Carbon Zero:
Curbing Climate Change and Driving Energy Efficiency at UCSB

A Critical Analysis of Technological, Financial, and Communication Strategies for Achieving Carbon Neutrality by 2025

CØ$_2$ Carbon Zero

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the INSTITUTE for ENERGY EFFICIENCY

BREN SCHOOL · UCSB

UNIVERSITY OF CALIFORNIA Carbon Neutrality Initiative

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Carbon Zero: Curbing Climate Change and Driving Energy Efficiency at UCSB

As authors of this Group Project report, we archive this report on the Bren School's website such that the results of our research are available for all to read. Our signatures on the document signify our joint responsibility to fulfill the archiving standards set by the Bren School of Environmental Science & Management.

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The Bren School of Environmental Science & Management produces professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a year-long activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Final Report is authored by MESM students and has been reviewed and approved by:

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Abstract

The University of California (UC) Carbon Neutrality Initiative (CNI) commits all ten UC campuses to reducing greenhouse gas emissions associated with onsite combustion and purchased electricity to net-zero by 2025. At UCSB past researchers from the Bren School identified specific projects to reach carbon neutrality, and we aimed to inform UCSB how to strategically advance them within the context of current governmental, financial, and communicative challenges on campus. This report focuses on three specific objectives: 1) Identify and prioritize building rooftops on the UCSB campus to streamline solar photovoltaic procurement and installation by conducting a multi-criteria solar assessment; 2) Evaluate the potential to finance energy efficiency projects under current budget allocations at UCSB with the proposed Utility Conservation Reinvestment Fund through scenario analyses; 3) Assess on-campus stakeholder challenges and feasible solutions for strategic communication and engagement to support CNI decision-making. This report provides an in-depth analysis of three specific, prioritized issues within the CNI and high-level recommendations for embedding sustainability-thinking into UCSB governance.

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Acronym List

AB 32 – California Assembly Bill No. 32, Global Warming Solutions Act of 2006
ACAC – American Campuses Act on Climate (2015)
ACUPCC - American College and University Presidents Climate Commitment
ArcGIS – Geographic Information Systems Software
BAU – Business as Usual
CAP – Climate Action Plan
CNI – Carbon Neutrality Initiative
COP 21 – 21st Meeting of the Conference of Parties
DC – Direct Current
DM – Deferred Maintenance
ESP – Energy Service Provider
FY – Fiscal Year
GCLC – UC Global Climate Leadership Council
GHG – Greenhouse Gases
GRF – Green Revolving Fund
GSF – Gross Square Feet
HVAC – Heating, Ventilation, and Air Conditioning
IEE – Institute for Energy Efficiency
IOU – Investor Owned Utilities
LiDAR – Light Detection and Ranging System
LRDP – Long Range Development Plan
NCEAS - National Center for Ecological Analysis and Synthesis
NSR – New Source Review
PPA – Power Purchase Agreement
PV – Photovoltaic
RPS – Renewable Portfolio Standard
SB 350 – California Senate Bill No. 350, Clean Energy and Pollution Reduction Act of 2015
SCE – Southern California Edison
SEP – Statewide Energy Partnership - add
STARS - Sustainability Tracking, Assessment, and Rating System
TGIF – The Green Initiative Fund
UC – University of California
UCSB – University of California, Santa Barbara
UCOP – University of California Office of the President
UNFCC – United Nations Framework Convention on Climate Change
UCRF – Utility Conservation Reinvestment Fund
WEP – (UC) Wholesale Energy Program

Executive Summary

In 2013, University of California (UC) President Janet Napolitano introduced the Carbon Neutrality Initiative (CNI), a commitment to make all UC campuses carbon neutral with respect to Scope 1 and 2 greenhouse gas (GHG) emissions by 2025. Eliminating direct onsite emissions (Scope 1) and indirect emissions from purchased electricity (Scope 2), will require significant planning efforts at each UC campus. The CNI is an ambitious climate change mitigation target that will require coordination across numerous campus units at UC Santa Barbara (UCSB). UCSB needs implementable GHG reduction strategies in the short-term to meet this ambitious goal.

Our project, Carbon Zero, continues a 2015 group master's thesis project, CarbNewt, at the UCSB Bren School. CarbNewt successfully demonstrated how UCSB could achieve carbon neutrality by 2025 in an idealized scenario. Dr. David Auston of the UCSB Institute for Energy Efficiency (IEE) initiated our project and aimed to supplement CarbNewt's work with additional analyses that focus on how UCSB can pragmatically advance progress towards the 2025 carbon neutrality goal. Our objectives were to 1) prioritize locations for onsite rooftop solar photovoltaics (PV); 2) address pressing questions regarding financing of energy efficiency projects; and 3) research current attitudes of the relevant stakeholders on campus and develop a communication and engagement strategy to aid campus administrators and students with their CNI efforts.

Multi-Criteria Solar Assessment

UCSB currently has 6 MW of solar PV installed or planned on campus with a goal of 11 MW by 2025. We evaluated and prioritized building rooftops based on solar irradiation potential and building characteristics to determine which buildings UCSB Facilities Management should prioritize when considering additional onsite solar development. By comparing project characteristics with actual insolation received, we identified 18 rooftops as suitable for solar panel installations. The total capacity left on the main campus is an estimated 4.0 to 5.6 MW. Installing solar panels to the maximum capacity will provide between 5,450 to 7,526 MWh per year for UCSB and reduce GHG emissions by 1,395 to 1,927 $MTCO_2e$ annually.

Financial Assessment

We performed a scenario analysis of UCSB’s proposed Utility Conservation Reinvestment Fund (UCRF) to evaluate the impact of varying utility escalation rates, project payback periods, and utility incentives on UCRF performance over a 2025 timeframe. Results of our scenario analysis estimated that the proposed UCRF structure will deliver between $10.4 million to $24.2 million in cumulative utility

savings as well as a 15 to 31% reduction in Business as Usual (BAU) Scope 1 and 2 emissions at UCSB in 2025. We also provided best practices and key lessons from case studies of green revolving funds at other institutions to demonstrate proof of concept and possible performance. Additionally, we performed a cost effectiveness analysis of Direct Access and Bundled Service electricity procurement. Our results show that Direct Access would carry a significant cost premium except when utility escalation rates approach 4% through 2025. Therefore, we strongly recommend further analysis of how UCSB can reduce GHG emissions from purchased electricity.

Strategic Communication & Engagement

We performed an assessment of student and administrative sentiment towards the CNI as well as researched the policy-making process at UCSB. Through a mixed-methods approach of interviews, focus groups, and a campus-wide survey, we explored the lack of campus engagement and action due to a general misunderstanding of the CNI's goals and value. Relevant stakeholders were unsure how they could contribute to the initiative given their current roles and were unable to measure the impact of their actions. We provide information directed to relevant stakeholders on how to better work together during the decision-making process in order to bridge information gaps among students, administrators, and faculty.

