RECOMMENDATIONS OF THE CLIMATE ACTION TASK FORCE FOR BOSTON UNIVERSITY'S CLIMATE ACTION PLAN

SYNTHESIS AND OVERVIEW
December 2017

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EXECUTIVE SUMMARY

Climate change is one of the seminal issues of our time. Its ramifications extend from basic science to diplomacy, from risk assessment to intergenerational ethics. We are now in a time when it can no longer be safely ignored, and large institutions like Boston University face a series of choices about how they respond to its challenges. Those choices involve not only addressing how BU examines its own actions about energy and preparedness, but also how these issues resonate through its research and educational missions. To address these issues, the Board of Trustees charged the University with creating a Climate Action Plan (CAP). The University convened a Climate Action Task Force comprised of faculty, staff, and students to consider a wide variety of options, communicate broadly with the University community, and bring recommendations forward.

The Climate Action Task Force convened in the autumn of 2016, and since then has explored ways in which BU might address reducing its greenhouse gas emissions and increasing campus resilience. In addition, the Task Force has explored how the broader issues of climate change and sustainability could be represented throughout BU's most important missions of providing excellent education, excellent research, and a positive life experience for students on its campuses.

Varying Levels of Resilience

The Charles River Campus (CRC) is likely to be resilient to catastrophic outcomes against even a 1-in-500-year flooding event today. But this resilience will not persist as sea levels, and therefore storm surges, continue to rise. By midcentury, a 1-in-500-year flooding event will be much more severe, and would likely overwhelm existing response mechanisms and financing. It is prudent to start designing new buildings on the CRC with these trends in mind, exploring options for portable flood barriers in some cases, and moving essential research and academic resources out of basements of existing buildings.

The Medical Campus, on the other hand, is extremely vulnerable to flooding and has many more essential research and academic resources in harm's way. A careful evaluation of the Medical Campus' existing and potential vulnerability should be done separately to quantitatively assess risk.

While the Medical Campus is nearly completely air conditioned, planning for the increasing likelihood of serious heat waves on the CRC has not been significant. Although air conditioning is being deployed in some buildings at times of major refurbishments, comprehensive planning, which might also include identifying cooling centers, should be done in concert with the City of Boston and our surrounding neighborhoods.

Ultimately, BU's resilience is closely tied to the city's resilience, and plans by the city to increase its own preparedness, deal with rising floodwaters, etc., have an immediate impact on the University. This is an opportunity for close collaboration.

Reducing Emissions

The University's emissions due to its own fossil fuel use and purchasing of electricity (i.e., its Scope 1 and 2 emissions) were approximately 129,400 metric tons of CO_2-equivalents (CO_2-e) in 2016. This includes both campuses' facilities, fleet and shuttle, properties in New England, and the small carbon sinks represented

by Tanglewood and Sargent Camp. Indirect emissions from transportation (including faculty, staff, and student travel), purchasing, and waste disposal (collectively known as Scope 3 emissions) are more difficult to estimate, and are not under the direct control of the University. In most cases, the University has not collected the data necessary to do good quantitative analyses, although we estimate that these various indirect emissions are on the order of 200,000 metric tons of CO_2-e.

Through the use of power purchasing agreements and significant investments in end-use efficiency projects that complement the achievements of the previous decade, the Task Force recommends an aggressive agenda of actions for Boston University to reduce its direct greenhouse gas emissions and emissions from power purchases to net zero by 2040.

The Task Force also recommends a series of pilot studies to explore options for reducing indirect emissions that the University does not control directly, but that are nevertheless the consequences of University actions and policies.

Research and Educational Benefits

We have done an analysis of the existing curriculum relevant to climate change and sustainability. There are gaps in the curriculum that could easily be filled; a renewed commitment to research on climate change and sustainability, supported by using the University itself as a living laboratory, could enhance our approach to not only understanding the specific threats of climate change, but also to demonstrating our commitment to reducing these threats through our own actions.

The Task Force recommends the creation of an academic Initiative on Climate Change and Sustainability to sharpen the University's focus on these issues. Such an initiative could play a catalytic role for research and education that cuts across the entire University by developing collaborative relationships with colleges, schools, departments, *sustainability@BU*, and existing University-wide centers.

The Costs and Value of Investing

Our 10-year financial forecast is now complete. The University should be considering the total costs of our recommendations to be in the neighborhood of $141M for capital investments and operating expenses over 10 years. These investments are expected to return a cumulative savings of over $85M to be reinvested into the Climate Action Investment Fund. For purposes of comparison, the University's calculation of incremental costs for its 10-year strategic plan are about $1.8B, more than 10 times as large. In the second decade of the BU BOLD scenario, while new costs will be incurred, the financial benefits of the energy-related projects should grow substantially, making the net costs over a long period of time much smaller and potentially even becoming net benefits.

Staffing, monitoring, and verification of the Task Force's recommendations will be necessary for long-term success in the CAP. These actions need to build on the already strong response of the University to sustainability.

If BU takes the actions the Task Force has recommended, Boston University will also take its place as one of the nation's leaders among universities in its commitment to climate action.

I. INTRODUCTION

Climate change is the most pressing environmental issue we face today. Its scientific basis is clear: the long-term transfer of carbon to the atmosphere through combustion of fossil fuels and the clearing of forested land for agriculture, along with a host of other human activities, has resulted in increases in the atmosphere's capacity to trap heat. In 2017, the concentration of carbon dioxide in the atmosphere passed 400 parts per million (ppm), a level not seen naturally for several million years. The documentation of climate change by the international scientific community has been both diligent and thorough: all the international and national scientific assessments that have been completed, and the vast majority of national academies of science, have concluded that human activities have not only caused these physical changes to the atmosphere, but also have changed the physical climate system itself on both global and regional scales. Further, the assessments show that there are serious consequences of those changes for everything from extreme weather events to damages from sea-level rise, adverse effects on human health, and losses of agricultural productivity (Box 1).

Climate change has been one of the most difficult and contentious policy issues, both nationally and internationally, to bedevil policymakers. Climate change is a risk management issue; reducing future harm from current emissions and ameliorating harm that cannot be avoided are both necessary. The general dimensions of global and national policy have been clear for a long time: decarbonize the energy system, halt deforestation (especially in the tropics), and implement sensible adaptation measures to both respond to and anticipate harm from climate change that cannot be avoided. But the disparity in historical emissions between the major industrial countries and the developing world, plus important aspirations in the latter for continued economic development,

BOX 1: SCIENTIFIC CONSENSUS ON CLIMATE CHANGE

The state of the science with respect to human influence on the climate system, and its subsequent impacts on important resources and economic sectors, has been evaluated multiple times over the past 30 years, both internationally and nationally (e.g., US NCA3, 2014; IPCC 2014). While many scientific uncertainties about processes and rates of change inevitably remain, there is a consistent and strong consensus on several major points.

The climate is changing, and the past several decades in particular have seen substantial warming, which is larger over land surfaces than over the oceans. Both globally and regionally, these changes are sufficiently large and well understood that they cannot be attributed to natural variability alone, although they are clearly modulated on annual and decadal scales by phenomena such as El Niño.

It is also the conclusion of several independent lines of evidence that the largest forcing of the change in the physical climate system is the increase in greenhouse gas concentrations in the atmosphere. The largest single contributor to these increases are emissions of carbon dioxide (CO_2). Concentrations of carbon dioxide in the atmosphere are at levels not seen previously for several million years, and isotopic evidence confirms that over the last two centuries roughly half the excess atmospheric CO_2 has come from burning fossil fuels and half from land-use change (largely clearing forests for increased agricultural land). Since roughly the end of World War II, the percentage contribution of fossil fuel combustion has climbed rapidly compared to land-use change, and the latest review of carbon cycle science (IPCC, 2013[1]) calculates that current anthropogenic CO_2 emissions are roughly 90% of the human-driven excess, with land-use change now accounting for about 10%. The conclusion of the vast majority of the scientific community that has studied these issues seriously is that human activities are the main causes of change in climate over the past several decades.

The consequences of these changes in climate on important resources, sectors of economic activity, and even human health are already being manifested. Sea-level rise and concomitant increases in storm surge threaten coastal communities and resources around the world. Agricultural productivity has been damaged, in spite of the known positive effects of atmospheric CO_2 on plant growth. Natural ecosystems in both terrestrial and marine environments are changing in character and geographic distribution as the climate system changes. Increasing prevalence of large and widespread heat waves has resulted in tens of thousands of excess deaths, even in the developed countries of western Europe.

Understanding how the future might unfold is one of the most difficult scientific challenges associated with climate change because it requires not only an understanding of all the natural factors and processes that affect the climate system and its downstream impacts, but also must consider human-driven greenhouse gas emissions and other important human-driven demands on natural resources. Scenario-based analysis is necessary because some of these forces are not predictable in the same sense as the underlying physics—and scenario-based analysis is always subject to revision as its assumptions are examined, and as the world progresses.

Risks to human health and well-being would rise to largely unacceptable levels if surface temperatures climb higher than 2°C above preindustrial levels, and there have been many analyses as to what that would entail in the human-driven components of the carbon cycle. These analyses conclude that global emissions would need to peak in the next several decades and then start to decline, reaching roughly 80% reductions compared to the early years of the 21st century in order to hold temperature increases to 2°C with a reasonable level of certainty. Achieving such ambitious emissions goals would require substantial changes to the energy economy to occur quickly.

1. IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.- K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO978110741532

and the inherent difficulty of decarbonizing industrial economies at scale have made both national and international agreements difficult to achieve.

In the US, research has been an emphasis for more than two decades, but the federal government has been slow to institute policies to address greenhouse gas emissions. Major policy implementation has been done at regional, state, and local levels. Cities have emerged as critical and major players. At the same time, important actors in the private sector have identified strategies for minimizing their greenhouse gas emissions, both for economic and reputational reasons, regardless of official government policies.

This is the milieu in which Boston University's community discussion about climate action finds itself. Discussions of divestment from fossil fuel–based industry within the University community have bubbled up to the Board of Trustees, which has set policy for how the endowment should be managed going forward. The City of Boston has announced that it intends to be carbon-neutral by 2050, and has published both a set of goals for its emissions and a vulnerability analysis to sea-level rise and heat waves. The University itself has expanded an already vigorous research effort on energy research, urban research, and sustainability science in which climate change plays a central role. And another critical element of the Board of Trustees' charge to the University has been to put in place a climate action plan. This recommendation from the Advisory Committee on Socially Responsible Investing to the full Board is (italics added):

(3) In order to increase the University's commitment to and focus on sustainability across teaching, research, and operations, the University should develop and incorporate into its Strategic Plan a detailed Climate Action Plan (the "CAP") that should outline specific near, intermediate, and long-term plans and associated goals for markedly increasing:

a. The amount of energy sourced from green alternative power producers (e.g., solar and/or wind either via the University's power purchasing arrangements or on-campus installations);
b. Energy use efficiency to reduce power demand;
c. Educational opportunities for students to understand climate change, its ramifications, and the need to solve the problem in their lifetimes; and to explore mitigation and adaptation strategies;
d. The University's cross-disciplinary coordination and support of research related to climate change, mitigation, and adaptation;
e. The understanding of all community members (students, faculty, and staff) that their individual choices and actions can have a profound impact on reducing the University's (and their own personal) carbon footprints; and
f. The University's preparation for the possible effects of future climate change on its physical plant.

The CAP should include implementation time frames, associated costs, and funding sources, as appropriate; articulate specific measurable goals with respect to both sourcing greener energy and reducing overall energy demand; and be a living document that is continuously refreshed and updated. Also, given its inclusion in the University's Strategic Plan, the CAP should be posted publicly on the University's website and progress with respect to its contents should be regularly reported to the Board of Trustees and the community.

Recognizing that the operating budget is a zero-sum proposition and that preservation of intergenerational equity for endowment distributions is important, the entire community will bear the burden of the compensating operating budget pressures (e.g., reduced student services, employee compensation, financial aid and/or tuition increases). However, the savings generated by the University's efforts to reduce overall energy demand should partially offset this burden.

The Boston University CAP Task Force was initiated by a charge (Box 2) from President Robert A. Brown in December 2016. Its members (Table 1) include faculty, staff, graduate students, and undergraduates from across the University. The charge to the CAP Task Force was to make recommendations to the University's senior leadership about strategies to reduce greenhouse gas (GHG) emissions, improve the University's resilience to climate changes that cannot be avoided, and integrate climate change topics into the University's educational and research missions. The Task Force was to report to President Brown and had a year to complete its task.

BOX 2: TASK FORCE CHARGE

While the CAP will be specific to Boston University, the plan must be put into the context that climate change is a global problem that extends beyond our campuses. The plan should therefore consider how to engage a broader community in this discussion. We should also consider this as an opportunity to elevate the University's position as a leader in addressing the challenges of climate change in its educational programs, research, operations, finance, and community engagement.

The Task Force is charged with developing a five-point CAP, described below, based on assessing science and long-term fiscal responsibility. The plan should build on resources already developed by BU faculty and staff (e.g., *sustainability*@BU) and suggest measurable medium- and long-term social and environmental goals/benefits.

