Description: Fahrenheit-based cooling degree days with a base temperature of 65 F

Source:	www.degreedays.net
Accuracy:	Estimates were made to account for missing data: the "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)
Station:	MANCHESTER AIRPORT, NH, US (71.44W,42.93N)
Station ID:	KMHT

First day	Last day	CDD	% Estimated
7/1/2017	6/30/2018	1004.9	0.08

Description:	Fahrenheit-based heating degree days with a base temperature of 65 F
Source:	www.degreedays.net
Accuracy:	Estimates were made to account for missing data: the "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)
Station:	MANCHESTER AIRPORT, NH, US (71.44W,42.93N)
Station ID:	KMHT

First day	Last day	HDD	% Estimated
7/1/2017	6/30/2018	6080	0.08

Employees: 8

Additional folks: 3

We were at 2021 for 2018-2019. We reached a max capacity for 2025 for a few days in early September.

SOUTHERN NEW HAMPSHIRE UNIVERSITY

baseline report and recommendations on

SCOPES 1 AND 2 GREENHOUSE GAS EMISSIONS

June 28, 2018

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EXECUTIVE SUMMARY

GreenerU first reviewed the available information on SNHU's Scope 1 and 2 emissions to establish an emissions baseline. Data sets were provided for the campus's many natural gas and electric utility meters. Based on the available data, GreenerU used a baseline period of calendar year 2017.

The total Scopes 1 and 2 campus emissions for this period were 6,716 metric tons of CO_2 equivalent ($MTCO_2e$).

The data sets provided were mostly complete; however, some estimated values were used where data points were missing. GreenerU recommends that SNHU adopt a more formalized internal process and system for the gathering, recording, and tracking of emissions inventory data.

GreenerU recommends these long-term strategies for reducing greenhouse gas emissions:

1. Invest in building energy efficiency

Investments in energy efficiency not only directly reduce total emissions related to energy use; they also help reduce the required capital investments for carbon-neutral electric and heating infrastructure and offer a multitude of ancillary benefits.

2. Transition to a carbon-neutral heating source

A carbon-neutral heating source can be achieved through a methodical transition from direct natural-gas consumption to electrically powered systems such as ground-source and air-source heat pumps.

3. Transition to a carbon-neutral electricity source

Clean, renewable electricity procured through both on- and off-site development of renewable generation offers an increasing degree of market availability and favorable financial arrangements.

4. Purchase carbon offsets

A comprehensive strategy will likely involve the procurement of some level of carbon offsets, requiring the University to examine its internal philosophy on this approach.

Combining these strategies, GreenerU has presented a possible scenario for SNHU wherein a reduction goal of 100% (zero net emissions) is targeted over a 25-year horizon.

Exact goals and a timeline will depend on the processes and outcomes involved in SNHU's broader sustainability planning process. These goals will then inform the school's eventual Climate Action Plan (CAP), which will further define and specify the blend of strategies to be used, with interim goals and concrete action items.

For SNHU to set and achieve ambitious carbon reduction goals, a multitude of innovative technologies and processes will be key. Most important, however, will be the radical institutional commitment required for the long-term planning and execution of these critical mitigation strategies.

IN CONTEXT: THE ROAD TO ZERO

In 2006, a group of twelve colleges and universities initiated the first American College and University Presidents' Climate Commitment (ACUPCC), "motivated by their conviction that higher education had the capacity and responsibility to lead on climate and sustainability." By 2008, more than 600 colleges and universities had signed on.

But what many schools have discovered is that getting to zero—or achieving carbon neutrality—is a long, hard road, and there are no shortcuts. And there are no guarantees. A 2015 Sightlines report showed that 65% of Second Nature signatories are essentially holding steady or losing progress toward carbon neutrality, and Second Nature reports that signatories have achieved only 19% in carbon reductions to date.

Likewise, media headlines indicate that investments in renewable energy increased rapidly among higher education institutions between 2006 and 2014 (see page 8), but the 240 campuses identified as purchasing renewable energy represent less than 6% of campuses overall.

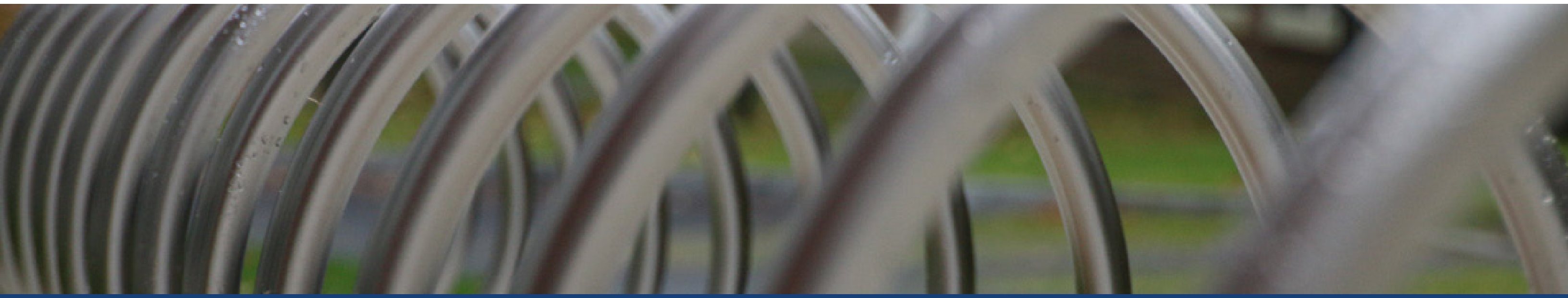
To be clear: nothing is simple about getting to zero.

The few schools that claim to have achieved carbon neutrality to date have done so through purchasing carbon offsets. While helpful, offsets are superficial fixes. Meaningful solutions to climate change will require **strategic management, interdisciplinary problem solving, and innovative technologies and policies**.

Given that, schools are tasked with creating and implementing long-term strategies to reimagine campus infrastructure to be carbon neutral. This relies on a four-prong strategy that every reasonable climate action plan is built on: reducing consumption, electrification, sourcing cleaner electricity, and buying or creating carbon offsets. These strategies are not unique, nor are they glamorous.

Efforts toward demand reduction, electrification, and shifting electricity supply to renewable sources can be a complex game of chess, with each move affecting future moves, and many variables changing the stakes at each juncture. Financial and infrastructure constraints must be carefully managed, and a strategy for institutionalizing this work is critical for success.

That said, efficiency technology has significantly improved in the last 10 years to meet a growing market demand for building energy savings (see Appendix B for examples). And renewable energy technology has become more affordable than ever—according to data from the National Renewable Energy Laboratory (NREL) and the Rocky Mountain Institute, solar and wind costs dropped by 77% and 60%, respectively, between 2009 and 2015.



There also are long-term financial benefits to investing in carbon neutrality. According to a 2017 Sightlines report, "energy efficiency and clean energy projects are strong investments that can yield three to five times the annual returns of traditional endowment investments."

But major barriers to exercising leadership in advancing carbon neutrality on campuses include "lack of prioritization, insufficient capital funding, and difficulties in influencing decision-makers," according to Sightlines (per Redshift Research 2015; Close and Close 2010).

Thus, at the end of the day, technology is only part of the equation. Getting to zero requires strategic thinking about longer-term policies and the bigger picture. The drive for quick paybacks on projects has proved to be an unsustainable business model for achieving more than token emissions reductions.

In the spring of 2011, Brown University partnered with GreenerU to reduce energy use in dorms. The project integrated engineered energy-efficiency improvements in Diman House, including control system enhancements, thermostatic radiator valves, low-flow shower heads, a new hot-water heater, and LED lighting, and a program for occupants to learn about energy-conserving behaviors. Compared to energy use at Olney House, an almost identical residence hall with no work done, Diman House used 58% less thermal energy.

Following that pilot, GreenerU worked with Brown University over the next several years to apply the same work across 34 residence halls. More than a thousand thermostatic radiator valves and dozens of resident training sessions later, the dorms at Brown are more comfortable, heating bills are far lower, and Brown has made notable progress toward reaching its greenhouse gas reduction goals.

On a larger scale, Carleton College in Northfield, Minnesota, recognized that their utility needs required investments that were going to establish the framework for how the college was going to meet its utility needs for the next hundred years. Carleton then instituted a Utility Master Plan as a significant part of its 2011 climate action plan that resulted in a dramatic transformation of Carlton's campus utilities and put them on the path to carbon neutrality.

Like all large-scale projects, these examples took an enormous amount of careful and inclusive planning. They involved months- or years-long conversations with trustees, administrators, students, faculty, and staff to gather diverse perspectives and get buy-in.

> Energy efficiency and clean energy projects are strong investments that can yield three to five times the annual returns of traditional endowment investments.

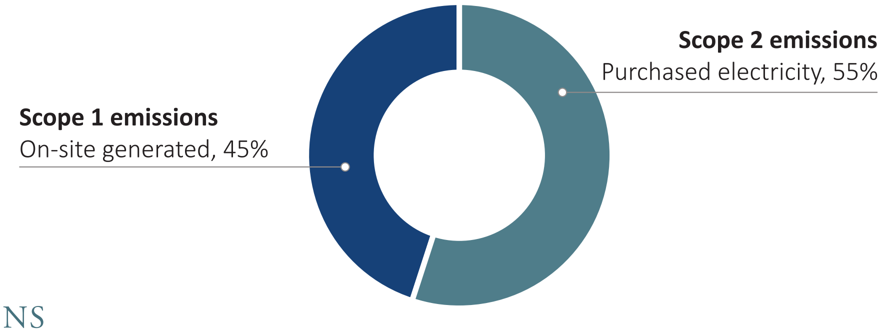
Rather than the focus on novel technical solutions, perhaps the most exciting facet of energy-efficiency work today is that what has been the nonstop game of building-maintenance Whac-a-Mole for the beleaguered facilities director has become a process by which everyone is part of—and proud of—the solution. And that echoes what institutions of learning are about.

Southern New Hampshire University has been cited in multiple national publications, including U.S. News & World Report, as a leader in innovation, with a pragmatic, skill-focused approach to competency-based learning. One of the strongest stances SNHU can take as a 21st-century educational institution—one that is aligned in its mission of relentlessly challenging the status quo—is to assume bold leadership in getting to zero.

BASELINE ASSESSMENT

Southern New Hampshire University's (SNHU) annual Scope 1 and Scope 2 greenhouse gas emissions are estimated at 6,714 metric tons of carbon dioxide equivalent (MTCO$_2$e). This initial estimate of baseline emissions is based on energy data provided by the University for both the main campus and certain satellite or off-campus properties. Further explanation of the data included in this baseline figure can be found in Appendix A: Analysis of Greenhouse Gas Emissions Data. Figure 1 shows a percent breakdown of each emissions component.

Figure 1. — Southern New Hampshire University's Scopes 1 and 2 greenhouse gas emissions footprint (MTCO$_2$e)



SCOPE 1 EMISSIONS

Scope 1 emissions totaled 3,021 MTCO$_2$e per year, or 45% of the campus total. This portion of SNHU's total emissions is comprised of:

- Natural gas combustion and propane combustion for space heating in buildings
- Diesel combustion in emergency generators
- Fuel combustion in campus fleet vehicles
- Use of refrigerants
- Use of fertilizers

SCOPE 2 EMISSIONS

Except for a small amount of electricity produced by a small cogeneration unit at the Athletic Complex, SNHU purchases its electric power through the local utility provider Eversource. Emissions associated with the purchase of electricity account for 3,693 MTCO$_2$e in 2017, or 55% of the campus total. This is derived from a location-based emissions factor for grid-purchased electricity in the New England region.

COMMON SOURCES OF GREENHOUSE GAS EMISSIONS

SCOPE 1

Generated directly on site, typically through the combustion of fossil fuels, including emissions from central heating plant, campus fleet vehicles, etc.

SCOPE 2

Generated off-site, but are directly attributable to the University's activities, such as emissions from purchased electricity

SCOPE 3

Other indirect emissions, such as those from the production and transport of materials consumed on site, travel not associated with campus fleet vehicles, etc.

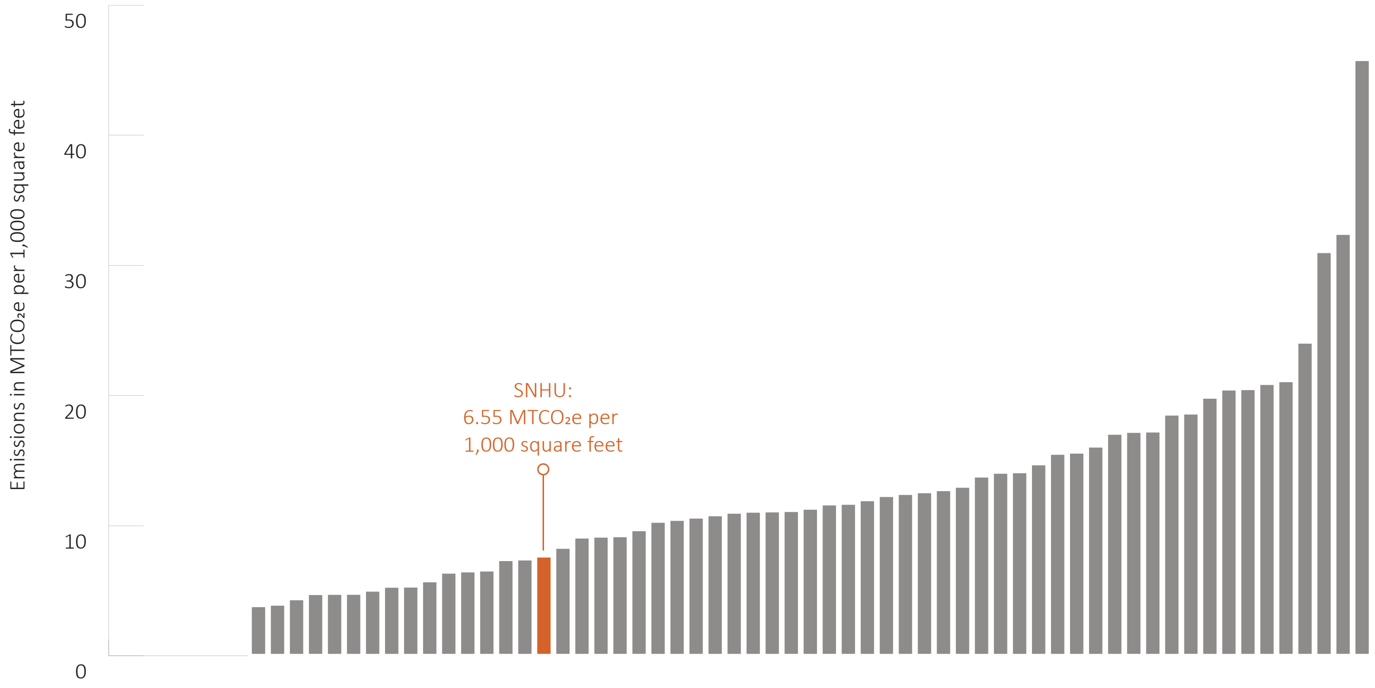
SCOPE 3 EMISSIONS

Scope 3 emissions were not included in the Phase 1 study. SNHU does not currently keep an inventory of Scope 3 emissions.

COMPARISON TO PEER INSTITUTIONS

GreenerU compared SNHU's total Scope 1 and 2 emissions figures to that of other campuses who self-report to the organization Second Nature. The data set below represents 54 diverse school campuses in the Northeast region with total building area between 500,000 and 1.5 million square feet. It should be noted that the emissions data available from Second Nature are self-reported and unverified; however, Figure 2 provides some context in which to consider SNHU's baseline emissions.

Figure 2. — Comparison of total campus emissions among schools in the Northeast U.S. of similar total square footage



RECOMMENDATIONS

TRACK GREENHOUSE GAS EMISSIONS

GreenerU recommends that SNHU build on this initial baseline data collection process and continue to track energy usage and maintain a GHG inventory. Several tools and tactics are useful for these purposes:

- ENERGY STAR Portfolio Manager® is an online platform created by the U.S. Department of Energy for tracking energy consumption across many buildings and utility accounts. It also offers a method for producing an EnergyStar score as comparative metric for certain qualifying building types. For some utility providers, Portfolio Manager also supports automatic connections to utility billing data for streamlined data collection.

- SIMAP™, or Sustainability Indicator Management and Analysis Platform, was created by the University of New Hampshire for higher education and allows easy entry and tracking of emissions metrics.

