Hot Topics
in Campus Energy
and Sustainability

Ivy+ Sustainability Collaborative

Report to Executive Leadership, Spring 2023
Including 30 campus sustainability programs across leading U.S. research institutions, this Collaborative embodies a shared objective to inform institutional strategic priorities through forecasting of emerging trends, best practices updates and collective impact data-reporting to executive leadership. This effort responds to an acknowledged need across higher education to better communicate critical updates to policy-makers and executive leadership who have the ability to influence institutional decisions and resource allocation.

This Collaborative represents an expansion of the original 14-member Ivy+ Sustainability Consortium (founded in 2004), to include additional leading research institutions with the capacity to provide rigorous data assessments and best practices reporting. The Ivy+ Sustainability Collaborative is unique among Ivy+ groups in its governance model, modest pooled financial resources, and a collective strategic planning framework that includes a priority to share learnings and scale impact broadly.
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Introduction

Top of mind for all leaders this past year were inflation and deepening political instability gripping the global economy. Given this context, including ongoing social and environmental challenges, higher education institutions are increasingly focused on strengthening decision-making processes and actions needed for long term resilience and stability. It is also becoming clear that demonstrating scalable energy, sustainability and decision-making solutions on our campuses requires leadership and alignment across both operational and academic administration. For example, if part of the core mission of our institutions is to influence the ability of our students to be effective leaders and be inspired by what is possible, then we must transform not only campus energy infrastructure but also the everyday campus experience. This whole-institution approach requires leadership alignment and clearly stated purpose.

Today’s decisions make a deep impression on our students and lock campuses into either fossil-based or renewable-energy-based infrastructure through at least the middle of this century, a critical deadline for avoiding the worst impacts of climate change. Strengthening storms and sudden cycles of drought and flooding, as seen in California in recent months, heighten the need for examples of tangible resiliency that our campuses can provide. In many cases, research institutions that have embraced applied strategies on their own campuses provide real-time knowhow with the potential to not only inspire our students but also to inform many communities around the world. On the global stage, a major breakthrough in climate aid came from the UNFCC’s COP27 this past December, when developed, wealthy nations agreed for the first time to establish a permanent Loss and Damage Fund for developing nations to help them combat the impacts of climate change and rising sea levels. While this effort begins to take shape on the international stage, the U.S. Congress passed the Inflation Reduction Act (IRA) which includes incentives for climate mitigation efforts that can be utilized by higher education. Many of our institutions are actively pursuing these opportunities to accelerate our collective transition to environmentally and socially just decarbonized operations, as one of the many ways we can demonstrate to future leaders, our students, what is possible in their own futures.

References
1. The Economist. 11 January 2023. What California’s deadly storms reveal about the state’s climate future.
Executive Summary

Ivy+ and Listening Post institutions continue to demonstrate actions needed to reduce greenhouse gas emissions immediately. Between 2005 and 2021, the average absolute greenhouse gas emissions of our institutions decreased by 23% (this average reduction is holding steady for the moment, but this Collaborative will continue monitoring). The primary methods used to achieve these reductions continue to be central plant efficiency & fuel switching, building efficiency & energy conservation, infrastructure conversions, renewable energy installations, and actions taken by our utilities to provide grid electricity from cleaner energy sources.

Nearly all of our institutions have emissions reduction goals; over 75% have specific plans for achieving carbon neutrality (up from 50% just in the past year), with target dates before 2050. Given the pace of global change, many Collaborative member institutions are actively investigating accelerating their target dates and some have already adopted new dates.

This past year Collaborative working groups began looking more extensively into Scope 3 (indirect) emissions, most notably those that result from the full life cycle of purchased goods and services. Higher education institutions, especially collectively, exert significant market influence through their contracts and purchases, and many of our institutions are beginning to develop Scope 3 accounting programs in the interest of stimulating sustainable product development. These actions also include the potential purchase of carbon offsets, which under rigorous standards can accelerate emission reductions beyond our campus communities. 30% of Collaborative members are purchasing carbon offsets, or plan to.

Justice, Equity, Diversity and Inclusion (JEDI) is emerging within the applied sustainability field and is contributing to our institutions’ racial justice initiatives, pushing the profession to be more inclusive in its staff-development and practices, and is amplifying alignments between sustainability work and environmental justice.

The report’s last section presents five case studies highlighting different financial models for campus modernization and decarbonization. These examples summarize the cases made to support investments in renewable and sustainable energy infrastructure.
Annual Update on Collective Greenhouse Gas Emissions

This section presents up-to-date institutional greenhouse gas (GHG) emissions data via rigorous and consistent methodology, curated by this Collaborative’s Data Collection and Learning Working Group. Results show both substantive collective progress as well as the range of diverse strategies employed. The charts below present data on Scope 1 and Scope 2 emissions resulting from direct use of fossil fuels and the indirect emissions from purchased utilities, respectively.

Prior to reviewing the figures below, please note that there are a number of caveats to the data presented. For example, these data and associated visualizations are not intended for cross-institutional comparisons. Instead, these data and accompanying visualizations should be used to reveal overarching trends in emissions reduction strategies and collective impact.

Nearly all of our institutions have emissions reduction goals; 79% have zero emissions goals, with a median goal year of 2041.

Greenhouse Gas Data Caveats

- The GHG data charts are intended only for internal use and may not be shared publicly.
- All data are self-reported by professional staff within institutions.
- Institutions have differing boundaries (e.g. leased spaces, health systems, and international campuses may or may not be included depending on how the boundary is defined), which could have a large impact on the magnitude of emissions reported.
- Institutions have differing emissions goals in terms of percent reduction, baseline year, and anticipated year in which the institution will meet its goal.
- Institutions reside in many different states, which means institutions purchase electricity from different regional grids. This means that one megawatt-hour (MWh) of electricity purchased at one institution could have larger emissions per MWh than another institution from another state.
- Institutions from different states have differing incentive programs as well as different climates, which impacts the amount of heating and cooling required to condition campus buildings.
- Some institutions report their data on a calendar year basis and other institutions report their data on a fiscal year basis.
- Any updates to institutional data, strategies or goals since March 2022 are not captured in this year’s report, but will be represented in the next.
GHG Emission Reductions to Date
(2021 reporting year)

Almost all participating institutions have set greenhouse gas reduction goals and achieved absolute reductions regardless of growth. Collectively, participating schools’ combined annual average emissions have decreased by 23% since 2005. Building efficiency and conservation has been the highest impact strategy, with an average emissions reduction of 31% among the 26 institutions that have employed it. 20% of participating institutions are currently employing offsets as part of their emissions reduction strategies.

Figure 1 shows by what percentage each institution has reduced its absolute Scope 1 and 2 emissions from a self-identified baseline year through 2021 and what reduction methods were employed. Figure 1 also shows each institutions’ emission reduction goal, which is represented by the dark gray dot. The range of years in parentheses represent institutional goal time frames. The prevalent methods used to meet the current level of reduction are central plant efficiency & fuel switching, building efficiency & conservation, and cleaner grids.
Planned GHG Emissions Reductions to Meet Future Goals

Figure 2 shows by what percentage each institution plans to reduce its Scope 1 and 2 emissions from a self-identified baseline year through its goal year, and the associated reduction methods. Figure 2 also shows each institution’s emissions reduction goal, represented by the dark gray dot. The range of years in parentheses represent institutions’ goal time frames. The main methods planned to meet the target reductions are central plant efficiency & fuel switching, building efficiency & conservation, and off-site renewable energy.

Off-site renewable energy is the highest impact strategy planned to date, with an average planned contribution to emissions reductions of 38% among the 21 schools who plan to employ it. Additionally, 30% of institutions plan to use offsets in some way in the future.