TABLE 1: TASK FORCE MEMBERS AND ORGANIZATION DIVIDED INTO WORKING GROUPS

GROUP	Energy	Transportation	Supply Chain & Waste	Climate Preparedness
CHAIR	Dennis Carlberg	Benjamin Thompson	Jennifer Luebke	Anthony Janetos
MEMBERS	Jacqueline Ashmore Sean Attri Elijah Ercolino Peter Fox-Penner Michael Gevelber Terry Hatfield John Helveston Lucy Hutyra Anthony Janetos Robert Kaufmann Jonathan Levy Tom Little Marta Marello Nathan Phillips Pamela Templer Lisa Tornatore	Dennis Carlberg John Helveston Marta Marello Nathan Phillips Peter Smokowski	Mun Aung Pan Eric Bindler Dennis Carlberg Rachel Eckles Jennifer Luebke Marta Marello Jason Park Nathan Philips Peter Smokowski	Bridget Baker Dennis Carlberg Madhu Dutta-Koheler Marta Marello

At its first meeting with President Brown, the Task Force decided to organize itself into four working groups.

Educational and research themes were to be considered as cross-cutting issues to be addressed by each working group, and then synthesized by the Task Force as a whole. The Task Force also accelerated its timeline to complete drafts of its recommendations in the late summer of 2017, so that the BU community could respond to them before the trustees make their final decisions.

Working groups met approximately weekly for the first several months of the Task Force. A weekly time was set aside for broader discussions of the Task Force as a whole, and the management of the Task Force also met weekly. Membership in working groups was on a volunteer basis and faculty, staff, and students with specific knowledge and expertise participated as needed. After the working groups developed a general sense of priorities and challenges, they provided an update in January and February of 2017 at public forums on the Charles River and Medical Campuses designed to get feedback from the BU community. The ideas generated at these fora were considered and synthesized into the deliberations of each working group. During the spring of 2017, analyses and recommendations from the working groups were synthesized into an overall report, which was then discussed and reviewed by the entire Task Force, before being briefed to President Brown, the BU senior leadership, and the Board of Trustees.

We intend BU's CAP to have several outcomes:

- To transform the University's ambition and approaches to reducing its direct use of energy and energy services, and thus its direct emissions of GHGs;
- To address all the aspects of the University's mission—education, research, and service—and to include those emissions we compel from our students, faculty, and staff;
- To provide a blueprint for how the University can become more resilient and better prepared for climate changes that cannot be avoided, including opportunities for cobenefits from our own actions;
- To integrate our planning with the broader Boston communities of which we are a part;
- To provide a mixture of direct actions, policy recommendations, and an ongoing effort to measure progress; and
- To establish BU as a leader among selective, urban, globally important research universities in this important endeavor.

The CAP will consider what can be accomplished now and in the very near-term, what can be accomplished by midcentury, and what needs to be considered over the longer term, through the end of the century, to adapt to a continually changing environment.

It will also include recommendations for continual monitoring, so that plans can be adjusted as needed to maintain progress, or to alter components that are not performing as needed, and accelerate others as necessary. The plan includes actions that BU can take unilaterally and also includes policies and informational options that BU may choose to make easily accessible to its students, faculty, and staff so that they have a clearer view of the options available to them as part of the BU community.

This document is a synthesis and overview of the work that each of the working groups has performed. It begins by discussing the current state of affairs for BU: the resiliency and preparedness of both the Charles River and Medical Campuses and the emissions that BU is currently responsible for. It then discusses the future and makes recommendations for how the University might increase its resilience and decrease its emissions rapidly. Finally, it discusses the contributions that an ongoing CAP can make to BU's research and educational missions and to the leadership position that BU can take among its peers.

II. HOW RESILIENT IS THE BU CAMPUS?

The term "resilience" has been used in many different ways in the literature on climate impacts and adaptation. The BU CAP Task Force has operationalized the concept of resilience by focusing on the steps the University would take to minimize the costs of recovering from impacts driven by the physical climate system. Our two major concerns have been flooding and heat waves, but as discussed below, we are also cognizant of the risks from local air pollution and its relationship with climate.

For flooding, we have assessed the potential magnitude by estimating cleanup costs for buildings on the CRC for floods of particular magnitudes and duration. Previous assessments of BU's vulnerability to flooding identified the major infrastructure that makes parts of both campuses vulnerable to flooding. Figure 1 shows water penetration at mean higher high water (MHHW) plus 4.2 feet, where MHHW is the average height of the two daily tides—over the last 19-year period. The dams at the Charles River and at the end of Fort Point Channel are the major points of vulnerability. The dam at Fort Point Channel is low, and could be breached in a major event. The dam on the Charles River is higher and has powerful pumps (with their own emergency power supply). But water can relatively easily flow around the dam in a major event. A 1-in-100-year flooding event using today's statistics would not have major impacts on the CRC and likely not on the Medical Campus (Figure 2).

BU offsets some of these financial risks with its insurance. The deductible for floodwater damage is $500K, and the total annual limit for storm-driven flooding is $250M. The University is insured against the presumed impacts of a 500-year event (Figure 3), i.e., an event that would occur in Boston with a probability of 0.2% in a year—the storm

FIGURE 1: CURRENT BARRIERS TO FLOODING OF BU CAMPUSES

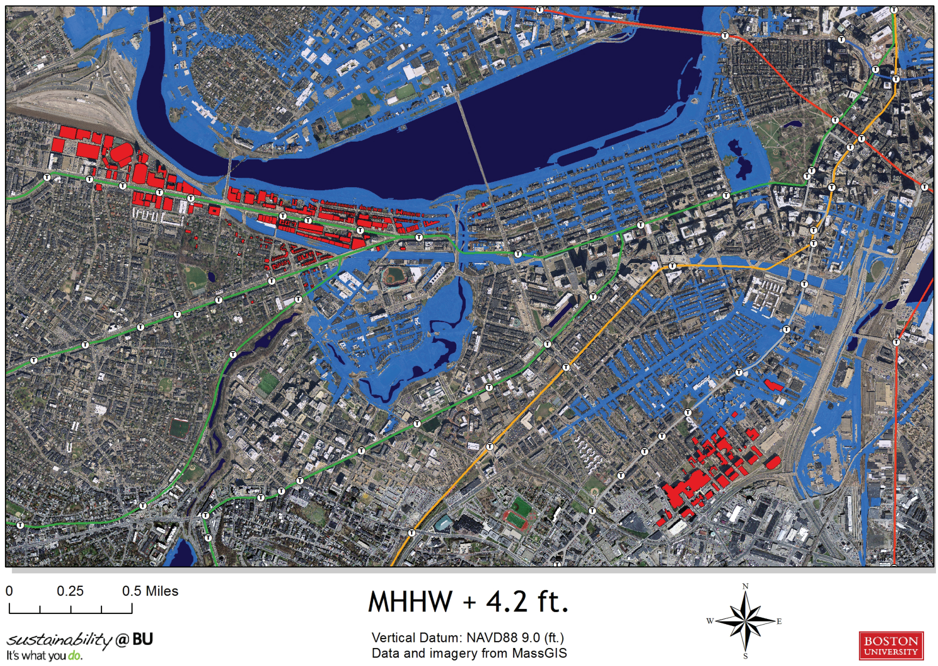
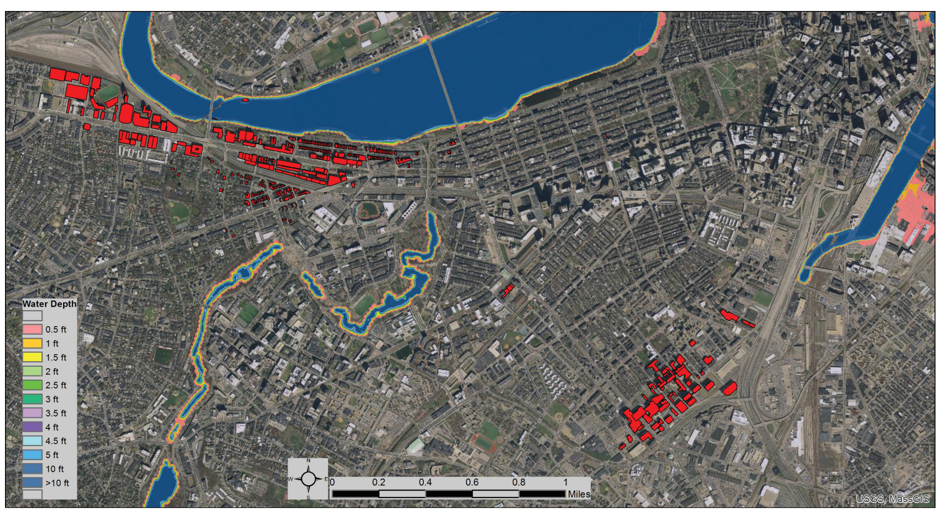


FIGURE 2: TODAY'S 1% FLOODING EVENT



during the 20th century that was the most similar to today's 0.2% storm was the Great Atlantic Hurricane of 1938. Note, however, that today's 0.2% event would be quite impactful on the Boston waterfront.

The conclusion is that today's risks of serious economic damage from storm water are relatively low, with even a 0.1% event (a thousand-year event) showing relatively small impacts, mostly along the low-lying brownstones on Bay State Road (Figure 4). Our current levels of insurance appear to be adequate for most events, and indeed, there is no evidence that we have found that the University has had a major flooding event during at least the last decade.

Heat waves show similar characteristics. Boston has not had a heat wave event that caused major morbidity or mortality in recent decades, but like other older New England cities, its infrastructure is not well adapted to much warmer climates than we currently experience. This maladaptation is primarily in housing infrastructure, and older buildings that are not air conditioned. There are no data from BU health facilities that show increases in heat-related illness or conditions during the summer months.

Although the University appears to be relatively resilient in today's climate, this will no longer be true over the next several decades, as flooding and heat waves are projected to pose much larger threats. Section V describes these threats in detail along with recommendations to improve resiliency.

FIGURE 3: TODAY'S 0.2% FLOODING EVENT

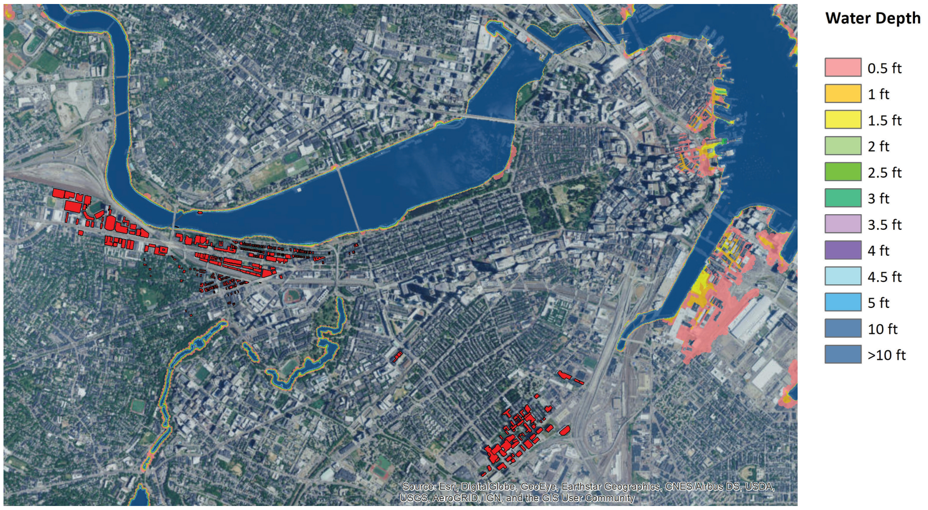
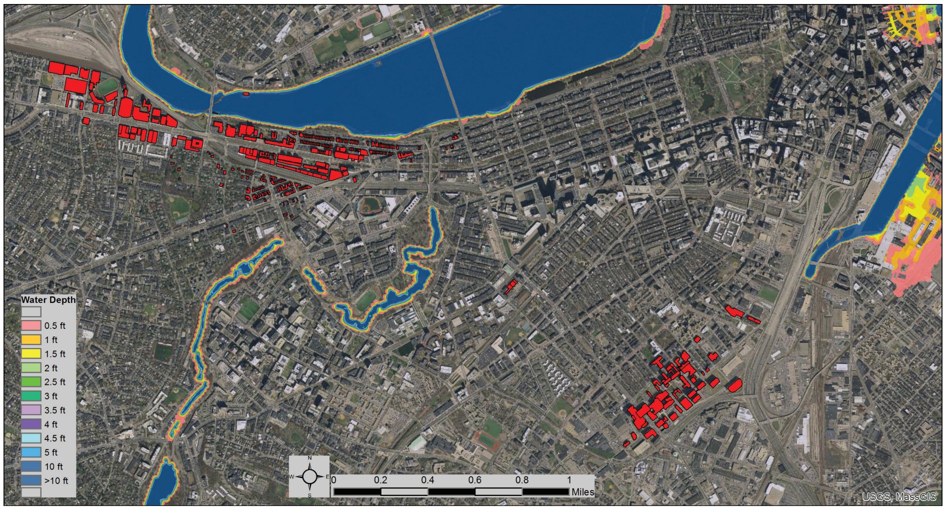


FIGURE 4: TODAY'S 0.1% FLOODING EVENT



III. WHAT DO WE EMIT AND WHY?

For emissions, we have first sought to document the current emissions of the University from all sources, and then establish a baseline scenario against which our recommendations, and eventually the University's progress, can be measured. This has been done in part for many years by *sustainability*@BU. Emissions are represented as CO_2-e (CO_2-equivalents), which accounts for any trace amounts of methane and other GHGs. The vast majority of BU's emissions, however, are simply in the form of CO_2.

