Wall insulation is kept intact in order to minimize construction disturbance
- Windows: New energy-efficient fiberglass windows, weather stripping at doors
- Foundation: air sealing and insulation at rim joists with closed-cell spray foam insulation

SYSTEMS

- Mini-split heat pumps
- Heat pump water heater in basement
- Induction range
- Renewable energy: 4kW solar PV system installed on roof

INCENTIVES

MASS SAVE

- Mass Save Whole-home Air Source Heat Pump rebate: \$10,000
- Heat pump water heater: \$750
- Weatherization: 75% of the cost of the roof insulation (assume \$3,500): \$2,625

STATE TAX CREDITS

- Solar PV: \$1,000

FEDERAL INFLATION REDUCTION ACT TAX CREDITS

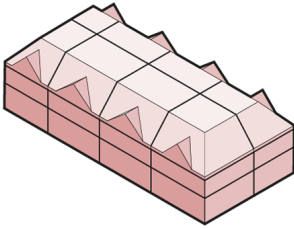
25C Residential Energy Efficiency Tax Credit

- Heat pumps and heat pump water heater: 30% of cost up to \$2,000
- Weatherization: \$1,200

25D Residential Clean Energy Tax Credit

- 30% of the cost of the solar PV system (assume \$14,000 installation): \$4,200

LARGE/MEDIUM MULTIFAMILY (12+ UNITS)



This case study illustrates a larger multifamily corridor building comprising rental apartments for a senior housing population. The building has centralized water heating but individual heating and cooling systems, and a membrane roof at the end of its service life.

EXISTING CONDITIONS

- Envelope: slab on grade; fiberglass batt insulation in walls, aging low slope roof
- Heating/cooling System: packaged terminal air conditioners (PTAC)
- Water heating: central gas fired boiler
- Appliances: electric resistance ranges

UPGRADES

ENVELOPE

- Foundation: air sealing at slab/wall
- Roof: new membrane roofing with polyiso insulation

SYSTEMS

- Mini-split heat pumps
- Heat pump water heater in basement
- Induction ranges
- Renewable energy: 4kW solar PV system installed on roof

INCENTIVES

MASS SAVE

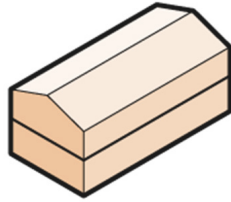
- Air Source Variable Refrigerant Flow Heat Pump Rebate - \$3,500 per ton (assumes 20 ton installation): \$70,000

FEDERAL INFLATION REDUCTION ACT TAX CREDITS

Section 48 Investment Tax Credit

- 30% of the cost of the solar PV system (assumes \$60,000 installation): \$18,000

STACKED DUPLEX (2 UNITS)



SINGLE FAMILY HOUSE CONVERTED INTO TWO UNITS, AND MAINTAINING ITS HISTORIC CHARACTER

This case study illustrates a single family house converted into two units, and assumes the building owner lives in one unit and rents out the other one. The exterior of the house maintains its historic character. Storm sashes are added over the existing windows, which can significantly improve energy efficiency while preserving historic windows (this is often a more cost-effective financial investment relative to window replacement).

These guidelines could also apply to an existing single family structure in which the owner may have plans to rearrange the interior to convert it to two units. Additional considerations for a future conversion would include meeting building and fire code requirements such as egress, separate utility meters such as electrical and ensuring service capacity, and other considerations.

EXISTING CONDITIONS

- Envelope: uninsulated walls and roof
- Heating System: oil-fired furnace in basement
- Water heating: indirect tank water heater in basement
- Appliances: electric resistance range

UPGRADES

ENVELOPE

- Walls: blown cellulose in stud cavities, after confirming no active knob and tube wiring present
- Roofs: retrofit insulation along the plane of the roof, requiring removal of the ceiling finish:
 - Ventilation baffles installed against the underside of existing roof sheathing, with eave and ridge vents
 - Blown cellulose insulation placed in rafter cavities
- Windows: storm windows
- Foundation: air sealing and insulation at rim joists with closed-cell spray foam insulation

SYSTEMS

- Mini-split heat pumps
- Heat pump water heaters in basement
- Induction ranges
- Renewable energy: 4.5kW solar PV system installed on roof, connected to owner's meter
- Electric vehicle charger

INCENTIVES

MASS SAVE

- Mass Save Whole-home Air Source Heat Pump rebate: \$10,000
- Heat pump water heater: \$750
- Weatherization: 75% of the cost of the wall and roof insulation (assume \$10,000): \$7,500

STATE TAX CREDITS

- Solar PV: \$1,000

FEDERAL INFLATION REDUCTION ACT TAX CREDITS

25C Residential Energy Efficiency Tax Credit

- Heat pumps and heat pump water heater: \$2,000
- Weatherization: \$1,200

25D Residential Clean Energy Tax Credit

- 30% of the cost of the solar PV system (assume \$15,000 installation): \$4,500