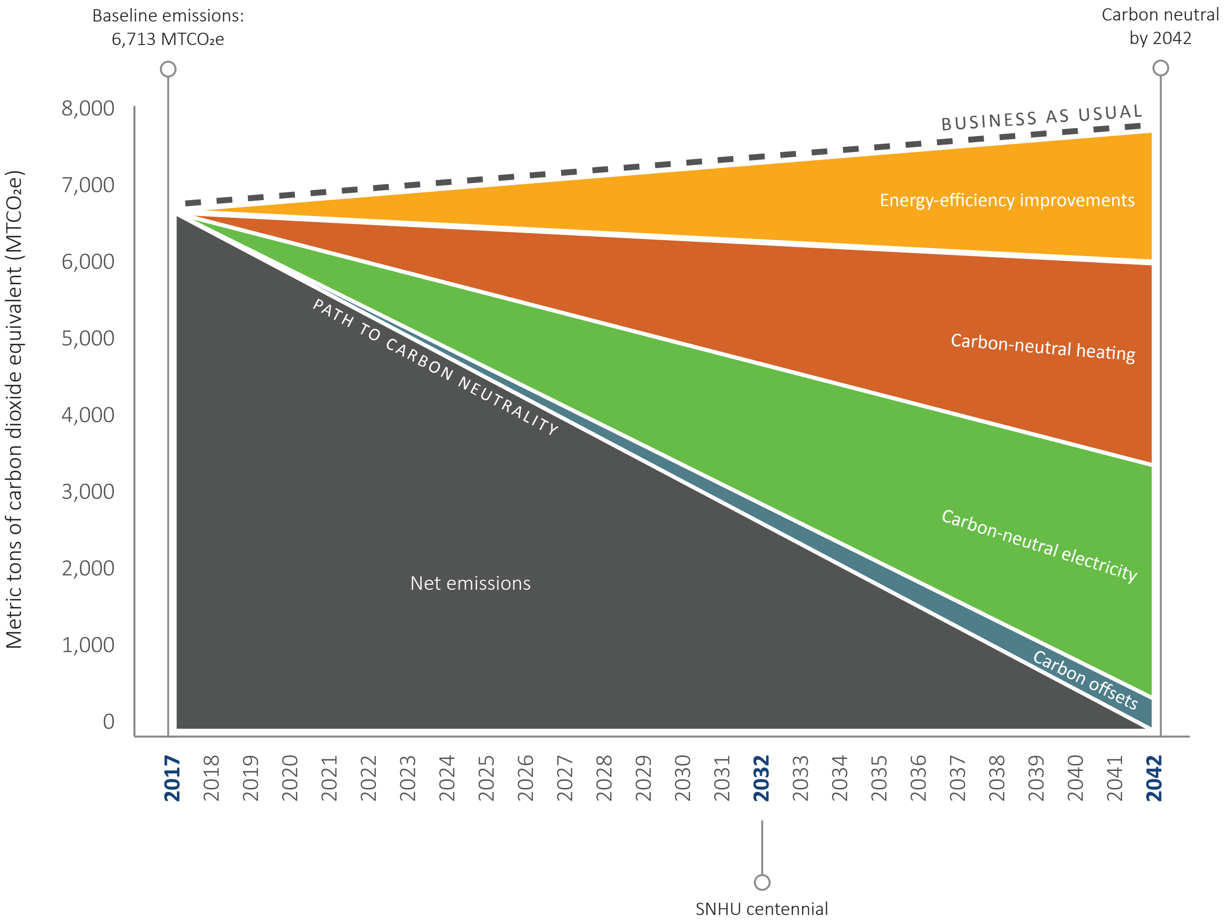
DEPLOY CARBON MIGITATION STRATEGIES

GreenerU recommends four core strategies for reducing greenhouse gas emissions. These strategies should all be considered as potential components of a climate action plan to be developed through the University's sustainability strategic planning process. The exact strategies and supporting tactics will be based on the goals set through this process and on the institution's values and commitments. Since specific goals for emissions reductions have not yet been established, we present a scenario where carbon neutrality is targeted by the year 2042.

The four core strategies, as illustrated in Figure 3, are:

1. Invest in building energy efficiency
2. Transition to a carbon-neutral heating source
3. Transition to a carbon-neutral electricity source
4. Purchase carbon offsets

Figure 3. — Four core emissions reduction strategies at Southern New Hampshire University



STRATEGY 1: INVEST IN BUILDING ENERGY EFFICIENCY

As part of the Scoping Audit Report (Appendix B), GreenerU performed an overview of the SNHU campus buildings and a high-level feasibility assessment of energy-efficiency opportunities. The Scoping Audit Report offers detailed findings based on a review of ten selected buildings on SNHU's campus and additional general observations of building efficiency opportunities.

In the ten buildings included in the high-level survey, GreenerU identified approximately $15.5 million in potential energy-efficiency projects, ranging from LED lighting to HVAC controls optimization, installation of energy recovery and adaptive re-use of entire buildings (see Appendix B). These projects are estimated to result in reductions in building energy use of approximately 30% electric and 26% natural gas.

Extrapolating these figures to the remaining buildings not included in the study, GreenerU estimates that the University can reduce its total campus energy use by approximately 20% through an investment of roughly $20 million in building-efficiency improvements. This would represent a reduction in 1,293 MTCO₂e.

While this represents a large investment, these projects can offer significant financial returns. A 2012 report by the Sustainable Endowments Institute studied the green revolving funds (GRFs) of dozens of colleges across the U.S. and found a median return on investment (ROI) of 28%. Even energy-efficiency programs that set a more relatively modest target of 10–15% can significantly outperform the rate of return from endowments or other available investments.

Reductions in building-energy use through efficiency projects directly reduce Scopes 1 and 2 emissions by lowering purchased energy requirements. Further, funds invested in efficiency improvements have multiple financial benefits, including:

- Reduced annual energy costs
- Reduced annual costs of other emissions-reduction strategies, such as purchasing offsets
- Potential to reduce first costs of capital projects providing carbon-neutral energy sources (as discussed later in this report)

Additionally, energy-efficiency projects offer a variety of non-energy-related benefits, such as addressing deferred maintenance, reducing annual maintenance costs, and improving comfort for building occupants.

INFRASTRUCTURE AS INVESTMENT

Campus infrastructure represents our institutions' greatest financial asset, exceeding the endowment, even at the wealthiest schools. These assets should be managed much like an investment portfolio.

Sightlines crystallized the benefits of asset management in a 2015 study where they found that "over time, $1 in stewardship avoids $3 in future capital renewal investment." Stewardship refers to proactively caring for facilities (thinking long-term) as opposed to reactively addressing deferred maintenance (waiting for things to break).

Many energy-efficiency projects are measured using a simple payback model, i.e., the amount of time it takes to achieve energy cost savings equal to the amount of the project's first costs. The problem is that the simple payback model "doesn't take into account that the buying power of money today is greater than the buying power of the same amount of money in the future."

A more accurate model for measuring the value of energy-efficiency investments would be to use net present value (NPV), or lifecycle cost savings. NPV is defined as the "time value of money," a way of comparing future cash flow in terms of today's dollars.

Investments in energy efficiency make even more sense when looking at net present value combined with internal rate of return (IRR), or the "rate at which the project breaks even." It is commonly used by financial analysts in conjunction with NPV, but the two methods of analysis use different variables: NPV assumes a particular discount rate for a company, but IRR calculates the actual return provided by a project's cash flow. An IRR of at least 10% tends to be attractive to investors.

STRATEGY 2: TRANSITION TO A CARBON-NEUTRAL HEATING SOURCE

Space heating with natural gas is currently the second largest source of greenhouse gas emissions on the SNHU campus. While improvements to building efficiency can reduce energy use, there will always be a need for heating across the campus's 1+ million square feet of space; therefore, a shift toward a carbon-neutral heating system must be considered.

Most buildings on SNHU's main campus are directly gas-fed, with heating provided either through direct combustion heating (e.g., gas-fired rooftop units) or through hot-water systems served by gas-fired hot-water boilers. This means that the transition to a carbon-neutral fuel source cannot be done in a campus-wide manner, as with a central plant conversion, but instead must be done at the building level.

Given these considerations, GreenerU believes that the University's heating must be transitioned to electrically driven systems. While electric-powered heating supplies are not inherently carbon-neutral on their own, they can be powered with clean electric energy, offering a pathway to emissions mitigation. The main components of GreenerU's recommended strategy for transitioning to an electrified heating system are:

- Air- and water-source heat pumps, a key technology for cold climates
- The incorporation of HVAC system re-designs during building renovations or adaptive re-use projects
- The investigation of ground-source heating and cooling opportunities and their relative feasibility
- The design of new hot-water systems to be low-temperature (low-exergy) for more compatibility with heat pumps, ground loops, and even solar heating

Air-source heat pumps are lifted onto the roof of the MSPCA-Angell Animal Medical Center in Jamaica Plain, Mass.

STRATEGY 3: TRANSITION TO A CARBON-NEUTRAL ELECTRICITY SOURCE

In pursuing the above strategy related to heating-system electrification, SNHU will see a migration of its single largest energy use from natural gas to electricity. While they have provided regional reductions in emissions, the current trends in the carbon intensity of the ISO New England regional electric grid will have a limited effect on future greenhouse gas mitigation if not paired with an approach toward carbon-neutral electric supply.

There are multiple pathways to carbon-neutral electricity, including solar photovoltaic, wind, low-impact hydro, and bioenergy. SNHU should consider each of these options.

Solar panels on the roof of Berry Sports Center at Dartmouth College, installed in 2017

The most visible pathway is on-site solar development. On-site development would require the University to identify eligible building rooftops or land space on which to build solar photovoltaic arrays. Opportunities exist for avoiding major capital costs through financed solar development projects and for cash flow-neutral solar power procurement. In an arrangement such as a power purchase agreement (PPA), SNHU would partner with a third-party developer (owner) who would install and own the solar array, while the University (host) would purchase the produced electric energy. The arrangements are highly negotiable and customizable to the needs of the system host and owner.

That said, given the large-scale, long-term goal of electrically powered heating, the total capacity requirement would be significant and likely much more than what the physical space of the campus can support, however. Therefore, the University should explore additional off-site developments. As with on-site solar, the University could partner with third-party developers of carbon-neutral electricity projects to make medium to long term purchases of renewable energy. These projects may be located in New England or elsewhere in the United States. The location of the project, type of renewable energy, and age of the project will impact the price of this electricity. Additionally, depending on the configuration of the agreement, these projects may offer the institution the opportunity to hedge their exposure to natural gas prices.

STRATEGY 4: PURCHASE CARBON OFFSETS

Even after rigorous reduction measures, to achieve full carbon neutrality the University will inevitably face the requirement to offset remaining carbon emissions. In particular, Scope 3 emissions (which are not quantified as of the writing of this report) are difficult for the University to completely control and present no single, clear path for elimination. Thus, the purchase of carbon offsets will become necessary to meet certain emissions reduction goals.

Important considerations for purchasing carbon offsets include verification, location, and timeline of said carbon mitigation efforts, as well as meeting standards of “additionality.” Additionality means the funding provided by the purchase of the carbon offset drives a new project beyond what is required by law and would have happened without the new funding or “business as usual.” Offset transactions should also be verified with an independent registry to avoid double-counting and that there are no competing claims to an offset.

While there may be some opportunity to engage students in identifying quality carbon offsets as a hands-on learning opportunity, SHNU should broadly look for offsets that bear certification from one of the three accredited organizations listed below. Each differs slightly, but generally supports the requirements listed above.

- Verified Carbon Standard
- Gold Standard
- Climate Action Reserve

Alternately, some institutions, while still observing the considerations listed above, focus on creating carbon offsets in their local communities. In the case of Duke University, not only are greenhouse gas reduction impacts considered, but also a project’s ability “to provide economic, social and environmental co-benefits beyond greenhouse gas reductions.”

Another example of how carbon offsets are purchased comes from Oberlin College, which has developed the following criteria:

Quality carbon offsets can be purchased to support renewable energy projects, such as wind, or reforestation efforts, but all carbon offsets should be carefully researched and reviewed.

- The College should not achieve carbon neutrality solely by purchasing carbon offsets and will generally avoid the purchase of carbon offsets from national or international brokers.

- Limited purchases of carbon offsets will be useful for supporting particular activities or events (e.g., transportation, graduation, speaker series, etc.).

- The College will support investment in local carbon offset projects and/or the purchase of local carbon offsets in limited quantities. Preference will be given to carbon offsets that have secondary benefits (e.g. the POWER fund and light bulb exchanges, which reduce utility costs of low-income members of the community).

Costs for carbon offsets can vary widely based on the above stated factors. Local projects may contribute to stronger relationships with the communities around SNHU and may allow for education opportunities for SNHU students but may be costlier. Conversely, international projects generally offer offsets at a lower cost. As a reference point, GreenerU obtained informal estimates for high-quality, verified offsets with pricing on the order of \$5 per $MTCO_2e$. This translates to an annual cost of about \$35,000 per year to offset all of the University's current annual carbon emissions.

RENEWABLE ENERGY CERTIFICATES (RECs)

For all renewable electricity projects, both on and off campus, SNHU should give careful consideration to the ownership and tracking of the renewable energy certificates (RECs) associated with the project. Because electricity from individual sources is mixed on our shared electricity grids, and because different regions of the United States are managed as separate electricity grids, RECs serve as a common accounting tool to track the environmental attributes of renewable electricity.

The simplest way to obtain RECs is to purchase them separately from the associated electricity. These RECs are labeled "unbundled." More complex ways to purchase RECs, such as through power purchase agreements, involve "bundled" RECs that also include the associated electricity. Both can be valid ways to source renewable electricity.

The wide range of RECs that are available today can make it challenging to understand if purchasing them is actually having an impact on increasing the amount of renewable energy on the grid. With that in mind, SNHU should always ensure that it owns and retires the RECs from any projects that it is involved with.

Beyond the question of REC ownership, there is one other question to consider when determining the impact of engaging in a renewable energy purchase: Would the renewable energy project happen without anyone purchasing these RECs? If a project is financially viable solely from the sale of electricity, then SNHU's involvement is not helping to catalyze new generation. Purchasing RECs from this type of project to include in one's greenhouse gas accounting is allowable but may not support SNHU's overall climate goals.

It is important to note that RECs are not interchangeable with carbon offsets. On a pragmatic level, RECs are only relevant in the context of Scope 2 emissions from purchased electricity. RECs may not be applied to emission from Scope 1 and 3 sources. From an accounting perspective, RECs allow SNHU to make claims under a "market-based" reporting standard about its Scope 2 emissions, but per the GHG Protocol Corporate Standard (World Resources Institute), SNHU must be transparent about its "location-based" emissions as well, which reflect the direct emissions of its relevant grid area (ISO-NE).

CONCLUSION

The challenge of achieving carbon neutrality may seem daunting. Institutions often ask whether carbon neutrality is even possible, and whether they have the means to tackle it. GreenerU has found that the answer to those questions lies not in one single, particularly innovative new technology; rather, the critical factor to success is institutional commitment and dedication to achieving these important long-term goals.

Institutions of learning that are seeing success in reducing their emissions in this area are methodically employing proven technologies such as solar photovoltaics, ground- and air- source heat pumps, and LED lighting. Each of these technologies has advanced dramatically in efficiency and affordability over the recent years. These institutions have noted that now, more than ever before, technological and market conditions have coalesced to create an environment favorable to the kinds of meaningful investments and operational changes needed for carbon mitigation.

These technologies are paired with extensive retrocommissioning and building envelope improvements. Schools are also trying many new administrative, policy, operational, and financial approaches that offer them the resources and tools required for major infrastructure transformation. These ingredients—with leadership, hard work, and the will to succeed—can deliver meaningful change.

Southern New Hampshire University has taken the first steps in understanding its carbon footprint and exploring options for setting and meeting reduction goals. The next steps are to set those goals and put in place a plan for success.

APPENDIX A:

ANALYSIS OF GREENHOUSE GAS EMISSIONS DATA

EMISSIONS SUMMARY

This technical appendix provides the details of the greenhouse gas emissions data gathered as part of GreenerU's Phase 1 report on baseline data for climate action planning. All data was provided by SNHU for use in this report. The assumptions, methods, and exclusions used in the emissions baseline are outlined below, with additional tables further illustrating the data used.

BASELINE GHG EMISSIONS

Table 1 shows SNHU's greenhouse gas emissions for Scopes 1 and 2 in the calendar year 2017, the most recent and complete data available. This serves as baseline emissions factors for all subsequent analyses.

Table 1. — SNHU Scopes 1 and 2 greenhouse gas emissions summary (2017 data)

Scope 1	**2017 data**		**Greenhouse gas emissions in MTCO2e**
Natural gas	52,211	MMBtu	2,776
Diesel	1,201	gallons	12
Propane	9,583	gallons	50
Gasoline (vehicles)	19,682	gallons	179
Refrigerants	n/a		-
Fertilizers (synthetic)	4,850	pounds	3
Fertilizers (organic)	1,350	pounds	0
Scope 2			
Purchased electricity	14,107,123	kWh	3,696
TOTAL			**6,716 MTCO2e**

BUILDINGS INCLUDED

Using the available data, this baseline captures the energy usage of the following:

- All buildings on the main campus
- Two Mill Yard properties (33 South Commercial and 186 Granite)
- 1230 Elm Street
- 15 West Alice Avenue

Additional satellite properties operated by the University have not been included. For future carbon accounting, SNHU should consider which of three approaches to use for defining the campus boundary: (a) equity share; (b) operational control; or (c) financial control. This decision will be an important factor as SNHU's operations continue to expand.

A number of buildings were razed during the 2017 baseline year. The electrical usage of these buildings while in operation is embedded in the main campus electrical meter. Gas data for these buildings was not available.

Refer to Table 8 in Appendix B for a complete list of buildings included in the baseline.

SCOPE 1 EMISSIONS

EMISSIONS FACTORS

Emissions factors for Scope 1 are listed in Table 2.

Table 2. — Emissions factors for Scope 1

Natural gas	0.053183	MTCO$_2$e per MMBtu
Diesel	0.010339	MTCO$_2$e per gallon
Propane	0.005261	MTCO$_2$e per gallon
Fertilizers (synthetic)	0.000544	MTCO$_2$e per pound

SCOPE 1

Generated directly on site, typically through the combustion of fossil fuels, including emissions from central heating plant, campus fleet vehicles, etc.

NATURAL GAS, DIESEL, AND PROPANE

SNHU's buildings are predominantly heated by natural gas. Generally, buildings are individually metered. The baseline includes data from 24 gas meters on the main campus and 12 meters at the Mill Yard properties (33 South Commercial and 186 Granite). For the Mill Yard buildings, no utility bills were available for January and February 2017, so estimates are included in the baseline for these months, based on 2018 usage. Also, the total gas usage of 33 South Commercial appears to be low for the size of the building, suggesting that some additional meters serve that facility but have not been captured in the baseline data, as illustrated in Tables 3 and 4.

Propane is used only for heating in one building (15 West Alice) and for an emergency generator in one building (Morrissey). Available records of deliveries made in the period have been included in the baseline (see Table 5).

Diesel is only used in several emergency generators. For the baseline, all available records of fuel deliveries made during the period have been included (see Table 6).

FLEET VEHICLES

Records from fleet vehicle gasoline purchases for the year 2017 were gathered and included in the baseline.

REFRIGERANTS

No data for refrigerant usage were available for this report.

FERTILIZERS

Records for purchased fertilizers in 2017 were gathered and included in the baseline.

