Prioritization of Sustainability Projects at Cornell

A Report for Cornell University Energy and Sustainability

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Think BIG LIVE GREEN

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Executive Summary

Sustainability at Cornell University is a complex process with many interested parties and stakeholders. A number of projects are in the pipeline for implementation on campus, and Cornell University Energy and Sustainability (E&S), a department with the obligation and opportunity to provide reliable, cost-effective, sustainable energy and water to campus, to develop a financial model with which to evaluate the projects. By conducting primary and secondary research, observed systems and developed a method with which to evaluate projects, as well as developed a set of recommendations to help Cornell reach its 2035 Carbon Neutrality goal. After discussions with experts in infrastructure and environmental finance, and consultations with our client, E&S, the team decided to base our model on the Net Present Value Plus (NPV+) method that incorporates actual cash flows and value considerations, which are important to the University but may not have a direct cash flow, such as carbon emissions.

Based on our research of sustainable infrastructure financing, cost/benefit models, and interviews with experts on sustainability, including members of the Senior Leaders Campus Action Group (SLCAG), we developed a set of recommendations that we believe will help Cornell reach its 2035 Carbon Neutrality goal.

Our interviews with Cornell faculty and staff who are members of or were recommended by SLCAG were very illuminating regarding the attitudes and perceptions about sustainability among members of the Cornell community. Based on these interviews, we arrived at four major findings:

1) Sustainability is not the top consideration for many projects at Cornell; it is one of many factors considered, including function, aesthetics and design
2) A high level of bureaucracy exists within the University, with many decision-makers and influencers; this necessitates extensive buy-in for approval of projects
3) The best buy-in will occur from a multi-disciplinary assessment of proposed projects
4) Colleges control most budgets and spending, but have little incentive to spend on projects which reduce energy consumption because projects are currently evaluated using a method (payback period) in which not all relevant costs are considered

To address these findings, we came up with five primary recommendations for Cornell E&S and the Cornell Administration:

1) Increase focus on the “quadruple bottom line”

   Continue to align academic purpose with sustainability to facilitate learning and empowerment. Submit proposals for sustainability-oriented projects through Engaged Cornell.
2) Create a roadmap to carbon neutrality by 2035 that is endorsed by the president of the University

   The NPV+ model we created can be used by E&S to evaluate projects and prioritize them on a roadmap so that budgets can be set and resources directed toward achieving carbon neutrality by 2035. Sustainable design can be further supported through the Development Office in soliciting donors favoring sustainability.
3) Align financial incentives to encourage sustainability projects in colleges across Cornell University

   Colleges need to reflect sustainability in their operational budgets, which the university can incentivize.
4) Increase financial training for administrators

   Understanding the time value of money is critical to making smart budget decisions, and using the NPV+ model we designed rather than the payback period method of evaluation currently used will enable administrators to account for gains and losses across numerous indicators over the lifespans of projects.

5) Enhance sustainability leadership from Senior Administrators, Trustees and Donors

The University needs to create an expectation that units include long-term maintenance costs in annual budgets to reflect actual lifespans of materials and resource consumption. Sustainability needs to be reflected as a true priority of University leaders in order to be sufficiently factored into decision-making and budgets across Colleges and University units.

Introduction

Energy & Sustainability (E&S) supplies and manages energy and water resources for Cornell University's Ithaca campus, and leads the sustainable campus transformation. E&S has about 50 members in its unit, and is looking for a new way to evaluate capital investment projects that will decrease use of resources. Cornell University has a long history of leadership in sustainability research and project implementation, and the university is working to address its own environmental footprint. E&S would like to develop a comprehensive cost-benefit framework for evaluating potential sustainability investments (e.g., renewable energy projects or energy conservation initiatives). Currently, Cornell does not consider the value of the environmental attributes or other benefits associated with projects as a part of the overall economic analysis. Accounting for the value of environmental attributes and other associated project benefits could substantially improve the viability of such projects and advance our sustainability efforts and, ultimately, influence decision-making.

The three tasks incorporated in this project were to: 1) Review economic analysis of past projects involving renewable energy supply and energy conservation (Energy Conservation Initiative projects, new buildings, and renovations) and document NPV calculation practices; 2) Research various strategies for valuing environmental attributes and other intangible benefits (for example the Global Footprint Network's NPV+ model) and document and compare potential options; and 3) Develop a recommended strategy in consultation with E&S and Division of Financial Affairs staff and create a spreadsheet/tool for performing the analysis. This paper will address the analysis, discuss our research, compare and contrast models, introduce the model we ultimately chose and designed, and present our recommendations.

Sustainability at Cornell is a complex process with many interested parties and stakeholders. There are a number of projects waiting for implementation on campus which needs to be evaluated and prioritized. Cornell University's leadership has committed to achieving a goal of Carbon Neutrality by 2035. By developing a system to evaluate projects, Cornell can work towards implementing these sustainability projects and achieving the goal of carbon neutrality.

To date, Cornell has undertaken a number of projects that have cost millions of dollars each year. These projects include building energy conservation projects, building energy conservation studies and lighting upgrades to buildings on Cornell's Ithaca campus, off-campus, other real estate, and campus life and dining facilities. To fund these projects, Cornell has aggressively pursued NYSERDA funding and other alternative funding and financing sources available (Howe, 2013). In order to determine whether a project will be undertaken and who will do the work, a number of factors are taken into account (Cornell Energy and Sustainability). The purpose of the project is to research, analyze and recommend other methods of evaluation than Cornell's current methods, or adaptation those models. This paper will discuss the current method, as well as other possible methods that could be used.

Through research, reading and primary research, we observed systems and developed a method with which to evaluate projects, as well as developed a set of recommendations to help Cornell reach the 2035 Carbon Neutrality goal. We began with reviewing literature available on this topic—becoming familiar with the various types of evaluation models, researching how other institutions undertake similar projects, and investigating how carbon dioxide (CO_2) and other greenhouse gases are valued in order to determine the proper indicators for the model we would build. Our next steps involved comparing and contrasting existing models to be sure we selected the most appropriate model. We began interviewing experts in sustainability and finance initiatives and other topics on campus as well as off campus to inform our decision making. Ultimately we concluded that the NPV+ model was best, as it values both indicators that have actual cash flows associated with them, such as the operations and maintenance costs of a project, as well as indicators that don't have real cash flows associated with them although they are important to the model user, such as CO_2 emissions.

We also examined and tried to understand decision-making bodies around the university, and worked to choose and build a defensible model that had broad appeal across many groups. Throughout this paper, we hope to demonstrate the rationale behind our research conclusions and model, and make suggestions that will ultimately help Cornell University become more environmentally sustainable through the adoption of projects which reduce resource consumption and the carbon footprint.

Literature Review

The Future of Renewable Energy

The Solutions Project is an organization that is working to accelerate the transition to 100% clean, renewable energy for all people and purposes through public and leader engagement and lobbying primarily at the state level. According to the Solutions Project, the projected energy mix for the U.S. in 2050 consists of water, wind and solar. The approximate blend is 48.4% wind and 46.8% solar, with the remaining 4.8% coming from water and geothermal sources (hydroelectric 3.9%, wave + tidal 0.4%, geo 0.5%). This projection varies by state depending on their natural resources, and New York's proportion is approximately 50% wind, 42.6% solar, 7.4% coming from water sources (hydroelectric 6.5%, wave + tidal 0.9%) (The Solutions Project, 2016).

A 2015 research project conducted by the Solutions Project in conjunction with a professor of civil and environmental engineering at Stanford University, Mark Jacobson, analyzed the current amount and source of fuel consumed – coal, oil, gas, nuclear, renewables – and calculated the fuel demands if all fuel usage were replaced with electricity (Jacobson, et al., 2015). If all fuel consumed, including that consumed in cars, homes and industry, is replaced with electricity, "across all 50 states, we saw a 39 percent reduction in total end-use power demand by the year 2050," Jacobson said. "About 6 percentage points of that is gained through efficiency improvements to infrastructure, but the bulk is the result of replacing current sources and uses of combustion energy with electricity" (Carey, 2015). The grid would be powered by renewable energy sources, which vary depending on the resources available in each state. This is a significant reduction in consumption, and Cornell has a role to play in responsible energy consumption by becoming carbon neutral by 2035 (The Solutions Project, 2016).