Our primary focus is on Scope 1 and Scope 2 emissions, because they are the emissions that the University has direct control over. Scope 1 emissions are those that the University emits directly. Gas and oil burned in boilers across both the Charles River and Medical Campuses are examples, as are emissions from the BU vehicle fleet. Scope 2 emissions are those that are the result of BU's purchases of steam and electricity, the latter of which comes from ISO New England, i.e., the local grid. Scope 3 emissions are either compelled by the University or are indirect consequences of the University's actions. Examples include emissions from commuting by faculty and staff, emissions associated with student travel to and from campus for the academic year, emissions from waste disposal, emissions associated with purchasing supplies, and the emissions associated with providing dining services.

Scope 1 emissions take into account all buildings on both campuses, including the National Emerging Infectious Diseases Laboratories (NEIDL), and BU's share of the Massachusetts Green High Performance Computing Center (MGHPCC). The assessment of Scope 1 emissions also takes into account that BU owns Tanglewood in Massachusetts and Sargent Camp in New Hampshire, which turn out to constitute small sinks of GHGs as trees and other woody vegetation continue to grow. Scope 2 emissions incorporate electricity purchases on both the Charles River and Medical Campuses, include the NEIDL, and BU's share of the MGHPCC. Scope 3 emissions constitute the biggest change from previous practice, as they had not been estimated before. The Task Force has concentrated on travel emissions, from the ordinary commuting of faculty and staff, and has also done the first estimates of the travel we expect from faculty in their research and educational missions, and the travel that we compel from undergraduate and graduate students to attend one of our Boston campuses.

FIGURE 5: CURRENT BU EMISSIONS BY SOURCE

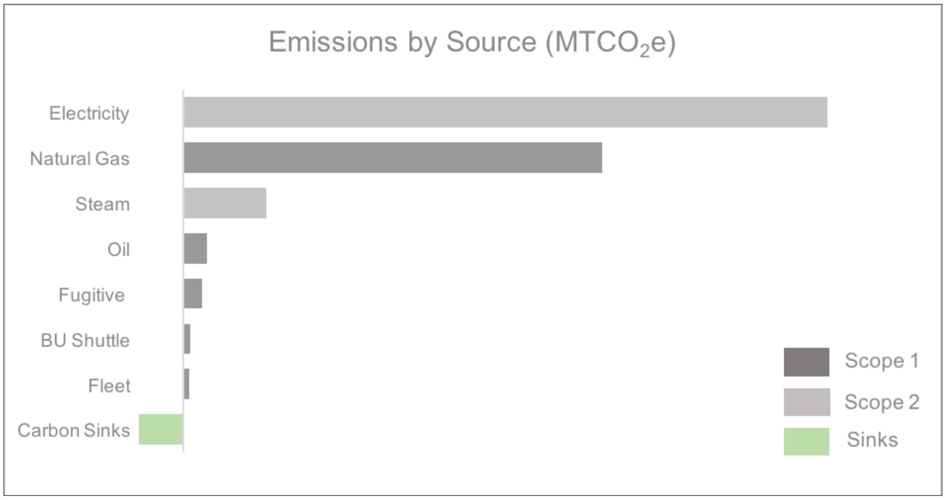


TABLE 2: FY2016 EMISSIONS BY FACILITY

	SCOPE 1	SCOPE 2	TOTAL MTCO$_2$e
FACILITIES			
CRC	46,600	51,500	98,000
Medical Campus	800	23,300	24,100
MGHPCC		800	800
Tanglewood	100	100	200
NEIDL	300	2,400	2,700
Carbon Sinks			-4,700
FLEET	700		700
BU SHUTTLE (BUS)	800		800
CRC & MEDICAL CAMPUS FUGITIVE EMISSIONS	2,100		2,100
TOTAL (CO_2e)	51,400	78,100	**124,700**

The summary of our findings is shown in Figure 5 and Table 2. We have shown 2016 as the base year, since it is the year for which the most up-to-date and complete data are available.

In order to provide a scenario of the future against which progress can be evaluated, we created a projection based on data that have been collected over the past decade of BU's efforts, and on some simple assumptions about how the future might unfold. Our Scope 1 and Scope 2 emissions have declined over the past decade due to efforts on campus to improve energy efficiency, switching from oil to natural gas, and the penetration of natural gas and renewables in the ISO New England grid. At current levels of effort, emissions have declined about 25% over that time, and we assume that BU will do no worse in the coming decade, even if no enhanced actions are taken. On the other hand, the campus will continue to grow. We assume that campus square footage, and thus energy demand, will grow at a rate of about 0.75% per year, which is consistent with recent growth rates. The sinks from natural areas that BU owns in Massachusetts and New Hampshire are also unlikely to change much, assuming that no unique events (e.g., fire, severe storms) occur. Finally, we assume that the ISO New England grid will continue to "green up" at the same rate as it has done over the past decade. Figure 6 shows the result of these assumptions. Note that this baseline scenario would take the University to almost a 20% reduction in its Scope 1 and 2 emissions by 2050 simply by doing about what we are doing now.

BU's emissions from travel, purchasing, and the waste stream the University generates are large and complicated. Faculty at large research universities are often expected to travel as part of their research and service activities. BU purchases some of the tickets directly through its Concur system, but others are paid for by third parties, and are mostly invisible to internal fiscal controls. These must be estimated through surveying faculty and

FIGURE 6: BASELINE EMISSIONS PROJECTIONS

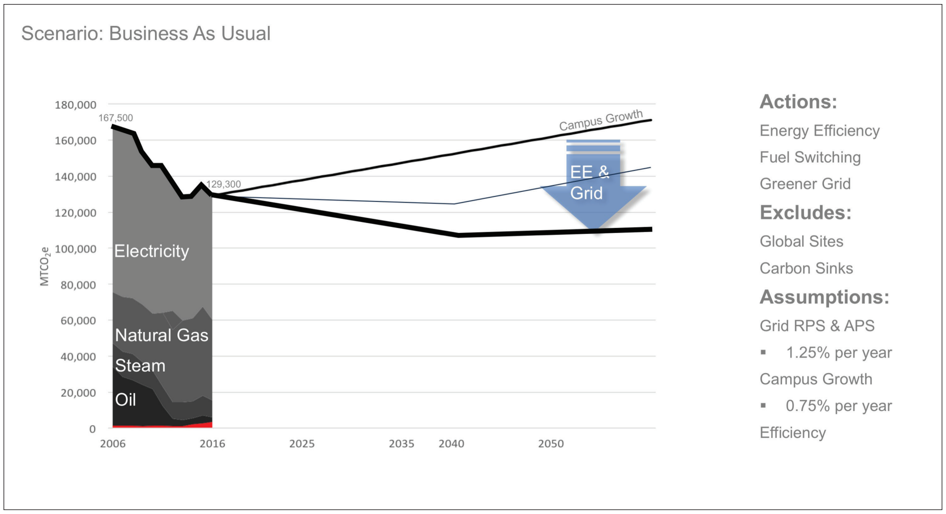
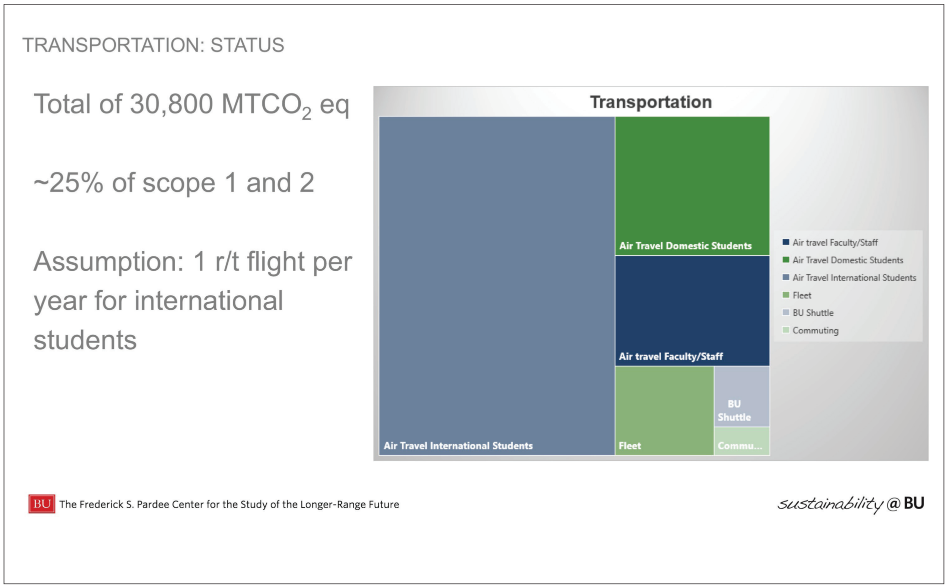


FIGURE 7: TRANSPORTATION EMISSIONS



staff. Commuting by faculty and staff can be estimated reasonably through knowing the number of parking passes that are issued and home addresses, knowing how many people take advantage of MBTA pass programs, and through annual surveys of commuting practices. But no one has previously estimated either graduate student or undergraduate travel, and this gap is obviously important: there is a total of 9,000 international students—3,606 are undergrads, 3,409 are grad students, and ~2,000 are "other." On top of these 9,000 students, there are 1,350 international scholars. We estimate travel emissions from these sources by using some very simplifying assumptions—one round trip per year, no flights for students from within 200 miles of Boston, embarking cities for foreign students being the capital city of their country of origin. These assumptions appear conservative, and when they are applied, along with commuting and faculty and staff travel, the total is about 30,800 $MTCO_2$-e, roughly 25% of the total of Scope 1 and 2 emissions (Figure 7). In Figure 7, the sizes of the rectangles are equivalent to the relative magnitudes of emissions from each identified activity.

The last component of Scope 3 emissions is purchasing and waste disposal. In order to make a quantitative estimate of current emissions and a reasonable baseline scenario, one would have to perform life-cycle analyses for each of the major purchasing and waste categories. In most cases, the data required for such analyses have simply not been collected by the University. We have concluded that in spite of significant progress in these areas from the standpoint of sustainability, we are unable to quantitatively assess their impacts on emissions.

This is not to discount their possible importance. There are emissions associated with each product that the University purchases, whether it is paper or food, that are the result of everything done to produce that product and how it is transported. There are emissions associated with the disposal of waste material, whether it is construction waste, traditional trash and recycling, or food waste. Some of this material is recycled; some is composted or taken to organic digester facilities; other materials are taken to waste-to-energy facilities to be converted to methane/natural gas that is then burned for energy. Each supply chain for each product has its own characteristic GHG signature. But there has been no systematic effort at characterizing all the relevant supply chains for the University, let alone calculating their GHG signatures. While this can, in principle, be done, the University currently lacks the information to make quantitative estimates of GHG emissions from these sources (Box 3).

BOX 3: QUALITATIVE ESTIMATES OF BU'S SCOPE 3 EMISSIONS

While quantitative estimates of BU's Scope 3 emissions cannot reliably be determined at this time, it is possible to do qualitative estimates in at least two different ways. One is to use a GHG estimator developed by the World Resources Institute (WRI), which uses expenditures in different institutional categories and EPA data to derive estimates of emissions. Using the WRI calculator and BU's purchasing data results in an estimate of about 226,000 tonnes of CO_2-e.

Another is to assume that BU's purchasing expenditures on goods and services are roughly in proportion to the distribution of services in the US economy as a whole, and then use the ratio of emissions per dollar of GDP (i.e., carbon intensity) to scale an estimate of emissions for BU. Using this method results in an estimate of about 178,000 tonnes of CO_2-e.

Each method has significant uncertainties associated with it. There is no good way to tell which estimate might be more accurate, although comparing the second method to known travel emissions from Concur data suggests that they are similar. We conclude that BU's Scope 3 emissions are likely somewhere around the midpoint of the two, or roughly 202,000 tonnes of CO_2-e.

IV. RECOMMENDATIONS FOR REDUCING SCOPE 1 AND 2 EMISSIONS

The Task Force has considered three abatement scenarios, which we have labeled as BU Good, BU Better, and BU BOLD. Each focuses on reductions to Scope 1 and 2 emissions, since these are directly under BU's control. The scenarios have the same basic elements—meeting BU's electricity demand with renewable energy, increasing BU's investment in end-use efficiency projects by emphasizing improved controls over HVAC and lighting, managing growth by certifying new buildings to LEED Gold, emphasizing low energy use intensity (EUI), and finally, purchasing certified offsets (a reduction of GHGs avoided, sequestered, or destroyed), if necessary to close the gap and meet our commitments. The primary difference among the scenarios is in the level of effort expended in each element and the timing of when BU reaches carbon neutrality for its Scope 1 and 2 emissions.