SCOPE 2 EMISSIONS

Scope 2 emissions from electricity can be calculated based on the regional mix of electricity (location-based) or the mix of electricity procured from a supplier (market-based). This analysis uses the location-based method as the simpler and more transparent mechanism. In the U.S., this data is readily available from the U.S. Environmental Protection Agency's eGRID (Emissions and Generation Resource Integrated Database) program. The SIMAP emissions inventory tool uses the eGrid data set and for SNHU, the "NEWE" region was selected to represent emissions from the New England electricity grid.

SCOPE 2

Generated off-site, but are directly attributable to the University's activities, such as emissions from purchased electricity

The main campus is served by a "large general" service account with Eversource. The supply contract for this main account is with Constellation New Energy. The school also has about a dozen other small electric services on the main campus, an account for 15 West Alice Ave, ten accounts for 1230 Elm Street, and 16 accounts for 33 South Commercial. The electric accounts serving the 186 Granite Street are not paid by SNHU and usage data was not available for this study. Refer to Table 7 for additional detail on electric meters and data included.

The emissions factor for purchased electricity is 0.000262 MTCO$_2$e per kWh.

If SNHU works with its electricity supplier to purchase a lower-carbon electricity mix, it may wish to report its market-based mix of electricity to reflect its efforts.

OPERATIONAL DEFINITION OF CAMPUS BOUNDARY

As a large and evolving organization, determining SNHU's campus boundary is a complex task. There are two concepts to keep in mind for determining organizational boundaries: (1) the primary driver of reporting is transparency; and (2) certain sources of emissions may be excluded from reporting for any number of reasons, but they should be listed in any public reports.

There are generally accepted standards that can be used for determining boundaries. The GHG Protocol Corporate Accounting and Reporting Standard by The Climate Registry provides a few different methods of setting an organizational boundary, but the method generally used in higher education is called "operational control." This method served as a guide in creating this report. Organizational control is defined under the following context: "An entity has operational control over an operation (e.g., a business unit or facility) if the entity or one of its subsidiaries has the full authority to introduce and implement its operating policies. The entity that holds the operating license for an operation typically has operational control" (see page 13).

Under the GHG Protocol Corporate Accounting and Reporting Standard, emissions must be reported from leases (including finance, capital, or operating leases). This may not be directly feasible due to a lack of data, but approximations may be estimated by using square footage and space use.

SCOPE 1: NATURAL GAS DATA

Table 3. — SNHU natural gas data: main campus (2017)

	JAN ‘17	FEB ‘17	MAR ‘17	APR ‘17	MAY ‘17	JUN ‘17	JUL ‘17	AUG ‘17	SEP ‘17	OCT ‘17	NOV ‘17	DEC ‘17
	“DIRECT MMBtu”	“DIRECT MMBtu”	“DIRECT MMBtu”	“DIRECT MMBtu”	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu
ACC	308.72	210.05	198.97	149.43	103.3	80.8	79	73.2	79.2	80.9	98.9	188.9
Athletics	1498.77	1261.85	1401.75	966.36	262.2	106.6	133.1	102.8	99.1	66.8	117.9	667.9
Athletics water heater	0	0	0	0	0	0	0	0	0	0	0	0
Belknap	288.11	269.02	175.59	260.1	25.8	0	0	0	0	0	0	5.9
Conway	185.95	156.72	185.54	146.36	73.9	32.3	10.7	11.2	24.1	32.4	60.1	148.2
Dining Hall	1013.54	1045.44	1201.33	918.25	692.6	437.1	322.5	353.8	485.2	542.2	755.9	1082.2
Exeter	232.61	192.92	202.36	143.49	55.6	31.4	3.9	4.4	10.4	13.8	53.4	166.2
Green Center	141.33	107.59	129.95	84.52	14.3	7.2	0.7	1.3	7.1	6.2	24.1	9.4
Gustafson	152.6	144.9	142.7	135.7	68.7	DNA	19.3	24.3	22.2	22.4	40.5	105.8
Hampton	291.59	259.69	268.21	201.95	73.9	36.1	15.6	29.8	67	53.8	12.1	24.2
Hospitality	354.16	399.29	555.79	492.71	279.3	117.6	71.9	75.6	95.9	140.3	206	35.5
IT Gen Unit	0.71	0.31	0.31	0.31	0.3	0.3	0.2	0	0.2	0.4	0.2	0.1
Lincoln	174.05	150.77	168.82	138.57	64	32.9	9.1	9.5	20.5	24.8	58	137.6
LLC	655.69	509.75	552.31	429.13	346.3	254.9	182.6	181.3	256.3	285.8	339.4	423.1
New Castle	405.74	444.41	473.75	394.67	178.6	43	4.7	3.4	14.8	52.2	184.6	413.9
Operations Center	186.25	147.38	159.38	116	48.5	23.9	8.8	6.9	5.2	7	39	146.9
Robert Frost	339.69	246.36	277.74	204.31	62.3	28.2	2.3	5.3	14.1	21	69.6	227.5
Spaulding	2.26	5.84	7.8		5.1	1.2	0.7	0.7	1.5	5.2	5	3.6
Stark	155.59	126.35	354.98	111.08	9.7	0	0	0	0	0	0	0
Student Center	242.77	191.59	212.31	156.82	50.2	31.7	21.1	22	27	29.6	62.5	174.7
Tuckerman	153.95	161.23	138.46	94.77	92.8	47.4	18.3	17.8	26.8	48	50.7	55.3
Washington	307.39	294.26	331.79	244.82	115.7	26.2	6	4.1	22.1	46.4	94.2	270.2
Webster Hall	211.18	156.72	190.47	124.31	37.9	22.3	1.4	1.4	5.6	7.1	32.7	141.5
Windsor	330.57	279.28	306.77	231.59	126	63.9	35.3	21.7	12.9	23.6	58.4	236.1
Madison	43.2	28.1	22.8	22	DNA	DNA	DNA	DNA	DNA	3.1	16.2	27.4
Monadnock	DNA	496.1	412.6	363.8	197.6	DNA	47.5	34.1	46.8	98.1	213.9	448.1
Athletic Complex	374.7	330.2	248.9	208.2	DNA	DNA	DNA	DNA	DNA	59.1	146.5	193.7

SUBTOTAL	47,805 MMBtu

Table 4. — SNHU natural gas data: off campus (2017)

	JAN ‘17	FEB ‘17	MAR ‘17	APR ‘17	MAY ‘17	JUN ‘17	JUL ‘17	AUG ‘17	SEP ‘17	OCT ‘17	NOV ‘17	DEC ‘17
	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu	LIBERTY MMBtu
33 South Commercial	1.8	0.8	1.2	0	0	0	0	0	0	0	0.7	1.6
33 South Commercial	57.9	48.2	61.6	52.2	45.4	44	46.9	47.2	43.7	51.4	58	55.8
33 South Commercial	122.3	60.4	96.6	22.7	8.4	0	0	0	0.7	12.9	44.6	92.4
33 South Commercial	27.3	17.9	8.6	1.3	0	0	0	0	0	0	3.5	14.2
33 South Commercial	58.2	36	40.4	14.8	5.8	0.5	0.1	0	0.3	6.4	31.9	48.5
33 South Commercial	263.2	146.9	150.6	32.3	8.3	2.3	0	0.1	0.2	10.2	109	207
33 South Commercial	36.7	17.7	27.1	10.1	3.5	0.5	0	0	0.2	3.1	23.1	36.4
186 Granite Street	61.5	46.1	41	16.6	6.1	2.2	1	0.4	0.5	4	40.3	52.7
186 Granite Street	114.8	59	55.7	33	11.9	1.9	0	0	0.2	1.5	24.9	53.9
186 Granite Street	64.7	35.7	26.3	15.2	2.9	0.2	0.2	0	0.2	1.1	11.8	29.3
186 Granite Street	224.3	148	160.9	60.8	26.3	3.9	0.1	0	1	20.8	125.4	185.3
186 Granite Street	53.7	24.6	0	0	0	0	0	0	0.1	3.2	26.6	40.7

SUBTOTAL	4,406 MMBtu
GRAND TOTAL	**52,211 MMBtu**

—blue cells indicate values based on 2018 data
—green cells indicate data not available

SCOPE 1: PROPANE AND DIESEL DATA

Table 5. — SNHU propane data (2017)

	JAN '17	FEB '17	MAR '17	APR '17	MAY '17	JUN '17	JUL '17	AUG '17	SEP '17	OCT '17	NOV '17	DEC '17
	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons
15 W Alice	923.6	2151	-	-	-	-	-	-	-	-	-	-
Morrissey	-	-	-	-	-	-	-	-	-	-	-	-
17 W Alice	-	-	-	-	-	50	2843	-	405.3	-	1586.5	1624
									GRAND TOTAL			**9,583 gallons**

Table 6. — SNHU diesel data (2017)

	JAN '17	FEB '17	MAR '17	APR '17	MAY '17	JUN '17	JUL '17	AUG '17	SEP '17	OCT '17	NOV '17	DEC '17
	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons	gallons
Generator @ LLC	-	-	-	-	-	-	-	-	303.9	-	-	-
Generator @ New Dining Hall	-	-	-	-	-	-	-	-	195.7	-	-	-
Generator @ New Dining Hall fire pump	-	-	-	-	-	-	-	-	-	-	49.1	-
Generator @ Washington Hall	-	-	-	-	-	-	-	-	-	-	252.9	-
Generator @ Operations	-	-	-	-	-	-	-	-	95.8	-	-	-
Generator @ Gustafson	-	-	-	-	-	-	-	-	-	-	-	-
Generator @ TK	-	-	-	-	-	-	-	-	303.9	-	-	-
								GRAND TOTAL				**1,201 gallons**

SCOPE 2: ELECTRICITY DATA

Table 7. — SNHU electricity data (2017)

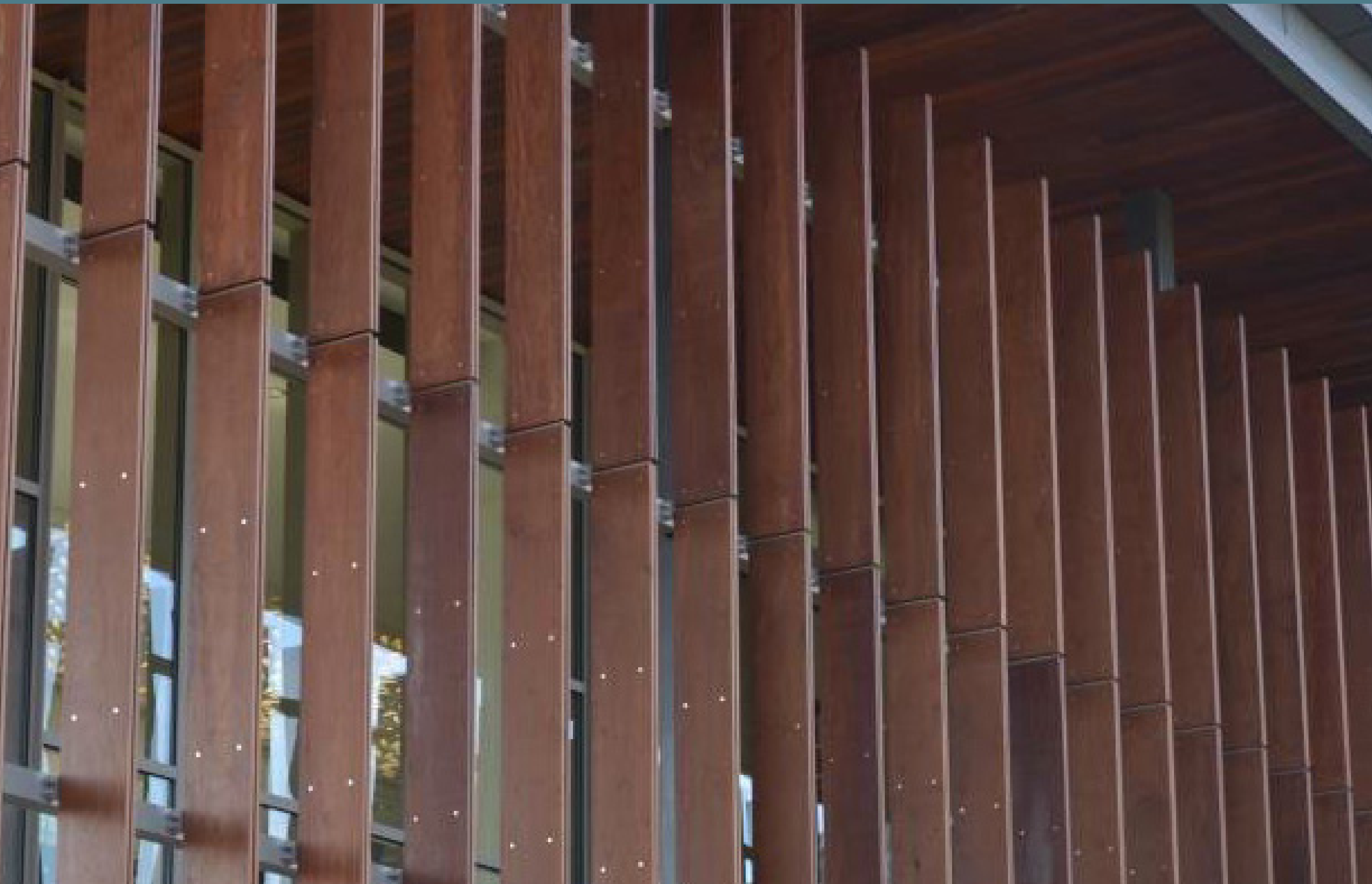
	JAN '17	FEB '17	MAR '17	APR '17	MAY '17	JUN '17	JUL '17	AUG '17	SEP '17	OCT '17	NOV '17	DEC '17
	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh	Eversource kWh
Blinking yellow by Morrissey	13	6	0	0	0	0	0	0	0	0	0	0
Madison House	3971	1881	1531	1501	782	-	404	357	337	51	1107	1238
Ford House	291	120	126	141	87	-	74.7	85	77	82	116	135
Traffic light by ACC	16	8	8	101.9	8	-	7	8	8	7	8	8
Traffic light by Old Central rcv'g	16	7	7	9	7	-	7	8	8	7	8	8
Baseball field shed	1027	412	391	404	349		328	396	403	430	515	442
Belknap Hall	1608	9120	0	0	2480	0	1790.7	3080	2920	3080	0	3240
Meter pedestal by Lot 12	755	0	0	0	0	0	0	0	0	0	0	0
Morrissey	3131	2850	261	2158	1956		1984.7	2080	1766	1639	1735	1985
74 Martins Ferry Road	0	0	0	0	0	0	0	0	0	0	0	0
53 Martins Ferry Road	213	210	250	204	130	153	153	153	176	134	170	210
15 W Alice Ave	12840	7880	3400				120	0	0	0	0	0
15 W Alice Ave rear	0	0	0	0	0	0	0	0	0	0	0	0
16 Leonard Ave	24.5	27	0	0	0	0	0	0	0	0	0	0
Large power	1145385	1273020	1238210	118159	851551	865893	1059353	921660	1126828	1179661	1215092	1379735
1228 Elm Ste 400	3865	3923	4265	3842	DNA	4308	4231	4240	4020	3817	3829	3500
1230 Elm Fl 1 Unit 102	4844	5203	5278	4695	DNA	4438	4170	4170	4098	4226	4270	4693
1228 Elm Unit 104 (901)	215	169	223	178	DNA	173	158	153	161	205	173	203
1228 Elm	6760	DNA	6920	6400	DNA	6800	6560	6800	6400	6240	680	6360
1228 Elm Ste 401	11411	10845	10498	8330	DNA	9934	9292	8703	8863	8853	10686	11187
1228 Elm Ste 103 (902)	4981	4564	4146	3657	DNA	4815	4802	4666	3935	3497	3632	6212
1228 Elm Ste 101	4227	3736	3455	2596	DNA	2936	2790	2487	2435	3135	4589	5480
1228 Elm Unit 100	5341	4808	4306	3546	DNA	4716	4595	4306	3687	3383	4055	5829
1230 Elm Unit 200	5995	6500	6130	5125	DNA	6430	5967	5329	5243	5247	6327	9367
1228 Elm Ste 201	3821	3722	3592	3164	DNA	4697	4153	3583	3143	2990	3230	4692
33 S Commercial	0	0	0	0	0	0	0	0	0	0	0	0
33 S Commercial	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	-	-	-
33 S Commercial	5954.7	5572	5546	6391	5600	6607	6478	6788	6603	6397	6746	7002.9
33 S Commercial	5906.5	5867	5566	6990	6842	10999	10996	11253	10393	9165	8456	7222
33 S Commercial	8342.9	8815	8681	9994	9612	13457	14275.8	13852	10009	10566	9926	9259.3
33 S Commercial Ste 205	8526.5	8198	8325	10032	8683	11697	12988.7	13862	11941	9819	9105	9686.9
33 S Commercial	672.8	698	808	1176	1201	1986	1693	1346	1652	1471	991	939.6
33 S Commercial	3959.2	4213	4285	4937	4874	9529		8186	6432	4037	4123	4583.6
33 S Commercial	1964.6	2140	2223	2956	3285	5432	6258	6395	5460	3859	2631	2386.5
33 S Commercial Ste 308	6455.6	6146	5671	9667	10637	10061	10044	9871	8899	7009	5337	5378.7
33 S Commercial	11182	10800	11000	12100	12200	19400	22400	22000	17200	11000	10400	11919.4
31 S Commercial Ste 101A	13400	12500	11800	DNA	DNA	DNA	15000	15900	14900	12900	12900	11300
33 S Commercial Ste 103	5672	5107	4436	DNA	DNA	DNA	6332	6731	6295	5499	5400	4932
33 S Commercial Ste 203	8426	7976	7541	DNA	DNA	DNA	14276	13852	11479	10566	9926	8469
33 S Commercial Ste 306	2775	2970	2556	DNA	DNA	DNA	3568	3555	3376	2978	2309	2007
31 S Commercial Ste 101A	4105	3884	3177	DNA	DNA	DNA	3364	3145	2481	1940	2980	3127

GRAND TOTAL **14,107,123 kWh**

—blue cells indicate values based on 2018 data
—green cells indicate data not available

APPENDIX B:

ENERGY EFFICIENCY SCOPING AUDIT



SCOPING AUDIT SUMMARY

As part of Phase 1 of SNHU's sustainability strategic planning initiative, GreenerU performed an energy-efficiency scoping audit of the University's campus. The goals of this high-level study were:

1. To gain an overall understanding of the campus building stock, its general condition and its baseline energy usage, and
2. To assess technical and financial feasibility of energy saving opportunities across the campus.

