

Strive toward net zero energy buildings: Municipal buildings

REDUCE ENERGY USE IN MUNICIPAL BUILDINGS BY ADOPTING EFFICIENCY MEASURES

Description and purpose of strategy: Municipalities have a direct incentive to reduce energy use, with financial and technical resources exclusively available to municipalities that pledge to cut municipal energy use by an ambitious but achievable goal of 20% over five years and meet additional criteria established in the Green Communities Act. By leveraging exclusive resources and grants, Green Communities can help finance net zero energy projects in new and existing municipal buildings.

Content of fact sheet: An overview of the Massachusetts Green Community designation, as well as the economic and equity implications, best practices, and the state of practice of achieving net zero energy in new and existing municipal buildings.

Implementation support: This fact sheet expands upon strategies and actions from the Climate Actions Database, which can be found at: capecodcommission.org/climate.

BENEFITS

- Greenhouse gas (GHG) emissions reductions or sequestration
- Health improvement from reduced pollutants
- Increased recreation
- Lower maintenance/operational costs
- Environmental enhancement/protection
- Less damage to infrastructure
- Higher property value
- Increased resilience
- Job and economic growth

COSTS

- Higher capital costs
- Higher maintenance costs
- Higher operational costs
- Additional time for municipal staff to implement

KEY FINDINGS



Equity: There are opportunities to reduce GHG emissions and pollution through net zero energy buildings, but ensuring municipalities can finance net zero energy emission projects in low-income communities is imperative.



Financial benefits: Available grant funding for net zero energy is multiple orders of magnitude less than what would be required to achieve net zero energy across all municipal buildings. To bridge the financing gap, municipalities should consider energy savings performance contracts (ESPCs).



Non-market benefits: Improvements in health from reduced pollutants are major benefits of Green Communities projects.



GHG reductions: Green Communities striving for net zero energy in new and existing municipal buildings have the potential to reduce a large portion of municipal energy use.



Ease of implementation: Preliminary implementation actions include creating an inventory of existing municipal buildings, designating an employee to coordinate municipal energy efficiency efforts, and conducting energy emission audits.

BENEFIT COST ANALYSIS

Municipal buildings often account for most municipal energy use. For example, in the cities of Somerville and Falmouth, municipal buildings make up 72% and 65% of all municipal energy use, respectively. Strategies to reduce energy use in these buildings include electrifying heating, ventilation, and air conditioning (HVAC) systems, achieving Leadership in Energy and Environmental Design (LEED) certification, and transitioning to or building net zero energy municipal buildings. In 2022, the Town of Acton commissioned a study by an engineering firm to estimate the costs of electrifying their existing municipal buildings. To assess the potential costs and benefits of electrifying existing buildings, selected Town of Acton estimates are presented below, in lieu of estimates specific to Barnstable County, due to similarities regarding the ages and types of buildings in Acton and Barnstable.

Net zero energy: For the purposes of this fact sheet, we define net zero energy as a building that “balances its energy needs with energy produced from renewable, zero-emission sources” (USGSA, nd). This definition is from the U.S. General Services Administration, which identifies two characteristics that distinguish net zero energy from previous energy efficiency approaches: (1) the baseline and target are “zero,” and (2) energy use must be supplied from renewable energy.

ELECTRIFYING SELECTED ACTON MUNICIPAL BUILDINGS: AVERAGE ATTRIBUTES, COST, AND GHG REDUCTIONS

BUILDING	AREA FT ²	ENERGY USE REDUCTION %	CONVERSION COST \$	GHG REDUCTION %	CONVERSION COST \$ PER FT ²
Acton Town Hall	24,144	70%	\$845,040	65%	\$35
Acton Memorial Library	48,259	68%	\$1,689,065	63%	\$35
Acton Public Safety Facility	26,033	64%	\$911,155	64%	\$35
Average	32,812	67%	\$1,148,420	64%	\$35

Building conversion costs presented in the above table include:

- Removing mechanical equipment served by high-temperature hot water and replacing it with equipment sized to meet building heating loads at the low-temperature hot water design temperature.
- Replacing central equipment, including air handling units and rooftop units.
- Replacing terminal equipment, including finned tube radiators, reheat coils, and fan coil units.

Building conversion costs are based on the age of each building and HVAC system, the type of HVAC system, building use, and historical status. All municipal buildings evaluated were estimated to have “high” conversion costs, which is \$35/ft², due to their age and heating systems. Medium- and low-cost scenarios were \$22/ft² and \$10/ft², respectively. Though these projects are a net cost after upgrading the system and factoring in yearly energy costs, they provide benefits in the form of GHG reductions and reduced criteria pollutants. Costs per megatonne (MT) CO₂e reduced and non-market benefits specific to the Town of Acton can be found in the table below ([Town of Acton, 2022](#)).

