
City of Cambridge Getting to Net Zero Action Plan

FY 2017 Progress Report

February 2018





City of Cambridge
CLIMATE PROTECTION ACTION COMMITTEE

February 12, 2018

Dear Mr. DePasquale:

The City of Cambridge's Climate Protection Action Committee (CPAC) is tasked with overseeing the City's Net Zero Action Plan (Plan) and reporting on its progress on an annual basis. This letter serves as the second annual progress assessment, which includes themes and recommendations for the Plan and the Cambridge Community Development Department (CDD) which is managing the Plan.

CPAC appreciates the significant achievements that have been made in the second year of the Plan's implementation, including significant interest and enrollment in the custom retrofit multifamily efficiency pilot program, implementation of renewable energy and energy efficiency projects proposed as part of the initial municipal facilities improvement plan, and completion of an energy benchmarking study to better understand current energy use in Cambridge laboratories.

However, the progress of the action items outlined below risk falling behind the Plan's implementation objectives:

1. There are three zoning amendments that should be adopted as part of a comprehensive package: Action 2.3 Increase Green Building Requirements, Action 2.5 Removal of Barriers to Increased Insulation, and Action 3.2 Rooftop-ready solar requirements. CDD Staff have put significant work into shaping a zoning package addressing these topics and language is currently been drafted for consideration. CPAC recommends the City finalize appropriate language and pass the necessary amendments to implement these policy changes.
2. Action 2.2.1, the Market Based Incentive Program, would provide financial incentives for residential, commercial and laboratory buildings to achieve net zero emissions in advance of requirements. The feasibility study for residential buildings is behind schedule and needs to be completed. Although the studies for commercial, manufacturing and laboratory buildings are not scheduled to commence until after the residential pilot is underway, given the delay in the initial residential study, CPAC recommends that the incentive study include all types of buildings as proposed by staff so this item does not fall further behind.

Finally, in the coming year CPAC expects to see continued progress on Action 1.1.2: Additional Building Energy Use Disclosure Ordinance (BEUDO) requirements and custom retrofit program (building off of the multi-family pilot program), and Action 4: Local Carbon Fund, so they can move out of the design/feasibility stage and into implementation.

Very truly yours,

A handwritten signature in black ink, appearing to read 'Melissa Chan', written in a cursive style.

Melissa Chan, Chair

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INTRODUCTION

Background

The City of Cambridge shares increasing global concerns about the crisis of climate change and the many challenges it presents. This crisis threatens the ability of the planet to support secure, healthy, productive, and enriching lives for current and future generations. The City of Cambridge has long been steadfast in addressing climate change. In 2002, the City adopted the Climate Protection Action Plan, our first attempt at proposing emissions reduction targets and recommendations to reduce greenhouse gas (GHG) emissions. Since then, the City has committed to a range of initiatives to support sustainable lifestyles and move the community toward greater resilience to climate change. Recently the City made a commitment through the Metro Mayors Coalition¹ to achieve carbon neutrality by 2050. In Cambridge, buildings are both the problem and the solution for addressing climate change: more than 80% of our greenhouse gas emissions result from building operations and, as a sign of our thriving economy, new building development steadily continues. If the city can get to net zero emissions in the building sector, we will have made major progress towards achieving the U.N.'s goal of carbon neutrality in our cities.

In 2013, in response to community concern that continued construction activity would make the goal of reducing greenhouse gas emissions harder, the City convened the Getting to Net Zero Task Force to foster a deep conversation among stakeholders to advance the goal of setting Cambridge on a trajectory to becoming a “net zero community,” with a focus on carbon emissions from building operations. **For Cambridge, ‘net zero’ refers to a building or a community of buildings for which, on an annual basis, all greenhouse gas emissions resulting from building operations are offset by carbon-free energy production.** Achieving the net zero objective relies on a combination of energy efficiency improvements, renewable energy production and, where necessary, purchase of carbon offsets or, potentially, credits (that meet specific criteria). After fifteen months of intensive discussions, outside expert analysis, and consultation across sectors including the general public, the Task Force delivered a 25-year framework for setting Cambridge on the trajectory to becoming a net zero community.²

Annual Report Purpose and Structure

In accordance with the recommendations of the Net Zero Action Plan (see Action 5.2), the Cambridge Community Development Department (CDD) has committed to conduct ongoing monitoring and reporting of progress towards the Net Zero Action Plan goals. In collaboration with the Climate Protection Action Committee (CPAC) which has agreed to provide oversight of




¹ <http://www.mapc.org/metro-mayors-coalition>

² This language is drawn from the Getting to Net Zero Framework report, which can be found along with additional materials about the Cambridge Net Zero Action Plan at <http://www.cambridgema.gov/CDD/Projects/Climate/NetZeroTaskForce>

the Plan, CDD committed to providing an annual report to CPAC and the public to summarize progress towards each action slated for the previous fiscal year.³ This is the second such report.

Net Zero Action Plan annual reports are intended to provide an overview of each action planned for that year, including the action items, progress made, and next steps to reach the annual goals. The annual report will also provide quantitative outputs as appropriate for each action, for example the number of green buildings permitted during the past year, as well as broader outcomes such as changes in community-wide GHG emissions. The first citywide GHG Community Inventory was completed in early 2017 and serves as a baseline indicator for the Net Zero Action Plan. Because GHG emissions are measured at the community scale in Cambridge, however, attributing changes in GHG emissions to individual Net Zero actions will likely be challenging. Therefore, annual building performance measured by the Building Energy Use Disclosure ordinance and individual action outputs and their alignment with the assumptions of the Net Zero GHG Model⁴ will serve as an indicator of the direction and magnitude of potential GHG reductions that can be attributed to the Plan.

This report is structured to parallel the Net Zero Action Plan, with actions falling into five categories. In addition to detailed information, a summary box such as the one to the right is provided for each action. The green, yellow, or red light indicates the overall status of the action and whether it is on track, making progress but delayed, or behind, respectively. Note that the progress status is based on what was

	Action status (on track, in progress, or behind)
	Action barriers (regulatory, institutional, resources)
	Next steps

accomplished towards the FY17 action items up to the writing of this report in October 2017. The mountain symbol represents key challenges to successful implementation of the action including regulatory, institutional, and resource barriers. The footprints represent next steps for the action.

Following discussion of qualitative progress towards each of the actions is a section summarizing quantitative indicators and their change over time.

³ For the full Plan schedule, see Appendix 1 ; City of Cambridge fiscal years run from July 1-June 30

⁴ http://www.cambridgema.gov/CDD/Projects/Climate/~/_media/89814C94911A49388ECDBAAEAE7366A6.ashx

FISCAL YEAR 2017 ACTION PROGRESS UPDATES

Fiscal Year 2017 is the second year of Net Zero Action Plan implementation. Actions initiated in FY16 are beginning implementation, while a new set of actions commence study of feasibility and design. FY17 included actions in all five categories: Action 1 – Energy Efficiency in Existing Buildings, Action 2 – Net Zero New Construction, Action 3 – Energy Supply, Action 4 – Local Carbon Fund, and Action 5 – Engagement and Capacity Building.

Action 1 – Energy Efficiency in Existing Buildings




The intent of this action is to ensure that all buildings are operating optimally and, where necessary, are retrofitted to maximize efficiency. In FY17, the Custom Retrofit Program for residential buildings began pilot implementation and study of potential additional Building Energy Use Disclosure Ordinance requirements began.

Action 1.1.1: Custom Retrofit Program

Introduction

Because Cambridge’s housing stock is dominated by multi-family buildings, which make up over 90% of residential units, the City has focused on strengthening utility retrofit programs for multi-family buildings. Beginning in 2013, the Cambridge Energy Alliance partnered with MIT’s Department of Urban Studies and Planning and NSTAR

(now Eversource) to design a pilot program to overcome barriers to achieving energy efficiency in medium size (5-50 unit) multi-family buildings. Key conclusions of the resulting study⁵ to inform the pilot program are to (1) build trust between building occupants/owners and the utilities/energy efficiency providers by adopting a performance-based approach to building upgrades and payments; (2) ease administration of the assessment and retrofit process by assigning each building owner a single owner’s agent to manage all aspects of the process; (3) connect building owners to accessible financing options, including existing state and utility incentives; (4) integrate renewable energy solutions such as solar PV into the energy efficiency retrofit process to streamline the renovation process; and (5) conduct a targeted marketing process to efficiently identify and enroll prospective building owners, with a focus on condominiums and renter-occupied properties with master-metered heating/hot water systems as well as landlord-occupied rental properties to reduce split incentive barriers. Lessons from a multi-family program could be applied to a commercial custom retrofit program in the future.

	Multi-Family Energy Pilot in implementation
	Coordination with utility and vendor to streamline program delivery
	Multi-Family Advisor offering and program tracking/evaluation

FY17 Action Items

Begin implementation of the Multi-Family Pilot program.

⁵ See http://web.mit.edu/energy-efficiency/docs/EESP_Michaels_PathwaysInMultiFamilyHousing.pdf

Progress Towards FY17 Action Items

The Cambridge Multi-Family Energy Pilot kicked off on Earth Day 2017 following continued program coordination with Eversource and their multi-family contractor, CLEAResult. The final pilot program design is meant to provide multi-family buildings with 5-49 units comprehensive energy assessment and retrofit services with a single point of contact. Building owners and tenants can enroll in the program directly with Eversource/CLEAResult or through the Cambridge Energy Alliance.⁶ They are then assigned a Principal Point of Contact who schedules the energy assessment and provides the results along with a comprehensive energy retrofit package. Cambridge contracted with Zapotec Energy to provide a parallel solar assessment and proposal for properties which express interest. Outreach included online media, street signs, Hubway station posters, flyers, and postcards, as well as canvassing through the Cambridge summer high school internship program. **As of October 2017, over 50 properties has expressed in interest in the program and 19 buildings including 950 units have enrolled.** This represents approximately 10% of all of the units in the targeted buildings. The City is continuing to work with Eversource and CLEAResult to streamline the enrollment and communication process with property owners to make sure the process is as user-friendly as possible.