Cornell's Emissions-related Goals

In 2014, President Skorton announced that Cornell would accelerate the campus carbon neutrality goal from 2050 to 2035, that is, net campus carbon emissions would be zero by 2035. The Senior Leaders Climate Action Group (SLCAG) is charged with developing a plan that will move the campus toward this goal with a broadly based approach that relies on a number of technologies, rather than the previous plan which relies largely on geothermal energy. (Keller, 2016)

When President Skorton announced that Cornell was advancing its goal toward carbon neutrality to 2035, he stated that, "We are fortunate that we can build on our ongoing efforts to make our campus more sustainable through our traditions of collaboration in education and research across our colleges, schools and administrative units. By intensifying our commitment to carbon neutrality, we have the potential to develop new approaches, applications and technologies that will be valuable on our own campus and globally" (Friedlander, 2015).

Cornell aims to prioritize investment and develop a realistic timeline for its transition to renewable energy through a long-term Energy Procurement Plan. Part of the University's next step to achieve this goal is to hire a consultant to complete a load profile and perform a market analysis of available external projects (wind, solar, geothermal, biogas, and hydropower) that could be incorporated into Cornell's long-term energy portfolio. Based on the consultant's recommendations, SLCAG can develop the plan to move towards the Carbon Neutrality goal (Cornell University, 2013).

Cornell's Current Carbon Usage

As of April 2015, Cornell emitted approximately 182,000 metric tons of CO_2 equivalent (CO_2e) each year from heating, cooling, and electrifying the Ithaca campus along with emissions from fleet vehicles. This was a significant decrease from 2008, when Cornell's estimated carbon footprint was 319,000 metric tons of CO_2-equivalent. Cornell created 19 initiatives to help achieve its goal of net zero emissions, which consist of five main categories (Cornell Climate Action Plan, 2009):

Green Development	**Energy Conservation**	**Alternative Transportation**	**Fuel Mix and Renewables**	**Offsetting Actions**
Building energy conservation	Building energy standards	Commuter travel	Hybrid E.G.S. system	Defined offsets
Conservation outreach	Improved land use	Business travel	Wind power	Undefined offsets
Steam line upgrade	Space planning and management	Campus fleet	Turbine generator replacement	Community offsets
Smart grid			Upgraded hydro capacity	
			Wood co-firing	
			C.U.R.B.I.	

The emissions are categorized into three types at Cornell University:

- Scope 1 emission: natural gas combustion at the Cornell Central Energy Plant for heat and electricity (presently exempt from carbon taxation, but likely to be brought into mandated tax in the future) along with fuel use by fleet vehicles;
- Scope 2 emission: purchased electricity bought from the power grid;
- Scope 3 emission: emissions related to business travel (the total commuting and business travel footprint is roughly 59,000 tons (CO_2 equivalent) and about 27% of Cornell's current annual carbon emissions) (Carbon Charge Working Group, 2015).

Valuing Carbon

There are many ways that carbon is valued, which is often referred to as the social cost of carbon. Many organizations including the United States Congressional Budget Office, and other universities like Yale have placed a value on carbon. Attempting to value carbon emissions has been done for some time, and many organizations within the United States have been working at it since the mid-2000s. The primary environmental objective of a charge on carbon is to set a price that reflects the "real" costs such emissions impose—accounting for the damages that are expected to arise from climate change, including effects on agricultural productivity and human health, coastal inundation, and other changes. Cornell is considering four major categories of carbon accounting systems to implement a carbon charge. Once a method of carbon charge is selected (if at all), the charge would be implemented according to the descriptions below:

- Shadow Carbon Charge: Cornell would begin to include information on the carbon content on utility bills and a "shadow charge" that would indicate a cost of embedded carbon for their utilities as if there was a charge.
- Revenue Neutral Carbon Accounting: Units (which can include colleges, but also includes non-academic entities within Cornell, such as E&S) within Cornell pay if they exceed their emission target, and all the money a college pays for emitting carbon is later returned, making the overall process revenue neutral.
- Traditional carbon charge: A specified charge would be levied on specific campus activities such as utility use or fleet vehicle use. Billing units would be responsible for the payment of these charges and administrative units would ensure that collected resources are appropriately allocated to projects that reduce carbon emissions.
- Cap and Trade: A Cornell marketplace for trading carbon credits between units would be created where colleges below their emission target could receive funds from the sale of carbon credits to colleges that are above their target.

The highest-rated university carbon reduction model, in terms of cost efficiency of implementation, simplicity of administration, and educational/demonstration value, is Revenue Neutral (British Columbia Style carbon tax) (Carbon Charge Working Group, 2015).

Cornell's Current Methodologies for Renewable Energy Analysis

Cornell has been conducting its own renewable energy analysis for the University as a whole, using basic assumptions:

- The annual purchase is 50,000 Megawatt-hours (Mwh)
- The starting price is $50
- The rate increases at 3% annually
- Contract year: 15 years (2017-2032)

Cornell projects the NPV over a 15-year period. The NPV is calculated from different price scenarios (fixed price, floating price low, floating price base, floating price high). The annual discount rate for NPV calculation varies from 5% to 8% (Zemanick, 2016).

Phase I of the Energy Conservation Initiative (ECI) aims to undertake roughly $33M in projects that meet the criteria for either a 7-year billed or 10-year marginal payback. Phase 1 projects are expected to reduce Ithaca Campus utility costs by over $3 million per year by 2016. Phase 1 was launched in 2010 and was completed in 2015. As of spring 2016, Phase 2 projects are just starting to begin, and would stretch the payback criteria to 20 years marginal or 15 years billed – to enable further energy reductions throughout campus facilities (Cornell University, 2013). Marginal cost is the commodity only cost; while billed cost is the "all in" cost of supplying the utility to the end user, including Central Energy Plant personnel, debt servicing, maintenance, and operations. Phase 2 of the Energy Conservation Initiative aims to reduce Cornell's marginal utility costs by $1.5 million per year. The work will focus on heat recovery in buildings with 100% outside air, full campus LED lighting conversion, further controls upgrades, and building envelope improvements (Cornell University, 2013).

Carbon Pricing

The price of carbon has been set by various organizations, which have a significant range. Two examples are:

- The US Congressional Budget Office assessed carbon at $20 per metric ton in 2012 and is raising that price at a nominal rate of 5.6 percent per year. The price per ton of carbon in 2016 would grow to $24.87.

- Yale University assesses their carbon emissions in various ways:
  - the cost of their sustainability programs ($2-15 per ton CO_2e);
  - Carbon price in cap and trade markets (currently $4 -$15 per ton CO_2e);
  - Social cost of carbon ($40/ ton in federal regulations);
  - Forecasts of CO_2e price by companies ($10-$100 per ton CO_2e) (Carbon Charge Working Group, 2015).

Internationally, there has been a plunge in oil prices and a change to accelerate energy price reforms. A number of countries adopted carbon pricing through carbon emission trading schemes (ETS) or carbon taxes. There is also a growing interest in new infrastructure investment and finance. Extremely low long-term real interest rates provide an extraordinarily favorable financing environment for infrastructure investment. A World Bank Report states that if carbon pricing were widely adopted around the world, an appropriate average price would be $50 per ton of CO_2 (The Global Commission on the Economy and Climate, 2015).

Currently, Cornell's all units and colleges purchase renewable energy from internal sources (solar, hydro, etc.) at a slightly higher cost ($.02 per kWh), and revenue generated through the surcharge is used to implement small energy conservation projects (Carbon Charge Working Group, 2015).

