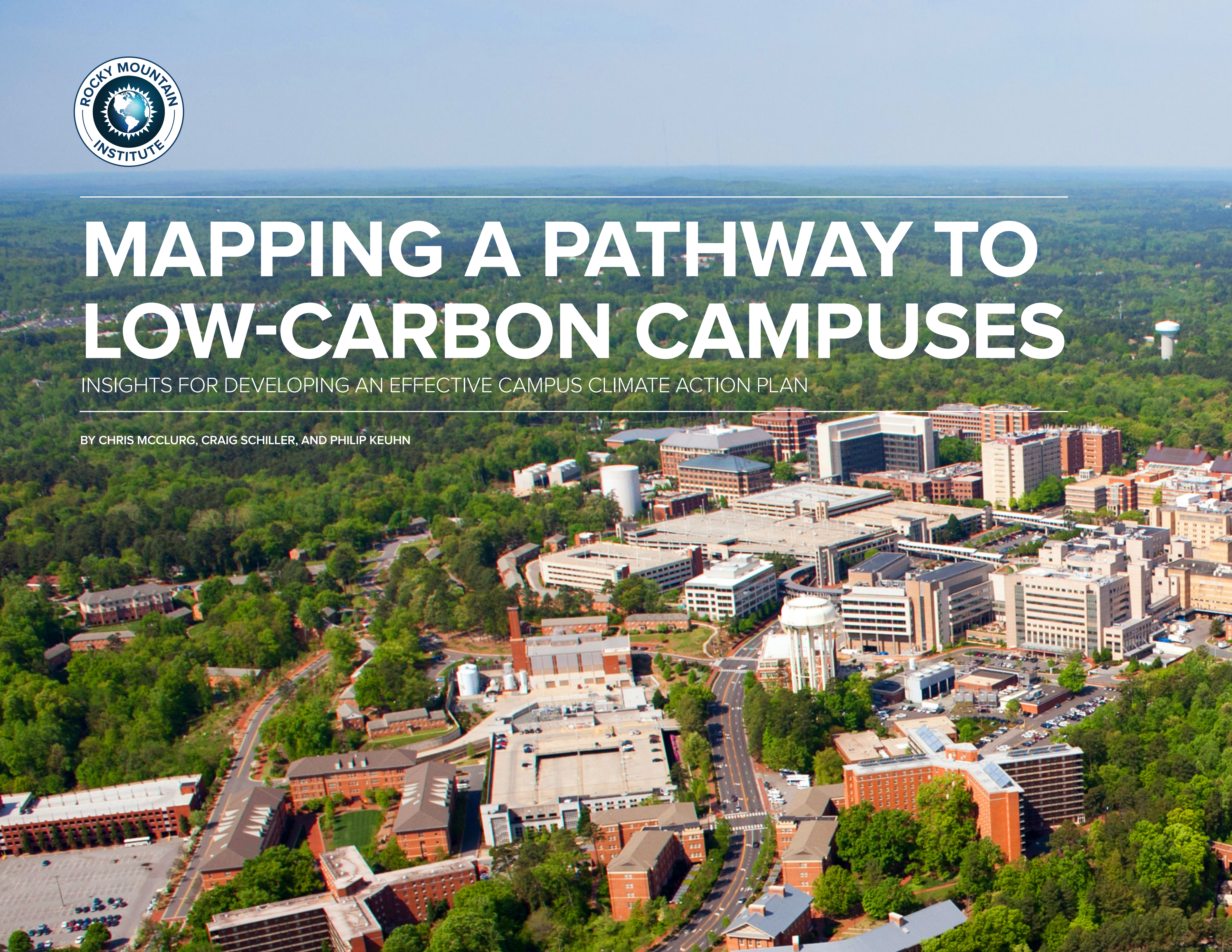

MAPPING A PATHWAY TO LOW-CARBON CAMPUSES

INSIGHTS FOR DEVELOPING AN EFFECTIVE CAMPUS CLIMATE ACTION PLAN

BY CHRIS MCCLURG, CRAIG SCHILLER, AND PHILIP KEUHN

INSIGHTS FOR DEVELOPING AN EFFECTIVE CAMPUS CLIMATE ACTION PLAN

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About Rocky Mountain Institute

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. In 2014, RMI merged with Carbon War Room (CWR), whose business-led market interventions advance a low-carbon economy. The combined organization has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

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INTRODUCTION

INTRODUCTION

Rocky Mountain Institute (RMI), an independent and nonpartisan nonprofit, has driven the efficient and restorative use of resources for more than three decades with a heavy emphasis on integrative design.

Over the last few years, RMI has partnered with universities to develop aggressive carbon-reduction/neutrality plans and to share best practices associated with energy efficiency and renewable energy across organizations.[1] Through these engagements, we have gathered insights on how to approach a climate action plan, as well as common pitfalls. The insights provided illustrate ways to **innovate** beyond business-as-usual practices. Depending on current campus policies and organizational structures, several of the insights may not be feasible to implement on day one, but can be built into the climate action plan to be phased in over time. If barriers to implementing these innovations exist, case studies are provided to demonstrate how they can be overcome and provide resources for doing that.

This guide does not aim to provide step-by-step instructions for developing a climate action plan, but instead **highlights best practices and insights to maximize the impact and feasibility of a plan.**

The RMI logo indicates case studies in which RMI was directly involved.

For guidance on the full process of developing a climate action plan, see:

- The Association for the Advancement of Sustainability in Higher Education's (AASHE's) Cool Campus! A How-To Guide for College and University Climate Action Planning
- American College & University Presidents' Climate Commitment's (ACUPCC's) Implementation Guide
- U.S. Green Building Council's (USGBC's) Road Map to a Green Campus (broader sustainability)

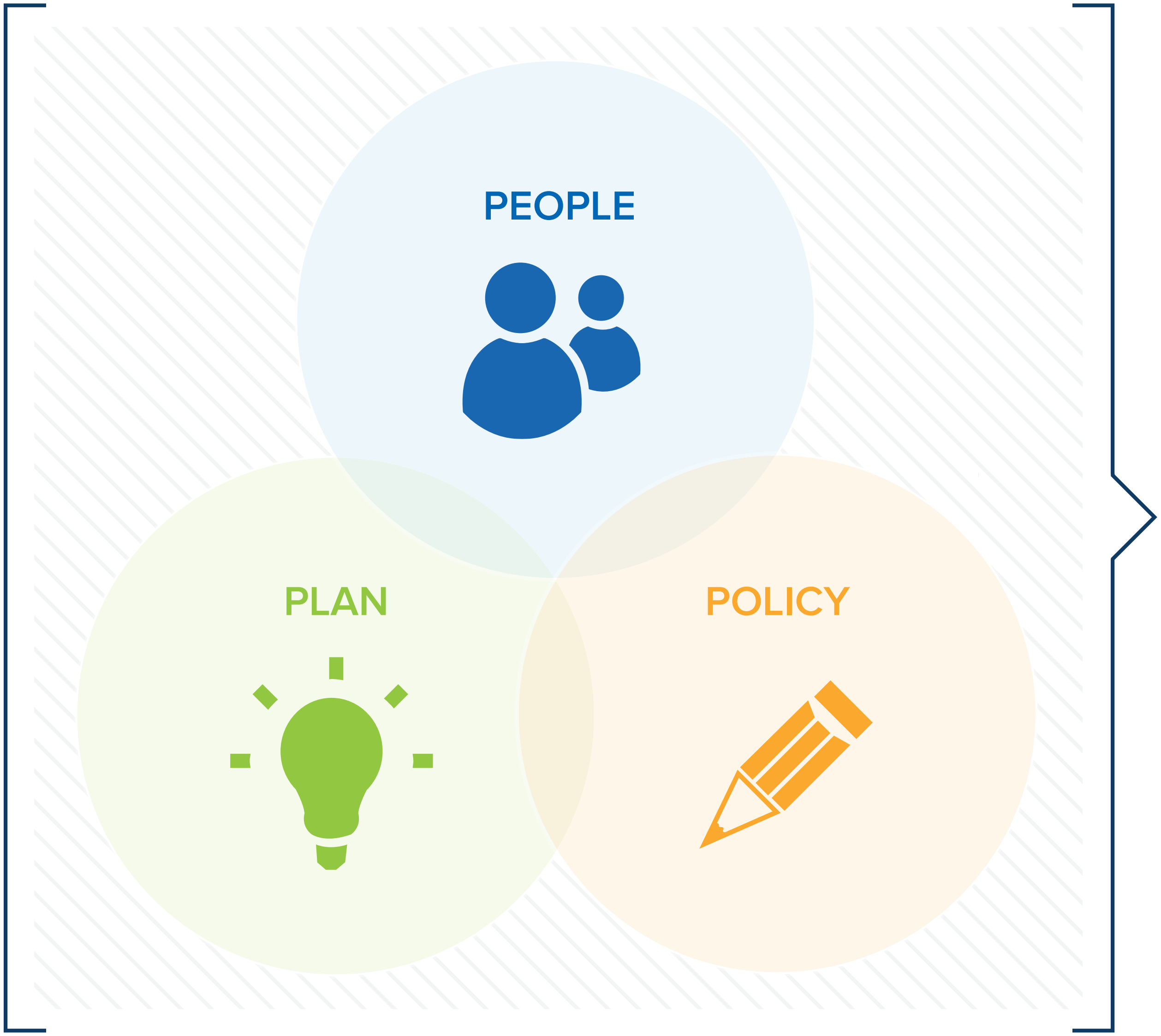
Figure 1 illustrates how these best practices and insights can be broken into three major categories: people, policy, and plan. Each of the bullets listed in the figure will be addressed in more detail throughout the guide. The discussion of each insight is broken into four subcategories: concept, case study, implementation, and resources. Many additional case studies focused on campus carbon-reduction projects are available.

A few of the many sources available for additional case studies include:

- AASHE's STARS Annual Review 2015
- AASHE's Online Hub
- Driving Energy Efficiency Through Higher Education Collaboration
- USGBC's Center for Green Schools

[1] OVER THE LAST FEW YEARS, RMI HAS PARTNERED WITH ARIZONA STATE UNIVERSITY AND THE UNIVERSITY OF BRITISH COLUMBIA TO DEVELOP AGGRESSIVE CARBON-REDUCTION/NEUTRALITY PLANS. RMI HAS ALSO JOINED LEADING UNIVERSITIES SUCH AS HARVARD, UC DAVIS, AND UT AUSTIN TO SHARE BEST PRACTICES ASSOCIATED WITH ENERGY EFFICIENCY AND RENEWABLE ENERGY ACROSS ORGANIZATIONS.

Figure 1: **Key Climate Action Plan Development and Implementation Insights**



PEOPLE

- Assembling a Highly Effective Team
- Actively Cultivate Internal Support
- Invest in Resources to Meet the Campus's Evolving Needs
- Structure Meetings to Promote Innovation

POLICY

- Define the Investment Decision-Making Process
- Standardize & Strengthen Contracts

PLAN

- Develop Baselines
- Define Metrics
- Weigh Possible Renewable-Energy Technologies & Contracts
- Plan & Implement Portfolio-Wide Projects, Not Just Building-by-Building Projects
- Increase the Pace & Accuracy of Plan Development through Iteration
- Reduce Loads to Reduce Equipment Capacity
- Capitalize on Planned Maintenance & Incremental Costs

Table 1: **From Insight to Action (part 1)**

INSIGHT	ACTION ITEMS
People	
Assembling a Highly Effective Team	1. Map out key skill sets to develop and implement the Climate Action Plan and identifiy potential resources to be added to the team that can provide each skill set (pg 14). 2. Explore potential partnerships with external organizations, such as research, industry, utiltiies, and nonprofits (pg 15).
Actively Cultivate Internal Support	1. Characterize key stakeholders using a power and interest matrix (pg 19). 2. Identify and align Climate Action Plan with stakeholder goals and ensure deliverables have a clear stakeholder audience identified (pg 20).
Invest in Resources to Meet the Campus's Evolving Needs	1. Evaluate current operational resource and knowledge gaps, especially those associated with the more complex controls and HVAC systems present in many new high-performance buildings. Investigate alternative technical or training options for meeting this need (pg 22). 2. Investigate automated ongoing commissioning solutions.
Structure Meetings to Promote Innovation	1. Collect a tool set of faciliation techniques for team meetings that promote divergent thinking and creativity. Consider hiring an outside facilitator with experience in this area (pg 26). 2. Use conceptual building-energy modeling and other high-level analyses to steer early design conversations (pg 27).
Policy	
Define the Investment Decision-Making Process	1. Work with decision makers to establish project economic evaluation methodology and thresholds that allows carbon reduction projects to be evaluated using the same criteria as other campus investments, ideally life cycle cost analysis (LCCA) (pg. 31). 2. Develop a life cycle cost-analysis calculator or leverage existing LCCA software (pg 32).
Standardize & Strengthen Contracts	1. Identify department(s) on campus that control or impact requests for proposals and contracts. Evaluate RFPs and contract language from the point of view of developing the climate action plan as well as from the point of view of executing projects within the plan (pg 38). 2. Expand RFPs to include performance targets and required processes such as energy modeling and life cycle cost analysis (pg 39). 3. Consider leveraging a contract structure for implementing projects that include rewards for energy performance (pg 39).