### Figure 2

<table>
<thead>
<tr>
<th>Institution</th>
<th>Planned Reductions</th>
<th>Goal Year</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10%</td>
<td>(2018-2046)</td>
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<tr>
<td>B</td>
<td>20%</td>
<td>(2019-2045)</td>
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<tr>
<td>C</td>
<td>30%</td>
<td>(2006-2030)</td>
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<td>D</td>
<td>40%</td>
<td>(2008-2035)</td>
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<td>E</td>
<td>50%</td>
<td>(2010-2020)</td>
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<td>F</td>
<td>60%</td>
<td>(2007-2024)</td>
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<td>70%</td>
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**Reduction Methods**

- Central Plant Efficiency & Fuel Switching
- Building Efficiency & Conservation
- Cleaner Grid
- Onsite Renewable Energy
- Offsite Renewable Energy
- Carbon Offsets
- Other & Unknown
- Unbundled RECS

**FOR INTERNAL USE ONLY**
Historical GHG Emissions, Gross Building Area, and GHG Intensity

Our institutions have achieved greenhouse gas reductions even while adding new, on-campus building space. Figure 3 shows Scope 1 and 2 greenhouse gas emissions in units of metric tons of carbon dioxide equivalent (MTCO₂e), gross area in units of square feet (ft²), and GHG emissions intensity (GHG emissions per area) in MTCO₂e/ft² between 2005 and 2021. In summary:

- Figure 3a shows that **average absolute emissions decreased by 23%**.
- Figure 3b shows that **average gross building area increased by 28%**.
- Figure 3c shows that **average GHG emissions intensity decreased by 42%**.

The performance across all institutions is represented as a moving average (the orange lines) of the two previous years, current year, and two subsequent years; for example, the 2007 value is the average of all schools’ data points between 2005-2009. The average is represented in this way to reduce the misleading appearance of large changes primarily associated with the lack of data in particular years; for example only 7 of 26 institutions reported data for 2005.

Since 2005, participating institutions decreased absolute emissions by 23% while gross building area increased by 28%.
2022-2023 Special Topic Briefs

Carbon Offsets Best Practices

Since 2021, a strong cohort of our Collaborative institutions have continued holding focused discussions on defensible approaches to using carbon offsets as part of carbon neutrality strategies. In 2022, Staff from the Duke Carbon Offsets Initiative led quarterly conversations including case studies from peer institutions. These discussions included climate justice as a priority consideration, internal air travel policies to reduce Scope 3 emissions, and an overview of airline neutrality goals and strategies. Beyond this, the nineteen participating institutions discussed internal goals and shared resources and ideas to advance rigorous standards for carbon offset selection.

Justice, Equity, Diversity and Inclusion (JEDI)

The Collaborative formed a Justice, Equity, Diversity, and Inclusion working group in the fall of 2020 in response to discussions at our summer 2020 Summit. In 2022, the JEDI working group developed an inventory of justice-related efforts across Collaborative institutions, identified best practices, and shared information back to campuses. The inventory evaluated published statements of support for justice issues, sustainability strategies that incorporate JEDI goals, JEDI hiring practices, collaborative programming with a JEDI focus, and more.

Fifteen institutions completed the inventory, with results reviewed at the Collaborative Summit at Harvard University in June 2022. The inventory establishes a preliminary baseline from which to assess future JEDI efforts across the Collaborative.

Roughly half of reporting institutions have active partnerships and strategies related to JEDI, with integration into sustainability and climate plans as well as day-to-day programs and practices.

Based on results from the inventory, the JEDI committee initiated new programming in 2022, starting with a “Coffee Chat” for Collaborative participants. The initial Coffee Chat focused on equity in hiring and retention within offices of sustainability.

External Links
1. https://sustainability.duke.edu/offsets

Among participating institutions, 20% are currently employing offsets as part of their emissions reduction strategies and 30% plan to use offsets in the future.
Scope 3 Emissions: Food

Reporting on and managing indirect Scope 3 emissions at our institutions is of increasing importance. The Collaborative’s Data Collection and Learning Working Group has historically led efforts to benchmark these emissions in categories like air travel and waste. After a preliminary exploration of institutions’ comprehensive purchased goods & services scope 3 emissions in 2020-21, the Working Group selected food-related emissions as a specific sub-category on which to focus in 2021-22 due to high potential for individual and collective food purchasing leverage, increasing student interest in sustainable food choices, and robust emissions data availability in the food industry.

Through this effort, the Working Group promoted a food data categorization tool developed by a Stanford student that significantly reduces the work associated with food-related emissions inventorying. Tool methodologies, lessons learned, and emissions reduction strategies were then shared via a webinar featuring representatives from Stanford, Harvard, and University of Virginia. This tool continues to be available to Collaborative members, and we encourage its use. Please contact your sustainability officer if interested in learning more.

Future focus areas will include Scope 3 emissions and embodied carbon associated with building materials.

Collaborative Climate Action Planning Survey (2022-2023)

Spearheaded by Johns Hopkins University, this survey captures actionable information from Collaborative members regarding greenhouse gas emissions reduction strategies. Of the 30 members, 23 responded to the survey.

Note that this detailed survey was conducted more recently than the standard annual data presented in the earlier section of this report. While the general trends are the same, some of the data points have shifted slightly given changes in institutional targets and strategies.

Key takeaways include:
• All respondents have a greenhouse gas reduction target
• Regardless of terminology used, all focus on direct campus-based emissions reductions as soon as possible as the primary strategy
• A strong emerging trend indicates institutions are expanding their inventories to include Scope 3, or, indirect emissions (encompassing procurement, for example)
• Carbon offsets are largely being considered for Scope 3 emissions and interim emissions while infrastructure conversions are underway
• National as well as state policies and regulatory contexts are increasingly supporting and accelerating greenhouse gas emissions reduction as an institutional priority for most Collaborative members

The full survey results are available as an addendum to this report.

An emerging trend indicates leading institutions are expanding their greenhouse gas inventories to include Scope 3, or, value chain emissions
Case Studies: Financial Models for Campus Modernization and Decarbonization

Executive Summary

Higher education is exceptionally well-positioned to demonstrate planning processes and on-the-ground strategies to influence sustainable practices and behaviors at all scales, from personal to global. Collectively, these sites accelerate the adoption of best practices while actively testing innovations that can help speed the transition from research to application. Importantly, the energy infrastructure conversion initiatives highlighted here illustrate defensible decision-making processes that include financial analyses in the context of core missions of service, research, and education.

These five campus examples summarize the cases made to support investments in sustainable energy infrastructure and renewable energy sources, given both institutional and global carbon reduction targets. Each institution describes the components of the analyses employed to better understand the full costs and benefits over time, to support informed decision-making. Many also include a proxy cost for carbon in their analyses, to value the damages associated with greenhouse gas emissions. Each also provides lessons learned from their processes, to inform future efforts.

Among the early adopters, these institutions often employed consultation partners to navigate the necessary new analyses, which also has served to strengthen the expertise among consultants that will benefit subsequent clients.

Common themes in the case studies are:
- Reaching net-zero will take years and transitional actions must start now
- Leadership buy-in is essential
- Institutions must be flexible in planning phases and willing to change course given new information
- Sustained advocacy is critical from the beginning and throughout the project lifecycle
- Cross-departmental commitment and engagement is required

We hope these case studies act as a springboard for institutions to accelerate infrastructure conversion solutions that embody service to people and the planet.
Case Study 1

Brown University: Infrastructure conversion underway to meet 2040 net-zero and decarbonization goal

Background
The only way to avoid the catastrophic effects of climate change is to cut greenhouse gas (GHG) emissions as quickly as possible. Brown can demonstrate that a large, complex institution can develop clear and realistic paths to net-zero emissions. Brown is committed to cutting its GHG gas emissions to net-zero by 2040 or sooner, with a 75% reduction by 2025. This effort will cost the university about $200 million, not including significant utility cost savings from virtual power purchase agreements (PPAs). It is the largest investment ever in University sustainability, and the work is well underway. Its roadmap of campus initiatives and financial plans include the following:

- Converting the central heat plant from 150 pounds per square inch (psi) of steam to pressurized hot water, building a more efficient heat plant, and preparing for the integration of electric heat pumps.
- Entering renewable energy power purchase agreements (PPAs) to offset 100% of campus usage through about 2027.
- Requiring all major renovations and new construction be net-zero or net-zero ready.
- Transitioning vehicles and grounds equipment to electric-powered.
- Purchasing destructed refrigerant offsets to meet the 2025 goal of 75% reduction (interim measure).
- Electrifying the central heat plant to complete campus decarbonization.