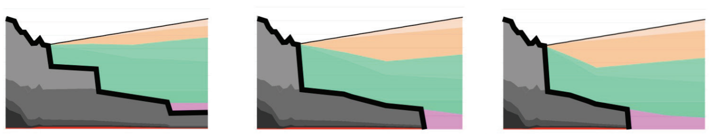
For the University to reduce emissions over the long term, it is necessary to reduce demand while sourcing energy through clean renewable resources. While reducing the energy demand of 15 million square feet will take time and require a continuous effort, it is critical to begin to address the source of our energy as soon as possible. A power purchasing agreement (PPA) will allow the University to begin purchasing renewable energy immediately while beginning its longer-term effort to increase its end-use efficiency. The purchase of renewable energy will result in significant emissions reductions quickly and lock in those reductions over the longer term.

The University is engaged in a process to procure renewable energy through a PPA contingent upon a positive vote by the Board of Trustees. This will allow the University to act quickly to complete a PPA contract and take advantage of the federal tax incentives for renewable energy before those incentives end. The primary criteria developed by the CAP Task Force for purchasing renewable energy include: projected emissions reductions, the inclusion of certified renewable energy certificates, additionality, projected environmental and health cobenefits, education and research opportunities, and project economics. Box 4 outlines each criterion, and how we propose to apply it to Boston University.

Figure 8 shows in schematic form the three scenarios we have analyzed. All percentage reductions are relative to BU's FY2006 emissions. The curves illustrate the suite of strategies and tools we propose be used to achieve each scenario's goals.

FIGURE 8: THE TASK FORCE'S THREE SCENARIOS

ENERGY: RECOMMENDATIONS



Strategies	BU Good	BU Better	BU BOLD
Goal (GHG reduction)	80% by 2050	100% by 2050	**100% by 2040**
GHG Cumulative Reduction MTCO2e through 2050	2,100,000	2,800,000	**3,300,000**
Relative to City of Boston	Falling short	Aligned with goal	**Ahead of goal**
Energy Efficiency Impact % GHG Reduction	17% by 2050	31% by 2042	**31% by 2032**
Energy Efficiency Strategies	Metering, Monitoring & Verification LED Lighting & Controls Existing BAS Optimization BUMC Labs Program	Add: CRC Conversion to Digital Controls Rooftop HVAC Optimization Dorm Energy Controls Optimization	Accelerated Energy Efficiency Schedule
Renewable Energy	50% until 2030 100% after 2030	100%	**100%**
Electrification & Steam to Hot Water	With natural replacement of aging equipment	With natural replacement of aging equipment	**With natural replacement of aging equipment**

BU BOLD

Short Term

1. Reinvest savings from EE
2. RE: 100%

Mid Term

1. EE 31%
2. RE 100%

Long Term

1. Electrification
2. Offsets

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sustainability@BU

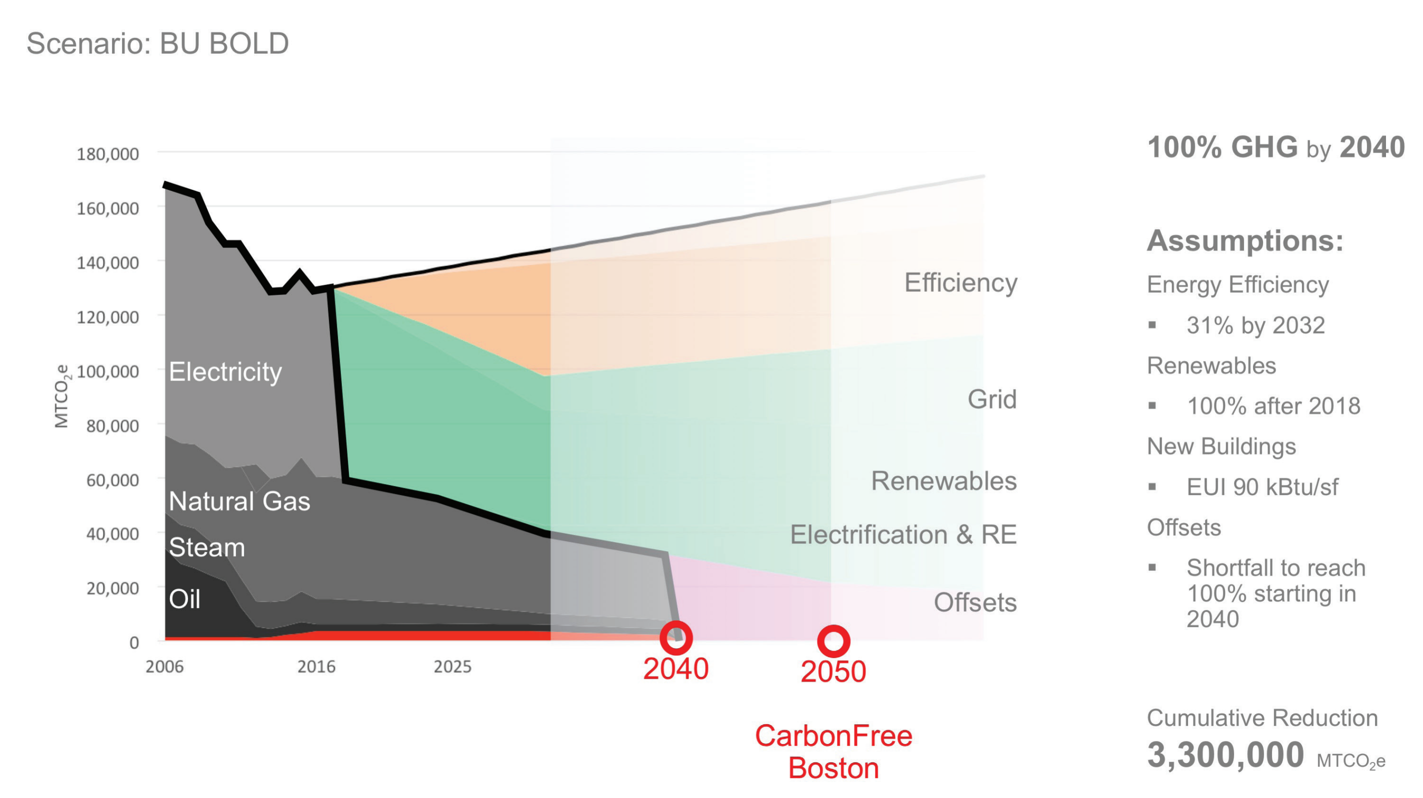
- Reducing demand through energy efficiency is illustrated in orange where the lighter orange represents new construction and the darker orange represents efficiency improvements in our existing buildings.
- The green represents electricity emissions reductions with the light green representing the decarbonization of the ISO New England grid, the middle green representing the purchase of renewable energy, and the darkest green representing the electrification of the energy source used for heating buildings from on-site fossil fuel burning and sourcing that energy from renewables.
- The magenta color represents the purchase of certified offsets to meet the commitments in later years.

The Task Force recommends **that the University adopt the BU BOLD scenario as its target, and seek to reduce its Scope 1 and 2 emissions to become carbon neutral by 2040, a decade earlier than the City of Boston. BU BOLD is an ambitious but realistic strategy that would place the University in a leadership role locally and nationally and would provide the greatest opportunities for sustained environmental benefits**.

BU BOLD (Figure 9) would require the initial PPA to effectively meet all of BU's electricity demand at the beginning and ensure that remains the case in any subsequent PPA later in the scenario. Investments in energy efficiency projects on campus would need to be significantly larger and more rapid than in other scenarios. For example, the University would need to do a conversion to digital controls in 34 buildings and introduce rooftop unit controls in 33, along with optimizing HVAC controls in dormitory spaces. The University would need to enforce LEED Gold certification for new construction that operate at a minimum of 50% better than the building code. The University would hit 100% reductions for Scope 1 and 2 emissions in 2040, a decade ahead of the city's goal.

The other scenarios (BU Good and BU Better) are described in Appendix 1.

FIGURE 9: BU BOLD



BOX 4: REDUCING BU'S GHG EMISSIONS WITH PPAs

PROJECTED EMISSIONS REDUCTIONS

We are seeking a project that will have the greatest impact on emissions reductions. GHG emissions reductions will be greater in markets where more fossil fuels are used to generate electricity. Scientifically, it doesn't matter where reductions come from. Carbon dioxide is well mixed globally, so reductions from any one place are equivalent to reductions from any other place. Through the efforts of the Regional Greenhouse Gas Initiative, ISO New England has already become one of the "greenest" power grids in the country. It is dominated by natural gas and nuclear power, with hydro, wind, coal, and "other" making up the rest. There may be other criteria that favor one location over another such as jobs and air quality. Considering these facts caused us to look for power grids with greater fossil fuel emissions, i.e., grids dominated by coal for current and projected energy generation.

At any one time, the actual mix of energy sources is a function of the demand, which is often a function of local climate and economic conditions. Demand varies during the day, seasonally, and over longer periods of time as a function of how many people are in a region, what kinds of businesses operate there, and technological and policy changes that improve end-use efficiency. Some power plants provide the base load for a region, others come on line when demand increases and peaks. It is important for the University to choose a project not by the average annual emissions on a particular grid, but by the actual marginal emissions generated on the grid at the times when renewable sources are most likely to be producing. We are, therefore, seeking projects where the anticipated emissions from fossil fuels will be greatest on that grid—at the time the renewable energy is being produced, and thus the highest differential of marginal emissions.

Because we are not generating our own electricity, we must find sources of renewable energy, purchase it, and account for the difference between emissions from renewables and those that are emitted on the grid at the time the renewable power is being generated. This is necessary because transmission limitations on the grid do not allow us to receive "green electrons" directly from other parts of the national grid. Our demand will be satisfied by renewable energy produced elsewhere in the country.

RENEWABLE ENERGY CERTIFICATES

An accounting device known as a renewable energy certificate (REC) is used to keep track of renewable energy transactions, and the RECs are then retired. A REC is a contractual instrument equivalent to one megawatt-hour of renewable energy generation on the electricity grid. RECs are the sole means to claim usage of grid-connected renewable electricity in the US and are used for compliance with the Renewable Portfolio Standards within the US. By retiring the REC, no one else can also claim credit for the same renewable energy, thus avoiding double-counting. For the University to have confidence that double-counting is avoided, the RECs will be Green-e Certified. This third-party certification will be provided through Green-e Energy, an independent certification and verification program for renewable energy. It is a voluntary consumer-protection program that certifies renewable energy options offered by utilities and marketers in the voluntary renewable energy market.

ADDITIONALITY

This means the project will generate new renewable energy that would not otherwise have been generated. The concept of additionality can be complex. We have focused on the simplest and clearest definition—the University's contractual commitment and strong credit rating enable the project developer to obtain the financing necessary to build a new project. Without the University's commitment, the project would not move forward. Additionality is an absolute requirement for any project in which we participate, because it is the only way that the University can know that its net demand for electricity is generating fewer GHG emissions than would otherwise occur. Additionality can be determined with sufficient due diligence during the project selection process.

PROJECTED ENVIRONMENTAL AND HEALTH COBENEFITS

All large-scale energy engineering projects have environmental impacts from the construction process and through operations. During the due diligence process for project selection, we will seek projects that minimize their construction and operational impacts and maximize any potential health benefits.

EDUCATION AND RESEARCH OPPORTUNITIES

Access to both real-time data and the physical project sites for research and educational purposes are a requirement for project selection. Since the renewable energy project will likely be a considerable distance from campus, webcams will also be required during construction and ongoing operations of the project. We want the CAP to be transparent, and we also want the actions undertaken as part of it to provide both educational benefits and opportunities for faculty and student research.

PROJECT ECONOMICS

Project economics will be evaluated based on the Net Present Value per megawatt-hour. The PPA will be implemented through a Contract for Differences where the University will be obligated to purchase the electricity at a fixed rate per megawatt-hour over a specified period. Since the electricity in the grid cannot be delivered directly to the University, the electricity will be sold at the hub where the renewable energy is being generated at the wholesale market price at the time of generation. The difference between the purchase and sale prices will generate a monthly bill or a check for the University.

The price of renewable energy projects in any part of the US grid varies widely due to many factors. Whether new transmission capacity needs to be added, the demand for new renewable energy, the availability of technology, the credit worthiness of the developer, the availability of capital for projects, and the assessment of how the energy market is likely to evolve all influence the prices that can be negotiated for renewable power. Prices vary geographically in different parts of the grid fairly substantially, with the New England region having high prices compared to other parts of the grid.

V. RECOMMENDATIONS FOR INCREASING RESILIENCE

We are already in a world where climate change impacts are evident domestically and internationally, and where the underlying science is clear that impacts will continue to increase, absent action to reduce GHG emissions. Moreover, even if GHG emissions were to stop immediately, their long lifetimes in the atmosphere would ensure that climate change would continue for decades. Thus, building resilience to current risks and adaptation to potential future impacts are essential in any serious response to climate change.