Project Significance and Objectives

Significance

In November 2013, UC President Janet Napolitano, instituted the Carbon Neutrality Initiative, a commitment for all ten UC campuses and five medical centers to emit net zero GHG emissions by 2025.[1] If successful, the UC system will be the first university system in the world to become carbon neutral. Achieving carbon neutrality at UCSB offers the institution an opportunity to further its sustainability and climate goals in its operations, teaching, and research. With California's standing as a global leader in GHG mitigation and policies, UCSB can significantly influence the conversation by demonstrating which strategies prove effective. UCSB's sustainability reputation and accomplishments also provide great value to the experience of students, staff, and faculty. By wholeheartedly pursuing carbon neutrality, UCSB can secure its reputation as a leader in research and sustainability.

Pursuing the CNI offers UCSB significant long-term cost savings from increased energy efficiency and onsite renewable energy generation. Planned energy efficiency projects over the next five years are expected to have an average payback time of just 6.42 years with annual savings of more than $1 million.[2] By pursuing renewable energy and energy efficiency projects, UCSB can reduce it's purchased electricity demand which minimizes the risk of fluctuating energy prices.

UCSB has taken steps to improve energy efficiency and has been successful in reaching the campus goal of reducing emissions to below 1990 levels by 2020. However, the campus faces several major challenges to achieving the CNI including a University of California Office of the President (UCOP) mandate to increase enrollment by an additional 1% of students annually which will add roughly 1 million gross square feet (GSF) of new housing and facilities by 2025.[3] Additional students and buildings will increase energy demand on campus, intensifying the need to reduce emissions from energy generation, implement new energy-saving technologies, and potentially purchase carbon offsets in order to achieve carbon neutrality by 2025. However, UCSB is currently unable to accrue additional debt due to past large capital expenditures for infrastructure on campus. Aligning the CNI with enrollment growth and subsequent campus expansion is imperative in order to lessen competing priorities for a tight budget. Funding of carbon neutrality projects will require innovative financial strategies.

[1] University of California. 2016. The University of California's Commitment to Climate Solutions. *UC Carbon Neutrality Initiative*. Web. November 28, 2016
[2] UCSB Office of Sustainability. 2015. Climate Action Plan 2016 Draft. Santa Barbara, CA.
[3] University of California, Santa Barbara. 2015. UC Santa Barbara Long Range Development Plan.

To achieve carbon neutrality, UCSB will need comprehensive planning and implementation strategies in the short-term. The previous Bren group project, CarbNewt, initiated the effort to develop an optimal roadmap for achieving carbon neutrality by identifying cost-effective technologies and a timetable for deploying these projects. CarbNewt addressed many of the questions surrounding "what" technologies should be used and "when" they should be scheduled. We sought to answer "how" UCSB can feasibly implement these projects given the current constraints and attitudes of students and staff on campus. In this report, we present usable and relevant analysis detailing solar PV energy generation options, financing mechanisms, and communication strategies to inform UCSB's decision-makers and students of pathways towards achieving carbon neutrality by 2025.

Our client was the UCSB Institute for Energy Efficiency (IEE) represented by Dr. David Auston. The IEE will utilize the results of the project to inform decisions regarding UCSB's optimal pathway towards achieving carbon neutrality by 2025. The project deliverables aim to inform and motivate carbon neutrality efforts on campus, and target students, faculty, and administration as intended audiences. Ultimately, we hope that recommendations from this project can inform best practices at other universities and institutions striving for carbon neutrality.

Objectives

Working with our client, we identified three distinct areas at UCSB where we could find ways to effectively implement carbon neutrality. First, we recognized the need to prioritize rooftops to aid Facilities Management in their goal of installing an additional 5 MW of solar PV on campus. Second, as a resource constrained campus, securing upfront capital for energy efficiency projects is a significant hurdle to project implementation; thus, we analyzed potential financial frameworks that can alleviate this challenge. Finally, we researched the decision-making process on campus and identified opportunities to align and engage campus groups while exploring potentials to move the CNI forward through the complex decision-making system.

I. Technological Objective

We aimed to prioritize future sites for implementing on-campus solar PV and estimate the total solar capacity of the main campus by assessing rooftop characteristics and comparing them with the energy generation potential of each rooftop. We observed a need for information to be streamlined so that decision-makers on campus can efficiently meet their stated goals of increasing onsite solar PV while maximizing the benefits from this key technology.

II. Financial Objective

We sought 1) to determine the potential for financing energy efficiency projects through 2025 with the proposed UCRF by means of a scenario analysis and 2) to recommend best practices for reinvestment fund implementation and operation at UCSB with an evaluation of case studies of reinvestment funds at other universities. Additionally, we performed a cost-effectiveness analysis of Direct Access and Bundled Service electricity procurement in order to assess whether UCSB could green its purchased electricity supply in a cost-effective manner by switching to Direct Access electricity procurement.

III. Strategic Communication & Engagement Objective

We aimed to identify opportunities to increase support of carbon neutrality projects by different audiences on campus. Additionally, we strived to embed sustainability criteria into the long-term vision for campus planning. We accomplished this through 1) understanding how CNI-related projects move through UCSB's governance given current attitudes toward carbon neutrality and 2) exploring how to align the CNI with campus goals and priorities by providing communication strategies to address information gaps among campus groups.

Background

The CNI pledges for the UC system to become carbon neutral for all Scope 1 and Scope 2 emissions by 2025, and carbon neutral for all Scope 3 emissions by 2050. Primarily, Scope 1 emissions are all direct emissions from sources owned or controlled by the University. Scope 2 emissions are all indirect emissions, mainly from purchased electricity, heat, or steam. Scope 3 emissions include campus commuting and business air-travel. Two years after the start of the CNI by President Napolitano, UCSB Chancellor Henry Yang signed the American Campuses Act on Climate (ACAC) launched by the White House.[4] The ACAC cements the UC-wide CNI at UCSB and strengthens the higher education community voice in support of the 21st session of the United Nations Framework Convention on Climate Change (UNFCC) Conference of Parties (COP 21) climate negotiations from Paris.[5]

State of California

The State of California has its own emissions reductions targets, which the UC system is subject to and the CNI expands upon these requirements. The Global Warming Solutions Act of 2006 (AB 32) set a goal for California to limit equivalent statewide GHG emissions to 1990 levels by 2020.[6] California Senate Bill (SB 350), the Clean Energy and Pollution Reduction Act of 2015, increased California's renewable portfolio standard (RPS) from 33% by 2020 to 50% by the year 2030. SB 350 also expanded on AB 32 with a GHG emissions reduction of 40% below 1990 levels by 2030 and 80% by 2050.[7] UCSB also needs to meet strict New Source Review (NSR) standards. NSR is a permitting program through the Santa Barbara County Air Pollution Control District to ensure that the county meets Clean Air Plan goals.[8]

UC System

With the goal of the CNI, the UC system is striving to be the first university system in the country, and the first major university system in the world to become carbon neutral. UC committed $1 billion over five years to invest in climate change and sustainability solutions as part of the White House Clean Energy Investment Initiative.[9] In the fall of 2015, the UC Energy Services Unit initiated the first of two solar projects totaling 80 MW, the largest solar purchase of any university in the

[4] The White House. 2015. American Campus Act on Climate. *The White House Statements and* Releases. Web. November 28, 2016.
[5] Ibid.
[6] Assem. Bill No. 32. 2006. Regular Session.
[7] Senate Bill No. 350. 2015. Regular Session. *Clean Energy and Pollution Reduction Act of 2015.*
[8] UCSB Office of Sustainability. 2016. Climate Action Plan 2016 Draft. Santa Barbara, CA.
[9] University of California. 2015. Annual Report on Sustainable Practices.

country.[10] The UC's total emissions are now below 2000 levels and three of the ten campuses, including UCSB, have reduced emissions to 1990 levels.[11] UC wants to work to integrate carbon neutrality into its research, teaching, and public service mission to maintain its position as a global leader on climate.