Table 1: **From Insight to Action (part 2)**

Plan	
Develop Baselines	1) Project business-as-usual energy consumption, cost, and carbon emmissions into the future reltative to the timeline of the carbon action plan. In addition to current energy performance, consider campus growth projections and energy cost escalations (pg 44). 2) Ensure baseline captures all energy consumption and carbon emissions within the scope of the plan, such as transportation systems and street lighting (pg 45). 3) Characterize fuel streams to ensure carbon emission factors are appropriately calcuated. For instance, if electricity is generated in a central plant on campus, the carbon emissions will likely vary when compared to electricity purchased from the grid (pg 46).
Weigh Possible Renewable-Energy Technologies & Contracts	1) Evaluate renewable energy credits, on-site renewable generation, and off-site renewable energy contracts (pg 48). 2) Calculate renewable energy economics in a way that they can be directly compared with energy efficiency projects to ensure the most cost effective path to carbon reduction can be identified (pg48).
Plan & Implement Portfolio-Wide Projects, Not Just Building-by-Building Projects	1) Identify low-cost and high-economic-return carbon-reduction measures that can be installed in a large number of buildings throughout campus. Use the kick start carbon-reduction measures to capture early savings, develop momentum for the plan, and collect information for future carbon-reduction measures while in the buildings (pg 55). 2) Develop a plan that allows buildings to achieve a "deep retrofit over time" (pg 56).
Increase the Pace & Accuracy of Plan Development through Iteration	1) Spend less time upfront developing a climate action plan, but establish feedback loops to continuously learn from projects and refine the plan (pg 58). 2) Strategically collect and analyze data to avoid "data-analysis paralysis." If individual buildings are to be benchmarked, move through this process quickly (pg 61).
Reduce Loads to Reduce Equipment Capacity	1) Consider the cost benefits of central plant-capacity reductions when evaluating building energy efficiency projects (pg 64). 2) Address any department silos that prevent system-wide optimization due to split incentives (pg 65).
Capitalize on Planned Maintenance & Incremental Costs	1) Identify planned projects that will impact building occupancy and align energy efficiency projects to minimize impact to occupants (pg 68). 2) Develop an asset database and map estimated end-of-useful-life of equipment across the campus to identify and schedule projects that can leverage incremental cost for energy efficiency improvements (pg 70).

SC

SCOPE

SCOPE

This guide focuses on the development of a climate action plan, shown as the "Develop plan" step in Figure 2. Due to the iterative nature of RMI's approach, the other three steps are touched upon in this document but the primary focus is developing the plan. A prerequisite is garnering support and approval for developing and implementing a plan. If this has not yet occurred, refer to Accelerating Campus Climate Initiatives, a guide developed by RMI in 2010, for additional resources.

Figure 2: **High-level Timeline for Climate Action Plan**

1 DEVELOP SUPPORT AND APPROVAL → 2 **DEVELOP PLAN** → 3 IMPLEMENT PLAN → 4 ENSURE PERSISTENCE

With over 4,500 campuses in the United States alone, we recognize there are a wide variety of organizations structures, policies, and motivations that must be navigated. Some of our insights and suggestions may be particularly relevant to campuses seeking to innovate beyond conventional approaches—which universities are well positioned to do as higher-learning institutions—but we believe most of these concepts will be useful to campuses regardless of their level of ambition, size of endowment, or carbon footprint.

Not all of the insights fit cleanly into one of the three categories illustrated in Figure 1; some insights may bridge all three. One commonality of all of the insights is that they are much more impactful when implemented as early in the process as possible. Additionally, synergies can be captured between the insights.

PEOPLE

PEOPLE

This first category of insights addresses how people impact the development of a climate action plan and recommends ways to facilitate success. The section touches on a broad set of topics, including assembling a team, engaging with stakeholders, making sure campus facilities staff has the correct skill sets as building systems are modified per the climate action plan, and processes that can help the team innovate.

01 ASSEMBLING A HIGHLY EFFECTIVE TEAM

ASSEMBLING A HIGHLY EFFECTIVE TEAM

CONCEPT

Assembling a highly effective team is not a novel concept, but taking shortcuts during this phase is a common misstep when developing and executing a climate action plan. Taking the time to assemble an enthusiastic, comprehensive, and deeply knowledgeable team will constantly pay dividends down the road. A crucial element of this is to clearly map out the goals, requirements, skills, critical stakeholders, and resources needed for each aspect of a climate action plan so the right team can be assembled to accomplish it.

Just as important as member selection is the dynamic of the team, which is critical to the success of the project. Much has been written on this subject, so we will not try to capture best practices in this guide.

The following are two case studies illustrating successful partnerships:

CASE STUDY 1

In April 2013, President Obama sounded a call to action by establishing "Grand Challenges," ambitious yet achievable goals to solve our biggest societal issues. In response, the University of California Los Angeles (UCLA) launched one of the most aspirational campus-municipality partnerships in the country. The Sustainable LA Grand Challenge Project is a collaborative effort between the City of Los Angeles and UCLA dedicated to achieving 100% sustainability in water, energy, and biodiversity within the city by 2050.

With 150 faculty and researchers, as well as 30 departments, currently committed to the challenge, UCLA has assembled one of the largest and most diverse action teams in higher education. To coordinate and organize the ambitious endeavor, UCLA is creating action plans from four interdisciplinary research committees on energy, water, biodiversity, and spatial and discipline integration (which focuses on integrating the other three teams). These action plans, when completed, will establish research priorities, required funding, and knowledge gaps. Then, the individual action plans will be aggregated into a holistic road map establishing the next steps over the next few years. In addition, a robust project team was established early on, consisting of executive directors, project and program directors, research chancellors, and student and public-relations officers, to ensure the success of the project's planning phase.

CASE STUDY 2

Colorado State University (CSU) doesn't have a dedicated sustainability office, as some other colleges and universities do. Rather, an interdepartmental and interdisciplinary committee was formed to help achieve the university president's progressive sustainability goals. The President's Sustainability Committee (PSC) was formed by several passionate staff members and, after obtaining senior buy-in, is reporting directly to the vice president of operations. An energy engineer, campus energy coordinator, and sustainability director were among the original committee members who helped implement a green revolving fund, LED-lighting retrofits, and a 20-year power purchase agreement. One of the keys to the success of the PSC's projects was the addition of a full-time retrocommissioning engineer, who works with Controls Tech to identify and fix no-cost/low-cost problems in buildings. By adding enthusiastic staff to the committee that fill established needs, CSU achieved its goal and, in March 2015, became the first school to achieve a Sustainability Tracking, Assessment & Rating System's (STARS) Platinum Rating from the Association for the Advancement of Sustainability in Higher Education.

IMPLEMENTATION

Map key skill sets required to successfully develop and implement a climate action plan and select and recruit core team members who have these skill sets or ensure the core team has access to people with these skill sets. Table 2 provides examples of key skill sets.

Table 2: **Examples of Key Skill Sets Required to Develop and Implement a Climate Action Plan**

SKILL SET	POTENTIAL RESOURCES	PROJECT IMPLEMENTATION EXAMPLES
Building energy and efficiency analysis	Facility managers, building operators, energy consultants, professors, students, manufacturers and installers of energy efficiency measures, ESCOs	Creating and calibrating building energy models, performing energy audits
Economic evaluation	Consultants, professors, students, finance and business departments	Performing project life cycle-cost analysis
Financing	Consultants, professors, banks or financial institutions, investment-management divisions, campus finance and business departments	Characterizing potential project financing options, facilitating implementation of project financing
Renewable-energy technologies and contract structures	Consultants, professors, nonprofits, renewable-energy providers	Evaluating potential renewable-energy projects or contracts, establishing an economic threshold for energy-efficiency projects
Knowledge of campus buildings and systems, such as a central plant	Facility managers, facility engineers, department heads and staff, service providers	Highlighting opportunities for improvement and potential energy-conservation measures, collecting asset and operating data, ensuring persistence of energy savings
Project costs	Procurement departments, consultants, service providers	Providing cost estimates to be used in evaluating the economics of projects
Campus policies and procedures	Chancellor's offices, department heads, campus master planning departments, architectural committees, building construction and facilities departments, transportation departments	Characterizing existing campus policies, helping refine policies when required
Transportation systems	Parking and transportation services, municipal transportation services	Providing inputs to estimate carbon impact from transportation systems, exploring alternative options for carbon reductions
Campus enrollment information and growth projections	Chancellor's offices, Dean's offices	Providing inputs to develop carbon-emissions estimates for future years

Table 2 includes several service providers as examples of potential resources, such as manufactures and installers of energy-efficiency measures, energy service companies (ESCOs), banks, and renewable-energy providers. Although service providers regularly provide invaluable insight and information for projects, it should be noted that it is best practice to have a third-party hired directly by the campus to provide neutral evaluation.

Additionally, there may be opportunities for partnerships with organizations with goals that align with the campus's goals. Partnering with external organizations can also help overcome internal barriers, such as limited expertise and funding. These partnerships can open opportunities for additional funding streams and knowledge bases. Examples of potential partners are provided in Table 3.

Table 3: **Examples of Potential Partnerships**

Through our project work we have observed these best practices:

- Use your internal resources early and extensively, but keep the team as slim and focused as you can to allow decisions to be made quickly. Pull in experts as needed during the process to ensure you have the full spectrum of skill sets required.
- Before hiring external consultants, clearly define their scope of work and document this in the contract very specifically. This is beneficial for all parties to ensure deliverables are focused and time and money are used most effectively.

Resources:

- AASHE: Discussion on assigning clear roles and responsibilities among team members
- Accelerating Campus Climate Initiatives Structure Meetings to Promote Innovation
- http://renewables.morris.umn.edu/ (excerpt from a longer discussion in Accelerating Campus Climate Initiatives)

02 ACTIVELY CULTIVATE INTERNAL SUPPORT

ACTIVELY CULTIVATE INTERNAL SUPPORT

CONCEPT

Teams looking to successfully implement a climate action plan must identify, engage, and actively cultivate the support of key stakeholders. A stakeholder may be an individual or organization with a vested interest in the climate action plan, a potential hurdle or advocate, or a key decision maker.

CASE STUDY 1

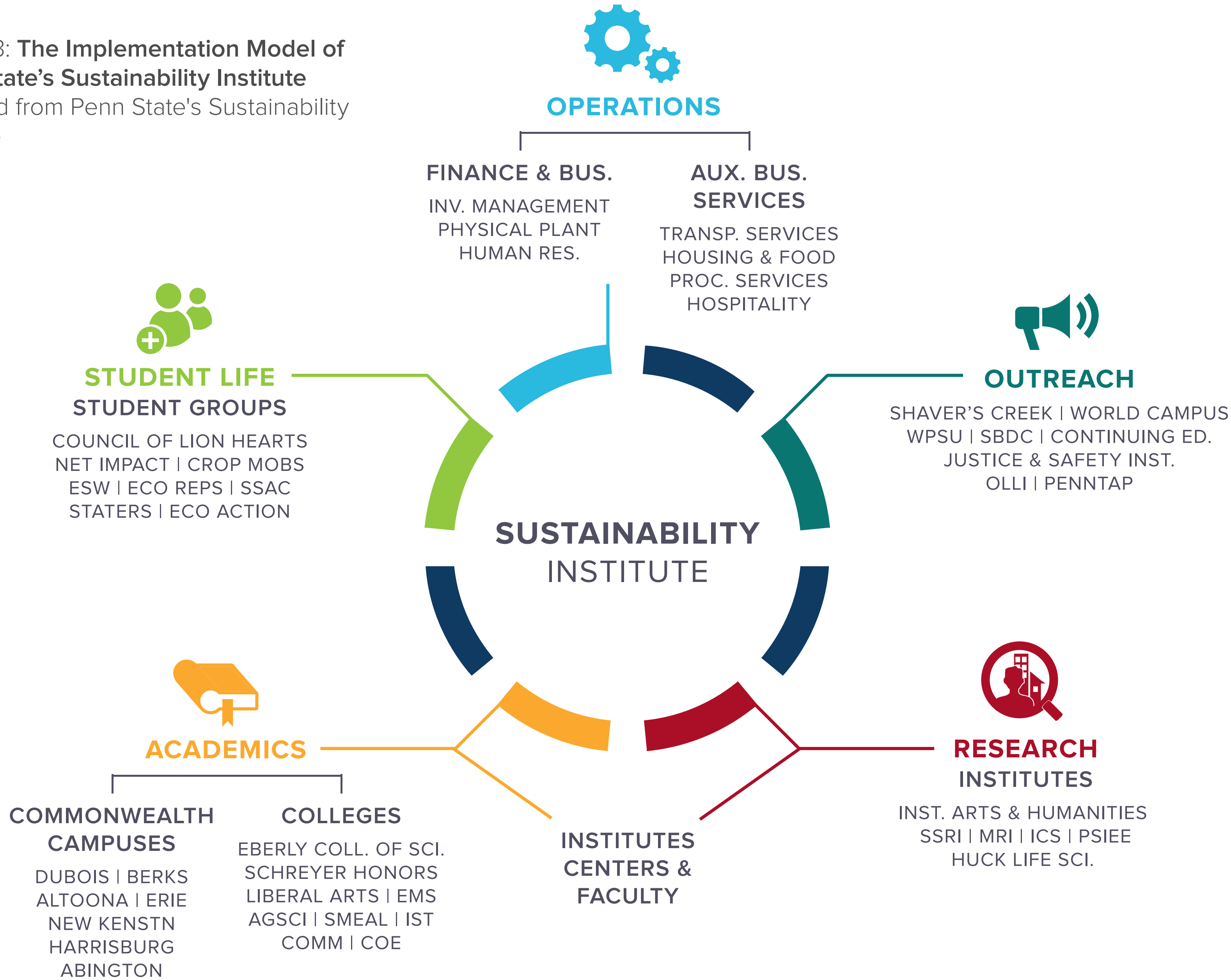
The University of British Columbia's (UBC's) Living Laboratory program, in which "faculty, staff and students and private, public and NGO partners use the University's physical plant, combined with UBC's education and research capabilities, to test, study, teach, apply and share lessons learned, technologies created and policies developed." UBC owns and operates its own infrastructure, including electric- and heat-generation facilities, and has incorporated these facilities into its curriculum and research. In addition to partnerships, the effort includes the SEEDS program, which facilitates interactions between faculty, staff, and students to initiate cross-disciplinary and impactful research projects. Overall, UBC's Living Laboratory program illustrates how much impact engaging a broad set of stakeholders can have on developing and implementing sustainability and carbon-reduction projects.