This information, along with a baseline of greenhouse gas emissions for campus operations, is intended to inform the development of an initial set of strategies for the reduction of emissions and energy usage. This report summarizes the process and findings from the scoping level.

GreenerU conducted field surveys in ten SNHU buildings, covering approximately one-third of the square footage of the total building stock. In addition, available energy data at the building level was reviewed along with additional relevant building information provided by SNHU facilities staff. Based on this gathered information, a portfolio of potential energy efficiency strategies was developed, along with estimated investment costs and energy savings levels.

Across the ten properties surveyed, GreenerU identified efficiency opportunities totaling more than:

- 2 million kilowatt-hours and 9,000 MMBtu per year in electric and thermal energy savings
- 1,140 metric tons of CO_2 equivalent ($MTCO_2e$) per year in emissions reductions
- $15.5 million budgeted project investment

GreenerU also made the following high-level observations about SNHU's buildings:

1. SNHU has a rapidly changing building stock. New construction and renewal projects provide the opportunity and impetus to set energy-efficiency goals.

2. Opportunities for deeper efficiency gains exist across campus. Buildings old and new can be targeted for significant energy-conservation projects and ongoing management.

3. A strategy is needed for campus energy infrastructure improvements. Rather than perform building system renewals in isolation, a broader view and long-term strategy should be developed.

Key technologies for long-term consideration to lower greenhouse gas emissions are ground-source heating and cooling systems; variable refrigerant flow (VRF) HVAC systems; and district energy systems.

METHODOLOGY

Starting with a kick-off meeting on April 11, 2018, Dallase Scott, Lisa Bjerke, and Chris Lewis of GreenerU met with Mary Dukakis and Scott Greeb of SNHU to review the project plan. Greeb and Lewis subsequently met to further discuss the campus energy infrastructure, utility rates, past projects, problem areas, and other factors for consideration in the energy efficiency scoping audit. Together, they made a joint selection of ten buildings for a scoping audit with the intent of creating a representative sample (see Table 8). The buildings cover a range of ages and use types and make up more than 30% of the square footage of the entire campus stock.[1]

Table 8. — Scoping audit building stock

Building	**Type**	**Area (ft^2)**
Athletics/Fieldhouse	Athletic	71,963
Exeter Hall	Academic	27,882
Student Center	Student center	35,160
Washington	Residence	50,000
Hospitality	Academic	30,000
Robert Frost	Academic	58,800
Dining Hall	Dining	47,700
Tuckerman	Residence	80,120
Library Learning Commons	Academic	51,250
33 South Commercial	Administrative	134,290
TOTAL		**587,165**

Following the kick-off, GreenerU staff performed building walkthroughs with assistance from Facilities staff who were familiar with the buildings and energy systems. The surveys were performed to gain a general understanding of building conditions, use types and patterns, energy-related building systems, energy management systems, etc.

GreenerU then compiled building survey information and developed high-level estimates for building energy use and breakdown, efficiency project costs, and potential for emissions and energy reductions.

Generally, natural gas bills were analyzed for the buildings in the study, but no electrical submetering data was available. GreenerU used information from the main meter and benchmarking data to estimate building electrical use. Average energy use intensity (EUI) figures were applied based on building type, with further adjustments made based on the collected field data.

For the purposes of estimating energy cost savings, average unit cost rates were derived from the available utility bills. These rates are $1.126/therm for natural gas and $0.17/kWh for electricity.

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[1] Campus total of 1,741,239 gross square feet includes satellite properties and excludes buildings slated for decommissioning in 2018.

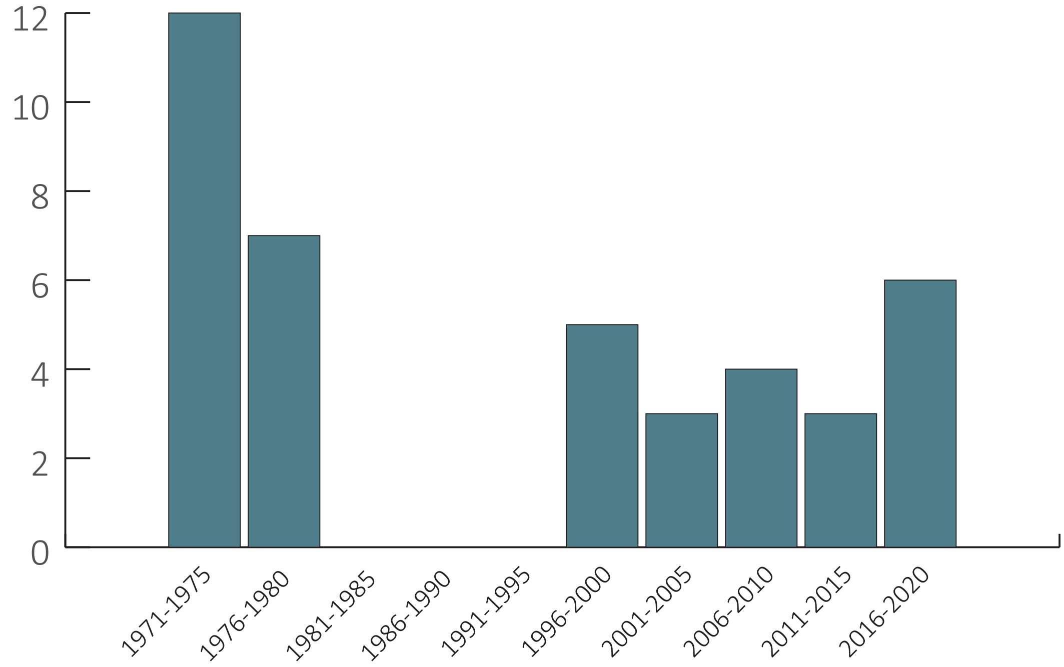
FINDINGS

GreenerU has made the following general observations about the surveyed buildings and energy systems.

1. SNHU HAS A RAPIDLY CHANGING BUILDING STOCK

BUILDING AGE AND PROGRAM	SNHU's building stock ranges in ages from 1970s vintage to new buildings currently in construction. SNHU is also continuing to make changes to its educational programs, thus affecting the overall campus square footage. See Figure 1 for a snapshot of campus growth from 1971 to the present.
NEW CONSTRUCTION AND RENOVATION	The campus has brought online approximately 200,000 square feet of new or renovated building space in 2016 and 2017. Another 200,000 square feet is planned for 2018 and 2019.
NEWER BUILDINGS	Newly constructed and recently renovated buildings are employing the latest designs in energy and sustainability. The planned new College of Engineering, Technology and Aeronautics (CETA) building, slated for completion in 2019, is being built to LEED Silver certification standards.
OLDER BUILDINGS	Older buildings on campus generally have more conventional energy systems, with some basic efficiency improvements.

Figure 4. — SNHU additions to building stock, 1971–present



2. OPPORTUNITIES EXIST FOR DEEPER EFFICIENCY GAINS ACROSS CAMPUS IN OLDER AND NEWER BUILDINGS

IN OLDER BUILDINGS

The site surveys performed in this study intentionally focused on the older buildings on campus. The following are general observations on opportunities for efficiency improvements.

LIGHTING INFRASTRUCTURE	Some LED lighting was observed on campus, but a majority of lighting systems are still fluorescent. Even in buildings constructed as recently as 2014, fluorescents are in use and an upgrade to LED is warranted.
LIGHTING CONTROLS SYSTEMS	No networked lighting controls systems were observed in the surveyed buildings. Networked lighting controls are now more cost-effective than ever, and offer optimal efficiency, user experience, and demand response capability.
BUILDING ENVELOPE	Some minor opportunities for improving weather stripping and air sealing in older buildings were noted. For more significant improvements to building envelope performance, substantial construction efforts will be required and should be considered during other planned capital improvements.
RETROCOMMISSIONING	While virtually all buildings at SNHU have DDC controls, many are due for a thorough retrocommissioning process to address faulty or uncalibrated components and other mechanical deficiencies which occur over time in all buildings.
CONTROLS OPTIMIZATION	SNHU has HVAC controls infrastructure across campus, with basic controls strategies in place. This presents an opportunity to implement advanced controls strategies, which include best-in-class or “high performance” control sequences, optimizing the energy performance of HVAC equipment.
ONGOING PERFORMANCE MONITORING	While SNHU’s building management system (BMS) is used for monitoring and troubleshooting of HVAC systems, the school does not yet use a data-driven or systematic approach to continuous commissioning. Ongoing performance monitoring uses data monitoring and analytics to ensure ongoing optimized controls and energy performance.
OTHER EFFICIENCY OPPORTUNITIES	Additional efficiency opportunities are discussed in the following sections on building information, and include: classroom scheduling integration; VAV conversions; IAQ-base ventilation; laundry ozone; kitchen hood controls; walk-in cooler controls; radiator valve controls; and more.

IN NEWER BUILDINGS

Although more recently constructed buildings are ostensibly higher performing, it is GreenerU's experience that this does not necessarily hold true. While newer HVAC and controls systems are designed for higher efficiency, their increased complexity creates opportunities for energy-wasting deficiencies.

RETROCOMMISSIONING	While virtually all buildings at SNHU have DDC controls, many are due for a thorough retro-commissioning process to address faulty or uncalibrated components and other mechanical deficiencies which occur over time in all buildings.
CONTROLS OPTIMIZATION	SNHU has HVAC controls infrastructure across campus, with basic controls strategies in place. This presents an opportunity to implement advanced controls strategies, which include best-in-class or "high performance" control sequences, optimizing the energy performance of HVAC equipment.
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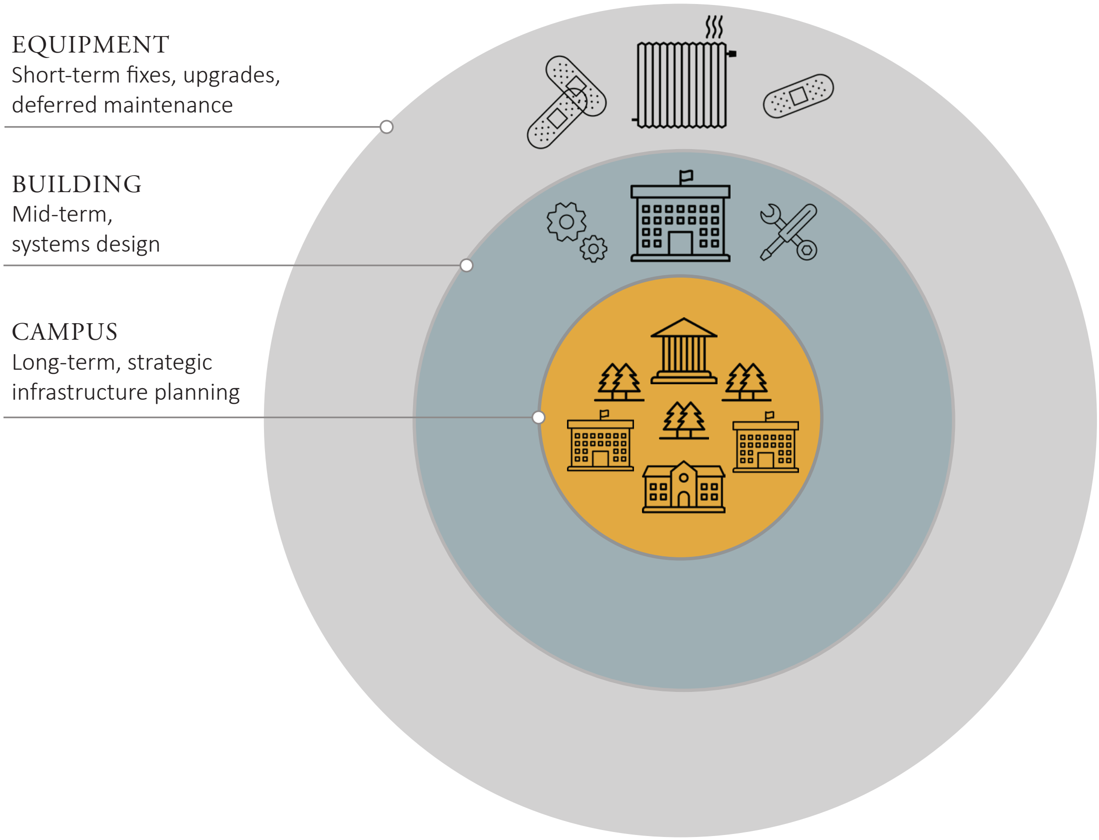
3. A STRATEGY IS NEEDED FOR CAMPUS ENERGY INFRASTRUCTURE IMPROVEMENTS

Performing energy efficiency retrofits on existing buildings can achieve significant reductions in energy use; however, to go a level deeper, even more substantial upgrades to the energy infrastructure are required. Due to the relatively larger capital cost requirements, projects of this nature are best performed in conjunction with other capital improvements and planned system renewals.

An effective strategy for long-term efficiency improvement, however, requires a departure from business-as-usual equipment upgrade projects, which typically consist of replacement-in-kind and do not re-examine the energy systems at both the building and campus level. This is particularly true when buildings undergo changes in space use over time, as continues to happen at SNHU. Figure 5 illustrates a bullseye approach of seeing long-term infrastructure improvements in the context of an overall campus decarbonization plan.

Figure 5. — Campus-, building- and equipment-level planning and investment

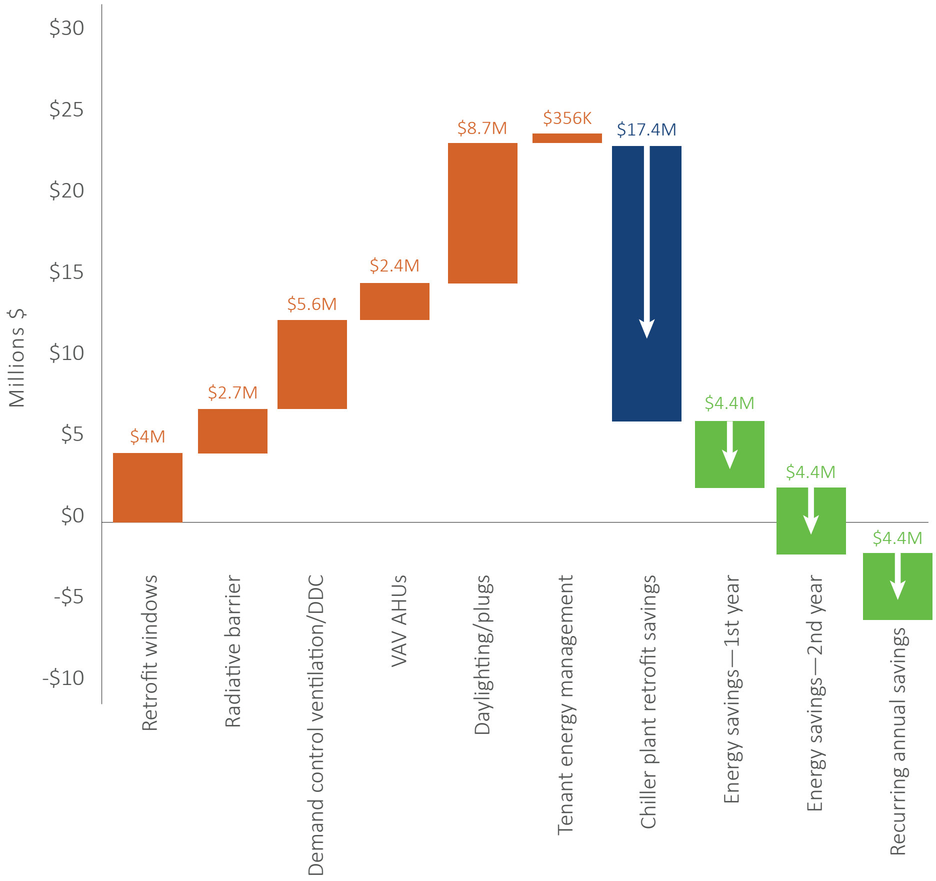


When performing a cost-benefit analysis of campus infrastructure, the simple metric of annual energy cost savings and payback can be misleading. A greater return on investment (ROI) is possible with energy-efficiency projects, with additional benefits ranging from decreased maintenance time and costs, increased equipment functionality, and increased building occupant comfort, in addition to reducing dependence on fossil fuels.

Further, a study by the Rocky Mountain Institute shows that a deep-energy retrofit of the Empire State Building in New York City yielded an expected 38% in energy savings. This project entailed remanufacturing the building's 6,514 windows with advanced glazing, improving lighting throughout the building, and a renovation of the chiller plant. The comprehensive nature of the project enabled the Empire State Building to bundle shorter-payback projects with those having longer paybacks, thus enabling the building owners to realize energy savings sooner.

Figure 6 illustrates the Empire State Building's measures and expenditures (in orange), followed by subsequent capital cost reductions (in blue) and annual energy savings (in green). Annual utility costs before the retrofit were $11 million; afterward, annual energy costs are around $6.6 million.

Figure 6. — CASE STUDY—tunneling through the cost barrier: energy-efficiency investments and returns at the Empire State Building[2]



Thus, GreenerU recommends that the following considerations be taken by SNHU when developing a longer-term strategic plan for energy infrastructure systems:

CENTRALIZED VERSUS DE-CENTRALIZED HEATING

For any college campus, especially one in a cold climate such as New England, space heating is a significant portion of total campus energy consumption. SNHU's heating infrastructure is currently a de-centralized gas distribution network—in other words, there is no central heating plant. Table 9 illustrates the pros and cons of a decentralized heating infrastructure at SNHU.