Next Steps

The Cambridge Energy Alliance is in the process of procuring a multi-family energy advisor to supplement the services of the CLEAResult primary point of contact. Because Eversource can only support certain energy retrofits, the goal of the multi-family energy advisor is to help building owners and residents make coordinated decisions about the full range of potential energy retrofits, including energy efficiency, solar PV, and fuel-switching such as replacing oil or gas with air-source heat pumps. Cambridge Energy Alliance will continue to track the results of the Pilot through FY18 and coordinate with Eversource and CLEAResult to address program needs as they come up. MIT may be available to assist with program evaluation and data analysis once more buildings have completed the assessment and retrofit processes and being to see energy savings. The Multi-Family Pilot is scheduled to last through FY18, followed by a period of review before launching a full Multi-Family Program in FY20. Analysis of BEUDO data (see Action 1.1.2 below) could help inform design of a pilot program for large multi-family buildings and commercial buildings before FY20.

⁶ <http://www.cambridgeenergyalliance.org>

Action 1.1.2: Additional BEUDO Requirements

Introduction

The Cambridge Building Energy Use Disclosure Ordinance (BEUDO), enacted in 2014, requires parcels with non-residential buildings totaling 25,000 square feet or greater as well as parcels with residential buildings totaling 50 or more units to annually report and disclose their energy and water use.⁷ BEUDO did not initially include any required actions for buildings to reduce their energy or water use beyond the annual reporting because the Net Zero Action Plan was in development. This action aims to determine potential required actions for BEUDO to target savings among the least efficient buildings. Actions contemplated by NZAP include audits, retro-commissioning, and operations and energy management plans to be completed on a regular basis.



BEUDO Requirement design process underway; Phase 1 data analysis complete



Manage coordination with related actions



Conduct Phase 2 stakeholder-based program design process

FY17 Action Items

Begin a two-year process to design additional BEUDO requirements. Determine which buildings will be impacted by the new requirements, including the Cambridge-specific performance thresholds necessary to achieve the emission reduction goals of the Net Zero Action Plan.

Progress Towards FY17 Action Items

In spring 2017, CDD engaged Meister Consultants Group to conduct a “phase 1” technical analysis of BEUDO data to help determine the basis for potential requirements. The study included research of the structure of requirements in other jurisdictions, analysis of the impact of different performance tiers within the BEUDO dataset, and examination of the impact of requirements for these buildings around energy audits, retro-commissioning, and operations and maintenance planning. It was found that other jurisdictions generally require buildings to take actions such as energy audits or retro-commissioning unless they receive an exemption based on current energy performance or certification; that targeting the lowest 20% of buildings in Cambridge would lead to significant potential energy savings; and that these energy savings lead to significant GHG reductions and retrofits to achieve them are cost-effective, particularly considering available utility incentives.⁸

⁷ 2015 reporting applied to parcels with 50,000 square feet or greater; Disclosure not required in 2015; for more details, see

<http://www.cambridgema.gov/CDD/zoninganddevelopment/sustainablebldgs/buildingenergydisclosureordinance.aspx> ; See also the 2015 BEUDO Summary Report:

http://www.cambridgema.gov/CDD/zoninganddevelopment/sustainablebldgs/~/_media/809369A43E674BA485E6C546E1C11D8.ashx; For the full reported data set for 2016, see the Cambridge Open Data Portal:

<https://data.cambridgema.gov/Planning/2016-Cambridge-Building-Energy-and-Water-Use-Data-/72g6-j7aq>

⁸ See the full report and analysis at: http://cambridgeenergyalliance.org/wp-content/uploads/Memo_MasterCambridgeBEUDOPhase1.pdf

Next Steps

In FY18, CDD will work with a consultant to conduct “phase 2” of the project through a stakeholder-driven process to build consensus around requirements and program structure for BEUDO buildings, establish operations and maintenance plan templates for new and existing buildings, and begin development of a comprehensive retrofit program design and structure to enable all buildings subject to BEUDO reporting to achieve the requirements established for the ordinance as well as voluntary energy and GHG savings. This scope of work combines elements from Action 1.1.2 (Additional BEUDO Requirements), 1.1.1 (Custom Retrofit Program), and 1.1.4 (O&M Plan Requirement) of the NZAP. It makes sense to take a coordinated approach to these actions because they will affect an overlapping set of buildings, can share resources (ie: O&M Plan templates for existing and new buildings), and through parallel implementation can provide building owners with a full set of options to maximize their energy savings in as streamlined and cost-effective a manner possible.

Action 2 – Net Zero New Construction

While newly constructed buildings contribute a small portion of Cambridge’s total GHG emissions, targeting net zero for new buildings is a bold step that will stimulate investments in net zero innovation that can benefit both new and existing buildings. The process and governance framework for new requirements is to ensure that meaningful financial analysis can take place and industry capacity is commensurate with the requirements. It is important to note that the recommended net zero target years will be evaluated at regular intervals and regulatory changes will be proposed at least 24 months prior to final enactment.

Table 1 - Targets for net zero new construction by sector

Type:	Municipal	Residential	Multi-Family	Commercial	Institutional	Labs
Target Year:	2020	2022	2025	2025	2025	2030

The following set of actions are designed to support and incentivize achievement of net zero GHG emissions performance in newly constructed buildings in Cambridge.

Action 2.2.1: Market Based Incentive Program

Introduction

In order to achieve net zero buildings in less than ten years, Cambridge is exploring the use of financial mechanisms to motivate the market and accelerate innovation. MIT and Harvard have agreed to collaborate with the City on this investigation in order to determine the most effective incentives for the

Cambridge context. These could include tools such as green building bonds, “green banks”, and adjusting pricing of permit fees (or rebates) based on performance.



University collaboration to study program approaches in progress



Action behind schedule due to delayed start in FY16



Proceed with research and review of market-based incentive approaches, including commercial and institutional

FY17 Action Items

Pilot a market based incentive approach for new construction and major renovations in the residential sector where there is less complexity and shorter construction cycles. The pilot would later be extended to the commercial and institutional sectors.

Progress Towards FY17 Action Items

Proceeding after the delay to this Action’s commencement in FY16, in FY17 staff coordinated with Harvard and MIT and designed a study approach to achieving the program goals listed above. This study will be conducted by a Harvard or MIT student researcher in FY18. The results of the study will be reviewed by university faculty and inform next steps for potential pilot program design, including the possibility of a “virtual pilot” which could test the impact of a program on paper to current development projects.

Next Steps

The market based incentive study will be commenced in the first half of FY18, followed by additional program design as described above, including a potential pilot program design for the commercial and institutional sectors along with residential. If a market incentive program for these sectors is deemed feasible, pilot implementation in FY19 would follow the original NZAP schedule. The status of this action should therefore be evaluated at the end of FY18.

Action 2.2.2: Height and FAR Bonus

Introduction

To generate early action the City should explore the potential impact of offering additional floor area allowance (FAR) and extra height to projects that achieve net zero emissions.

Projects will need to demonstrate and commit to net zero emissions through their design in order to meet eligibility requirements for additional FAR award. A performance deposit should be

held until 24 months following occupancy. Projects should also have to agree to share lessons on how net zero was achieved in their projects. FAR incentives have proven effective in other dense jurisdictions where building space is at a premium. For example, in Arlington County, Virginia, nearly all new “site plan” (similar to Cambridge Special Permit) projects have voluntarily pursued LEED certification since additional FAR was offered as an incentive beginning in 2008.⁹ The CDD Community Planning Division has also observed, however, that density bonuses are limited in nature and run the risk of being over-utilized by competing program priorities.



Part of current Envision Cambridge action prioritization



Timing of Envision Cambridge process and regulatory limits to use of bonuses



Policy vetting and potential implementation through Envision

FY17 Action Items

Complete consideration of the feasibility of offering height and/or FAR bonuses to new Cambridge buildings which commit to pursuing net zero emissions. This action is to occur as part of the “Envision Cambridge” citywide planning process.¹⁰ Begin program implementation.

Progress Towards FY17 Action Items

The Envision Cambridge planning project began in fall 2015 and as of fall 2017 is beginning to consider detailed policy recommendations such as height and/or FAR bonuses for high performing buildings. This policy has been included in the list produced by the Climate and Environment Working Group.

Next Steps

Continued reliance on the citywide planning process for this policy is beneficial because the impact of any density bonuses can be planned for in context of medium to long-term urban development goals. This helps mitigate the risk of over-use of density bonuses. There is potential overlap in the outcomes of market-based incentives (Action 2.2.1) with the goals of this Action. Therefore, it may be prudent to pursue a coordinated and staged approach to these actions based on their observed impacts. As the citywide plan is fleshed out over the course of FY18, concrete steps to implement potential density bonuses in context of other incentives should come to light.

⁹ <https://environment.arlingtonva.us/energy/green-building/green-building-bonus-density-program/>

¹⁰ <http://envision.cambridgema.gov/>

Action 2.3: Increase Green Building Requirements in Cambridge Zoning Ordinance

Introduction

Article 22 of the Cambridge Zoning Ordinance, *Sustainable Design and Development*, promotes environmentally sustainable and energy-efficient design and development practices in new construction and renovation of buildings in the city.¹¹ Article 22 currently requires that new buildings 25,000-50,000GFA (gross floor area) meet the requirements of the Leadership in Energy and Environmental Design (LEED) Green Building Rating System at the level ‘Certified’ or better, and that new buildings 50,000GFA or greater meet the requirements of LEED ‘Silver’ or better. Increasing the Green Building Requirements in the Cambridge Zoning Ordinance was identified by the Net Zero Task Force as a measure with significant potential impact on future GHG emissions.



Previously delayed requirements are ready for implementation



State building code barriers and development of third-party review process



Bring initial zoning amendment package to City Council and continue study of performance based options

FY17 Action Items

Implement the Cambridge Green Building Requirement that all new construction and major renovation projects over 25,000GFA to meet LEED criteria at the ‘Gold’ level or better. Projects should also achieve a minimum of 6 points under LEED’s Optimize Energy Performance credit and the requirements of the Enhanced Commissioning credit to ensure superior energy efficient design and operation.