CASE STUDY 2

Penn State University's Sustainability Institute actively cultivates support from stakeholders across the university, and often within the community, for all of its sustainability projects. In fact, this is a core part of its operational structure within the university. Penn State realized the traditional and siloed hierarchical organizational structure of a university was inimical to the interdisciplinary nature of sustainability projects. To overcome this, the sustainability department separated itself from any existing department by creating a Sustainability Institute that could interact equally with the other divisions within the university. The institute's implementation model is to act as an integrator and agent of transformation by supporting the existing initiatives of university departments. It also cultivates interdisciplinary support across traditional silos when creating new initiatives and projects by leveraging the needs and wants of other stakeholders and interested parties.

Figure 3 illustrates how Penn State's Sustainability Institute interacts across disciplines within the university.

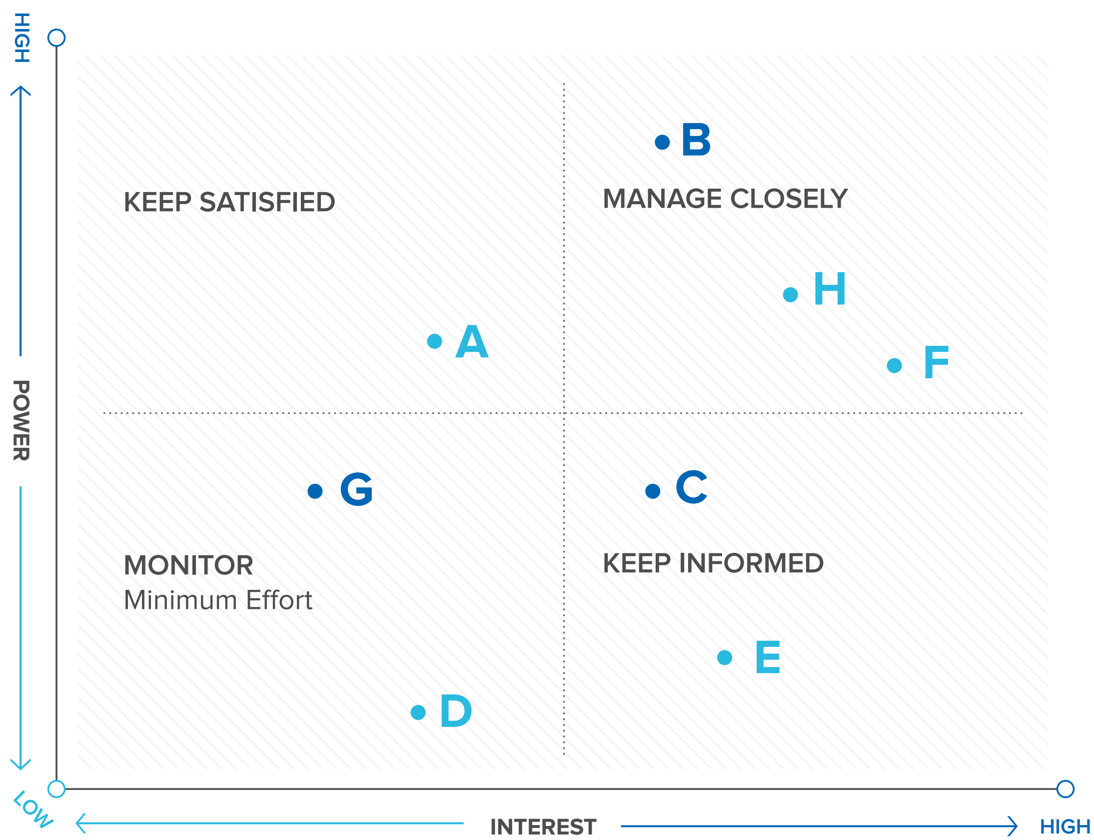
Figure 3: **The Implementation Model of Penn State's Sustainability Institute**
Adapted from Penn State's Sustainability Institute



IMPLEMENTATION

Identify as many potential stakeholders as possible and speak with them in order to understand their needs and concerns. One of the most successful implementation methods sustainability practitioners have used to cultivate internal support is to adjust their work to meet the needs of important stakeholders. As work on the plan proceeds, continue to engage stakeholders and collect feedback. Figure 4 illustrates a power and interest matrix, which is one method for characterizing stakeholders. This tool can be used to monitor how stakeholders' relationships with the project change over time.

Figure 4: **Characterization of Key Stakeholders: Power & Interest Matrix**



Actively reaching out will lead to a more robust and broadly supported end product, which will greatly increase the chance of the plan's successful implementation. To ensure the continued support of particularly important stakeholders, such as key decision makers, it may be prudent to add their representatives to the core team or establish an advisory council.

In addition, momentum for the climate action plan can be amplified by identifying and aligning with other stakeholder goals. ***For instance:***

- Facilitating research and additional grant opportunities
- Improving the university's reputation
- Engaging with the local community
- Supplementing student education
- Engaging corporate partners

When developing deliverables, be very clear about what stakeholder audiences they need to serve. Do they target the board or governors or regents? Facility managers? Loop them in early to be clear about objectives.

Resources:

- Article: *Harvard Business Review*, "A List of Goals is Not a Strategy"
- MindTools—Stakeholder Analysis

03 INVEST IN RESOURCES TO MEET THE CAMPUS'S EVOLVING NEEDS

INVEST IN RESOURCES TO MEET THE CAMPUS'S EVOLVING NEEDS

CONCEPT

As climate action plans are implemented, there is commonly a shift in needed campus-employee skill sets. This can impact campus planners, sustainability departments, fleet managers, plant managers, and facility operation and maintenance (O&M) departments, as well as many other campus roles. It can become difficult to recruit and maintain these skill sets, leading to issues with plan continuity stemming from high turnover.

One of the most common areas suffering from skill and staffing disparities, and one with the highest energy implications, is building controls and maintenance. New high-performance buildings have complex systems that rely on extensive metering and building automation. Therefore, skills associated with building automation, electronics troubleshooting, and programming become more important for facility O&M staff. Identifying these skill sets and crafting a recruiting strategy to find and retain staff is crucial.

Another approach to supplement staffing is to identify technologies that can support current staffing and fill in any skill-set gaps. Remote continuous commissioning is a rapidly growing field supporting university controls and O&M teams and ensuring continued efficient building operation. However, a skilled team is still required to manage and implement this technology. Ongoing commissioning, also referred to as continuous commissioning®, monitoring-based commissioning, and fault detection and diagnostics, is a process of optimizing or ensuring persistence of optimum building performance by continuously analyzing operational and energy data. Commonly seen as an analytics package that piggybacks on a building automation system, it converts large raw data sets into actionable recommendations. This technology has demonstrated savings ranging from 2% to 25% with paybacks from two months to two years.

CASE STUDY

The North Carolina State Energy Office, University of North Carolina schools, and a North Carolina community college have partnered to create a "Supertech" program to meet the expanding technical needs of building-maintenance personnel working in universities. This program would consist of a two-year technical degree from the community college paired with an apprenticeship program at a participating university. After graduation from the program, the local university would commit to hiring the student.

The curriculum was developed in conjunction with the facilities departments of the universities and included classes in:

1. Physics for Building Science
2. Mechanical and Electrical Devices
3. Blueprint Reading
4. Fundamentals of HVAC and Troubleshooting HVAC Systems
5. DDC Control-System Logic and Programming
6. HVAC Design
7. Building Commissioning
8. Energy Management and Efficiency in Building Systems
9. Databases and Networking

Other universities have followed a similar approach and successfully partnered with local trade schools for skilled building-maintenance technicians.

IMPLEMENTATION

The first step is identifying the skill sets and staffing required to operate efficient buildings and implement a climate action plan. Benchmarking with other universities is key to identifying what is required to produce positive results. Key staff to benchmark include controls and commissioning engineers, building managers, and energy managers. Respective professional societies can also provide additional resources to define required skill sets to feed into job definitions.

The best path to addressing staffing deficiencies will depend on available resources and current capacity. Technology, such as remote continuous commissioning, can be an attractive option with significant returns, but is fruitful only when the university or service provider has the resources to properly integrate the system and implement measures identified with the system. If remote continuous commissioning technology is a good fit, clearly define your campus's needs before procuring a solution. There are many approaches to remote commissioning, which will vary in the technology and management required from the university.

Resources:

- MIT Continuous Commissioning
- Institute for Building Efficiency
- Texas A&M Continuous Commissioning
- SkySpark
- EnerNOC

04 STRUCTURE MEETINGS TO PROMOTE INNOVATION

STRUCTURE MEETINGS TO PROMOTE INNOVATION

CONCEPT

Developing a climate action plan tends to be a highly analytical, right-brained process. Incorporate processes that facilitate creativity and divergent thinking into team meetings to innovate better solutions for achieving carbon reduction.

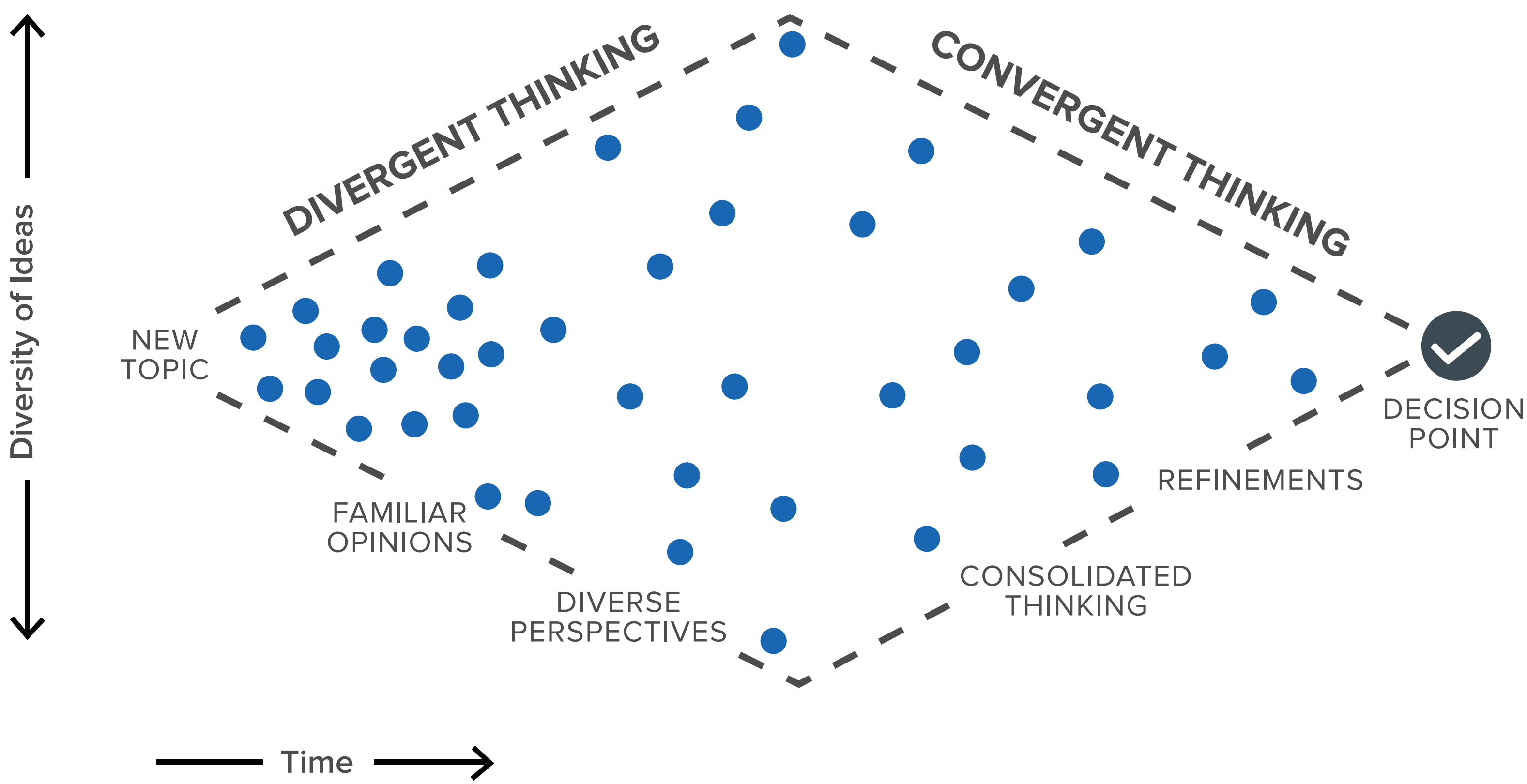
CASE STUDY

The benefits of bringing all stakeholders together in an early creative-design session were demonstrated during a RMI-facilitated design charrette for the Indianapolis City-County Building. The client was driven to not only reduce energy, but also address ongoing occupant-comfort issues. RMI convened an early charrette to brainstorm all potential approaches with a broad group of stakeholders, including occupants, building owners, and maintenance personnel. Initially, the group was focusing on efficiency measures for the existing air handlers. However, while listing out all sources of energy consumption, a maintenance engineer mentioned the need to continuously pump groundwater from the building's basement. This insight led the group to completely pivot to considering a geothermal system taking advantage of this existing groundwater. This change resulted in 46% energy savings while addressing an ongoing maintenance issue. Without the initial creative charrette, this integrated solution would not have been discovered.

IMPLEMENTATION

Facilitate project meetings in a way that promotes divergent thinking and creativity (Figure 5). The project team starts with the problem they are trying to solve and develops a broad set of ideas before starting to converge on a decision, which can ensure the project team doesn't replicate less-than-optimal projects and processes. Although generating a diverse set of ideas is not necessary for every stage of developing and implementing a climate action plan, it can be a very powerful process during early phases of both the plan's development and individual project development, as well as times when the team runs into issues or gets stuck.

Figure 5: **Divergent-Convergent Idea-Generation Methodology**



Many teams benefit from having a third-party facilitator convene these divergent thinking sessions. The open and comfortable atmosphere necessary for divergent thinking in a team environment is fragile, and since many participants are not well versed in the exercises, a facilitator can be very helpful with keeping the group focused.