UCSB

UCSB has a history of green initiatives and student-driven sustainability efforts. In 2015, UCSB was ranked 3rd in Princeton Review's list of top 50 green colleges and 1st among public universities.[12] In Winter of 2017, UCSB earned a gold rating in the Sustainability Tracking, Assessment, and Rating System (STARS) from the Association for the Advancement of Sustainability in Higher Education.[13] In 2006, UCSB students created The Green Initiative Fund (TGIF) which was the first green fee in the UC system. It generates approximately $180,000 per year from a fee of $3.47 per quarter per student. TGIF allocates funds to projects to increase the amount of renewable energy used on campus, increase energy efficiency of buildings and laboratories, reduce the amount of waste generated by the university, and support internships and education initiatives on campus.[14]

The Bren School of Environment Science & Management

The Bren School has been supportive of the CNI, dedicating three Master's thesis group projects to researching the CNI at UCSB. The Bren School tasks Master's candidates to form a team and work with a client to perform research and provide recommendations to solve an environmental problem. A group in 2014 created a timeline and framework for a behavior-based energy conservation program throughout campus. They researched education and strategic messaging to reduce building-level energy consumption and influence how individual occupants behave.[15] In 2015, another Bren group, CarbNewt, identified the most promising energy efficiency strategies, assessed onsite and off-site renewable energy options, and created a deployment schedule of financially-feasible technologies to capture the

[10] University of California. 2015. Annual Report on Sustainable Practices.
[11] University of California. 2016. The University of California's Commitment to Climate Solutions. *UC Carbon Neutrality Initiative*. Web. November 28, 2016
[12] Foulsham, George. 2015. Greenest Public University in the U.S. *The UC Santa Barbara Current*.
[13] Leachman, Shelly. 2017. *"A Sustainability Star."* The UC Santa Barbara Current. Web. Accessed on 5 Feb. 2017.
[14] TGIF Bylaws. 2013. Mission Statement. Web. November 20, 2016.
[15] Campbell, L., Creelman, I., Harris, S., Olson, B. 2014. Operational Effectiveness: Energy Management Initiative. *Bren School of Environmental Science & Management, University of California, Santa Barbara.*

greatest emissions reductions through 2025.[16] Their analysis identified both demand and supply-side GHG mitigation strategies that could reduce UCSB emissions by 60% and viable carbon offset options to reduce the remaining 40% to achieve carbon neutrality by 2025. With the help of a green reinvestment fund, an internal funding mechanism that finances energy projects that generate cost savings, they found the cost of such projects to be $15.7 million.

With over 40,000 $MTCO_2e$ projected for 2025 under a BAU scenario, UCSB must implement a portfolio of GHG mitigation strategies.[17] Developing a sound financial and communication plan is the first step in successfully implementing the necessary actions needed to reach net-zero emissions. This project investigates on-campus solar potential, financial strategies, and stakeholder engagement strategies. With proper planning, the CNI can bolster UCSB's core mission to be a leading research and educational institution. With an engaged community of students, administrators, and faculty, the CNI provides the opportunity for UCSB to align its research and history of environmentalism with practical onsite implementation to create a richer learning environment.

[16] Bart, H., Kaysen, B., Maggass, M., Park, H., Watson, O. 2015 Achieving Carbon Neutrality at UCSB By 2025: A Critical Analysis of Technological and Financial Strategies. *Bren School of Environmental Science & Management, University of California Santa Barbara.*
[17] Ibid.

Technology

In seeking to improve the implementation process of sustainable technologies at UCSB, we focused our attention on onsite solar PV for a number of reasons. First, emissions from purchased electricity represent a sizable portion, roughly a third, of UCSB's total GHG emissions. Next, the use of Power Purchase Agreements (PPAs), described below, removes the need for upfront capital and makes it one of the most attractive initial options for UCSB to achieve its CNI goals. Finally, an in-depth assessment of the solar PV potential of campus buildings was lacking, and there was urgency for information to be streamlined as the demand for solar projects on campus increases. By developing our recommendations, our goal was to formalize best practices for future decision-makers and increase the pace of solar PV adoption on campus in order to optimize the financial and emissions benefits from this technology.

Background

Reducing Emissions from Purchased Electricity

Strategies for reducing GHG emissions from purchased electricity are crucial to reaching carbon neutrality. Purchased electricity from UCSB's investor-owned utility Southern California Edison (SCE) currently accounts for 32.8% of the campus's total GHG emissions, or 26,049 $MTCO_2e$ in 2015.[18] Electricity demand on campus will intensify due to goals to increase electrification of heating in campus buildings in order to minimize use of natural gas, as well as the planned campus expansion of roughly 1 million GSF of new housing and facilities by 2025. In addition to onsite solar installations, strategies for reducing emissions from purchased electricity include, but are not limited to: behavior change, energy efficiency, other renewable energy options such as biogas and off-site solar energy, as well as the potential to purchase renewable energy from SCE. SCE currently offers a green rate for commercial customers to choose solar energy sources for 100% of their energy usage. This option, however comes at a cost of $0.0411- 0.0637 per kWh in addition to regular charges which far surpasses the rate that UCSB would pay for onsite solar generation through a PPA.[19]

Current and Future Onsite Solar PV Goals

Expanding onsite renewable energy generation is essential for UCSB to meet its GHG reduction goals. In 2016, onsite renewables amounted to 0.67 MW for a total estimated annual energy production of 992,122 kWh per year. The campus is currently installing 5.32 more MW of onsite solar PV panels to come online within the

[18] UCSB Office of Sustainability. 2016. Climate Action Plan 2016 Draft. Santa Barbara, CA.
[19] Southern California Edison. "Green Rate." N.p., n.d. Web. 21 Feb. 2017

next few years.[20] By 2025, UCSB will have to implement additional solar panels to reduce demand for purchased electricity with a goal of 10.99 total MW by 2025 presented in the 2016 Climate Action Plan (CAP).[21] With decreasing prices of solar panel technology and increasing energy prices, solar panel implementation can achieve significant savings for UCSB. By 2025 the 10.99 MW of on-campus panels are estimated to mitigate 3,787 $MTCO_2e$ with an estimated savings of $400,000 to $500,000 annually.[22] However, the campus's total solar capacity is unknown. Choosing the right sites for these solar panel installations is critical to the success of these projects. In this analysis, we estimated the total solar capacity of the main campus, and recommend the best sites for future solar installation.

