Sustainability at Colleges in the Pioneer Valley: Special Focus on Mount Holyoke College

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Abstract

Climate change is the existential issue of our time, and institutions of higher education can have a measurable impact thereon through sustainability initiatives like carbon neutrality goals. To understand where four institutions, Amherst, Hampshire, Mount Holyoke, and Smith Colleges, stand in terms of their relative sustainability, a comparative case study approach was employed with a focus on four critical parameters. Data were collected representing water use, energy use, greenhouse gas (GHG) emissions, and curriculum at the institutions. The first three parameters represent the three traditional pillars of sustainability; the fourth parameter, curriculum, was chosen to reflect a more holistic view of sustainability at institutions of higher education. The findings for each parameter were examined relative to the other institutions to reach a better understanding of patterns and factors influencing parameter values. A significant portion of the study concerns the limitations and merits of the available values to truly represent the parameters. Ultimately, Hampshire proved to have the best overall values across the four parameters while Amherst had the worst. Smith and Mount Holyoke Colleges alternated between second and third place, suggesting that they have achieved some sustainability success but could do even more. A second focus of the study was Mount Holyoke College's individual situation and institution specific recommendations to improve sustainability data collection procedures and by extension sustainability on campus. A series of recommendations were made to create a consistent and comprehensive approach to this data collection, to increase regular campus-wide collaboration on sustainability efforts, and to restructure existing data collection and management procedures and division of tasks among staff at the Miller Worley Center of the Environment.

Introduction

Climate change is one of the most pressing issues of our time, and institutions of higher education play a role both as climate change contributors and as locations of sustainability research, learning, and experimental initiatives. College and university campuses in the United States contribute a measurable percentage, two percent, to the country's annual greenhouse gas (GHG) emissions and, therefore, contribute to climate change (Shriberg, 2002). Recognizing their own climate impact and unique position at the intersection of research and education, institutions' campuses have served, and continue to serve, as experimental spaces for small-scale sustainability efforts. These efforts incorporate serving as role models for other sectors working on sustainability and carbon or climate neutrality, sustainability research, and the education of future leaders and professionals. Institutions have also taken a range of approaches from setting goals of carbon or climate neutrality, to making significant investments in renewable energy, to retrofitting buildings campus-wide. Even when sustainability goals and timelines are similar, the strategies utilized to achieve these goals vary. Let's start by briefly considering the role institutions play in society as role models for, experimental spaces for, and education centers of, sustainability efforts.

Institutions as Role Models, Experimental Spaces, and Educational Centers

Institutions of higher education serve as role models and experimental settings for sustainability efforts applicable not just to higher education, but also to other sectors. Such institutions are in a unique position to experiment with, and share, strategies the greater society could use to mitigate impacts of climate change and to achieve carbon neutrality (Nixon, 2002). Institutions working towards sustainability individually and collectively also lead by example and demonstrate to other sectors potential pathways to sustainability and carbon neutrality (Jain

et al., 2017, p. 112). These institutional sustainability movements are avenues for future research and collaboration within, between, and outside of, institutions of higher education (Kurland, 2011). In addition, higher education shapes students, many of whom become society's professionals and leaders, serving as a leverage point for the development of a more sustainable society (Jain et al., 2017, p. 111).

Institutions do not just play a positive role, they are also a part of the problem of climate change. Colleges and universities in the United States are responsible for almost two percent of the United States' total annual GHG emissions. This is equivalent to approximately one quarter of GHG emissions from the entire state of California (Sinha et al., 2010). While two percent may not sound significant, this actually represents 5.4% of all residential and commercial buildings in the United States (Environmental Protection Agency (EPA), 2020). Achieving net zero carbon dioxide, a GHG, has become a growing focus of environmental efforts in higher education.

Nearly 700 US institutions, representing 30% of enrolled students, have taken carbon neutrality further, pledging to achieve climate neutrality, or net zero GHG emissions, by signing the American College and University Presidents' Climate Commitment (ACUPCC) (Breen, 2010). Climate neutrality, unlike carbon neutrality, covers all GHGs, not just carbon dioxide. Not all institutions working towards carbon neutrality have signed the ACUPCC, so the percentage working towards carbon neutrality is likely higher. While carbon neutrality is important in that it typically focuses on reducing GHG emissions, it is, as will be discussed below, but one piece of sustainability (Klein-Banai and Theis, 2013; Singh, 2020). Institutions of higher education also focus on such components as curriculum, environmental justice, and campus engagement around sustainability issues. The following section synthesizes some best practices from the academic literature on institutions that have achieved some, or all, of their sustainability goals.

Best Practices for Achieving Sustainability Goals in Higher Education

The bulk of the reviewed academic literature identifies general patterns of best practices in institutions' approaches to achieving their sustainability goals. One best practice is an organic, bottom-up approach progressing from a grassroots movement to executives accepting parts of the business case for campus sustainability to a campus leader developing and envisioning a plan (Krizek et al., 2012; Shriberg, 2002). The described progression is driven by, and includes, diverse stakeholders, potentially including alums and activists. Krizek et al. (2012) emphasize campus leaders must respond to grassroots movements in a timely manner for campus sustainability efforts to be integrated into the institutions' governance. Plans envisioned by a campus leader must be strategic in prioritizing the wide range of suggested sustainability initiatives a college or university could undertake, considering the financial costs and benefit to its reputation (Posner and Stuart, 2013; Krizek et al., 2012). While these plans may be developed by one person, they require collaboration across campus to be executed. The result is a campus community where sustainability is fully self-actualized and integrated into the governance rather than siloed (Krizek et al., 2012, p. 22). Given institutions' sustainability goals are largely achieved through a series of projects, a key component is flexibility of the administration and the general management of the initiatives (James and Card, 2012; White, 2014).

The literature indicates institutions' sustainability plans are quite diverse, but with similar points of focus and similar missing components (White, 2014). The most common point of focus is operational variables, particularly quantitative water use, energy consumption, and GHG emission production. These operational, or environmental, metrics are central to most institutions' outlined plans and strategies. As White (2014) discusses, this is likely due to the cost-saving benefits of improving operational efficiency, which motivates institutions to establish

such goals based on financial benefit. Thus, water and energy use as well as GHG emissions are three of the four parameters included in this study; the fourth is curriculum.

The inclusion of curriculum relates to literature indicating institutions successful in achieving their sustainability goals focus on education in addition to institutional assessment of campus sustainability measures (James and Card, 2012). While operational efficiency and systematic assessment of campus sustainability measures are included in most institutions' sustainability plans, the academic and administrative sides of sustainability receive less attention. The academic and administrative sides include course offerings and administrative involvement.

Sustainability education is important in part since it increases understanding of, and commitment to, sustainability generally and in part as it increases the likelihood that students will engage in environmentally sound practices while on campus. The latter not only helps colleges and universities reach their sustainability goals, it also helps their bottom lines. Among college students, the Value-Belief-Norm (VBN) theory holds true in that students' values matter in their environmental decision-making. While values differ among students and thus, their impact on students' environmental decisions, this supports the notion that beliefs directly influence norms, which in turn, directly and indirectly, influence behavior. Coursework contributes to these beliefs and thus, sustainability-related education influences environmental-related behaviors (Whitley et al., 2016). This connection indicates institution-wide sustainability initiatives must be woven through curriculum in addition to research and operations, among other areas on campus (White, 2014). In this study, this is addressed with the inclusion of the curriculum parameter representing sustainability course offerings. Sustainability at institutions of higher education encompasses many other facets, which have informed the author's understanding of how sustainability is defined and can be

achieved.

Limitations of Sustainability in Higher Education

These facets are incorporated into the wide range of institutions' definitions of sustainability. The definitions are not just focused on the traditional environmental sphere, but also include factors such as economic development and social equity. Newport et al. (2003) emphasize the importance of looking beyond traditional environmental sustainability elements like operational sustainability and sustainability education to incorporate the relevant social and economical spheres. To some, sustainable institutions are those that divest from fossil fuel holdings and discuss social equity in addition to reductions to their environmental footprints (Newport et al., 2003). To others, sustainable institutions have a master plan, an environmental plan, green building initiatives, environmental guidelines, an environmental statement, signed declarations to achieve established goals, or something similar (Alshuwaikhat and Abubakar, 2008). These different definitions do not lend themselves well to comparing sustainability across different institutions of higher education. Nor do largely qualitative factors such as social justice and equity lend themselves well to direct comparison among colleges and universities. For this reason, largely qualitative factors are not the focus of this study. Studies including such invaluable information as campus attitudes around sustainability are by the author's understanding crucial to a truly holistic look at sustainability and should be conducted to complement and enhance quantitative-focused studies such as this.

The omission of, or lack of focus on, qualitative metrics is critiqued in the literature investigating current practices institutions utilize to establish and reach their sustainability goals. Newport et al. (2003) state that much needs to be accomplished and addressed before an institution can achieve comprehensive institutional change. If an institution achieves all of its

quantitative sustainability goals, is the campus and therefore, the college or university, truly sustainable? Institutions can consider such questions by turning to the existing literature, developing future studies, and engaging a truly diverse range of stakeholders to craft sustainability goals incorporating both quantitative and qualitative metrics. Doing so will allow a more holistic vision of sustainability.

Role of Governments in Institutional Sustainability

Beyond sustainability goals, local, state, and federal governments have established laws, regulations, guidelines, and initiatives which have both hindered and supported institutions' sustainability efforts. In the Pioneer Valley, the Town of Amherst resolved to consume 100% clean, renewable energy as soon as possible (Greisemer, n.d.). For the local institutions of higher education - Amherst College, Hampshire College, and the University of Massachusetts at Amherst - the clean, renewable energy resolution by the Town may encourage them to also achieve this goal as quickly as possible. Across the US, local town and city governments have established similar commitments as well as regulations and initiatives, thereby encouraging colleges and universities to start, accelerate, or continue their own sustainability efforts (Steinbrecher, 2018). States have also played a role. In the Commonwealth of Massachusetts, the state government, with private contractors, designs and manages construction projects on public land, focused on conserving water and energy. Recent projects have benefitted Salem State University, University of Massachusetts at Lowell, and Roxbury Community College (Division of Capital Asset Management and Maintenance Office of Energy & Sustainability, n.d.). This support from the state can be utilized by institutions in their sustainability efforts, while also providing the state a financial incentive in the form of lower water and energy costs. Similar programs can be found in other US states and in the US federal government (NC Clean Energy

Technology Center, n.d.).

On the federal level, laws, regulations, guidelines, and initiatives may help or hinder institutions' sustainability efforts. In 2017, for instance, the US administration proposed defunding the Energy Star Program, a standard used internationally to designate products that are energy efficient. Doing so would have cost institutions in terms of energy costs and/or staff time spent trying to source energy efficient products rather than simply identifying them through Energy Star labels (O'Sullivan, 2017). In the end, the program was not cut, but the possibility shows how vulnerable institutions and their sustainability goals can be to factors outside of their control. Overall, governments at all levels can, through laws, regulations, guidelines, and initiatives, support, stall, or block sustainability at institutions both in the US and internationally.

Summary

Institutions of higher education have a markable impact on the United States' annual GHG emissions and thus contribute to climate change. Many institutions have pledged to work towards carbon neutrality, which concerns carbon dioxide emissions, as well as further sustainability goals like energy use and expansion of related academic programs. Such efforts educate future professionals and leaders through research and coursework; they also serve as small-scale experimental models for approaches to sustainability applicable also to other sectors. Plans are quite diverse, but often focus on quantitative operational metrics, typically with a secondary, or no, focus on qualitative factors like social equity. The literature discusses the importance of data collection around chosen metrics to establish baselines and to measure progress along with the practice of collaboration. United States local, state, and federal governments can, and do, support and/or stall institutions' sustainability goals through laws, regulations, guidelines, and a range of environmental initiatives. Since definitions of

sustainability differ among institutions, cross-institutional comparisons are difficult, but can still be informative. The definitions typically fail to incorporate qualitative metrics and thus, are typically not holistic representations of sustainability at a particular college of university. It is up to each college or university to decide how holistic it wants its sustainability goals to be. It is the author's sincere hope that this study will serve as a starting point for Mount Holyoke College.

Methods

Comparative Case Study

The analysis in this paper will be framed utilizing a comparative case study approach. The case study approach encompases understanding sustainability at the institutions studied through multiple quantitative data parameters. Utilizing this approach allows for direct comparisons of the collected information as well as a broader analysis of how the institutions compare to each other. The comparative case study approach aids in the deeper understanding of sustainability at each of the institutions of higher education based on comparable parameters. The Association for the Advancement of Sustainability in Higher Education (AASHE) supports this direct comparison approach as its programs and resources are widely used globally, including outside higher education (Association for the Advancement of Sustainability in Higher Education, n.d.-a).

In this paper, Mount Holyoke College will be compared to three of the institutions in the Five College Consortium - Amherst College, Hampshire College, and Smith College. The fifth institution, the University of Massachusetts, is not included as it is significantly larger and a public university. All four institutions studied are in close proximity with very similar climates, and are private liberal arts institutions with 2,500 or fewer mostly residential students, as is further detailed below. Students can easily travel to, and take classes at, all four institutions;

students who do so are exposed to the different curricula, projects, and campuses. The many connections and similarities lead to the comparative case study approach employed to compare sustainability at the four Pioneer Valley institutions.

STARS Reports

Much of the data utilized for this case study comes from AASHE's Sustainability Tracking, Assessment, and Rating System (STARS). It was established in response to a 2006 request by the Higher Education Associations Sustainability Consortium (HEASC) for AASHE to develop a system rating sustainability on campuses of higher education. The System is open to both domestic and international institutions of higher education. The first edition of STARS, STARS 1.0, was released in 2010, and multiple editions have subsequently been released with the most recent edition being STARS 2.2, released in 2019 (Association for the Advancement of Sustainability in Higher Education, n.d.-b).

Foundationally, STARS encourages sustainability-minded improvement by institutions, sharing of information and practices, and growing the size and diversity of the campus sustainability community. As described by AASHE, STARS is a framework for institutions of education to self-report their sustainability efforts through a number of qualitative and quantitative metrics. The system is set up for a wide range of institution types, and includes both long-term goals for institutions with well-developed sustainability practices and entry points for institutions just beginning their sustainability journeys. The Sustainability Tracking, Assessment, and Rating System provides a basis for comparison of institutions across time due to the common measurements, which are utilized for the basis of this case study. Institutions participating in STARS may receive a rating of Bronze, Silver, Gold, or Platinum or be designated as a Reporter institution. The latter means the institution's report is not scored, not

subject to AASHE review and verification, and not all sections must be completed (Association for the Advancement of Sustainability in Higher Education, n.d.-e). Reporter institutions either do not receive enough points to be rated Bronze or choose not to receive a rating for a number of reasons. Ratings are based on the institution's sustainability achievements as measured by a variety of different metrics (Association for the Advancement of Sustainability in Higher Education, n.d.-c).

Overview of Case Study Institutions

The table below illustrates characteristics of each institution studied and some relevant environmental information. These values are elaborated upon in the following sections.

Table 1

Comparative Table of Institutional Attributes

Attribute	Amherst	Hampshire	Mount Holyoke	Smith
Gender	Coed	Coed	HWC	W
Undergraduate Enrollment	1,850	750	2,200	2,500
Post-grad Program (Y/N)	N	N	Y	Y
Residential Students	1,813	645	2,112	2,350
Living on Campus	98%	86%	96%	94%
Campus Size (acres)	1,000	800	700	147
Gross Building Floor Area (square feet)	2,185,644	802,800	2,149,320	3,196,705
Environmental Center Established	2014	-	1998	2009
Courses Offered	850	1,275	880	1,225
Carbon/Climate Neutrality Goal	2030	2022	2037	2030
Endowment	$2.47 billion	$54.5 million	$794.2 million	$2 billion
Offsets*	0%	21%	0%	0.4%

* Offsets are recorded as a percentage of each institutions' gross GHG emissions. Citations can be found in the following sections.