Infrastructure Conversion Process
In 2018 Brown University was nearing the achievement of its 2020 GHG gas goals. In response, President Paxson charged the Office of Sustainability, Facilities Management, and the Assistant Provost for Sustainability to develop a recommendation for Brown’s next GHG gas emissions commitment. A committee of staff, faculty, and students convened to work with consultants to develop operationally realistic and financially workable scenarios. The Corporation of Brown University approved the goals and capital expenditures estimate shown in figure #1. The goal to cut campus GHG emissions by 75% by 2025 and achieve net-zero no later than 2040 was based on infrastructure changes, rather than a heavy reliance on buying carbon offsets and other indirect measures.

Brown University is working now to secure renewable energy contracts to cover 100% of its electricity use.
Case Example – System Modification Plans

The original plan had four phases and a total estimated capital expenditure of $197M in today’s dollars ($322M escalated to the completion date of 2040). Also, the original plan envisioned an additional cost of $700,000/yr. to switch away from fossil fuel combustion and convert the Central Heating Plant (CHP) to run on recycled bio-oil. However, that approach was modified to include limited offset purchases, as noted below.

Phase 1: Renewable Electricity - Brown entered into contractual agreements to off-take renewable energy that will offset the electricity the university pulls from the grid. They expect electricity use to roughly double between now and 2040. Thus, the first round of PPAs will need to be supplemented in future years.

The university is now working to secure renewable energy contracts to cover 100% of its electricity use. To date, Brown has developed three solar and one wind project. It expects the utility savings from the solar projects in RI to be ~$87M and the income from the wind project to be ~$1.4M over the lifetime of the contract.

Phase 2: Interim Natural Gas Solutions – Brown’s Central Heating Plant (CHP) accounted for roughly 25% of total campus emissions in 2018. The university considered using renewable natural gas (RNG) to reduce its net emissions but found the cost and counterparty risk prohibitive. Instead, the university bought verified, additional, and permanent carbon offsets. The university must use offsets until the Central Heating Plant can be fully electrified and powered by emissions-free electricity.

Phase 3: Building Renovations - Concurrent with Phases 1 and 2, the university began an extensive retrofit for final electrification of campus heating by 2040. An electrified CHP will need to operate at much lower water distribution temperatures than it currently produces. Because of the lower water temperatures, the university must modify both the loop and buildings. Brown published a comprehensive plan for these modifications in 2020.

Phase 4: Electrification of the Central Heating Plant and all remaining fossil heating systems on campus. Renovation of buildings and the water distribution loop will allow electrification of the CHP (planned for 2038-2040). The university has not committed to a final design for the retrofit and is focusing instead on driving the temperature of distributed water as low as possible. This strategy ensures good heat source options in the future.

A sampling of comparative cash flow analyses are shown in figure #2. The cash flow summary in figure #3 indicates how project finances were structured. Additional funding was identified in the reallocation of previously budgeted funding (shown in red) to help finance decarbonization and cut the annual net expenditures.
Spring 2023 Hot Topics on Campus Energy and Sustainability

BROWN UNIVERSITY: FIGURE 2

Snapshot of Cash Flow Scenarios

<table>
<thead>
<tr>
<th>PROJECT PRIORITY</th>
<th>PROJECT TYPE &amp; DESCRIPTION</th>
<th>FY2021 PROJECT COST</th>
<th>CUMULATIVE FY2021 PROJECT COST ($)</th>
<th>STEADY</th>
<th>FAST</th>
<th>SLOW</th>
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<tr>
<td></td>
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<td></td>
<td>Projected Escalated Project Cost ($)</td>
<td>Cumulative Escalated Project Cost ($)</td>
<td>Projected Fiscal Year of Project Start</td>
<td>Cumulative Fiscal Year of Project Start</td>
<td>Projected Fiscal Year of Project Start</td>
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<td>FY 2022</td>
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<td>HX Grouping 3 (HX-12B, 16A, 35A)</td>
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<td>$6,100,000</td>
<td>FY 2025</td>
<td>FY 2025</td>
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</table>

BROWN UNIVERSITY: FIGURE 3

Snapshot of Expected Cash Flow

2040 DECARBONIZATION - ON LOOP BUILDINGS - EXPECTED

| Cash Flow for Campus Decarbonization Scopes 1 and 2 emissions only | FY2021 | FY2022 | FY2023 | FY2024 | FY2025 | FY2026 | FY2027 | FY2028 | FY2029 | FY2030 | FY2031 | FY2032 | FY2033 | FY2034 | FY2035 | FY2036 | FY2037 | FY2038 | FY2039 | FY2040 |
|-----------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| CAPITAL EXPENDITURES                                           |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Phase 2 Building Upgrades (FY20-40)                            | 106,900| 535    | 300    | 6,100  | 2,490  | 6,800  | 1,555  | 4,393  |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Phase 3 Electrical Feeder (FY39)                               | 25,600 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Phase 4 ASHP (FY40)                                            | 64,200 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| TOTAL                                                          | 196,700| 535    | 300    | 6,100  | 2,490  | 6,800  | 1,555  | 4,393  |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Total Escalated CAPEX                                          | 239,188|        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| ANNUAL NET CAPITAL EXPENDITURE FLOW                            |        | 535    | 300    | 6,100  | 2,490  | 6,800  | 1,555  | 4,393  |        |        |        |        |        |        |        |        |        |        |        |        |        |
| OPERATING EXPENSE / RENEWAL EXPENDITURE IMPACTS (REALLOCATION) |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Project Expiration Date                                       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Dry Bridge Electricity Savings                                 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Richmond Electricity Savings                                   |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Burrillville Electricity Savings                               |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Mesquite Star Wholesale PPA Income (5/25/2035)                  | $61    | $21    | $172   | $190   | $193   | $150   | $51    | $51    | $51    | $51    | $51    | $51    |        |        |        |        |        |        |        |        |        |        |
| ECI Project Funding Source                                     | $2,000 | $2,000 | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |        |
| Building Renewal Reduction                                     | $250   | $500   | $500   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   | $750   |
| Gifts                                                          | $0     | $0     | $126   | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     | $0     |
| Carbon Offsets (Off Loop Buildings)                           | $2,000 | $2,000 | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| NET OPERATING EXPENSE SAVINGS                                  | $3,061 | $3,271 | $2,477 | $2,007 | $6,457 | $3,750 | $4,161 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| NET TRANSFERRED TO PROJECT                                     | $4,477 | $4,048 | $6,457 | $3,750 | $4,161 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| ANNUAL NET EXPENDITURE FLOW                                    | -2,526 | -2,971 | $3,623 | $343   | $232   | -6,403 | -6,702 | $7,002 | -17,652|        |        |        |        |        |        |        |        |        |        |        |        |        |

Net Expenditure Flow ($000s)

| TOTAL 2020-2040 (CASH FLOW)         | $72,587 |
| FY2020-2025 (CASH FLOW)             | $(4,363) |
The university is funding decarbonization by reallocating funds from the Energy Conservation Project ($3M per year) and $1M per year of renewal. These allocations will end when building upgrades are completed in 2035. Additionally, the investment in the four renewable energy projects is expected to offset much of the capital expenditures and offset purchases. The three solar farms in RI are expected to be operational in 2022/2023, and savings associated with these projects will be realized as utility credits on Brown’s National Grid electric invoices. Once operational, Brown can expect ~$87M in savings through 2040 from these three solar projects. The Mesquite Star Texas wind farm is expected to bring an additional ~ $1.5M in income. However, the university realizes that decarbonization will not fully pay for itself, and additional funding mechanisms will be necessary to reach Brown’s goals.

Lessons Learned and Next Steps

1. Base goals on operational and financial models: Many institutions and organizations create goals without understanding the operational, technical and financial requirements to meet them. Beginning with scenario exercises before establishing a goal allowed Brown to set realistic objectives.

2. Schematic “visionary” plans can be surprisingly accurate: Brown worked with several consultants as it developed decarbonization goals. The broad scope and overall budget remained essentially unchanged, despite adjustments and improvements to the implementation plan. Working with a reliable partner, a university’s visioning plan can help get a process going. Start now, tweak later.