Progress Towards FY17 Action Items

Staff have continued work to draft a revised Article 22 to be submitted to City Council as a zoning amendment. It has been determined that the state building stretch energy code which came into effect on January 1, 2017 meets the 6-point improvement targeted by the Net Zero Action Plan. However, some new buildings in Cambridge that are subject to Special Permit requirements are smaller than the thresholds that trigger the amended Stretch Code; these are being strongly encouraged to meet the same energy performance voluntarily through the design review process. In fall 2016, Cambridge adopted the latest version of LEED (Version 4) under the current Article 22 permitting requirements, increasing the stringency of building energy performance. New buildings are also being asked to present a decarbonization pathway plan along with their application, which acknowledges that while the buildings may not achieve net

¹¹ See <http://www.cambridgema.gov/CDD/zoninganddevelopment/Zoning/Ordinance> for the full Zoning Ordinance

zero emissions today, developers should plan for a technically achievable pathway to do so within the life of the building.¹²

In FY17, 11 projects were permitted following Green Building Review.¹³ Nine of the eleven are certifiable at the level of LEED Silver, and two at the level of LEED Gold.¹⁴

Staff are working to improve the efficiency and quality of the Green Building Review process,¹⁵ including mechanisms to given input earlier in the design process and options for cost-effective third-party review of energy models. Staff are also researching options for performance-based building requirements that would not conflict with the state building code. Cambridge is participating in a project with 9 other jurisdictions organized by the Urban Sustainable Directors Network which will devote additional resources to developing performance-based models for cities.

Next Steps

Staff have initiated a planning and stakeholder engagement process in fall 2017 to compose and solicit input on a zoning amendment package including requirements for LEED Gold, enhanced commissioning, and eliminating barriers to increased insulation (Action 2.5, below). The goal is to bring this package to City Council in 2018. Staff will continue to research performance-based alternatives for building energy requirements.

¹² For examples of such pathways for different building types, see the New York “One City Built to Last” technical working group report: *Transforming New York City Buildings for a Low-Carbon Future*; http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/TWGREport_04212016.pdf

¹³ For more information, see the Green Building Dashboard: <https://app.powerbi.com/view?r=eyJrIjoizTk0OWZmYTctZDljNy00N2MxLTg0OWUtYTEyYzZiZWY1YTNkliwidCI6ImMwNmE4YmU3LTg0NzktNGQ3My1iMzUxLTkzYmM5YmE4Mjk1YyIsImMiOjN9>

¹⁴ 9 of 11 based on LEED 2009, 1 on LEED for Homes 2010, and 1 on LEED V4

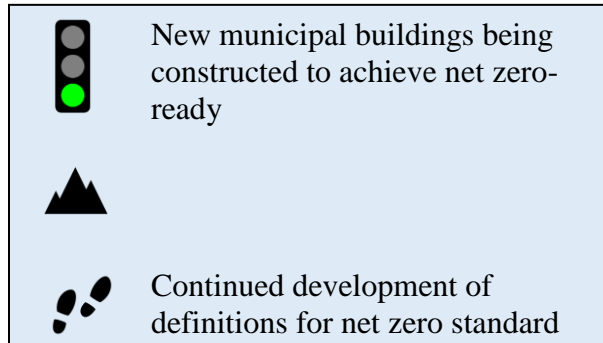
¹⁵ <http://www.cambridgema.gov/CDD/zoninganddevelopment/sustainablebldgs/greenbldgrequirements>

Action 2.4.1: Net Zero Requirement for New Construction of Municipal Buildings

Introduction

To demonstrate leadership it is important that the City establish policies to pursue net zero emissions in municipal buildings. Specifically, new construction should target net zero or be ‘net zero ready’ in the near term. Net zero ready buildings achieve maximum energy savings (e.g. >80% more efficient than code requirement) and are designed to accommodate 100% of annual

energy consumption by on or off-site renewable sources, recognizing that constraints such as site area or location may preclude access to sufficient onsite renewable energy to meet 100% of energy demand.¹⁶ This policy would also be applicable to “gut renovations” where a building is being completely renovated with new electrical, mechanical, interior, and envelope systems.



FY17 Action Items

Implement the established policy that new construction of municipal buildings should target net zero readiness.

Progress Towards FY17 Action Items

The Net Zero Action Plan adopted by City Council in 2015 serves as the policy guiding new municipal building construction. Staff are continuing to define key aspects of “net zero ready” including the potential role of offsets through work on the Local Carbon Fund (Action 4). Current municipal construction projects are pursuing net zero readiness: the King Open School began construction in spring 2017 and will be fossil fuel free, 859 Mass Ave began gut renovations in summer 2017 including installation of a ground-source heat pump, and the Taylor Square Fire House renovation is planned to include a variable refrigerant flow system utilizing ground source heat pumps.

Next Steps

The City will continue to pursue net zero-readiness for its new construction projects until the net zero requirement takes effect in 2020. Continued definition of this requirement needs to be completed at least two years before the standard. These will be presented along with the conclusion of the Local Carbon Fund design in FY18.

¹⁶ As defined on page 16 of the Net Zero Action Plan Summary of Proposed Actions:
<http://www.cambridgema.gov/CDD/Projects/Climate/~media/BF531928BB7D4526AE2D8538E025E0BA.ashx>

Action 2.4.2: Renewal of Municipal Buildings

Introduction

Cambridge also seeks to set an example by showing leadership in the energy efficient renewal of existing municipal buildings. The Task Force recommends introducing greenhouse gas reductions as a key component throughout the municipal facilities improvement strategy and integrating it with other priorities, such as life safety, and accessibility.



Initial planning complete and implementation in process



Resource limits to achieve multiple institutional goals



Continue implementation and tracking of results

FY17 Action Items

Continue design and begin implementation of a phased municipal building improvement strategy where (1) greenhouse gas reduction is a priority when constructing facility improvement projects and (2) operational improvements are implemented to achieve targets established and tracked by the Cambridge Department of Public Works. The strategy will involve continuous self-evaluation requiring increased performance levels as technology and local capacity is improved.

Progress Towards FY17 Action Items

In FY17, the initial Municipal Facilities Improvement Plan (MFIP) was completed to (1) assist the City in developing performance metrics and goals for its building portfolio in key facility disciplines; (2) perform and document a needs and condition assessment of 41 municipal facilities; (3) develop and document a phased Capital Improvement Plan of identified facilities; and (4) develop a GHG emissions reduction plan for municipal facilities. The City has committed \$5 million per year for 5 years to implement the plan recommendations. Implementation of improvements to municipal buildings is in progress: **8 energy efficiency and renewable energy projects were completed in FY17 and another 9 projects are underway. These include the installation of almost 250kW of solar PV, HVAC upgrades and optimization, and LED lighting retrofits, and building envelope improvements resulting in savings of over 220,000kWh, 5,000 therms, and \$53,000 in energy costs to the City.**

Next Steps

A municipal GHG reduction target for 2030 will be set by the end of calendar year 2017. Implementation of MFIP improvements will continue throughout FY18. The nature and impact of these renovations on energy use will be tracked and reported.

Action 2.5: Removal of Barriers to Increased Insulation

Introduction

One strategy to improve building efficiency is to increase the amount of insulation on the exterior of buildings. Because the addition of insulation effectively increases the footprint of a building and may incur into side yard set-back requirements, the Zoning Ordinance can introduce regulatory barriers to this retrofit. Currently, Article 22 of the Zoning Ordinance allows Yard Exceptions for

existing buildings to install exterior insulation as long as it does not increase the thickness of the exterior wall by more than 4 inches or result in the wall being less than 7 feet, 2 inches from the nearest property line.¹⁷ This action calls for development of an approach to remove barriers in the Zoning Ordinance to enable the addition of exterior insulation with the purpose of improving the energy efficiency of residential buildings.



Study of options completed, but behind implementation schedule



Regulatory prioritization of potential zoning changes in context of other needs



Determine implementation pathway in coordination with other zoning requirements

FY17 Action Items

Implement a potential new policy through amendments to the Cambridge Zoning Ordinance to remove barriers to increased exterior insulation during residential building renovations.

Progress Towards FY17 Action Items

Staff have completed a study of the technical options for exterior insulation, the compatibility of potential insulation approaches with the current Cambridge Zoning Ordinance, and the feasibility and impacts of potential revisions to the Zoning Ordinance to allow for additional exterior insulation.¹⁸ The study included consultation with Homeowner's Rehab, Inc. and local green building practitioners and outlines ten scenarios in which exterior insulation might be added to existing buildings. These scenarios are tested against the Zoning Ordinance requirements and building energy standards required by the state building code and high performing building guidelines. GIS analysis examined the setbacks of existing residential buildings in Cambridge. It was found that, while there is a scenario that can allow most building types to meet code under the current Zoning Ordinance limits to wall thickness, many buildings are out of conformance with yard setbacks and therefore additional changes to the Zoning Ordinance would be needed to allow additional exterior insulation.

Next Steps

Staff are pursuing a package of amendments to Article 22 of the Cambridge Zoning Ordinance (see Action 2.3) to be brought to City Council in early 2018 that could include changes to Yard Exceptions for Added Exterior Insulation to allow for additional exterior insulation.

¹⁷ Article 22.43.2: Yard Exceptions for Added Exterior Insulation

¹⁸ **Link to study will be provided once finalized**

Action 3 – Energy Supply

While maximizing building efficiency is the first priority of the Net Zero Action Plan and will lead to the most GHG savings, to achieve net zero and improve community resiliency will also require a significant shift in the supply of the remaining energy needs of Cambridge buildings away from fossil fuel-based sources and toward low- or zero-carbon sources. This will include realizing a significant portion of the city’s solar potential (both PV and thermal), taking advantage of all opportunities to harvest waste heat, and expanding and developing additional district energy capacity. As part of a regional grid served by a regional utility, it is also important for Cambridge to engage with this utility in order to secure its cooperation and support to help Cambridge achieve its Net Zero goals.




Action 3.1: Low Carbon Energy Supply Strategy

Introduction

A comprehensive low carbon energy supply strategy is needed for the City to better understand the opportunity and pathways to achieve a transformation of its energy supply system.

The Low Carbon Energy Supply Strategy will define:

- Where and how low carbon and district energy can occur in Cambridge given current and emerging technologies.
- The role the City will play in developing and enabling district energy and distributed generation.
- Where and how the City and utilities could begin to modernize the grid infrastructure.
- The full technical and economic potential for solar PV and solar thermal installations throughout the city.
- The opportunities and potential for storage that improves resiliency and the potential to utilize more renewable energy.
- The policies and investment strategies that should be employed to improve deployment of low carbon and renewable energy.

	Study completed in fall 2017 ready to pursue next steps
	Coordination among regional entities for successful action
	Begin implementation through regional collaboration

FY17 Action Items

Engage a qualified consultant to complete a Low Carbon Energy Supply Strategy study which will meet the goals listed above. The study should be completed in FY17, at which point implementation of strategies identified in the study should begin.