Procurement Methods

There are multiple options for UCSB to procure solar panels, including purchasing them outright or entering into a PPA. In a PPA, a solar company leases the solar panels to the University and is responsible for all installation and maintenance costs. The solar company then sells the power generated from the solar panels to the University at a pre-negotiated rate that is lower than the local utility rate. In return, the solar company earns a profit by receiving the sales of this electricity and capitalizing on any tax credits and other incentives they may receive.[23] In the past, UCSB has partaken in both PPAs as well as purchasing its own solar panels. Both options have advantages and disadvantages.

The majority of solar panels presently at UCSB - including the 115 kW PV installation at the Multi-Activities Center and the 500 kW installation atop Parking Lot 22 - are funded by the Renewable Energy Initiative, a quarterly student lock-in fee that was generated through student support. Solar PV panels have a typical payback period of around 7 to 8 years, with virtually free generation thereafter.[24] As the lifetime and efficiency solar PV panels increase, it is becoming more attractive to purchase solar panels. However, funds from the Renewable Energy Initiative are limited and insufficient to finance all the solar projects needed at UCSB. Budget constraints make it difficult to secure the high upfront costs necessary for solar panel purchase and installation.

Commercial PV solar panel costs have declined by more than 50% from 2009 to 2016 (5.23 to 2.13 $/Watt). Prices are expected to continue to fall and then stabilize in the near-term.[25] As solar generated energy continues to decrease below the cost

[20] UCSB Office of Sustainability. 2016. Climate Action Plan 2016 Draft. Santa Barbara, CA.
[21] Ibid.
[22] Ibid.
[23] Solar Energy Industries Association. 2012. Solar Power Purchase Agreements (PPAs). Fact Sheet.
[24] Student Affairs Staff, UCSB. Informational Interview. Santa Barbara, CA. 11 November 2016.
[25] Fu, Ran, Donald Chung, Travis Lowder, David Feldman, Kristen Ardani, and Robert Margolis. "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2016." (2016): n. pag. National Renewable Energy Laboratory. Web. 15 Mar. 2017.

of energy procured through its energy service provider SCE, UCSB stands to gain considerable savings from either owning panels or leasing them through a PPA.

In 2015, UCSB entered into a PPA with solar panel company SunPower, to install 5.32 MW of PV panels on campus rooftops and parking lots. The biggest advantages of a PPA are that they avoid the high upfront costs of solar panel purchase and installation. Prices are kept low by taking advantage of the federally mandated 30% Investment Tax Credit on installation costs through 2019 which decreases to 10% by 2023.[26] Public institutions are not generally eligible for the tax credit, but the project can receive these savings by partnering with third-party company in a PPA.

Another significant benefit of a PPA is that UCSB does not have to pay for the maintenance and installation costs of the panels. The company who enters into the PPA with the campus pays for all the installation and maintenance costs. From 2008 to 2012, 80% of the cost decrease in solar PV systems was due to falling module costs. Soft costs like installation labor, permitting, inspection, and financing are not decreasing alongside module costs and now account for 60% of total PV costs.[27] In the future, PPAs could become more enticing as UCSB can take advantage of dropping PV prices but avoid the static costs of installation and maintenance.

By leasing instead of owning the solar panels, UCSB avoids several costs. The value of solar panels decrease over time as their performance degrades by about 20% over their 25 to 30-year lifetime. Generally, system inverters must be replaced after 13 years at 9.5% cost of the original system. Maintenance and insurance cost is generally 1.0% of the initial cost and the system has limited scrap metal value at the end of its life.[28]

Lastly, receiving a fixed rate for electricity reduces risks associated with fluctuating energy prices and eases long-term planning. PPAs provide less risk than owning the panels because the solar company is responsible for the system performance of the panels. In past PPA agreements, if the panels did not meet 97% of their annual estimated energy production than the solar company would reimburse UCSB for the system's inefficiencies.[29]

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[26] US Dept. of Energy. "Business Energy Investment Tax Credit (ITC)." Energy.gov. 2017. Web. 21 March 2017.

[27] Morris, J., K. Calhoun, J. Goodman, and D. Seif. 2013. Reducing Solar PV Soft Costs: A Focus on Installation Labor. Rocky Mountain Institute. Boulder, CO.

[28] Swift, K. 2013. A comparison of the cost and financial returns for solar photovoltaic systems installed by businesses in different locations across the United States. *Renewable Energy.* 57:137-143.

[29] Sager, Jordan. "UCSB Energy Present and Future." Air & Waste Management Channel Island Chapter Meeting, 27 October 2016, Harry's Plaza Café, Santa Barbara, CA. Presentation.

Since high upfront costs for solar panel installation projects are constrained due to campus budgets and how projects are prioritized by campus decision-making, the majority of solar panel installations procured until 2025 will be through PPAs. As such, this analysis only considered rooftop characteristics that would incur a cost to UCSB, such as roof modifications. Rooftop characteristics that deal with maintenance and installation were not considered as these costs were assumed to be paid for by the solar company.

Solar PV Panels

Rooftop solar arrays, rather than ground-mounted systems, have the additional benefits of eliminating land use needs, being less vulnerable to vandalism, and providing more aesthetic value.[30] For this analysis we only considered rooftops, rather than building facades, because although building facades generally provide triple the area of rooftops, they only receive 41% of the total irradiation that rooftops receive.[31]

Past rooftop solar panel installations at UCSB used a dual-tilt ballasted racking system. This type of racking system increases the surface area of the panels to maximize the insolation received by the panels as the sun moves from east to west. The panel type used for these projects was a monocrystalline solar panel. Monocrystalline, as opposed to poly-crystalline or thin film solar cells, are the most efficient for sunlight conversion.[32]

Methodology

We compared selected rooftop characteristics for solar site installations with the energy generation potential of each rooftop to estimate the total solar capacity of the main campus and make a final recommendation to UCSB about the best sites for solar installation. We gathered roof characteristics to include in the solar assessment through working with staff in Facilities Management and roofing technical specialists, as well as reviewing literature. After this information generating period, we chose seven characteristics as the most important to consider for solar installation. The seven characteristics were: project size, adherence to the campuses Long Range Development Plan (LRDP), weight-bearing capacity, slope of roof, roof age, type of roof, and the deferred maintenance (DM) status of the roof.

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[30] Kodysh, J.B., O.A. Omitaomu, B.L. Bhaduri, and B.S. Neish. 2013. Methodology for estimating solar potential on multiple building rooftop photovoltaic systems. *Sustainable Cities and Society.* 8:31-41.

[31] Fath, K., J. Stengel, W. Sprenger, H.R. Wilson, F. Schultmann, and T.E. Kuhn. 2015. A method for predicting the economic potential of (building-integrated) photovoltaics in urban areas based on hourly Radiance simulations. *Solar Energy.* 116:357-370.