3. Divide and conquer: Planning and implementing reductions for Scope 1 and 2 emissions can be done in parallel by different teams. Brown had one consultant and an internal team to secure Scope 2 reduction assets while another team worked on the Roadmap for Scope 1 conversions.

4. Stay Flexible: When Brown realized that the planned Renewable Natural Gas (RNG) bridge conversion of the heat plant boilers to biofuel would offer no actual GHG reduction and would assume additional risk, a team investigated and secured high-quality offset alternatives. The university holds decarbonization summits to stay current and adjusts plans as needed.
Case Study 2

Stanford University: Stanford Energy Systems Innovations (SESI) Project

Background

From 1987 to 2015, Stanford University employed a district energy system. This system consisted of a gas-fired combined heat and power (CHP) central energy facility (CEF) and power, steam, and chilled water distribution systems to provide electricity, heating, and cooling to its buildings. Although efficient, its fossil-fuel-based source caused the CHP to produce 90% of Stanford's GHG emissions and consume 25% of the campus' potable water supply. As the cogeneration plant approached the end of its useful life, Stanford examined conversion to new options that assured reliability, contained cost, and reduced GHGs.

In 2009, an investigation of sustainable options to succeed the gas-fired cogeneration system uncovered a significant real-time overlap between heating and cooling. The study revealed that Stanford University could reuse 70% of the waste heat from the chilled water system to meet 93% of campus heating loads if they converted the heat distribution system from steam to hot water. In the same year, Stanford University released a comprehensive and long-range Energy and Climate Action plan to raise the bar in energy efficiency and the use of innovative, clean, and renewable energy supplies on campus. The plan included high-efficiency standards for new buildings; continued efficiency improvements for existing buildings; and the cutting-edge energy supply system known as the Stanford Energy System Innovations (SESI) project. SESI represents a transformation of university energy supply from a 100% fossil-fuel-based combined heat and power (CHP) plant to grid-sourced electricity and a more efficient electric heat recovery system. In 2011, Stanford's greenhouse gas (GHG) emissions peaked at 230,000 metric tons. This new system and Stanford's solar procurement reduce campus emissions approximately 68% below peak levels, saving 18% of campus potable water.

The university aims to end its Scope 1, 2, and 3 greenhouse gas emissions by 2050 with intermediate goals for emission reduction and 100% renewable electricity. Stanford achieved its goal of generating 100% of campus electricity needs from renewable sources when its second of two solar plants came online in March 2022. The university is on track to reduce direct greenhouse gas emissions associated with owned facilities and vehicles to 80% below peak levels by 2025.

Infrastructure Conversion Process

In setting the vision and principles, the Stanford Energy Systems Innovations (SESI) program integrated input and leadership from staff, students, and faculty. They also maintained regular communication with Stanford's Executive Cabinet and Board of Trustees. SESI prepared a GHG reduction options report in 2008 and presented it to the university administration. They held later reviews with more detailed analysis with the Board...
of Trustees in 2009, 2010, and throughout 2011. Two different faculty advisement committees participated during this inception phase of the project (President’s Blue Ribbon Task Force in 2008 and 2009 and Board of Trustees Energy Advisory Committee in 2010 and 2011). More than 25 faculty members and 100 students participated through student groups and departmental queries over the entire course of SESI planning and implementation.

After Trustee approval in 2011 and subsequent construction, the University completed steam conversion to hot water in 2015. In April 2015, the university began decommissioning the old cogeneration plant. At this time, Stanford also agreed with SunPower to build 78.5 MW of solar PV, with 5.5MW located on the Stanford campus.

Case Example

Stanford’s new Central Energy Facility (CEF) includes heat recovery chillers, thermal energy storage tanks, a high-voltage substation, and an advanced controls system patented by Stanford. The efficiencies gained from the new CEF and hot water conversion, along with Stanford’s commitment to get much of its electricity from solar, reduce the university’s GHG emissions by 68% from peak levels and saves 18% of campus potable water. With a net present value of $1.17 billion, a grid-powered central energy facility with heat recovery was the option with one of the lowest life-cycle costs (Figure 1). Although the capital investment was $485 million, which was among the lowest considered, this option will provide significant life cycle cost savings ranging from $43 million to $109 million over all the other base energy system options. The Department of Project Management managed the design and construction of 22 miles of hot-water pipe, the conversion of 155 buildings to receive hot water instead of steam, and the installation of the Central Energy Facility (CEF) and a new campus high-voltage substation. Stanford University sequenced this work in multiple phases to minimize disruption to campus life.

Lessons Learned

1. **Plan for contingencies.** We never know what the future holds—like more extreme weather and hotter days—so initiating a best use case from past temperature records is a good jumping-off point. Still, a reasonable margin of contingency is smarter and necessary. Often, the appeal to save money or the lack of financial backing can lead to undersizing equipment and square footage and obscuring an accurate forecast.

2. **Don’t make assumptions.** Have honest conversations with leadership about capital planning to ensure that the proposed infrastructure matches the forecasted campus growth rate. Think big—size for 30 years as opposed to 10 years.

3. **Never let a good crisis go to waste.** Learn from mistakes and leverage the situation to advocate for expansion, more resources, etc.

4. **Look ahead and consider making the infrastructure more reliable.** With the goal of eventually eliminating emergency diesel generators, Stanford is bound by technology and waiting for the development of better energy storage solutions.

External Links

### Comparative Cost, GHG, and Water Use of Energy Supply Options

Summary of comparative costs, carbon emissions, and water use across various energy generation options. Life-cycle cost decision criteria are shown in bars. The segments include: initial capital investment in red, operations and maintenance cost in blue, cost of purchasing electricity in purple, and cost of purchasing natural gas in yellow. Net present value (NPV) of each energy generation option is shown in the $ figure above the composite bars. Environmental attributes are shown in bubbles via total GHG and water use icons.
Case Study 3

California Institute of Technology: Decarbonization of the campus utility distribution system

Background

California Institute of Technology (Caltech) is an urban 125-acre campus in Pasadena, CA. The total building space is about 4.75 million square feet, with a total campus population of 5,800 students, staff, and faculty. Annual electricity consumption is 110 GWh, and the institution consumed 221 million gallons of water in fiscal year 2021.

Caltech has been engaged in energy efficiency projects for the past three decades, tracing back to the installation of a cogeneration system in the 1990s. This cogeneration system currently supplies 68% of overall campus electricity needs and has served as the backbone of a utility distribution system that supplies chilled water, steam, and electricity to a campus core of over 70 buildings with widely varying needs. These buildings house numerous complex mechanical systems and equipment with a mix of pneumatic and direct digital controls. Ventilation needs range from traditional office buildings to 24/7 laboratories with dozens of fume hoods and high plug load devices throughout the campus. Despite these intense demands, Caltech has positioned itself as a net exporter of electricity to the grid through the use of the campus cogeneration system, natural gas-powered fuel cells, and an onsite solar photovoltaic (PV) system.

Infrastructure Conversion Process

While this supply and distribution system has served Caltech well for the past few decades, future research needs, tightening regulatory pressures, and the need for modernization and resilience have pushed the institute to search for a new method of meeting heating needs and supplying the campus with electricity. An ideal future energy state would increase energy reliability, bolster campus resilience, and solve ongoing deferred maintenance issues.

In response to these increasing pressures and carbon emissions since 2011, Caltech initiated an energy resource planning study in 2015. This study allowed Caltech’s sustainability program to convene a committee of in-house experts, guided by consulting firm Customer First Renewables, to explore dozens of future energy supply scenarios. While this three-year process yielded a future scenario where Caltech would retire the cogeneration system in 2025, further exploration of the campus distribution system was warranted to understand the implications for electricity demand and heating needs. Caltech enlisted the help of consulting firm Affiliated Engineers, Inc. (AEI) to create a utility master plan, which identified current constraints and immediate needs for the electricity distribution and chilled water generation system. The utility master plan concluded that the current steam system is sufficient for current and near-term future needs but...
will preclude Caltech from reaching future carbon goals. AEI worked on a final thermal study in 2020 and 2021 to determine how Caltech might complete a campus conversion from steam to hot water while minimizing disruption to the campus. The phasing of the conversion, the cost of ownership, and resultant carbon reductions were detailed in the final report, which allowed Caltech Facilities Services and Planning to provide a complete picture to higher administration.