Progress Towards FY17 Action Items

The Low Carbon Energy Supply Strategy study (LCESS) kicked off in October 2016 and has involved four major phases: (1) analysis of existing factors and barriers, (2) identification of opportunities and scenarios, (3) consideration of changes and benefits related to each scenario, and (4) feasibility assessment of preferred scenarios. The consultant research has been guided by a working group including stakeholders from local utilities, universities, sustainability groups, neighboring communities, and relevant City departments. There has also been a significant public engagement component of the project to help educate Cambridge residents about energy supply issues and how they can take part in greening Cambridge's energy supply. Outreach materials include a full-page article in the Getting Around Cambridge magazine,¹⁹ a roll-up poster for events, and Hubway kiosk ads slated to roll out in fall 2017.

The LCESS study²⁰ examined multiple scenarios through which to satisfy the future demand for energy in Cambridge with low-carbon energy sources. Due to climate change, future energy demand projections anticipate increases in cooling demand across the City, and particularly in existing dense areas such as Harvard and MIT/Kendall square as well as newly developing areas such as North Point and Alewife, though buildings in Cambridge will continue to be heating-dominated through 2040. Less dense residential neighborhoods are best served by building-level electrification using air or ground-source heat pumps driven by solar photovoltaics. Buildings in high density areas could also be electrified individually, though this comes at high cost and with limited resilience. Therefore, these regions would ideally be supplied heating and cooling through expanded existing and new district energy systems powered by electricity or biomass which increase resilience and flexibility of fuel sources and technology evolves. Grid electricity will continue to be a dominant energy source in Cambridge, particularly as buildings electrify their heating systems, and therefore regional efforts to decarbonize the electricity grid are crucial to lowering GHG emissions.

Next Steps

The LCESS study was completed in fall 2017. Because of the transformation and long-term nature of the LCESS and regional impacts and investments needed to carry out the scenarios, it is recommended to pursue implementation through regional entities such as the Metropolitan Area Planning Council Metro Mayors coalition.²¹ LCESS goals are supported by a number of ongoing energy transformation programs currently being carried out by Cambridge, including Sunny Cambridge²² and support to electrify residential HVAC systems.

¹⁹ <http://www.cambridgema.gov/CDD/News/2017/7/gettingaroundcambridgemagazine.aspx>, p. 19

²⁰ **Link to study will be added once finalized.**

²¹ <http://www.mapc.org/14-metro-mayors-commit-combat-prepare-climate-change>

²² <http://www.sunnycambridge.org>

Action 3.2: Rooftop Ready Solar Requirement

Introduction

The Rooftop Solar Requirement is intended to help meet the Net Zero goal by encouraging additional onsite renewable energy generation, with a focus on solar. The Action should begin with the exploration of a requirement that all roofs on new construction projects must be solar ready. “Solar ready” means that buildings are designed to accommodate the future installation of roof-mounted solar panels including either photovoltaic or solar thermal. In the future, the City will consider options to require onsite solar installations for new buildings and major roof replacements.



State code requirements adopted; additional requirements under consideration in zoning package



Regulatory challenges regarding potential building code conflict



Determine implementation pathway in coordination with other zoning requirements

FY17 Action Items

Implement solar ready requirements for new buildings in Cambridge based on recommendations made in the FY16 study.

Progress Towards FY17 Action Items

In spring 2017, the Massachusetts State Board of Building Regulations and Standard adopted a solar ready provision in the state building code that requires solar readiness in buildings of three or fewer stories.²³ Staff must determine how this requirement interacts with Cambridge-specific requirements for solar readiness, which would impact a broader set of buildings. Solar ready requirements could be implemented through Article 22 of the Cambridge Zoning Ordinance in tandem with increased Green Building Requirements (Action 2.3) and removal of barriers to increased insulation (Action 2.5) or through Article 19 Urban Design Guidelines. Implementation of the solar ready requirements was been delayed in FY17 to allow for a single zoning amendment package to be presented to City Council including all three measures.

Next Steps




Staff are pursuing a package of amendments to Article 22 and Article 19 of the Cambridge Zoning Ordinance (see Action 2.3) that could include solar ready requirements beyond the state building code. Following consultation with staff and stakeholders, the goal is to bring this package before the City Council for adoption in early 2018.

²³ <http://www.mass.gov/ocabr/government/oca-agencies/dpl-lp/opsi/consumer-prot-and-bus-lic/license-type/csl/building-codebbrs.html>

Action 3.3: Develop a Memorandum of Understanding with Local Utilities

Introduction

Cities can collaborate with utilities on projects of mutual interest to result in energy use and emissions reductions. City-utility data sharing is particularly essential to understanding where and how energy is used in the city and what opportunities exist to decrease and green this energy use. The declaration and definition of this collaboration can impact its effectiveness, so a formal agreement on how the City of Cambridge, Eversource and Veolia can work together on the following areas is recommended:

	MOUs under continued consideration for FY18 adoption
	Determination of scope of agreement
	Leverage LCESS implementation for utility dialogue

- Investigating and piloting smart grid projects
- Investing in incentive programs
- Data sharing
- Investigation, development and expansion of district energy systems
- Interconnection issues that limit deployment of solar PV and co-generation
- Using solar PV to strategically address distribution congestion
- Work to increase resiliency of the electric, gas, and steam systems

FY17 Action Items

Agree upon and begin implementation of a memorandum of understanding (MOU) with Eversource and Veolia based on areas of mutual interest and have senior officials meet regularly to monitor and manage progress. Explore if there is benefit to including the state government and regional partners to this collaboration.

Progress Towards FY17 Action Items

Progress on adopting the MOU between Cambridge and Eversource was delayed in FY17 due to concern from Eversource on the scope of the MOU. A narrower draft focusing primarily on commitments and incentives for municipal energy savings is nearing consensus. Separate progress was made to deploy the Multi-Family Pilot Program (see Action 1.1.1) on schedule.

Veolia participated in the Low Carbon Energy Supply Strategy (LCESS) Advisory Committee along with Eversource (see Action 3.1) and through this forum participated in regular conversations about the future of energy planning in Cambridge.

Next Steps

The revised Eversource MOU is on track to be adopted in FY18. Regional collaboration to discuss next steps for the LCESS could provide a platform for ongoing dialogue and relationship building with Veolia and Eversource.

Action 4 – Local Carbon Fund

For Cambridge to become a net zero community, it will require an annual energy balance across the entirety of the city’s building stock. Where it is not possible or is exceptionally challenging for individual projects to achieve net zero emissions through the combination of efficiency and renewable energy generation, an alternative approach is to introduce a locally managed carbon fund that provides an option to purchase carbon offsets on a voluntary basis. The money collected would go into a local carbon fund, the proceeds of which will support Cambridge-based greenhouse gas reduction initiatives and renewable or low-carbon energy projects. Ideally, a locally based carbon fund would be developed and operated independently or at arm’s length of the City.

Action 4: Investigate Local Carbon Fund

Introduction

A Local Carbon Fund would serve as a vehicle that is easy to use as an alternative method to achieve net zero emissions over the short and medium term. The preliminary analysis should explore issues such as the development of a methodology for determining validity of offset projects. The offsets need not be “gold level” certified, but the accreditation methodology should be robust. In contrast to traditional offset frameworks, which typically are limited to supporting large-scale projects, a local carbon fund should be structured such that it can support a range of Cambridge-based emission reduction projects regardless of the scale of the project.



Feasibility study moving forward on schedule



Uncertainty regarding Fund utilization and accompanying administrative costs



Continue feasibility analysis with stakeholder engagement

FY17 Action Items

Begin feasibility assessment of a Local Carbon Fund for Cambridge, with an emphasis on potential standards for carbon offsets including project scope, additionality, ownership and verification. Analyze how these offset standards would apply to potential project types available in Cambridge and consider the thresholds and appropriate timeframes of carbon offsets to meet net zero emissions requirements and the appetite of local institutions.

Progress Towards FY17 Action Items

Following a solicitation in spring 2017, CDD selected Meister Consultants Group (MCG) to complete the feasibility assessment of a Local Carbon Fund in two phases. The first phase, completed in summer 2017, focused on the topics listed above. MCG conducted a literature and interviews with existing carbon fund administrators to set potential parameters for offset standards, which were refined through two workshops with City staff. MCG also conducted technical analysis of the potential “appetite” for offsets by future developments in Cambridge and compared this demand to a supply curve of projects in Cambridge from a variety of energy

efficiency, renewable energy, demand reduction, and transportation technologies. The results of these analysis were presented to a group of NZAP stakeholders for initial feedback.

Next Steps

Phase two of the Local Carbon Fund feasibility assessment will focus on program design with input from stakeholder. In fall 2017, MCG interviewed stakeholders who may be interested in participating in a Local Carbon Fund, including members of the Net Zero Task Force and the Cambridge Compact for a Sustainable Future to determine their key goals and barriers to participating in a Fund. Administrative costs will be estimated for a range of project types to establish a potential budget for the Fund that balances demand and supply. Then, with ongoing stakeholder engagement through focus groups, MCG will consider program design elements including operational structure, institutional management, financing, and verification. An implementation plan including resource needs, timing, and risk management will serve as a final project deliverable to inform next steps for the City moving into FY19.

Action 5 – Engagement and Capacity Building




The strength of the Net Zero Action Plan is built on the comprehensive stakeholder engagement which led to its formation. Therefore, continued engagement of stakeholders throughout Cambridge and related interest groups is crucial to the successful implementation of the plan. The Task Force recommended that the City continue to invest staff time and resources into identifying tools, innovative ideas, training opportunities, grants and other resources to support residents and commercial property owners in working toward the aggressive goals of the Plan.

Action 5.1: Communication Strategy

Introduction

To maintain a high level of stakeholder engagement around the Net Zero Action Plan, the City should develop a comprehensive long-term communications strategy around the Cambridge Net Zero objective. The strategy will ensure that key stakeholders including City officials, the building industry, and Cambridge residents remain aware of the progress toward net zero and engaged with the

initiative as needed or desired. The strategy will also enable the Net Zero Action Plan to serve as a touchpoint for broader energy and climate education in Cambridge, encouraging residents to take personal responsibility for helping Cambridge to meet its ambitious climate change mitigation and adaptation goals.

	Implementation of multi-faceted communication strategy ongoing
	Broaden community awareness of Net Zero Action Plan
	Continue development of new Net Zero website with Communication Director

FY17 Action Items

Over FY16 and FY17, develop and begin implementation of a comprehensive communications strategy around the Net Zero Action Plan objectives and components. Integrate stakeholder engagement and public communications into each Action as appropriate.