Amherst College

Amherst College is a private coeducational liberal arts baccalaureate college founded in 1821 and located in Amherst, MA, a college town of 38,000 (Amherst College, n.d.-a). Approximately 1,850 students are enrolled each academic year, equally split between males and females. Amherst is a residential college with 98% of students, approximately 1,813 students, living on campus in a typical year. The campus is 1,000 acres and includes a 500 acre Wildlife Sanctuary (Amherst College, n.d.-b). Amherst College offers 40 majors across 850 courses per academic year (Amherst College, n.d.-b) and as of June 30, 2019, has an endowment of $2.473 billion (Amherst College, n.d.-c). In October, 2014, Amherst College established the Office of Environmental Sustainability to become more operationally sustainable and engage students on sustainability issues in and out of the classroom. Amherst has come forth with a goal to achieve climate/carbon neutrality by 2030 primarily through modernizing its energy system, converting it from fossil fuels to renewable electricity (Amherst College, n.d.-d). Note the College uses the terms climate and carbon neutrality interchangeably throughout its discourse. This will be reflected throughout this paper. As of December, 2015, Amherst College had reduced emissions from 2006 levels by 30% (Amherst College, n.d.-e).

Hampshire College

Hampshire College is a private liberal arts baccalaureate institution founded in 1970 and located in South Amherst, MA. The presidents of Amherst College, Smith College, Mount Holyoke College, and University of Massachusetts Amherst pushed for a unique institution of higher education centered on innovation and self-designed discovery through hands-on experiences. Hampshire College has an endowment of $54.5 million (Hampshire College, n.d.-a). The College offers 50 areas of study; individualized combinations of these areas of study

take the place of majors at more traditional institutions (Hampshire College, n.d.-b). In a typical year, approximately 750 students are enrolled, with 86% of students, approximately 645 students, living on campus. The campus is made up of 800 acres of former orchards and farmlands, including a farm over 80 acres in size (Hampshire College, n.d.-c). Hampshire has a comprehensive plan to be climate neutral by 2022, a requirement of its participation in the American College and University Presidents' Climate Commitment (Hampshire College, n.d.-d). The main features of the plan are high performance future buildings, renovation of buildings and energy retrofits, renewable energy, and elimination of solid waste. (Hampshire College, 2012). Hampshire does not currently have a Sustainability Department, but has a number of related centers and student organizations (S. Draper, personal communication, February 19, 2021).

Mount Holyoke College

Mount Holyoke College (MHC) is a private, liberal arts gender diverse historically women's college with an annual enrollment of around 2,200 undergraduate students. The College has a coeducational Master's of Arts in Teaching program with an annual enrollment of approximately 120 students, thus it is not a baccalaureate institution (Mount Holyoke College, n.d.-a). Mount Holyoke College was founded in 1837 and is located in South Hadley, MA, population approximately 17,800 (U.S. Census Bureau, 2019). 96% of students, around 2,112 students, (Mount Holyoke College, n.d.-a) live on MHC's 700 acres campus, which includes 120 acres of equestrian cross-country courses (Mount Holyoke College, 2019-a). Mount Holyoke College offers 48 majors, (Mount Holyoke College, n.d.-b) and 880 classes (Mount Holyoke College, 2020-b; P. Prewitt-Freilino, personal communication, February 22, 2021). Its endowment stands at $800 million as of December 31st, 2019 (Association for the Advancement of Sustainability in Higher Education, 2019-b). Mount Holyoke's Miller Worley Center for the

Environment was founded in 1998 with a focus on engaging students in various dimensions of current environmental challenges (Mount Holyoke College, n.d.-c). In January of 2018, the College established a goal of carbon neutrality by 2037, the College's bicentennial. The proposed strategy is improving energy efficiency and investing in conservation, retrofitting historic buildings, and moving towards carbon-neutral heating and electricity sources (Mount Holyoke College, n.d.-d).

Smith College

Smith College is a private liberal arts women's college founded in 1871 in Northampton, MA, a city of 28,000 (US Census, 2019). In a typical year, approximately 2,500 undergraduate students enroll at Smith (Smith College, n.d.-a) which offers 50 majors and around 1,225 courses (Smith College, n.d.-b). The College also has coeducational post-graduate programs and graduate degrees with about 100 students (Smith College, n.d.-c). Approximately 94% percent of undergraduate students, 2,350 students, live on campus (Smith College, n.d.-d). Smith has an endowment of over $2 billion as of December, 2020, (McCartney and Overseth, 2020) and a 147 acre campus (Smith College, n.d.-e). Smith's Center for the Environment, Ecological Design, and Sustainability (CEEDS), founded in 2009, connects students with academic and practical environmental experiences (J. Benkley, personal communication, February 9, 2021). The Center aims for Smith to be more operationally sustainable with the inclusion of students and faculty (Smith College, n.d.-f), contributing to the institution's goal of carbon neutrality by 2030. A key component of the plan to become carbon neutral is a transition to solely renewable energy (Smith College, n.d.-g).

Parameters - Definitions and Justifications

The parameters chosen here to represent overall sustainability at the institutions of higher education were selected from STARS reports. The categories represented - water use, energy use, GHG emissions, and curriculum - were determined by the author to be representative of the overall sustainability of the institutions. Water use connects to this picture of sustainability as heating of water contributes to energy use, greenhouse gas emissions, and the depletion of a non-renewable resource. The energy use parameter covers the campus energy consumption, which is connected to both water use and GHG emissions. Sustainability goals at many institutions, including all those studied here, set a date for net zero greenhouse gas emissions, thereby warranting the inclusion of the GHG emissions parameter in this study. Curriculum broadens sustainability beyond the traditional sustainability metrics, including courses being taught on the campuses to introduce students to sustainability-inclusive topics. It is considered that student exposure to sustainability-related topics through curriculum may influence students to behave more sustainably. Let us now look at each parameter.

Water Use

The water use data utilized were potable water use in gallons per gross square foot of floor area. This comes from potable water use data and gross floor area, representing a rate of water consumption by the institution based on the building sizes to account for the variation among the different institutions studied. Water consumption covers all sources from which potable water was withdrawn for the institutions' use.

The water use parameter chosen, gallons per square foot of gross square feet of building space, appears to be the most robust of those included in STARS reports. Other metrics reported through STARS are per weighted campus user and per unit area of vegetated grounds, which

come with clear drawbacks (Association for the Advancement of Sustainability in Higher Education, 2019-c). The weighted campus user metric only includes students and employees of the institutions. Thus, camps or events utilizing campus buildings and thereby contributing to gross water use are not considered in this calculation. Such omission could lead to under-representation of the weighted campus users and miscalculations of this metric. A similar issue surrounds water use per unit area of vegetated grounds as vegetated grounds could encompass both unmanaged and actively managed grounds. Managed grounds may be landscaped, watered, or otherwise maintained by humans whereas unmanaged grounds do not receive any human intervention or treatment. Thus, managed grounds typically have an associated potable water footprint from such actions while unmanaged grounds do not. This is a concern when an institution has a large campus area with a large portion of mixed unmanaged and actively managed land, like Amherst College's 500 acre Wildlife Sanctuary. Inclusion of unmanaged grounds in the total area of vegetated grounds would benefit campuses with unmanaged grounds as the divisor of water use is much larger despite water not being used on these unmanaged grounds. This goes to show that inclusion of unmanaged vegetated grounds in these calculations skews the reality of weighted water use. Thus, water use per gross square foot of building space is utilized instead throughout this study.

Energy Use

The parameter representing energy use consists of two different metrics, the *site* energy use and the difference between *site* and *source* energy rates. Both are measured in millions of British thermal units per unit of floor area, gross square foot, MMBtu/GSF.

Site Energy. Site energy is here defined as the heat and electricity consumed by buildings on the institutions' campuses, which comes directly from utility bills. Per the STARS Technical

Manual, site energy is the sum of the grid-purchased electricity, electricity from on-site renewables, district steam/hot water (sourced from offsite), and energy from other sources like natural gas, divided by the gross floor area of building space (Association for the Advancement of Sustainability in Higher Education, 2019-c).

Differences Between Site and Source Energy. Source energy is the total building energy consumption = (A x B) + C + D + E (Association for the Advancement of Sustainability in Higher Education, 2019-c).

A = imported electricity (kilowatt hours - kWh)

B = source-site ratio for imported electricity (from the energy supplier or a standard metric)

C = the kWh of electricity from on-site, non-combustion facilities/devices renewables (kWh)

D = stationary fuels used on-site to generate electricity and/or thermal energy (MMBtu)

E = imported steam, hot water, and/or chilled water (MMBtu)

The difference between source energy and site energy, source minus site energy, isolates the energy lost during production and delivery (Energy Star, 2020). This difference provides insight into the energy efficiency of production at, and transportation from, the institution's off-campus energy source(s). Different types of fuel used to produce the energy consumed on-campus range in efficiency. Larger calculated differences in site and source energy indicate lower rates of efficiency at these off-campus generation sites (Energy Star, 2020). Institutions cannot always control these rates of efficiency as, depending on their locations, institutions may only have one option for sourcing off-campus energy. For example, an institution in a town with only one utility providing electricity is forced to choose that utility to meet campus electricity needs. The same can be said for the different fuel sources and types of energy required for that institution.

Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions are represented by the adjusted net Scope 1 and 2 GHG emissions per weighted campus user. It is expressed in metric tons of carbon dioxide equivalent (MTCO2e). Greenhouse gases measured include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, which are converted to carbon dioxide equivalents (CO2e). Each greenhouse gas has a different weighted impact on the environment (Environmental Protection Agency, n.d.). These gases were measured for Scope 1 emissions from on-campus sources like steam and electricity generation, as well as for Scope 2 emissions from purchased off-campus sources, like grid electricity (Klein-Banai and Theis, 2013). Scope 1 and 2 emissions were summed, and the net carbon offsets are subtracted to get an institution's annual adjusted net GHG emissions.

The parameter value accounts for adjusted net GHG emissions and the combined campus populations of students and employees. This value is then divided by the number of weighted campus users to get the rate per weighted campus user at that institution. The weighting accounts for the variation in time and resource consumption among the different campus users, students, and employees. The equations behind the exact calculations and weights given to campus user groups were set by AASHE for STARS (Association for the Advancement of Sustainability in Higher Education, 2019-c). The final parameter is the adjusted net Scope 1 and 2 GHG emissions per weighted campus user (MTCO2e).

All the institutions in this study, and many others globally, have set goals of carbon or climate neutrality to reduce these GHG emissions. Carbon neutrality is defined as net-zero emissions of carbon dioxide and is typically achieved through a combination of carbon dioxide emission reduction, energy source conversion, and carbon offsets (National Renewable Energy

Laboratory, n.d.). Factors impacting GHG emissions include size of a college or university, the amount of building space, especially that which is energy intense, and the proportion of commuting faculty, staff, and students (Klein-Banai and Theis, 2013). These factors suggest institutions must employ individualized methods to reduce GHG emissions and improve overall sustainability. While carbon neutrality does not necessarily mean eliminating all GHG emissions due to later-discussed offsets, most, if not all, institutions seek to achieve carbon neutrality by significantly reducing emissions. Climate neutrality, on the other hand, also known as net zero GHG emissions, is achieved through similar means with reductions focusing on all GHGs, not just carbon dioxide (UC Davis, 2020). This is because approximately 88% of the GHG emissions are associated with institutions' purchased electricity, stationary combustion, and commuting to the campus (Sinha et al., 2010). While the impacts of commuting are only partially in the control of institutions, there are some actions colleges and universities can take to reduce commuting-related emissions. This includes providing on-campus housing, carpooling incentives, and electric vehicle charging stations (Center for Climate and Energy Solutions, 2017). Given all the institutions in this study have set carbon neutrality goals, it is important to understand the GHG emissions of each institution, and by extension, each institution's progress toward its carbon neutrality goal.

Curriculum

The curriculum data encompass two different quantitative metrics, the percentage of courses that are sustainability course offerings and the percentage of academic departments, or an institution's equivalent, offering at least one sustainability course. Sustainability courses encompass both sustainability-focused and sustainability-inclusive courses with the following definitions. Sustainability-focused courses have a title or description with an explicit main focus

on sustainability, ranging from foundational sustainability issues, to applications of sustainability within fields, to major sustainability challenges like climate change. Courses deemed sustainability-inclusive are not explicitly focused on sustainability but incorporate sustainability in their course content through a sustainability unit, challenge, or activity. These undergraduate courses were then calculated as a percentage of all undergraduate courses offered during an academic year; the different departments offering such courses were also calculated as a percentage of each institution's academic departments.

Data Collection Approach

The compiled data for Amherst College, Hampshire College, and Smith College were sourced from the AASHE STARS online portal (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2020-a; 2018; 2019-b). Mount Holyoke College's data were gathered from the College's most recent Reporter STARS report and other sources, because the report was neither complete nor was it verified by AASHE (Association for the Advancement of Sustainability in Higher Education, 2019-b). The most recent publicly available Participant Report for each institution was selected and utilized. For Amherst College, the version 2.1 Silver STARS report submitted on March 1, 2019, was the data source. Hampshire College's Gold STARS report was version 2.1 and submitted on March 30, 2018 (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2018). The STARS report from Smith College was version 2.2 for the Silver level and was submitted on March 2, 2020 (Association for the Advancement of Sustainability in Higher Education, 2020-a). Mount Holyoke College's version 2.1 STARS report for the *Reporter* level was submitted on February 26th, 2019 (Association for the Advancement of Sustainability in Higher Education, 2019-b). All reports aside from MHC's were submitted for STARS Ratings, so they were subject to review by

AASHE staff with higher provisional scores and ratings subject to more comprehensive review (Association for the Advancement of Sustainability in Higher Education, n.d.-d). While the reviews are quite comprehensive, the reviewers cannot verify every single metric, so for the purposes of this study, it is assumed the institutions are accurately self-reporting. The reports are only valid for three years from the submission date as circumstances and data are constantly changing (Association for the Advancement of Sustainability in Higher Education, n.d.-e). Due to the pandemic, the three year validity period was extended, rendering all included reports still valid. Also note that all reports were submitted pre-pandemic, so the data in this study reflect a traditionally functioning year.

Since some of Mount Holyoke College's STARS report information is incomplete and none verified, only some data were pulled from the most-recent STARS report (Association for the Advancement of Sustainability in Higher Education, 2019-b). For the remaining parameters, the most recent pre-pandemic data was compiled from other sources. These sources include MHC's Office of Institutional Research & Effectiveness, Office of the Registrar, Facilities Management, and the Miller Worley Center for the Environment (MWCE). As noted elsewhere, the data aside from Mount Holyoke's curriculum data reflects a typical, pre-pandemic year. The collected data from the respective institutions can be referenced in Appendix A.

Water Use

Water use data were collected directly from Amherst, Hampshire, and Smith Colleges' STARS reports. Basic unit conversions were utilized to convert Amherst's value to the units utilized by Hampshire and Smith Colleges, that is potable water use per unit of floor area in gallons per square foot of floor area. For Mount Holyoke College, more recent data than the utilized STARS report were available in the form of FY 2019 water bills and a building square

footage spreadsheet from Facilities Management (Facilities Management, n.d.). All purchased water was assumed to be potable. From these data, the appropriate calculations and conversions were made to get gallons of potable water use per square foot of floor area values for FY 2019.

Energy Use

The values representing energy use, site energy, and the difference between site and source energy, in MMBtu/GSF, were taken directly from Amherst, Hampshire, Mount Holyoke, and Smith Colleges' most recent STARS reports (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2020-a; 2018; 2019-b). More recent data were not available at the time of this study. Note that an error was found in Amherst College's report. The energy use values for Amherst College were reported as millions of British thermal units per gross square meter, MMBtu/GSM. Upon analysis, however, this particular label of units was found to be incorrect through the following process. At an early stage of the study, the reported MMBtu/GSM rates were converted to MMBtu/GSF rates and compared to the other institutions' values. The values for both site and source energy were found to be significantly lower for Amherst, 0.013 and 0.018, versus the average of the other institutions, 0.10 and 0.14, respectively. After this discovery, the raw value of gross floor area of building space in GSM, directly from the STARS report, was converted to GSF. This figure was then divided by the site energy value, building energy consumption, and the source energy value in MMBtu to get MMBtu/GSF. This value had the same units, MMBtu/GSF, as the other institutions making it directly comparable. These newly-computed MMBtu/GSF values were identical to Amherst College's reported MMBtu/GSM values for site and source energy, indicating the units for the values in the STARS report were incorrect. Thus, the STARS report values for Amherst College were utilized for direct comparison using the units MMBtu/GSF.