[32] Bergamasco, L. and P. Asinari. 2011. Scalable Methodology for the photovoltaic solar energy potential assessment based on available roof surface area: Application to Piedmont Region (Italy). 2011. *Solar Energy.* 85:1041-1055.

Roof Characteristics

Project Size

For a solar project to be considered viable, the minimum project size is 100 kW direct current (DC) for peak capacity. For each rooftop, we estimated the project size by multiplying total viable space for solar panels by the capacity of a standard solar panel module per module area. We used the specifications for panels that were installed for recent projects at UCSB, SunPower's E-Series commercial solar panels.[33]

Adherence to Long Range Development Plan

UCSB's LRDP is a document that includes a land use plan for the physical development of the University through 2025. The LRDP serves as an outline of development, but funding, schedules, and campus acceptance ultimately determine the outcome of development projects. By 2025, the campus will enroll additional students at a growth rate of 1% per year. Consequently, roughly 1 million GSF of new facilities and housing are scheduled to be constructed through 2025.[34] As the campus grows, buildings that are deemed for demolition or replacement by the LRDP are not good candidates for solar installation.

Weight-Bearing Capacity

The weight-bearing capacity of buildings must be taken into consideration as PV panels generally add 10-15 kg of weight per m^2 of roof space.[35] Concrete buildings are designed to hold very heavy loads so the additional weight of solar panels are generally not a concern.[36] Some campus buildings are wooden and an analysis would need to be performed to determine if they could sustain the extra weight. Building construction type is not the only factor to take into consideration, however, as previous solar installations on the Events Center failed due to concerns over the roof's weight-bearing potential even though the building is non-wooden.

For our analysis, non-wooden buildings are the preferred building type for weight-bearing capacity, even though a qualified engineer would have to perform a comprehensive weight-bearing assessment on each individual building before solar panel installation can be considered.

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[33] SunPower. "E Series Commercial Solar Panels." N.p., 2013. Web. 22 Feb. 2017.
[34] UCSB Office of Planning & Design. 2015. 2010 UC Santa Barbara Long Range Development Plan. Santa Barbara, CA.
[35] Horvath, M., D. Kassai-Szoo, and C. Tamas. 2016. Solar energy potential of roofs on urban level based on building typology. *Energy and Buildings.* 111:278-289.
[36] Facilities Management, UCSB. Informational Interview. Santa Barbara, CA. 25 October 2016.

Slope of Roof

Flat and sloped roofs are both viable options for solar installation sites. However, sloped roofs come with some additional considerations. Sloped roofs must face south to receive the highest insolation, which leaves most of the roof unviable. Many steeply sloped rooftops have mansards, which is an area underneath the roof's peak slope where equipment is stored. Roofs with mansards are not suitable for solar installation.[37]

In a city-wide study, the largest PV potential was found to be on the rooftops of large flat buildings.[38] Additionally, flat roofs make solar panel access easier for installation and maintenance. For this analysis, the insolation was measured for both flat roofs and roofs favorably sloped (19.4° - 49.4°) facing south.

To determine roof slopes we used the "Slope" tool in ArcGIS to analyze Light Detection and Ranging (LiDAR) data to create a rooftop slope map of the campus. We used the "Aspect" tool to determine slopes facing south.

Age of Roof

The average lifespan of each roof type varied from 20 to 35 years (Table 1).

Table 1: The Lifespan of Different On-Campus Roof Types. *Tiles last 30-75 years but underlayment must be replaced every 15-25 years. Data sources: 1. Coffelt, D.P., 2010. 2. International Association of Certified Home Inspectors, 2017. 3. Church Mutual Insurance Company, 2014. 4. Facilities Management, 2016.

Roof Type	Lifespan (yrs)	Average Lifespan (yrs)
Tile	15 - 25 [1*]	20
Built Up	30 [2]	30
Foam	30 [3]	30
Single-ply	30 - 40 [4]	35

The remaining lifetime for each roof was calculated by comparing the actual age of the roof to the average lifespan of each roof type. Since PPAs are expected to last for 20 years, roofs with over 20 years of life left are preferred.

[37] Facilities Management, UCSB. Informational Interview. Santa Barbara, CA. 25 October 2016.
[38] Hofierka, J., and J. Kanuk. 2009. Assessment of photovoltaic potential in urban areas using open-source solar radiation tools. *Renewable Energy.* 34:2206-2214.

Type of Roof

There are four main roof types on campus: tile, built-up, foam, and single-ply. Tile is predominantly used on sloped roofs. Built-up roofs are comprised of an asphalt layer with gravel on top. Foam roofs have insulation sprayed on which tends to collapse over time, and are generally the oldest roofs found on campus. Single-ply roofs are made of a thin PVC layer which are manufactured by Sika Sarnafil. Personnel at Facilities Management recommend Sarnafil rooftops as the preferred material type for solar installation because they are water tight, easy to patch, and have a long lifetime. Most new rooftops on campus are now constructed with Sarnafil, totaling about a quarter of all on-campus roofs.[39]

We partnered with Facilities Management, who gathered roof material data for this project.

Deferred Maintenance

There are several rooftops on the campus's DM list. These are rooftops that are in poor condition and eventually need to be replaced when funding is available. As there are many types of projects on the DM list, including elevators, fire alarms, mechanical projects, roads, classrooms, and special projects, competition for project funding is severe. The projects each year are selected based on three priorities: consequence of failure, asset importance, and strategic objectives. Projects that assure safety such as fire alarms and elevators are top priority and often the state mandates that these projects be completed first. Accordingly, rooftops are not often chosen for project funding. Last year four rooftops were identified for project funding (Broida Hall, Library, South Hall, and Public Safety) but were outcompeted.[40]

DM funding makes rooftop selection difficult because the schedule for roof replacement is unclear. Newly redone roofs are often prime candidates for solar installation. If a roof on the DM list is identified as a good site for solar installation, this may strengthen the likelihood of project selection and subsequent funding for roof replacement. A synergy between roof maintenance and solar installation could benefit both the CNI and Facilities Management on campus.

Calculation of Energy Generation Potential of Rooftops

We calculated the energy generation potential of each rooftop based on LiDAR data obtained from the Geography Department and Facilities Management at UCSB. This remote sensing technology is used to collect aerial topographic data. LiDAR sensors transmit billions of visible and infrared laser light pulses which are reflected back to

[39] Facilities Management, UCSB. Informational Interview. Santa Barbara, CA. 25 October 2016.
[40] Operations and Maintenance, UCSB. "Deferred Maintenance Information." Received by Emily Waddington, 3 November 2016.

the sensor when they hit a solid object. The LiDAR sensors are combined with GPS to create spatial positions for every data point. Benefits of LiDAR are that no disruptions are needed to collect data, the collection process is fast, and the results are very accurate.[41] We analyzed data with a 2' x 2' resolution.