Cornell is seeking innovative financing mechanisms. This is an "enabling" action that will facilitate other priority actions by identifying alternative sources of funding for both capital and operating expenditures. Cornell E&S will explore innovative financing mechanisms such as a systematic way to identify grant opportunities, third-party ownership of solar, wind, and other renewable energy facilities, and strategies to support the work of the Green Revolving Loan Fund action team. Successful full-scale implementation of innovative financing methods will also require investment in university infrastructure to optimize the heat distribution system, as well as to develop the biomass technology (e.g. gasification) and feed stocks (e.g. regional supply, transportation logistics, etc.) needed to optimize the system to handle the campus heating load (Cornell University, 2013).

Cornell's Public Climate Action Acceleration Report recommended that an appropriate carbon charge be added to utility bills to reflect the carbon emissions associated with campus steam, chilled water, and electricity production. Year 1 is recommended with costs in the $20-$30/ton range. As an example, a charge of about \$24/ton CO_2 would raise approximately \$3M per year, representing about 6% of the campus utility bill (Cornell University, 2013).

NPV+

Our research into NPV+ led us to a document that discussed the valuation of natural capital in California. The valuation method called Benefit Transfer Methodology (BTM) is used to estimate the economic value of ecosystem services. The minimum total value of Santa Cruz County's natural capital as an economic asset is between \$22 billion and \$61 billion, calculated over 100 years at a 3.5% discount rate since it is widely used in the private market. This conservative approach to valuation treats natural capital in a similar manner as built capital (i.e. depreciating its value over time). However, since natural capital is not degraded or depleted and will likely continue into the future, a 0% discount rate was used, bringing the natural capital asset value to between \$81 and \$220 billion. BTM is a validated and well-established methodology that estimates the value of ecological goods or services by using primary studies in comparable locations (Schmidt, Lozano, Robins, Schwartz, & Batker, 2014).

Ecosystem Service Valuation methods were used in primary studies as various ways to value different aspects of Santa Cruz County. The three approaches used to value various types of natural resources include revealed preference approaches, cost-based approaches and stated-preference approaches. Approaches and methods of costing are described in the Table 1.

Table 1

Ecosystem Service Valuation Method		Description
Revealed preference approaches	Market pricing	Used to value products that are sold in markets, such as timber, agricultural products and water.
	Travel cost	Based on the cost of travel required to consume or enjoy ecosystem services. Travel costs can reflect the implied value of the service. For example, recreation areas attract tourists whose value placed on that area must be at least what they were willing to pay to travel to it (i.e. lakes, reservoirs).
	Hedonic Pricing	The value of a service estimated by comparing the prices of similar, but non-identical goods under the assumption that the price of a good can be broken down into its attributes (i.e. hedonic value would be the difference between the price of a house on the coast versus a similar inland house).
	Production approaches	Service values are assigned from the impacts of those services on economic outputs (i.e. Improvement in water health leads to an increase in commercial and recreational salmon catch).
Cost-based approaches	Replacement cost	The cost of replacing an ecosystem service with a man-made system (i.e. replacing a watershed's natural filtration service with a man-made water filtration plant).
	Avoidance cost	The value of avoided or mitigated costs which would have been incurred in the absence of those services (i.e. if wetlands are lost, additional costs are incurred during storms as coastal property is damaged).
Stated-preference approaches	Contingent valuation	People are asked to state directly what they would pay for a certain environmental service (i.e. willingness to pay to preserve a local wilderness area for aesthetic reasons).

(Schmidt, Lozano, Robins, Schwartz, & Batker, 2014).

This study also focused on Natural Capital Stewardship. The investment in natural capital through stewardship improves ecosystem services, therefore improving human prosperity and health, bringing multiple benefits. These benefits can include securing crop yields, protecting water resources, controlling pests, and producing nutritious foods when an investment is made in protecting natural regulating services such as soil formation and soil retention. If wetlands are invested in and protected, "the results showed these wetland types sequester approximately 2.1 and 4.7 metric tons of CO_2 per acre per year respectively. Based on the current price of a metric ton of CO_2 in California's cap and trade program ($11.50), each acre of wetlands restored or created could therefore have an annual market value of between $24 and $54 for carbon sequestration." Stewardship of natural capital also avoids costs. "A well-known example is New York City, which chose to invest $1.5 billion in watershed protection in its Catskills watershed, and has saved $6 billion in capital costs and $300 million in annual operating costs for a filtration plant it would otherwise have been required to build."

The study also included a case study on the economic benefits of stewardship investment. This was done through ROI and Benefit-Cost Analysis (BCA). The measurement of ROI has been proved to be superior to other decision-making tools for ensuring cost-efficiency and the maximization of benefits. In the case study, costs were estimated as one-time costs, maintenance costs, and opportunity costs. Overall, this document illustrated multiple valuation methods, such as the BTM and Ecosystem Service Valuation Methods within the NPV+ model, which may be appropriate for using in Cornell's valuation. However, this would require a more complicated model that may not be as user friendly (Schmidt, Lozano, Robins, Schwartz, & Batker, 2014).

Cornell's Projects

To date, Cornell has undertaken a number of sustainability projects that have cost millions of dollars each year. These projects include building energy conservation projects, building energy conservation studies and lighting upgrades. These include buildings on Cornell's Ithaca campus, but also off-campus buildings owned by the University, other real estate owned by the University, and campus life and dining facilities. To fund these projects, Cornell has aggressively pursued NYSERDA funding and alternative funding and financing sources (Howe, 2013).

In order to determine if a project will be implemented and who will do the work, a number of factors are taken into account:

- Cost and payback
- Delivery on schedule
- Quality of work
- Contracting ease and flexibility (Cornell Energy and Sustainability)

Data & Methodology

Key Questions

In order to develop the most beneficial and customized tool that Cornell Energy and Sustainability can use to evaluate the various inputs that would reflect the impact of renewable energy projects, energy conservation initiatives, new buildings and renovations, we asked the following questions:

- What is the current methodology that Cornell University uses?
- What other methodologies can be considered?
- Are there any similar projects used by peer institutions? And if so, what methodology they use?
- Who are the main stakeholders at Cornell University?

The issue at hand – the development of a cost-benefit framework for evaluating potential sustainability investments that could substantially impact a project's Net Present Value (NPV), and ultimately, influence decision making – impacts several stakeholders. These different stakeholder groups, from professors to students and administrative staff, may have different priorities, resource constraints, and views on the need, benefits, and ease of use of a cost-benefit framework that shows the impact of a project's NPV.

In addition to our research into models used by other institutions, our main methodology consisted of interviews with stakeholders, scholars, and experts in topics related to energy and finance.

The purpose of these interviews would be to provide us with a better understanding on how to approach Cornell Energy and Sustainability needs.

Advisory Meetings

Due to the purposes and complexity of this project, we consulted with expert scholars and professionals to assess our scope. We sought advice from John Foote, Executive Director of the Cornell Program in Infrastructure Policy, due to his experience in infrastructure finance, project finance and public finance, and John Tobin, Professor of Practice at Cornell Institute for Public Affairs (CIPA) and the Dyson School of Applied Economics and Management, due to his expertise in corporate sustainability practices, environmental finance, and impact investing. Also, Drew Lisac, Vice President of External Affairs at Global Footprint Network – which provides tools and programs that can help decision-makers recognize the impact of ecological overshoot on their own policies, investments, and projects – and former Dean at Stanford University, was important to our research since he recommended the NPV + methodology, which are discussed below in this section. These meetings were beneficial as we considered all of the capital budgeting techniques to explore with Cornell Energy and Sustainability and looked for the best method to fit Cornell's need.