Progress Towards FY17 Action Items

Regular communication and outreach around the Net Zero Action Plan continued in FY17. There is increasing interest in net zero planning among communities across the greater Boston region which led to multiple requests for presentations and consultation to support planning processes. Lexington²⁴ and Concord²⁵ both adopted net zero planning processes, and institutions such as the US Green Building Council Massachusetts Chapter and Metropolitan Regional Planning Council hosted Cambridge staff at workshops to help inform other communities' plan development.

²⁴ <http://lexington.wickedlocal.com/article/20160421/news/160428685>

²⁵ <http://www.concordma.gov/DocumentCenter/View/1604>

Staff also commissioned a design firm to help enhance the “visual identity” of the Net Zero Action Plan. Work products include a custom illustration which captures many aspects of the Net Zero Action Plan in Cambridge, including energy efficiency, renewable energy, and iconic Cambridge buildings. Individual elements can be drawn from the illustration to contribute to ongoing outreach campaigns, such as the Low Carbon Energy Supply Strategy Hubway posters described below. The visual identity also includes an updated logo and fonts package with design instructions to create a consistent and recognizable brand for the Net Zero Action Plan across multiple media.

Work continued on an online sustainability dashboard to provide a concise and engaging source of information about sustainability metrics that relate to the Net Zero Action Plan outcomes such as community-wide GHG emissions and the number of LEED-certified buildings in Cambridge. This dashboard should feed into a new website for the Net Zero Action Plan that has been requested through the City Information Technology department.

The Low Carbon Energy Supply Strategy study (Action 3.1) begun in October 2016 is an example of an individual action with its own public engagement strategy. Over the course of FY17, an informational article about the Strategy was published as part of the Getting Around Cambridge Magazine,²⁶ a roll-up banner infographic was created for the Cambridge Science Festival and used regularly at outreach events, and a series of Hubway kiosk posters was designed with a complementary website²⁷ to educate residents about their energy sources and encourage them to act to decarbonize their energy supply.

Next Steps

In FY18, staff will continue to implement outreach and communication for the Net Zero Action Plan in collaboration with the CDD Communications Director. Priorities include development of a new Net Zero Action Plan website that focuses more on program implementation and how residents can get involved.

²⁶ <http://bikelifecities.com/wp-content/flipbook/cambridge-summer-2017/?page=18>

²⁷ <http://www.cambridgema.gov/low-carbon>

Action 5.2: Develop Ongoing Capacity to Manage Getting to Net Zero Project

Introduction

While the Cambridge Net Zero Action Plan was completed by the Getting to Net Zero Task Force in early 2015, in the years that follow the initiative will be led by the City of Cambridge along with partners and community stakeholders. As such, it is essential that the initiative be resourced accordingly so that its objectives will be met over the duration of the project.



On track with implementation of NZAP management and reporting structure



Ensure continued coordination among partner institutions



Complete annual report review and ongoing program monitoring

FY17 Action Items

Continue monitoring roles and responsibilities for implementing the Cambridge Net Zero initiative over the long term. This includes assigning project leads for each of the actions, identifying research and implementation partners, and maintaining a reporting structure and a governance structure to ensure that the project remains on track and consistent.

Progress Towards FY17 Action Items

In FY17, the Cambridge Climate Protection Action Committee (CPAC) continued to serve as the governing body responsible for ongoing oversight of the Plan. Staff provide NZAP updates at monthly CPAC meetings. CPAC also received and reviewed the FY16 annual report outlining progress towards actions for the previous year and results of these actions on clean energy measures and GHG emissions in Cambridge. As laid out in the Plan, Program Wide Reviews are scheduled for every five years to involve a wide range of stakeholders in a comprehensive review of progress along the Plan and necessary adjustments moving forward based on changes in technology, policy, and other influential factors. The first of these reviews is due to occur in FY 2020.

The Cambridge Net Zero Energy Planner continued to oversee daily implementation of the Plan, including scoping projects, hiring consultants, and managing projects throughout their timelines. Research and implementation partners were engaged as appropriate, for example Harvard and MIT to facilitate the Market Based Incentive Program study (Action 2.2.1) and the Cambridge Compact for a Sustainable Future to investigate Net Zero Lab Standards (Action 5.3).




Next Steps

This report should be reviewed and received by CPAC, including any feedback on program management and communications. In FY 2020, a comprehensive Program Wide Review will be organized to make necessary adjustments to the Plan trajectory. Individual actions will be monitored and managed on an ongoing basis to provide opportunities for CPAC and outside stakeholder feedback and guidance, including periodic engagement of the Net Zero Task Force.

Action 5.3: Net Zero Lab Standards

Introduction

Commercial and academic laboratories are responsible for approximately one third of the current energy demand in Cambridge. Given this large impact, the challenges for laboratories to significantly reduce their energy use while meeting operational, health, and regulatory standards, and the lack of net zero lab examples, the Net Zero Action Plan includes a stakeholder-based process to research and develop new standards for lab operations that support lower energy use.

	In progress through Compact for a Sustainable Future workplan
	Diversity of laboratory uses and energy needs
	Evaluation of potential laboratory energy standards for piloting

FY17 Action Items

Continue work by a coalition of industry stakeholders, research institutions and industrial hygienists to collaborate on new standards for reducing energy use that can be trialed without compromising safety or research integrity. Develop initial standards to be piloted in future years.

Progress Towards FY17 Action Items

The Cambridge Compact for a Sustainable Future²⁸ successfully convened a working group to consider the feasibility of potential standards for reducing energy use in Cambridge laboratories, with support from City staff. The working group met regularly and decided to pursue laboratory energy benchmarking study to better understand current energy use in Cambridge labs, building on a similar study conducted by the Boston Green Ribbon Commission.²⁹ The study, conducted by kW Engineers, analyzed data reported by 98 buildings owned by 7 commercial and academic institutions. Through the study, more detailed information about laboratory energy and water use was collected than is available through the Building Energy Use Disclosure Ordinance, including energy use by laboratory type and information about operational practices that could affect energy consumption. This data could serve as a starting point for the working group to consider the feasibility of developing best practices to be piloted in Cambridge laboratories.

The collaboration between institutions participating in the laboratory working group was highlighted in a recent plenary at the International Institute for Sustainable Laboratories (I2SL) conference. I2SL has been participating in the working group and can serve as a conduit to amplify the lessons learned in Cambridge while also bringing resources from throughout the I2SL network to bear on Cambridge activities.

²⁸ <https://cambridgecompact.org/>

²⁹ <http://www.greenribboncommission.org/document/boston-area-lab-energy-benchmarking-study/>

Next Steps

In FY18 the Compact Net Zero Labs working group should evaluate the data collected through the benchmarking study and consider best practices for energy efficient lab design and operations which could inform pilot standards for Cambridge labs to trial. A stretch action involves the exploration of funding opportunities to develop or implement a pilot implementation program.

FISCAL YEAR 2017 QUANTITATIVE INDICATORS

While the bulk of this first-year report has focused on the progress toward each of the Net Zero Plan Actions, data from the 2012 Community GHG Inventory and the 2017 Building Energy Use Disclosure Ordinance report serve as initial quantitative indicators of building energy use and emissions in Cambridge. These indicators serve as a helpful baseline for measuring progress towards Cambridge becoming a net zero community and evaluating the effect of the Net Zero Action Plan in future years.

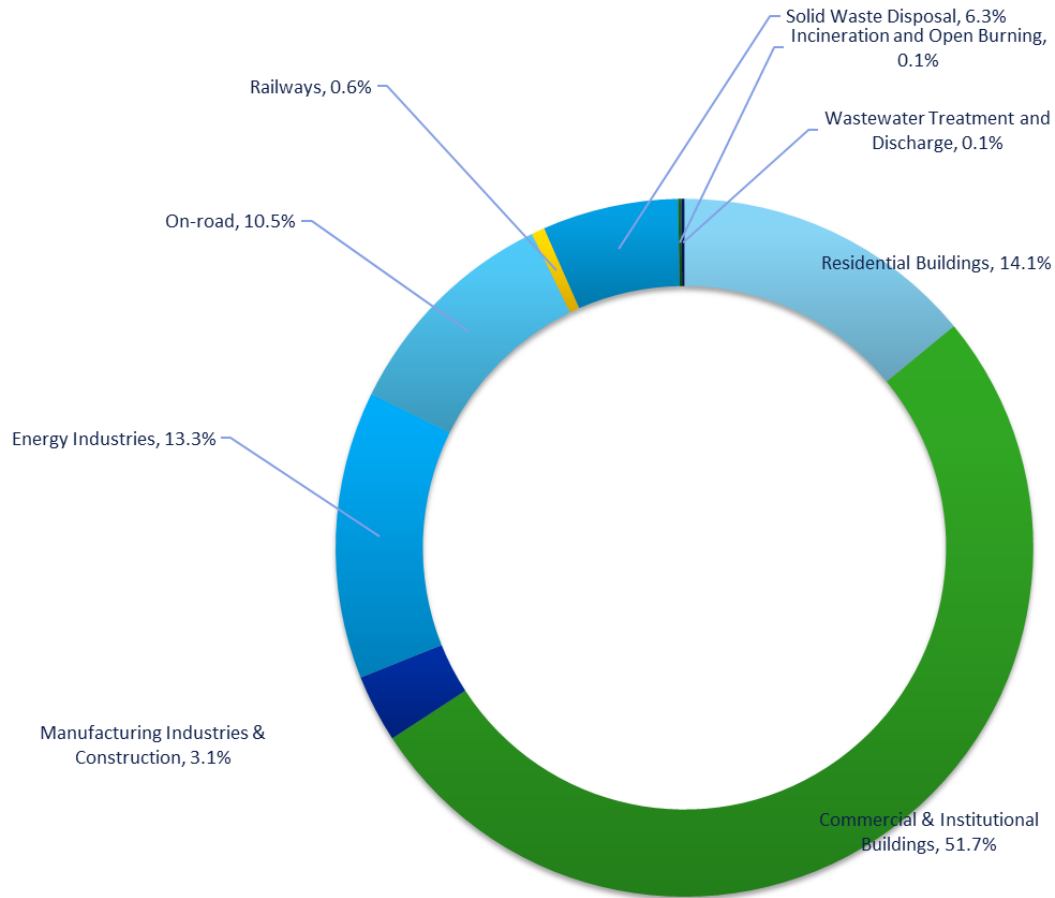
Community Greenhouse Gas Inventory

In FY17, the City of Cambridge completed a community-wide GHG inventory to meet its commitment as a participant in the Compact of Mayors³⁰ to mitigate climate change. A comprehensive GHG inventory helps the City better understand where GHG emissions are generated and then develop strategies for reducing these GHG emissions. The inventory was completed for 2012 because of data availability and alignment with the municipal inventory. External limits to data prevent annual updates to the Inventory, so this analysis has not changed from the FY16 Annual Report. Staff are working to develop a process to achieve more regular updates and hope to complete a 2016 GHG inventory in FY19.