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[2] Harrington, Eric, and Cara Carmichael. Rocky Mountain Institute. "Project Case Study: Empire State Building," 2009.

Table 9. — Pros and cons of SNHU's decentralized heating infrastructure

Pros	Cons
Ability to convert building energy systems independently and gradually	Inability to convert building energy sources en masse, as with a central plant conversion
No thermal losses in distribution network	Limitation in system level efficiencies and diversity
Less maintenance to distribution network	

A third configuration is known as "distributed" energy systems. In this model, buildings are interconnected and able to transfer energy across a distribution network; however, in a key difference from centralized systems, heating and cooling equipment is distributed across various locations throughout the network. Both centralized and distributed heating systems require an extensive amount of distribution infrastructure, which SNHU's campus currently lacks.

ELECTRIFICATION OF HEATING SYSTEMS: HEAT PUMPS

To move toward higher-efficiency, lower-carbon energy systems, SNHU will need to consider how to migrate from natural gas heating to an electric-powered heating source. Electrification of heating systems is considered to be a critical pathway to carbon neutrality, as it removes a direct dependence on a fossil fuel source with a view toward a future sustainable electric supply.

Many of SNHU's main campus buildings rely on gas-fired airside heating. Unlike hydronic heating, which can be converted at the source (boiler), these systems require a more complex conversion process to various pieces of equipment.

Variable refrigerant flow (VRF) heat pumps are recently a burgeoning technology in North America, but they have been used widely in Europe and Asia for decades. Recent advances in the market have made VRF an increasingly viable option for heating and cooling systems, even in cold-weather climates.

Furthermore, VRF is a good option for retrofit and renewal applications, since the required piping is small in size, and there is a wide array of available terminal units. Since SNHU will likely be faced with retrofitting existing airside systems with VRF, dedicated outdoor air systems (DOAS) can also be equipped with VRF-compatible heating and cooling.

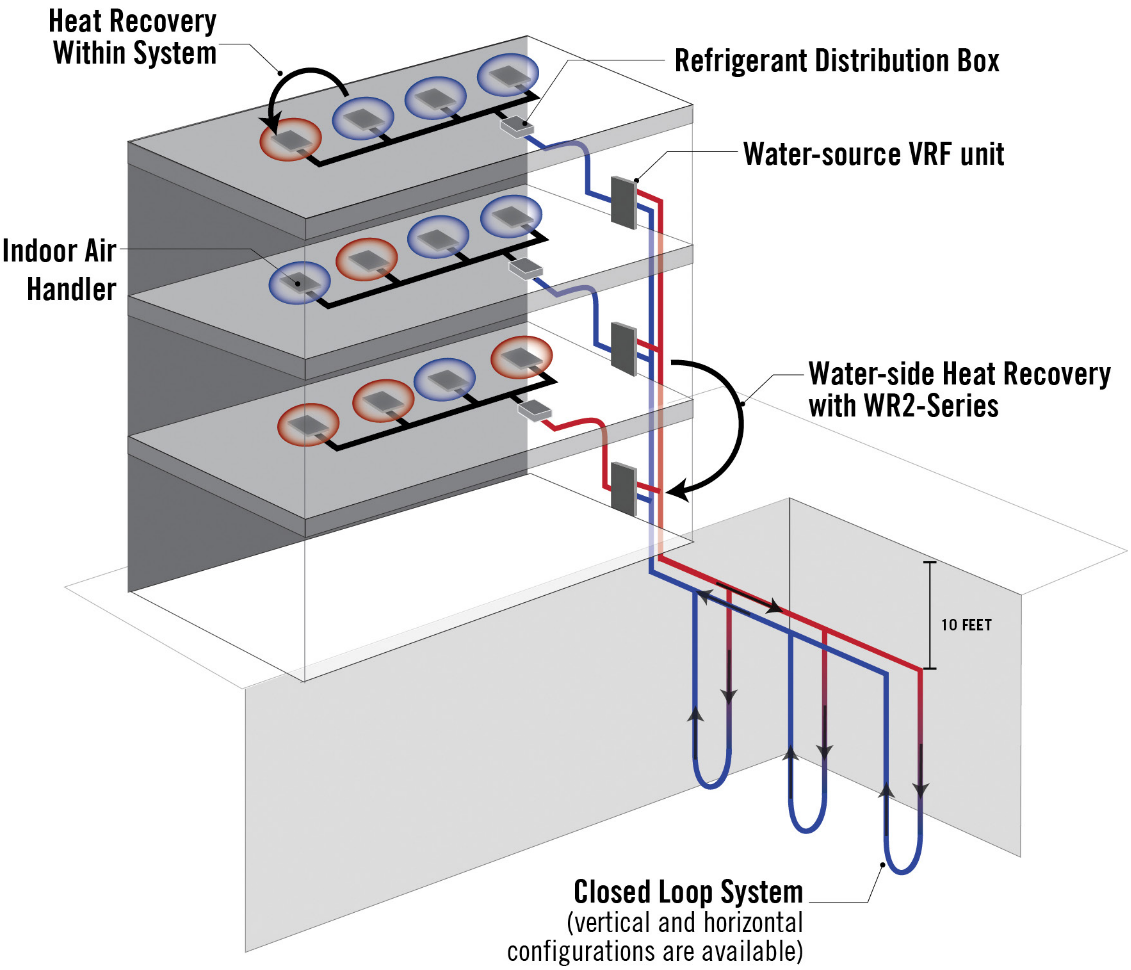
Variable refrigerant flow air-side unit

Dedicated outdoor air system

GROUND-SOURCE HEATING AND COOLING

SNHU already employs air-source VRF heat pumps in several of its buildings (Penman Stadium, Tuckerman, e.g.). The limits of air-source heat pumps begin to be stretched in climates where ambient air temperatures reach as low as zero degrees Fahrenheit. This often means the use of supplemental heating through more conventional means (gas heating). VRF technology (see Figure 6) offers the added flexibility of also working in water-source applications, including in combination with ground loops. This type of system achieves even higher efficiencies by capturing available low-grade heat from the ground.

Figure 6. — Ground-source variable refrigerant flow (VRF) system

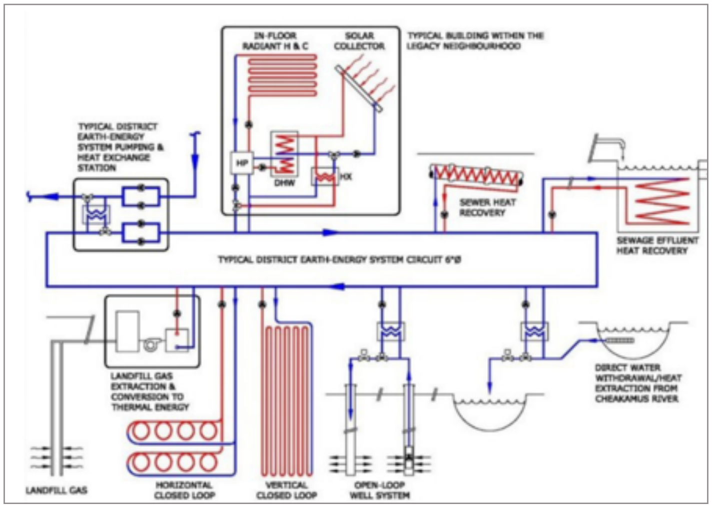


To further understand the feasibility of ground-source systems on SNHU's campus, GreenerU recommends performing soil testing and installation of test wells to determine ground conductivity and heat transfer characteristics.

PUTTING IT ALL TOGETHER: DISTRICT ENERGY SYSTEMS

Combining the concepts behind distributed heating systems with ground source heating and electrically driven heat pumps is the developing concept of a district energy system. In this scenario, various heating and cooling loads are interconnected by a common "ambient temperature loop" which acts as both a source and sink for heat transfer. Connected buildings are equipped with heat pumps in a variety of configurations, which act as both heat sinks or sources, depending on their mode of operation. This arrangement allows for extremely high operating efficiencies and minimizes waste through "energy recycling."

Whistler Athletes' Village district energy system in British Columbia



Example schematic of a district energy system

District energy systems offer the next generation of energy efficiency plus numerous operational benefits. Should SNHU choose to pursue the development and construction of a campus-wide energy infrastructure system, GreenerU recommends further analysis of the district energy system as an option.

BUILDING DESCRIPTIONS AND ECMS

ENERGY CONSERVATION STRATEGIES

This attachment contains the data collected from the building surveys conducted during the energy efficiency analysis portion of Phase 1 and discusses the energy conservation measures recommended. Further analysis of the energy usage and efficiency opportunities for each building can be found in Appendix B: Building Energy Efficiency Data.

ENERGY CONSERVATION MEASURES

LED lighting	Upgrade interior and exterior systems to LED
Advanced lighting controls	Install advanced, networked, multi-parameter lighting controls; includes occupancy, scheduling, task tuning, and daylight harvesting
Lighting controls integration with and energy management system (EMS)	Integrate lighting control system to the EMS, providing real-time occupancy-based temperature controls, setbacks and capability for electrical demand management
EMS expansion	Expand EMS to integrate additional equipment not currently being controlled
Classroom scheduling integration	Integrate class and events scheduling software with EMS to control space temperatures based on schedule usage
Controls system optimization	Deploy latest advance energy strategies and controls sequences on existing equipment: • CO_2-based demand-controlled ventilation • Trim-and-respond type discharge air and static pressure resets • Temperature setpoint standardization
Convert to variable air volume	Install variable frequency drives (VFDs) on constant-volume AHUs and RTUs; install local zone dampers or variable air volumes (VAVs) for zone control
Indoor air quality-based ventilation	Install indoor air “cleaning” equipment to reduce outdoor ventilation air requirement while maintaining indoor air quality (IAQ), per ASHRAE 62.1 standards.
Laundry ozone	Install ozone generators on centralized laundry facilities, reducing hot water demand
Envelope improvements	Provide attic insulation, weather stripping, doors seals, window seals, and caulking, etc.
Kitchen hood controls	Install variable speed drives on kitchen hood fans and controls for demand-based variable volume
Walk-in cooler controls	Install high-efficiency evaporator fan motors and controllers for refrigeration and door heaters to optimize energy use
DDC radiator valves	Convert thermostatic radiator valves to direct digital controlled devices that can be programmed remotely

OTHER PROJECT OPPORTUNITIES

Energy submetering	Install electrical submeters in buildings throughout campus to better profile demand and annual usage
Eliminate natatorium	Decommission the pool at the Athletic Center and in-fill the space
Convert to VRF	Convert heating/cooling systems to air-source heat pump (VRF) systems
Adaptive reuse	Perform a complete building renovation and design for maximum energy efficiency
Greener Dorms	Implement student occupancy engagement and sustainability awareness program

BENCHMARKING

Having completed a survey for each building in the study, an estimate of the energy usage and list of possible efficiency measures were created for each building.

To estimate each building's energy usage, GreenerU used benchmarking data from its database of university building energy use. Buildings were categorized by space type and compared to electricity and thermal metrics for comparable buildings. Further adjustments to the estimates were made for each building based on characteristics of the building's energy systems and use patterns, as observed during the audit.

Figures 7-16 on the following pages show thermal and electric EUI per square foot per year for the buildings in the study as compared to GreenerU's benchmarking database.

Figure 7. — Benchmark comparison of SNHU Athletic Center's estimated electricity use intensity against GreenerU's database of comparable buildings

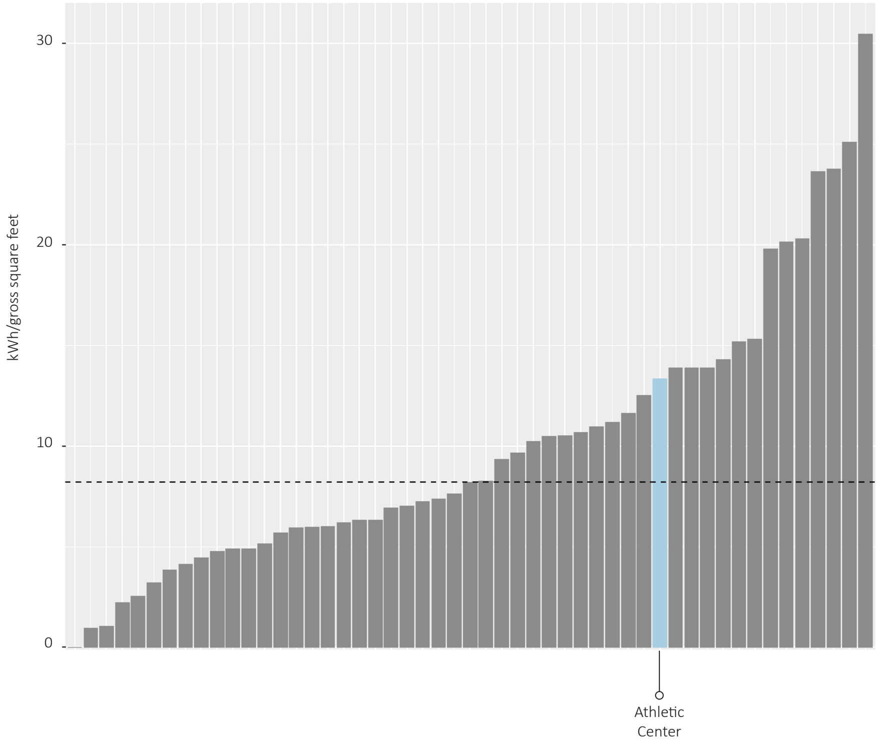
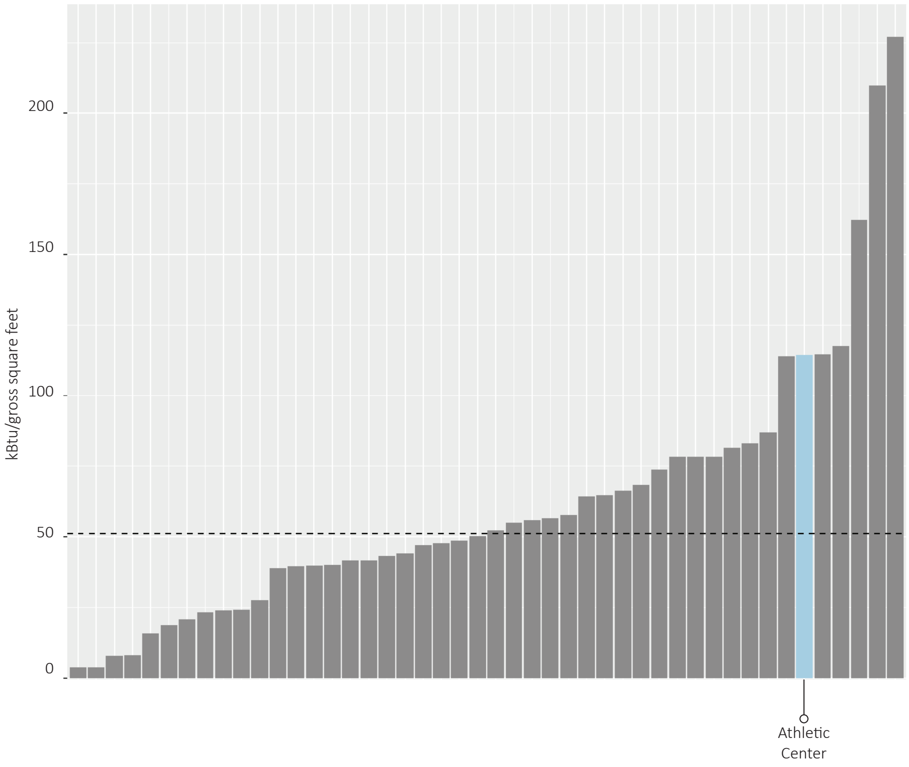


Figure 8. — Benchmark comparison of SNHU Athletic Center's actual thermal use intensity against GreenerU's database of comparable buildings



BUILDING DESCRIPTION: ATHLETICS

The Athletics Complex is a two-story structure built in 1971. It houses gymnasiums, a natatorium, fitness center, dance studio, weight room, laundry facilities, locker rooms, meeting room, and administrative support offices.

This building also hosts a 65-kilowatt cogeneration unit, which provides heating hot water to the pool and other heating loads in the building. It was reported that due to limited pool usage in the summer months, the cogeneration system does not operate full time in the summer, or at times rejects waste heat to the atmosphere.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent. Fixture types include: recessed troffers; parabolics with T8 U-tube lamps; T5 surface mounted fixtures; direct/indirect linear fixtures; and fluorescent high-bay fixtures. Occupancy controls were observed on some lighting circuits, including on some of the high-bay fixtures in the gym spaces.
Heating	Primary heating is provided through gas-fired rooftop units. The building has approximately 20 RTUs serving various spaces. Gas-fired boilers also provide a heating hot water system which serves the pool and various radiation and unit heaters in miscellaneous locations. The heating hot water loop is also supplemented by waste heat from the cogeneration unit.
Cooling	The approximately 20 rooftop units are predominantly equipped with DX cooling and economizer function.
Ventilation	Ventilation air is distributed by the rooftop units. Units serving the main gym are equipped with CO_2 sensors, but most units are not configured with demand-controlled ventilation.
Envelope	The building is of block construction with corrugated metal siding. It has a combination of flat membrane and pitched corrugated metal roofing. The building has a relatively low window area. The majority of the window area is in the main gymnasium and pool and is a translucent window panel system. This provides good thermal insulation while permitting visible light transmission.
Controls	The building is equipped with a modern DDC control system on a majority of major mechanical systems, integrated with the campus energy management system (EMS). The existing hot water boilers are integrated to the EMS. Hot-water pumps have variable speed drives with loop pressure control.
Domestic hot-water system	The main mechanical room has three large (estimated 200 gallons each) domestic hot water storage tanks, served by an indirect instantaneous Patterson-Kelly hot water heater.