Interviews with SLCAG Members and References

To gain a better understanding of perspectives and priorities related to sustainability (including financing of sustainability projects) at Cornell, E&S arranged opportunities for us to meet with members of the SLCAG. Led by Lance Collins, the Joseph Silbert Dean of Engineering, and Kyu Jung Whang, Vice President for Infrastructure, Properties and Planning (IPP), the committee features an array of administrators, deans, faculty and student leaders to help guide the university's climate-action direction. This group represents the major stakeholders at Cornell University, and therefore, has an important influence on the decision making concerning sustainability at Cornell University. We interviewed the following SLCAG members and other faculty recommended by SLCAG based on relevant experience:

- Paul Streeter, Vice President for Budget and Planning;
- Bob Howarth, David R. Atkinson Professor of Ecology and Environmental Biology;
- Mark Milstein, Clinical Professor of Management and Director of the Center for Sustainable Global Enterprise;
- Tishya Rao, Undergraduate student, A.A.P., 18', Urban and Regional Studies major;
- Steven Wolf, Associate Professor, Dept. of Natural Resources, Environmental Governance; and
- Aaron Sachs, Associate Professor on Nature and Culture.

These interviews provided us with different approaches and perspectives to be considered when recommending a capital budget method, since each of these members touched on aspects ranging from perception and reputational benefits from the implementation of sustainability initiatives on campus (intangible assets), to the perception of students regarding such projects.

It was important for us to understand the perspectives of the stakeholders who would review, interpret and make decisions about using any model we would develop. This was an important aspect that we considered, since the model we proposed would require a departure from existing methods. Currently, Cornell University uses a payback period methodology in order to understand the investment made and its potential recovery over time.

Capital Budgeting Methodologies

Capital budgeting is the process of evaluating specific investment decisions. The purpose is to analyze projects and decide which ones to include in the budget. Capital budgeting decisions define an organization's strategic direction, which is very important for the future of the organization. Based on our literature review pertaining to the best practices of capital budgeting, several methodologies/models were evaluated for the purposes of this project and to develop a tool that fits the best to E&S's preferences. Brief descriptions and aspects of the different methodologies considered are shown on Table 2.

Table 2

Capital Budgeting Comparison			
Method	**Description**	**Advantages**	**Disadvantages**
Payback Period	Is popular with business analysts for several reasons. First, simplicity. Most companies will use a team of employees with varied backgrounds to evaluate capital projects. Using the Payback method and reducing the evaluation to a simple number of years is an easily understood concept.	1. Simple to compute 2. Provides some information on the risk of the investment 3. Provides a crude measure of liquidity	1. No concrete decision criteria to indicate whether an investment increases the firm's value 2. Ignores cash flows beyond the payback period 3. Ignores the time value of money. Ignores the risk of future cash flows
Net Present Value (NPV)	Is the present value of the cash flows at the required rate of return of our project compared to the initial investment. It is a method of calculating the return on investment for a project or expenditure. By looking at all the expected cash inflows and outflows from the investment and translating those returns into today's dollars, you can decide whether the project is worthwhile.	1. Tells whether the investment will increase the firm's value 2. Considers all the cash flows 3. Considers the time value of money 4. Considers the risk of future cash flows	1. Requires an estimated cost of capital in order to calculate the NPV
Internal Rate of Return	Is the rate at which the project breaks even. It is commonly used by financial analysts to calculate the actual return provided by the project's cash flows, then compare that rate with the company's hurdle rate (how much it mandates that investments return). If the IRR is higher, it's a worthwhile investment.	1. Tells whether the investment will increase the firm's value 2. Considers all the cash flows 3. Considers the time value of money 4. Considers the risk of future cash flows	1. Requires an estimate cost of capital in order to make a decision 2. May not give the value-maximizing decision when used to compare mutually exclusive projects 3. May not give the value-maximizing decision when used to choose projects when there is capital rationing 4. Cannot be used in situations in which the sign of the cash flow of a project changes more than once during the project's life.
Cost-Benefit Analysis	Is a method of evaluation that estimates the value of projects to determine whether those projects are worth undertaking or continuing.	1. The main advantage is that is easy to understand. 2. Easy to transfer to various scenarios	1. Accuracy with regard to benefits and costs must be closely monitored because benefits are easy to double count. 2. Difficulty in being mutually exclusive and collectively exhaustive.
NPV +	Includes unpriced factors, such as the cost of environmental degradation and benefits like ecological resiliency. In the NPV+ framework, any investment may be a "capital project"; all costs and benefits - even those where no monetary exchange occurs - are "cash flows"	1. Tells whether the investment will increase the firm's value 2. Considers all the cash flows 3. Considers the time value of money 4. Considers the risk of future cash flows	1. Requires an estimated cost of capital in order to calculate the NPV 2. Requires user to assign values to non-monetary indicators, which may be subjective

Sources:
- ***"Payback Period and NPV: Their Different Cash Flows"* (Ardalan, 2012)**
- ***"Advantage and Disadvantages of the Different Capital Budgeting Techniques"* (Peterson-Drake, n.d.)**
- ***" A Refresher on Net Present Value"* (Gallo, A Refresher on Net Present Value, 2014)**
- ***" A Refresher on IRR"* (Gallo, A Refresher on Internal Rate of Return, 2016)**

Findings

The findings from our interviews and research were very illuminating regarding the attitudes about sustainability among members of the Cornell community. We arrived at four major findings:

1) Sustainability is not the top consideration for many projects at Cornell; it is one of many factors considered, including function, aesthetics and design
2) A high level of bureaucracy exists within the University, with many decision-makers and influencers; this necessitates extensive buy-in for approval of projects
3) The best buy-in will occur from a multi-disciplinary assessment of proposed projects
4) Colleges control most budgets and spending, but have little incentive to spend on projects which reduce energy consumption because projects are currently evaluated using a method (payback period) in which not all relevant costs are considered

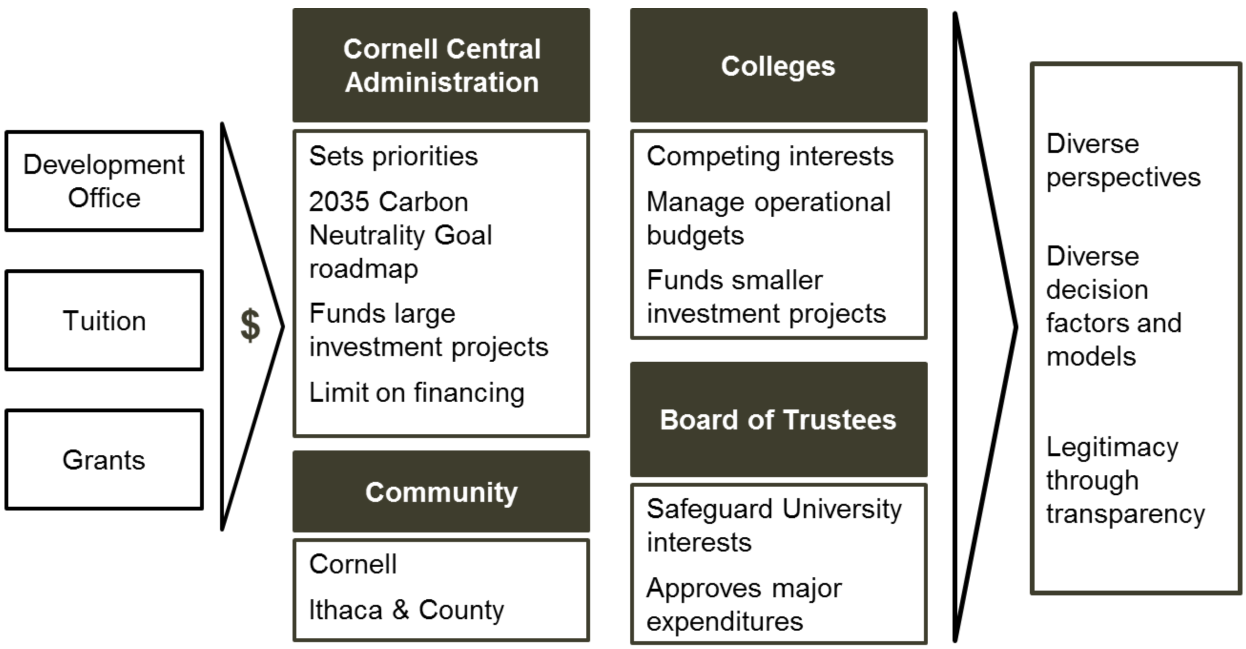
Although each individual we interviewed was passionate about sustainability and individually committed to the University's 2035 carbon neutrality goal, we found that sustainability was not perceived as a top priority at the current time by the University Administration and leadership. Additionally, in the decision-making process, many other factors precede sustainability or the carbon footprint of a building. For example, when the University decides to build a new building, it is not until a design and architect are selected that the carbon footprint or other sustainability factors are considered. Factors that are considered before sustainability include the aesthetics of a building. Since a popular style of modern building is glass, which has a very low insulation value, the impact to heat and cool these buildings is far greater than a building constructed of another material. Many of these buildings ultimately receive a LEED certification as well because of other design features. While this is admirable, the buildings could be designed with a more sustainable rating; in other words, the University is doing well, but could be doing better by making sustainable design a higher priority for projects at the inception of the process.