Greenhouse Gas Emissions

Greenhouse gas (GHG) emission values per weighted campus user (MTCO2e) were taken directly from Amherst, Hampshire, and Smith Colleges' STARS reports (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2020-a; 2018; 2019-b). These values represent the performance years' adjusted net Scope 1 and Scope 2 total greenhouse gas emissions, weighted for the campus users. For this parameter, only Scope 1 and 2 factors are included, consistent with metrics from STARS participant reports. While the reasoning for this restriction is not spelled out, it does reflect financial and logistical barriers to calculate Scope 3 emissions. Understanding business travel, commutes to campus, and other metrics contributing to Scope 3 emissions can prove more difficult than Scopes 1 and 2. Institutions can also choose which GHG emission sources to incorporate into their Scope 3 emission calculations, so direct comparison is not useful if different sources are accounted for.

For Mount Holyoke, the values from Fiscal Year (FY) 2018, July 1st, 2017, to June 30th, 2018, were calculated in the Sustainability Indicator Management & Analysis Platform, SIMAP, a platform for campus inventories. The platform took in emission values from a multitude of sources, calculating GHG emissions in MTCO2e based on institutional characteristics and established emission factors. The values from SIMAP can be directly entered into STARS, so they are analogous to those from the other institutions' STARS reports. This value was obtained from a figure on the MWCE's website (Mount Holyoke College, n.d.-e) and verified with MWCE staff (J. Lassonde, personal communication, February 26, 2021). According to MHC's most recent, and only, STARS report, the institution had no carbon offsets for FY 2017. This was also verified to remain true for FY 2018 with MWCE staff). Thus, the adjusted net and gross GHG emissions are analogous, due to MHC's lack of carbon offsets.

To calculate the rate per weighted campus user, the values in MHC's STARS report were cross-referenced with the data for the 2016-17 academic year available through MHC's Office of Institutional Research & Effectiveness (Mount Holyoke College, n.d.-h). The exact methodology utilized for the previous report is unknown, so working backward provided the best estimates of the true methods and values. The following equations were determined based on the available STARS report and common data set values for the academic year 2017-2018 (Mount Holyoke College, n.d.-i). The author created this equation working backwards from the computed value and available historical data. The equation was utilized to calculate the number of weighted campus users for FY 2018 since the latest available GHG emission value is from FY 2018. The number of students resident on-site equals A x B + (C - A) x D - 2.

A = number of first-time first-year students

B = percentage of these students who live in college-owned, -operated, or -affiliated housing

C = total number of full-time degree-seeking undergraduates

D = percentage of undergraduates who live in college-owned, -operated, or -affiliated housing

Mount Holyoke College's most recent STARS report used academic year 2016-2017 data to calculate the number of weighted campus users (Association for the Advancement of Sustainability in Higher Education, 2019-b). Working backwards from the common data set values and those in the STARS report, the author determined two people were subtracted at the end of the above calculation. This might be due to two students leaving campus housing between when the common data set was published around March 2018, and when the value was requested for use in the STARS report. This discrepancy is not significant enough to warrant concern.

The above-described value for the number of students resident on-site for FY 2018 was entered into the following equation to produce the number of weighted campus users at MHC.

The number of weighted campus users = (A + B + C) + 0.75[(D - A) + (E - B) - F] (Association for the Advancement of Sustainability in Higher Education, 2019-c).

A = number of students resident on-site (calculated by above equation)

B = number of employees resident on-site

C = number of other individuals resident on-site and/or the number of staffed hospital beds

D = total full-time equivalent student enrollment

E = full-time equivalent employees (faculty and staff)

F = full-time equivalent students enrolled exclusively in distance education

Note the number of employees resident on-site, 4, the number of individuals resident on-site and/or staffed hospital beds, 0, and the full-time equivalent of students enrolled exclusively in distance education were assumed to be constant from the year prior. These values were identical according to the STARS report for both FY 2018 and FY 2005. The full-time equivalent of employees was available directly from the Office of Institutional Research & Effectiveness (Mount Holyoke College, n.d.-f) and two people were subtracted as appeared standard per MHC's STARS report.

Curriculum

The curriculum parameter metrics were pulled from Amherst, Hampshire, and Smith Colleges' STARS reports, more specifically the percentage of courses that are sustainability course offerings and the percentage of academic departments with sustainability course offerings (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2020-a; 2018; 2019-b). A review of disclosed methods in the institutions' STARS reports shows discrepancies of the methods used to count sustainability course offerings. Hampshire College utilized sustainability and sustainability-adjacent faculty to identify relevant courses against the

institution's three stated pillars of sustainability (Association for the Advancement of Sustainability in Higher Education, 2018) while Smith and Amherst College inventoried their full course catalogs using AASHE definitions (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2020-a).

The author had access to more recent data for Mount Holyoke, so this route was chosen since the STARS report was not verified. Collecting these data for MHC mirrors the process outlined in AASHE's *STARS Technical Manual,* with process decisions made based on feasibility (Association for the Advancement of Sustainability in Higher Education, 2019-c). The process of collecting data regarding sustainability-focused and sustainability-inclusive courses at MHC started with MHC's course scheduling platform, my.mountholyoke. From a search in my.mountholyoke, all Fall 2020 and Spring 2021 courses were selected and listed. Courses titles that potentially aligned with the definitions of sustainability-focused courses and sustainability-inclusive courses were short-listed. The course descriptions for the identified courses were then reviewed against the *Technical Manual* definitions, and the relevant ones were added to the list of courses (see Appendix B).

This list of courses was supplemented with the courses labeled by the Registrar as counting towards the Environmental Studies major in my.mountholyoke. Due to some courses being offered every few years, Tim Farnham, the Environmental Studies chair, provided an additional list of major courses specific to the 2020-2021 academic year (personal communication, January 28, 2021). These lists were compiled, compared to the *Technical Manual* definitions (Association for the Advancement of Sustainability in Higher Education, 2019-c), and utilized in combination with the total number of courses offered in the 2020-2021 academic year from the Office of Institutional Research & Effectiveness (Mount Holyoke

College, 2020-b) and the Office of the Registrar (P. Prewitt-Freilino, personal communication, February 22, 2021). The total number of academic departments were counted from the list of Academic Departments found on the MHC website (Mount Holyoke College, 2020-a). The academic departments offering the final list of sustainability-focused and sustainability-inclusive were tallied and calculated as a percentage of the total number of academic departments at MHC (see Appendix C).

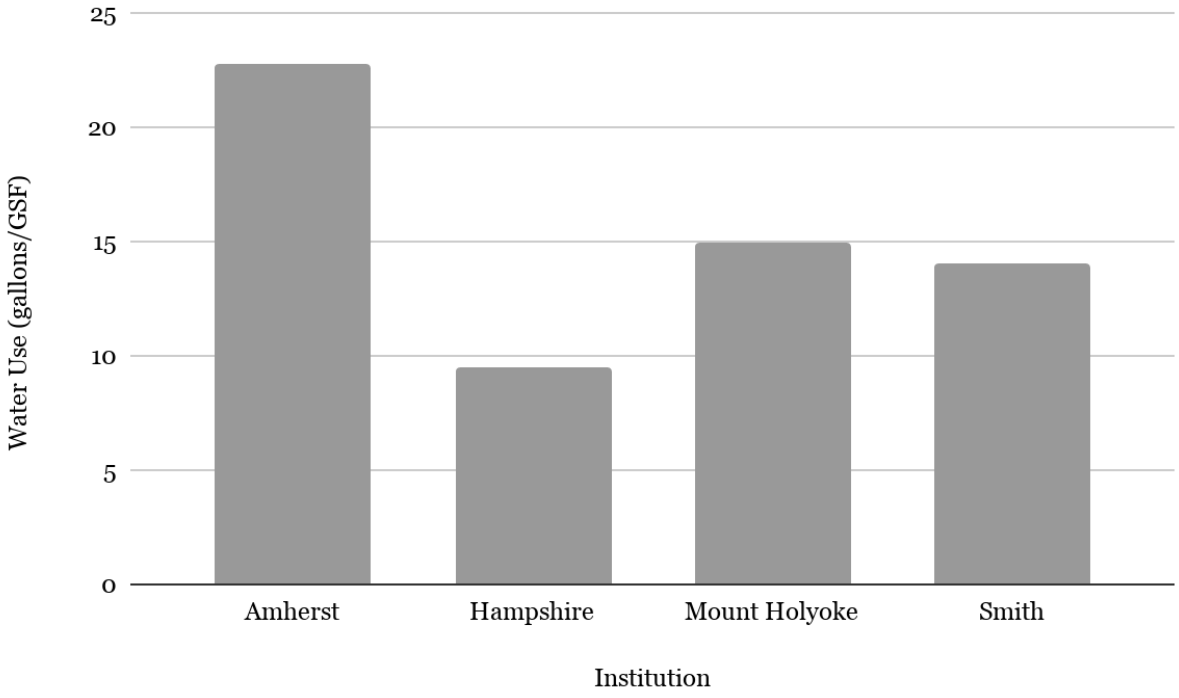
Results

Four parameters are utilized to compare sustainability at four Pioneer Valley institutions, Amherst, Hampshire, Mount Holyoke, and Smith Colleges. These parameters, water use, energy use, greenhouse gas emissions, and curriculum, represent pillars of sustainability and are directly comparable. The following figures detail the specific findings parameter by parameter.

Water Use

Figure 1

Water Use at the Institutions



Note: Amherst Colleges' GHG emissions represent FY 2016, Hampshire Colleges' represent FY 2017, and Mount Holyoke and Smith Colleges' represent FY 2019.

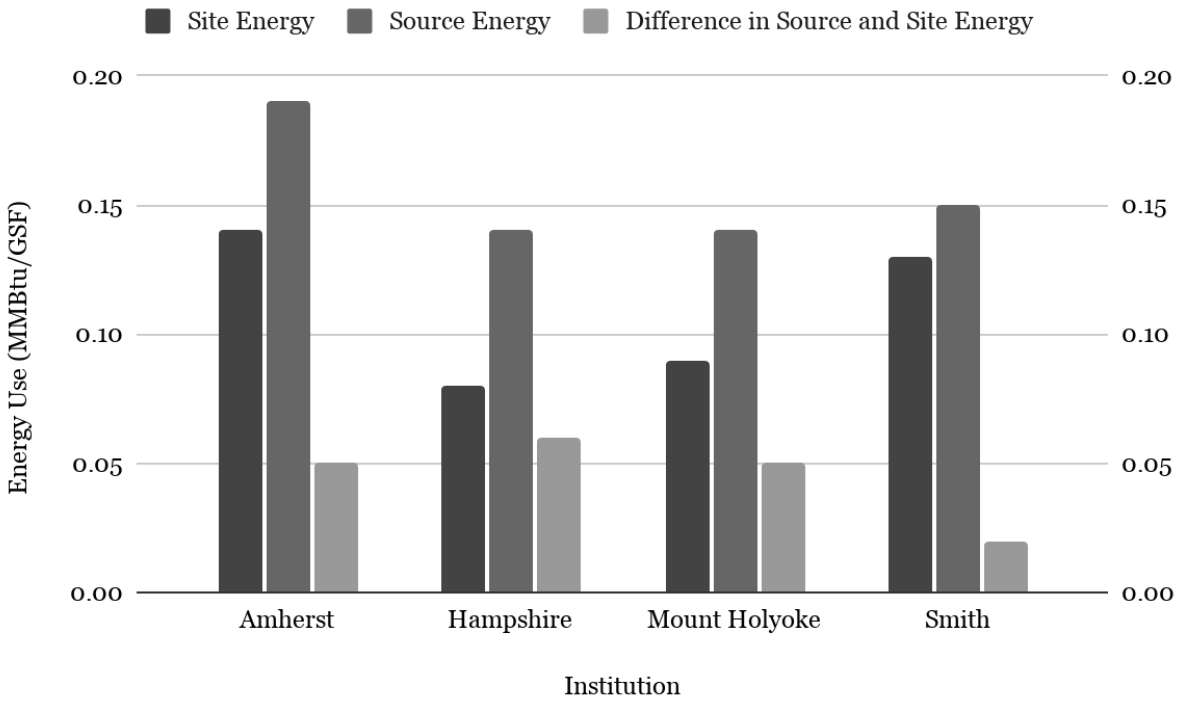
The water use in gallons per gross square feet of building space at each institution is illustrated in Figure 1. Amherst College had the highest water use at 22.74 gallons per GSF while the lowest water use was 9.51 gallons/GSF for Hampshire College (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2018), 42% of Amherst College's

water use. Across the four institutions, the average water use was 15.325 gallons/GSF with both Smith and Mount Holyoke Colleges using water at a slightly lower rate than the average.

Energy Use

Figure 2

Energy Use in Site and the Difference Between Site and Source Site Energy for the Institutions



Note: The represented fiscal years are FY 2017 for Hampshire College, FY 2018 for Mount Holyoke and Amherst Colleges, and FY 2019 for Smith College.

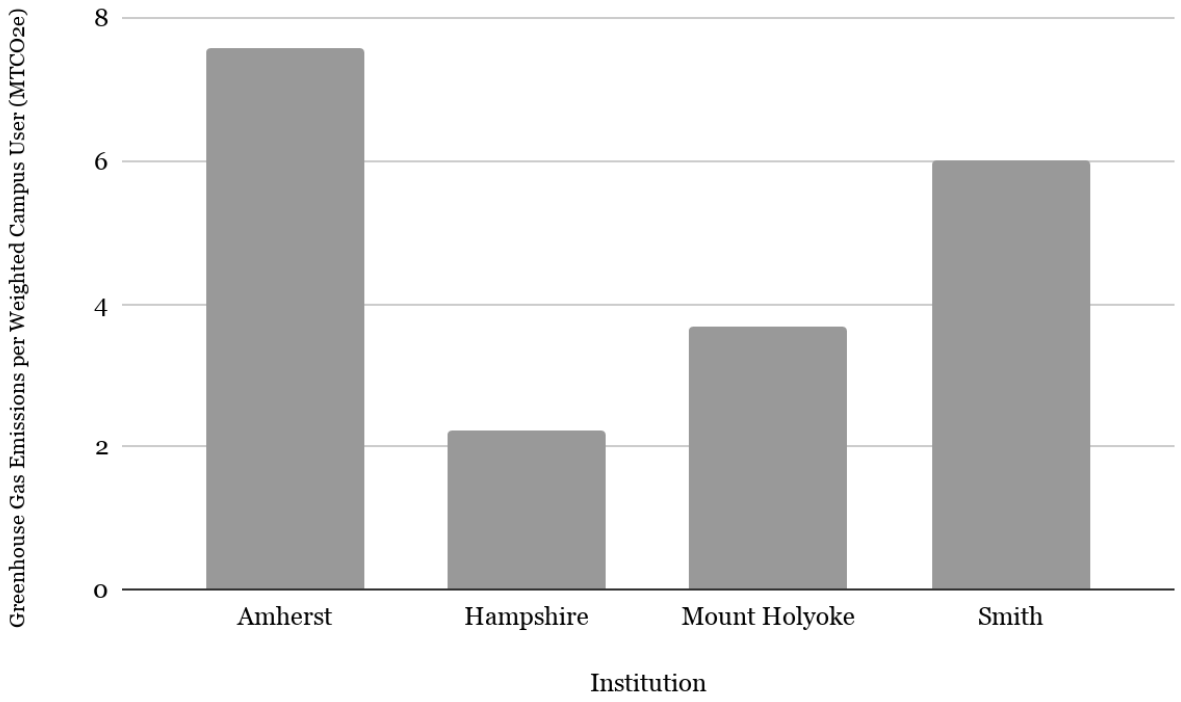
Energy use in million British thermal units (MMBtu) per gross square foot (GSF) of building space floor area represented by both source and site energy for each institution is represented in Figure 2. On average, site energy use is 0.11 MMBtu/GSF and the difference between source and site energy use is 0.05 MMBtu/GSF across the four institutions studied. For site energy, Hampshire College has the minimum rate of 0.08 MMBtu/GSF while Amherst College has the maximum of 0.14 MMBtu/GSF (Association for the Advancement of Sustainability in Higher Education, 2018; 2019-a). The difference in source versus site energy is

the lowest for Smith College at 0.02 MMBtu/GSF and the highest for Hampshire College at 0.06 MMBtu/GSF (Association for the Advancement of Sustainability in Higher Education, 2020-a; 2018).