As seen in the summary graph below, the majority of GHG emissions generated in Cambridge are related to building energy use, including residential buildings, commercial and institutional buildings, manufacturing industries and construction, and energy industries such as combined heat and power plants that provide energy to buildings in Cambridge, for a total of 82%. This emphasizes the importance of the Net Zero Action Plan's goal of eliminating GHG emissions from building operations in Cambridge. Total stationary 2012 GHG emissions are 1,202,956 MT CO₂e.

³⁰ <https://www.compactofmayors.org/>

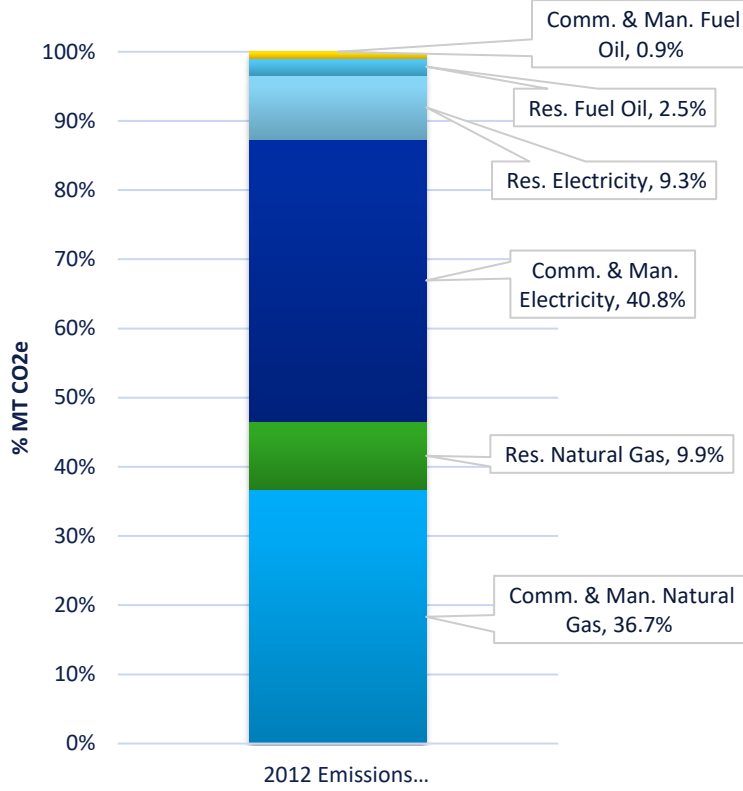
2012 Cambridge Community GHG Inventory



A deeper dive into the emissions data related to building operations shows that natural gas and electricity are each responsible for a little under than half of building energy emissions, and fuel oil for less than 1%. Natural gas consumed on-site currently has a lower emissions factor than electricity generated off-site,³¹ but does not have the long-term potential to eliminate these GHG emissions. Therefore, transitioning to cleaner electricity sources, as is being explored in the Low Carbon Energy Supply Study (Action 3.1), is crucial both to reducing GHG emissions from the current electricity demand and providing a carbon-neutral energy supply option to replace natural gas in the long term.

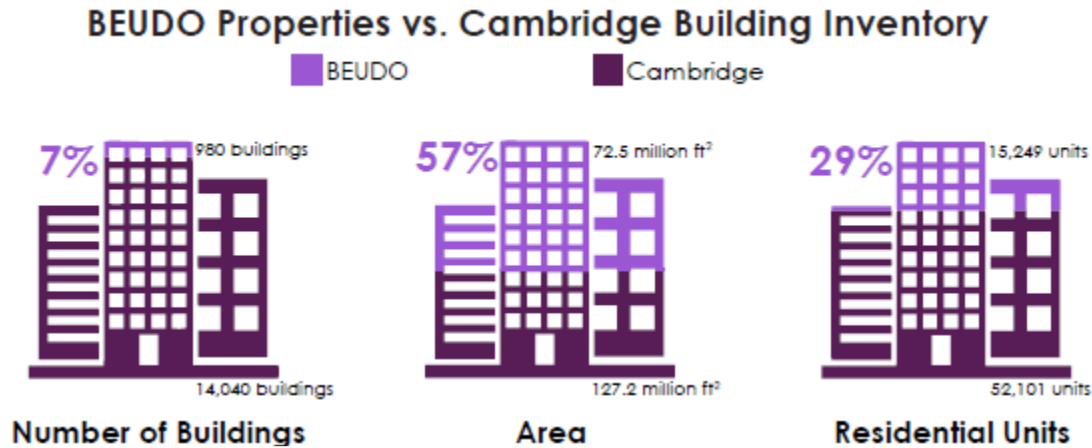
³¹ There are concerns about GHG emissions from fugitive methane emissions due to leaks in the natural gas production process and transmission infrastructure, for example: <http://www.nrel.gov/docs/fy16osti/62820.pdf>

Total Annual Consumer Energy-use Emissions



Building Energy Use Disclosure Ordinance

The Cambridge Building Energy Use Disclosure Ordinance (BEUDO) requires parcels with non-residential buildings of a total of 25,000 square feet or greater as well as parcels with residential buildings totaling 50 or more units to annually report and disclose their energy and water use.³² By requiring the largest buildings to report their energy use, Cambridge can gain important information about the energy consumption of a majority of the total building area in the City while streamlining the data collection process to the largest energy consumers, as illustrated by the graphic below.

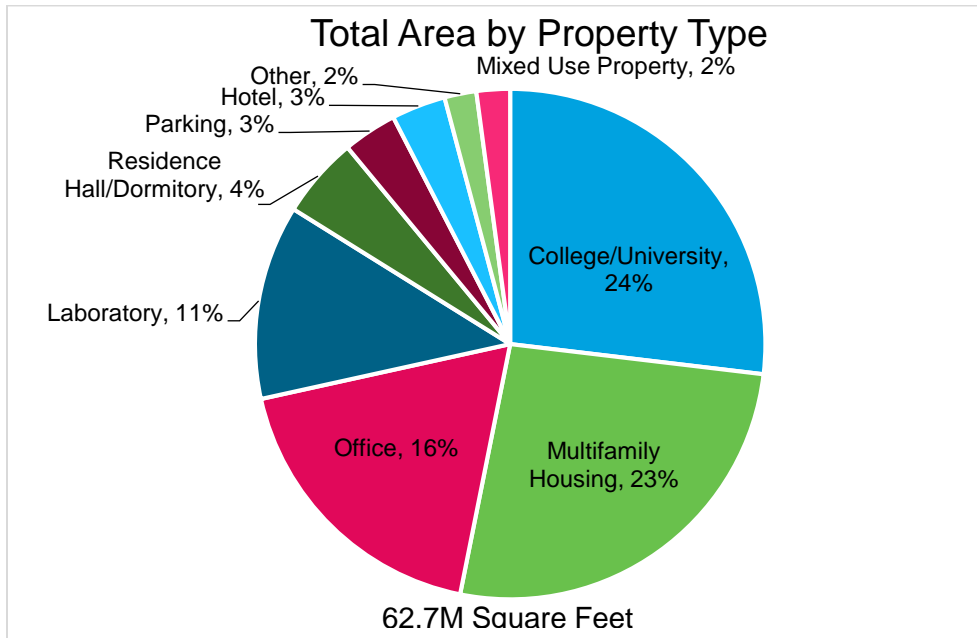


The graphs below summarize the data collected in the 2016 BEUDO reports.³³ Academic properties make up the largest proportion of BEUDO reporters, followed by multifamily housing and office buildings. However, energy use for laboratories, even though they consist of only 11% of the reported building area, is 24% of the total energy use and greater than multifamily and offices, illustrating the much higher energy intensity of laboratories than other building types.

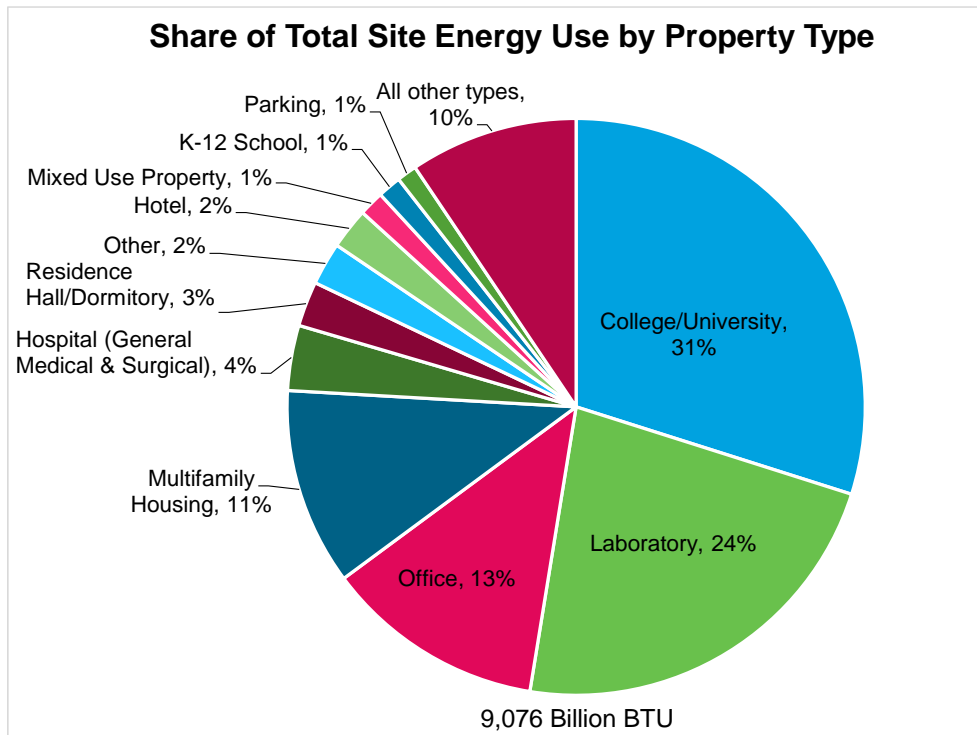
³² 2015 reporting applied to parcels with 50,000 square feet or greater; Disclosure not required in 2015; for more details, see <http://www.cambridgema.gov/CDD/zoninganddevelopment/sustainablebldgs/buildingenergydisclosureordinance.aspx>