BENEFITS AND COSTS OF ELECTRIFICATION

BUILDING	NET COST PER MT CO ₂ REDUCED	ANNUAL HEALTH BENEFIT	ANNUAL SOCIAL COST OF CARBON BENEFITS
	\$ PER METRIC TON CO ₂	\$	\$
Acton Town Hall	\$851	\$673–\$1,516	\$4,265–\$12,979
Acton Memorial Library	\$504	\$1,495–\$3,369	\$9,867–\$30,025
Acton Public Safety Facility	\$378	\$1,162–\$2,619	\$7,512–\$22,858
Average	\$578	\$1,110–\$2,501	\$7,214–\$21,954

Creating an inventory of building energy use can support an effective cost-benefit analysis of electrifying municipal buildings. Adding solar arrays to municipal buildings can also reduce emissions and should be investigated. To estimate conversion costs for electrifying municipal buildings, a cost of \$35 per square foot can be multiplied by the area of a municipal building (though a medium- or low-cost scenario could change the cost per square foot, as described below).

In addition to electrification of municipal buildings, net zero energy buildings could help further reduce municipal energy use. Multiple studies have shown constructing net zero energy buildings is similar in cost to constructing “conventional” buildings. A California study found that net zero energy buildings incur a 0–7% new construction cost premium, and a Vermont study found similarly that net zero energy commercial buildings incur a 7% new construction cost premium. According to a Massachusetts study that reviewed net zero emissions K–12 school buildings, projects break even after 15 years and have a total cost savings of \$20 per square foot over 30 years relative to a conventional building baseline ([USGBC MA, 2019](#)). Due to the important connection between educational buildings and equity within communities, costs related to educational buildings are of particular importance.

Switching to a local green energy provider is another important opportunity for municipalities to consider. For example, Cape Light Compact Local Green offers an option to match electricity use with 100% Massachusetts RPS Class I renewable energy certificates (RECs) for approximately \$0.2540 per kWh ([Cape Light Compact, 2023](#)). For comparison, Eversource offers its Basic Service (22% from MA RPS Class I RECs) at rates ranging from \$0.26176 - \$0.3996 per kWh ([MA Power Choice, 2023](#)). For a benefit cost analysis of switching to 100% renewable energy sources, please see the fact sheet titled “Generate and increase the use of clean electricity”, which covers the total benefit cost per kWh.

EQUITY

Green Communities have the potential to result in a variety of outcomes that would strengthen equity and reduce burdens on vulnerable populations. Potential benefits include:

- **Enhanced economic opportunity.** Green Communities policies may lead to increased job opportunities related to new construction projects and renovations on existing buildings. For equity benefits to accrue, municipalities would need to ensure community members have access to these jobs and possess requisite skills, which might require targeted incentives, training, and other accessibility measures. Municipalities could also prioritize hiring local, women- or minority-owned contractors.
- **Improved air quality.** Green Communities policies could lead to a reduction in GHG emissions and pollution. Ensuring that potential energy efficiency options are available to low-income communities could result in air quality benefits for these populations.

Optimizing Equity During Implementation

Despite the benefits mentioned above, there can still be equity-related impacts for low-income communities and renters. Ensuring municipalities can finance net zero energy emission projects in low-income communities is critical, particularly for jurisdictions with a limited tax base. Energy savings performance contracts (ESPCs) should be considered by municipalities as an alternative to using municipal capital to fund these projects. According to the U.S. Department of Energy's Office of State and Community Energy Programs, ESPCs offer a well-established, budget-neutral approach to financing energy efficiency projects. By entering an ESPC with an energy service company, municipalities can finance energy efficiency projects with future energy savings, all while leaving their capital budget untouched. More broadly, municipalities seeking to optimize equity will need to balance municipal building actions with other energy-efficiency strategies that provide more direct equity benefits.

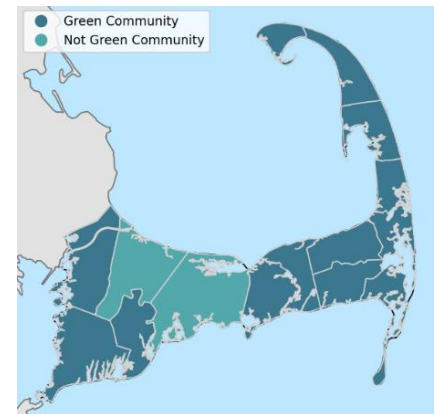
STATE OF PRACTICE

General State of Practice

The Green Communities Division of the Massachusetts Department of Energy Resources (DOER) was created by the Green Communities Act of 2008. By 2012, 100 communities had received the Green Community designation. As of December 2022, 290 communities were designated as Green Communities. Given that Massachusetts has a total of 312 cities and towns, this program has grown rapidly.