Greenhouse Gas Emissions

Figure 3

Greenhouse Gas Emissions at the Institutions



Note: Hampshire College values represent FY 2017 and Amherst, Mount Holyoke, and Smith Colleges represent FY 2018.

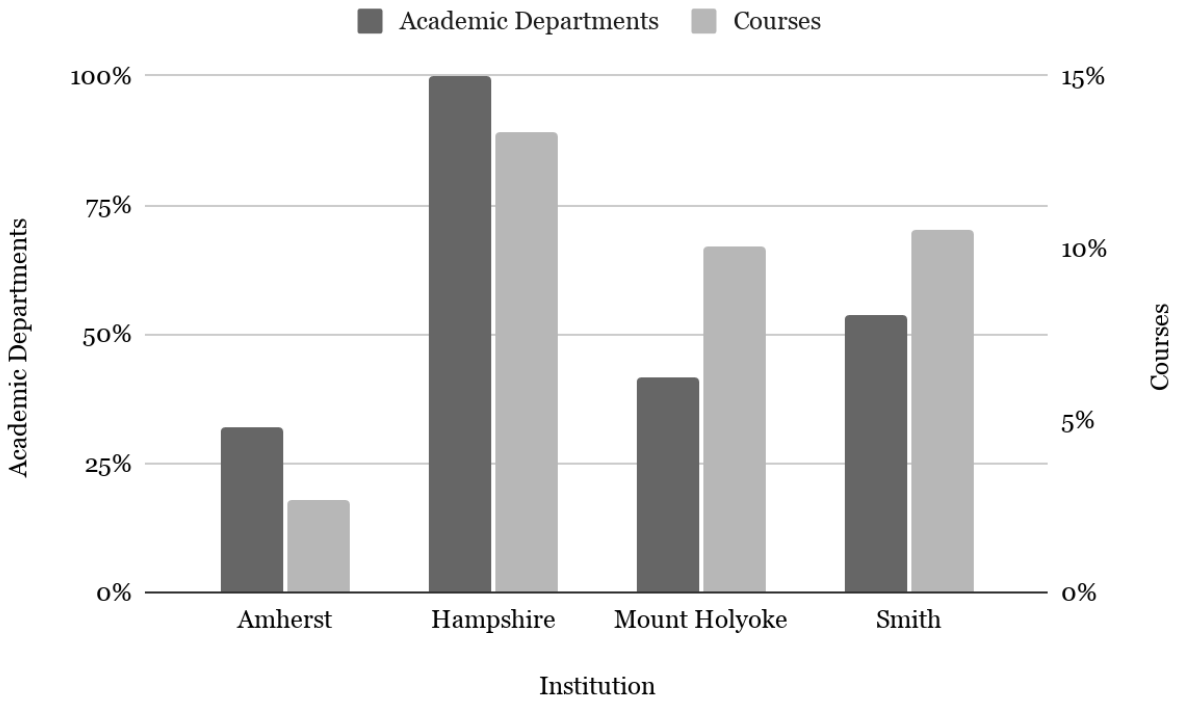
Figure 3 portrays the range of GHG emissions in metric tons of carbon dioxide equivalent per weighted campus user across the four different institutions in this study. For this parameter, GHG emissions are represented by adjusted net Scope 1 and 2 GHG emissions. On average, the institutions were associated with 5 MTCO2e GHG emissions per weighted campus user with a low value of 2.2 MTCO2e per weighted campus user for Hampshire College (Association for the Advancement of Sustainability in Higher Education, 2018) and a high value of 8 MTCO2e per

weighted campus user for Amherst College (Association for the Advancement of Sustainability in Higher Education, 2019-a).

Curriculum

Figure 4

Sustainability Courses and Departments offering Sustainability Courses at the Institutions



Note: The represented academic years are 2018-2019 for Hampshire College, 2019-2020 for Smith College, 2020-2021 for Mount Holyoke College, and an aggregate of 2015-2018 for Amherst College.

The percentage of course offerings categorized sustainability-focused and sustainability-inclusive and the percentage of academic departments offering such courses at each institution are depicted in Figure 4. Across the four institutions, an average of 57% of departments had sustainability course offerings and 9% of courses were sustainability-focused or sustainability-inclusive courses. Hampshire College had the highest percentages for both values making up the curriculum parameter, 100% and 13%, respectively (Association for the

Advancement of Sustainability in Higher Education, 2018) while Amherst College had the lowest percentages of 32% and 3% (Association for the Advancement of Sustainability in Higher Education, 2019-a).

Discussion

Parameters

The four parameters investigated among the four Pioneer Valley institutions are directly comparable, so any patterns provide insight into how they might be related or predictive. Rather than comparing the exact values, this study will focus on how the institutions rank for each parameter as depicted in Table 2 below (Appendix A). The best value for GHG emissions is the lowest rate of MTCO2e per campus user as fewer emissions are better for the environment/preferred. For water use, fewer gallons of potable water per gross square foot of floor area is preferred as potable water is a finite resource, and its consumption is tied to energy consumption for extraction, treatment, pumping/transportation, and heating. Curriculum was aggregated as each institution had the same relative ranking for percentage of sustainability course offerings and departments offering such courses (Figure 4). Higher percentages were deemed better as this suggests more students are exposed to sustainability concepts. Lastly, energy use was represented by an aggregate of site and the difference between source and site energy in MMBtu per gross square foot of building space with lower rates ranked higher.

Comparison Limitations

The above direct comparisons across the parameters do have some notable limitations. Comparison of the GHG emission parameter brings up limitations, namely potentially unequal starting points, the differing financial means, and the omission of Scope 3 emissions. The main limitation surrounding the water use parameter is unused building space undervaluing the rate of

water use. Curriculum has two potential limitations, overweighting of departments due to the number of departments at an institution and subjective interpretation of how courses should be categorized. One additional limitation not discussed further is the compilation of values from multiple years utilized in this study, rendering comparisons not specific to a particular year. Initiatives discussed may have been implemented by an institution, but their impacts on data values are not always reflected in the data. The initiatives may have been implemented after data was collected for the reports or take time to be reflected by data values.

Water Use

The use of building space is quite representative of institutions in terms of classroom and office sizes as well as dorm space for residential students. Water use is tied to bathrooms, washing machines, and kitchens as well as vegetative space, which is not factored into this parameter. The one noted limitation is the inclusion of any unused space in the floor area calculations as the inclusion of unused space would lead the divisor to be bigger than reality and to underrepresent the true rate of water use. Thus, selecting water use per building space sufficiently accounts for interior building space, but not for outdoor use of water. The weight of this latter factor depends on what proportion of the campus is actively managed, and how much water is used in this area since this is an additional source of water use outside of building space. While all of the institutions studied are in close geographic proximity, landscapes do vary some and so do outside water needs as exemplified by MHC's golf course. Isolating these variables was not possible in this study and therefore, the water use parameter, gallons per gross square foot of building space, was determined to be the best approximation and was utilized to represent water use.

Energy Use

There are similar limitations to both the water and energy use parameters when they are utilized for comparison across the four institutions studied. Both metrics are rates of units of water or energy per gross square feet of building space; this seems to be representative of the institution's size in residential, academic, and infrastructure buildings (Table 1). The only notable limitations of the energy use parameter is the inclusion of unused space and omission of outside space in the total square feet of building space, just as with water use. Indoor building energy use might be underrepresented, depending on the proportion of gross building space that is unused but still accounted for. With an artificially large divisor due to the inclusion of unused space, the rate of energy use appears smaller than it is. It is essential to keep unused space in mind when making decisions or conducting future studies as its inclusion can skew the data. While these spaces may exist, none were identified during this study at the colleges studied. Future studies looking at the same issue would be well advised to consider such spaces before developing related sustainability plans.

Energy use may also be associated with outside activities like outdoor lights and charging of landscaping equipment. Energy use outside of the counted buildings would not be associated with the denominator value, so the rate would overrepresent the rate of energy use - the denominator would not account for the land on which energy is used outdoors. While currently unknown, the combination of unused building space and land on which energy is used, if similar, would counteract each other and suggest the energy use per unit of building space rate is truly representative.

An additional, related limitation is the difference in energy intensity of the floor area. The assumption of this parameter is that each square foot of floor space has the same rate of energy

use. The STARS reports from three of the four studied institutions, version 2.1, have a parameter accounting for this: building energy consumption (site energy) per unit of EUI-adjusted floor area per degree day for the performance year. There is, however, not an equivalent metric for Smith College (Association for the Advancement of Sustainability in Higher Education, 2020-a). Energy use intensity (EUI)-adjusted floor area is a metric accounting for large differences in EUI based on types of building space such as laboratory and heath-care space (Association for the Advancement of Sustainability in Higher Education, 2019). The aspect of degree days takes into account the impact of the outside air temperature on the building energy requirements, but since all of the institutions are within close geographic proximity, this is not needed for direct comparison (Association for the Advancement of Sustainability in Higher Education, 2019, p. 165). Ideally, one would utilize this parameter which accounts for additional factors like energy use intensity. Due to the lack of availability of this information for Smith College, this parameter was not utilized in this study.

One might be concerned about different source-site ratios for grid-purchased electricity across the compared institutions as large differences would significantly affect source energy figures, but this ratio for all institutions is 3.14 (Association for the Advancement of Sustainability in Higher Education, 2020-a; 2019-a; 2018; 2019-b). This ratio is consistent across the institutions, likely because all the institutions purchase grid electricity from the same or similar companies since they are in close geographic proximity. Proceeding with the above-described unknowns, this metric best represents energy use of those available in the STARS reports and was utilized for direct comparison in this study.

Greenhouse Gas Emissions

There are three notable limitations to utilizing greenhouse emissions measured in adjusted net Scope 1 and 2 GHG emissions per weighted campus user. The first limitation is each institution started its sustainability or carbon/climate neutrality journey at a different level of environmental efficiency and point in time. If an institution had relatively low water use or GHG emissions due to historical infrastructure decisions, the institution may already have low water use or GHG emissions. Decisions made prior to sustainability goals or efforts are likely highly influential on where the college currently stands. For example, if a college invested money in upgrading to the most efficient appliances such as boilers and toilets across the board, its water use and GHG emissions would be lower than other institutions at an earlier point in time. Thus, the college might have made an earlier carbon neutrality goal, reducing its emissions early to meet its earlier goals, especially relative to other institutions. The GHG parameter in this study does not account for the different starting places of the four institutions studied, but remains the best metric among the weighted GHG emission rates available in STARS.

The second limitation is the metric does not take into account an institution's financial means to implement GHG emission reduction measures. An institution may not be financially able to spend as much money on these measures as the other institutions in this study or may need to implement measures more gradually. Such an institution's GHG emissions would likely be higher than the other institutions. This is especially true for the most expensive measures like replacing energy systems, which often have the biggest impact on emissions (Hampshire College, 2012, p. 24). Presumably an institution would know its financial cost of achieving carbon/climate neutrality, but the institution's overall financial situation can change and unexpected expenses do happen.

The final notable limitation is GHG emission values only include Scope 1 and 2 emissions, not Scope 3. Scope 3 emissions are in-direct to the institution, including those tied to wastewater, water management, transportation for business and commuting, and emissions tied to purchasing of goods and services (Worcester Polytechnic Institute, 2018, p. 7). If Scope 3 GHG emissions were included in the overall GHG emission metric, this would lead to a more all-encompassing measure. There are two benefits to not including Scope 3 emissions when these values are being directly compared across institutions, namely variation in study abroad rates and differences in measurement methods. Scope 3 emissions do include school-sponsored study abroad (such as through financial aid), and not all institutions measure Scope 3 emissions the same way due to the variety of factors and GHG emission rates associated with travel modes, etc. The last relevant piece to note is institutions do not consistently include or omit Scope 3 emissions from carbon/climate neutrality goals; for example, Hampshire's goal of climate neutrality by 2022 covers all non-fleet transportation emissions with a follow-up goal of 2032 for climate neutrality of fleet transportation emissions (Hampshire College, 2012, p. 5).

The adjusted net GHG emissions accounts for any carbon offsets, purchased or otherwise. An institution achieves carbon neutrality when its carbon offsets equal, or are greater than, its gross Scope 1 and Scope 2 emissions. Since none of the institutions in this study have achieved carbon or climate neutrality, these emission values prove valuable as they are not near zero. Small adjusted net Scope 1 and 2 GHG emissions per weighted campus user values due to large offsets would be difficult to compare as any offsets would mask the true rate of associated GHG emissions with resource use. The adjusted net emissions account for these carbon offsets, which for the institutions studied range from Hampshire's 21% of gross Scope 1 2 GHG emissions to MHC's zero percent (Association for the Advancement of Sustainability in Higher Education,

2020-a; 2019-a; 2018; 2019-b; Table 1). The carbon offsets typically necessary for an institution to achieve carbon or climate neutrality are purchased or counted as sequestered in an on-campus site, and those purchases would not occur unless or until necessary for carbon/climate neutrality. Regardless of whether or not offsets were included in the calculation of GHG emissions, the institutions would still be ranked the same relative to one another, so this limitation is more of a note to keep in mind. The issues surrounding carbon offsets will be discussed in a later section.

A related issue possibly worth consideration by another researcher is the influence endowment has, if any, on colleges' sustainability and abilities to reach carbon neutrality. In this study, Hampshire has, by far, the smallest endowment and yet the best overall sustainability metrics and the earliest climate or carbon neutrality goal, climate neutrality by 2022 (Table 1). One might assume there are factors outside of wealth and these metrics that have influenced its willingness and ability to pursue sustainability goals. Metrics could range from image and brand concerns to unusually strong leadership commitment to sustainability. The actual factors would be an excellent focus of another study.

Curriculum

The curriculum parameter is calculated as a percentage of courses and departments, so despite the variation in institution size, it can quite easily be directly compared across institutions. Henceforth curriculum is considered as an aggregate since the relative rankings of both the percentage of departments with sustainability course offerings and the percentage of courses labeled sustainability-focused or sustainability-inclusive are identical for each institution (Figure 4). There is a concern worth mentioning, namely when an institution offers few courses overall, the addition or subtraction of one sustainability course has an outsized impact on the overall percentage of sustainability-focused and sustainability-inclusive courses. The same can

be said for institutions with a relatively small number of departments. Hampshire College falls into the latter category as the College has five academic departments offering courses, whereas Smith College has 39 departments, Amherst College has 28 departments, and Mount Holyoke College has 36 departments (Association for the Advancement of Sustainability in Higher Education, 2018; 2020-a; 2019-a; 2019-b).

In addition to the heavier weight of each Hampshire department, a review of Hampshire's academic departments, known as interdisciplinary schools, shows that each covers a wide breadth of subjects (Hampshire College, n.d.-e). And the fact that departments offer sustainability-focused and/or sustainability-inclusive course(s) does not indicate all students in those departments actually take those classes. With departments of wider breadth, this is increasingly likely. While the decision to include the percentage of departments with sustainability course offerings was made to ensure sustainability course access to students of different majors was considered, this is a limitation when considering Hampshire College due to the small number of schools. By the same token, it is possibly more impactful to have many departments offering somewhat sustainability-inclusive courses than to have a few departments offering sustainability-focused courses. This issue is not resolved here. The department parameter also does not measure the number of courses within each department, one course sufficient for a department to be counted. In other words, a single course can, and does, have an outsized impact. Despite this, both parameters are included, but data on departments must be considered with caution. Suggestions for remedies can be found in later sections.