FIGURE 10: THE 1% EVENT IN 2070

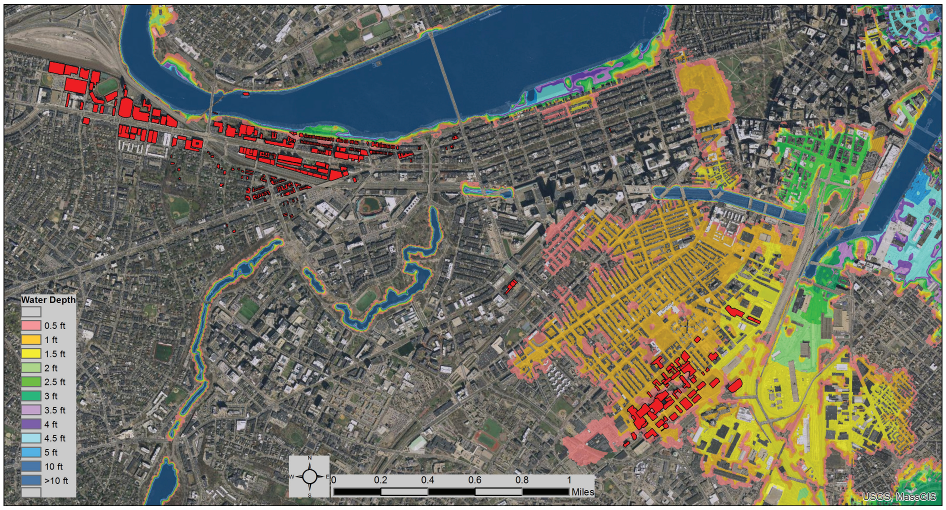
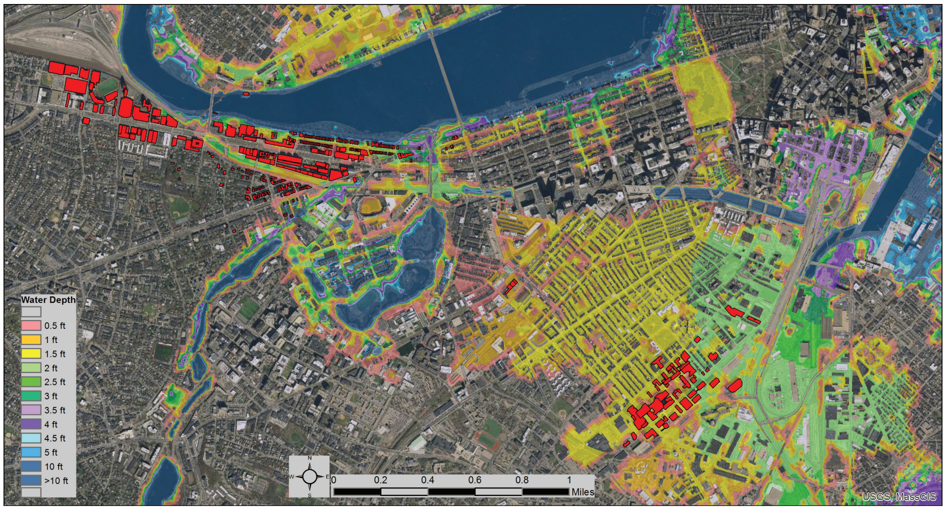


FIGURE 11: THE 0.2% EVENT IN 2070

Any assessment of future risk needs to consider a) the probabilities of events and their potential magnitude b) resources at risk and c) cost of responding to events. For the probability of such flooding events, we used the same scenarios of the future climate that have been used by the City of Boston in their vulnerability analysis. Future climate is not perfectly predictable on such local scales, of course, but the use of scenarios provides reasonable guidance for the changes in probabilities of severe events associated with a changing climate system. As far as the presence of resources at risk and cost of response to flooding events, the Task Force recommends a thorough evaluation for the Medical Campus where the impact is known to be much higher than the CRC, for which a rough estimate is shown below. The Task Force also recommends a deeper analysis of impacts with regard to heat waves.

In Section I, we discussed the current state of resilience of the BU campuses. Neither the CRC nor the Medical campus has recently experienced either flooding or heat waves that have caused severe damage to University property or seriously altered the quality of life for students, staff, or faculty. At the same time, there are known vulnerabilities in our infrastructure, as has been revealed by previous vulnerability studies, especially to water. A major challenge is understand-

FIGURE 12: THE 0.1% EVENT IN 2070



ing how the probability of environmental challenges is likely to change as the physical climate system changes and how that might affect the distribution of costs required to recover from those damages.

Examination of the scenarios used by the City of Boston to evaluate its own vulnerability reveals a potentially very different situation by around 2070, roughly 50 years from now, should no additional preparation be taken. By that time, a flood that is due to a 1-in-100-year event would be far larger than a flood of similar probability today and would result in major inundation and damage on the Medical Campus and even parts of the CRC (Figure 10). If BU were still to be insured to the 0.2% event at the same level of financial risk, there is an extremely good chance that such an event would incur significant costs (Figure 11), possibly exceeding coverage limits. A 1-in-1,000-year event (Figure 12) would be extremely expensive to recover from and would almost certainly exceed the coverage limits. The extent of inundation in the city as a whole suggests that BU by itself might not be able to recover sufficiently to continue operations on the current campuses in the aftermath of such an event.

These probabilities may seem small, but it is important to keep in mind that, in a 30-year period, the likelihood of a 1-in-100-year event taking place is 26% if the underlying probability doesn't change. And in this case, the probability is actually increasing over that period of time. BU is likely to experience such an event in the coming decades, well within the lifetime of most of its infrastructure.

Exposure to the physical threat itself is only part of the picture. Of additional concern are the resources at risk. Based on the building walk-throughs conducted by the Task Force on the CRC, most of the buildings on Bay State Road have their boilers and electrical equipment in the basements. With one exception (paper files that are stored in the basement of the General Counsel's Offices), Bay State Road does not contain research-related resources or University-related resources that are potentially or practically irreplaceable. There are possibly some assets in the College of Arts & Sciences (CAS) that would be vulnerable to a major event (e.g., ice cores from Antarctica that are stored in secure facilities in the basement). The major concern for floods of different magnitudes would be cleanup costs, including the time potentially lost while cleanup and repair occurs.

The costs of responding to major flooding events are likely to be substantial. Estimates based on surveys of buildings on the CRC range from about $65 per square foot to $75 per square foot for cleanup costs due to major floods that inundate basements and prohibit access for several days. On the CRC, for buildings on Cummington, and for CAS, this translates to roughly $1M per building for an extremely severe event. Costs per square foot for the brownstones on Bay State Road would be similar, and although each building is much smaller, access is difficult, and the brownstones all have heating and electrical equipment in the basements. Depending on the actual size of the building, cleanup costs for brownstones would range from $15K–$70K per building.

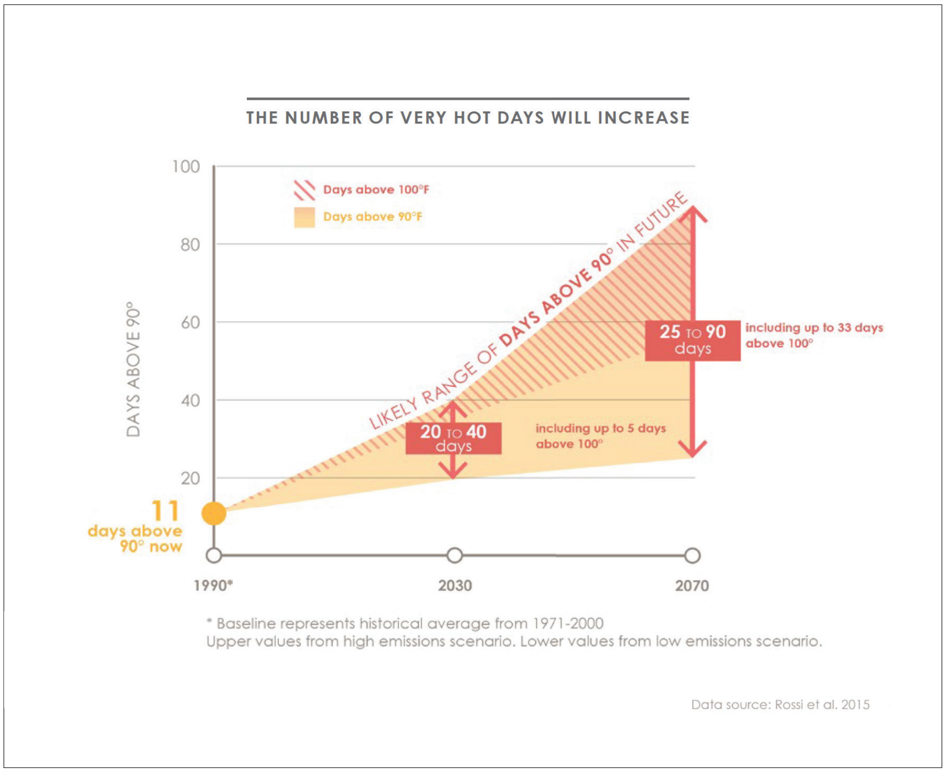
The conclusion of these coarse-grained analyses is that a major flooding event would indeed be quite expensive to recover from, almost certainly costing in the $2M–$10M range for the CRC alone, with a possibility of much higher costs. The Medical Campus is estimated to have $25M of exposure to storm water damage, and the BU Boathouse by itself is in the range of $5M of exposure.

The situation on the Medical Campus is substantially different. Not only is the potential exposure to flooding threats considerably higher, but there are many resources housed on the first floors and basements of the existing buildings that are pragmatically irreplaceable for either research or clinical purposes. **We have not attempted to calculate the costs in this report, but strongly recommend that the University undertake to do so separately from the CRC, as soon as possible.**

The situation with respect to heat waves and air quality is a bit different. Boston currently experiences around 11 days a year with temperatures higher than 90°F. Scenarios of the future analyzed by the City of Boston show this number increasing to around 20–40 days by 2030, and even more (25–90) by 2070,

depending on whether a low-emissions or high-emissions future scenario is examined (Figure 13).

FIGURE 13: DAYS ABOVE 90ºF



Housing, business, and public infrastructure are not designed to deal with heat waves of these durations. While the summer months are generally thought of as the time when BU has fewer students and faculty in residence, in fact, University housing on the CRC is in broad use, as are many classrooms and laboratories on both campuses. Heat waves have been a significant source of morbidity and mortality in cities around the world for decades, and this stress is expected to increase. While some cities have put Heat Adaptation Plans (HAPs) in place, their effectiveness is poorly understood. **BU also has to consider its relationships with surrounding communities in terms of providing cooling centers should major heat events occur.**

In addition to heat waves, ground-level ozone pollution has long been known to be potentially sensitive to a warming climate, and although Boston and eastern Massachusetts are currently within Environmental Protection Agency (EPA) guidelines for ozone, a warming regional climate will make that more difficult. Fine particulates (PM2.5) are a current health hazard but are relatively less sensitive to a changing climate. However, both ground-level ozone and PM2.5 concentrations are sensitive to both the volume and type of vehicular traffic at both local and regional scale. BU's own fleet of vehicles is far too small a fraction of the total traffic volume in and around either campus to be a significant source of pollution. But the overall volume, congestion, and timing of traffic patterns is clearly an issue for the city, both in terms of air pollution and GHG emissions, and how Boston and the Commonwealth of Massachusetts decide to regulate vehicular traffic to meet future GHG and air-quality goals will be the significant forces affecting the exposure of the BU community. In addition, it is worth noting that some of the strategies to make BU resilient to heat waves (e.g., increased access to air-conditioned spaces) can also reduce exposures to air pollution, which tend to increase during extended heat waves.

For increasing the University's resilience to water damage, some of our recommendations are for current or near-term actions; others are for the longer term. Specificallly:

The University should invest in portable flood barriers against water damage to avert or minimize damage from 1% events (i.e., the 1-in-100-year flood) on a case-by-case basis, after an examination of the relevant risks and costs. No retrofits on the CRC are recommended at this time.

The University should perform additional analysis of the expenses for a 1-in-1,000-year event. The University is currently insured for a 1-in-500-year event, but the insurance does not account for future environmental conditions, when the 1-in-100-year events will be of the same magnitude as today's 1-in-500-year event.

With respect to heat waves, at this time the most prudent course of action would be to make sure that early warning capabilities are developed. The existing relationships with the National Weather Service (NWS) that have proven to be useful in preparing for significant storm events should also encompass warnings for serious heat waves. Planning should begin for establishing cooling centers on campus for those heat waves deemed severe enough that cooling centers will be necessary; this should include

a ready-to-go information campaign about the centers targeted at residents of those housing units that do not currently have air conditioning and could therefore be at risk in a serious event. Coordination with the City of Boston would be worthwhile, so that BU and the City of Boston are in sync on criteria for responses to excessive heat. **The same course of actions should occur with air quality, ranging from ensuring the University gets air-quality alerts from the NWS, to increasing the density of real-time air-quality monitoring on both the Charles River and Medical Campuses.**

The University should begin and maintain an ongoing effort to develop risk-based resilience analysis, incorporating both the likelihood of flooding, wind, and heat events and the costs of responding. A full-time staff member should be hired to coordinate resilience actions and prepare a plan for enhancing the University's resilience over the coming decades.

Although there are few irreplaceable research resources in basements on the CRC, there are likely to be many on the Medical Campus. The University should begin now to develop guidelines for moving such resources out of the basements in an orderly way to reduce overall risk.