³³ Calendar year 2016 data is reported to the City in summer 2017

Total Area of Properties in 2016 BEUDO Analysis³⁴



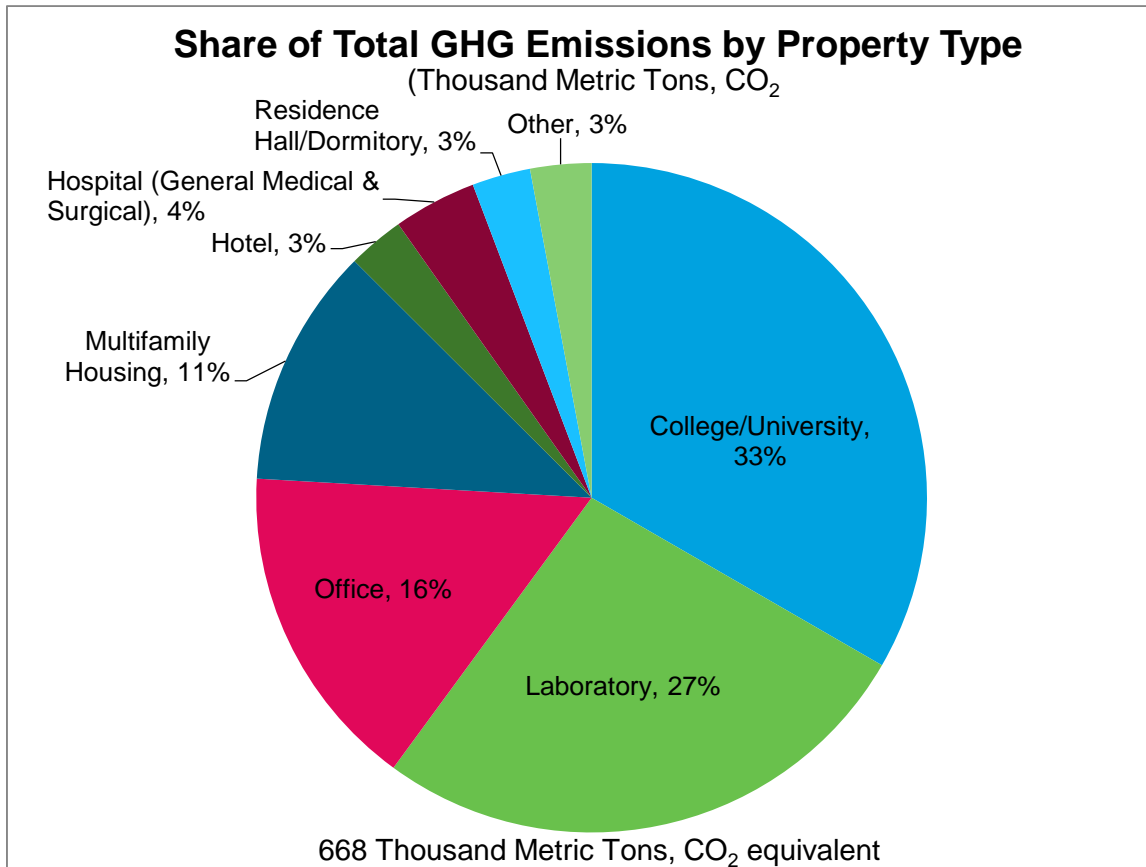
Total Site Energy Use of Properties in 2016 BEUDO Analysis



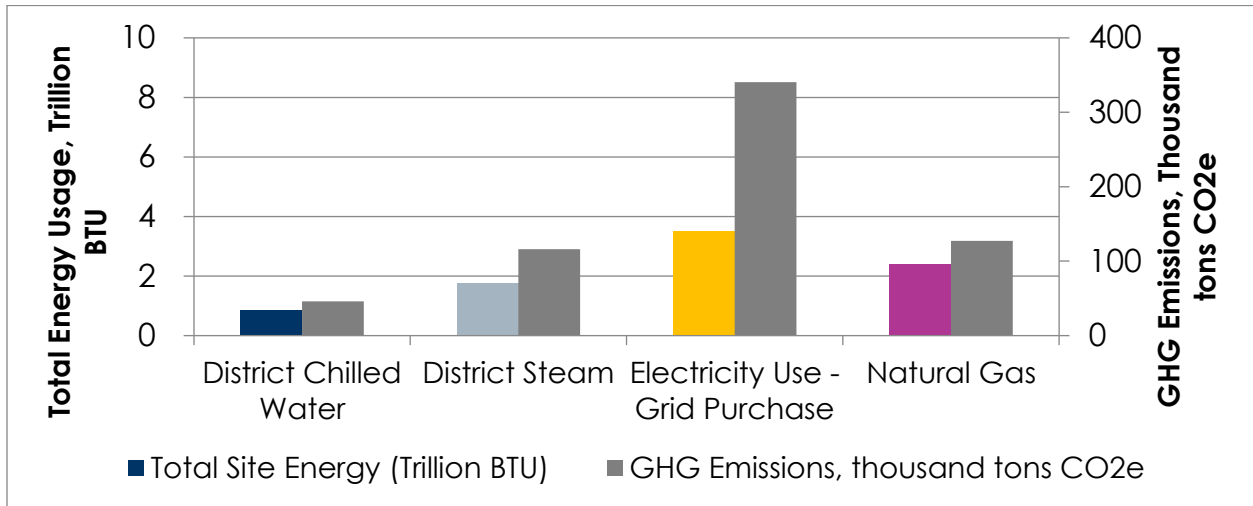
³⁴ "Residence Hall" or dormitories are not included in college/university to distinguish between residential building energy use profiles and those of academic, administrative, and research buildings on campuses.

Greenhouse gas emissions are tied not only to total energy usage, but also to the mix of fuel types used at each property type. The pie chart below shows the share of total emissions contributed by each property type. Emissions are a product of energy use and the GHG intensity of each fuel. Electricity currently has a higher GHG emissions factor than natural gas, as seen in the first bar graph. A comparison of fuel mix across property types is located in the second bar graph.

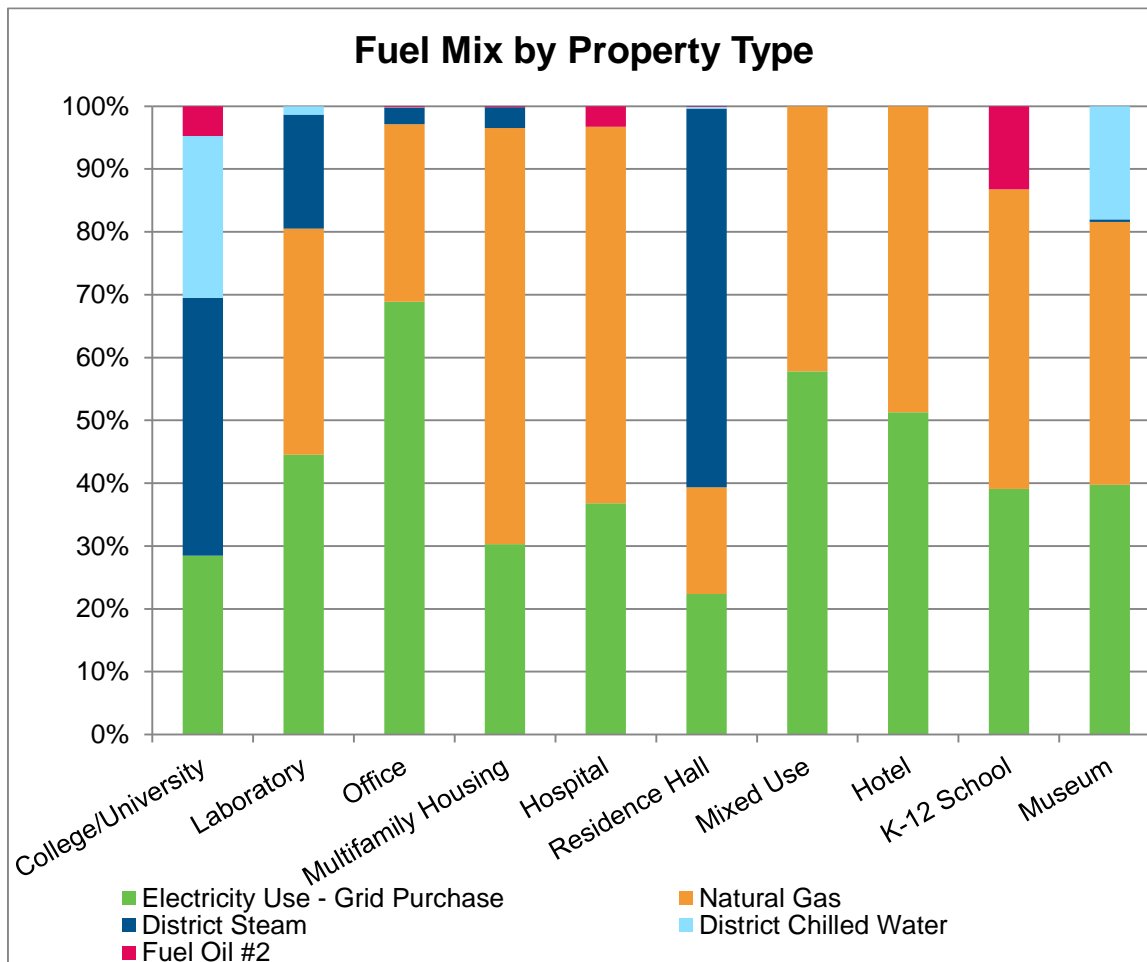
Total Greenhouse Gas Emissions of Properties in 2016 BEUDO Analysis