The actual solar radiation that strikes each rooftop can differ significantly from local area climactic trends.[42] It is necessary to analyze each rooftop to take into account effects such as weather patterns, roof size, slope, and orientation that affect the amount of solar radiation reaching each building.[43] We created an insolation layer of the campus in ArcGIS by analyzing the LiDAR data with the "Area Solar Radiation" tool which bases its calculations on the reflectivity of surfaces. We used the "Raster Calculator" to sum up the available incoming solar radiation reaching each rooftop. Rooftop obstructions were removed by the application of a low-angle slope layer. Obstructions include structural and mechanical equipment like overhead tanks, heating, ventilation and air conditioning (HVAC) vents, skylights, and plumbing equipment.

Rooftop space surrounding obstructions are often unsuitable due to space necessary to access these obstructions for maintenance. Other areas are unsuitable due to close approximation of rooftop obstructions that block off areas of space that would otherwise fit solar panels. To incorporate this unsuitable space, each rooftop was ranked very high to very low for spacing of roof obstructions via a visual analysis in ArcGIS. We then calculated and applied an obstruction factor into each rooftop's total viable space. Additionally, a six-foot set-back from roof edges for solar panels was incorporated into our calculation of available roof space.

The rooftops with the highest incoming solar radiation and most available space for solar panels have the highest energy generation potential. Figure 1 below shows our methodological process. We then compared our analysis with the rooftop characteristics described above to determine the best sites on campus for rooftop solar installation.

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[41] Kodysh, J.B., O.A. Omitaomu, B.L. Bhaduri, and B.S. Neish. 2013. Methodology for estimating solar potential on multiple building rooftop photovoltaic systems. *Sustainable Cities and Society.* 8:31-41.

[42] Hofierka, J., and J. Kanuk. 2009. Assessment of photovoltaic potential in urban areas using open-source solar radiation tools. *Renewable Energy.* 34:2206-2214.

[43] Kodysh, J.B., O.A. Omitaomu, B.L. Bhaduri, and B.S. Neish. 2013. Methodology for estimating solar potential on multiple building rooftop photovoltaic systems. *Sustainable Cities and Society.* 8:31-41.

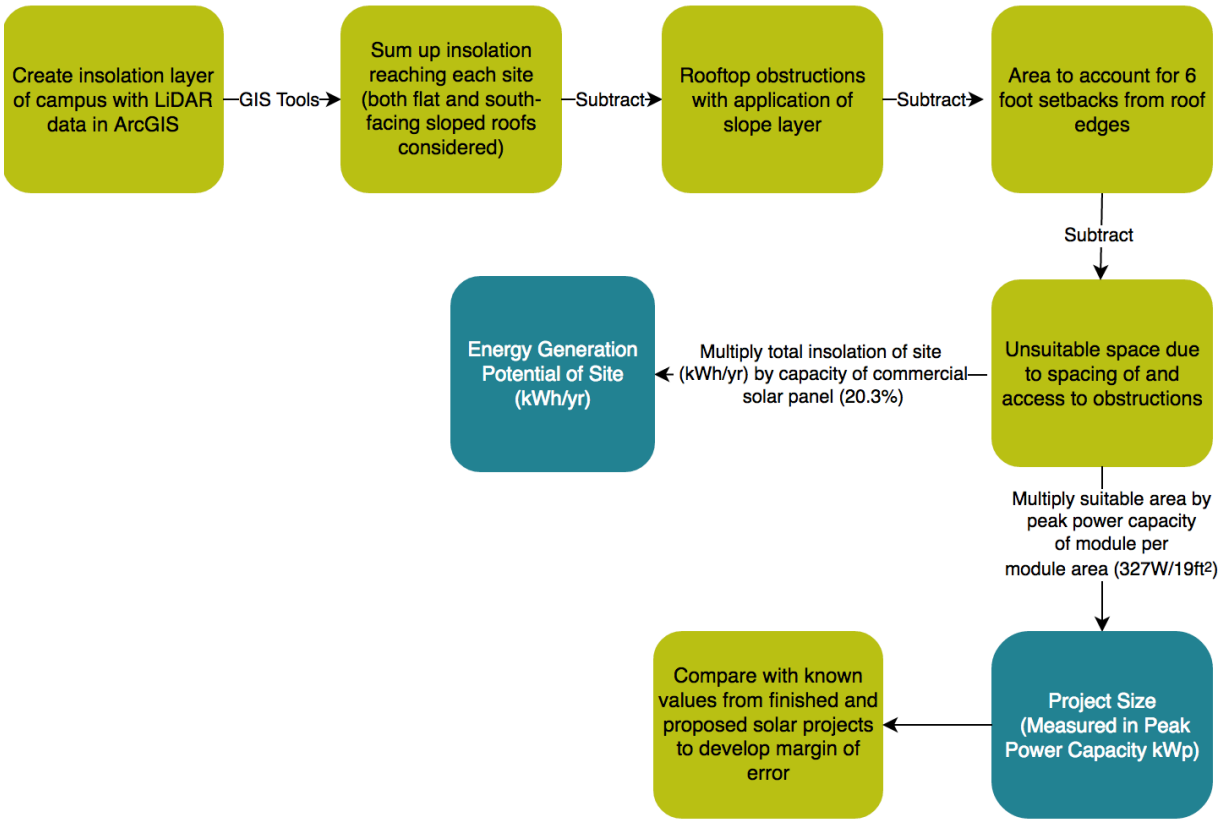

Figure 1: Rooftop Energy Generation Potential Methodology. The calculation of the energy generation potential of each rooftop involved a mixed methodology of analyzing LiDAR data using tools in ArcGIS and manual calculations to estimate suitable roof space.

Prioritization of Rooftop Sites and Calculation of Total Solar Capacity of Main Campus

We calculated the total solar capacity of the main campus by summing up the incoming solar radiation of buildings that meet the following requirements: the project size was greater than 100 kWp (DC), the building was not scheduled for demolition or listed as temporary, and there were no solar panels already present or planned for the near future. Buildings that met these guidelines were then categorized into first, second, or third priority based on the parameters outlined in Table 2.

Table 2: **Prioritization of Rooftop Sites Based on Project Characteristics**. Project characteristics for first, second, and third priority sites are identified. Higher priority sites have the most desirable characteristics. The characteristics for building inclusion in the total campus capacity are also listed in the right column.

Project Characteristics		First Priority Roofs	Second Priority Roofs	Third Priority Roofs	Total Campus Capacity
Project Size > 100 kWp		X	X	X	X
Building not Scheduled for Demolition or Listed as Temporary		X	X	X	X
No Solar Panels Already Present or Scheduled		X	X	X	X
Building Passes Initial Weight-bearing Assessment		X	X	X	
Rooftop Flat to Slope Percentage > 0.7		X			
Roof has > 20 Years Life Left (Except for DM Listed Roofs)		X	X		
Roofing is Single-ply Material		X	X		
Roof not Listed for Deferred Maintenance		X			
Total Insolation Received by Rooftop (kWh/year)	> 250,000	X	X		
	> 100,000	X	X	X	

Results and Discussion

Tabulated results are expressed in Table 3 below. Planned or already completed solar PV on campus is shown in Figure 2. In addition, the three priorities are displayed in their own UCSB campus maps, which indicate the locations and estimated capacities of each building (Figures 3, 4, and 5). We incorporated an uncertainty analysis into the results to create a range for peak power capacity and actual insolation received. We added an error margin of 16% to these calculations after comparing our values with known values of already implemented solar projects as well as expected values from estimates for proposed project sites.