Another notable limitation of the parameter is the omission of students enrolled in Five College sustainability-focused and sustainability-inclusive courses. Students at Amherst, Hampshire, Mount Holyoke, and Smith Colleges as well as the University of Massachusetts at

Amherst, known as UMass Amherst, can take courses through the five institutions, which make up the Five College Consortium. The way the curriculum parameters were set up by AASHE does not take into account this unique course interchange. In other words, sustainability-focused and sustainability-inclusive courses taken at other institutions are not included in the parameter values, obscuring the true student exposure to sustainability concepts through coursework. There are a number of additional factors to consider including variation in rates of off-campus class enrollment at each institution and the ability of students to take certain courses due to prerequisites, course restrictions, and other considerations. No remedy for this complicated situation was identified, but the information has value and further research might be warranted.

As detailed in the Methods section, the process for identifying sustainability course offerings is quite subjective. AASHE provides definitions for sustainability-focused and sustainability-inclusive courses generally, but these definitions can be viewed both broadly and narrowly, leading to significant differences in interpretation. While reviewing the methods described by the institutions and utilized for MHC data collection, a variety of methods are described, which further suggests significant variation among the four institutions studied. This is the reality for all institutions reporting to AASHE STARS, and the review process does include curriculum list review, so this limitation is something to consider, especially when institutions' values are marginally different. The only such case in this study is MHC, which has a 0.48% lower percentage of courses that are sustainability course offerings than Smith. Since curriculum is utilized as an aggregate and the difference is more pronounced, 9.53% for departments with sustainability course offerings, this limitation is not of concern (Association for the Advancement of Sustainability in Higher Education, 2019-b; 2020-a).

Comparison of Parameters across Institutions

As seen above, each parameter represents a tangled combination of many different factors, so untangling the sources behind each metric cannot be easily done. However, recognizing *patterns* between institutions proves valuable because they provide insight beyond the individual parameters considered here.

Table 2

Comparative Table of Relative Institutional Parameter Rankings

Rank	Water Use	Energy Use	GHG Emissions	Curriculum
1 (best)	Hampshire	Hampshire	Hampshire	Hampshire
2	Smith	Mount Holyoke	Mount Holyoke	Smith
3	Mount Holyoke	Smith	Smith	Mount Holyoke
4 (worst)	Amherst	Amherst	Amherst	Amherst

Hampshire College consistently has the best relative values across GHG emissions, water and energy use, and sustainability curriculum while Amherst College has the worst across all parameters. Smith College is second-best for water use and sustainability curriculum, but second worst for GHG emissions and energy use. In terms of GHG emissions and energy use, MHC's values fall just below Hampshire's, but MHC is third, behind Smith, for both water use and curriculum (Table 2). With each institution ranking similarly across the four parameters, the findings suggest the relative sustainability of each institution is consistent i.e. Hampshire consistently places at the top, Amherst consistently places at the bottom. Similarly, Smith and MHC alternate between second and third, consistently placing in the middle (Table 2). This also suggests some parameter values could be dependent on one another. The following sections break down the institutions' rankings parameter-by-parameter.

Water Use

Water use, defined as gallons per gross square foot of building space, accounts for building space, but not for the differing water use intensities of the spaces. Hampshire College has the best, that is lowest, rate of water use while Amherst has the worst. Smith is second-best and Mount Holyoke is third (Table 2). Hampshire's ranking makes sense due to the College's relatively low rate of *residential* students, proactive water saving measures, its own non-municipal farm irrigation water source, a pond, and the most imminent climate neutrality goal, 2022 (Association for the Advancement of Sustainability in Higher Education, 2018; Table 1). With fewer people spending the majority of their time on campus consuming water, the rates of water use are expected to be, and are, lower. This is especially true in residential spaces where students shower, use the restroom, eat, and drink - clearly one would expect higher rates of water use for residential students than for non-residential or distance learning students. Faculty and staff are assumed to have similar rates of water use across the four institutions as none of the colleges have recorded significant numbers of employees resident on-site (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2020-a; 2019-b; 2018).

Water use is directly influenced by proactive water saving measures; this is clearly seen in Hampshire's favorable numbers. One of Hampshire's first-year residence halls, the 250-bed Merrill Dorm, houses almost 40% of its residential students. It was retrofitted in 2015 with devices reducing hot water use through behavioral choices along with explanatory signage. The devices reduce flow once hot water starts flowing, returning to full flow only when the user initiates this by pulling a string. Faucet aerators to reduce flow and low flow shower heads were also installed at this time. The behavior-modifying devices were installed and the faucets and shower heads retrofitted in the remaining residence halls in 2017. This indicates the College has

implemented initiatives campus-wide to influence students' behavior as soon as they arrive, and throughout their time, on campus (Association for the Advancement of Sustainability in Higher Education, 2018).

In addition to retrofitting and behavior measures, Hampshire has reduced water usage in other ways. Unlike the other colleges, Hampshire has a farm, which covers 10% of its campus. Since the farm's irrigation source is an adjacent pond rather than municipal water, this reduces the amount of water that might otherwise be used to actively manage this landscape (Association for the Advancement of Sustainability in Higher Education, 2018). The College's relatively low rate of water use and significant reduction efforts are likely related to its imminent climate neutrality goal of 2022. As the College works towards climate neutrality, it can reduce its GHG footprint by reducing water use, especially as it gets closer to its goal.

In contrast, Amherst College has the highest rate of water use. 98% of Amherst College's students are residential, the highest percentage among the institutions studied (Amherst College, n.d.-b). The College's high rate of water use makes sense given nearly all students consume most of their water on campus. In addition, the College is a relatively late adopter of common water-saving measures such as low-flow toilets and showerheads. Per Amherst's most recent STARS report the College is implementing low flow shower heads and toilets in addition to dual-flush toilets only when maintenance or replacement is required; it is not proactively replacing outdated fixtures. Some low-flow shower heads were installed gradually beginning in 2005, but the extent of these installations is unknown. Amherst's 2019 STARS Report also notes that its washing machine replacements took place in 2005; further improvements are not mentioned in the report. This could suggest poor data reporting or a general reactive approach to

water saving measures rather than the more proactive approach seen at the other institutions (Association for the Advancement of Sustainability in Higher Education, 2019-a).

Amherst College's 2030 climate neutrality goal is nine years away, so there may exist, or have existed, a certain comfort level with delaying implementation of such measures in addition to potential financial reasons at play. Regardless, Amherst College is currently behind the three other institutions, all of which have already proactively implemented basic water-saving measures such as low-flow faucets and showers (Association for the Advancement of Sustainability in Higher Education, 2020-a; 2018; 2019-b).

While it is pretty clear why Amherst has the worst water use rate, it is not entirely clear why Smith College performs better than MHC. Smith has the second-best rate of water use at 14.08 gallons/GSF. Smith has implemented various water-saving measures including educational programs regarding water conservation, such as an annual "shorter shower" competition. As of March, 2020, when the College submitted its most recent STARS report, the first of three phases of its campus irrigation system upgrade was also underway. This upgrade reduces outdoor water use, especially as the phases cumulatively have a larger and larger impact. The timing of implementation is not clear, so this project may or may not have impacted the water use values in this study and thus, where the institution ranks. Reviewing Smith's STARS reports from 2014 and 2017, it appears Smith College had a building with a rainwater capture system and low-flow fixtures as well as river water utilization for some irrigation. These changes are not reflected in the most recent STARS reports, but if they are still in use, this too could help to explain why Smith is relatively water efficient (Association for the Advancement of Sustainability in Higher Education, 2020-a).

Mount Holyoke College is ranked third-best relative to the other institutions included in this study. This is despite the fact that MHC has implemented a range of water saving measures. Part of the explanation could be that Mount Holyoke appears to focus on building water use, while Smith primarily focuses on outdoor, irrigation water use. Given the breakdown between indoor and outdoor water use is not available for either college, it is not possible to know which measures have a greater impact. It is also unclear whether the Colleges focus their efforts on indoor or outdoor water use as they perceive these different areas as having the highest impact or being the most reducible (Association for the Advancement of Sustainability in Higher Education, 2019-b).

Like Smith, Mount Holyoke has implemented education initiatives; it has also implemented campus-wide, not just single building, low-flow faucets and other built-in water saving measures. According to MHC's STARS report, the student Eco-Reps provide water conservation education on a routine basis. Students are exposed to their efforts throughout their time at Mount Holyoke, starting with their first day on campus when they meet the student Eco-reps during check-in. This routine education and exposure is assumed to be somewhat successful in changing individual student habits towards conservation water use. The second piece mentioned in the STARS report is water conservation methods built into the institution's infrastructure. In 2007, all faucets were fitted with aerators, reducing flow by almost 23%. The other built-in measure for water conservation is the ongoing installation and retrofitting of highly efficient shower heads and toilets. These built-in measures reduce water use and do not rely on individuals changing their habits. The combination of the educational initiatives and wide-spread built-in water reduction measures does not align with Mount Holyoke's third-best ranking for water use among the studied institutions. Other factors like outdoor water use, including for the

golf course, and MHC's horse population may also be at play (Association for the Advancement of Sustainability in Higher Education, 2019-b)

Energy Use

The energy use parameter is defined in this study by two metrics, site energy, and the difference between site and source energy. Both are measured in millions of British thermal units per gross square foot of building space floor area, MMBtu/GSF. Across the four institutions studied, the rankings of both site energy and the difference between site and source energy are identical to GHG emissions. Hampshire and Mount Holyoke Colleges have equal rates of source energy use; they do, however, differ in site energy use. The difference in site and source energy use is therefore higher at Hampshire College and lower at Mount Holyoke College (Association for the Advancement of Sustainability in Higher Education, 2018; 2019-b). Mount Holyoke College's overall second place rank for energy use makes sense given the campus-wide site energy reduction initiatives MHC has implemented despite having a relatively high percentage of energy intensive space. Smith College ranks third for site energy, but first for the difference in site versus source energy (Association for the Advancement of Sustainability in Higher Education, 2020-a). Amherst is fourth, or worst, for site energy, but is tied with Mount Holyoke for second in regards to the difference in site and source energy use. Regardless, Amherst is ranked fourth overall for energy use among the four institutions studied (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2018). Let us look at each form of energy separately.

Site Energy. Site energy specifically focuses on energy consumed in a building as reflected on utility bills. Comparing site energy values across the four studied institutions indicates how energy efficient the campus buildings and their systems are as well as the energy

use behavior of people using the campus buildings. Site energy influencing factors are intertwined and together provide valuable information regarding their combined impact. A number of factors can influence site energy usage rates such as highly insulated, energy efficient, windows and efficient appliances including high efficiency boilers and refrigerators (Energy Star, n.d.). Site energy usage rates are also influenced by people consuming energy for devices, lights, heating water, turning up the heat or air conditioning, and the like. However, this can be restricted or reduced by occupancy sensors and pre-set temperature gages, among other measures.

For perspective on the significance of the difference in site energy use among the institutions studied, even a 0.01 MMBtu/GSF increase would have a large environmental impact. Compounded over Hampshire's 802,800 GSF of building space, a 0.01 MMBtu/GSF increase in site energy would be an increase of 8,028 MMBtu - equivalent to almost 66,740.9 gallons of motor gasoline (U.S. Energy Information Administration (EIA), 2020). If this 0.01 MMBtu/GSF increase were applied to Smith College, the institution with the largest building area, the equivalent values would be 240,267.2 gallons of motor gasoline. In other words, the difference between the colleges' values have a greater actual environmental impact than the numbers themselves may suggest.

For Hampshire College, having the lowest site energy rate, energy consumption per gross square foot of building space, of the studied institutions indicates the campus's buildings consume the lowest amount of heat and electricity per GSF. In other words, Hampshire College's buildings and users are the most energy efficient. This finding connects directly to Hampshire having the lowest rate of water use and GHG emissions as energy is needed for water use and has associated GHG emissions. With Hampshire College approaching its climate neutrality goal

of 2022, the institution appears to have lowered its site energy use by working to convert all lights to LEDs, installing occupancy sensors, and setting temperatures for heating and cooling, among other measures. This information comes from Hampshire College's most recent STARS report, submitted in 2017 (Association for the Advancement of Sustainability in Higher Education, 2018), so over the past four years the College may have implemented additional measures further reducing its site energy use. The pre-programmed building temperatures vary among the institutions (Association for the Advancement of Sustainability in Higher Education, 2020-a; 2019-a; 2018; 2019-b) and thus, the impact of the pre-programming on site energy consumption also varies. Understanding each institution's pre-programmed temperature decisions is beyond the scope of this study. The final factor contributing to site energy use is on-campus generation systems, which differ among the studied institutions. Hampshire has a passive heating and cooling system in a dorm housing 38% percent of residential students and has solar arrays capable of producing 100% of its electricity (Association for the Advancement of Sustainability in Higher Education, 2018). The types for the other institutions are detailed below.

Investigating Smith and Amherst Colleges, Smith has the second highest rates of site energy use per gross square foot of building space while Amherst has the highest rates (Figure 2). These rankings indicate Smith and Amherst's buildings and/or their building users are less energy efficient than those at Hampshire and Mount Holyoke Colleges. Smith College's relatively high 0.13 MMBtu/GSF rate of site energy does not align with the multiple site energy-saving measures they have implemented: gas water heater replacements, ventilation reductions in a building, and retro-commissioning of some buildings (Association for the Advancement of Sustainability in Higher Education, 2020-a). Retro-commissioning is generally

improving the efficiency of a building's energy-using equipment and systems (Building Efficiency Initiative, 2013). This lack of alignment might be explained by the aforementioned limitation that each institution started at a different initial rate of site energy use before reduction measures were implemented. Smith may have had a higher initial rate, so even significant reductions would not bring them as low as Hampshire and Mount Holyoke Colleges. Looking at on-campus generation systems, Smith has a gas combustion turbine which supports approximately 50% of heating use and 65% of electricity use annually. Unlike Hampshire's mostly renewable energy, Smith has a less efficient system which further contributes to the higher rate of site energy use (Association for the Advancement of Sustainability in Higher Education, 2020-a).

A similar conclusion is reached for Amherst College, which is ranked worst for site energy use despite having implemented some energy-saving measures. Building temperatures are set based on occupancy which lends to reduced site energy use rates, and LEDs are installed primarily during necessary replacements. Amherst College does not proactively install LEDs, and does not report how widespread campus LED use really is. Like Smith, Amherst also has a cogeneration system consisting of a gas turbine generator, which supplies around 67% of annual electricity use and a connected steam turbine, which satisfies 30% of heating use on campus (Association for the Advancement of Sustainability in Higher Education, 2019-a). These less efficient energy sources contribute to the higher rate of site energy use found at Amherst College.

At Mount Holyoke College, the education programs through the Sustainability program and the student Eco-reps focus on energy conservation. These programs include an annual energy savings competition among the residence halls and an eco-orientation covering energy conservation for all new employees. These programs likely contribute to lower rates of energy

consumption among both students and staff as they influence both individual and collective habits. Non-LED tasking lighting also has an impact on energy consumption, and MHC provides free task lighting LEDs for students, faculty, and staff. Doing so encourages wide-spread use of LEDs beyond just institutional lighting. The LED program comes with some awareness around why the College provides these free LED lights (Association for the Advancement of Sustainability in Higher Education, 2019-b).

In addition to these measures, MHC has implemented further campus-wide energy conservation initiatives. Expanding on the task-lighting LEDs, the College has a plan to replace all interior and exterior campus lighting with LEDs. Through February, 2019, when the STARS report was submitted, 25% of interior lighting and 98% of exterior building lighting had been updated to LED. Since the institution had, and implemented, a plan for these replacements, these percentages are likely even higher today. Mount Holyoke has proactively replaced LEDs, unlike i.e. Amherst College which replaces lighting with LEDs only as needed. In addition to the LEDs, one of MHC's residence halls, Creighton Hall, and the community center have solar hot water systems. This residence hall water system provides approximately 30% of the building's hot water needs, reducing MHC's overall energy use tied to hot water consumption. According to the STARS report, the Community Center, which was then under construction, centralizes the six separate dining halls into one location with energy efficient dining equipment, including the compressors and exhaust hoods. At MHC, when mechanical equipment needs replacing, energy efficient equipment is chosen whenever possible (Association for the Advancement of Sustainability in Higher Education, 2019-b).