Potential facilitation strategies include assembling a diverse group of stakeholders able to contribute ideas from a broad range of backgrounds and points of view, brainstorming or a brainstorming variation such as the step ladder, and establishing a technical potential.[2]

Conceptual building-energy modeling and other high-level analyses should be used to evaluate and prioritize ideas. Even so, innovative ideas can also introduce risk. Pilot projects can allow the team to test new ideas and then extrapolate learnings to larger projects. In this vein, pilot projects shouldn't always be expected to be successful and achieve a projected economic return. This expectation can result in overly conservative energy-efficiency projects. Pilot projects can test new ideas and less-common solutions to develop innovative approaches that can be propagated to improve overall portfolio-retrofit economics. Additional analysis and instrumentation may be justified to extract maximum information and learnings. If approaching pilot projects in this way does not fit into the policies of the facilities department, consider having faculty lead this effort.

Resources:

- Institute of Design at Stanford
- IDEO
- Doblin
- Western Washington University Electric Bike Pilot
- Stanford University Room Temperature Biological Sample Storage
- IBPSA-USA's Software Listing

[2] BRAINSTORMING IS AN OVERUSED TERM FOR A PROCESS THAT IS SELDOM EXECUTED PROPERLY. TRY FACILITATING A MEETING WHILE RIGIDLY FOLLOWING THE RULES AND SEE WHAT NEW IDEAS YOUR TEAM COMES UP WITH.

PL POLICY

POLICY

Energy-Cost Responsibility: In many cases, academic departments are not responsible for paying for energy usage for the buildings they occupy, but they are responsible for facility upgrades and remodels. As a result, department chairs and faculty members have no incentive to prioritize energy efficiency or use the most sustainable practices.

This second category of insights focuses on standardizing and strengthening campus policies that have the potential to impact the climate action plan. The fate of the plan can depend heavily on these policies and, in many cases, it is critical to address misalignments before starting plan development. Dedicate time early to characterize campus policies and procedures, determine how they will impact the climate action plan, and work to make adjustments as needed. Many policies can impact the climate action plan, and we do not attempt to cover them all. We provide a few examples of policies that may be in conflict with a climate action plan here.

New-Construction Policies for Buildings: Construction departments are often rewarded for completing buildings on time and under budget, but then a separate team is held responsible for the building's operations and maintenance. As a result, the construction team is incentivized to deliver buildings cheaply and on time, but not to prioritize energy-efficient design or optimized operations. The result is lower-cost buildings that then take more energy and money to operate and maintain.

An excellent resource for additional content on standardization is the American National Standards Institute's (ANSI) Energy Efficiency Standardization Coordination Collaborative (EESCC).

Two more detailed examples of campus policies, including how they may impact a climate action plan and ways to address their issues, are provided in this section:

- Define the Investment Decision-Making Process
- Standardize and Strengthen Contracts

05 DEFINE THE INVESTMENT DECISION-MAKING PROCESS

DEFINE THE INVESTMENT DECISION-MAKING PROCESS

CONCEPT

Project approval is often dependent on the economic threshold the project is evaluated against, as well as the way the economic return for the project is calculated. Fully defining both the threshold and the calculation method and ensuring that energy- and carbon-reduction projects are evaluated on a level playing field with other campus investments can significantly improve the likelihood of success of the climate action plan.

Start by determining whether carbon-reduction projects are evaluated using the same criteria as other campus investments. If not, can policies be adjusted to align project investment decision-making to ensure the campus invests its money in projects with the best return? For instance, in some cases a better return can be achieved by investing in building energy-efficiency or renewable-energy sources than can be achieved by endowment investments. Ultimately, your goal should be to determine a consistent project-investment threshold (e.g., projects will be funded if net-present-value positive) within the context of other campus investments. The economic threshold for energy-efficiency projects and renewable-energy projects should be equivalent.

Clearly define how energy-efficiency projects will be evaluated. Using life cycle-cost analysis (LCCA) is strongly recommended for economic evaluation, as it provides a more comprehensive view of the project than simple-payback or return-on-investment calculations. Life cycle-cost analysis takes into account the time value of money as well as revenues and expenditures incurred over the lifetime of a project. Simple-payback or return-on-investment calculations commonly do not do this. LCCA can result in significantly different conclusions, depending on the inputs and assumptions used, regarding project economics that can impact investment decisions.

Energy-efficiency projects can also produce value beyond the energy-cost savings that is often not captured in economic analyses. Building improvements resulting from energy retrofits can bring in additional research revenue, increase student and staff retention, and significantly benefit a university's recruiting ability. Although quantifying these benefits can be challenging, it is possible to provide approximate values, which can influence the decision-making process. Processes for presenting and considering these additional values should be standardized across all projects.

CASE STUDY

At UC Irvine, lab buildings account for two-thirds of the campus's core energy use and was seen as an essential end use to address in order to meet the school's ACUPCC goals. Therefore, in 2008, the University of California's Smart Labs program was created. It has subsequently gained international recognition for its success in economically reducing the energy consumption of the school's labs. Of the labs enrolled in the program, 90% have achieved energy savings of over 50% through efficiency upgrades, such as real-time demand control ventilation, exhaust-fan energy reductions, continuous commissioning, and lighting efficiency. These results were achieved with a return on investment between 4–8 years, consistently exceeding the bond-revenue requirements that were used to fund the program.

In fact, the energy-efficiency savings have provided a payback 6% lower than the cost of capital, making the program one of the most economical energy investments at the university. Wendell Brase, UC Irvine's vice chancellor for administrative and business services and chair of the University of California's Climate Solutions Steering Group, expects these economics to be comparable for most laboratories at other universities.

IMPLEMENTATION

Develop a life cycle cost-analysis calculator to evaluate the projects being considered for the climate action plan. The calculator can be developed in Microsoft Excel, Matlab, or other analytics software, or an existing LCCA tool such as LCCAid or BLCC can be used.

Many variables can be included in a life cycle-cost analysis; collecting accurate inputs for each variable can be difficult and time consuming. The more comprehensive you can be, the more accurate the conclusions will be, but if time and resources are limited, perform a sensitivity analysis to understand the priority of each input and eliminate low-impact variables from the analysis.

Variables commonly included in life cycle-cost analysis include:

- Ongoing replacement cost. For instance, the hardware and labor cost of replacing lamps that fail
- Escalation rates. Hardware, labor, utility rates, and other variables likely increase over time
- Whole-system operating-cost impacts. For instance, reducing cooling requirements doesn't just save money due to reduced chiller energy. It can also reduce chilled water-pump energy, cooling-tower energy, cooling-tower water consumption, and cooling-tower water-treatment chemicals
- Electricity peak-demand (kW) cost reductions and potential revenue from demand response programs
- Comprehensive first cost. In addition to hardware and labor cost associated with installing an energy-efficiency measure, there may also be M&V cost, disposal cost, design cost, business-acquisition cost, site visit cost, energy- and economic-analysis cost, and overhead and profit
- Incentives: utility incentives; federal-, state-, and local-government tax credits/incentives; grants
- Tax benefits from depreciation
- Financing fees
- Value beyond energy savings, such as improved student performance, increased enrollment, and a healthier workforce

The following is an excerpt from a RMI white paper titled *Life Cycle Cost Analysis: Is it Worth the Effort?*, which illustrates how LCCA can result in a different conclusion regarding project feasibility than simple payback.

Consider the replacement, in January 2011, of an old 500-ton centrifugal chiller that runs for the equivalent of 2,000 full load-hours per year. ***We will assume the following project requirements:***

Table 4: **Project Requirements for Simple LCCA**

CATEGORY	VALUE
Timeframe	10 years
Economic Evaluation	8%
Electricity Rate	$0.12/kWh
Demand Charge	$10/kW/mo (for 8 months out of the year)

The key to establishing the baseline in this example is to estimate the remaining life of the chiller and account for the capital expense required to replace it at the end of its useful life. Suppose the chiller is estimated to have a remaining life of five years. Therefore, in 2016, the baseline will need to include the cost of a replacement chiller. Table 5 lists the critical information:

Table 5: **Chiller Data**

CATEGORY	BASELINE EXISTING CHILLER	BASELINE REPLACEMENT CHILLER	NEW EFFICIENT CHILLER
Efficiency	0.65 kW/ton	0.577 kW/ton	0.50 kW/ton
Year Service Starts	2011	2016	2011
Year Service Ends	2015	2020	2020
Electricity Used (kWh/yr)	650,000	576,557	500,000
Demand (kW)	325	288.3	250
Electricity Cost ($/yr)	$78,000.00	$69,186.88	$60,000.00
Timeframe	$26,000.00	$23,062.30	$20,000.00
Capital Cost	N/A	$230,000.00 (RS Means)	$287,500.00 (25% Premium)

We will also assume the new chiller will save $5,000 per year in maintenance for the first five years. The savings end at year six because, at that point, the old chiller will have been replaced. The LCCA yields the annual discounted cash flows shown in Table 6.

Table 6: **Discounted Cash Flows Over Time**

CATEGORY									
2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
-$258,500	**$27,074**	**$25,276**	**$23,598**	**$22,032**	**$165,296**	**$8,194**	**$7,663**	**$7,166**	**$6,702**

The annual savings are large for the first five years and reduce significantly after the installation of the code-compliant chiller. Also, the discounted cost of this chiller can be clearly seen in 2016. Summing up the discounted cash flows results in a net present value of $34,501 (ROI of 11.2%). Now let's do the same analysis using a simple payback approach.

We divide the capital cost of the efficient chiller by the reduction in annual energy cost ($104,000 – $80,000 = $24,000) to get:

$$\textbf{SIMPLE PAYBACK} = \frac{\$287{,}500}{\$24.000/\text{YR}} = \textbf{12.0 YEARS}$$

Since the simple payback is greater than the timeframe of the analysis, this measure would not be accepted. However, the more comprehensive LCCA shows that the project has a positive net present value (NPV) and makes financial sense.

LCCA results are sensitive to the discount rate and number of years included in the NPV analysis. Select values that allow energy investments to be directly compared to other campus investments.

NPV results can be more difficult for people without a financial background when compared to simple payback. Include an explanation of the results and consider reporting in discounted simple payback instead of NPV.

Resources:

- The National Institute of Standards and Technology (NIST) Life-Cycle Costing Manual for the Federal Energy Management Program
- Stanford's Guidelines for Life Cycle Cost Analysis
- Rocky Mountain Institute's LCCAid Calculator
- NIST's Building Life Cycle Cost Program
- *Whole Building Design Guide (WBDG) – Life Cycle Cost Analysis*
- Rocky Mountain Institute's report Reporting and Quantifying the Value Beyond Energy Cost Savings

06

STANDARDIZE & STRENGTHEN CONTRACTS

STANDARDIZE & STRENGTHEN CONTRACTS

CONCEPT

Requests for proposals (RFPs) and, ultimately, contracts greatly impact the performance of implemented projects and therefore the success of the climate action plan. This is true for developing the plan as well as for implementing projects tied to the plan. Clearly define project goals and ensure that partners, consultants, and contractors are legally obligated to deliver on these goals.

CASE STUDY

The following case study of RMI's Innovation Center contracting-structure illustrates how starting with a strong process and contract can yield better results. RMI leveraged an Integrated Project Delivery (IPD) process. Unlike a traditional design/bid/build contract, two unique aspects of the IPD methodology were that it created a shared risk/reward framework and a highly integrative design process.

Per the agreement, during the planning/design phase, the designers, general contractors, and subcontractors worked together to create a truly integrated design and identify any project savings. Any innovative measures that provided cost savings against the base target cost were split—25% was added to the team's profit and the remaining 75% was added back into the project to enable additional scope.

At the end of construction, if the team was able to drive the actual project costs below the final target cost, all project cost savings were split 50/50 with the owner and design/construction team. If the project came in over budget, the additional cost was subtracted from the design/construction team's profits.

Although building energy performance was defined in the owner's project requirements, RMI opted to offer a performance-reward pool to further incentivize building operational performance. The performance reward provided incentives to go beyond the stated energy-efficiency goal of 19 kBTU/sf/year. This reward was paid out 18 months after occupancy, and performance was verified by updating the energy model.

Overall, the contractual mechanisms of IPD and the performance pool played a crucial role in aligning the team's incentives and driving an integrated design process focusing on cost and performance.

IMPLEMENTATION

Identify department(s) on campus that control or impact requests for proposals and contracts. Work with these stakeholders to adjust documents and policies as necessary to ensure the success of the climate action plan. Evaluate RFPs and contract language from the point of view of developing the climate action plan as well as from the point of view of executing projects within the plan.

REQUESTS FOR PROPOSALS

Clearly describe project goals and consider providing a framework for a standardized response to RFPs to facilitate "apples-to-apples" comparison of proposals. The School of the Art Institute Chicago adjusted its RFP to identify multiple firms capable of and highly interested in performing a whole-building, deep energy-retrofit analysis for its 280 S. Columbus Drive facility. The winning firm delivered multiple options for how the school can meet its goals.

Use the RFP to convey project requirements. In addition to first-cost criteria, the RFP should include performance targets and required processes such as energy modeling and life cycle-cost analysis. Contracts should be written to hold the project team accountable for project performance or, better yet, to reward all parties for superior project outcomes.

CONTRACTS

Ensure the contract structure being used facilitates the results you are aiming for. This may require shifting away from standard contracts used by the university to a contract that rewards for energy performance. RMI has leveraged contracts through Integrated Project Delivery in constructing our new office building and Innovation Center in Basalt, CO (see case study). More detail on structuring contracts for energy performance is provided in the Resources section.

When appropriate, include performance targets in the contract to have hard numbers the project can be evaluated against and enforced. For instance, for a lighting-retrofit project, a lighting power-density target of 0.5 watts per square foot may be used.