The five First Priority sites are the Recreation Center, University Center, Student Health, Kerr Hall, and Intercollegiate Athletics buildings. These sites meet all the prerequisites described above - they demonstrate high solar potential, are predominantly flat, and are not included on the DM list. These ready-to-go, high potential sites total for an estimated capacity of 1.591 MW.

Table 3: Final Rooftop Recommendations for the Solar Site Assessment. An uncertainty range of ±16% is included in all calculations to account for differences between our calculations with actual values of suitable space for known rooftops. The combined peak power of all modules ranges from 4.0 to 5.6 MW. The actual insolation received by rooftop space suitable for solar panels ranges from 5,450 to 7,526 MWh for the first year. This amounts to a GHG reduction of 1,395 to 1,927 $MTCO_2e$ for the first year of the panels life.

Solar Site Assessment Rooftop Recommendations

Building Name	Peak Power Capacity (kWp)	Actual Insolation for First Year (MWh)	GHG Reduction for First Year ($MTCO_2e$)
First Priority			
Recreation Center	526	762	195
University Center	335	475	122
Student Health	328	453	116
Kerr Hall	214	307	79
Intercollegiate Athletics	188	267	68
Second Priority			
Phelps Hall	479	655	168
Theater and Dance East	432	592	152
Music	384	529	135
Davidson Library	345	443	113
Arts	293	332	85
Cheadle Hall	239	315	81
Humanities and Social Sciences Building	186	257	66
Third Priority			
Central Storehouse	207	301	77
Ellison Hall	149	210	54
Engineering II	121	175	45
South Hall	102	143	37
Broida Hall	127	138	35
Harold Frank Hall	106	135	35
Totals	4.8 MW	6,488 MWh	1,661 $MTCO_2e$
Range ± 16%	4.0 - 5.6 MW	5,450 - 7,526 MWh	1,395 - 1,927 $MTCO_2e$

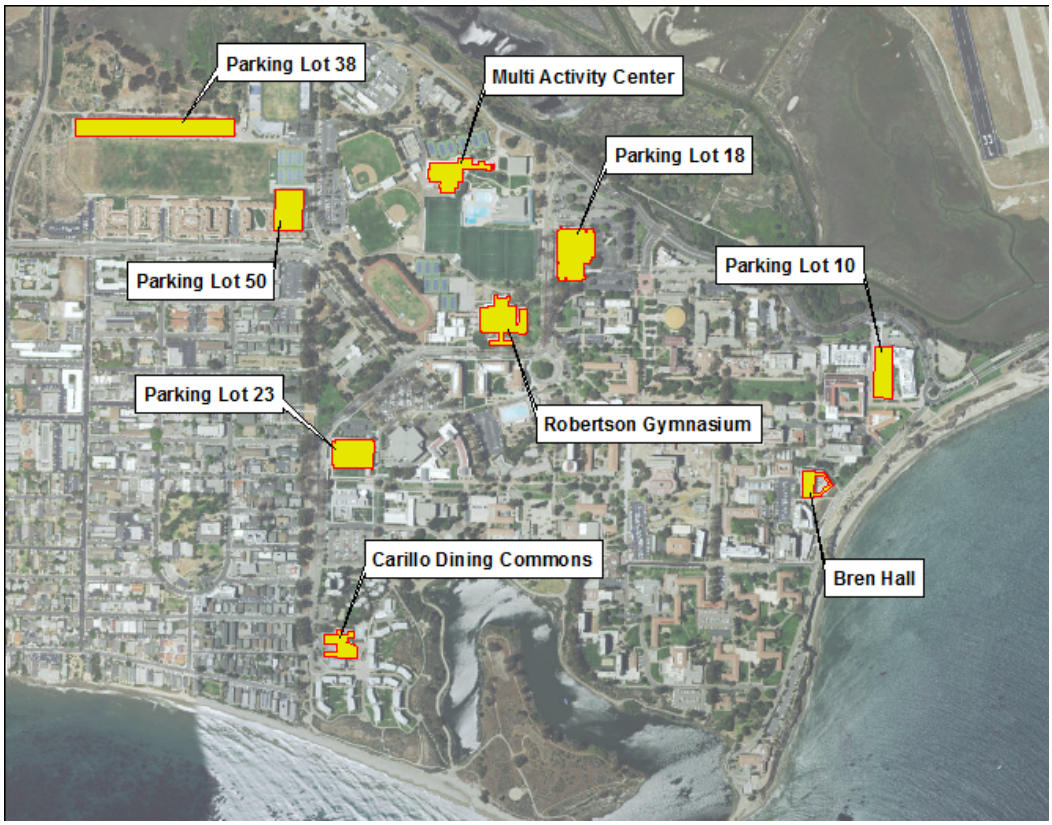

Figure 2: Sites with PV Installations Planned or Completed. Estimated total capacity: 5.99 MW

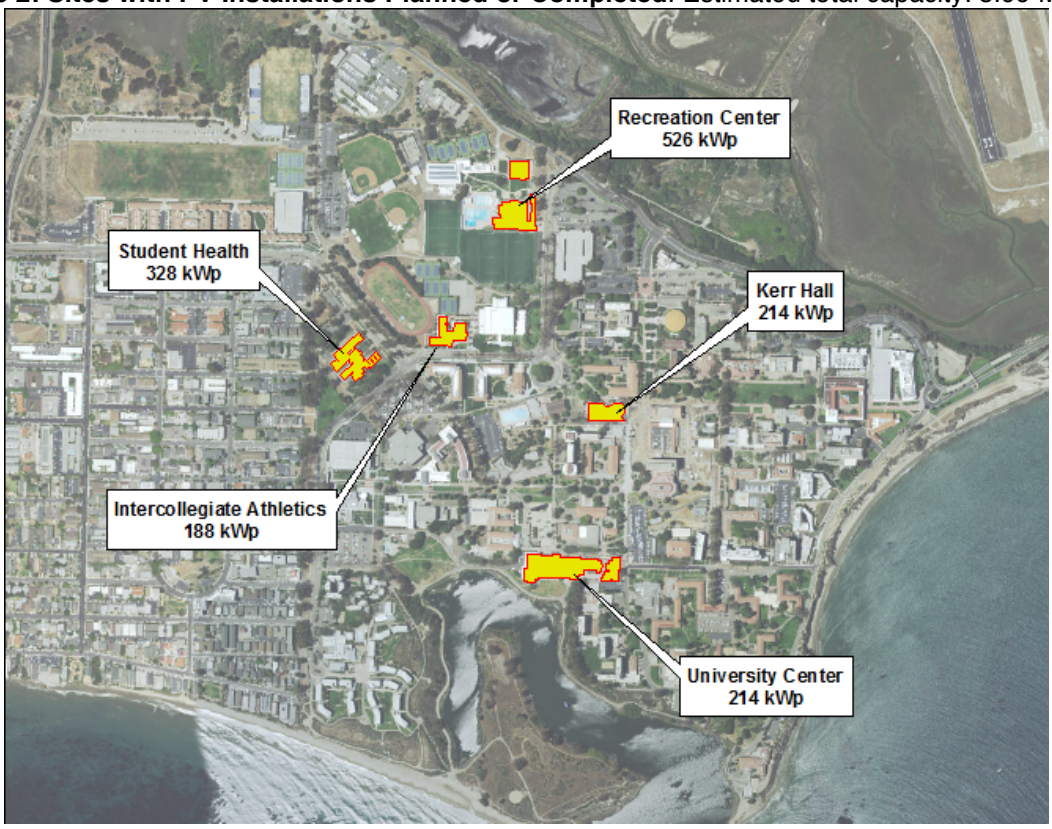

Figure 3: First Priority Rooftop Recommendations. Estimated total capacity: 1.591 MW.