Case Example

The in-depth study of Caltech’s thermal system provided excellent clarity on Caltech’s campus levels of simultaneous heating and cooling. Despite the campus’s location in an arid climate, Caltech has significant waste heat available for recovery throughout all twelve months of the year due to precooling and reheating of air for humidification balance (Figure 1).

Caltech worked with AEI on a total cost of ownership analysis based on three scenarios: 1) the business as usual (BAU) scenario from the energy resource plan, 2) a future campus heating state with four heat-recovery chillers, and 3) an optional 2-million-gallon chilled water thermal energy storage addition. They analyzed these three scenarios for their electricity, gas, maintenance, and capital costs to create a 60-year total cost of ownership for each system (Figure 2).

A desire to reduce carbon emissions was a key factor throughout these investigations. With a new BAU scenario determined after the completion of the energy resource plan, Caltech would be able to realize a 43% cut in emissions compared to maintaining the cogeneration system. Further, converting the campus heating system from steam to hot water would provide a 70% emission cut compared to continuing with a steam-based heating system and cogeneration-based electricity (Figure 3).
Caltech Decarbonization via Steam to Hot Water Conversion - 60 Year Net Present Cost

Greenhouse Gas Emissions Projections
Lessons Learned and Next Steps

1. **Price of natural gas.** Natural gas prices are the critical variable for BAU costs, given the significant heating needs of the campus, even in the absence of a cogeneration system. Market changes in 2022 alone have tipped the balance and made the switch from steam to hot water cheaper over a 60-year timescale than the BAU scenario.

2. **Dedicated project manager.** The conversion from steam to hot water will take approximately ten years due to the number of buildings needing conversion and the requirement that normal campus operations be maintained as much as possible. A dedicated project manager for the entire conversion would be necessary to guide the project to completion.

3. **Additionality and clarity.** Collaboration with our local utility on an offsite renewables project will require a creative approach, given their status as a municipal utility. Additionality (the assurance that the investment is truly additive to infrastructure that would have been developed anyway) and a clear definition of the project will be critical factors for Caltech.

4. **Solving the entire challenge.** A switch from steam to hot water and using offsite renewable power for electricity will not solve the entirety of Caltech’s carbon challenges. However, it will allow for a more modernized campus that can more easily transition to net-zero in the 2030s or early 2040s.

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Market changes in 2022 alone have tipped the balance and made the switch from steam to hot water cheaper over a 60-year timescale than the BAU scenario.
Case Study 4
Princeton University: Infrastructure conversion now underway to meet 2046 net-zero goal

Background
Princeton University is actively responding to the emergency-status findings of the IPCC's sixth assessment report and other climate change and sustainability research by incorporating the search for solutions into its academic research agenda service mission, as well as in campus operations. For example, the university's Net-Zero America: Potential Pathways, Infrastructure, and Impacts report offers scenarios at an unprecedented level of granularity for the United States to reach net-zero emissions by 2050, and the university has committed to reaching net-zero in campus operations by 2046, the university's 300th anniversary, or sooner (Figure 1). Various campus initiatives currently establish the basis for achieving carbon neutrality, including the following:

- Full campus conversion from steam to hot water distribution system with geo-exchange wells, building a super-efficient heating and cooling system that will be fossil-fuel free once all electricity is sourced from renewables.
- Continued investment in energy efficiency improvements in buildings, including passive strategies (e.g., orienting buildings to optimize environmental conditions, solar shading), active strategies (e.g., equipment upgrades, building automation, heat recovery, reduced ventilation rates), and design strategies (more efficient use of space, layered land-use functions). Many of these strategies yield paybacks of less than ten years.
- Maximizing all opportunities for on-site solar photovoltaic installations, including rooftop, parking facility, and ground-mounted. At full build-out, on-site solar PV will deliver 19% of campus electricity needs.
- Acquiring electricity from renewable sources off-campus, such as solar PV and offshore wind.

Infrastructure Conversion Process
Setting the stage for later commitment to infrastructure conversion was a set of decision-making criteria developed by a faculty CO$_2$ Task Force, appointed by President Christopher Eisgruber.

Setting the stage for later commitment to infrastructure conversion was a set of decision-making criteria developed by a faculty CO$_2$ Task Force.
in 2015. This Task Force comprised world-renowned faculty in ethics, economics, ecology, energy and climate change fields and recommended the University apply the criteria to achieving carbon neutrality by 2046, the institution’s 300th Anniversary, or sooner. The criteria stressed the importance of early action and direct carbon emissions reduction. Subsequently, climate action planning was integrated across several formal processes, including Princeton’s current Campus Plan, Infrastructure Master Plan (IMP), and Capital Plan. A commitment to infrastructure conversion from steam to hot water with geo-exchange was a critical outcome of these planning efforts and complies with the early action and direct reduction criteria established by the Task Force. It is also important to note that climate action intersects a number of other sustainability areas, and implementation coordination across the comprehensive portfolio outlined in Princeton’s Sustainability Action Plan is one of the primary roles of its Office of Sustainability.

**Case Example**

The adoption of the plan to convert from steam to a heating hot water distribution system with geo-exchange wells required gaining institutional leadership support. In 2018, Facilities presented two different 30-year scenarios to Princeton’s Trustee Committee on Grounds and Buildings for campus energy evolution.

| PRINCETON UNIVERSITY: TABLE 1 |

**Princeton’s Early Cost Summary Analysis**  
*(does not represent final figures)*

<table>
<thead>
<tr>
<th>YEARS</th>
<th>CONTINUE CURRENT OPERATIONS</th>
<th>HEAT PUMP CHILLERS W/ GEOEXCHANGE</th>
<th>PREMIUM</th>
</tr>
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<tbody>
<tr>
<td>Project Costs</td>
<td>0-10</td>
<td>$184</td>
<td>$239</td>
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<tr>
<td>Operating Costs</td>
<td></td>
<td>$158</td>
<td>$144</td>
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<tr>
<td>Sub Total</td>
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<td>$342</td>
<td>$383</td>
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<tr>
<td>NPV Project Costs</td>
<td></td>
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<td>$167</td>
</tr>
<tr>
<td>NPV Operating</td>
<td></td>
<td>$117</td>
<td>$108</td>
</tr>
<tr>
<td>Project Costs</td>
<td>11-20</td>
<td>$48</td>
<td>$174</td>
</tr>
<tr>
<td>Operating Costs</td>
<td></td>
<td>$188</td>
<td>$142</td>
</tr>
<tr>
<td>Sub Total</td>
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<td>$316</td>
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<td>NPV Project Costs</td>
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<td>$75</td>
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<tr>
<td>NPV Operating</td>
<td></td>
<td>$84</td>
<td>$64</td>
</tr>
<tr>
<td>Project Costs</td>
<td>21-30</td>
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<td>$42</td>
</tr>
<tr>
<td>Operating Costs</td>
<td></td>
<td>$228</td>
<td>$151</td>
</tr>
<tr>
<td>Sub Total</td>
<td></td>
<td>$263</td>
<td>$193</td>
</tr>
<tr>
<td>NPV Project Costs</td>
<td></td>
<td>$9</td>
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<td>NPV Operating</td>
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<tr>
<td><strong>TOTAL COSTS 0-30</strong></td>
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<td>$892</td>
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<tr>
<td><strong>TOTAL NET PRESENT VALUE 0-30</strong></td>
<td></td>
<td>$409</td>
<td>$468</td>
</tr>
</tbody>
</table>

The total net present value (NPV) for years 0-30 is an estimated $59M more for the low-carbon option. The cost over 30 years includes a $45/MTCO₂ e proxy carbon price to account for the social, ecological, and economic costs of continuing current operations (CCO). The low-carbon option achieves net-zero by 2046 or sooner. Updated proxy carbon price at Princeton is now $228/MTCO₂ e, based on a more regionally accurate calculation methodology, which would today result in an even more favorable analysis.
In the continuing current operations (CCO) scenario, outlined in Table 1, Facilities would maintain the present-day heating and cooling system and extend central steam and chilled water service to all new buildings, requiring an expansion of the current natural gas fueled cogeneration plant. Ground source heat pumps would continue to be a small contributor to the energy portfolio. Implementing this scenario, Princeton University would emit more than 135,000 metric tons of carbon in 2046.