Many sources can be leveraged for establishing performance targets, such as:

- Working with the campus construction department and other subject-matter experts
- The latest versions of energy standards, such as ASHRAE's 90.1 and 189.1
- Advanced energy design guides

Specific performance targets can also be applied to other project goals, such as:

- First cost (e.g., <$0.95 per square foot)
- Technology risk (e.g., LED must comply with IESNA LM 79)
- Environmental benefits (e.g., GHG emissions reduced by a minimum of 40%)
- System reliability (e.g., warranty period of five years or 75,000 hours rated life)

Resources

- The IPD Framework, HansonBridgett
- The Integrated Project Delivery Alliance
- Energy Performance Contracting for New Buildings
- RMI: Green Pays Its Way—Performance-Based Fees
- http://www.boma.org/sustainability/info-resources/Documents/Final%20Packet.pdf
- http://energy.gov/eere/buildings/advanced-energy-retrofit-guides
- http://www.rmi.org/retrofit_depot_download_the_guides
- https://www.ashrae.org/standards-research--technology/advanced-energy-design-guides
- Deep RFP through AIA

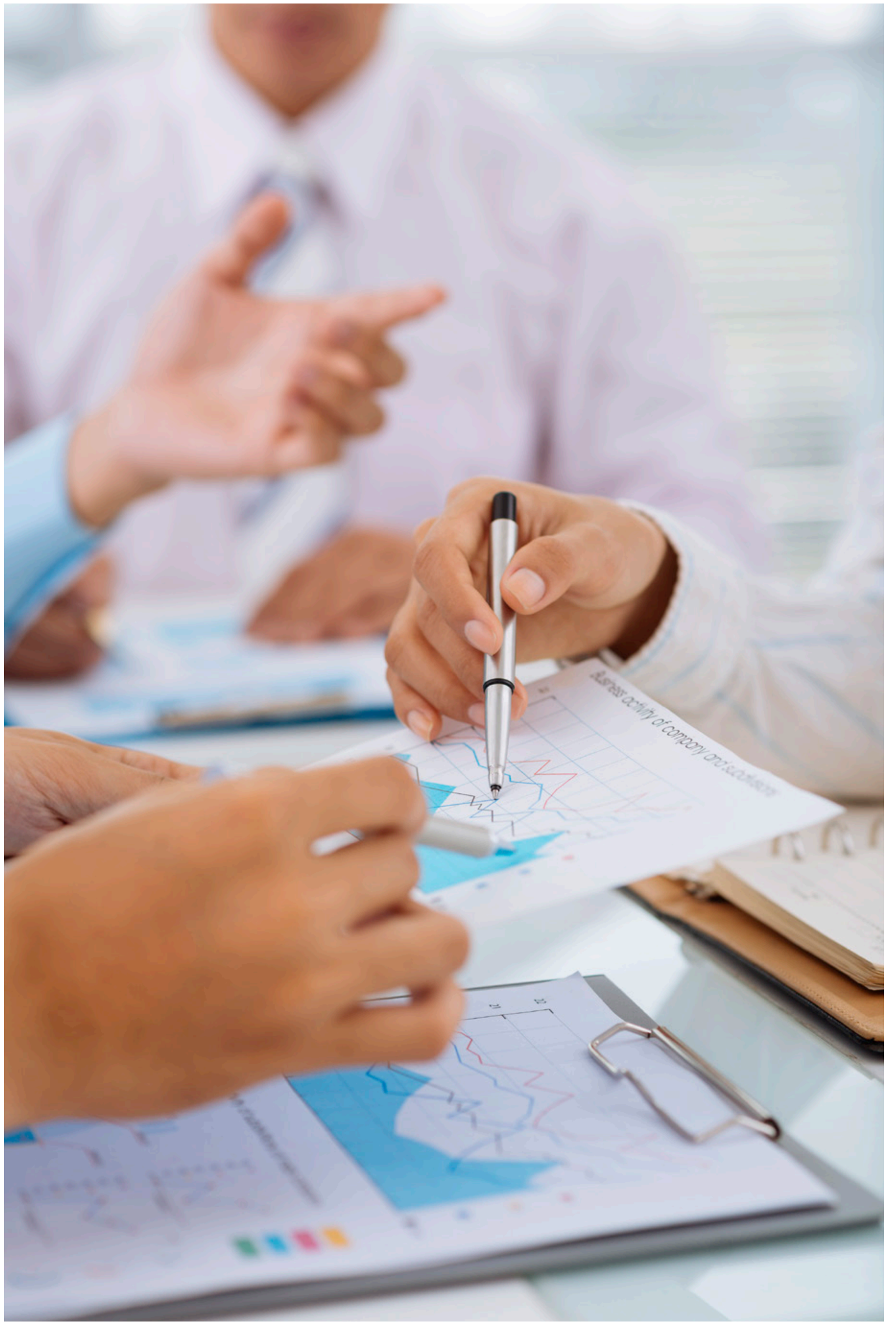
PL

PLAN

PLAN

This final section of insights focuses on analysis and approaches for developing the climate action plan. Insights such as Plan & Implement Portfolio-Wide Projects and Regularly Iterate the Climate Action Plan are based on the premise that a climate action plan is most effective when it is a living document that is updated and refined as more information is available and lessons are learned. Instead of allotting a large portion of the budget to developing a climate action plan prior to completing any projects, it is more efficient and more accurate to iterate the plan using feedback loops as projects are implemented.

We recognize that some organizations will not be comfortable with this approach and will need a finalized climate action plan prior to initiating projects. The majority of the recommendations and concepts presented in this section are applicable to either approach, but we recommend giving strong consideration to the former.



07

DEVELOP BASELINES

DEVELOP BASELINES

CONCEPT

Before creating a carbon-reduction strategy, it is important—if not essential—to develop an understanding of a university's baseline. If for no other reason, most climate action plans, at their core, are a projection of carbon reduction, which has to be relative to a baseline. Although at first glance creating a baseline seems quite straightforward, a couple of complexities can make it challenging.

First, the baseline is a projection of future carbon emissions, not current carbon emissions. For instance, if the overarching goal of the climate action plan is to reduce campus carbon emissions by 50% by 2030 then the baseline would be the projected carbon emissions for the year 2030 if the plan were not implemented (business as usual). ***Projecting the baseline into the future requires consideration of:***

- Planned growth in building area[3]
- Planned growth in student population
- Planned savings from already occurring energy efficiency
- Projected increases in energy costs
- Changes in carbon emissions from energy sources such as electricity

Second, more than one baseline will likely be required. The most common three are energy, cost, and carbon. Energy must be characterized for each energy stream (e.g., grid electricity, natural gas, campus-owned solar). The energy use per fuel stream can then be used to determine the cost and carbon baselines.

CASE STUDY

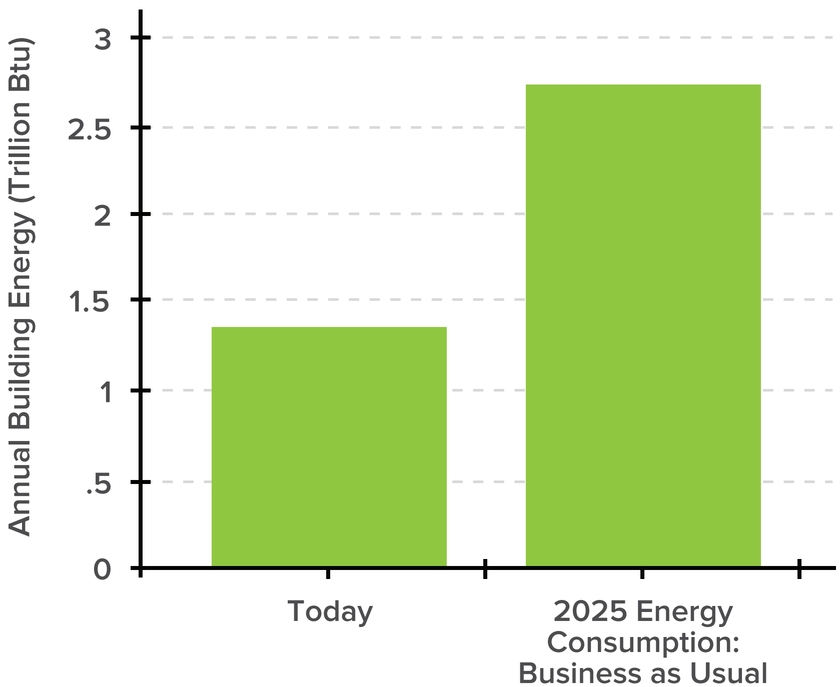
Many large universities have aggressive campus-growth plans to accelerate student enrollment. When calculating a baseline energy consumption, it is crucial this projected growth is accounted for in the plan. When RMI worked with a large university to develop its carbon action plan, this projected baseline became a key aspect of the analysis and discussion.

The first step in accurately projecting future consumption is identifying the current campus consumption per space type and square footage. This data can then be extrapolated out to the anticipated future square footage, and refined based on potential space types. The process of projecting the energy associated with high-energy space types, such as labs, provides key information to stakeholders like campus planners and department heads about the energy and cost implications of aggressive expansion plans in energy-intensive space types.

[3] BUILDING AREA IS DRIVEN BY STUDENT GROWTH, AND DETERMINING A REASONABLE ESTIMATE OF STUDENT GROWTH (IN 15 OR 25 YEARS) CAN BE VERY DIFFICULT AND CAN EVEN BECOME A CONTENTIOUS TOPIC.

Once RMI developed the business-as-usual baseline accounting for future growth, it became clear that this growth will be the primary factor driving campus energy consumption. By visually presenting the significant impact of growth under business-as-usual plan projects in the figure below, stakeholders were able to fully understand and conceptualize the impact of this growth. This impact came as a surprise to many important stakeholders, and resulted in an important discussion about this course of action.

Figure 6: **Waterfall Chart Illustrating Campus Energy Reduction Projections**



This analysis also underlined the significant impact new construction had on campus energy consumption. This shifted the discussion from a purely retrofit-focused approach to one that placed greater importance on new-construction guidelines. Without the impact of growth having been considered in the energy baselines, these crucial conversations would not have happened.

IMPLEMENTATION

Start by characterizing campus energy use. To accurately project the energy use to future years, include as much fidelity as possible with the data available. For instance, submetered chilled-water consumption per building or major piece of equipment is preferable to electricity input at the chiller, because the energy use of the chiller can then be appropriately allocated to end uses and more accurately projected into the future.

Also, make sure all energy consumption within the scope of the plan is included in the baseline. This could include transportation systems, energy use by street lighting, parking garages, and others.

Once baseline energy use is characterized for the campus it can be converted to both carbon emissions and energy cost by multiplying energy use per energy stream by the appropriate conversion factors. This can become complex, since a portion of electricity may be generated by solar PV, natural gas plants, or other generation sources that have different carbon emissions and cost than electricity purchased by the local utility. Calculating the cost of electricity can have additional complicating factors such as a portion of the cost being tied to electricity demand, not consumption. One solution is to review historic utility bills and contracts to characterize costs.

Converting to carbon emissions can also become complex since carbon emissions for a given fuel source vary based on how the energy is generated and supplied. For instance, electricity will have a significantly different carbon-emissions factor when generated from coal than from hydro or nuclear. The relative emissions between the energy sources in Table 7 demonstrates the significant role the energy source plays in emissions calculations.

Table 7: **Relative CO_2 Emissions from Common Energy Sources**

Characterizing the campus's energy, cost, and carbon baselines can also help prioritize projects, since not all energy sources have an equal impact on the three metrics. For instance, if electricity is supplied from a utility that is using coal, it will be more impactful to reduce a kBtu of electric energy than if it were supplied from a natural gas combined-heat-and-power plant.

ENERGY SOURCE	CO_2 EMISSIONS (lbs of CO_2 per kWh)
Electricity from Coal Power Plant	2.13
Electricity from a Natural Gas Power Plant	1.21
Wind, Solar, Hydro	0

Resources:

- Article: Analyzing Energy-Efficiency Opportunities across Building Portfolios
- U.S. Energy Information Administration
- Energy Star Portfolio Manager
- LBL Energy Benchmarking for Buildings and Industries
- FirstFuel FirstAdvisor

08 WEIGH POSSIBLE RENEWABLE-ENERGY TECHNOLOGIES & CONTRACTS

WEIGH POSSIBLE RENEWABLE-ENERGY TECHNOLOGIES AND CONTRACTS

CONCEPT

Rather than considering potential projects on a case-by-case basis, a team should, ideally, first evaluate its institution's key constraints and priorities. Identifying these decision criteria early on and then creating a long-term strategy that takes these issues into account will help your team narrow the range of possible options and avoid wasting time on projects that do not fit the university's broader needs.

Campuses considering renewable energy have three basic options: renewable energy credits (RECs), on-site generation (e.g., rooftop PV), and contracts with off-site renewable energy generators. The optimal renewable energy solutions for your campus can vary significantly based on your priorities and local conditions.

RECs: Renewable energy credits are generated by operating renewable energy generators (e.g., wind or solar farms), with one REC generated for each megawatt-hour produced by the plant. These RECs are bought and sold, with the ultimate owner being able to claim that they "used" the green energy. RECs are simple and easily scalable, but always come at a cost premium and arguably do not help add new generation, as all payments are made to existing plants.

On-site Generation: On-site generation is highly visible and can provide significant economic savings in some areas. Rooftop solar PV, biomass plants, and combined-heat-and-power plants using natural gas are some of the most common forms of on-site generation.

Off-site Contracts: Off-site contracts, or power purchase agreements (PPAs), allow campuses to purchase energy from larger installations that are not located physically on a university's campus. Depending upon the local regulations, this energy can sometimes either be used to offset the campus's utility bill or sold into the local wholesale market. In either case, the university can keep the RECs and truthfully claim to be supporting a new renewable energy plant.

Each of these options should also be weighed against the cost for energy efficiency in the building portfolio to reduce the consumption by the same amount. Where there is "low-hanging fruit" on campus, it can often be cheaper to invest in efficiency projects. Potential projects with equivalent savings should be evaluated before investing in renewable infrastructure.

A crucial tool for weighing these options can be a model showing their total energy generation as well as total energy demand on an hourly basis. Programs, such as the ReOpt program provided by the National Renewable Energy Laboratory, allow users to find an optimal mixture of generation resources to meet their hourly needs throughout a typical year.