We also gained some insight into how Cornell functions. The University is unique in how the colleges function with a high degree of independence under a central administration; however, the colleges also take a lot of direction or cues from the central administration. With this in mind, there needs to be a top-down approach from the Central Administration when making sustainability a priority across the university. Despite the Provost and then-acting President of the University, Michael Kotlikoff, reaffirming Cornell's dedication to achieving carbon neutrality by 2035, there is no centralized plan or strategic path from which the colleges can take direction.

Through our interviews, we discovered that the navigation process to secure project funding and approval is extremely complicated—projects often get caught up in a high level of bureaucracy. The approval process depends on a number of factors (project cost, scope, goal, and originator, among others) and visually looks like a plate of spaghetti. The approval path is tricky to find and varies frequently. Additionally, there are levels of approval and projects include many stakeholders, nearly all of which are swayed by many factors and models and consensus is often very difficult to achieve.

Because there are many stakeholders in projects across the campus, there are a lot of ideas about what the most important decision factors should be. In order to make sustainability a priority for such a diverse audience, and to lend perspective from many viewpoints, it seems that the best buy-in will result from a multi-disciplinary approach. If groups of students from different departments were engaged across the campus to help E&S evaluate sustainability-oriented projects, the intersection of the ideas that are produced could be powerful and could likely sway multiple stakeholders. It was also suggested that involving the community at large will help the shift towards carbon neutrality gain legitimacy. The Cornell community is very diverse and as the largest employer in the area has significant impact in local communities, Tompkins County and throughout the region. If at least some of these communities are engaged to share their viewpoints, concerns and how they potentially can be included in the shift towards carbon neutrality, the entire process may shift.

In order to gain a greater understanding of our stakeholders to help us in selecting indicators that are important in making decisions on sustainability-oriented projects, we identified the various stakeholders and categorized them by stage and sphere of influence. The stakeholder stages are inflows, entities within the university, and resultants. Inflows occur where major sources of funding enter the University, and include the development office, which solicits donations from alumni and other potential donors; tuition paid by students; and grants, which are written and solicited by faculty and graduate students. Entities within the University include the Cornell Central Administration, the Community, the Colleges and the Board of Trustees. The resultants are diverse perspectives, diverse decision factors and models, and legitimacy through transparency.



The largest influencer is the Cornell Central Administration. This group sets priorities, drives the 2035 Carbon Neutrality Goal roadmap, funds large investment projects, and operates within financial constraints. The University is refraining from borrowing money through debt to finance projects until performance of the endowment improves. Therefore, currently most major projects, like new buildings, are funded by major donations or through partnerships with private enterprises.

As previously discussed, the Community includes not only the Cornell Community, but also Ithaca, Tompkins County and the larger region. The colleges within Cornell represent competing interests, not only between themselves, but also within colleges. With ideas about how and where money should be spent but finite resources, colleges compete for faculty, student enrollment and funding. The colleges also manage their own operational budgets, which include expenses for consumption of utilities and maintenance and upkeep of facilities. It should be noted here that there is an $880 million backlog of deferred maintenance projects, much of which could be addressed by undertaking some of the sustainability oriented projects E&S is considering.

The Board of Trustees is looking to safeguard University interests, which include the University's reputation and financial status. Therefore, they approve most major expenditures and so are some of the most important central figures in University decision-making. Two key decision factors for the Board of Trustees are reputation of the University, and the financial implications of projects.

Next we want to delve into the NPV+ model to explain those indictors we identified and recommended to put in the model and why it is recommended for Cornell sustainability projects.

Indicators

The NPV+ model we developed has a number of indicators which were shaped by our research into different methods of evaluation, valuation processes, and what Cornell and other institutions find important or value. Our findings led us to consider 13 indicators, which we would include in a cost-benefit analysis. Using some of these indicators to which we could assign a value, we were able to create the NPV+ model. The indicators are broken down between costs, quantifiable benefits and non-quantifiable benefits.

The costs we considered are:

1) One-time costs
2) Operation and maintenance (O&M) costs
3) Opportunity costs

The benefits we considered are:

1) Energy cost reduction and water conservation
2) Carbon offset
3) Statistical life saving
4) Tourism Revenue
5) Reputation
6) Environmental incentives
7) Flood control and habitat
8) Morale

Below are examples of some of the costs and benefits in the context of some projects that Cornell E&S has shared with us, such as FIM 3, an LED lighting upgrade, and FIM 4, a project to install heat recapture systems on Corson-Mudd Hall.

Costs:

1) One-time Cost

This is the implementation cost or upfront cost for each project.
In the project FIM 4 (Install Heat Recovery System on ACS 1,2& 3), the implementation cost is $1,327,027.

2) Operation and Maintenance (O&M) Cost

This includes all the costs required to operate and maintain a project throughout the lifecycle of the project. This includes, but is not restricted to, periodic maintenance required for a mechanical system for both parts and labor, energy to power a new system or building (depending on how benefits are calculated, energy costs may be included in a net figure for overall energy reduction), and other similar costs. These can also include costs recouped by replacing an old system. We identified three examples of O&M costs that would result from specific projects:

a. Project lifecycle and cost savings

With a project such as the LED lighting upgrade (FIM 3), the O&M cost should include the difference between the cost of traditional lighting and the cost of LED lighting. Because the lifespan of LED lights is longer, the evaluation would use a longer time horizon to match up with it. In our model, we used 20 years as an example, but it can be adjusted based on the specific life span of each project. In years where traditional bulbs would be replaced, the replacement cost would be shown as a positive cash inflow since it is a cost avoided by using LED lights.

b. Landfill costs

When evaluating recycling projects, we suggest considering the following three costs: the cost for transportation of the landfill waste, the cost of CO_2 emission along with the transportation and the CO_2 emissions produced in disposing of used water bottles as waste.

Waste at Cornell Ithaca campus in 2015 weighed 3342.47 tons. Between 350,000-400,000 bottles of water are sold on Cornell campus every year. By summing the transportation cost of landfill waste per pound, the CO_2 emissions caused by the transportation and disposal of the water bottles, we can arrive at the total cost of putting recyclables in a landfill each year. If there is an additional charge for putting recyclables in the landfill, that should be entered into the equation as well.

c. Labor

The labor cost for O&M varies with each specific project. Some of the sustainability projects have reduced labor costs from greater efficiency, so those projects can potentially decrease the labor cost. For example, in FIM 3, the longer lifespan of the LED light bulbs carries significantly lower labor costs because they only need to be replaced on average every 10 to 20 years, as opposed to incandescent or fluorescent bulbs that need replacement much more frequently. This decrease in cost between comparative projects can be considered a positive cash flow cost.

3) Opportunity Cost

This cost is calculated as the value of the next best alternative use of the same resources foregone in order to undertake the project selected. This includes land development or other resources used for sustainability projects that would not otherwise be available once used. In a project like converting on-street parking spaces to green infrastructure, the opportunity cost is the forgone revenue that would come from selling annual parking permits. This would be calculated by multiplying the projected reduced number of drivers who would have bought the parking permit by the revenue per parking permit per year to get the total forgone revenue from parking permit sales in each year as the opportunity cost.