Figure 9. — Benchmark comparison of SNHU academic buildings' estimated electricity use intensity against GreenerU's database of comparable buildings

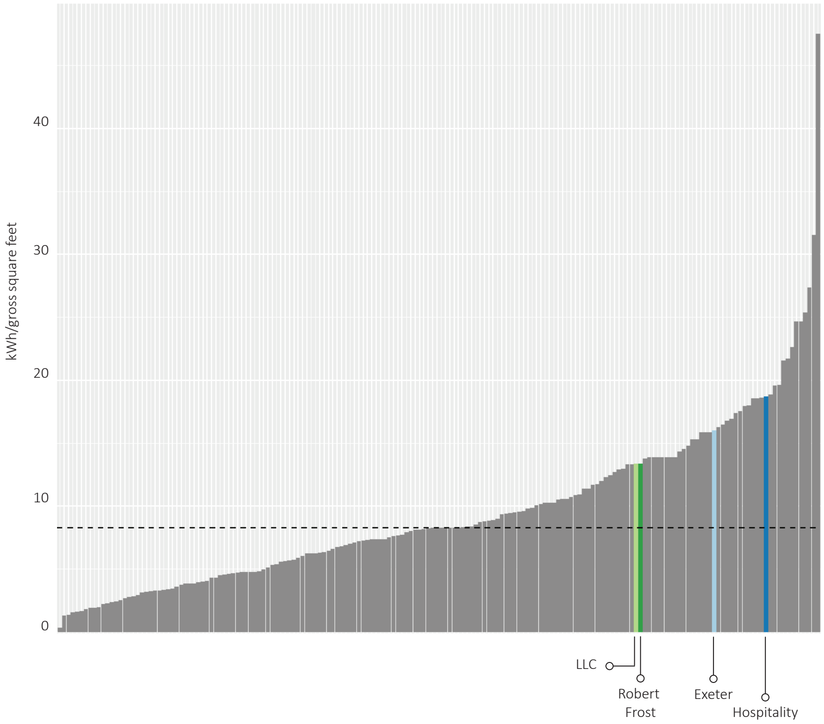
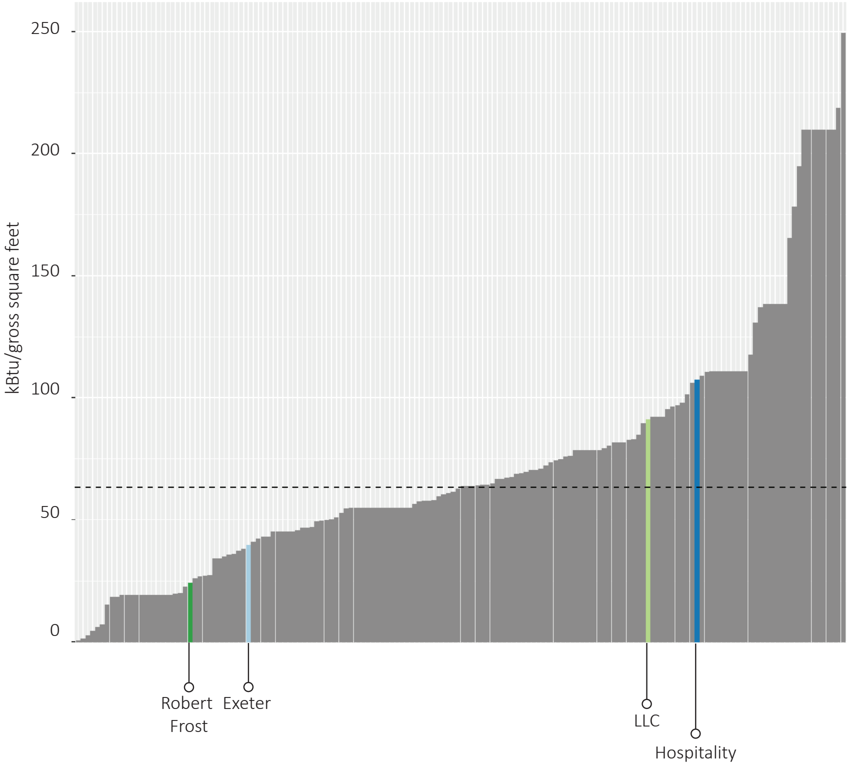


Figure 10. — Benchmark comparison of SNHU academic buildings' actual thermal use intensity against GreenerU's database of comparable buildings



BUILDING DESCRIPTION: EXETER

Exeter Hall is a ~28,000-square-foot single-story building built in 1971. It houses various academic and administrative spaces including the Registrar's office, student financial services and human resources. It also contains a data center. Spaces include mostly private offices, open office areas and conference rooms.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent. Fixture types include T8 three-lamp parabolic troffers, and recessed downlights.
Heating	The primary heating source is gas-fired rooftop units. There are approximately 20 RTUs serving the building. Some electric cabinet-unit heaters serve entryways and vestibules.
Cooling	Cooling is provided by the RTUs, which are equipped with DX cooling. The data center is served by a Liebert computer room air conditioning (CRAC) unit.
Ventilation	The building is ventilated by the array of rooftop units. Several units are equipped with CO_2 sensors. A majority of spaces do not have CO2 sensors or demand-controlled ventilation (DCV).
Envelope	The building is one story with wood façade and a recently replaced roof. Staff reported that the roof and wall insulation, dating back to original construction in 1971, is minimal. The façade is reportedly beginning to show signs of failure and is due for upgrading. Storefront glazing by the North entrance is single-glazed and presumably the typical vintage throughout the building.
Controls	The building is equipped with a modern DDC control system on a majority of major mechanical systems, integrated with the campus energy management system (EMS). The RTUs generally have economizer function, scheduling capability and unoccupied temperature setbacks.
Domestic hot-water system	The building is served with an electric hot water heater.

BUILDING DESCRIPTION: ROBERT FROST

Robert Frost Hall is a ~59,000 square foot three story building constructed in 2001. It is primarily an academic building, housing various academic departments, classrooms, seminar rooms and faculty offices. It also contains a small art gallery, with plans for expansion of exhibit area.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent. Fixture types include primarily recessed four-lamp T8 parabolic troffers, recessed downlights, and linear direct/indirect fixtures.
Heating	The building is heated by approximately 18 gas-fired rooftop units (RTUs). About half of the units are single zone or constant volume and about half are variable volume, serving zone VAV boxes with no reheats.
Cooling	The RTUs are equipped with stages of DX to provide cooling. The VAV boxes served by the rooftops provide cooling control for certain zones.
Ventilation	Ventilation is also provided by the RTUs. Generally, the units are equipped with economizer function, but do not have CO_2 sensors or demand-controlled ventilation capability.
Envelope	The building has a brick façade and flat roof. Windows are double-glazed with operable sashes.
Controls	Frost Hall has modern DDC controls systems integrated to the campus energy management system (EMS). RTUs are equipped with occupancy scheduling and enthalpy-based economizer functions. Generally, units are not equipped with CO_2 sensors or demand-controlled ventilation functionality.
Domestic hot-water system	Domestic hot water is provided by one gas-fired and one electric hot water heater, both with storage capacity.

BUILDING DESCRIPTION: LLC

The Library Learning Commons (LLC) is a ~51,000-square-foot building constructed in 2014. It serves as the campus's main library and academic learning center, housing library services, book stacks, open study areas, support offices, classrooms, computer rooms, and data center.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent. Fixture types include architectural style pendant mounted direct/indirect linears, recessed downlights and center basket style recessed troffers.
Heating	The building is heated by two high efficiency gas-fired boilers. The hydronic loop serves air handling units, VAV reheats and other terminal units.
Cooling	The building is supplied cooling by DX from the two main rooftop units (RTUs). Cooling to the zones is controlled by variable air volume (VAV) terminal boxes. The data center is cooled ductless split air conditioning units.
Ventilation	The building is ventilated by the two main RTUs. VAV boxes deliver primary air to the spaces. Each air handling unit monitors the CO_2 level in multiple zones.
Envelope	The building has three floors and a basement and has a brick, wood and glass façade.
Controls	The building has fully modern HVAC controls integrated with the energy management system (EMS). The controls system uses the latest controls strategies, including occupancy scheduling and CO_2-based demand-controlled ventilation.
Domestic hot-water system	Domestic hot water is provided by a pair of high efficiency gas-fired domestic hot water heaters.

BUILDING DESCRIPTION: HOSPITALITY

The Hospitality building is a 30,000-square-foot facility constructed in 1996. It is used primarily for hospitality industry educational programs and houses a variety of food preparation spaces including kitchens, restaurant and dining areas, food storage, classrooms, offices, and multi-purpose spaces.

Due to its specific function, the building has a unique set of HVAC systems and is estimated to have a very high energy use intensity (EUI); however, the University's hospitality educational programs are changing, and the building is expected to undergo a major change in space use. It has not yet been determined how the building will be used in the future, but it is likely that it will need extensive renovation work to meet updated space programming needs. This presents an opportunity to design for maximum energy efficiency, a process that should begin early in programming.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent. Fixture types include primarily recessed troffers with linear T8 lamps and parabolic 2' x 2' troffers with biaxial U-tube lamps. Some lighting circuits have ceiling mounted occupancy sensors.
Heating	Heating to the building is mainly provided by seven gas-fired rooftop units, supplying air to interior spaces.
Cooling	The rooftop units are equipped with DX cooling. There is cooling generally throughout all areas of the building.
Ventilation	The rooftop units provide outside air ventilation to the building. Kitchen hood exhaust fans are used to ventilate spaces with cooking equipment. Make-up air is provided by rooftop units and make-up air units. At least some kitchen hoods were observed to have digital control displays, indicating a demand- and/or user-based variable volume control system. Kitchen hood and any associated make-up air systems are not integrated into the campus energy management system. Generally, the rooftop units do not have CO_2 sensors for demand-controlled ventilation functionality.
Envelope	The building has two stories plus a basement, with brick façade and pitched metal roof. Windows are double-glazed, double-hung with operable sashes in some areas.
Controls	The building has a DDC controls system integrated to the EMS. The EMS has occupancy scheduling capacity for RTUs, but it is not integrated to the kitchen exhaust systems. RTUs are generally constant volume and equipped with enthalpy-based economizer control.
Domestic hot-water system	A 1,000-MBH gas-fired hot water boiler provides heated service water to the kitchens and provides tempered domestic hot water for the building.
Other	Kitchen equipment is generally gas-fired (as opposed to steam heated) and dish washing operations are served by the hot water boiler. The building has various walk-in coolers and freezers in the multiple kitchen and food storage areas.

Figure 11. — Benchmark comparison of SNHU administrative building's estimated electricity use intensity against GreenerU's database of comparable buildings

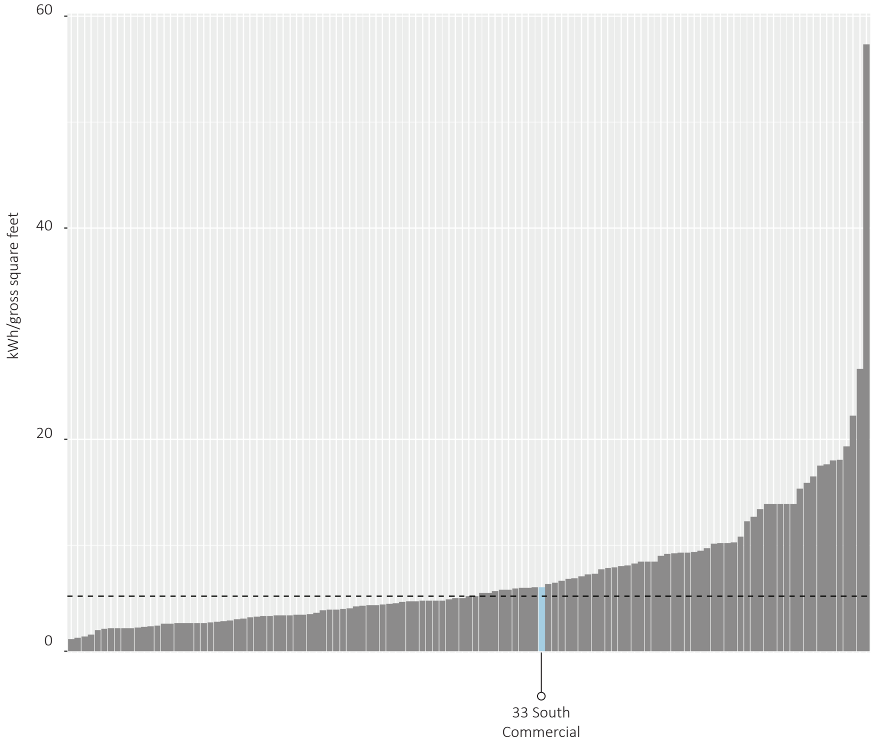
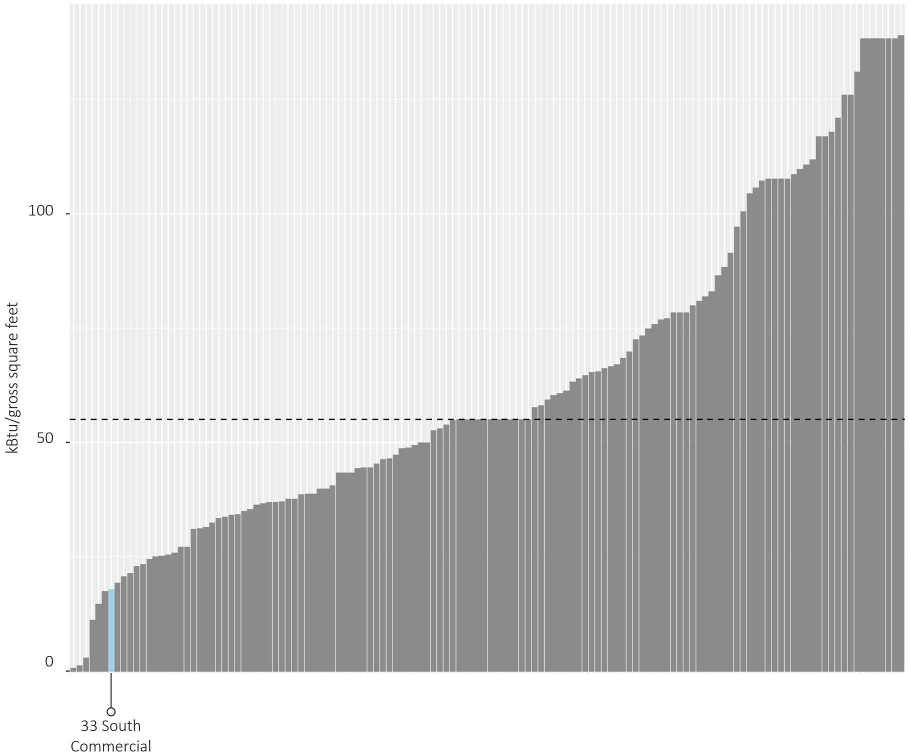


Figure 12. — Benchmark comparison of SNHU administrative building's actual thermal use intensity against GreenerU's database of comparable buildings



BUILDING DESCRIPTION: MILL YARD

The Mill Yard facilities consist of three properties—33 South Commercial, 55 South Commercial, and 186 Granite Street—housed in a single large building, originally constructed as a textile mill in the late 19th or early 20th century. The University occupies a majority of the 33 South Commercial and 186 Granite Street addresses, with a few leased tenant spaces also housed in 186 Granite. The school has recently signed a lease for the 55 South Commercial property and is in the process of phasing out tenant leases and beginning programming for fit-out and move-in to the newly acquired area. The total square footage of the three facilities is approximately 415,000 square feet.

The facility is the primary site of the University's online learning programs. Much of the square footage is occupied by open-plan office area with cubicles. There are also conference rooms, private offices, break rooms, computer rooms, and an employee cafeteria. The building operates mainly on a schedule of normal business hours, but some services remain active with extended hours to support West Coast students.

The University will be exploring options for new mechanical systems in the 55 South Commercial property, for new space fit-outs and expansion to currently occupied spaces, as well as future fit-outs.

BUILDING FEATURES

Lighting	The lighting systems are mainly fluorescent are throughout the facility. Some pendant fixtures have been retrofitted with LED screw-in lamps. Many of the same fixture type are fitted with compact fluorescent screw-in lamps. Some T12 linear fluorescent fixtures are in use in stairwells. Many open office areas receive natural daylight from ample window area and minimal interior walls.
Heating	A majority of the occupied spaces are heated primarily with small gas-fired air-handling units serving single zones or sub-zones of the open office areas. On the fourth (top) floor, the spaces are generally served by rooftop units, also with gas heating. An old gas-fired fire-tube steam boiler provides heating for the 55 South property. Cast iron steam radiators still serve some select areas in the old wing.
Cooling	In 33 South Commercial and 186 Granite, the small AHUs and RTUs are generally equipped with DX cooling. Other mini splits or multi-zone splits are also used in some interior thermal zones such as conference rooms, allowing them to be decoupled from the main office spaces for better control.
Ventilation	Ventilation is mainly provided by relatively small, indoor energy recovery ventilators located throughout the spaces in mechanical rooms or exposed ceiling mounted. Rooftop units on the upper floors also provide fresh air for ventilation. A kitchen hood exhaust system with make-up air unit serve the kitchen in the cafeteria.
Envelope	The building is four stories and of brick construction. Many areas have exposed brick finish on exterior walls and have no wall insulation applied. Windows are double glazed aluminum frame replacement windows. Most are fixed sash, but some areas have small operable sashes for user operability.
Controls	The HVAC equipment generally has digital controls systems, but not a true energy management system (EMS). The digital thermostats on the small unitary equipment throughout the office spaces are networked, allowing some remote access to setpoint adjustments and scheduling / setbacks.
Domestic hot-water system	55 South Commercial currently houses a manufacturing facility in parts of the lower level, which uses steam for its manufacturing processes. This tenant is moving out soon, given the new lease agreement, but thermal usage from the manufacturing processes is expected to be a component of the historical energy usage of the building.