In general, we have concluded that retrofitting existing buildings is unlikely to be a wise expenditure of funds. However, when buildings are due for maintenance or refurbishment, there is an opportunity to make reasonable structural changes. For example, this would be an optimal time in a building's lifetime to move critical equipment in basements or first floors to higher floors. The City of Boston is using an elevation of 19.5 feet above Boston City Base, which is equivalent to 7.3 feet above current high tide (7.3 feet MHHW) as a resilience elevation, but this can be set to a higher value by the University, if warranted. At the same time, it would be wise for the University to collaborate with the City of Boston on resilience zoning, to allow for greater building height and floor-area ratio (FAR) to offset the loss of floor area to flood exposure.

With respect to excessive heat, we are not recommending retrofitting existing buildings. But the feasibility of installing air conditioning should be considered strongly when buildings, especially dormitories, are in need of major renovation. There are no data currently available for the extent the effects increased penetration of air conditioning will have on BU's energy demand, but it is clear air conditioning will increase demand. Minimizing increased energy consumption from air conditioning will be an important consideration during the design process. This impact will need to be monitored as part of the overall upgrade in monitoring for energy efficiency.

The University's infrastructure will not remain constant, of course. As space and finances allow, new construction projects will be planned on both the Charles River and Medical Campuses. We therefore also make recommendations for future construction of BU infrastructure. **The most immediate recommendation is that new construction on either campus should not have electrical or mechanical controls or equipment in the basement or the first floor. Indeed, in most cases, buildings without a basement would be preferable. But if basements are necessary, they should only be used for nonessential services and constructed so that they can be easily cleaned and repaired if/when they are flooded. Potential uses might be for parking, for example. Building design should maximize energy efficiency from the beginning and use as much natural ventilation as possible to reduce the overall need for air conditioning.**

At some time in the future, it is possible that regional solutions to reduce the metropolitan area's vulnerability to flooding will become necessary: e.g., proposals to build floodgates around the Harbor Islands. Should that come to pass, the University may face a decision as to whether its funds are more effectively spent on a regional solution, rather than deal specifically with campus-level vulnerability. However, this prospect, while possible, seems long enough in the future not to be an immediate concern. It is also possible that later in the century, if the world remains on a high emissions/high GHG concentration pathway, the Medical Campus and the lower end of the CRC become essentially unusable because their functioning would be disrupted too frequently. In that case, BU's options might include a planned migration out of its current configuration to farther up Commonwealth Avenue. But we are a long way from needing to do that.

VI. BEYOND SCOPE 1 AND 2 EMISSIONS

The Task Force's initial proposal focuses on the University's direct emissions and emissions incurred as a consequence of our purchases of electricity. But these are clearly not the University's only GHGs of consequence. There are Scope 3 emissions that result from the everyday business of the University's operations, but which the University does not directly control. In this section, we explore the emissions from transportation and from the purchasing and waste streams of the University, with an eye toward beginning to quantify them and identifying options either for reducing them, or for pilot studies that will give the University the data it needs to identify better options for reducing them.

TRANSPORTATION

The Task Force has done a preliminary estimate of the transportation emissions that are a consequence of BU's annual activities. In doing so, we have taken a much broader view of what "counts" than other universities have done in their CAPs. Our philosophy is that we should identify transportation-related emissions from BU employees (faculty and staff), but also those incurred by both undergraduate and graduate students, since we compel their appearance on campus. In addition, the Study Abroad program, a centerpiece of the BU undergraduate experience, generates substantial travel emissions each year, as more than 1,000 students participate on an annual basis. For BU staff, the primary transportation-related emissions are from commuting to and from campus. For faculty, on the other hand, there are commuting emissions, but there are also emissions that are a consequence of travel on grants, serving on review panels and advisory committees, and generally pursuing their research and teaching responsibilities. BU also operates a small fleet of vehicles, from its campus police force to vehicles for the operations and maintenance staff, and the athletic department. Finally, there is the BU Shuttle, which technically is operated by contractors, but which would not exist without the University's demand.

Our philosophy in identifying these emissions and beginning to estimate their magnitudes is that they are the inevitable consequence of BU's research and educational mission. We have chosen to be an internationally important research university with a selective undergraduate population of students, and these choices lead us directly to these kind of travel costs. We should understand them and begin to understand how we can reduce their environmental impacts.

Using simplifying assumptions, we have derived an initial crude estimate of the emissions from all these activities, which we calculate to be roughly 31,000 MTCO2-e, or roughly 25% of the total Scope 1 and 2 emissions, as discussed above. These numbers are highly uncertain because we lack data on many of the means of transportation, and they are sensitive to the assumptions underlying them (e.g., we assume one round trip per year for international students).

Most of the decisions about travel-related emissions are individual choices that balance time, money, convenience, environmental impact, and many other factors. For the most part, except for emissions of the BU fleet itself, they are not under the control of the University, nor will they be. The challenge for BU then becomes what can the University do to reduce these emissions through indirect means, either with policies that nudge choices in an environmentally favorable direction or through providing information or other services.

Our recommendations for reducing emissions from transportation, therefore, are largely a series of pilot studies, to be conducted over the first two to three years of the BU CAP. Pilot studies would have two primary goals: to get a better understanding of what the transportation-related emissions really are, by reducing the uncertainties in the data and in the calculations; and to identify how much influence the University can in fact wield on the individual decisions that result in the bulk of the emissions.

With respect to air travel, a primary need is to put in place monitoring programs, which may be survey-based, to track non-Concur-based travel of faculty and staff. Accurate reporting of student travel habits will also be important. A third element will be to provide easy access to information and action on offset programs for air tickets and other ticketed travel and then track to see how much of an effect, if any, provision of this information has. Finally, a communications effort should be mounted to more fully explain the teleconferencing

options that already exist within BU, which are not broadly appreciated, and see whether they can be expanded.

Transportation demand management (TDM) will clearly be necessary to handle commuting and staff-related activities. With the decline of parking capacity, introducing zone parking with dynamic pricing will better align parking demand with availability across campus. This would be an immediate enhancement, but it also requires deploying new parking technology, sensors, and management systems to make it work; we currently monitor parking lots essentially by having staff walk around and do visual surveys, which is not an effective way to manage a more sophisticated parking system.

There is some existing support infrastructure for electric vehicles. But this could be usefully expanded, potentially in stages, as they become more common in the BU community. Enhancing existing programs in commuter choice for public transportation, including such programs as Workout to Work and Guaranteed Ride Home, could also be attempted. These would need to be implemented as pilot programs and the results tracked carefully, so the University can make a judgment as to which programs are the most effective and why.

All such programs would likely also require a very close working relationship with the City of Boston, the City of Brookline, and the Mass DOT to enhance opportunities for multimodal solutions.

The BU Shuttle is a Scope 1 transportation element. It is useful but could become much more efficient. **Simple steps would include upgrading the GPS system and mobile app so that it provides closer to real-time information that can help potential passengers make the decision to wait, walk, or use some other mode of transportation (e.g., cycling). Over the longer term, the University should do a study of the implications (both emissions and costs) of shifting to electric buses in the 2022 time frame.**

Scope 1 emissions in transportation also include the emissions from the BU Fleet itself, including maintenance vehicles, the campus police force, and vehicles for Athletics and some University departments. **As vehicle technology and costs continue to evolve, we recommend a pilot study using electric vehicles in some departments by 2020, and then, depending on the results, phasing in an electric fleet during the 2020s, as routine maintenance and replacement schedules allow.**

Finally, the continued development of a Bicycle Master Plan should be supported, to ensure that this alternative transportation choice remains available and safe, especially for moving around the CRC.

PURCHASING AND WASTE STREAMS

The University obviously has a very large footprint of purchasing, using, and ultimately discarding all sorts of items, from paper and furniture to laboratory equipment. We also are the major provider of dining services for the resident undergraduate population and many others in the University community. The challenge of how to handle the various and diverse waste streams from University operations has been a focus of *sustainability*@BU, Dining Services, and Facilities Management & Planning for many years. Each of these operational categories generates a footprint of GHGs—in part embedded in the products themselves and certainly from the transportation needed to get them to BU and remove them from campus—and then also from the method of disposal, whether it is reused, recycled, landfilled, incinerated, gasified, or composted.

The challenge from the CAP perspective is that while we know that many, if not most, of these emissions can be characterized and calculated, in practice the University collects waste data in tonnage but has not collected the data necessary to calculate associated emissions. At the same time, it is clear that from an overall sustainability perspective, there is a great need for the University to continue the advances that have been made under that rubric. Indeed, characterizing emissions footprints from purchasing, food, and waste disposal comes down to a need for consistent life-cycle analyses for products, delivery, and how the University disposes of waste—from the standpoint of their GHG emissions. This has not been done, and while improving our sustainability goals likely will reduce GHG emissions overall from these activities, we cannot document the extent of the effect at this time.

For purchasing of durable and disposable goods, we recommend that the University make a policy commitment to reduce use and reuse goods whenever applicable, and that it implement tracking systems that would enable staff to make progress on that commitment. This would accelerate existing sustainability goals. Those goals can also be accelerated by ensuring that sustainability-related requirements, such as use of more sustainable practices, better corporate reporting, reduced packaging, and consolidated delivery schedules, are used as selection criteria in future RFPs for services, and that there are data-provision requirements in the subsequently awarded contracts. Demand-side management could begin to be implemented through enhanced training, especially for administrators and other employees responsible for purchasing, and nudges toward more sustainable products.

Dining Services have made enormous strides in their overall sustainability goals, but again, we have little idea how that translates into GHG emissions. Aramark, the primary contractor for BU, is an industry leader in sustainability. Our qualitative assessment is that the University could require Aramark to provide the information needed for life-cycle analyses, thus building on the current strong efforts to reduce pre- and post-consumer waste.

Waste diversion and disposal has been, and remains, an important sustainability goal, but characterizing its GHG signatures is elusive. Contractors have some data on amounts of waste that they pick up from different locations on the BU campus but not the composition of the waste, which can make a huge difference in emissions signatures. Food waste is either gasified or composted; other waste is reused, recycled, or incinerated. The average construction waste diversion rate from BU's LEED projects is 91%. Construction waste diversion from non-LEED projects is not tracked. **At this time, we recommend that the University pursue Zero Waste Certification on a pilot basis with the US Zero Waste Business Council, and establish a Zero Waste Sustainability goal (which in reality means that 90% of our waste would be diverted away from landfills, including 90% of construction waste). In addition, we recommend that tools for life-cycle analysis and embedded carbon analyses be developed as educational resources and then applied to major components of the University's spending profile so that better information on GHG emissions can be developed over the next several years.**

VII. CURRICULUM AND RESEARCH

The University's highest priorities will always be its research and educational missions. It is therefore imperative that the BU CAP have a meaningful interface with both of these central aspects of the University.

Throughout the development of the CAP, we have already benefited from significant interactions and contributions from both graduate and undergraduate students. But more can clearly be done. Three areas of the University's pedagogical assets in particular stand out as opportunities: the BU Hub, the Kilachand Honors College, and the Frederick S. Pardee School of Global Studies. The BU Hub is a renewal of BU's philosophy about undergraduate education. It focuses on the development of a set of skills and an interdisciplinary approach to learning that prepares students for both a more complete understanding of the world, and their place in it as ethical, global citizens. Little of the Hub's approach is based on specific topics, but focuses instead on the development of critically important intellectual skills and habits of thought. The Kilachand Honors College strongly emphasizes diversity in thought and perspective. Throughout their four years of matriculation, one of the four course slots each term consists of a core curriculum that is explicitly interdisciplinary, spanning the arts and humanities, natural sciences, and social sciences. Kilachand core courses are team-taught by professors from diverse disciplines who engage the students in intellectual and problem-solving apprenticeships, attacking the great challenges facing society that will shape the students' lives and careers. In this way, Kilachand serves as a crucible for interdisciplinary teaching across the One BU. One of those challenges is anthropogenic climate change, and the Kilachand sophomore core course for 2018 is being reinvented with climate change as its thematic focus. The Frederick S. Pardee School of Global Studies trains undergraduate and graduate students for careers in international relations, political science, and global policy. Environmental policy is in the mix but not a principal focus of the school. The importance of climate change as a driver of human affairs is both a reason and an opportunity to strengthen environmental science and policy in the Pardee curriculum.

There are, in our view, a handful of topics or issues that encompass such a broad scope of science, ethics, diplomacy, engineering, health, and a regard for global citizenship that it is hard to imagine a situation in which they do not touch nearly every aspect of an undergraduate's educational program. We believe that climate change and, more broadly, sustainability are such topics. **In pragmatic terms, we propose that every undergraduate be touched in some way in their educational program by exposure to some aspect of these issues before they graduate.** We are not advocating that every BU student become an expert on change in the physical climate system, but any well-educated person should have an appreciation for the way that these issues spread throughout the broad range of intellectual pursuits available to them at BU.