Benefits:

1) Energy reduction and water conservation

This benefit is calculated according to the saved billed cost of electricity usage and water conservation of the sustainability projects at the current or projected rate. It should be measured in common units, i.e. kilowatt-hours (kWh) or gallons. This benefit is already included in E&S's current evaluation model. For example, in the project FIM 4, the marginal cost saving for utility bill is $23,017.

2) Carbon offset

This benefit is also known as the social cost of carbon, and should be calculated using the actual or projected average amount of carbon produced per kWh for Cornell's power grid, unless a project is tied directly to a specific source. A dollar value should be assigned and used for the duration of a project, and may increase at an estimated appropriate rate. For the model we built, we assign the social cost of carbon at $0.02 per pound ($40 per ton), increasing at a rate of 20% to reflect the quickly approaching goal of being carbon neutral by 2035. Based on our research, the social cost of carbon is valued from $2 to $200 by different institutions and companies. Yale priced it with $50-$200 per ton CO_2 to meet its 2020 emissions target. So $40 per ton is a relatively low starting price. By multiplying the average CO_2 produced per kWh usage of electricity, the carbon emission social price and electricity savings per year, we can get the social benefit of the reduced greenhouse emission.

3) Statistical life saving

The reduced CO_2 emission will improve air quality and therefore reduce the probability of people becoming ill. The US government's Value of a Statistical Life (VSL) database and United States Department of Agriculture (USDA) Forest Service both revealed related data and correlation. We suggest assigning a dollar value on this benefit as well. Based on VSL and USDA data, we assumed that each pound of carbon emission reduced will bring $0.001 worth of air quality improvement in 2015 (United States Forest Service, n.d.). The value of air quality improved per year through reduced carbon emission from the saved electricity consumed from each project is calculated by multiplying the assigned value by kWh of electricity saved and CO_2 produced per kWh.

4) Tourism revenue

Attractive landscapes, clean water and air, and birds and wildlife are the basis of the area's recreation economy. Located in Ithaca within the Finger Lakes region, the beauty of Cornell's campus is widely appreciated and a wide range of outdoor activities are available here. Hiking, kayaking, tree climbing, boating and bird watching are all activities that can be enhanced by sustainable development. Besides attracting people to engage in recreational activities like hiking, the open spaces and natural beauty can also increase Cornell's attractiveness to students, faculty and staff and Ithaca's attractiveness to business.

Tourism revenue may not be a major benefit for projects like upgrading lighting system with LED and installing heat recovery system, but it should be taken into consideration for projects involving natural resources, such as the Cornell Plantations or the Cornell Sailing Center, or involving on-campus hospitality, such as the Statler Hotel. The value entered would be the projected increase in revenue the University receives as a result of a project.

5) Reputational benefit

Cornell has historically had a reputation of being a leader in progressive initiatives, beginning with its founding mission to educate all people, which was very rare in its time. Since then the University has had a number of firsts, and has the potential to be the first carbon neutral Ivy League University. Increasing campus sustainability and moving towards carbon neutrality will boost Cornell's reputation, and it may help with attracting scholars, students, and research projects and grants to the University. Since the attractiveness to scholars and students is still under discussion and difficult to be quantified with a dollar value, we only recommend including the dollar value of grants attracted to Cornell by sustainable initiatives or carbon neutrality to the model. However, further study should be undertaken to help value the Cornell brand and the potential increase the University would see in its brand value or competitive advantage based on a project or series of projects.

6) Environmental incentives

Renewable Energy Credits (REC) represent the environmental attributes of the power produced from renewable energy projects and are sold separate from commodity electricity. Unbundled REC sales grew to 36 million MWh in 2014, increasing 15% from 2013 (United States Department of Energy, 2016). The price of national retail REC products ranges from 0.5¢/kWh to 5.0¢/kWh according to the U.S. Office of Energy Efficiency & Renewable Energy. Cornell has renewable energy projects (for example, the Snyder Road Solar Farm) that generate REC, and the benefit can be calculated as number of MWh of renewable energy multiplied by the price of REC. Also included in this indicator would be any other incentive or payment the University would receive from a utility, government, or other entity in exchange for undertaking a project.

7) Flood control and habitat preservation

Cornell has rich resources regarding lakes, grasslands and forests, which all provide protection from flooding and other disturbances, thus reducing the devastating effects including property damage, lost work time, and human casualties. As a matter of fact, the Mitigation Policy FD-108-024-01, approved by Federal Emergency Management Agency in 2013, allows inclusion of ecosystem services in benefit-cost analysis for acquisition projects in response to the rising natural disaster costs and climate uncertainty (Schmidt, Lozano, Robins, Schwartz, & Batker, 2014). This policy is applied for all private residential, business, public utility, city, county, and state impacted infrastructure. Sustainable projects, especially those contributing to environment protection, should be recognized for the associated benefits and cost savings from flood control.

Apart from flood control, the value of the natural habitat for some wildlife species should also be considered, as Cornell is famous for wildlife populations including birds. However, due to the limited time of our project, flood control and habitat is not studied in detail. We recommend further study for this topic in the future to better understand the value of sustainable projects.

8) Morale

With tangible and intangible costs and benefits discussed above, we would like to point out one indicator that is almost immeasurable but very important: morale.

Some of the projects may have the function of reminding people of the influence of their actions on environment. If the projects can visualize how human activities influence the environment, for example, where garbage goes after it is created, it can boost people's motivation to reduce their impact by changing their daily behavior.

Besides the incentive for environmental friendly behavior, some projects can also increase people's willingness to protect the environment. The way people react to climate change shows that when the current situation seems hopeless, people then stop paying attention to environment protection because it seems hopeless. But if a project is really concrete and brings visible benefits, it can have a powerful effect on people's actions (Sachs, 2016).

It is very difficult to assign a value to morale. However, one possible way to do so is to survey people for their willingness to pay for a certain environmental improvement on campus, or to measure productivity before and after a project is implemented. However, this value is not included in the model we deliver since this would be a very long and challenging aspect to value and would likely not sway the final results. We encourage further study in this topic.

Model Description

This NPV+ model is meant to enable Cornell E&S to evaluate projects for prioritization, and to help gain support for those projects from campus leadership. The model expands the traditional NPV analysis by also including the factors with environmental and social attributes. It is comprised of three major parts:

1) The first component is the spreadsheet for indicators used to measure costs and benefits.

We aimed to build a generic capital evaluation model for the potential sustainability and energy projects on Cornell campus. We identified several cost/ benefit indicators, which include traditional considerations such as upfront costs, O&M costs, and other related cash inflows and outflows, as well as indicators with environmental and social impacts through assigning dollar value to them, i.e. the cost of carbon emission and value of improved air quality. Different projects might have different indicators, so we categorized those indicators into different groups and built one spread sheet for each group of indicators.

Each spreadsheet consists of the expected costs/benefits for each year during the evaluation horizon and the assumptions for how to calculate those costs/benefits.

The assumptions are right below the cost/benefit values from different project. The cells in pink are initial assumptions (hard coded) that could be replaced with the user-specific data. They are linked to ultimately get the values of costs/benefits. The corresponding cost/benefit values from different projects are placed on the top of the page and will be plugged into the dashboard page.

2) The second component is the dashboard page.
For each project, we identify various costs/benefits. After calculating the values of costs and benefits from the project on the corresponding spreadsheets of indicators, we link them back to the dashboard to list all the costs and benefits from that project and get the net cost/benefit in each year during the evaluation horizon. Then we calculate the NPV for the project. Projects with positive NPV are the ones to be recommended to implement, the higher the NPV value of the project, the more it should be considered. We call this value NPV+ because it also takes the costs and benefits of environmental and social impact into consideration as real cash flow. NPV+ model was brought to our attention first by Cornell E&S as a possibility, recommended by Professor John Foote to us and has been used by Global Footprint Network.