The low-carbon scenario would incorporate all-electric heat pump chillers with geo-exchange and thermal storage, enabling facilities to replace fossil-fuel generated steam with hot water and also provide cooling to the campus. Hundreds of geo-exchange wells drilled to 850 ft would take advantage of the subsurface rock to store heat during warmer seasons and extract it during colder ones. This conversion would establish a more resilient, easier to maintain, system that is potentially fossil-free once all electricity is sourced from renewables.

Lifecycle cost analysis, inclusive of a proxy carbon price ($45 per metric ton at the time of analysis), was used to evaluate strategies by considering full

Heat pump chillers with geoexchange (blue wedge) would emit approx. 50,000 metric tons less carbon in 2046 than the CCO strategy. The university will reduce emissions further by using renewable and low-carbon energy sources both on and off campus (green wedge), and by leveraging the future greening of the regional utility grid. Remaining solutions (orange wedge) may include a combination of biofuels and other strategies.
costs and benefits over time, rather than strictly the first costs. In Princeton’s case, replacing the aging steam infrastructure with a modern, fossil-free ready system, was only marginally more expensive over time than maintaining and expanding the existing infrastructure. Princeton’s newly adopted proxy carbon price of $228/metric ton of CO$_2$e, calculated based on real regional market cost of renewable electricity, would have made the conversion cost calculation even more attractive. The shift also avoided future risks inherent with investing in fossil-fuel based systems, and aligned with the University’s research, teaching and service mission.

Princeton’s scenario-based financial analyses were driven by a commitment to net-zero emissions and included a proxy price for carbon. Taking the necessary time to develop and review scenarios with leadership led to executive level support. The Princeton University campus is now among the first sites in the nation to combine these technologies at a campus-wide scale.

In Princeton’s case, replacing the aging steam infrastructure with a modern, fossil-free ready system, was only marginally more expensive over time than maintaining and expanding the existing infrastructure.

Lessons Learned and Next Steps

1. **Set a clear target.** The work of Facilities, the Office of Sustainability, executive leaders, and the faculty CO$_2$ Task Force set the stage for all subsequent climate action planning at Princeton. Setting targets spurs commitment and is a significant first step.

2. **Implement research-informed, data-driven responses.** An in-depth study, supported by faculty input, provided the analyses for supporting decisions about energy systems investments. As more institutions delve into their own analyses, the outcomes will serve to inform policy and decision-making on a much broader scale.

3. **Integrate planning processes.** There are significant benefits to integrating sustainability and infrastructure planning into strategic and capital planning processes, followed by implementation strategies embedded in institutional design and construction standards and processes. Princeton has also found it effective to establish an advocacy committee to assure that its broad goals are being applied at the project scale in a coordinated way.

4. **The time to start is now.** Society will be “stuck” with infrastructure choices made by today’s decision-makers. This is the critical moment to leverage leadership influence to assure that the infrastructure we invest in today is effective in supporting climate justice, human and planetary health.

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External Links

1. [https://netzeroamerica.princeton.edu/](https://netzeroamerica.princeton.edu/)
Case Study 5

Smith College: District energy system conversion under construction to meet 2030 carbon neutrality goal

Background

Smith College has been committed to addressing climate change since signing the Climate Leadership Commitment in 2007. This commitment is evident in the Report of the Study Group on Climate Change, a strategic plan that proposed a set of institutional responses that have been completed or are underway. These include:

- a substantial divestment of fossil fuel from endowment investments,
- a commitment to hiring faculty with climate change as an aspect of their research,
- the completion of a themed campus "Year on Climate Change",
- a commitment to experimentation with a carbon proxy price for capital investments, and
- electrification of the campus district energy system and contracting for renewable electricity.

The Geothermal Campus Energy Project is the subject of this case study. Importantly, Smith advanced this project while adhering to our principle that climate actions holistically integrate the academic mission, operations, and finances. The Geothermal Campus Energy Project integrated faculty and student research on topics including carbon pricing, the future use of battery power, and college and university policy approaches to carbon neutrality.

District Energy Planning Process

Smith completed two planning phases for the Geothermal Energy Project, beginning with a 2017 conceptual study showing that conversion from steam to low-temperature hot water (120F-130F) for heating distribution is an essential first step to lowering CO₂ emissions from district energy.

Lowering distribution temperature will enable Smith to exploit the 20% of hours of the year in which the campus demands simultaneous heating and cooling.
The study highlighted 1) the significant efficiency of eliminating high pressure steam heat distribution, and 2) that lowering distribution temperature will enable Smith to exploit the 20% of hours of the year in which the campus demands simultaneous heating and cooling (Figure 1). The conceptual study also proposed a 4-pipe system (separate heating loop and cooling loop rather than a single ambient loop system) to best leverage these efficiency opportunities.

The second phase of planning was the District Energy Master Plan completed in 2020, which included a life-cycle cost analysis (LCCA) to compare the proposed system design to a "business as usual" approach (Figure 2). Creation of the LCCA clarified the financial impact of the proposed plan and demonstrated typically non-financial considerations. For example, Smith's proxy carbon price was included (Figure 2 below) to quantify the future potential cost of regulated CO$_2$ emissions, and the social cost of Smith's emissions. In addition, the LCCA provided a mechanism through which to compare the programmatic benefits associated with an improved system (e.g., the implementation of the proposed design will provide central air conditioning to an additional 20 buildings on the Smith campus). This will provide the college with additional climate resiliency, programmatic flexibility, and a better experience for students. We showed the addition of air conditioning in the comparison by adding the expected cost to 20 buildings in the "business as usual" case. Finally, Massachusetts will provide significant incentive payments for heat-pump based technology, which were subtracted from the "commodities" component of the future case.
Approval Process

The Geothermal Campus Energy Project represents the single largest capital investment in Smith College's history. There are more complex policy implications, project finances (with a payback), and technical details than with a single building. College leadership and trustees would need to understand and be comfortable with this complexity in order to approve the project.

Smith's president convened a District Energy Working Group (DEWG) to address this challenge. The DEWG included three members of the Board, three faculty, three administrators and two students. The membership of this group reflected the college's integrated approach to campus sustainability. The DEWG engaged faculty members whose research and teaching has included aspects of policy, technology, and economics associated with the system design. These faculty had been engaged (through the Center for the Environment, Ecological Design and Sustainability) for years and currently have active research with students, including two student members of the DEWG.

A pivotal component of the DEWG process was trustee engagement that included three “Deep Dive” sessions on policy, technology, and finances. The first two sessions were presented by faculty and their students. This helped to reduce the knowledge gap associated with the project, and highlighted ways in which the project was deeply aligned with research and education.

Lessons Learned

1. **Keep your design teams focused.** Conversion from steam to hot water was the most important aspect for Smith College because 90% of our CO₂ emissions are associated with buildings on the district system. We had to direct consultants to work that problem ONLY, and away from other sources of GHG emissions such as transportation.
2. Start your LCCA early and keep it up to date as you progress through the project. Detailed life-cycle cost analysis helped us isolate direct financial benefits as well as significant indirect benefits e.g., added air-conditioning, reducing future regulatory risk and the social cost of CO$_2$ emissions.

3. Focus on the “enabling infrastructure”. We are aiming to move our infrastructure systems to be consistent with a zero-carbon world in the future; but we are not insisting on that today. We targeted a 90% CO$_2$ reduction from geothermal. We will do this by using electricity (heat pumps), but we will continue to use fossil fuel for peak heating requirements. This is because our buildings are not yet fully ready for low-temperature heating and attempting to do so added significantly to the cost. We will get to zero through the regular process of upgrading campus buildings.