We have done an initial analysis of the courses offered at BU that specifically call out climate change and/or sustainability as topics. Our intent has been to identify where there might be gaps in which courses could be developed, using the Hub guidelines, to ensure that a more complete appreciation of the complexity of climate change and sustainability could be developed. With respect to climate change, there are multiple courses offered on various aspects of the physical science of the climate system, and some dimensions of climate change are captured in courses on terrestrial and marine ecology. Similarly, there are some courses on international environmental policy and agreements in which the climate change debates play an important role, and a small number of courses on US environmental policy. But there are essentially no courses on the ways in which local, state, and regional climate policies might interact with national and/or international policies. There are no courses specifically on climate economics. There are no courses specifically on climate impacts overall, and very little focus on climate as a contributor to public health challenges around the world, either directly or indirectly. **It is our view that all of these gaps (and more we do not have the space to articulate here) provide a huge opportunity for the BU academic community to propose curricula that would delve more deeply into the scientific, economic, governance, engineering, social, and ethical challenges that climate change and sustainability pose to current and future generations.**

Throughout the CAP, there are multiple opportunities for using the campus itself as a laboratory for further study and research opportunities for both faculty and students.

BU is uniquely positioned to offer students research opportunities for understanding the intrinsic connections between human society and ecosystems, especially along the urban-rural gradient. Students can gain a solid understanding of the overall fluxes of material and energy among land, water, and the atmosphere both on campus (e.g., carbon and nitrogen monitoring stations in the heart of the city) and at other BU-related facilities, such as Sargent Camp in New Hampshire and the University of Belize marine laboratory at Calabash Caye, and through BU's collaborative relationship with the Massachusetts Audubon Society and its statewide system of ecological reserves.

These assets and institutional relationships also provide opportunities for better understanding of the interactions between biological diversity and ecosystem processes. Developing tools for life-cycle analysis and engineering studies of energy efficiency options provide fertile research grounds for faculty and students interested in how energy-efficiency investments might make a difference in practice and should provide practical goals for fundamental research in materials and in energy systems. More careful monitoring of energy use, of the urban climate on the BU campus, and analysis of water- and heat-related threats can lead to new insights about both climate mitigation and adaptation. BU's campuses could become experimental testbeds for urban carbon sequestration and other ways to reduce our GHG footprint. And because both threats and opportunities for BU will change over time, there should be renewed emphasis on fundamental understanding of how both physical and built environments are changing over time. We should also recognize that the CAP will itself generate an enormous amount of information on energy use, economics, biogeochemical fluxes, and decision-making as a process incorporating both rational economics and other aspects of institutional behavior and can be both a generator of information and an object of study in its own right.

But while it is clear that both the educational and research missions of BU can be strengthened vis-à-vis using climate change and sustainability as lenses through which to focus our efforts, how this is to be accomplished is less clear. The University could leave it up to individual departments, schools, and colleges. But this makes the opportunity to understand how the University's research and educational enterprise is responding to climate change and sustainability issues both everyone's job and no one's job. There would be no focal point for information or for nurturing the kind of interdisciplinary collaborations that should characterize the University's response to this call.

We therefore propose that the University establish an academic Initiative on Climate Change and Sustainability. From a research perspective, the initiative would play a coordination role in stimulating climate and sustainability research on campus, ensuring that BU's campuses themselves become a unified laboratory for measurement and experimentation and catalyzing interdisciplinary collaborations that would otherwise be difficult to convene. From an educational perspective, the initiative would work with departments and schools to characterize the suite of courses that address climate and sustainability issues, identify gaps, and advocate for strategies that would address those gaps in both undergraduate and graduate education. From the perspective of ensuring continuing engagement of the BU community, the initiative would sponsor seminars and conferences, provide ongoing monitoring of the University's response to the CAP, and generally provide a focal point for the University on climate- and sustainability-related issues.

VIII. HOW MUCH DO THESE RECOMMENDATIONS COST?

The Task Force's charge includes understanding the potential costs of the recommendations we have made for BU to reduce its Scope 1 and 2 emissions to neutrality by 2040, creating a pathway for dealing with Scope 3 emissions, and improving the University's resilience. In fact, the costs we need to consider would be the incremental costs of moving forward. We can think of these costs as being in several categories:

- Costs of a PPA: i.e., any incremental costs associated with buying renewable energy
- Investments in end-use efficiency projects associated with improved controls over HVAC and lighting
- Investments to replace equipment and technologies with more efficient equipment
- Costs associated with Scope 3 emissions
- Costs of increasing resilience, which could include moving valuable material out of basements and installing temporary flood barriers

As noted earlier, the University is engaged in a process to procure renewable energy through a PPA and now, from bids received from 127 wind and solar projects in the US, we expect this renewable energy purchase will only be at a modest cost to the University. PPA prices we have been offered have dropped by 45% from November 2015 to November 2017. Electricity grid prices where this power will be sold have generally remained flat since 2015 and are projected to continue flat over the next several years. The University is continuing to analyze the financial risks.

We have done a fairly detailed analysis of the cost of end-use efficiency projects that take advantage of improved controls over HVAC and lighting. The bottom line is that for the first decade, investments are likely to be in the range of $7.5M per year, and those annual costs are likely to persist for the 14 years we project for such projects in the BU Bold scenario, adding up to as much as $170M. However, we also calculate those projects to have an internal rate of return close to 10%, calculated over 30 years, with a net savings reaching positive values at around 14–16 years. In the second decade, there are net benefits, which grow significantly with each subsequent year. Total cost savings from energy-efficiency projects are projected to be as much as $135M over the same 14 years. We have additionally proposed an expansion and some changes of operation for the current revolving loan fund that would allow capital from project savings to be used for the next round of projects. Appendix 2 provides more detail.

At this time, we cannot forecast incremental costs of purchasing new equipment as part of end-use efficiency projects. However, because the gains associated with better controls are so large, we believe that replacing outmoded equipment with more modern, more efficient equipment can very likely be done on existing maintenance schedules. We believe this will make any incremental costs much smaller than they would be if there needed to be premature retirement of equipment.

Incremental costs associated with Scope 3 emissions can only be estimated after the University has conducted appropriate pilot studies. Some of our recommendations in the near term are for better data collection and monitoring, and while these costs will not be zero, they are also likely not to be large.

Finally, near-term incremental costs associated with increasing resilience are likely to be small but, as our risk grows, could become more substantial in ways that we are not able to estimate at this time. Results from a more detailed analysis of the Medical Campus will be needed before more can be said.

Our 10-year financial forecast is now complete. The University should be considering the total costs of our recommendations to be in the neighborhood of $141M for capital investments and operating expenses over 10 years. These investments are expected to return a cumulative savings of over $85M to be reinvested into the Climate Action Investment Fund. For purposes of comparison, the University's calculation of incremental costs for its 10-year strategic plan are about $1.8B, more than 10 times as large. In the second decade of the BU Bold scenario, while new costs will be incurred, the financial benefits of the energy-related projects should grow substantially, making the net costs over a long period of time much smaller and potentially even becoming net benefits.

IX. HOW DO WE MOVE FORWARD SYSTEMATICALLY?

This is the core of BU's first CAP, but under no circumstances should it be the last. The Task Force's recommendations are built around our current circumstances with respect to emissions and vulnerability, but they also revolve around several potential scenarios of the future, with all their attendant uncertainties. As stated previously, we are more confident about the near-term aspects of these scenarios, and our uncertainty increases as time passes. This is for simple reasons: we have assumed reasonable ways in which the future might unfold, but how the future actually unfolds will depend on legal, technological, financial factors, how fast the University learns, how fast the New England grid acquires more renewable energy, what happens to other regional grids where we have PPAs, and so on. These factors are not completely predictable, so BU will need to maintain flexibility to adjust its course as time goes on. Monitoring the University's performance on at least an annual basis will be necessary, of course, but is not enough by itself. **We also recommend that the CAP be reviewed by the University, and revised at five-year intervals, with minor adjustments as needed on decadal time frames. The most efficient way to do this is to integrate the review and revision process with the University's strategic planning process. This would also encourage the full integration of the CAP into the everyday operations of the University.** Figure 14 right illustrates this concept.

It is important also to recognize that BU is not alone among major universities in pursuing a climate action plan. The Task Force has reviewed the goals and schedules that other universities, both peer institutions and other institutions of interest, have set for themselves. Figure 15 shows how BU's goals and schedules exemplified in the BU BOLD scenario compare to those of other universities and colleges. Implementing the CAP as we have recommended would result in BU being among the national leaders in climate action plans in terms of percentage reductions and aggressiveness of schedule.

FIGURE 14: TIME FRAMES FOR BU CAP REVISIONS AND THE BU STRATEGIC PLAN

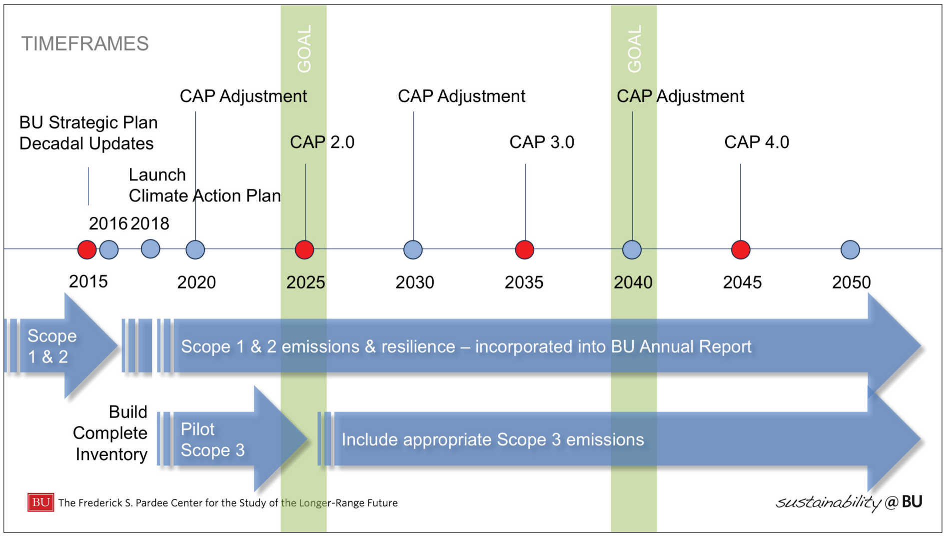
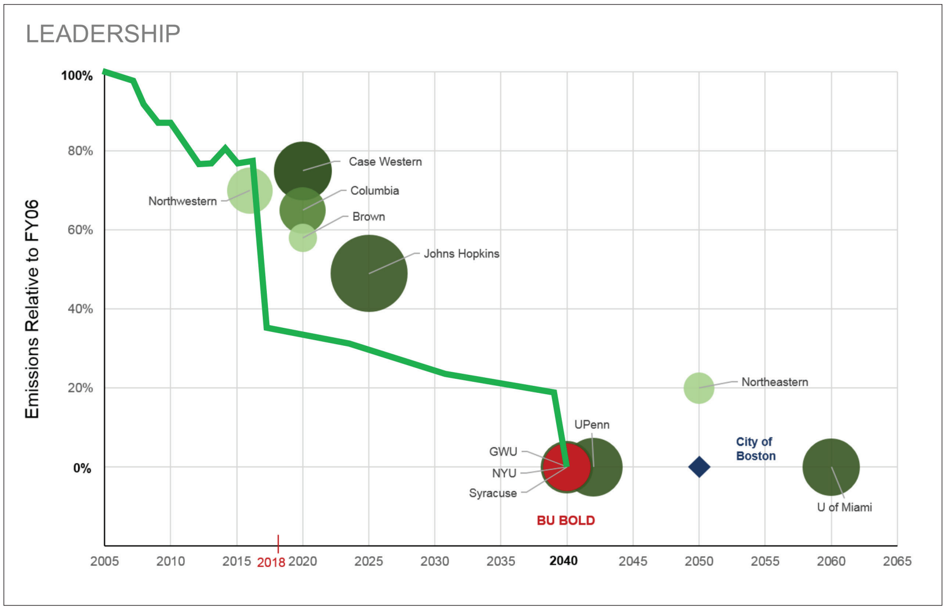


FIGURE 15: BU BOLD EQUALS BU LEADERSHIP



X. A VISION OF CAMPUS FOR THE FUTURE

FIGURE 16: A VIEW OF BU GREENS

Our current recommendations are incremental; they consider a BU campus that is more or less similar to today's. But as an offshoot of the Task Force's efforts, we also have considered what a more environment-friendly, "green" BU campus would look like. Using permeable materials instead of concrete, with much more green space and local installations of renewable energy from wind and solar, would create a campus that is more livable, more resilient, and more welcoming in the midst of the city. An example of what the BU Greens, our vision for the campus of the future, might look like is shown above (Figure 16). A more detailed discussion will appear along with the individual working group reports.

XI. CONCLUSION

Boston University has chosen to be great, even when resources were constrained and the path forward was not easy or obvious. The most important interpretation is for the future. We are at a point in our institutional evolution where we must make the kinds of choices that will move the University forward. In other words, if we can't do everything brilliantly at once—and we can't—then we must make smart, difficult choices. We must make selective investments that will give us the biggest impact and that will do the most to improve the University's overall standing in the years to come.

This is the core concept expressed in Boston University's Strategic Plan. It is also the core concept behind the Task Force's recommendations to BU for the first version of the CAP. We believe that with aggressive action to reduce the University's GHG emissions, to increase the University's resilience, and to promote the educational and research enterprises with respect to climate change and sustainability, that BU will continue on its quest to be a leader. We have recommended an extremely aggressive approach for reducing BU's emissions, that will require significant investments to achieve, but that we believe is feasible, prudent, and ultimately important for reducing the University's long-term reliance on fossil fuels. We have also recommended initial steps and longer-range planning to increase the University's resilience to change that cannot be avoided, so that we can continue to be resilient while our risk is still manageable in the current environment.