On the same page, we also created a table to conduct a sensitivity analysis by calculating the NPV values with varying discount rates. Another table was created to get values of IRR, payback period, discounted payback period under our model for each project, although the NPV method is the method we highly recommended Cornell to use. (NPV is widely used by private companies and is recommended by experts from academia as well.)

3) The third part of the model is an auxiliary page for cash flows.
This page will help to calculate the payback period and discounted payback period for each project as we mentioned above in the comparative analysis table on the dashboard page.

We listed the cash inflow and outflow in each year during the evaluation horizon for each project and also calculated the present value for those cash flows using the project's discount rate. The next two columns were used to get the cumulative cash flow balance and discounted cash flow balance. Then we identified the two cash flows with the negative one in the first year, followed by the positive one in the second year. We used the number of the year for those cash flows to get our related payback period.

Advantages of the model

As Cornell has as its goal to achieve carbon neutrality in 2035, the model is constructed to fit into this time schedule and to carefully explain the NPV of each project after considering the operation and maintenance cost, carbon reduction (not just carbon offset), statistical lifesaving benefit (calculated from the value of improved air quality), and etc.

1) Timespan
As Cornell has the goal of achieving carbon neutrality in 2035, we built the model with a timeline from 2015 to 2035 to project the costs and benefits of each renewable energy project and to monitor the quantity of carbon reduction contributed by this project. That being the case, the amount of carbon reduction of each project can be calculated and the user of this model is able to plan for projects needed to achieve the carbon neutrality goal. As this model enables the user to clearly see the carbon offset of each individual project as well as the total carbon offset of all the planned projects, it allows the user to prioritize the planned projects by comparing their payment schedules, carbon offsets, return on investment, and the benefits other than carbon offset. The timespan can also be adjusted based on the expected lifespan of the project if it is longer or shorter than the 2035 time horizon.

2) One excel sheet for each indicator

As discussed before, 11 indicators for potential costs and benefits are identified for the renewable energy projects, and each indicator has its assumptions and calculation methods. Not all the projects will use all the indicators listed, and which indicators are used depends on the nature of the project. A heat recovery project has energy reduction, carbon reduction and statistical lifesaving. We built one working sheet for each indicator so that the user can work on one indicator on an independent working sheet. This allows the user to put the assumptions and inputs for one indicator into one working sheet without to alleviate any unnecessary confusion associated with putting all the indicators and assumptions in one sheet. The user can also determine which indicators to use for one project and leave the unnecessary indicators blank.

3) Dashboard sheet for the big picture

Every indicator sheet is linked back to the dashboard sheet in the model so that the user can see the big picture for one project and easily find out the results from each indicator without going back to that particular sheet. The dashboard also allows the user to perform sensitivity analysis to test against different discount rates, financing structure, and other assumptions that may affect the NPV of this project.

4) Capital budgeting comparison

Currently Cornell mainly uses payback period analysis for budgeting and project evaluation, which is easy to conduct and requires less data inputs. However, we recommend NPV+ analysis since this method accounts for the time value of money and the lifespan of the project, not just the first several years of it. In addition, NPV+ model also takes the non-cash benefits into the consideration. We do understand that the payback period method may bring some convenience. We have incorporated IRR, payback period, discounted payback period and NPV+ in the dashboard based on the same cash flow that we calculated by utilizing the indicator sheets. This enables users to choose the budgeting tool that they feel most comfortable with.

5) Flexibility

For most of the indicator calculations, the user needs to identify assumptions to use for the project, for example, the carbon price, the growth rate of the carbon price, the price of electricity, and etc. For every one of these assumptions, you may find several numbers from different resources, and these numbers may be largely different from one another, providing a range of prices for each assumption. Each of the prices has its own rationale and merits and we would not say which one is better than others. One advantage of this model is that the user can change the assumptions that we built in the spread sheet according to his/her particular needs.

6) Openness

In this report we identified 11 indicators for the potential costs and benefits associated with the renewable energy projects, and further studies are welcomed to discuss new indicators to be plugged into the model. This can be accommodated by plugging in a new indicator to add a new sheet and link the results back to the dashboard.

Recommendations

Based on our findings and research, we have five recommendations:

1) Increase focus on the University's "quadruple bottom line" goals

Continue to align academic purpose with sustainability. This will empower students, faculty and staff to be part of the decision-making process at the University as well as teach students what sustainability is, how to make decisions, take action and implement it across their profession upon graduation. Students and faculty from different colleges have an opportunity to become involved in sustainability projects, such as those led in Architecture, Planning, Engineering, Business, Human Ecology and History[1]. Proposals for achieving these goals and undertaking sustainability-oriented projects (i.e. in partnership with the engineering or architecture school) could be submitted through Engaged Cornell, which can potentially act as a new source of untapped funding.

2) Create a roadmap to carbon neutrality by 2035 that is endorsed by the president and Board of Trustees of the University

There is currently no clearly understood or articulated plan to achieve carbon neutrality by 2035. It is a massive goal with far-reaching impacts that will not be achieved without immediately undertaking increased action towards becoming carbon neutral. Without guidance on what needs to happen to achieve this goal, colleges and administrations are left to get to these goals on their own. E&S needs to evaluate and prioritize projects on a roadmap so that budgets can be set and resources directed at achieving this goal. Our recommendation is that these projects be evaluated for carbon impact and budgetary implications using the model we are creating with this project, aligned in two to four main courses of action and presented to the University administration. The courses of action can have varied budget assumptions (i.e. how cash flows to fund these projects will vary) with projects aligned around those assumptions. If the President of the University approved one (and provided potential recommendations on changes or modifications) and helped to drive that through the University leadership to begin developing budgets, soliciting donations through the Development Office, and setting project priorities across the University, this would serve as a catalyst for additional sustainability initiatives.

The University also can reconsider opportunistic projects. Sustainable design in future projects can be encouraged. This can also be driven through the Development Office if donors with an eye towards sustainability and who support the 2035 Carbon Neutrality goal are targeted.

3) Align financial incentives across Cornell University

In order to influence colleges within the University to undertake more sustainability-oriented projects, budgetary implications for colleges can drive operative budget decision to reflect sustainability needs. One potential option for this is to create and levy an incremental Carbon Tax on the colleges. The University can make a realistic assessment of where the carbon emissions or energy consumption by one college could realistically be set (i.e. without undertaking projects that are outside the scope of colleges responsibility), and charge a "tax" on when above that. Revenue generated from this tax could be put towards deferred maintenance projects and green projects across the University.

Colleges could also be incentivized by owning more than an operating budget, such as being able to borrow money from the university to reinforce the concept of time value of money. Currently, there is no difference between having money today or money in five years, so there is no incentive to invest in

[1] As previously mentioned in this paper, studies to evaluate the value of morale and the Cornell brand can be studied through partnerships with CIPA, the history department and Johnson (through partnerships with the Center for Sustainable Global Enterprise or the Marketing department).

projects today that will result in long-run cost savings. How this could be done would need to be studied in the future.

4) Increase financial and budgeting training for administrators

We strongly suggest the adoption of the NPV+ model to evaluate projects, but all decision-making parties need to be able to understand what it provides. Our interviews revealed that one of the major reasons that payback period is currently used as a primary means of project evaluation is because it is easy for college administrators to understand. Each college has very capable financial administrators who may or may not have been trained on this method. Training on the NPV+ model in order to at a minimum understand the assumptions behind the NPV+ model and what it provides would enhance administrators' participation in analyzing the costs and benefits of sustainability projects and decision-making. Key concepts are the time value of money, the concept of a NPV or NPV+ analysis of a project, and the limitations and drawbacks of payback period evaluation. This knowledge would ultimately enable them to make more sound financial decisions for the future of their college.