These different campus-wide initiatives built into the infrastructure of Mount Holyoke College contribute to MHC's second-best ranking. All these components combined contribute

towards the college's favorable site energy footprint. Reducing a number of areas at once rather than just focusing on one or two allows the College to reduce energy use across the board and to arrive at the second-best rank. Site energy also includes heating demands, which are detailed in a following section. Such energy is also reduced by a combination of initiatives built into the infrastructure of the institution and by people's actions.

The last piece of the puzzle helps explain why Mount Holyoke College is ranked worse than Hampshire College in terms of energy use. At 5% of GSF, Mount Holyoke has a 1.9 times higher percentage of laboratory space compared to Hampshire College's 2.6%. For healthcare space, MHC has 0.5% healthcare space to Hampshire's zero percent. Both types of space are energy intensive due to the nature of the activity for which they are used. With a higher percentage of such spaces comes higher rates of energy use, which partly explains why MHC is behind Hampshire despite the institution's campus-wide energy saving initiatives (Association for the Advancement of Sustainability in Higher Education, 2019-b; 2018).

Difference between Source and Site Energy. As outlined in the Methods section, institutions may be restricted in what energy sources they can utilize; these differences between site and source energy cannot be solely attributed to choice. A component of these differences can be attributed to the proportion of total energy use an institution purchased from an off-campus source. This connects directly to on-campus energy generation rates such as the difference between the percentage of energy for heat generated on Smith College's campus versus Amherst College's campus. Smith and Amherst Colleges' systems produce similar percentages, with just a 2% difference, of electricity produced and consumed on campus. On the other hand, 20% less energy for heating is produced on-campus at Amherst compared to Smith. Thus, Amherst uses 20% more off-campus energy for heating. The more energy is consumed, the

more energy is lost during production and transport even if the rates of loss are the same. This is so as energy loss is measured per GSF, not per unit of energy consumed. This provides an explanation for the higher difference in source versus site energy rates for Amherst compared to Smith. This further detail is not available through the STARS report and other public sources for Hampshire and Mount Holyoke Colleges (Association for the Advancement of Sustainability in Higher Education, 2019-a; 202-a).

Since the difference in source versus site energy can be explained by a number of factors, it is hard to isolate one, or even a combination of, variables as the source of these observed differences. Still, Hampshire College clearly has the highest difference in source versus site energy at 0.06 MMBtu/GSF. One possibility is that Hampshire's off-campus energy source(s) is/are the least efficient, and that its rates of off-campus energy use is relatively high. Amherst College has the mid-range difference of 0.05 MMBtu/GSF, just below Hampshire's 0.06 MMBtu/GSF value. Following the logic for Hampshire College, Amherst College possibly has an off-campus energy source(s) in the mid-range of efficiency and mid-range rates of off-campus energy use. Smith College has the smallest difference in source versus site energy at 0.02 MMBtu/GSF. Following the logic for Hampshire and Amherst Colleges, Smith College possibly has the most energy efficient off-campus provider(s) and uses lower rates of off-campus energy (Association for the Advancement of Sustainability in Higher Education, 2018; 2019-a; 2020-a; 2019-b). Given the GHG footprint of energy sources is likely lower for more efficient sources, choosing a more efficient source would reduce the institutions' GHG emissions (Energy Star, n.d.). Each institution utilizes a different mix of off-campus energy sources and fuels to fulfill its needs as is reflected in the STARS reports.

At Mount Holyoke, the difference between source and site energy use is average among the institutions studied at 0.05 MMBtu/GSF. The difference between the rates of site and source energy for MHC provides limited insight into which of MHC's energy sources are the most energy efficient. Just under a quarter of the energy consumed in terms of MMBtu comes from grid-purchased electricity, less than one percent is from electricity from on-site renewables, and the remainder is from all other sources (Association for the Advancement of Sustainability in Higher Education, 2019-b). With the limited information available, the on-site renewables is assumed to be the aforementioned solar hot water systems, and the "other sources" are partially or completely oil or natural gas used for the cogeneration plant (Association for the Advancement of Sustainability in Higher Education, 2019-b).

This determination does not provide significant insight into the efficiency given most of the campus' energy comes from the other energy sources or the combination of other energy sources. However, since MHC stands second-best among the institutions studied with the majority of energy coming from other sources, these other sources are relatively efficient compared to the aggregates of sources utilized by the other institutions. The grid-purchased electricity and electricity from on-site renewables are the minority, but do contribute about a quarter of MMBtus. These electricity sources must be relatively energy efficient, otherwise the "other sources" would be outweighed by this quarter. Under the assumption that the majority energy source deemed "other" is at least partially oil and natural gas, this aligns with MHC's backpressure steam turbine, which is quite efficient (U.S. Department of Energy, 2012, p. 1). Mount Holyoke has solar panels capable of generating around 6% of campus annual energy use, but has sold the rights to the local utility and thus, does not benefit from having these solar

panels (Mount Holyoke College, n.d.-g). This is a clear example of a carbon lock-in and a change is recommended later in this paper.

Carbon lock-ins occur when carbon-intensive systems cannot be replaced or changed due to technical, financial, and/or policy reasons (Erickson et al., 2015). Carbon lock-in is the obstacle Worsham and Brecha (2017) identify as potentially preventing institutions of higher education from successfully following paths towards decarbonising. As it stands, carbon lock-in perpetuates fossil fuels despite known risks and available cost-effective alternatives largely due to slow diffusion of low-carbon technologies. Carbon lock-ins can be the largest obstacle facing a college working towards carbon/climate neutrality and may also be a point at which institutions' significant carbon liability is exposed. Some institutions have dealt with carbon lock-ins, facing high costs to purchase carbon offsets or regulatory penalties when low-carbon technologies are favored. These penalties typically come from local regulators restricting use of low-carbon technologies and the need to break long-term contracts with local utility companies. Ultimately, institutions must consider any investments made on carbon-emitting infrastructure as this would mean sticking with their traditional carbon-intensive route and offsetting to achieve carbon/climate neutrality. On the other hand, switching over to less carbon-intense technologies often comes with potentially prohibitive penalties from carbon lock-ins.

Greenhouse Gas Emissions

Hampshire College has the lowest GHG emissions per weighted campus user of all the institutions studied. With the lowest rates of energy and water use in combination with high percentages of sustainability curriculum and the earliest climate neutrality goal, this makes sense (Association for the Advancement of Sustainability in Higher Education, 2018). The GHG emissions associated with water use on campus are connected to energy use, given energy use

includes energy expended for heating, chilling, and transporting of water. The more water that is used, the higher the water's GHG footprint. Since Hampshire has the lowest relative water use rates, it makes sense that Hampshire also has lowest GHG emissions among the four institutions (Association for the Advancement of Sustainability in Higher Education, 2018; Table 2).

The opposite can be said for Amherst College, which stands last, or worst, among all the institutions studied for energy use, water use, curriculum, and GHG emissions (Association for the Advancement of Sustainability in Higher Education, 2019-a; Table 2). With Amherst's higher rates of energy and water use comes higher GHG emissions, the opposite of Hampshire College. For the same reasons Hampshire has the lowest relative rates and thus, the lowest GHG emissions, Amherst has the highest relative rates and thus, the highest GHG emissions. Smith College does not fit neatly into this pattern, placing third-best for GHG emissions and rate of energy use but second-best for both water use and curriculum. Mount Holyoke College has a similar profile (Table 2). Given the large number of factors impacting parameter values, the lack of a pattern could partly be explained by outside factors. This is especially true for the less directly connected water use and curriculum parameters, but not for the highly related GHG emissions and energy use parameters. Scope 1 and 2 GHG emissions are directly related to energy use, explaining why all the studied colleges rank the same for both GHG emissions and energy use.

As institutions work towards goals of carbon or climate neutrality, they reduce their GHG emissions and thus, the rate of GHG emissions per weighted campus user. With lower GHG emissions, the institutions must purchase fewer offsets to achieve their goals of neutrality, providing a strong financial incentive for reduction. With Hampshire College's 2022 climate neutrality goal, implementations of energy-saving measures, building retrofits, and other

measures have already been made, contributing to the reduction of GHG emissions (Association for the Advancement of Sustainability in Higher Education, 2018).

On the other hand, Amherst College has a mid-range climate neutrality goal of 2030; it also has higher rates of water and energy use than Hampshire. The same can be said for Smith and Mount Holyoke Colleges which have carbon neutrality goals of 2030 and 2037, respectively (Table 1). Unlike Hampshire College, Amherst, Mount Holyoke, and Smith Colleges, have likely not yet fully implemented most of their carbon or climate neutrality plans due to their later goals. Plans specific to achieving carbon or climate neutrality might be more large-scale and proactive in nature with the direct intent to reduce GHG emissions, whereas previous upgrades were cost-saving and implemented as needed. Thus, notable reductions in GHG emissions may not be observed until a significant part of larger scale measures are executed. For many institutions, these measures may be related to on and off campus energy sources given the majority of GHG emissions are associated with institutions' purchased electricity and stationary combustion (Sinha et al., 2010). It is also important to note that each institution has started implementing its strategy towards carbon or climate neutrality at a different point in time - when the institutions started implementing their plans could not be determined based on publicly available information and likely varies widely by definition.

Another consideration around carbon offsets is that the GHG emission metric factors in carbon offsets. The metric is adjusted net, not gross, Scope 1 and 2 GHG emissions. Referencing Table 1, Hampshire College had offsets for a recent building project, 21.3%, and on-campus composting, one tenth of a percent, a total of 21.4% of its gross GHG emissions (Association for the Advancement of Sustainability in Higher Education, 2018). Smith's offsets were just 0.4% of ita gross GHG emissions (Association for the Advancement of Sustainability in Higher

Education, 2020-a), and both Amherst and Mount Holyoke Colleges recorded no offsets (Association for the Advancement of Sustainability in Higher Education, 2019-a; 2019-b). This correlates with Hampshire having the lowest rate of emissions per weighted campus user, especially compared to the other institutions.

As carbon and climate neutrality plans are executed, some institutions may decide to be less aggressive with GHG reduction projects, choosing instead to pay for more offsets provided they have the financial means to do so. Institutions that choose to pay for carbon offsets as the final push to achieve carbon or climate neutrality often wait until then to do so due to the cost - large or small, some institutions simply do not want to pay more than "they have to." However, a critical consideration with offsets is not just finances, but also such concerns as morality and the greater good. A college may be philosophically or morally opposed to using offsets to achieve its carbon or climate neutrality goal. It may consider offsets a "cop-out" or a way to achieve carbon or climate neutrality without doing the hard work, or truly becoming more sustainable. These and other issues and tensions surrounding offsets make them a highly charged issue for colleges. To learn more about offsets in higher education, refer to sources such as Second Nature's Offset Network (Second Nature, n.d.).

Among the four institutions studied, MHC's GHG emissions are slightly higher than Hampshire College and lower than both Amherst and Smith Colleges'. Mount Holyoke being second for GHG emissions makes sense given it is third-lowest for water use and second-lowest for energy use. Water and energy use have carbon footprints, so with lower rates of water and energy use come lower GHG emissions. In addition, Mount Holyoke College does not have any carbon offsets, so the adjusted net and gross Scope 1 and 2 GHG emissions are identical. The most recent STARS report, from February, 2019, is referenced here under the assumption that FY

2017 data are similar to FY 2018, the data utilized in this study. According to the report, the majority of GHG emissions come from Scope 1 stationary combustion, "other" Scope 1 sources, and Scope 2 emissions from purchased electricity in order from largest to smallest. Mount Holyoke has an onsite cogeneration system made up of a backpressure steam turbine which uses oil or natural gas to create steam and generate electricity for heating (Association for the Advancement of Sustainability in Higher Education, 2019-b). The majority of the institution's greenhouse gases come from this cogeneration system, which produces the electricity for the campus's heating needs.

Curriculum

The last study parameter, curriculum, further illuminates that the colleges' choices influence college rankings in the study. Through application of the Value-Belief-Norm (VBN) theory, described above, a college student's beliefs directly influence their norms and thus, influence behavior both directly and indirectly. Sustainability-focused and/or sustainability-inclusive education, measured by the curriculum metric, contributes to students' beliefs. Students' values and thus, beliefs influence their environmental decision-making and behavior (Whitley et al., 2016). The connection described by the VBN theory indicates the benefit of sustainability coursework and why such sustainability-focused and/or sustainability-inclusive coursework should be integrated into academic departments across campus (White, 2014). The extent to which students receive sustainability education through coursework is to a significant degree measured by the curriculum metrics. One can predict students exposed to sustainability-focused and/or sustainability-inclusive courses and departments will alter their habits to be more environmentally conscious, although to varying degrees.

Hampshire College ranks best for both the percentage of sustainability course offerings and percentage of departments offering such courses. While the latter is inflated due to Hampshire's small number of departments/schools, the more representative percentage of sustainability course offerings is still the highest. Based on the previously described connection between sustainability course offerings and sustainability behavior, this indicates Hampshire's students have a high rate of sustainability beliefs and norms. This might begin to explain why Hampshire is best across all the parameters - students alter their behaviors to be more sustainable in response to coursework, reducing their own energy consumption, water use, and associated GHG emissions. Cumulatively among Hampshire students, this would amount to reductions of the institution's values as well. With a presumably higher proportion of faculty members teaching these sustainability-focused and sustainability-inclusive courses, Hampshire faculty likely have also reduced their footprints, further reducing the institution's water use, energy use, and GHG emission values (Association for the Advancement of Sustainability in Higher Education, 2018).

In contrast, Amherst placed last in the percentage of sustainability course offerings and the percentage of departments with such offerings by a fair margin (Appendix A; Figure 4). While curriculum is not directly predictive of the water use or GHG emission metrics, curriculum can be indicative of student and staff exposure to sustainability concepts. Intuitively, this affects how "visible" or ingrained sustainability is in the campus environment. At Amherst, just 2.7% of courses are sustainability course offerings, and only 32% of academic departments offer such courses, so exposure to sustainability concepts appears relatively low (Association for the Advancement of Sustainability in Higher Education, 2019-b). Comparison to curriculum exposes students and staff to sustainability concepts and may be tied to rethinking, and reduction,

of resource use. This benefit clearly depends on how many people are exposed to these concepts. With relatively low rates of exposure at Amherst College, resource consumption is likely not reduced by a large enough proportion of the population to be measurable. Thus, Amherst College ranking last for curriculum shows an overall pattern consistent across GHG emissions and water use with Amherst worst among the four institutions studied (Association for the Advancement of Sustainability in Higher Education, 2019-a).

Smith, on the other hand, is second behind Hampshire. This suggests that even though Smith is not doing well in terms of GHG emissions relative to the other colleges, the campus community is developing a culture of sustainability. Relative to the other institutions, the percentage of students exposed to sustainability-focused and/or sustainability-inclusive courses offered through a variety of departments is high with 10.55% of courses deemed sustainability course offerings, and 53.85% of departments offering such courses (Association for the Advancement of Sustainability in Higher Education, 2020-a). With the majority of departments offering such courses, most students have the opportunity to take sustainability-focused or sustainability-inclusive courses. It is just not clear from the data used here whether the majority of students actually take these courses. Regardless, the relevant number of courses and departments suggests Smith has an academic focus on sustainability with both faculty and student interest. Faculty develop courses, and these courses presumably only continue with sufficient student enrollment. One might predict Smith will see future reductions in water use and GHG emissions as students respond to learning about sustainability by reducing their individual consumption.

Mount Holyoke College is third among the institutions for both the percentage of academic departments with sustainability-focused or sustainability-inclusive course offerings and

for the percentage of courses deemed sustainability-focused or sustainability-inclusive. Just over forty percent of departments offer sustainability-focused and/or sustainability-inclusive courses, despite the interdisciplinary nature of the UN's Sustainable Development Goals (SDGs). This indicates sustainability is not well integrated into the institution's academic framework and priorities. Just 10.07% of MHC's courses are sustainability offerings, indicating that few students are exposed to sustainability in a given academic year. As discussed in the following recommendations section, this indicates Mount Holyoke could expand such sustainability course offerings to reach more students in an academic setting, thereby further supporting its sustainability goals (Association for the Advancement of Sustainability in Higher Education, 2019-b).