APPENDIX 1: BU GOOD AND BU BETTER SCENARIOS

In BU Good (Figure A1.1), an initial PPA to provide roughly 50% of our current electricity demand would be needed, and our assumption is that such a contract would be in force for a dozen years (2018–2030). After 2030, an additional PPA would be needed in order to meet the rest of BU's electricity demands. In the period between 2018 and 2050, an additional 17% of emissions reductions would be implemented through energy-efficiency measures. Energy-efficiency measures would involve continuing to replace lighting with LEDs (79 buildings by 2050), optimizing existing Building Automation Systems (BAS) (19 buildings), and optimizing airflow in the BUMC labs (6 buildings). Improved metering and monitoring of energy use would be required, and about four additional staff would need to be hired. This could be accomplished with annual project expenditures of about $4M per year, and improving 1–2 buildings per year, with a net cumulative break-even point at around 14–15 years. As the campus grows at .75% per year (25% by 2050), holding emissions growth down in new buildings becomes a critical strategy. This could be done by enforcing LEED Gold certification for new construction that operate at a minimum of 30% better than the building code. To reach and maintain the final goal of 80% emissions reductions by 2050, BU would need to purchase certified offsets starting in 2050. The later years of the scenario are clearly more uncertain than the early years.

BU Better (Figure A1.2) has the same general elements as BU Good. In this case, though, the initial PPA would need to be significantly larger—effectively meeting all of BU's electricity demand at the beginning and ensuring that remains the case in any subsequent PPA later in the scenario. We assume changes in the New England grid that are identical to those in the first scenario. However, investments in energy-efficiency projects on campus would need to be significantly larger and more rapid than in the BU Good scenario.

FIGURE A1.1: BU GOOD

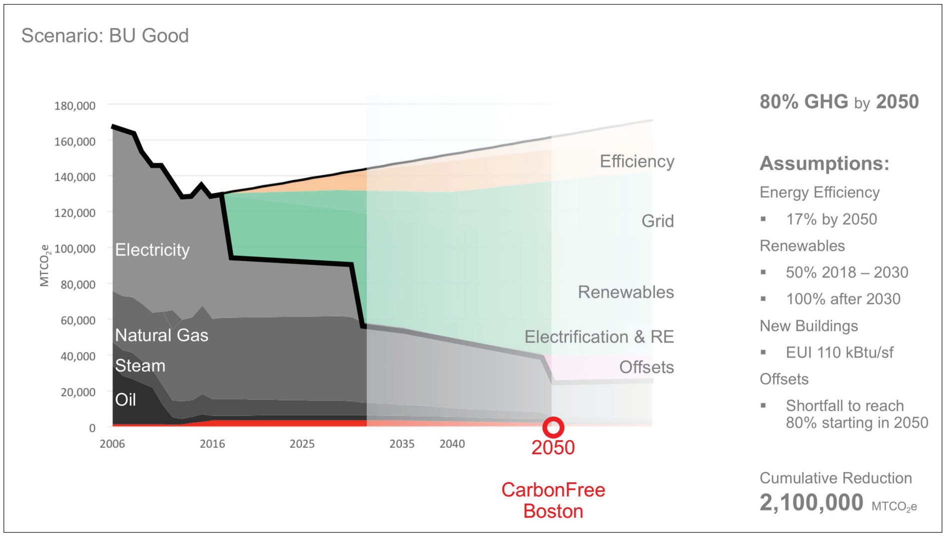
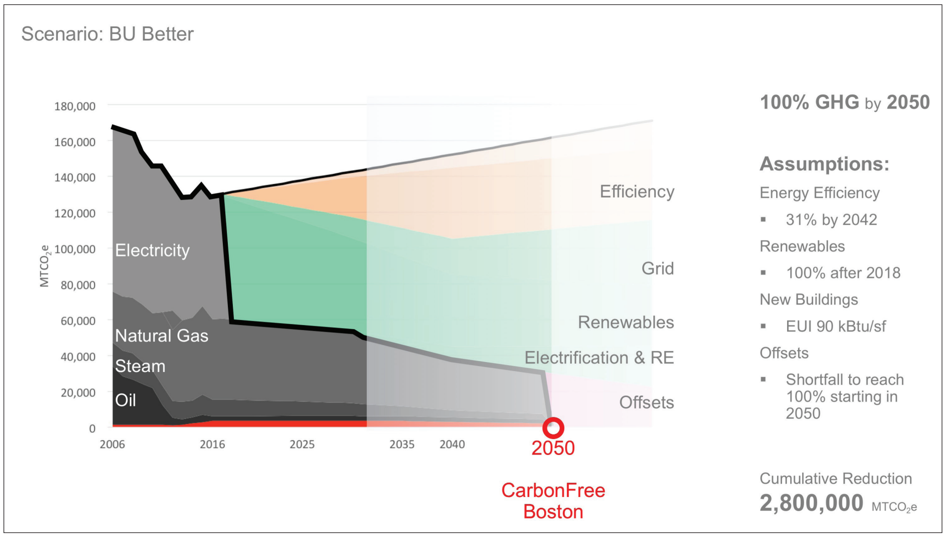


FIGURE A1.2: BU BETTER



In addition to all the BU Good efficiency investments, the University would need to convert to digital controls in 34 buildings and introduce rooftop unit controls in 33 along with optimizing HVAC controls in dormitory spaces. Total project costs would be substantially larger than in BU Good, and three additional staff would be required, but the internal rate of return would also be higher, and the time to net cumulative breakeven would be roughly the same.

Average investment per year would only be slightly higher ($4.3M vs $4.1M). However, the University would need to enforce LEED Gold certification for new construction that operate at a minimum of 40% better than the building code. The University would hit 100% reductions for Scope 1 and 2 emissions in 2050, which would be roughly consistent with the City of Boston's goal.

APPENDIX 2: COSTS OF CLIMATE ACTION

The Task Force has done a preliminary analysis of the costs of the proposed end-use efficiency projects. The results are summarized in Table A2.1 below. The major features of costs and savings are similar for all three scenarios—early investment leads to near-term net costs, but the energy savings eventually overtakes costs and net benefits begin to accumulate after the first decade and become quite substantial in later years.

For BU BOLD, we illustrate the time course of annual costs, savings, and net benefit (cost) in Figure A2.1 below. The most important feature is that after the first decade of investment, benefits begin to exceed costs and the net benefits increase rapidly over time.

Boston University currently has one Sustainability Revolving Loan Fund for the CRC and one for the Medical Campus. The CRC revolving loan fund was created in 2009 with $1M from operating capital as a way to fund quick-payback energy projects. Over time, it has evolved and grown to be the main funding source for energy-efficiency projects.

When an energy project is funded by the Sustainability Revolving Loan Fund, a one-time withdrawal is made to cover the cost of the project at the time the project begins. Once the project completes, the annual operating budget for that building is reduced by the annual calculated energy cost savings and the savings generated by the project will begin repaying the fund for the cost of the project. The annual repayment amount is equal to the annual energy cost savings from the project, and repayments continue until the Sustainability Revolving Loan Fund has been replenished. After the fund has been repaid, the annual

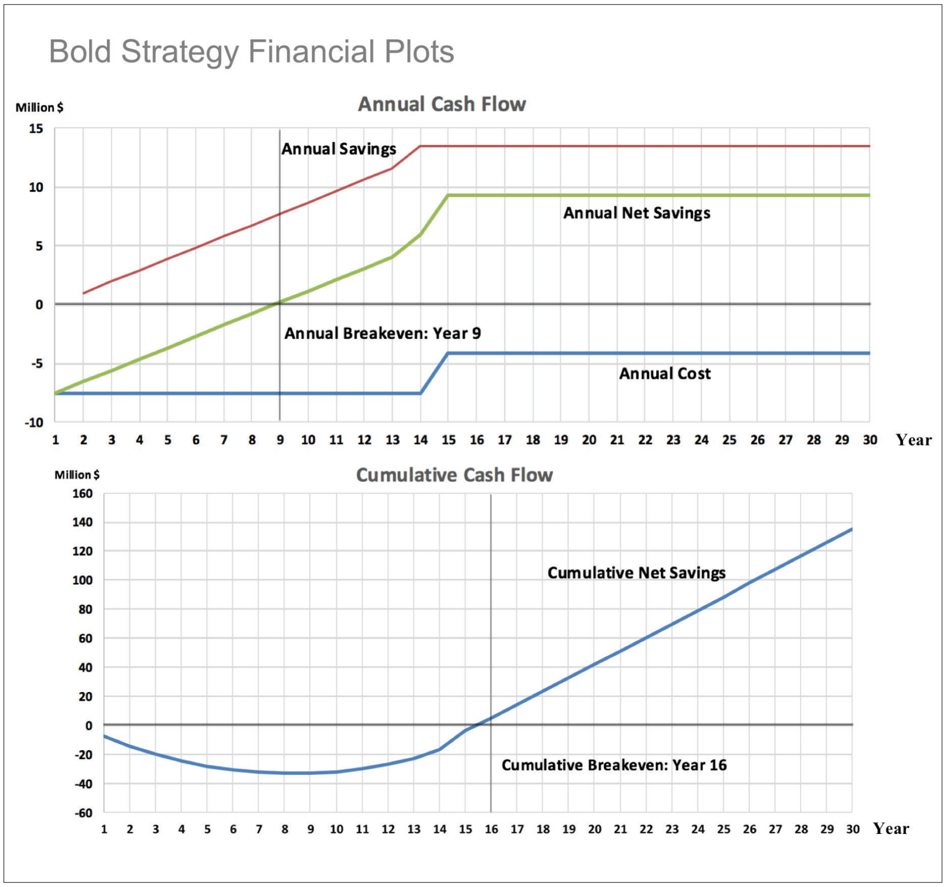
TABLE A2.1: OVERVIEW OF ENERGY-EFFICIENCY ACTIONS

Overview of BU EE Strategies

GHG Scenarios (Year reduction)	EE $ savings	EE GHG Savings	EE period (yr) of time	Total Invest [1] / Invest/yr [2] (millions)	Add. Staff	Total Net Savings [1] / Savings/yr [3] (millions)	30 yr IRR % [1]
Good (2050 80%)	**20%**	**17%**	**30**	**$88** / **$2.0**	**4**	**$32.5** / **$8.0**	**9.1%**
- Lighting & Controls (79 bldgs)							
- Existing BAS optimization (19 bldgs)							
- BUMC Labs: (6 bldgs)							
Better (2050 100%) All Good Projects, plus:	**33%**	**31%**	**24**	**$149** / **$4.1**	**7**	**$88** / **$13.5**	**10.1%**
- Conversion to Digital Control							
- RTU & Dorm HVAC Control (59-79 bldgs)							
BU Bold (2040 100%) All projects of Better, but accelerated (59-79 bldgs)	**33%**	**31%**	**14**	**$170** / **$7.5**	**9**	**$135** / **$13.5**	**9.9%**

1) Incl. staff and maintenance 2) Avg over EE period, incl staff 3) Avg after EE period

FIGURE A2.1



energy savings from the utility budget drops to the University's bottom line.

Depending on how many projects are done and how long their relative paybacks are, the fund may be limited in its funding ability year over year. Originally, the intent was that the fund would be repaid within one or two years. As BU began to focus more on energy efficiency, the faster payback projects were completed and longer payback projects became more common. With the creation of the Building Automation Systems group in 2012, an initiative to ramp up energy reduction efforts to 10% over five years increased the use of the fund to its limit. The initial funding amount quickly became insufficient, and through the annual budget process, it was increased several times to its current amount of $4.7M to meet the funding needs of the initiative.

The recommendations in the CAP will require a significant ramp up of energy efficiency projects. Projects currently being considered are generally higher in cost and longer in payback than before. To support this effort, a new type of revolving fund will be needed, one that reinvests the savings from projects over the period they deliver savings, rather than dropping to the University's bottom line at the end of the payback period. This will help build the fund while additional investments are added on an annual basis. We propose reconstituting the current Sustainability Revolving Loan Funds from each campus into one Climate Action Investment Fund integrated for both campuses. The effect would be self-sustained growth of funds to support the increase in pace of project completion and the ability to invest in more capital intensive, longer payback projects to be phased in later.

Beyond the funding itself, additional measurement and verification will be required for funding increases by energy project savings. Energy project savings should be confirmed prior to infusions of capital to the fund by ensuring that the energy project is performing as intended. With enhanced measurement and verification, project savings can be assessed more accurately and lower the risk of unforeseen budgetary issues to the University. Increased maintenance will also be necessary for the University to maintain project savings in the field to ensure recurring savings.

With higher costs and longer paybacks, the scope of energy projects is also changing. Deferred maintenance costs are becoming a larger portion of the cost of energy projects, as deferred items are needed to be addressed before an energy project can be completed and function as designed. Increased costs without energy savings associated lengthens paybacks and ties up funding for future projects. In some cases, another funding source should be considered so as not to hinder the steady cash flow provided by the Climate Action Investment Fund.