4. Take a disciplined approach to building renovation. Building renovation is the most expensive aspect of our project (more than drilling wells or building the new heating and cooling plants or new distribution. We have attempted to apply three disciplines in this area. First, by aligning deferred maintenance building renovations projects to the project where possible. Where this is not possible, we are staying focused on mechanical renovation where this is applicable, and avoiding allowing other improvements to creep into project scope. Third, lowering the temperature of building circulation heat will suggest that some buildings will need mechanical renovation. We are attempting to be conservative in our approach to these buildings erring on the side of not renovating these mechanical systems, instead opting for air-sealing and localized repairs, possibly local circulation temperature increases to resolve any heating issues in the medium term.

5. Add a construction manager to the design team early to clarify cost and smooth project execution.

6. Clarify the timeline up front. We requested Board approval for the entire six-year project, even though we only initially needed approval for Phase 1. We wanted to know that our Board understood the full scope of the investment to ensure success at full build.

7. Involve relevant students and faculty in board education and decision-making processes.

External Links
3. https://www.smith.edu/about-smith/ycc
5. https://smithgeoenergy.info/
7. https://smithgeoenergy.info/
Addendum

Climate Action Planning Survey (full report)
Introduction

In the Fall of 2022, a survey was distributed to the Ivy+ Sustainability Collaborative to gather information on trends in climate action planning among participating universities. The intent of the survey was to build on years of quantitative greenhouse gas (GHG) emissions tracking and benchmarking with qualitative information on a range of broader climate action planning topics. Acknowledging that climate action planning is an increasingly complex and strategic priority for universities, survey results provide a more detailed understanding of each institution's commitments, progress towards stated goals, scopes and terminologies utilized, planning approaches, internal stakeholder coordination, and the regulatory and institutional contexts motivating those decisions.

Survey responses demonstrated emerging trends among participating institutions, as well as unique approaches to goal setting, planning, and implementation. Notable takeaways include that all responding institutions have set at least one GHG reduction goal, and many have reached or updated their goal as part of their evolving climate action strategies. Although there is a lack of standardization among institutional GHG commitments and scopes, the primary focus for institutions is reducing on-site fossil fuel use and emissions sources between now and 2050, whether framed as “carbon neutrality”, “net-zero”, “fossil-fuel free”, or another term. Similarly, while the main focus of emissions reductions are on scope 1 (on-site) and 2 (purchased utility) sources, institutions are expanding their emissions inventories to include new sources aligned with national and global reporting standards, such as leased spaces and certain scope 3 emissions categories. The results of the survey also highlight the role of carbon offsets in short- and long-term carbon commitments.

A new factor that was explored through this assessment is the regional context for state and city goals, and legislation that is influencing university decision-making. A majority of Ivy+ Sustainability Collaborative universities find themselves in states and cities that have adopted their own climate action commitments with implications for higher education institutions. These range from voluntary alignment on carbon reductions, mandated requirements for GHG and energy reporting, as well as legislation requiring emissions reductions and energy efficiency performance among large building owners.

The results of this survey strongly demonstrate the prioritization that Ivy+ Sustainability Collaborative institutions are placing on climate action as a high priority organizational strategy, the increasingly complex factors that are considered in planning and decision-making, and insights about strategic alignment across institutions.

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Survey Results

A. Climate Action Goal-Setting and Scopes

Schools have ambitious climate action strategies, and many are acting proactively, setting new interim goals, accelerating their commitments, and expanding beyond scope 1&2 sources.

All but one university responded that they have set an initial greenhouse gas (GHG) reduction goal, and 13 of 23 respondents reported that they have set an initial goal and updated it at least once. Of the 23 respondents, 16 universities have also set interim targets on the pathway to achieving a long-term goal, demonstrating an inclination towards progress and accountability.

Figure 1 below shows each respondent's GHG reduction goal by time and terminology. Results show there are a wide variety of terms used to describe emission reduction goals. "Carbon neutrality" is the most common term used, followed by "Net-Zero" and "Fossil Fuel Free." Among the respondents in the Other- "Zero" category, two universities report a goal of "zero actual" or "actual zero" emissions. The universities in the Other- "Reduction" category set emission reduction goals to a certain level below their baseline year.

Through a cursory review of each university's climate action commitment websites and publications (see Appendix 1), terminology often varies even within a single institution, indicating a need for greater consistency and clarity in communications.

**FIGURE 1**

GHG reduction goals by year and terminology

REDUCTION METHODS

- **Carbon Neutrality**
- **Net-Zero**
- **Fossil Fuel Free**
- **Other-"Zero"**
- **Other-"Reduction"**
Survey results show that scope 1 and 2 GHG emissions sources remain the primary focus of carbon reduction goals. Whereas scope 3 (value chain) GHG emissions, as well as emissions from leased spaces and hospital/health systems are less commonly reported (as shown in Figure 2). Scope 3 emissions have been growing in importance among universities, with more frequent mentions on sustainability websites and publications. Figure 3 shows the frequency of specific scope 3 emissions categories included in reduction commitments across 23 Collaborative respondents—the most common being business travel and employee commuting, which aligns with Second Nature’s Presidents’ Climate Leadership Commitment.¹

### FIGURE 2

**Emission categories additional to Scopes 1 and 2 included in reduction commitments**

<table>
<thead>
<tr>
<th>EMISSIONS</th>
<th>Included</th>
<th>Not Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope 3</td>
<td>35%</td>
<td>65%</td>
</tr>
<tr>
<td>Leased Spaces</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>Hospitals/Health Systems</td>
<td>10%</td>
<td>90%</td>
</tr>
</tbody>
</table>

### FIGURE 3

**Frequency of Scope 3 categories included in reduction commitments**

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Travel</td>
<td>9</td>
</tr>
<tr>
<td>Employee Commuting</td>
<td>8</td>
</tr>
<tr>
<td>Waste Generated in Operations</td>
<td>7</td>
</tr>
<tr>
<td>Fuel- or Energy-Related Activities</td>
<td>6</td>
</tr>
<tr>
<td>Upstream Transportation &amp; Distribution</td>
<td>4</td>
</tr>
<tr>
<td>Upstream Leased Assets</td>
<td>3</td>
</tr>
<tr>
<td>Purchased Goods &amp; Services</td>
<td>3</td>
</tr>
<tr>
<td>Investments</td>
<td>2</td>
</tr>
<tr>
<td>Downstream Leased Assets</td>
<td>2</td>
</tr>
<tr>
<td>Capital Goods</td>
<td>2</td>
</tr>
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</table>
B. Climate Action Planning and Evaluation

Most schools engaged in extensive planning processes before setting climate action goals, conducting costing analyses and developing energy master plans. A majority have worked with consulting firms to develop plans aligned with industry standards and best-practices.

Table 1 shows what plans and studies Ivy+ Sustainability Collaborative universities have completed as part of their processes to develop GHG reduction goals. Most universities conducted costing scenarios, followed by hiring firms for planning studies and developing an energy master plan. Nearly half of respondents completed all three actions polled, while only two respondents did not engage in any of these actions at their institutions.

Additionally, **15 of 23 respondents** have begun engaging in climate resilience planning. Of those integrating climate resilience into their planning, many are increasingly collaborating with community stakeholders and integrating resilience in emergency management, building standards, and landscape practices. Three respondents have begun developing an institutional resilience plan.

### TABLE 1

<table>
<thead>
<tr>
<th>INSTITUTION</th>
<th>CONDUCTING COSTING SCENARIOS</th>
<th>HIRING FIRMS FOR PLANNING STUDIES</th>
<th>DEVELOPING AN ENERGY MASTER PLAN</th>
<th>NONE OF THE ABOVE</th>
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<td>✓</td>
<td></td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>D</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>J</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>K</td>
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<td>L</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>O</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>✓</td>
<td></td>
<td></td>
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<td>S</td>
<td>✓</td>
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</tr>
<tr>
<td>T</td>
<td>✓</td>
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<td></td>
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<td></td>
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</tr>
<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Z</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Addendum: Climate Action Planning Survey (full report)**
C. Carbon Offsets

Currently, only 10 of 23 universities have formally decided to include carbon offsets in their reduction strategies, however another 8 are currently undecided or working to have offsets approved as part of their plan.

Overall, 18 of 23 universities have taken some action to inform their carbon offset assessment process including financial evaluations, development of sourcing criteria, and/or evaluations of specific projects, while only 4 universities responded that they explicitly were not using offsets. Of the 10 universities currently including offsets in their plan, 8 are already purchasing them and a majority are counting offsets towards their scope 1 and 2 emissions.