Additional Factors Influencing Parameter Values

In addition to the many factors mentioned above, a number of other factors influence an institution's parameter status. One such factor is when each institution made its specific goal of carbon or climate neutrality, given the 15 year range identified among the four institutions studied. Institutions may take different approaches to reaching their goals of carbon or climate neutrality, leading to varied rates of changes to parameters over time. For example, one institution may implement many costly interventions immediately after announcing its goal, and another may plan to make smaller changes over time until its goal date. Institutions likely also implement different measures at different stages of their plan to achieve carbon or climate neutrality, leading to varied rates of change. Financial considerations must also be taken into account as institutions may select an approach based on their financial means to pay for the infrastructure or other improvements up front, incrementally, or through some combination of approaches. As discussed in the offsets section, institutions may have non-financial reasons for

purchasing or not purchasing carbon offsets. Instead, institutions may attempt to quickly achieve carbon or climate neutrality by reducing carbon and/or GHG emissions as rapidly as possible.

The current pandemic is another factor one might consider due to large, unplanned changes to institutional finances and drastic reduction of resource use. This could lead to delays or reduced funds for sustainability plans and goals. In terms of data, the pandemic likely altered the resource-related measures like GHG emissions and water use, due to a non-traditional residential student population for part of Spring 2020 and all of academic year 2020-2021. This data was not utilized as all reports referenced from AASHE STARS were for institutions outside of MHC and were submitted pre-pandemic with pre-pandemic data. For Mount Holyoke, the only data from the pandemic was 2020-2021 curriculum data, which were likely impacted by the pandemic. Some courses, including hands-on courses like Introduction to Environmental Entrepreneurship: Campus Sustainability were not run as they could not be successfully conducted online. Thus, the percentage of sustainability-focused and sustainability-inclusive courses might be lower than in traditional years. A related concern is the lack of first year exposure to sustainability concepts through programs like the student Eco-Reps program, which did not run academic year 2020-2021. Although a related program, the Campus Sustainability Coordinators, was run, this is exclusively online programming, which may have lesser impact than in person programming. On a more positive note, the 2020-2021 academic year curriculum percentage of sustainability-focused and sustainability-inclusive course offerings is slightly higher than academic year 2017-2018, according to MHC's most recent STARS report (Association for the Advancement of Sustainability in Higher Education, 2019-b).

Due to the multiple factors outlined above and others not discussed, further study is needed to understand how influential each factor is and why. These studies could include the

impact of the pandemic on goals and plans for carbon or climate neutrality, the financial aspects of decisions, and longer term studies of sustainability and carbon or climate neutrality progress over time. Also, further study could include a range of qualitative factors such as descriptions of how the campus is used as a living laboratory and progress towards environmental justice, among others.

Issues and Recommendations for Mount Holyoke

The following sections focus on some of the data collection issues that arose during the course of this study and on recommendations specific to Mount Holyoke College. While the Methods section suggests a fairly linear experience with data collection for MHC, it does not fully illustrate how inconsistent, and frankly messy, data collection by, and on, Mount Holyoke truly is. Case in point - due to various reasons, including staffing changes and the pandemic, MHC's typical environmental data collection practices were put on hold. As a consequence, i.e. the most recent GHG emissions data used in this study came not from a central database or a contact but rather from a single webpage figure of unclear origin (Mount Holyoke College, n.d.-e). For other parameters such as water use and curriculum information was neither easily accessible nor easily obtained. Given the importance of accurate and accessible data as the College moves towards its carbon neutrality goal, it is essential that a series of steps be taken to improve the college's data collection processes.

A Coordinated and Integrated Collaborative Approach

During the duration of the study, it has become clear Mount Holyoke does not have a coordinated and integrated collaborative approach to data collection. Employing such an approach is the first recommendation of this study. Measures of campus sustainability require such an approach due to the often interdisciplinary nature of institutions' chosen metrics. A

coordinated and integrated approach should be built into the "emerging over-arching [institutional] governance structures" as opposed to siloed initiatives by departments or offices (Krizek et al., 2012, p. 22). This type of approach was identified as a hallmark of institutions successful in reaching their campus sustainability goals. A component of a coordinated and integrated collaborative approach is systemized strategies for collecting data to calculate measures of campus sustainability. These are necessary at institutions striving to reach their sustainability goals (Posner and Stuart, 2013). The strategies can be in the form of understandable and consistently applied procedures for data collection and well-developed reporting platforms for sharing of data.

Collaboration is another component of a coordinated and integrated collaborative approach. One recommended form of collaboration is more intense, regular collaboration between academic departments or staff and facilities managers. Not only does this expand opportunities for potential hands-on sustainability projects involving a multitude of stakeholders, but it also fosters a collaborative relationship for collecting campus sustainability measure-related data. Such collaboration between data collectors and data providers should be generally exemplified in the collection of operational data (Savanick et al., 2008). For instance, data collectors may receive data from facilities managers through utility bills and supply inventories. This direct relationship specific to campus operation measures shows how critical collaboration is to institutions working towards their sustainability goals.

Like Mount Holyoke, many institutions face challenges specifically centered on a lack of coordination among necessary campus partners (Krizek et al., 2012). Sustained collaborative efforts are also important given that the most important piece of the puzzle is ensuring sustainability remains an ongoing focus on campus (Brinkhurst et al., 2011). Students, staff, and

faculty can come and go, but a sustained sustainability focus fosters achievement of sustainability goals.

Maintaining Accurate and Current Environmental Data

Maintaining environmental data, including campus sustainability measures such as those studied here - water and energy use, GHG emissions, and curriculum - is essential for institutions to know where they stand. Institutions can also use such measures to assess any value changes, to determine any course changes, and to identify when a goal has been achieved. At Mount Holyoke, this requires annual calculations and coordination across departments with the aggregator, the Miller Worley Center for the Environment (MWCE). Attention should be paid to these data also as the collection process itself connects the departments and offices providing the data toward a common goal. The first step towards greater buy-in is awareness; once people are introduced to the idea of campus sustainability, including through data collection coupled with explanations for why it matters, they become part of the larger conversation or think about ways they may contribute towards the institutions' goals. This in turn, increases the likelihood data will be collected and goals achieved.

Regularly scheduled data review is also essential to accurate data and should involve more than one entity. This data review should be informal and performed by college staff and students who are knowledgeable about the college and the data up for review. Data should be verified annually as even marginally incorrect calculations might cost MHC thousands of dollars in unnecessary projects or offsets over time. Comparing trends over time aids in this verification as any anomalies can be identified and addressed. For GHG calculations, Mount Holyoke utilizes SIMAP, the Sustainability Indicator Management & Analysis Platform, to facilitate calculations based on input data. The team at SIMAP does offer a data review service, but the MHC students,

faculty and students inputting the data understand the entered values better than anybody and have access to historical data to check whether values are reasonable. Therefore, it is not recommended MHC utilize SIMAP's review service, but rather practice internal reviewing. If internal review is too much of a burden, the College should employ SIMAP's review service.

Standardization of Procedures and Establishment of a Centralized Platform

Standardization, and streamlining, of procedures for data collection is another recommendation. This occurs to some extent with MHC's water use data and should be expanded to other data as well. Currently, water use data at MHC are sent directly to the MWCE by Facilities Management on an annual basis. The data are sent as an aggregate spreadsheet, which is workable but could be improved through the addition of a more comprehensive and accessible platform, discussed below. For data other than water use, the MWCE currently must request data as otherwise it is not received since the process is not automated.

Collecting GHG emission data for MHC proved more challenging than water use data. After communicating with MWCE staff, the most recent GHG emission data were identified via a figure on MWCE's website (Mount Holyoke College, n.d.-e). The data behind the figure could not be found by MWCE staff and was not consistent with the values submitted in MHC's 2019 STARS Report. However, the GHG emission value submitted is labeled as representing the period between July 1, 2017 and August 30, 2017, which was likely extrapolated to represent the entire year. It was eventually determined based on the webpage figure's labels that MHC's most recent GHG emission calculations were completed for FY 2018 with no values for FY 2019 and FY 2020. FY 2020 was not a typical year, so that is understandable, but it is concerning that an institution like Mount Holyoke, with a goal of carbon neutrality, has such outdated GHG emission values. In contrast, Mount Holyoke's energy use data were extremely simple to access

as it was taken directly from the institution's STARS report. The author simply had to pull the value from the platform for direct use in this study. This ease of access exemplifies how accessible sustainability data can, and for key metrics, should be.

A related recommendation is the establishment of a centralized platform for data submission and collection. Currently, MHC water use data, for instance, are sent as a spreadsheet to MWCE staff. The MWCE staff then processes these data to identify trends and calculate sustainability metrics, something that could be much more efficiently done with the use of a well-developed platform. Such a platform should be selected and developed through a collaboration between the MWCE, Facilities Management, and other related offices for water use and other similar environmental data. This collaboration will ensure the platform is understood by all involved parties and fits into existing inter-department or inter-office procedures. Annual submission of data to this accessible, centralized platform is sufficient. In addition, many departments or offices have these values on hand or must calculate them for budgetary or administrative purposes, so submitting them to a centralized platform would not be a significant burden. The same procedure should be used for the gross floor area data, which, under the current system, Facilities Management has not provided since 2018. It is also highly recommended that all relevant stakeholders be thoroughly briefed on the purpose and use of this platform in the hopes of achieving timely and accurate data submission.

While the platform is quite important, it brings little to no value if no data are entered or if the data entered are incorrect, inconsistent, or untimely. The author recommends the installation of additional meters and recording devices on individual buildings to track building-specific energy use. Taking this further, the College should consider fully automating routine data collection to eliminate issues of incorrect copying or inconsistent recording. An

investment in such automation, if financially and structurally feasible, could be expanded to other sustainability data collection processes. These data should not only be collected, but also automatically transferred to the established central reporting platform. Once the data are submitted to the central platform, calculations into metrics like GHG emissions per weighted campus user should follow within 60 days. The author recognizes some flexibility must be built in as students will likely be involved in these processes and are only employed during part of the calendar year. However, regular data calculations are necessary to observe trends and prevent large backlogs of unprocessed data. At present, there is a backlog of at least one and a half years.

On a related note, the author recommends MHC install tracking meters on individual buildings to make data collection more individualized. The College can respond to higher or lower usage rates on buildings by retrofitting buildings or initiating targeted educational campaigns for building users. At present, the College appears to be able to collect individual building energy use data, but not individual building water use data. For example, the Eco-Reps' competition to reduce energy usage in individual residential buildings appears to incorporate individual building data on energy use. Winners are chosen based on the percentage of energy reduced by building users in a specific time frame. On the other hand, a faculty has been told individual buildings do not have water meters (J. Albertine, personal communication, April 5, 2021). Further research indicates some buildings have individual meters, but others are grouped (Lang, 2019). This should be rectified by the installation of water meters on all possible buildings. Implementation of the recommendation to install meters on individual buildings, if feasible, would provide the College great insight and opportunities.

Delineation of Responsibilities to Ensure Continuation

The data review process highlighted the importance of not being overly reliant on one staff member or influenced by staffing changes. It also highlights the importance of clear deliantied data collection responsibilities. Mount Holyoke's Miller Worley Center for the Environment (MWCE) has historically been in charge of sustainability data collection and calculations, but in the midst of staffing changes and vacancies, these tasks have simply not been completed (J. Lassonde, personal communication, March 2, 2021). Not only does the institution not know where it stands, which is essential for planning and to mark progress, but it also has no clear process for how to manage data collection and calculations amid staff changes. Such data collection should be an integral part of several staff members' responsibilities, so it continues regardless of who holds a particular position.

As Jain et al. (2017) point out, no single person can work on, and understand, these types of efforts - collaboration among individuals and offices or departments fosters continued progress towards sustainability goals. At Mount Holyoke, the current system of data collection is too dependent on one staff member, the Director of Sustainability. Recent experiences with an extended vacancy in this position and a new hire helped reveal this significant dependence. Campus sustainability data collection relies on the Director of Sustainability as the single coordinator, so without this person's presence, most of the data are not gathered or sent to the MWCE. While a more automated system cannot be established overnight, steps can be taken to ensure environmental data is not solely reliant on direction by the Director of Sustainability. Other staff members within, and outside of, the MWCE should be informed and involved. Removing the need for a single person to coordinate this effort is paramount for its continued success.

Non-Academic Educational Initiatives

The curriculum parameter employed in this study does not incorporate or represent non-academic educational initiatives that occur on campus. Some examples of these initiatives, namely, energy and water use competitions, have been detailed for some colleges. These initiatives augment the traditional academic curriculum and an integral part of students' engagement in, and learning of, sustainability concepts. As of 2019, 90% of Mount Holyoke students were served by the College's peer-to-peer Eco-Reps educational program (Association for the Advancement of Sustainability in Higher Education, 2019-b). Since then, additional programs around diversity, equity, and inclusion in the environmental field as well as a Green Workplace Program have respectively served students and employees. It is recommended that these initiatives are continued and expanded upon to increase student, faculty, and staff awareness of, and involvement in, sustainability issues. The topic of Campus Engagement is a section of STARS reporting, which provides additional incentive for the College to further its efforts and receive associated points.

Sustainability Curriculum Data and Course Registration Improvements

At Mount Holyoke, curriculum and registration are great opportunities to improve practices for measuring progress and planning around curriculum-related sustainability goals. Mount Holyoke's curriculum data are currently not easily accessible, but there is significant potential for improvement. The Registrar's Office can remedy the lack of accessibility to some degree by adding to its categorization of course offerings as detailed below. As the literature of successful practices at institutions indicates, coordinated system-wide approaches to sustainability integrated into the institutional framework lends to increased success in truly becoming more sustainable and improving sustainability goals (Posner and Stuart, 2013). The

below initiative with the Registrar's Office loops the Office into this system-wide approach to sustainability.

The course-registration system, my.mountholyoke, uses tags indicating which courses count for the different Environmental Studies major requirements - humanities, natural science, and social science. This list is not exhaustive - in any given semester, only some of the many courses that count towards the Environmental Studies major are included in the system's tags (Appendix B). The lack of visibility and the inconsistency can lead to students not being aware of what classes they can take for the major and can also lead to student confusion. The Environmental Science tagged courses do not encompass all such sustainability-inclusive classes. There is also no tag for the Five College Certificate in Sustainability Studies, which defines sustainability more in line with the AASHE STARS definitions. This is a problem because students are not aware of the courses that count towards the certificate; this likely limits the number of students who attempt to achieve the certificate in the first place. Currently, students must cross-reference course offerings with an exhaustive list of courses across the Five Colleges. NEXUS programs, which are similar to Five College Certificates, do have such tags available for reference, while Five College Certificates do not. Any student, staff, or researcher attempting to find sustainability-aligned courses has to choose between going through a list of relevant keywords one-by-one to search courses on my.mountholyoke, writing out the short-listed courses, and reviewing the descriptions to ensure they meet the criteria and utilizing the incomplete list of Environmental Studies-counting courses.

The following contains four recommendations for Mount Holyoke's curriculum efforts relating to sustainability. The first is the addition of a sustainability tag, so those interested in sustainability-focused and/or sustainability-inclusive courses can easily find what they are

looking for. Currently, these tags are only accessible through some my.mountholyoke pages like the *Search for Classes* tab, but not through the Search and register for classes option under the *Registration* tab. In the author's experience, most students primarily utilize the latter option as it allows for direct compilation of a course to efficiently register once registration access opens. To make these tags more useful, the author would recommend the Registrar add the tag dropdown to the Search and register for classes option for students to more easily reference and select sustainability-focused and/or sustainability-inclusive courses. To expand the utilization and breadth of sustainability course offerings, the more accessible and centralized the process, the better.

Sustainability goes far beyond Environmental Studies and this small change helps three-fold - one, metrics around sustainability course offerings can be easily computed for year-by-year comparison, two, students can more easily find sustainability-focused and/or sustainability-inclusive courses of interest, and three, the College can earn AASHE STARS points for designating courses in its course catalog or listings. As more students show interest in sustainability by taking related courses, curriculum can expand to include more sustainability-focused and sustainability-inclusive courses, this means sustainability can be more integrated into the curriculum through a diverse range of departments. Without year-by-year comparison of the relevant course and department metrics, further initiatives cannot be developed or proposed as sound numerical support is required for development of institutional approval.