GHG Emissions by Energy Source

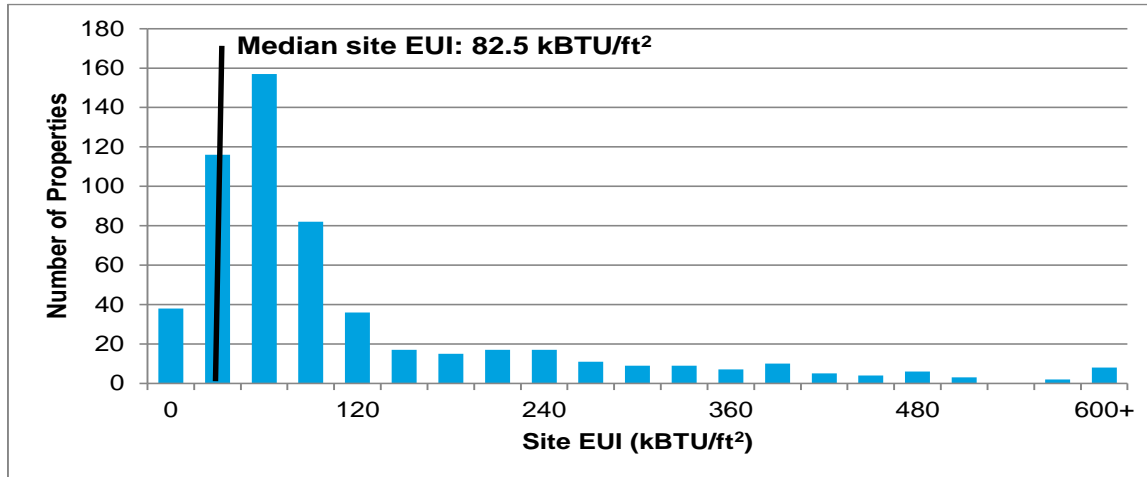


Fuel Mix by Property Type



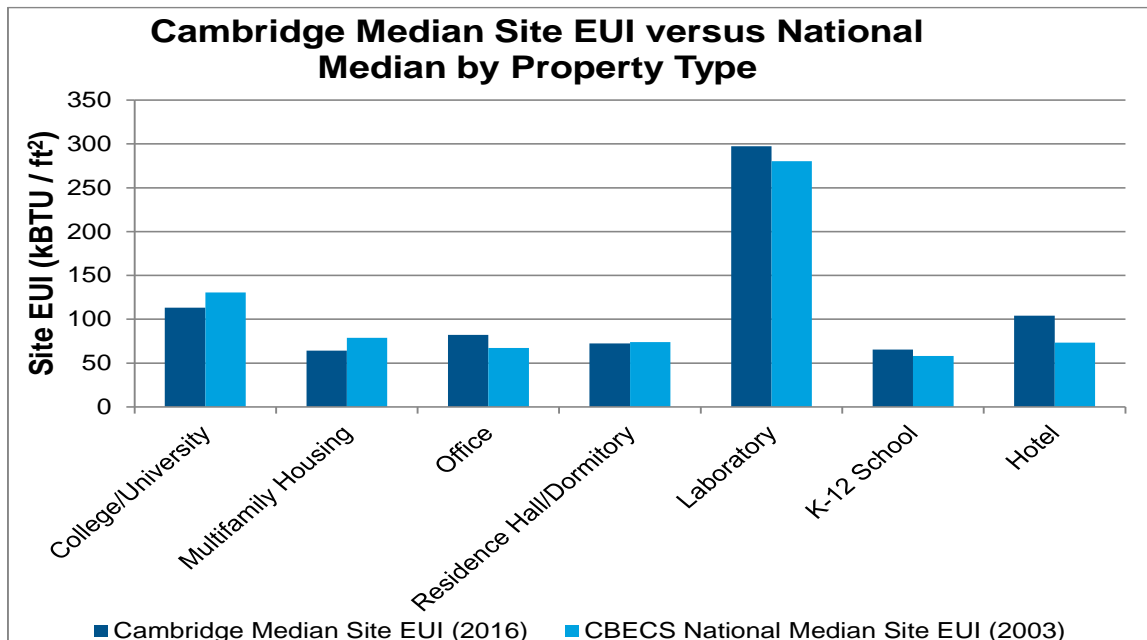
The energy use intensity, or EUI, of buildings is a helpful metric to normalize energy use across buildings of different sizes, much like an MPG sticker on a car. As illustrated in the graph below, most buildings reporting to BEUDO have an EUI below 100kbtu/ft², with a handful of buildings consuming much more energy.

Site EUI Distribution



In order to contextualize the results of the Cambridge analysis, median energy use intensities for various property types included in the Cambridge data are compared to the median energy use from the most recent Commercial Building Energy Consumption Survey (CBECS). Differences in median EUI may be due to more intensive activities, different climate and weather patterns, or differences in energy performance. Overall, BEUDO reporter site EUIs are quite close, if slightly higher than, national medians.

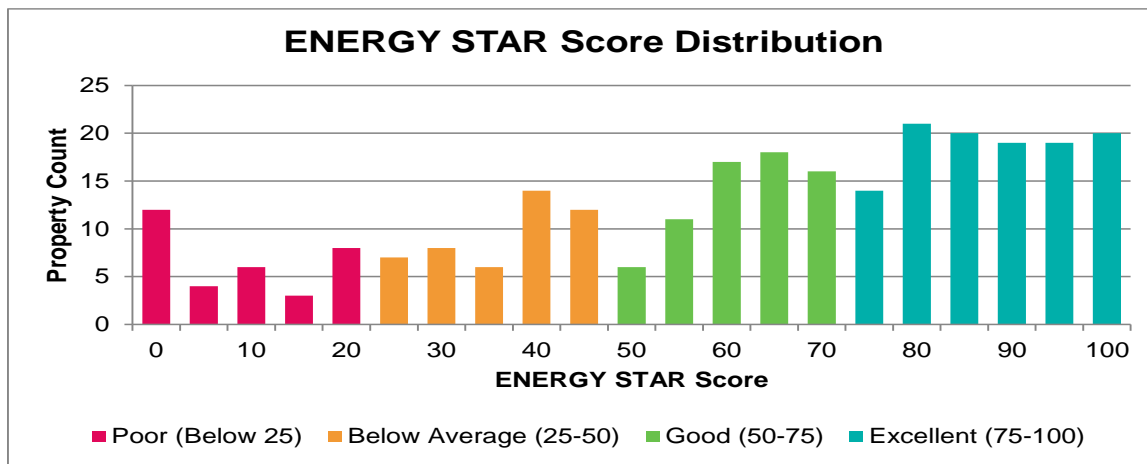
Median Site EUI versus National Median by Property Type



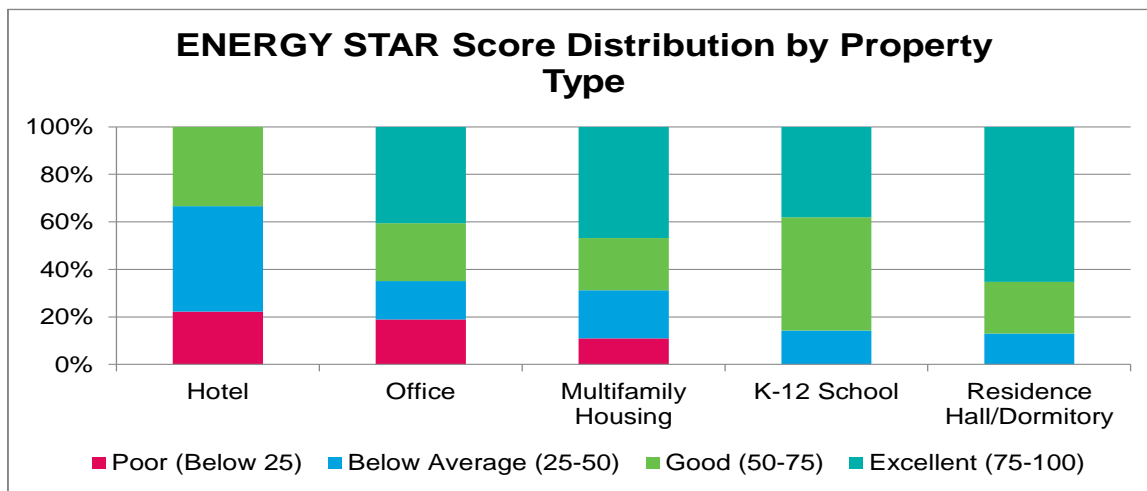
An additional comparison mechanism is the 1 – 100 ENERGY STAR score screening tool that helps property owners and managers assess how a building is performing. A score of 50 is the median; a score of 75 or higher means it’s a top performer and may be eligible for ENERGY STAR certification.

Out of the 538 reports included in the 2015 BEUDO data set, a subset of building categories are eligible for an ENERGY STAR score. The graph below shows the distribution of ENERGY STAR scores for these properties. Across all eligible properties, Cambridge buildings tend to perform better than their peers, with an average score of 64. The graph also shows a significant amount of properties with an ENERGY STAR score of zero, which may be due to incomplete information or a mixed use (such as a laboratory in an office building). The second graph shows the ENERGY STAR score by property type. Note that schools in the Cambridge data set have a higher EUI than the national median, and also have high ENERGY STAR scores. This indicates that the schools may have more energy intensive activities than the national median, but are using that energy more efficiently, thus giving them a higher energy performance score.

Distribution of Energy Star Scores



ENERGY STAR Score Distribution by Property Type



Based on the data in the BEUDO reports, many large building types in Cambridge are already on the way to efficient energy use, while others have a ways to go. Laboratories are clearly a key challenge based on their high EUI and significant proportion of total GHG emissions. It should be noted that the unique uses of laboratories along with health and safety requirements has much to do with their high emissions, and not necessarily the construction of the buildings themselves. Hotels, while having a lower ENERGY STAR score, only contribute a small proportion of Cambridge's GHG emissions, so may be less of a priority. The higher GHG emission factor of electricity from the grid illustrates the important of decarbonizing the electricity sector in the short term, which will enable additional emissions reductions by fuel switching from natural gas to electricity in the medium to long term. Annual BEUDO reports will serve as a key resource to tracking energy and GHG emission trends from large buildings in Cambridge and hopefully demonstrating the progress of the Net Zero Action Plan. Because the 2016 BEUDO report included additional commercial buildings between 25,000 and 50,000 square feet, it is difficult to compare it directly with the 2015 report described in the FY16 Net Zero Report; future BEUDO reports will allow for more direct comparison. BEUDO's direct connection to building energy performance also makes it an important tool for directly increasing this performance, as laid out in Action 1.1.2.