Figure 13. — Benchmark comparison of SNHU residence halls' estimated electricity use intensity against GreenerU's database of comparable buildings

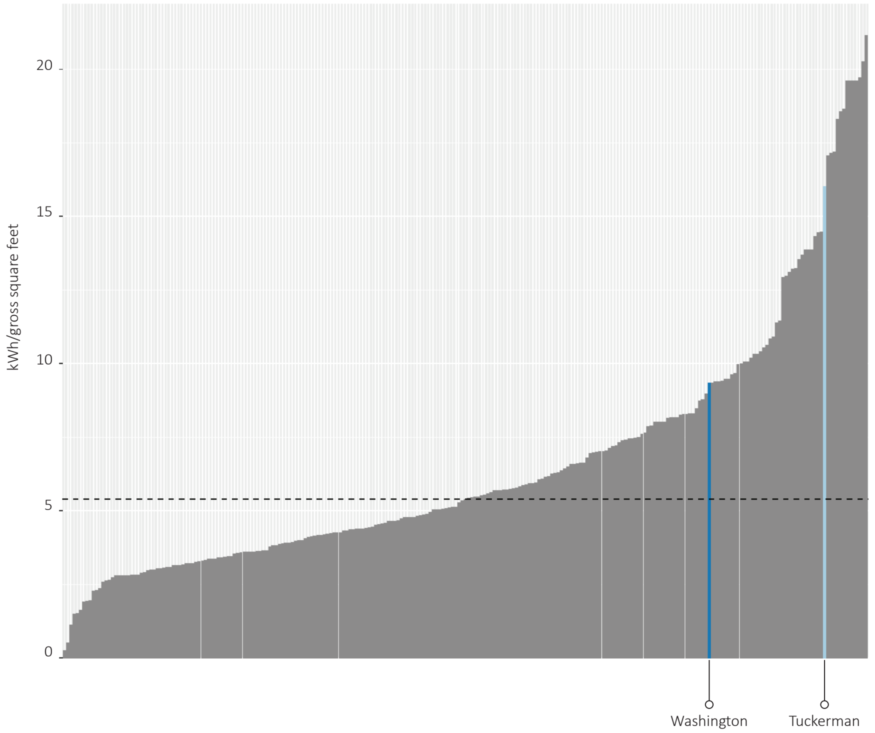
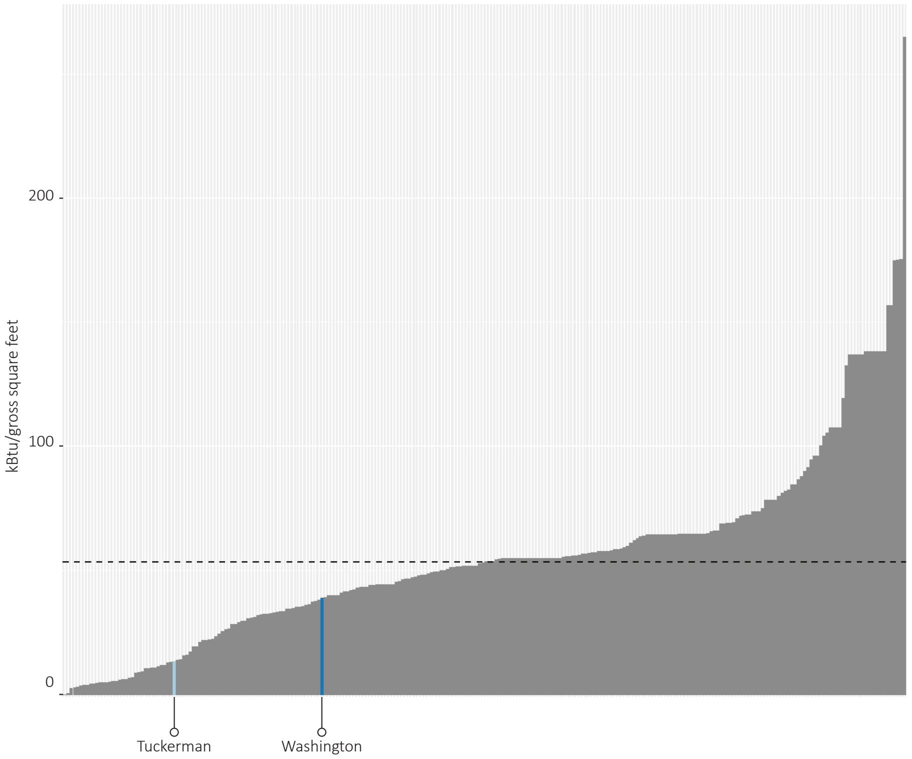


Figure 14. — Benchmark comparison of SNHU residence halls' actual thermal use intensity against GreenerU's database of comparable buildings



BUILDING DESCRIPTION: TUCKERMAN

Tuckerman is an ~80,000-square-foot student residence built in 2013. The building houses student dormitories and common areas, such as study lounges and laundry facilities.

BUILDING FEATURES

Lighting	The lighting systems are predominantly fluorescent. Fixture types include center-basket-style recessed troffers, decorative drum fixtures, and recessed downlights.
Heating	The building is heated with variable refrigerant flow (VRF) air-source heat pumps. Each room is provided with heating from a VRF indoor unit with locally accessible thermostat. Energy recovery ventilators are also gas-fired to provide heating of ventilation air.
Cooling	The VRF air-source heat pumps provide cooling throughout the building.
Ventilation	The building is ventilated with energy recovery ventilators with gas-fired heating.
Envelope	The building is four floors and has a façade of brick and architectural panel siding. Dorm rooms have double-glazed double-hung windows with operable sashes. Operable windows are not interlocked with local thermostats to lock-out heating and cooling while windows are open.
Controls	The building is equipped with modern DDC controls and is integrated with the campus energy management system (EMS). The temperature controls the VRF system are integrated with the EMS to provide centralized scheduling and setpoint control to each zone. Exhaust for the multi-purpose room is controlled by CO_2-based demand-controlled ventilation.
Domestic hot-water system	The building is provided domestic hot water for bathrooms and laundry facilities from four gas-fired domestic hot water heaters.

BUILDING DESCRIPTION: WASHINGTON

Washington is a 50,000-square-foot dormitory built in 1996. The building is comprised of four levels and two main wings. The building is used primarily as a student residence during the school year and contains dorm rooms, restrooms and shower rooms, common area lounges, and laundry facilities. Construction and energy systems are typical of student dorm buildings.

BUILDING FEATURES

Lighting	The lighting systems are LED. Main fixture types in hallways and common areas are recessed troffers with T8 lamps. Stairwells contain wrap style fixtures.
Heating	The building is heated by four gas-fired high efficiency hot water boilers, serving hot water radiators throughout the building. The hot water system is equipped with high efficiency variable speed circulator pumps with EC motors. Dorm rooms are heated using hot water radiators controlled with thermostatic valves.
Cooling	The building is not cooled.
Ventilation	The building is ventilated with toilet room and general exhaust fans, with make-up air provided by gas-fired air handling units.
Envelope	The building is three levels and has a brick façade.
Controls	The heating hot water and domestic hot water systems are digitally controlled with integration to the Energy Management System (EMS). The ventilation systems are not integrated with the EMS and either run continuously or are on locally controlled timeclocks.
Domestic hot-water system	Domestic hot water for bathrooms and showers is provided by four gas-fired domestic hot-water storage tanks.

Figure 15. — Benchmark comparison of SNHU student centers'' estimated electricity use intensity against GreenerU's database of comparable buildings

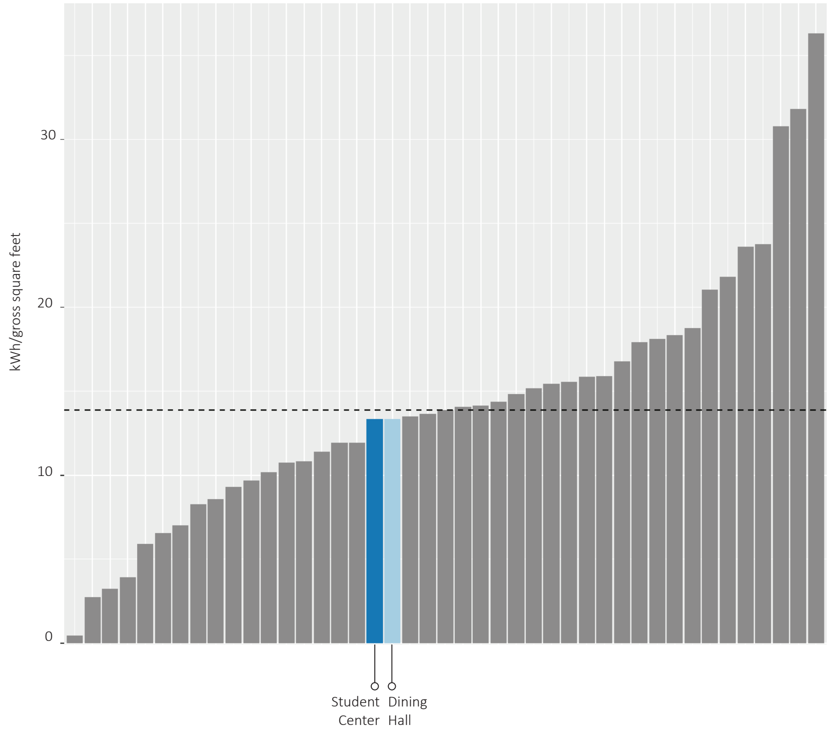
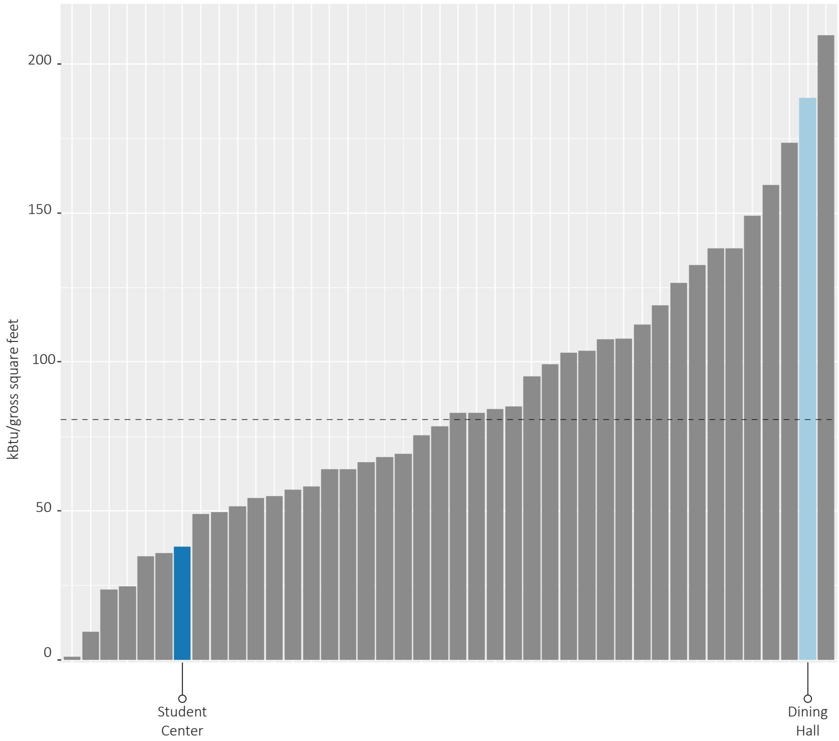


Figure 16. — Benchmark comparison of SNHU student centers' actual thermal use intensity against GreenerU's database of comparable buildings



BUILDING DESCRIPTION: STUDENT CENTER

The Student Center / Wellness Center is a ~35,000 square foot building originally constructed in 1971. The building has undergone several partial renovations, one as recently as 2012. The building houses a student union, mail room, café, book store, lounges, and offices of various student organizations.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent. Fixture types include center-basket-style recessed troffers, recessed downlights, wall sconces, and various decorative fixtures. Ceiling mounted occupancy sensors controlling lighting circuits were observed during the survey.
Heating	Heating is provided primarily from approximately 18 gas-fired rooftop units (RTUs). A pair of hot water boilers in the lower level mechanical room provides hot water for a small number of zone reheats and additionally serve the domestic hot water heater.
Cooling	Cooling is provided by the RTUs, which are equipped with one or two stages of DX cooling.
Ventilation	The RTUs provide mechanical ventilation for the spaces. Most RTUs serve a single zone or are multi-zone constant volume units. Generally, the units are equipped with an economizer function, but do not have CO_2 sensors or demand-controlled ventilation capability.
Envelope	The building is one story with wood façade and flat rubber roof. Its condition is unknown. Staff reported that the roof and wall insulation, dating back to original construction in 1971, is minimal. The façade is reportedly beginning to show signs of failure and is due for upgrading. Some portions of the façade have been re-sided and some windows upgraded to double-glazed. Single glazed windows are still in some areas of the building.
Controls	The building is equipped with a modern DDC control system on a majority of major mechanical systems, integrated with the campus energy management system (EMS). The RTUs generally have economizer function, scheduling capability and unoccupied temperature setbacks.
Domestic hot-water system	Domestic hot water is provided from an indirect water heater served by the gas boilers.

BUILDING DESCRIPTION: DINING HALL

The Dining Center (or Dining Hall) is a ~48,000-square-foot student dining facility built in 2010. The building houses primarily a student dining commons, function and events spaces, supporting food service and food prep areas, food storage, and offices.

BUILDING FEATURES

Lighting	The lighting systems are fluorescent.
Heating	Heating is provided by three gas-fired hot water boilers. The hydronic loop serves air-handling units, rooftop units and various terminal equipment including fan coil units and VAV reheats.
Cooling	An air-cooled chiller on the roof provides chilled water to the various air handling units. Spaces are cooled by variable air volume terminal boxes with hot water reheats.
Ventilation	Occupied spaces are ventilated by the variable volume air handling units and VAV terminal boxes. Seven kitchen exhaust fans with associated make-up air units serve the kitchen areas.
Envelope	The building is two stories with a flat roof and architectural panel siding. Windows are double-glazed with fixed sashes.
Controls	The building has updated DDC controls for HVAC equipment, integrated with the campus energy management system (EMS). The EMS provides occupancy scheduling and other controls functionality to the equipment. Some equipment, including the kitchen exhaust systems, are monitored by the EMS, but locally controlled.
Domestic hot-water system	Domestic hot water is stored in indirect storage tanks, served by the hot water boilers.
Other	Kitchen equipment is generally gas-fired (as opposed to steam-heated) and dishwashing operations are served by the hot-water boiler. The building has various walk-in coolers and freezers in the multiple kitchen and food storage areas.

Table 10. — Summary of SNHU building energy efficiency opportunities

Building	Existing annual usage (estimated)		Annual reductions (per year)				Estimated project budget ($)
	Electric (kWh)	Thermal (kBtu)	Electric (kWh)	Thermal (kBtu)	Cost ($)	Emissions (MTCO2e)	
Athletics	961,000	8,224,000	259,000	1,909,000	$65,000	170	$1,298,000
Exeter	447,000	1,106,000	149,000	358,000	$30,000	60	$1,705,000
Student Center	470,000	1,334,000	137,000	408,000	$28,000	60	$2,191,000
Washington	467,000	1,944,000	34,000	347,000	$9,000	30	$420,000
Robert Frost	785,000	1,420,000	255,000	431,000	$48,000	90	$1,205,000
Hospitality	561,000	3,221,000	421,000	2,415,000	$99,000	240	$6,000,000
Dining Hall	637,000	8,998,000	176,000	1,993,000	$53,000	150	$891,000
LLC	684,000	4,674,000	196,000	888,000	$43,000	100	$640,000
Tuckerman	1,284,000	1,082,000	283,000	124,000	$50,000	80	$429,000
33 S Commercial	813,000	2,399,000	221,000	274,000	$41,000	70	$803,000
TOTAL	**7,109,000**	**34,402,000**	**2,131,000**	**9,147,000**	**$466,000**	**1,050**	**$15,582,000**

ENERGY EFFICIENCY OPPORTUNITIES: ROBERT FROST

General Information

Building	Robert Frost
GSF	58,800
Space Use	Academic

ESTIMATED Utility Usage

	Existing		**Proposed**	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	785,279	13.4	530,279	9.0
Thermal Usage (kBtu)	1,419,740	24.1	988,740	16.8
TOTAL (kBtu)	**4,099,112**	**69.7**	**2,798,052**	**47.6**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**$ / GSF**	**Investment**
Lighting Systems	Large	161,000	-	$ 27,000	42	$ 4.0	$ 235,000
Controls Systems	Medium	27,000	94,000	$ 6,000	12	$ 1.1	$ 70,000
HVAC Systems	Large	38,000	135,000	$ 8,000	17	$ 15	$ 880,000
Building Envelope	Small	29,000	202,000	$ 7,000	18	$ 0.4	$ 20,000
Process & Plug Loads	None	-	-	$ -	-	$ -	$ -
TOTAL		**255,000**	**431,000**	**$ 48,000**	**90**	**$ 20.49**	**$ 1,205,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: ventilation system improvements, adding heat recovery; retrofit RTUs to variable speed.

Building Envelope: minor weather stripping, air sealing and window caulking/sealing.

Process & Plug Loads: none.

Additional Notes:
-Potential HVAC upgrade to VRF system for optimized system efficiency.

ENERGY EFFICIENCY OPPORTUNITIES: HOSPITALITY

General Information

Building	Hospitality
GSF	30,000
Space Use	Academic

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	560,914	18.7	139,914	4.7
Thermal Usage (kBtu)	3,220,530	107.4	805,530	26.9
TOTAL (kBtu)	**5,134,367**	**171.1**	**1,282,915**	**42.8**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**$ / GSF**	**Investment**
Lighting Systems	None	-	-	$ -	-	$ -	$ -
Controls Systems	Medium	-	-	$ -	-	$ -	$ -
HVAC Systems	Medium	-	-	$ -	-	$ -	$ -
Building Envelope	Small	-	-	$ -	-	$ -	$ -
Process & Plug Loads	None	-	-	$ -	-	$ -	$ -
Adaptive reuse	Large	421,000	2,415,000	$ 99,000	239	$ 200.0	$ 6,000,000
TOTAL		**421,000**	**2,415,000**	**$ 99,000**	**240**	**$ 200.00**	**$ 6,000,000**

Summary of Efficiency Opportunities

Lighting Systems: none.