Secondly, to understand how many students are taking the sustainability-focused and sustainability-inclusive courses offered, the Registrar should account for students taking multiple sustainability-focused or sustainability-inclusive courses. This would provide a more accurate

count of those taking a sustainability-focused or sustainability-inclusive course by eliminating the possibility of double-counting. Such a measure would represent the true numbers of students exposed to sustainability concepts through coursework. This measure would partially remedy the previously discussed issue with using the percentage of departments with sustainability course offerings as a measure of sustainability exposure. Third, MHC could expand, or build, sustainability - environmental and otherwise - data collection into classes in departments like Statistics, Computer Science, and Economics. This is both a practical project to introduce students to sustainability and another avenue through which the institution can build proper data collection procedures into its infrastructure. Fourth, it is recommended that those compiling the list of sustainability-focused and sustainability-inclusive courses survey professors in addition to the methodology utilized in this study. This method, assuming a high response rate, would capture most relevant courses as the professors know exactly what the course will encompass. Basing decisions of whether to include or exclude a course in the list of sustainability-focused or sustainability-inclusive courses could be problematic. The aforementioned recommendations contribute to student involvement and awareness of sustainability, something the College should aspire to expand.

Additional Recommendations

In addition to the above recommendations, many of the technical decisions to reduce water and energy use as well as GHG emissions can be found in the College's roadmap to carbon neutrality. This roadmap was developed by an outside team of experts and is very detailed and prescriptive. The author largely refrained from making recommendations in these areas, preferring to leave this to the hired experts.

The one related recommendation concerns Mount Holyoke's solar panels, which are

capable of generating around 6% of the campus' annual energy use (Mount Holyoke College, n.d.-g). The College could benefit from these solar panels by exiting the current carbon lock-in agreement. The specifics of this agreement and thus, the feasibility, is not public at this time. Exiting the agreement would reduce the carbon footprint of on-campus energy generation as solar panels are considered a renewable energy source. This would also reduce the energy purchased for the campus, further reducing the College's GHG emissions.

The author also recommends MHC require First Year Seminar (FYSEM) courses, a requirement of all first year students, incorporate a unit on sustainability. Such incorporation would introduce students to concepts of sustainability early in their college careers,would give students a more diverse perspective on sustainability, and could increase the likelihood that they make personal choices favorable to sustainability on campus. For example, a FYSEM course focused on music in film could incorporate discussion of nature-esque soundtracks, introducing the importance of valuing and preserving nature as well as serving as a jumping off point for discussions of sustainability on campus and elsewhere.

The last recommendation is increasing emphasis on qualitative sustainability metrics. As was noted above, quantitative metrics are only part of the picture and should be utilized in tandem with qualitative metrics to achieve a more holistic picture of campus sustainability. At Mount Holyoke, continued focus on diversity, equity, and inclusion, especially in environmental fields, is important to broaden understanding and awareness around the definition of sustainability. The continuation of the MWCE's student employees working on diversity, equity, and inclusion is by the author's account, an important part of this continued focus. Without the inclusion of qualitative metrics, a critical component of true sustainability is excluded.

Conclusion

Climate change is one of the most pressing issues of our time. Institutions of higher education have a measurable impact on climate change and serve as role models, educational spaces, and experimental models in global sustainability efforts. This study employed a comparative case study approach among four colleges and across four metrics, water and energy use, GHG emissions, and curriculum. Hampshire College is the relatively most successful institution, and Amherst College the least, across the four sustainability metrics studied. Mount Holyoke and Smith Colleges fall right in between. While these findings appear clear, there are limitations with the available data available to represent the four different parameters. Some of the most prominent limitations are inclusion of outdoor energy and water use in the energy and water use parameters, sustainability education only being measured through curriculum and not also through non-academic exposure to sustainability concepts, and the omission of Scope 3 GHG emissions.

While Mount Holyoke consistently ranked in the middle of the four colleges studied on the study's parameters, its overall sustainability situation is somewhat of a mixed bag. On the positive side, the College has set a goal for carbon neutrality (Mount Holyoke College, 2019-b), has hired experts to set out actionable steps for now through 2037, and has the MWCE as a campus center focused on these initiatives. Among other things, it also has established and active student-led educational sustainability programs, and a wide range of faculty teaching sustainability-focused and sustainability-inclusive courses in close to half of all departments. On the negative side, the College has not established robust data collection practices, collaboration on sustainability initiatives and data is lacking, and the College relies too heavily on a few MWCE staff members. Mount Holyoke also has not integrated sustainability into the College's

governance or into the curriculum to the extent that it could.

To rectify some of these issues, recommendations were made with a particular focus on MHC's data collection procedures. The main recommendations were to take a coordinated and integrated collaborative approach, maintain accurate and current environmental data, standardize procedures and establish a centralized platform, delineate staff responsibilities to ensure continuity, employ non academic education initiatives, and improve sustainability curriculum data and course registration processes. While this study is limited to four institutions, a comparative case study approach can be employed by other institutions to reflect on, and improve, their own data collection and reporting methodologies. By extension, this would aid the institutions in achieving their own sustainability goals.

Reflection

As I embarked on the journey of researching and writing this thesis in the midst of a raging pandemic, I initially thought I could reasonably quantify the sustainability efforts at the four institutions I was about to study. I also thought the data I would find, especially that of Mount Holyoke, would be comprehensive, accurate, and relatively accessible. Just weeks into the study, I realized that not only was I encountering information that could not readily be quantified and thus relatively well compared, I also encountered lots of data that was incomplete, outdated, and, in some instances, even correct. While this was initially discouraging, even alarming, I soon realized I would learn just as much from my deadends and miscues as from my successes. For every door that I went through, five more opened up, and I had to decide which to go through and which to leave open for somebody else.

As someone who has been working on sustainability at Mount Holyoke College for several years, the most troubling and, yet rewarding, aspect of the project was seeing the great

need for improvements to Mount Holyoke's data collection processes. Having the opportunity to make recommendations thereon fills me with hope that these processes can, and will, be improved even though that will be after my time at Mount Holyoke. It also fills me with hope that MHC can, and will, reach its carbon neutrality of 2037. While I do not consider carbon neutrality the end all, be all, I hope Mount Holyoke uses it as a stepping stone and continues to further its sustainability efforts for generations to come. Mount Holyoke forever shall be!

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Appendix A

Detailed parameter values

Parameter	Institution	STARS Category	Value	Unit
water use	Amherst	potable water use per unit of floor area	22.74	Gallons per gross square foot of building space
water use	Hampshire	potable water use per unit of floor area	9.51	Gallons per gross square foot of building space
water use	Mount Holyoke	potable water use per unit of floor area	14.97	Gallons per gross square foot of building space
water use	Smith	potable water use per unit of floor area	14.08	Gallons per gross square foot of building space
energy use	Amherst	site energy (building energy consumption) per unit of floor area	0.14	MMBtu per gross square foot of building space
energy use	Hampshire	site energy (building energy consumption) per unit of floor area	0.08	MMBtu per gross square foot of building space
energy use	Mount Holyoke	site energy (building energy consumption) per unit of floor area	0.09	MMBtu per gross square foot of building space
energy use	Smith	site energy (building energy consumption) per unit of floor area	0.13	MMBtu per gross square foot of building space
energy use	Amherst	source energy per unit of floor area	0.19	MMBtu per gross square foot of building space
energy use	Hampshire	source energy per unit of floor area	0.14	MMBtu per gross square foot of building space
energy use	Mount Holyoke	source energy per unit of floor area	0.14	MMBtu per gross square foot of building space
energy use	Smith	source energy per unit of floor area	0.15	MMBtu per gross square foot of building space
energy use	Amherst	difference in source versus site energy per unit of floor area	0.05	MMBtu per gross square foot of building space
energy use	Hampshire	difference in source versus site energy per unit of floor area	0.06	MMBtu per gross square foot of building space

energy use	Mount Holyoke	difference in source versus site energy per unit of floor area	0.05	MMBtu per gross square foot of building space
energy use	Smith	difference in source versus site energy per unit of floor area	0.02	MMBtu per gross square foot of building space
greenhouse gas emissions	Amherst	adjusted Scope 1 & 2 GHG emissions per weighted campus user	8	Metric Tons of CO2e per weighted campus user
greenhouse gas emissions	Hampshire	adjusted Scope 1 & 2 GHG emissions per weighted campus user	2.2	Metric Tons of CO2e per weighted campus user
greenhouse gas emissions	Mount Holyoke	adjusted Scope 1 & 2 GHG emissions per weighted campus user	4	Metric Tons of CO2e per weighted campus user
greenhouse gas emissions	Smith	adjusted Scope 1 & 2 GHG emissions per weighted campus user	6.01	Metric Tons of CO2e per weighted campus user
curriculum	Amherst	percentage of courses that are sustainability course offerings	2.70%	-
curriculum	Hampshire	percentage of courses that are sustainability course offerings	13.35%	-
curriculum	Mount Holyoke	percentage of courses that are sustainability course offerings	10.07%	-
curriculum	Smith	percentage of courses that are sustainability course offerings	10.55%	-
curriculum	Amherst	percentage of academic departments with sustainability course offerings	32.14%	-
curriculum	Hampshire	percentage of academic departments with sustainability course offerings	100%	-
curriculum	Mount Holyoke	percentage of academic departments with sustainability course offerings	41.67%	-
curriculum	Smith	percentage of academic departments with sustainability course offerings	53.85%	-

Appendix B

Categorized list of MHC sustainability courses

ENVST-HUM: Environmental Studies - Humanities		
course number	**course name**	**module**
ARTST-280EA-01	Art and Environment	4
CST-249DD-01/HIST-280DD-01	Diversity,Inclusion,Democracy	2
CST-249HE-01/HIST-277-01	History of Energy	3
CST-349AN-01/ENGL-366-01/GNDST-333AN-01	Love/Sex/Death in Anthropocene	2
ENVST-240-01	The Value of Nature	4
HIST-332-01	Environmental History of China	1
ENVST-NS: Environmental Studies - Natural Science		
course number	**course name**	**module**
BIOL-200-01	Intro II: How Organisms Devel	3
BIOL-200-01	Intro II: How Organisms Devel	4
BIOL-223-01	Ecology	4
BIOL-223-01	Ecology	2
BIOL-226-01	Evolution:Mking Sense of Life	3
BIOL-226-01	Evolution:Mking Sense of Life	4
BIOL-315-01	Behavioral Ecology	1
BIOL-315-02	Behavioral Ecology	2
CHEM-202-01	Organic Chemistry I	3
CHEM-202-01	Organic Chemistry I	2
CHEM-202-02	Organic Chemistry I	3
CHEM-202-03	Organic Chemistry I	3
CHEM-202-04	Organic Chemistry I	4
CHEM-202-05	Organic Chemistry I	4
ENVST-200-01	Environmental Science	1
ENVST-200-02	Environmental Science	2
ENVST-233EP-01	Environmental Pollution	4
ENVST-316-01	Restoration Ecology	3
ENVST-316-02	Restoration Ecology	4
ENVST-321HC-01	Human Health & Climate Change	1
GEOL-240-01	Geological Resources/Environ.	4
GEOG-202-01	History of Earth	4
GEOG-205-01	Mapping and Spatial Analysis	3
GEOG-230-01	Environmental Soil Science	4
GEOL-201-01	Rocks & Minerals	2

GEOL-203-01	The Earth's Surface	1
GEOL-227-01	Groundwater Geology	3
GEOL-342PE-01	Plastics in the Environment	2
ENVST-SS: Environmental Studies - Social Science		
course number	**course name**	**module**
ENVST-210-01	Political Ecology	3
ENVST-210-01	Political Ecology	2
ENVST-241-01	Environmental Issues	3
GEOG-204-01	Human Dimens/Environ Change	1
GEOG-208-01	Global Movements	2
GEOG-210-01	GIS for Soc Sci & Humanities	1
GEOG-304UP-01	Planning & the Envir.: Urban	4
GEOG-313-01	Third World Development	2
GEOG-319-01	Africa: Problems/Prospects	4
Additional Courses from Searches		
course number	**course name**	**module**
ANTHR-316NC-01	Special Topics in Anthropology: 'Across Nature and Culture: Anthropology and the Environment'	4
ARCH-255ED-01	Intermediate Studies in Architecture: 'Environmental Principles'	2
ARCH-305UE-01	Advanced Topics in Architecture: 'Public Space and Everyday Life in Globalizing Spanish Cities"	4
ARTH-101-01	The Built Environment	4
BIOL-145TR-01	Introductory Biology: 'The Tree of Life'	1
BIOL-145TR-02	Introductory Biology: 'The Tree of Life'	1
BIOL-145TR-03	Introductory Biology: 'The Tree of Life'	1
BIOL-145TR-04	Introductory Biology: 'The Tree of Life'	2
BIOL-145TR-05	Introductory Biology: 'The Tree of Life'	2
BIOL-145TR-06	Introductory Biology: 'The Tree of Life'	2
BIOL-315-01	Behavior Ecology	1
BIOL-315-02	Behavior Ecology	2
ECON-213-01	Economic Development	3
ECON-219-01	Environmental Economics	3
ECON-219-02	Environmental Economics	4
ECON-349DE-01	Advanced Topics in Economics: 'Advanced Economic Development'	2
ECON-349DE-01	Advanced Topics in Economics: 'Advanced Economic Development'	2
ECON-349PE-01	Advanced Topics in Economics: 'International Political Economy'	3
ENGL-217CT-01	Topics in English: ' Globalization and the City'	4
ENVST-104-01	Renewable Energy	4

ENVST-150DV-01	Hist./Theories of Development	4
ENVST-150PH-01	Environmental & Public Health	3
ENVST-150PH-01	Environmental & Public Health	2
ENVST-181-01	Food Justice/Feeding 10 Bil.	1
ENVST-321EQ-01	Food Equity and Empowerment	2
ENVST-390-01	Senior Sem/Environ Studies	1
ENVST-390-02	Senior Sem/Environ Studies	2
FYSEM-110EQ-01	Disaster Science: Earthquakes, Floods, and Volcanoes	1
GEOG-105-01	World Regional Geography	3
GEOG-105-01	World Regional Geography	1
GEOG-107-01	Introduction to the Physical Environment	1
GEOG-202-01	Cities in a Global Context	4
GEOG-206-01	Political Geography	3
GEOG-320-01	Research with Geospatial Technologies	2
GEOL-103-01	Oceanography	4
GEOL-107-01	Environmental Geology	1
GEOL-133-01	Mass Extinction, Dinosaurs and Ecological Recovery	4
HIST-249-01	The Environment and South Asian Lifeworlds	4
HIST-332-01	Environmental History of China	1
LATST-250PB-01	The Politics of Borders	3
MUSIC-203-01	Acoustic Ecology and Sonic Art	3
MUSIC-203-01	Acoustic Ecology and Sonic Art	1
POLIT-232-01	Introduction to International Political Economy	4
POLIT-387PT-01	Advanced Topics in Politics: 'Planetary Politics'	3
PSYCH-359BP-01	Seminar in Biological Bases of Behavior: 'Development, Environment, and Brain Plasticity'	4
SOCI-316DG-01	Special Topics in Sociology: 'Sociology of Development and Globalization'	2

Appendix C

Departments with sustainability course offering(s)

MHC Departments	Offers sustainability course(s) (yes/no)?
Africana Studies	
Art & Art History	yes
Asian Studies	
Astronomy	
Biochemistry	
Biological Sciences	yes
Chemistry	yes
Classics & Italian	
Computer Science	
Critical Social Thought	yes
Dance	
Economics	yes
English	yes
Environmental Studies	yes
Film Media Theater	
French	
Gender Studies	yes
Geology & Geography	yes
German Studies	
History	yes
International Relations	
Jewish Studies	
Mathematics & Statistics	
Music	yes
Neuroscience & Behavior	
Nexus Program	
Philosophy	
Physical Education & Athletics	
Physics	
Politics	yes
Psychology & Education	yes
Religion	
Romance Languages & Cultures	
Russian & Eurasian Studies	

Sociology & Anthropology	yes
Spanish, Latina/o, and Latin American Studies	yes