CASE STUDY 1

In 2014, to help achieve its carbon-neutrality goals by 2020, American University (AU) made a milestone commitment and partnership to purchase half its electricity from renewable sources. Through a PPA with partners George Washington University (GWU) and George Washington University Hospital, American University entered into a 20-year solar contract to purchase power from a 52-MW Duke Energy Renewables solar installation in North Carolina. Through economies of scale achieved by the partnership (called the Capital Partners Solar Project), this solar project will provide 123 million kWh annually to the universities, making it the largest nonutility solar-PV PPA in the United States at the time of its installation.

Purchasing renewable energy is a core element to AU's Climate Plan, which focuses on (1) reducing consumption, (2) producing renewable energy, (3) purchasing green power, and (4) purchasing other offsets for other emissions, such as travel. Therefore, although this PPA is expected to provide half of GWU and AU's power, AU will still purchase RECs for the remainder to ensure 100% of its power will be carbon neutral.

CASE STUDY 2

A key to developing an effective renewables strategy is stepping back and reviewing all opportunities and constraints in a university's utility relationship and access to regional resources. What may be a great opportunity in one region, say geothermal, may be the least favorable option in a hot, sunny climate. During this analysis, the cost per kWh of renewables must be evaluated against the cost of efficiency measures to reduce the load by the same amount of energy.

By following this holistic process, RMI was able to find a solution for a large university that capitalized on regional opportunities to create a retrofit and renewable package that was NPV positive. This university was located in a restricted utility market that was not favorable to net metering or more-advanced utility structures, such as wheeling. In addition, the campus already had a significant amount of on-site solar. These factors made private off-site energy production directly feeding satellite campuses very attractive. The off-site opportunities also made it a priority to start discussions with the utility to promote wheeling.

Although the area had abundant solar, the school already had significant investment in this area. This reliance on solar made the school susceptible to peaks during production drops during cloud events. These events often occurred during the fall, when student move-days produced peak loads. This made campus power reliability a significant priority. Stepping back and looking at all options, it was noted that the town had a large biogas resource. A long, standard ESCO contract provided a private-sector partner that could help maximize this resource with a private biogas facility.

Once these opportunities were identified, ReOpt was used to find the optimal weighting and potential cost per kWh. This cost could then be used as a threshold to evaluate efficiency projects. If a retrofit was cheaper than this cost per kWh, it was implemented. If the cost was higher than renewables, it was more cost effective to do another project or utilize renewables.

IMPLEMENTATION

Potential Areas to Prioritize:

- Cost/economic return: choose projects that provide the greatest economic savings
- Impact on targets: choose projects that have the largest impact on CO_2 emissions, renewable energy usage, etc.
- Campus grid reliability: choose projects that provide stability and resilience to the campus grid
- Visibility of efforts, and iconic nature of the installations: choose projects that students, faculty, and visitors will see on a regular basis
- Potential for grant funding and student projects: choose projects that employ cutting-edge technologies or systems that align with academic research and/or provide opportunities for student projects
- Local health and economic benefits: choose projects that have the greatest ability to reduce fossil fuel use locally, or those that will most benefit the local population in terms of providing jobs and stable tax revenue

Key Constraints:

- Budget for investment
- Economic return requirements (e.g., minimum IRR, NPV, etc.)
- Local renewable energy resources (e.g., wind speeds and solar radiation)
- Local regulations, which can impact: whether your campus can install rooftop PV using third-party leases; or whether your campus can purchase energy from an off-site wind or solar farm

Potential Technologies:

- Onshore wind
- Solar photovoltaics (PV)
- Biomass
- Combined heat and power using natural gas
- Solar thermal – less used
- Geothermal – few projects to date
- Concentrating solar power – no known campus projects to date
- Offshore wind – no known campus projects to date

Resources:

Example Approaches:

- Off-site Contracts: UC System demonstrated leadership and moved towards its carbon neutrality goal by purchasing energy from a large, off-site solar PV installation in California.
- On-site Generation: Arizona State University capitalized on its sunny climate by installing over 24 MW of solar on site.
- On-site Generation: University of Texas at Austin maximized reliability and efficiency by running on-site power plants.
- On-site Generation: University of British Columbia maximized the potential for academic research by installing an experimental biomass plant on its Vancouver campus.
- RECs: Georgetown University purchases more than 150,000 MWh of RECs each year in order to completely offset the electricity consumption of its Main, Medical, and East campuses.

09 PLAN & IMPLEMENT PORTFOLIO-WIDE PROJECTS

PLAN & IMPLEMENT PORTFOLIO-WIDE PROJECTS

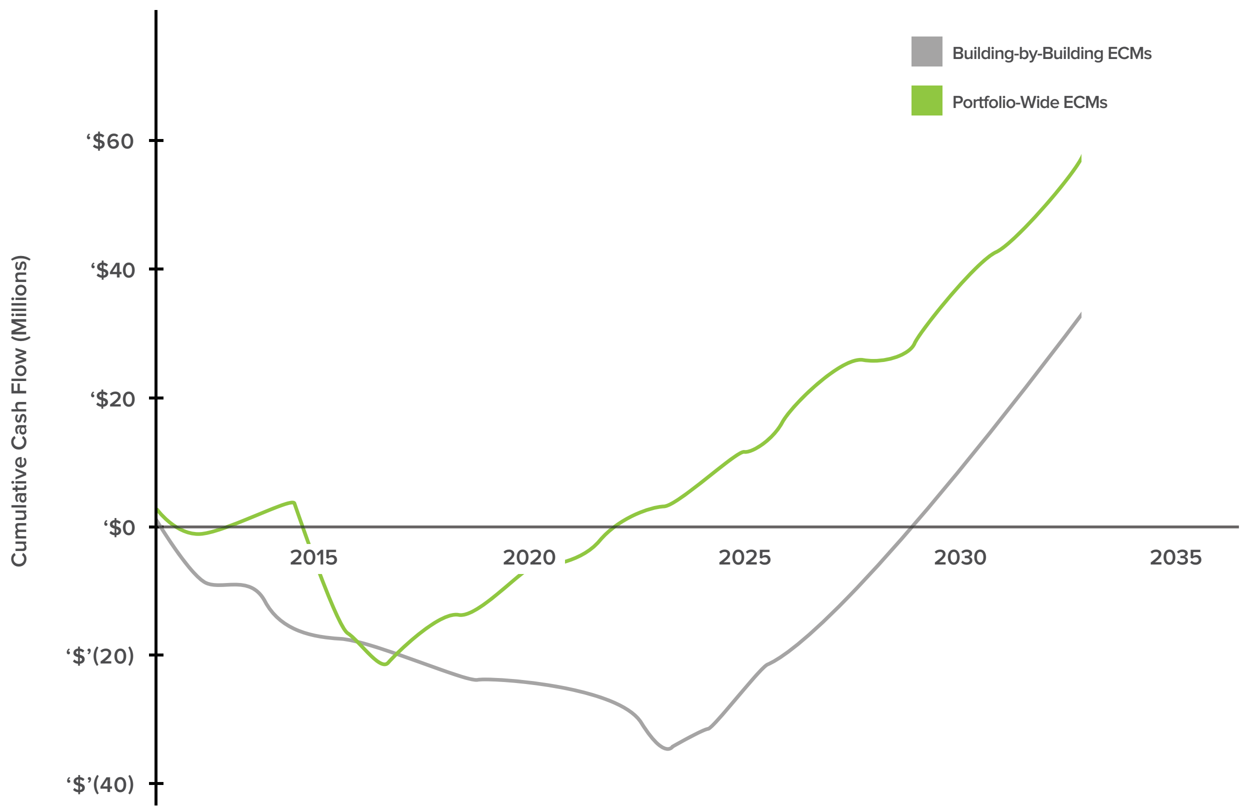
CONCEPT

Evaluating the potential to implement campus-wide carbon-reduction measures in addition to evaluating projects on a building-by-building basis has several advantages, such as spreading risk across the portfolio, economies of scale through bulk purchasing, streamlined processes such as site visits, and leveraging pilot projects to test new technologies and designs, to name a few. Ideally, campus-wide and building-by-building projects will be used in combination to achieve fast and broad deployment as well as deep savings. The fast and broad deployment of portfolio-wide reductions can dwarf much higher-percentage savings achieved in a single building, purely due to scale. Deploying measures quickly will also lead to greater accumulated savings by the end of the plan (see case study). With that said, developing a strategy to also incorporate more custom, building-by-building evaluation will ultimately be required to achieve the aggressive carbon-reduction targets of many campuses. See the implementation section for a proposed process incorporating each of these attributes.

CASE STUDY

RMI completed an extensive analysis of a national portfolio of big-box retail stores. Both highly customized, store-by-store deep retrofits as well as portfolio-wide measures, such as lighting and controls upgrades, were evaluated. Although the customized deeper retrofits make economic sense over time, it was determined that it was more economically advantageous to the portfolio owner to implement the portfolio-wide measures first. This is primarily because the portfolio-wide measures could be deployed more quickly and therefore the energy cost savings would have more time to accumulate, resulting in a higher cumulative cash flow for the portfolio, as illustrated in Figure 7.

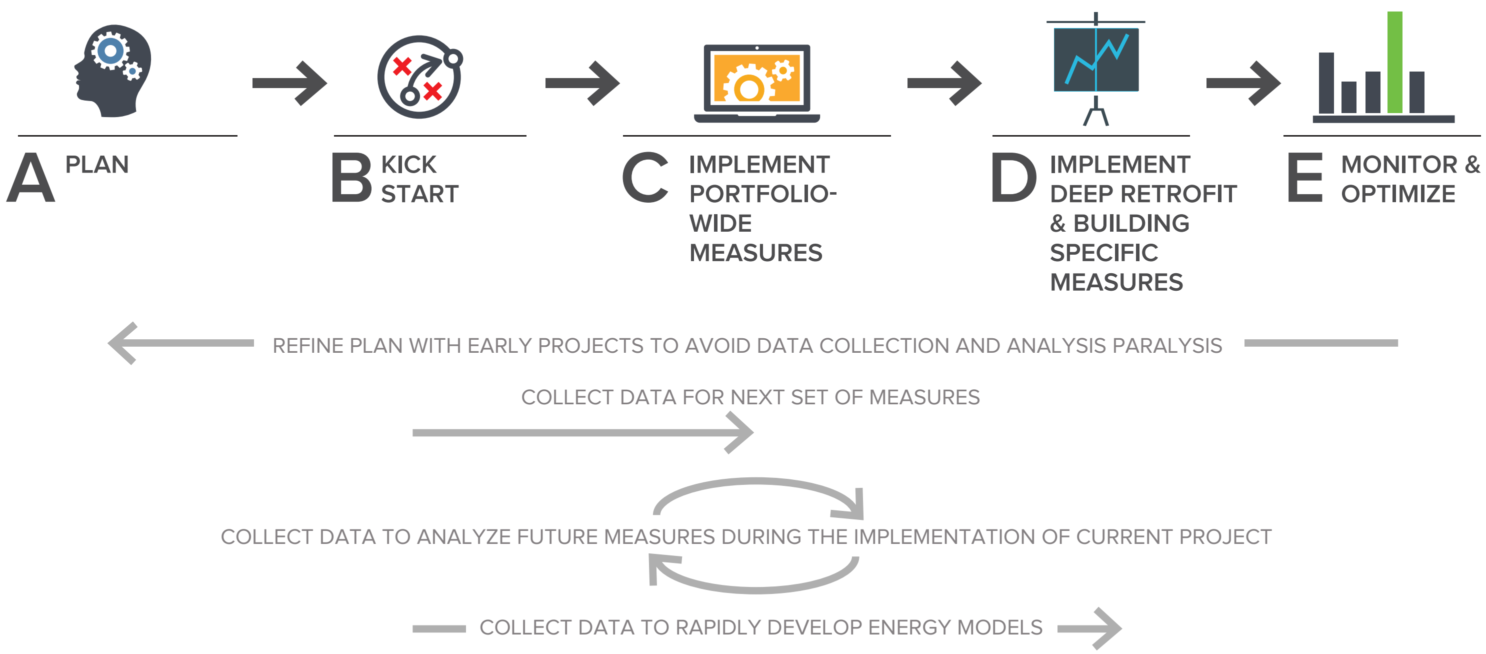
Figure 7: **Portfolio-Wide Versus Building-by-Building Energy Conservation Measures (ECM) Cash Flows**



IMPLEMENTATION

Figure 8 illustrates a proposed process that uses both campus-wide and building-by-building projects to achieve fast and broad deployment as well as deep savings. Each step in the illustration is further described below.

Figure 8: **Action-Oriented Portfolio Deep Retrofit Process**



PLAN

Develop a high-level plan, including a campus-wide business-as-usual energy cost and projected energy reductions that sum to the climate-action-plan goal, as illustrated in Figure 8. Group campus buildings into subsets based on how carbon-reduction measures will apply (e.g., dorms, labs, classrooms). Consider characterizing by building use and equipment in the building (i.e., variable-volume air-handling units, constant-volume air-handling units). Be careful not to get stuck in this phase. Do not make your plan specific enough to include every project required to reach your goal. Do develop feedback loops to allow the campus-wide projections and progress to be regularly refined throughout the plan's timeline.