Controls Systems: none.

HVAC Systems: none.

Building Envelope: none.

Process & Plug Loads: none.

Additional Notes:
-Perform complete adaptive re-use of building. Re-program and renovate with aggressive energy performance goals.

ENERGY EFFICIENCY OPPORTUNITIES: DINING HALL

General Information

Building	Dining Hall
GSF	47,700
Space Use	Dining

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	637,038	13.4	461,038	9.7
Thermal Usage (kBtu)	8,998,040	188.6	7,005,040	146.9
TOTAL (kBtu)	**11,171,612**	**234.2**	**8,578,100**	**179.8**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**$ / GSF**	**Investment**
Lighting Systems	Large	115,000	-	$ 20,000	30	$ 5.0	$ 239,000
Controls Systems	Medium	24,000	504,000	$ 10,000	33	$ 0.8	$ 40,000
HVAC Systems	Medium	17,000	576,000	$ 9,000	35	$ 10	$ 480,000
Building Envelope	Small	3,000	144,000	$ 2,000	8	$ 0.3	$ 13,000
Process & Plug Loads	Medium	17,000	769,000	$ 12,000	45	$ 2.5	$ 119,000
TOTAL		**176,000**	**1,993,000**	**$ 53,000**	**150**	**$ 18.68**	**$ 891,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning. Install new kitchen hood controls system.

HVAC Systems: ventilation system optimization; variable volume kitchen exhaust. Heat recovery chiller to provide simultaneous cooling and heating of HW and/or DHW.

Building Envelope: minor weather stripping, air sealing and window caulking/sealing.

Process & Plug Loads: walk-in cooler and freezer controls system. Kitchen equipment upgrades and management.

Additional Notes:
-Install heat recovery from kitchen drain water to heat city water supply to boilers and DHW heaters.

ENERGY EFFICIENCY OPPORTUNITIES: LLC

General Information

Building	LLC
GSF	51,250
Space Use	Academic

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	Usage / sq.ft.	Total Usage	Usage / sq.ft.
Electric Usage (kWh)	684,448	13.4	488,448	9.5
Thermal Usage (kBtu)	4,674,140	91.2	3,786,140	73.9
TOTAL (kBtu)	**7,009,477**	**136.8**	**5,452,725**	**106.4**

Measures

Efficiency Opportunity		Target Annual Reductions				Project Budget	
Efficiency Opportunity	Savings Opportunity	Electric (kWh)	Thermal (kBtu)	Energy Cost ($)	Emissions (MTCO$_2$e)	$ / GSF	Investment
Lighting Systems	Large	137,000	-	$ 23,000	36	$ 5.0	$ 256,000
Controls Systems	Large	37,000	444,000	$ 11,000	33	$ 1.1	$ 60,000
HVAC Systems	Medium	18,000	355,000	$ 7,000	24	$ 6	$ 310,000
Building Envelope	Small	4,000	89,000	$ 2,000	6	$ 0.3	$ 14,000
Process & Plug Loads	None	-	-	$ -	-	$ -	$ -
TOTAL		**196,000**	**888,000**	**$ 43,000**	**100**	**$ 12.49**	**$ 640,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: heat recovery chiller to provide simultaneous cooling and heating of HW reheat and/or DHW. Ventilation equipment optimization.

Building Envelope: minor weather stripping, air sealing and window caulking/sealing.

Process & Plug Loads: none.

Additional Notes: none.

ENERGY EFFICIENCY OPPORTUNITIES: TUCKERMAN

General Information

Building	Tuckerman
GSF	80,120
Space Use	Residence

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	1,284,011	16.0	1,001,011	12.5
Thermal Usage (kBtu)	1,081,520	13.5	957,520	12.0
TOTAL (kBtu)	**5,462,567**	**68.2**	**4,372,971**	**54.6**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**$ / GSF**	**Investment**
Lighting Systems	Large	193,000	-	$ 33,000	51	$ 3.8	$ 300,000
Controls Systems	Medium	82,000	103,000	$ 15,000	27	$ 1.1	$ 90,000
HVAC Systems	None	-	-	$ -	-	$ -	$ -
Building Envelope	Small	8,000	21,000	$ 2,000	3	$ 0.5	$ 39,000
Process & Plug Loads	None	-	-	$ -	-	$ -	$ -
TOTAL		**283,000**	**124,000**	**$ 50,000**	**80**	**$ 5.35**	**$ 429,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: none.

Building Envelope: minor weather stripping, air sealing and window caulking/sealing.

Process & Plug Loads: none.

Additional Notes:

-Implement GreenerDorms occupancy engagement and sustainability awareness program.

ENERGY EFFICIENCY OPPORTUNITIES: 33 S COMMERCIAL

General Information

Building	33 South
GSF	134,290
Space Use	Administrative

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	Usage / sq.ft.	Total Usage	Usage / sq.ft.
Electric Usage (kWh)	812,800	6.1	591,800	4.4
Thermal Usage (kBtu)	2,398,700	17.9	2,124,700	15.8
TOTAL (kBtu)	**5,171,974**	**38.5**	**4,143,922**	**30.9**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions (MTCO_2e)**	**$ / GSF**	**Investment**
Lighting Systems	Large	183,000	-	$ 31,000	48	$ 4.0	$ 537,000
Controls Systems	Medium	35,000	228,000	$ 9,000	21	$ 1.5	$ 200,000
HVAC Systems	None	-	-	$ -	-	$ -	$ -
Building Envelope	Small	3,000	46,000	$ 1,000	3	$ 0.5	$ 66,000
Process & Plug Loads	None	-	-	$ -	-	$ -	$ -
TOTAL		**221,000**	**274,000**	**$ 41,000**	**70**	**$ 5.98**	**$ 803,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: deploy new centralized energy management system (EMS), optimized sequences, and continuous commissioning.

HVAC Systems: none.

Building Envelope: minor weather stripping, air sealing and window caulking/sealing.

Process & Plug Loads: none.

Additional Notes: none.

ENERGY EFFICIENCY OPPORTUNITIES: ATHLETICS

General Information

Building	Athletics
GSF	71,963
Space Use	Athletic

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	961,072	13.4	702,072	9.8
Thermal Usage (kBtu)	8,223,930	114.3	6,314,930	87.8
TOTAL (kBtu)	**11,503,108**	**159.8**	**8,710,400**	**121.0**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**Cost / GSF**	**Installed Cost**
Lighting Systems	Large	151,000	-	$ 26,000	40	$ 5	$ 360,000
Controls Systems	Medium	37,000	461,000	$ 11,000	34	$ 2	$ 108,000
HVAC Systems	Medium	53,000	658,000	$ 16,000	49	$ 10	$ 720,000
Building Envelope	Small	5,000	132,000	$ 2,000	8	$ 0.1	$ 10,000
Process & Plug Loads	Medium	13,000	658,000	$ 10,000	38	$ 1.39	$ 100,000
TOTAL		**259,000**	**1,909,000**	**$ 65,000**	**170**	**$ 18.04**	**$ 1,298,000**

Description of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems. Install networked lighting controls systems in key areas, including athletic high bay applications.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: potential RTU replacements or modifications; ventilation system optimization; expand use of cogen thermal waste energy for space heating; other minor systems upgrades.

Building Envelope: minor weather-stripping and air sealing.

ENERGY EFFICIENCY OPPORTUNITIES: EXETER

General Information

Building	Exeter
GSF	27,882
Space Use	Academic

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	446,840	16.0	297,840	10.7
Thermal Usage (kBtu)	1,105,590	39.7	747,590	26.8
TOTAL (kBtu)	**2,630,207**	**94.3**	**1,763,819**	**63.3**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**$ / GSF**	**Investment**
Lighting Systems	Large	89,000	-	$ 15,000	23	$ 4.5	$ 125,000
Controls Systems	Medium	16,000	74,000	$ 4,000	8	$ 1.1	$ 30,000
HVAC Systems	Medium	27,000	126,000	$ 6,000	14	$ 10	$ 280,000
Building Envelope	Large	17,000	158,000	$ 5,000	13	$ 42	$ 1,170,000
Process & Plug Loads	None	-	-	$ -	-	$ -	$ 100,000
TOTAL		**149,000**	**358,000**	**$ 30,000**	**60**	**$ 61.15**	**$ 1,705,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: upgrade data center cooling equipment, adding heat reclaim for space heating.

Building Envelope: improve roof and exterior wall insulation, replace building facade.

Process & Plug Loads: none.

Additional Notes:
-Consider HVAC system upgrade to VRF, in combination with a project addressing the data center.
-Building facade is in need of upgrade - consider approaches to improve thermal envelope in combination with capital project.

ENERGY EFFICIENCY OPPORTUNITIES: STUDENT CENTER

General Information

Building	Student Center
GSF	35,160
Space Use	Student Center

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	469,565	13.4	332,565	9.5
Thermal Usage (kBtu)	1,334,100	37.9	926,100	26.3
TOTAL (kBtu)	**2,936,255**	**83.5**	**2,060,811**	**58.6**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions (MTCO$_2$e)**	**$ / GSF**	**Investment**
Lighting Systems	Large	75,000	-	$ 13,000	20	$ 4.0	$ 141,000
Controls Systems	Medium	16,000	84,000	$ 4,000	9	$ 1.1	$ 40,000
HVAC Systems	Large	28,000	144,000	$ 6,000	15	$ 15	$ 530,000
Building Envelope	Large	18,000	180,000	$ 5,000	14	$ 42	$ 1,480,000
Process & Plug Loads	None	-	-	$ -	-	$ -	$ -
TOTAL		**137,000**	**408,000**	**$ 28,000**	**60**	**$ 62.32**	**$ 2,191,000**

Summary of Efficiency Opportunities

Lighting Systems: complete replacement with LED lighting systems and advanced controls.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: ventilation system improvements, adding heat recovery; retrofit RTUs to variable speed.

Building Envelope: improve roof and exterior wall insulation, replace building facade. Replace single-glazed windows.

Process & Plug Loads: none.

Additional Notes:
-Consider HVAC system upgrade to VRF, in combination with a project addressing the data center.
-Building facade is in need of upgrade - consider approaches to improve thermal envelope in combination with capital project.

ENERGY EFFICIENCY OPPORTUNITIES: WASHINGTON

General Information

Building	Washington
GSF	50,000
Space Use	Residence

ESTIMATED Utility Usage

	Existing		Proposed	
	Total Usage	**Usage / sq.ft.**	**Total Usage**	**Usage / sq.ft.**
Electric Usage (kWh)	467,428	9.3	433,428	8.7
Thermal Usage (kBtu)	1,943,930	38.9	1,596,930	31.9
TOTAL (kBtu)	**3,538,794**	**70.8**	**3,075,786**	**61.5**

Measures

Efficiency Opportunity		**Target Annual Reductions**				**Project Budget**	
Efficiency Opportunity	**Savings Opportunity**	**Electric (kWh)**	**Thermal (kBtu)**	**Energy Cost ($)**	**Emissions ($MTCO_2e$)**	**$ / GSF**	**Investment**
Lighting Systems	None	-	-	$ -	-	$ -	$ -
Controls Systems	Medium	16,000	116,000	$ 4,000	10	$ 0.4	$ 20,000
HVAC Systems	Medium	11,000	132,000	$ 3,000	10	$ 8	$ 380,000
Building Envelope	Small	7,000	99,000	$ 2,000	7	$ 0.4	$ 20,000
Process & Plug Loads	None	-	-	$ -	-	$ 0.0	$ -
TOTAL		**34,000**	**347,000**	**$ 9,000**	**30**	**$ 8.40**	**$ 420,000**

Summary of Efficiency Opportunities

Lighting Systems: none.

Controls Systems: controls retro-commissioning, optimization, sequence improvements, and continuous commissioning.

HVAC Systems: ventilation system improvements, adding heat recovery ventilation.

Building Envelope: minor weather stripping, air sealing and window caulking/sealing.

Process & Plug Loads: none.

Additional Notes:
-Implement GreenerDorms occupancy engagement and sustainability awareness program.

APPENDIX C:
FINANCIAL STRATEGIES FOR CAMPUS EFFICIENCY PROJECTS

FINANCIAL STRATEGIES FOR CAMPUS ENERGY PROJECTS

With a diverse array of technical solutions now available to acheive climate neutrality, many institutions are working to determine how to fund their transition to low-carbon systems. Several strategies have been piloted by institutions ranging from Swarthmore College and Yale University to Arizona State University.

FUNDING OPTIONS FOR SUSTAINABILITY INITIATIVES

GREEN REVOLVING LOAN FUND

The model for a revolving loan fund is simple: starting with up-front capital, funds are invested in campus energy efficiency projects. A portion, or all, of the savings from the fund's projects are returned to the fund. When the initial capital is replaced, the fund is able to invest in additional energy-efficiency projects. Projects are generally required to have a payback of less than 10 years in order to facilitate turnover. Up-front capital could be provided by donors, the endowment, or utility savings. The Billion Dollar Green Challenge is an organized effort to have schools collectively commit $1 billion in revolving funds. Several dozen participants ranging from Boston University to University of Wyoming have committed over a hundred million dollars to date.

ENDOWMENT FINANCING

With endowment financing, funds are borrowed from the endowment for a fixed rate to invest in campus energy projects Projects provide a fixed return to the endowment, additional savings may accrue to the institution. These tactics are used at both public and private institutions. According to NACUBO (2016), endowments returned a 10-year average of 6.3%—roughly equivalent to a project that has a 15 year payback.

STRATEGIES FOR IMPLEMENTATION

LIFECYCLE COST EVALUATION

Many institutions do not consider lifecycle costs in a systematic manner. True lifecycle costing considers not only capital cost and energy savings, but also the remaining life of equipment, maintenance costs, and the inevitable cost of replacement, which can account for up to 42% of a building's lifecycle costs over a 20-year span.

HYBRID DEFERRED MAINTENANCE/ENERGY EFFICIENCY PROGRAMS

Blending deferred maintenance projects with quicker payback energy projects can be an effective way to gain approval. This approach leverages quick payback projects to help pay for longer-payback deferred maintenance projects. Consider a $200,000 chiller replacement project that reduces energy costs by $10,000 annually (a 20-year simple payback)—not attractive as an energy efficiency project. But if that chiller is at the end of its useful life and requires increasing resources to maintain, there may be good reason to replace it. Combine that chiller project with, for example, a $100,000 lighting project with $50,000 in annual savings and you have a $300,000, five-year payback package provides a more attractive return.

FINANCIAL POLICY

Shadow pricing, energy performance targets, and fees on emissions-generating activities could be combined make an institution a leader in using financial strategies to drive change on campus. A carbon tax would be a powerful (though blunt) tool for funding sustainability initiatives.

SHADOW PRICING ON CAPITAL PROJECTS

As part of infrastructure and equipment procurement, a theoretical price (set by the institution) for carbon emissions produced over the lifetime of a given piece of equipment or a building that is included in the analysis life-cycle costs. For example, in considering different lighting options, the “shadow price” of future carbon emissions of an (enegy-efficent) LED light would be lower than that of a corresponding (energy-intensive) incandescent light. This approach allows similar sustainability criteria to be applied to all projects.

ENERGY PERFORMANCE TARGETS FOR BUILDINGS

Given historical utility data for buildings, a weather-normalized energy use performance target may be set for a space. This target can give space managers or users some responsibility over their energy use. If applicable, a central facilities department and local space managers could share savings generated by surpassing the energy performance target to give space managers an incentive to conserve energy through behavior change, etc.

FEES ON EMISSIONS-GENERATING ACTIVITIES

Any emissions generating activities that can be managed and connected to individual departments could be charged a carbon fee to fund sustainability initiatives on campus. As with the energy performance targets, these additional charges could be used to incentivize reductions in these activities. Example activities include fleet fuel consumption, printing, commuting, air travel (study abroad and/or employee) could all be considered for application of an emissions fee.

CARBON TAX

As implemented at Swarthmore, a percentage of the budget of all departments is collected to create a central fund for sustainability initiatives. If rolled out with new fiscal year, it could be combined with general budget increase to reduce negative perceptions of the “tax” taking funds away from a department. This approach requires broad support from senior institutional leaders.

Scope	Start Date	End Date	Category	Source	Label
1	1/1/2017	12/31/2017	On-Campus	Distillate Oil (#1-4)	Distillate Oil (#1-4) 2017
1	1/1/2017	12/31/2017	On-Campus	LPG (Propane)	LPG (Propane) 2017
1	1/1/2017	12/31/2017	On-Campus	Natural Gas	Natural Gas 2017
1	1/1/2017	12/31/2017	University Fleet	Gasoline Fleet	Gasoline Fleet 2018
1	7/17/2017	9/17/2017	Fertilizer	Synthetic	Synthetic 2018
2	1/1/2017	12/31/2017	Electricity, Steam,	Electricity	Electricity 2017

Quantity	Unit	CO2 (kg)	CO2 (MTCDE)	Biogenic	CH4 (kg)	CH4	N2O (kg)	N2O
1,201.30	US gallon	12,322	12.32	0	2	0.04	0	0.03
9,583.40	US gallon	50,057	50.06	0	9	0.21	1	0.15
52,210.80	MMBtu	2,768,217	2,768.22	0	275	6.89	6	1.64
19,682.07	US gallon	174,511	174.51	0	37	0.92	12	3.66
2,900.00	pound	0	0	0	0	0	7	2.19
14,107,123.00	kWh	3,652,812	3,652.81	0	614	15.36	82	24.49

GHG	
12.4	
50.42	
2,776.74	
179.09	
2.19	*This data is from the 2017
3,692.66	