5) Improved sustainability leadership from Senior Administrators, Trustees and Donors

The University needs to create an expectation that units include long-term maintenance costs in annual budget since that is a very real component of project upkeep and will also reduce the backlog of deferred maintenance in the future. For example, consider the LED lighting project. Some schools delayed implementation because of its relatively high upfront cost. Current capital project evaluation criterion is only 5 years. The lifespan of LED lights can last as long as 10 to 20 years. In the long run, they can actually save costs of maintaining and changing light bulbs compared with other regular lights. With short-term evaluation horizon, the effect of the life cycle of sustainability projects can be ignored. A significant portion of this can be addressed by undertaking some of these sustainability-oriented projects that have longer lifespans and use fewer resources than some conventional approaches to correct this deferred maintenance. The up-front cost may be greater, but the long-term financial implication is less. Reinforcing this concept will encourage colleges and administrators to consider longer term implications.

Our final recommendation is that sustainability needs to be highlighted as a top priority of University leaders in order to be sufficiently factored into decision making and budgets across Colleges and University units. The central administration can drive priorities through colleges, and this leadership needs to be reinforced at all levels if sustainability and Carbon Neutrality goals are to be major commitments of the University. Cornell University has an opportunity to continue its legacy as a progressive, influential Ivy League University. Cornell had a number of firsts, beginning with admitting and educating women and minorities in alignment with the vision of A.D. White that any person can seek an education in any subject. Cornell's current opportunity is to continue this legacy and bolster its reputation by becoming the first Ivy League University with a commitment to and achievement of Carbon Neutrality. However, it needs to begin at the top and be backed by University administration and the Board of Trustees.

Conclusion

Cornell has a great opportunity to put itself ahead of its peers and cement its position as the greenest top University by becoming carbon neutral by 2035. There is a long way to go to achieve this goal, and in order to get there a number of initiatives must be taken. University leadership needs to drive changes on campus to achieve carbon neutrality. Additionally, incentives, particularly financially, need to be aligned for colleges since they have significant sway over decision making and allocating money for smaller projects.

The NPV+ model we developed was created to act as an evaluation and decision making tool for many parties, and includes indicators that don't have a direct cash flow associated with them but still have significant value to the University. It is flexible and can be adapted to any project the university is considering, adding or deleting indicators or changing assumptions on indicator values as necessary to reflect the priorities of the University or components or impacts of a project. It can be used as a decision tool to discuss projects or to pitch them to an approval authority, such as the Board of Trustees. We hope that it will be considered, used, and refined as suited to Cornell Energy and Sustainability and the University's needs.

We suggest further study be undertaken to build parts of this project, to share and refine the model and to explore the value and use of specific indicators, such as the value of the Cornell brand and the amount that various projects could add to the brand if they are implemented. We also suggest continuing to study further the impacts of morale and other factors that are much more difficult to value than others.

Appendix 1: Assumption inputs and calculations for each indicator

Cost indicators:

1) One-time cost is the upfront cost, which will be given in each project

2) Opportunity cost is the forgone alternative best use of the land and resources. We provide a scenario to calculate the forgone parking permit revenue for a project to convert a parking lot to a green infrastructure project. We gave our assumptions for the reduced number of drivers parking their car in the parking lot in year 1, annual parking permit charge from one driver in year 1, the growth rate of reduced number of drivers and the growth rate for parking charge. Using the growth rates we calculated the reduced number of drivers in each year and parking permit fee in each year.

*The foregone opportunity cost of this project in year i = Reduced # of drivers in year i * parking permit charge in year i (i= year 1,2…21)*

3) Operation & Maintenance cost should take the project life cycle into consideration; taking this into account, we evaluated each project on a relatively long-term horizon. For project FIM3 (changing LED light bulbs), we assumed the average lifespan for LED light bulbs is ten years while the lifespan for other regular light bulbs is two years, which means in every ten years we need to spend money on the LED light bulbs and labor cost associated with it to get them changed and for changing regular light bulbs it is every two years. The evaluation period for this project could only be 10 years, the reason we used 20 years in our model is to map out the carbon reduction from it to meet the 2035 goal. Extending 10 years to 20 years will not change the decision for this project. We also gave our assumptions for the unit prices for LED light bulbs and for the regular light bulbs, as well as the number of light bulbs needed. We assumed the price of light bulbs will increase at the 2% per year (=inflation rate).

The cost of light LED bulbs in each year = unit of LED light bulbs * unit price of LED light bulb in year 10j (j=1, 2)

The cost of current light bulbs in each year = unit of LED light bulbs * unit price of regular light bulb in year 2k (k=1, 2…10)

The cost of replacing current light bulbs with LED =-(The cost of light LED bulbs in each year - The cost of current light bulbs in each year)

The same rationale was used to calculate the cost of labor for changing light bulbs, given the assumption of labor cost in year one and the growth rate of the cost. We assumed the cost of labor for changing the two kinds of light bulbs will be the same. We got the following.

The labor cost of changing LED bulbs in each year = Labor cost in year 10 j (j=1, 2)

The labor cost of changing current bulbs in each year = Labor cost in year 2k (k=1, 2…10)

The labor cost of replacing current light bulbs with LED =-(The labor cost of changing LED bulbs in each year - The labor cost of changing current bulbs in each year)

Another kind of O&M cost, which could also take the environmental impact into consideration, is the landfill cost for some recycling projects.

We assumed the landfill cost is comprised of three components: transportation cost, carbon emission cost from transportation and carbon emission cost from the water bottles in the waste.

To calculate the transportation cost, we gave our assumptions for weight of landfill waste in year 1, transportation cost/ ton of landfill waste and the growth rates for landfill waste and cost of transportation.

*Transportation cost in each year = weight of landfill waste in year i * transportation cost/ ton of landfill waste in year i (i= year 1,2…21)*

To calculate the carbon emission cost from transportation, the assumptions for weight of CO_2 emission from transportation of one ton of waste in ponds, carbon emission cost per pound and the growth rate for cost of carbon emission were needed. It is noteworthy that we assigned a relatively rapid annual growth rate for the cost of carbon emission (20%), considering the potential huge losses caused by climate change.

Carbon emission cost from transportation = weight of landfill waste in year i the assumptions for weight of* CO_2 *emission from transportation of one ton of waste in ponds* cost of carbon emission charge in year i (i= year 1,2…21)*

To calculate the carbon emission cost, we calculated the assumptions for the weight of CO_2 emission caused by the plastic water bottles in year 1 and growth rate of the weight.

*Carbon emission cost from water bottles = weight of carbon emission caused by the plastic bottles in year I * cost of carbon emission charge in year i (i= year 1,2…21)*

The total cost from the landfill waste is the sum of the above three parts.

Benefit indicators:

1) Energy cost reduction: This indicator is usually given in each project, which is the annual marginal cost saving.

2) Carbon reduction: We calculated the benefit from the reduced carbon emission of the energy usage reduction. Assumptions such as the weight of CO_2 produced by each kWh usage of electricity, CO_2 produced by each Ton-Hr usage of chilled water, CO_2 produced by each klb of steam, and CO_2 produced of each million Btu usage of natural gas, price for one unit of carbon emission, electricity saved per year, chilled water saved per year, steam saved per year, natural gas saved per year, and growth rate for carbon emission cost were made according to our research.

*The benefit from the reduced carbon emission of the energy usage reduction= (Electricity usage saved per year ** CO_2 *produced/ kwh of electricity in pound + chilled water usage saved per year** CO_2 *produced/Ton-hr. of chilled water in pound + steam usage saved per year** CO_2 *produced/klb of steam in pound + natural gas usage saved per year** CO_2 *produced/MBtu in pound) * carbon emission price/ pound in year i (i= year 1,2…21)*

Air quality improved: The value of the benefit from improved air quality is calculated through the assumptions for value of improved air quality from each pound of reduced CO_2 emission, the weight of CO_2 produced by each kwh usage of electricity, unit carbon emission price and the growth rate for carbon emission cost.

*The benefit from improved air quality= Electricity usage saved per year ** CO_2 *produced/ kwh of electricity in pound * value of improved air quality from each pound of reduced* CO_2 *emission year i (i= year 1,2…21)*

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