Cape Cod Context

To date, all Cape Cod municipalities except Sandwich and Barnstable are designated Green Communities. Several communities have received Green Communities grants for municipal projects. Notably, projects on Cape Cod funded by these grants have focused on energy conservation measures for existing municipal facilities. Green Communities grants have not yet been used to fund net zero energy construction of new municipal buildings on Cape Cod, which may be due to the relatively modest average award amount. However, municipalities may combine grants to fill the gap.



GREEN COMMUNITIES FUNDING PROGRAM AWARDS

DATE	TOWN	PROJECT	AWARD
Feb 2020	Chatham	Energy conservation measures such as LED lighting in municipal facilities, including the library, Department of Public Works, and town annex.	\$134,040
Feb 2020	Dennis	Energy conservation measures (indirect hot water heaters, weatherization, Wi-Fi thermostats, lighting) in municipal facilities including the golf clubhouse and senior center.	\$160,170
Jan 2022	Harwich	Energy conservation measures, including HVAC upgrade and chiller installation, in municipal facilities including the community center.	\$160,952
Aug 2020	Provincetown	Energy conservation measures, including chiller replacement with fuel conversion, and administrative assistance in municipal facilities including the town hall.	\$138,350

Source: [MA Department of Energy Resources, 2022.](#)

CASE STUDY: CITY OF CAMBRIDGE, MA

Cambridge was designated as a Green Community in 2010 and has emerged as a leader in its efforts to pursue net zero emissions in new and existing municipal buildings. Net zero emissions buildings achieve an “overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere” ([Climate Council, 2020](#)). Cambridge launched its transition to net zero energy in existing municipal buildings with a comprehensive energy audit. Next came retro-commissioning, weatherization, and water treatment plant retrofits. Existing municipal buildings underwent major renovations, with upgrades to lighting and HVAC systems. These measures were made possible by almost \$950,000 in grants awarded by the Division of Green Communities, and generally had a payback period of less than seven years. In six years, these projects decreased the city’s energy consumption by 20%, reducing its annual energy costs by \$1.4 million as of 2016. To ensure ongoing support for energy efficiency projects, Cambridge increased resident parking sticker fees by \$12 in 2010, designating \$150,000 in revenue to these efforts on an annual basis ([MA DOER, 2016](#)). In 2019, Cambridge completed its first net zero emissions project with the construction of the King Open and Cambridge Street Upper Schools. While net zero emissions differ from net zero energy, where building energy needs are balanced with energy produced from renewable, zero-emission sources, the Green Communities Division elevates several best practices employed by the City of Cambridge that can be transferred to net zero energy projects. Best practices include engaging municipal staff at all levels, managing expectations, planning for operations and maintenance, and communicating benefits to the public. For more best practices, explore the case studies on the division’s website ([Green Communities Division, 2016](#)).



IMPLEMENTATION

Below are recommended actions for reducing energy use in municipal buildings:

- **Become a designated Green Community.** Green Communities gain access to exclusive financial and technical resources to support reducing energy use.
- **Inventory municipal buildings.** Create an inventory of existing municipal building energy use to analyze the costs and benefits of electrification.
- **Consider staffing availability.** Designate an employee to coordinate the town’s energy efficiency efforts.
- **Consider ESPCs.** Enter into an ESPC with an energy service company for a budget-neutral approach to financing energy improvements for existing buildings.
- **Conduct energy emission audits.** Use the Department of Energy’s Better Buildings [Emissions Reduction Planning Framework](#) to audit municipal buildings and, where possible, partner with energy service companies to share costs.
- **Select energy reduction measures.** Identify and prioritize measures that lead to emissions reductions.

REQUIRED EXPERTISE

Internal: Energy manager, facilities superintendent, head of maintenance, head custodian

External: Energy manager, energy service company, energy auditor

- **Implement emissions reduction measures.** Track the progress of emissions reductions against municipal goals.
- **Conduct retro-commissioning.** Evaluate and optimize existing base systems no less than every 10 years to ensure proper operation for a cost-effective approach to increasing energy efficiency.

Resources that may assist with implementation of energy reduction measures in municipal buildings are included below.

FINANCIAL AND TECHNICAL SUPPORT	
Green Communities Division	Provides regional coordinators, education, project guidance, technical assistance, and exclusive funding opportunities.
MassEnergyInsight	Free web-based tool that tracks energy use and identifies municipal buildings for assessment.
Cape Light Compact	Supports towns in implementing energy efficiency measures in municipal buildings.
ADDITIONAL INFORMATION	
Efficient Buildings—Identify Efficiency Measures	Guide to identifying opportunities for energy efficiency measures in municipal buildings.
Efficient Buildings—Implement Efficiency Measures	Considerations for implementing energy efficiency measures in municipal buildings, including financing resources.