As discussed in the introduction to this guide, resources are available for developing a climate action plan:

- The Association for the Advancement of Sustainability in Higher Education's (AASHE's) Cool Campus! A How-To Guide for College and University Climate Action Planning
- American College & University Presidents' Climate Commitment's (ACUPCC's) Implementation Guide

Carbon reduction may be part of a broader sustainability effort. Resources that provide a framework for a broader sustainability effort include:

- U.S. Green Building Council's (USGBC's) Road Map to a Green Campus
- The Sustainability Tracking, Assessment & Rating System (STARS)

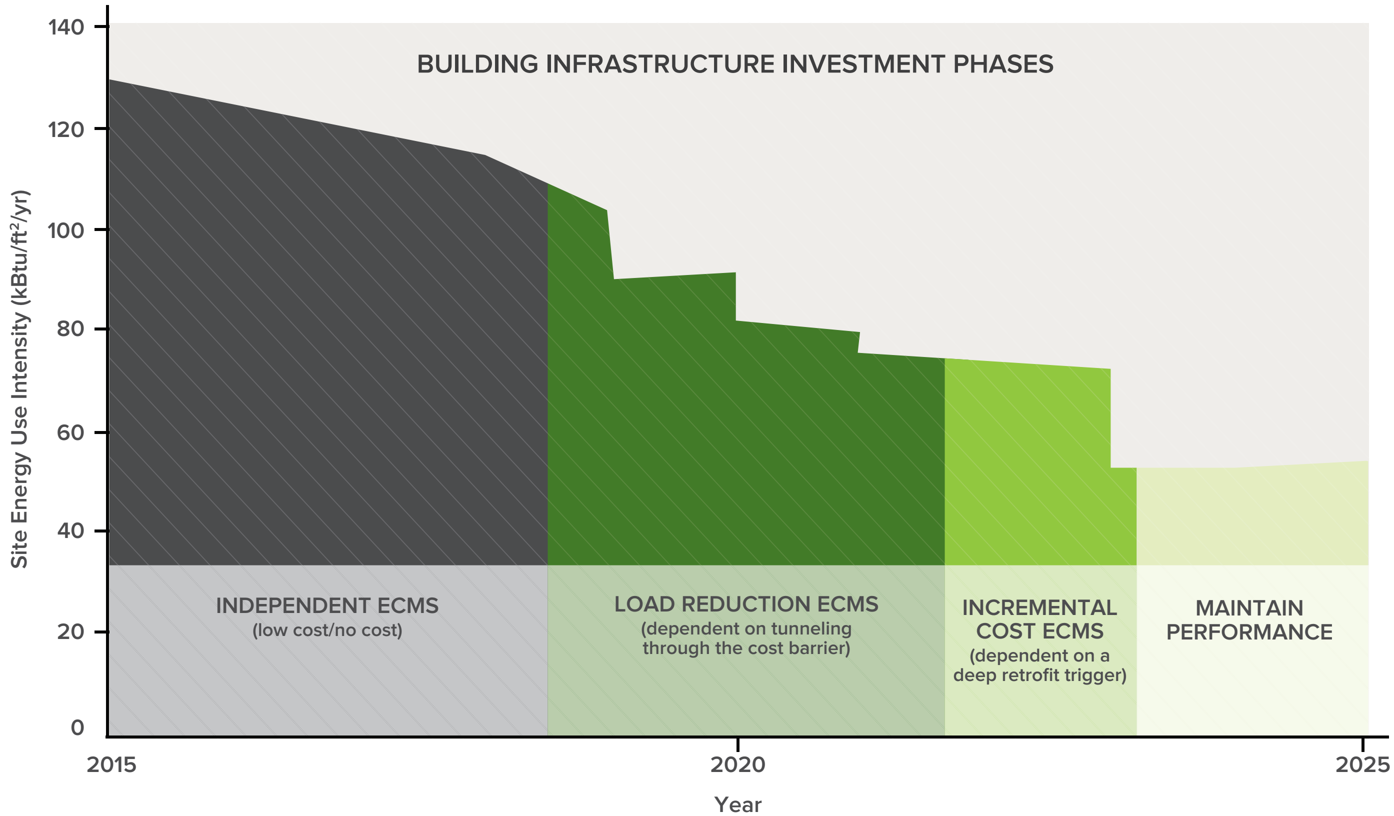
Kick Start: Identify low-cost and high-economic-return carbon-reduction measures that can be installed in a large number of buildings throughout campus (i.e., RCx, lighting, controls optimization). Design targeted audits and other strategies to streamline the analysis and implementation process. Use the kick start carbon-reduction measures to capture early savings, develop momentum for the plan, and collect information for future carbon-reduction measures while in the buildings. For instance, inputs for hourly building-energy simulations (a.k.a. energy models) can be collected while on site. Make sure these early projects do not conflict with later projects that have the potential for deeper energy savings. For instance, if there is a multizone air-handling unit, it may not be advantageous to convert all of the air handler's controls and actuators to direct digital control if there is a potential to replace the unit later in the climate action plan process, since the unit will always be inherently inefficient.

Implement Portfolio-Wide Measures: Review the characterization of buildings from the plan phase and brainstorm potential ECMs that can be deployed portfolio-wide or across a subset of buildings. Focus on load reduction before equipment efficiency, since load-reduction measures can reduce the capacity of new equipment. Collect information for future ECMs while in the buildings. Additionally, pilot projects can be used to evaluate projects in preparation for broad and rapid implementation, while mitigating risks.

Implement Deep Retrofit & Building Specific Measures: Use information collected from previous projects to analyze individual buildings for deep retrofits. Use energy modeling on select buildings to identify patterns and then implement ECMs portfolio-wide when possible. When using energy modeling, utilize information collected during previous steps for energy-model calibration.[4] Create building-specific road maps that time implementation based on end-of-useful-life of equipment, as illustrated in Figure 8. Road maps can be developed to plan the chronology of deep retrofits for individual projects. In many cases, buildings are not "ripe" for a deep retrofit because they require a major piece of equipment to reach the end of their useful life in order for a retrofit to be economically feasible, so that an upgrade can be made using incremental cost. Developing road maps can facilitate portfolio planning by adding visibility to when each building on campus will be ready for a deep retrofit and shifting investment from reactionary to proactive. Achieving deep retrofits in buildings and campus-wide carbon reduction are not mutually exclusive.

[4] FURTHER GUIDANCE FOR MODEL CALIBRATION CAN BE FOUND IN THE ASHRAE Guideline 14 - GUIDELINE 14-2014 -- MEASUREMENT OF ENERGY, DEMAND, AND WATER SAVINGS

Figure 9: **Deep Retrofit over Time**



Monitor & Optimize: Use ongoing commissioning, training, proactive maintenance, behavioral programs, and energy monitoring to maximize performance and ensure persistence. Develop a plan early in the retrofit process to minimize cost. Monitor the market for new technologies and reduction in cost.

Also monitor the market for new technologies and approaches. As they become market ready and viable, add them to the plan. Examples: microgrids with electric vehicles (EVs) as system load-balancing batteries, and integrating all systems to communicate with users about dynamic pricing signals.

10 INCREASE THE PACE & ACCURACY OF PLAN DEVELOPMENT

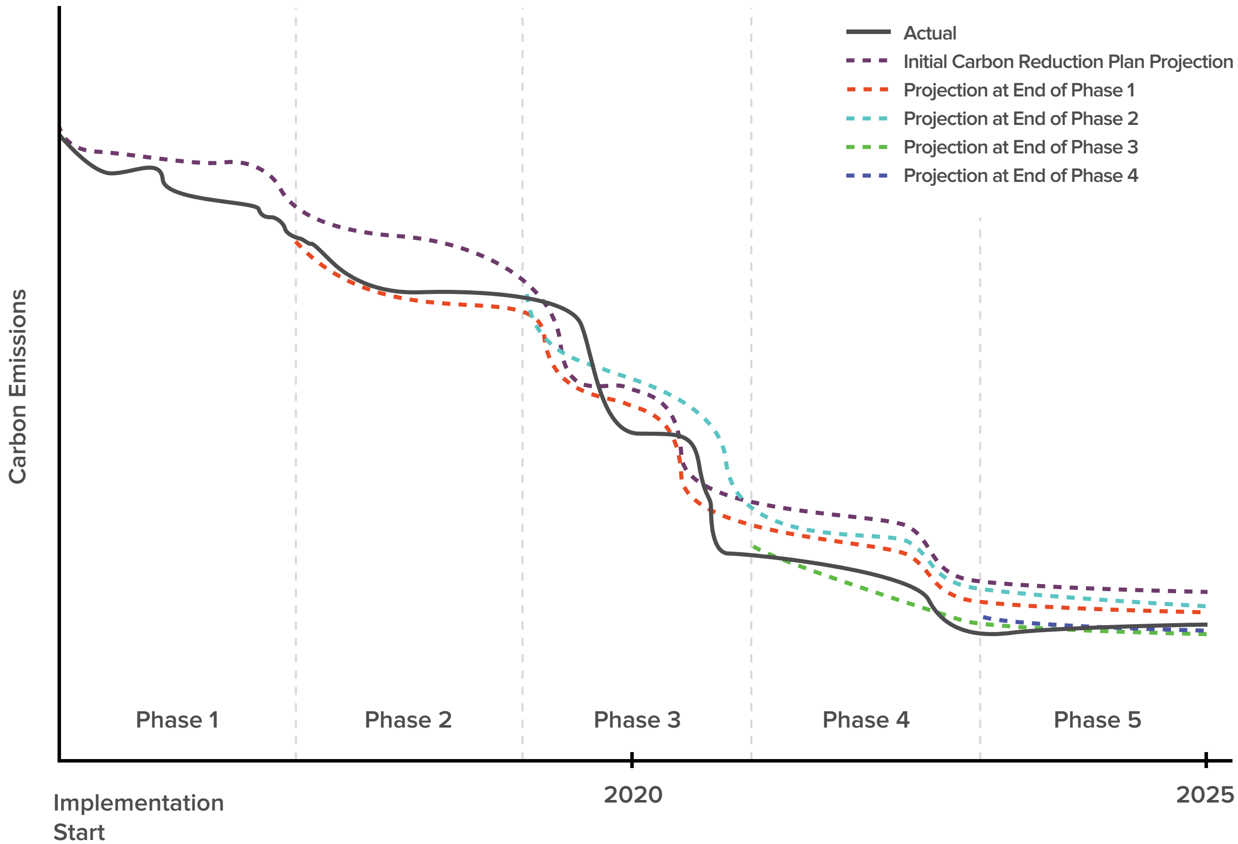
INCREASE THE PACE AND ACCURACY OF PLAN DEVELOPMENT

CONCEPT

Ideally, a climate action plan would be developed, approved, and executed in one pass. In reality, this is not usually feasible. As George E.P. Box stated, “Essentially, all models are wrong, but some are useful.” Large amounts of time and money can be invested in developing a plan, just to have a dynamic situation make it quickly obsolete. Consider spending less time upfront and establishing feedback loops to continuously learn from projects and refine the plan.

Figure 10 illustrates how carbon reduction targets can be refined at each phase of the project based on project learnings.

Figure 10: **Iterative Climate Action Plan Adjusted at Each Phase to Increase Accuracy Based on Learnings**



Benefits:

- Reduces time required to develop the initial plan
- Shifts from a static to a dynamic document
- Ensures continued focus on the plan
- Allows data to be collected over time, especially when information is incomplete or poor quality

Similar to this insight, green revolving funds enable carbon-reduction (e.g., renewable energy, energy efficiency) projects to be implemented without having a climate action plan completely finalized. The internal fund is used to finance projects and the project savings are tracked and used to replenish the green revolving fund. This can be an excellent way to build momentum for a climate action plan. It is recommended that a green revolving fund be implemented as part of a climate action plan, so that the overarching plan can be used to prioritize projects and ensure that whole-system thinking is incorporated into the decision-making process.

CASE STUDY

Second Nature, one of the founding, organizing, and supporting entities of the American College & University Presidents' Climate Commitment (ACUPCC), has been redefining the resources it provides for the ACUPCC. Through regular engagement with leaders in higher education, the signatories' progress towards reaching their carbon goals, and white papers on climate commitment implementation, Second Nature has realized a change in the needs of ACUPCC signatories. Due to internal turnover, momentum loss, and much of the low-hanging fruit having already been implemented, Second Nature has seen a lull in the progress higher education has been making towards climate neutrality goals. Therefore, Second Nature is developing further iterations of the initiatives and specific programs they provide to ACUPCC members to ensure they continue to progress towards their climate commitments.

IMPLEMENTATION

Note that individual carbon-reduction projects and the overall climate action plan are being addressed as different activities. In many cases, the plan is expected to be completed and approved before projects are implemented. An alternative approach is to spend less time on the plan initially, implement projects, and use the results of the projects to inform the overall climate action plan. This has several benefits, as described in the concept section above.

Because this process will result in investments occurring with a more-preliminary climate action plan, it is important to work with campus leadership to determine if this approach is acceptable. If approved, start with a broad, high-level, and agile approach to develop initial overarching carbon-reduction goals. Align data collection to this level and ensure team members do not "over deliver" during this phase and negatively impact the timeline and project budget. Project initial carbon-reduction targets for the entire project timeline. In Figure 10, this is illustrated as the "Initial Carbon Reduction Plan Projection" with a dashed purple line.

Implement early projects and compare results to initial carbon-reduction projections. In Figure 10, these early projects are labeled "Phase 1." The dashed purple line illustrates the initial projection and the solid black line illustrates actual result for each phase. Use the learnings to develop an updated projection for remaining project phases. Continue to implement, compare to estimates, and correct the overall climate action plan's projection.

The climate action plan will need to include estimated cost, which can be really difficult to estimate at the early phases of the plan's development. An iterative approach can reduce the burden by focusing detailed cost estimation on early projects.

To further streamline the early phases of the climate action plan, strategically collect and analyze data. Trying to collect large amounts of detailed data at the beginning of the planning process can have a negative impact on budget and cause "data-analysis paralysis." Define what data is critical for a given phase. Where data doesn't exist, consider using a proxy to help answer pressing questions. Table 8 provides a few examples of why data can be so difficult to collect and analyze quickly and cheaply.