Additionally, several schools specify that carbon offsets are a second priority to actual emissions reduction strategies. Three respondents that indicated they were purchasing offsets responded that the offsets are to be used as an interim bridge strategy or last-case option to meet reduction goals. These respondents specify that their universities’ prioritization is electrification and/or renewable power sources.

![Figure 4](image-url)

Proportions of universities’ carbon offset purchasing (2022)
D. Regional Climate Action

The universities surveyed are largely ahead of local climate commitments in terms of goals, strategic planning, and progress.

While many respondent universities are located in states with GHG emission reduction goals, there is a lag in climate action commitments at the state level compared to that of universities. 19 of 23 respondents are in states with climate action commitments, while all 23 respondents are in cities with GHG reduction commitments. Of those universities, 7 are directly impacted by local regulations requiring action from building owners. These regulations include energy efficiency requirements, updated building codes, and mandated GHG and/or energy reporting.

FIGURE 5

Locations of respondent universities overlaid on map of US states with emission regulations, as of August 2022
E. Institutional Strategic Alignment

Sustainability is trending towards becoming a core component of university strategic plans, and sustainability offices are increasingly collaborating with central communications teams and development offices as part of their climate action strategy.

In addition to including climate action in their strategic plans, universities have demonstrated institutional alignment by partnering with their communications and development offices. 18 of 23 universities have institutional communications regularly promoting climate goals and progress, with over a third of universities responding that their communications office is a key strategic partner, as shown in Figure 6. The involvement of universities’ development offices in support of their climate action plan remain limited in most schools. Very few development offices are described as proactive, while others are described as reactive if involved at all. Nearly two-thirds of responding universities report that their development office is not generally involved in raising support from funders for their climate action efforts.

11 of 23 respondents include their climate action commitment in their university's strategic plan.

References
1. https://secondnature.org/mission/
goal
Conclusion

Universities in the Ivy+ Sustainability Collaborative are at varying stages of development in their climate action commitments and progress, but all are working on university-wide carbon reduction goals. Most, but not all respondents, have committed to reducing their emissions to net-zero carbon, and there is an increasing emphasis on technical studies and implementation planning to support these priorities. Additionally, schools are expanding the specificity and scopes of their planning efforts to include areas such as climate resilience in addition to mitigation, scope 3 emissions, and rigorous criteria for carbon offsets—while more institutions are finding their climate action commitments integrated into their university strategic plans.

Universities are also being influenced by regional factors such as state- and city-level carbon reduction goals, and in a growing number of instances are responding to legislative requirements for reporting and performance outcomes related to emissions and energy use. Community collaboration is also occurring in planning and preparedness for climate risk and resilience.

While all respondents are working towards significant carbon reduction outcomes, terminologies and definitions still vary. Standardization of GHG reduction terminologies and clearly communicated definitions of terms may provide an opportunity to better clarify the intent of each institution’s goals to a wide array of audiences and to strengthen alignment around goal-setting best practices.
### Appendix 1: Additional information

<table>
<thead>
<tr>
<th>INSTITUTION</th>
<th>PRIMARY GHG REDUCTION GOAL</th>
<th>SCOPES INCLUDED</th>
<th>HOSPITALS LEASED SPACE</th>
<th>CARBON OFFSETS</th>
<th>ENGAGED CONSULTING FIRMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Net-zero by 2040</td>
<td>X</td>
<td>X</td>
<td>“Very minimal and only interim solution until full electrification”</td>
<td>EcoSystems</td>
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<tr>
<td>B</td>
<td>Carbon neutrality by 2045</td>
<td>X</td>
<td>No</td>
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<td>Affiliated Engineers, Inc. Customer First Renewables</td>
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<td>C</td>
<td>Net-zero by 2050</td>
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<td>X</td>
<td>Yes</td>
<td>Energy Strategies</td>
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<td>D</td>
<td>Carbon neutral by 2035</td>
<td>X</td>
<td>X</td>
<td>&quot;Mandates offsets be used as a last-case scenario[...]&quot;</td>
<td>Affiliated Engineers, Inc.</td>
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<tr>
<td>F</td>
<td>Carbon neutral by 2024</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
<td>AEI Engineering, Inc</td>
</tr>
<tr>
<td>J</td>
<td>Fossil Fuel Free by 2050</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Atelier Ten Arup</td>
</tr>
<tr>
<td>K</td>
<td>51% GHG reduction compared to 2008 baseline by 2025</td>
<td>X</td>
<td>No</td>
<td>Integral Group</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Carbon neutral by 2040</td>
<td>X</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Net-zero by 2046 with no offsets</td>
<td>X</td>
<td></td>
<td>“Still studying [if] any available markets are defensible and impactful [...]”</td>
<td>Atelier10 Burns &amp; McDonnell VHB</td>
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<tr>
<td>Q</td>
<td>Net-zero by 2050</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Undetermined</td>
</tr>
<tr>
<td>R</td>
<td>Carbon neutral by 2050</td>
<td>X</td>
<td></td>
<td></td>
<td>Undetermined</td>
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<tr>
<td>S</td>
<td>Reduce absolute emissions by 50% by 2030</td>
<td>X</td>
<td></td>
<td>“Considering a vPPA and verifiable offsets”</td>
<td>GBA Edison Energy</td>
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<tr>
<td>T</td>
<td>Carbon neutral by 2050</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>No</td>
</tr>
<tr>
<td>U</td>
<td>Reduce emissions from purchased power to net-zero by 2025. Eliminate direct, on-campus greenhouse gas emissions by 2040.</td>
<td>X</td>
<td>X</td>
<td>Undetermined</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Carbon neutral by 2042</td>
<td>X</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Carbon neutral by 2025</td>
<td>X</td>
<td></td>
<td>Yes</td>
<td>Glumac P2S Arup</td>
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<tr>
<td>X</td>
<td>Carbon neutral by 2030 and fossil fuel-free by 2050</td>
<td>X</td>
<td>X</td>
<td>Undetermined</td>
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<tr>
<td>Y</td>
<td>Working on setting an initial GHG goal</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Z</td>
<td>Carbon neutral by 2050</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
<td>Atelier10 HDR</td>
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<tr>
<td>AA</td>
<td>Carbon neutral by 2040</td>
<td>X</td>
<td></td>
<td></td>
<td>&quot;Potential VPPA&quot;</td>
</tr>
<tr>
<td>AB</td>
<td>Reduce emissions to 1990 levels by 2020</td>
<td>X</td>
<td></td>
<td>&quot;Currently proposing to include offsets and awaiting leadership feedback on new target&quot;</td>
<td>McClure Engineering Salas O'Brien Affiliated Engineers, Inc. Bernhard</td>
</tr>
<tr>
<td>AC</td>
<td>Zero actual carbon emissions by 2050</td>
<td>X</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

**FOR INTERNAL USE ONLY**
Selection of Upcoming Activities and Acknowledgements

Special Topic and Best Practices Webinars offered by the Collaborative

APRIL 2023
Webinar focused on higher education opportunities related to the Inflation Reduction Act (IRA)

MAY 2023
Listening Post Spring Meeting:
Summary of this report will be presented

Ivy+ Facilities Leadership Spring Meeting:
Collaborative members will present on embodied carbon of building materials

Available Resources
A companion presentation to this report is available on request to executive leadership at member institutions. Workshops and webinars are also available on request.

Acknowledgements
Special thanks go to Vivian Fuhrman, PhD, Assistant Director for External Partnerships, Andlinger Center for Energy and the Environment, Princeton University, for her partnership and skilled compilation of the case studies featured in this report. Report layout and design by Kelsey Armstrong.

Sustainability Collaborative Summits:

JUNE 2023
JANUARY 2024

Collaborative Working Groups:

HIGH FUNCTIONING GOVERNANCE
LEADERSHIP GUIDANCE & ADVOCACY
DATA COLLECTION & LEARNING
BRIDGE BUILDING
JUSTICE, EQUITY, DIVERSITY & INCLUSION (JEDI)
CARBON OFFSETS

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