Table 8: **Examples of Common Data Issues Associated with Buildings**

DATA TYPE	ENERGY-METER & BUILDING-AUTOMATION-SYSTEM DATA
Common Issues of Data Not Being Available	Buildings not individually metered, especially central systems such as CHW and steam. Meter not capable of collecting at appropriate interval (e.g., manual meter reading instead of digital meter). Automation system trend logs not initiated. Desired data points not available (e.g., no sensor)
Common Quality Issues of Data	Meter scaling factor incorrect, sensor out of calibration, sensor poorly located, no units (e.g., kW) provided with data output, output files not consistently formatted, no standard naming conventions, difficult to understand file names and no description, time intervals inconsistent or too long, data falling outside of range are zeroed

One approach to avoid collecting large sets of operational and submeter data is to prioritize projects on a building-by-building level using energy benchmarking. Building energy benchmarking compares a building against a peer group using software, such as Energy Star Portfolio Manager or FirstFuel FirstAdvisor, or by developing a custom peer set. ***This approach has several potential shortcomings:***

- Project economics can be impacted more significantly by asset condition and similar variables than by energy use (for instance, if a chiller is failing in a building and incremental cost can be used for the energy upgrade
- Energy streams may not be submetered at the building level (e.g., chilled water, steam)
- Portfolio-wide solutions may be more effective than building-by-building solutions for achieving carbon reductions (e.g., lighting, controls, retrocommissioning). Portfolio-wide solutions may be just as economically feasible in a building that benchmarks well as a building that doesn't
- Benchmarking can prove difficult with unique facilities or facility uses due to a lack of peer buildings

Benchmarking can provide insights about the portfolio and should be completed, but it is recommended that it be done quickly and placed within the context of a broader and more comprehensive methodology.

Resources:

- For additional information on using an iterative design procedure refer to the American National Standards Institute's (ANSI) Consensus Standard Guide 2.0 Integrative Process.

Green Revolving Funds:

- Sustainable Endowments Institute
- The Billion Dollar Green Challenge
- Report: Green Revolving Funds: An Introductory Guide to Implementation & Management
- Report: Greening the Bottom Line
- College Endowment Investment Trends and Best Practices (analysis from STARS data)
- Green Revolving Investment Tracking System (GRITS)

11 REDUCE LOADS TO REDUCE EQUIPMENT CAPACITY

REDUCE LOADS TO REDUCE EQUIPMENT CAPACITY

CONCEPT

System capacity derives from peak demand; therefore reducing loads can reduce equipment size and cost. Energy-efficiency investment is typically considered to reach a point of diminishing returns (see Figure 11), but leveraging capacity reductions can allow much deeper investments in efficiency while achieving higher returns (see Figure 12). RMI's cofounder, Amory Lovins, coined the phrase "tunneling through the cost barrier" for this type of occurrence.

Figure 11: **Investing to Point of Diminishing Returns**

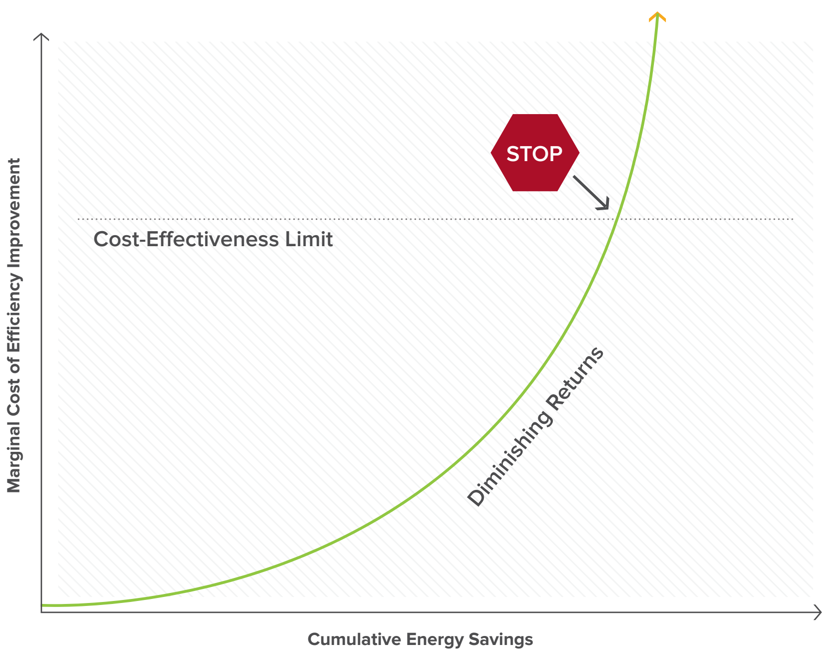
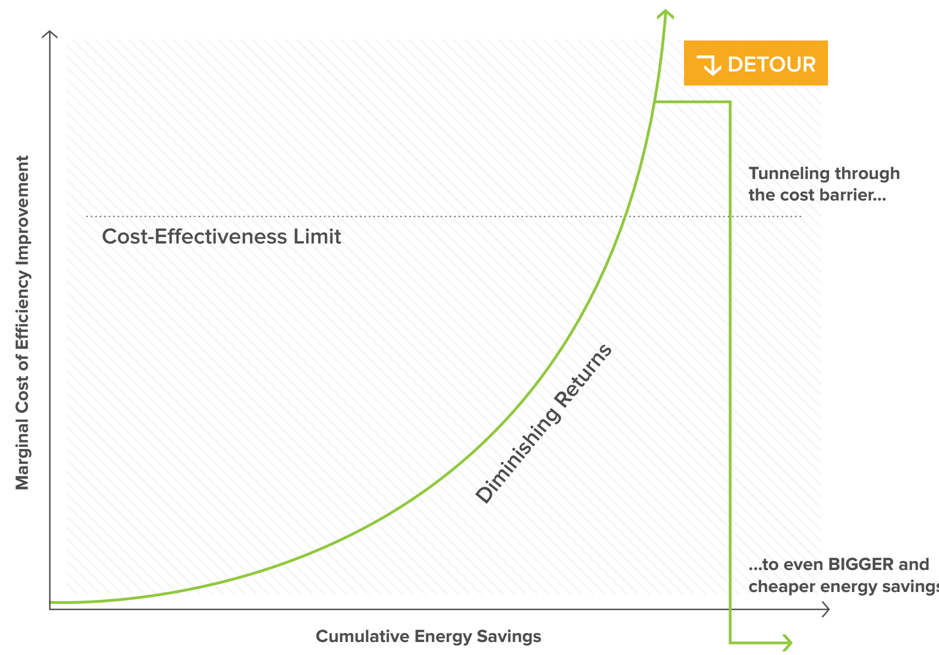


Figure 12: **Tunneling through the Cost Barrier**



The biggest impact of load reductions can be seen at the central plant. By reducing building loads, the central plant can avoid significant infrastructure investments. For rapidly expanding campuses, it can allow rapid square-footage expansion without additional infrastructure investments.

CASE STUDY

While working with Arizona State University and Ameresco on their carbon-neutrality plan, RMI explored how reduced loads impact equipment capacity at the campus level. The largest opportunity identified was the potential to reduce cooling-equipment capacity at the central plant through energy-efficiency projects that reduce cooling load across the portfolio. This aggregated cooling-reduction rolls up to significant savings at the central plant.

The capacity of the central-plant equipment (e.g., chillers) is determined based on the peak-cooling load. Each of the examples above help to reduce this peak load. Because Arizona State University's campus is growing, this has the potential of eliminating or reducing the need for expanded cooling capacity in future years as additional buildings are constructed and connected to the central plant. Additionally, when the cooling system reaches the end of its useful life, it can be replaced with a smaller system, reducing cost.

A few examples of how this can occur are provided below:

- Improving a building's envelope by installing high-performance windows, adding shading, increasing insulation, or making outside surfaces more reflective (such as a white roof) reduce cooling load
- Increasing the efficiency of equipment within a building will reduce heat dissipated into the space. For instance, replacing T12 fluorescent lighting with LEDs can cut the amount of heat introduced by lighting in half
- Many HVAC systems can be optimized to more effectively deliver cooling. Variable-air volume systems with reheat commonly cool air using chilled water and then reheat the air to temper at least a portion of the spaces. Modifying the systems or optimizing the control of the systems can reduce chilled-water consumption

IMPLEMENTATION

While the central-plant reductions can provide the most significant cost savings, these savings can also be the most difficult to capture. The savings in central-plant infrastructure are accounted for in different budgets than those in which the costs for the energy-efficiency projects are accounted for.

Project teams must coordinate with the central plant to understand the potential cost savings and plans for future infrastructure upgrades that could be avoided. All of these issues stem from the department silos that often plague universities. A central oversight committee or department is often required to look for these high-level opportunities and bridge multiple departments.

In order to account for the potential infrastructure savings at the central plant, the energy savings for each project must be accurately quantified and aggregated. Often, these savings must be quantified during the design process to justify additional investment in energy savings measures. These savings can best be quantified using building models. Depending on the certainty required by decision makers, a simple model requiring little detail could be used to provide a ballpark figure, or a more-detailed hourly model could be provided by the design team with greater accuracy.

Once anticipated savings are developed with the model, a central oversight committee (or other organization bridging capital projects and central plant) can look at the potential savings in light of other potential energy savings projects and future plant capacity and maintenance requirements. This approach is best for larger retrofits or a large energy-performance contract where a significant amount of energy savings is projected, as it will be hard to aggregate many smaller, uncertain projects.

Asset-management software to manage and plan central plant-infrastructure requirements can facilitate tracking of future plant upgrades and capacity constraints. There are several software options available, but the key is integrating the software into department policies and decisions.

Resources:

- Empire State Building case study on tunneling through the cost barrier
- FirstFuel FirstAdvisor
- The Association of Physical Plant Administrators (APPA)

12

CAPITALIZE ON PLANNED MAINTENANCE & INCREMENTAL COSTS

CAPITALIZE ON PLANNED MAINTENANCE AND INCREMENTAL COSTS

CONCEPT

When a piece of critical equipment fails, it must be replaced, at a minimum, with a one-for-one piece of equipment. For instance, if a ten-horsepower motor fails, the one-for-one replacement would be another ten-horsepower motor with the same efficiency. This business-as-usual expenditure will be incurred whether or not equipment efficiency is upgraded, therefore the additional cost of a more efficient motor should be considered an incremental cost.[5] When evaluating the project's ROI or payback periods, only the incremental cost for the more efficient motor should be included.

A secondary benefit to piggybacking on planned maintenance is reduced disruption to occupants. "Nice to have" energy retrofit projects often have difficulty accessing spaces with no swing space and packed schedules. As a result, they are often fighting for access during breaks, along with many other maintenance and upgrade projects. If the efficiency upgrade is part of the required equipment maintenance, it doesn't face any additional access constraints.

Due to these space constraints, a key opportunity for leveraging existing work is during a break in occupancy. This can be accomplished during a change of use or during a significant planned retrofit to address existing issues. Such occurrences present significant opportunities to access the space and should be utilized to implement a deep retrofit.

In order to take advantage of incremental cost opportunities, efficiency projects must piggyback on planned equipment maintenance and unplanned failures. This requires significant planning in coordinating equipment maintenance with retrofit opportunities. This should also influence how retrofits are prioritized across the portfolio. Taking advantage of an upcoming planned maintenance is crucial and could drive a project to a higher priority than previously planned projects. This level of coordination requires central oversight able to understand both capital projects and maintenance timelines. This is often difficult in siloed organizations, but asset-manager software can help manage the required information.

[5] DEFINING WHAT CONSTITUTES "END OF USEFUL LIFE" OF EQUIPMENT IS ALSO A CRITICAL STEP IN THIS PROCESS.

CASE STUDY

Table 9 provides implementation-cost data for a renovation of the Empire State Building. The business-as-usual column provides costs for projects that had to occur anyway due to upgrades to the building. The upgrade costs are optional expenditures to improve the energy efficiency of the building. When the economics for the energy-efficiency upgrades are calculated independently, the project results in a 24-year simple payback. When the business-as-usual scenario is taken into account and the incremental and avoided cost of the upgrades is used in the economic evaluation, the simple payback drops to just three years. One key reason for the dramatic improvement in economic return is because the chiller-plant capacity was going to have to be increased in the business-as-usual scenario, and the capacity increase was avoided by improving windows, lighting, and the radiative barrier to reduce cooling loads. This is phenomenon of “tunneling through the cost barrier” discussed earlier in the document.

Table 9: **Empire State Building Incremental-Cost Example**

BUILDING UPGRADE	BUSINESS-AS-USUAL COST	UPGRADE COST	INCREMENTAL COST
Windows	$455k	$4.5m	$4m
Radiative Barrier	$0	$2.7m	$2.7m
DDC Controls	$2m	$7.6m	$5.6m
Chiller Plant Retrofit	$22.4m	$5.1m	-$17.3m
VAV AHUs	$44.8m	$47.2m	$2.4m
Tenant Day/Lighting/Plugs	$16.1m	$24.5m	$8.4m
Tenant Energy Mgmt.	$0	$365k	$365k
TOTAL:	**$85.8m**	**$92.0m**	**$6.2m**

IMPLEMENTATION

The opportunity to leverage incremental cost occurs a limited number of times throughout a building's lifespan, and once a piece of equipment fails, it normally must be replaced immediately. To prepare for these eventualities, an asset database can help map estimated end-of-useful-life of equipment across the campus. Since end-of-useful-life significantly changes the economics of many energy-efficiency projects, the database can also be used to prioritize projects. **Business-as-usual costs identified with the asset database will likely dominate project economics relative to energy benchmarking, and therefore should be prioritized for portfolio planning.**

The active planning provided by an asset-management program allows bigger projects to take advantage of opportunities to access the space during a planned renovation or change of use. Often, a significant space renovation or change of use is an ideal time to implement multiple projects on many interconnected building systems to perform a deep retrofit. These deep retrofits focus on reducing loads across many systems to the point where primary heating and cooling systems can be downsized. This retrofit approach can be extremely powerful but requires more planning and design time than a standard isolated project. This requires significant lead time before a planned event that the deep retrofit could piggyback on and use incremental costing. This amount of preplanning is crucial and can be provided by an asset-management system.

Resources:

- http://www.rmi.org/retrofit_depot_101_specifying_triggers

CC CONCLUSION

CONCLUSION

Hopefully, through this guide and the 12 insights highlighted in it you have identified at least a few actionable concepts that will supplement the development of your campus's climate action plan. Focusing on people associated with developing and implementing the plan, as well as those who must ensure persistence of performance after implementation; focusing on campus policies and ensuring they facilitate successful implementation of the plan; and focusing on how the plan itself is developed, refined, and implemented will ensure a well-rounded approach.