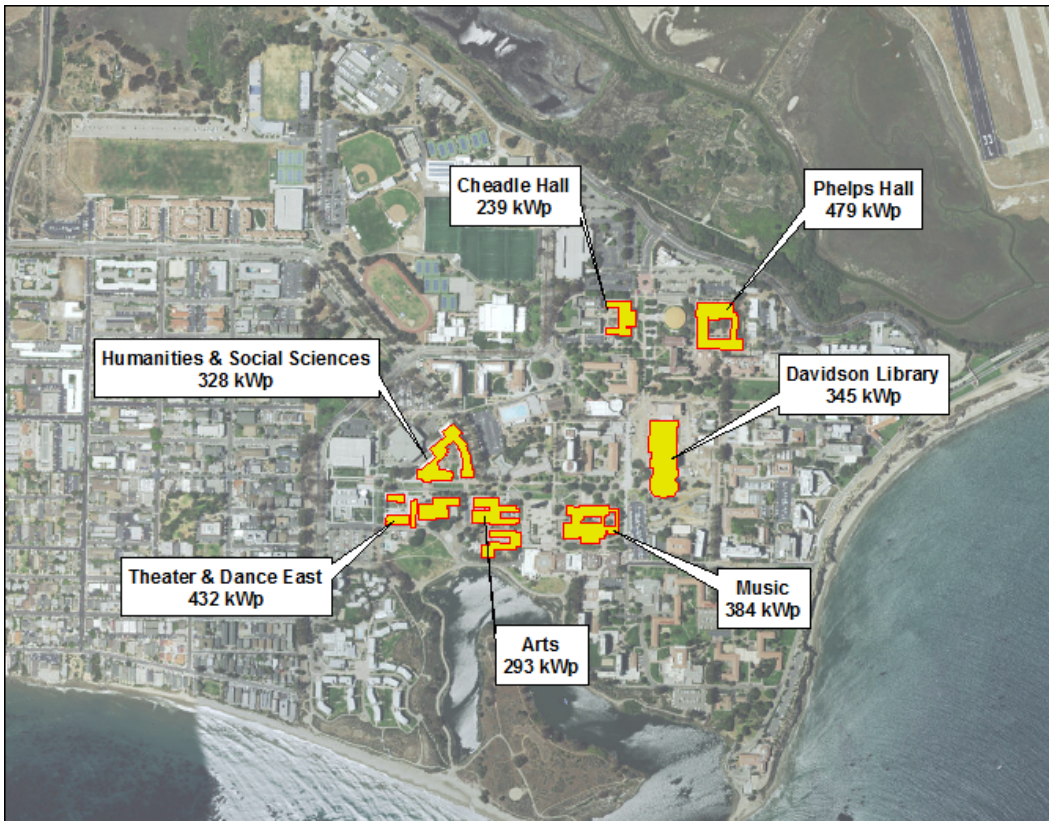

Figure 4: Second Priority Rooftop Recommendations. Estimated total capacity: 2.358 MW.

Figure 5: Third Priority Rooftop Recommendations. Estimated total capacity 0.812 MW.

Second Priority sites, of which there are seven, included Phelps Hall, Theater and Dance East, Davidson Library, and others. These roofs demonstrate high solar potential, though may have potential roadblocks associated with them. Rooftop characteristics are expressed in Table 4, below. For example, Phelps Hall, Theater and Dance East, Davidson Library, and Cheadle Hall all have roofs that are on the DM list. In addition, Phelps Hall, the Music building, and Davidson Library also have somewhat high percentages of sloped roof area relative to their total roof area. The Arts solar potential is almost entirely southern-facing slopes, with very few flat spaces. The estimated total capacity of Second Priority sites is 2.358 MW.

Third priority sites are buildings that meet our base criteria for solar potential. However, potential roadblocks or issues with these sites are more severe or numerous than Second Priority sites. Typically, the roofs are older, are not the preferred material (Sarnafil), and/or are on the DM list. These sites have an estimated total capacity of 0.812 MW.

Table 4: Recommended Rooftop Characteristics Data. Some of the rooftop characteristics that were taken into consideration for prioritization of sites. "ND" means no data exists.

Recommended Rooftop Characteristics

	Flat/Slope Percentage	Roof Life Left (Years)	Roof Material	Maintenace Listed
First Priority				
Recreation Center	100%	22	Singly-Ply	No
University Center	71%	20	Sarnafil	No
Student Health	100%	20	Sarnafil/Built-Up	No
Kerr Hall	100%	26	Sarnafil	No
Intercollegiate Athletics	100%	23	Sarnafil	No
Second Priority				
Phelps Hall	87%	-27	Built-Up	Yes
Theater and Dance East	100%	24/ND	Sarnafil/Built-Up	Yes
Music	54%	31/ND	Sarnafil/Built-Up	No
Davidson Library	76%	33/ND	Sarnafil/Built-Up	Yes
Arts	22%	33	Vinyl	No
Cheadle Hall	100%	22/ND	Sarnafil/Built-Up	Yes
Humanities and Social Sciences Building	100%	ND	Sarnafil	No
Third Priority				
Central Storehouse	100%	ND	ND	No
Ellison Hall	100%	-25	Built-Up	Yes
Engineering II	65%	27/ND	Sarnafil/Built-Up	Yes
South Hall	100%	-23	Built-Up	Yes
Broida Hall	53%	-25	Built-Up	Yes
Harold Frank Hall	100%	-27	Built-Up	Yes

Among all prioritized sites, the estimated total capacity of 4.0 to 5.6 MW would provide UCSB with an estimated 6,488 of MWh per year of energy. This would mitigate an estimated 1,661 $MTCO_2e$ for the first year of panel installations. To put this into perspective, that is the emissions equivalent of the typical annual electricity use of about 175 homes.[44] This total also puts UCSB in range of its goal of 10.99 MW on campus by 2025.

Through this analysis, we demonstrate that there is significant potential for UCSB to reach it goals for total installed solar capacity on campus by 2025. Prior to this analysis, it was not known if UCSB had enough suitable roof space to reach its goal. In addition, we have streamlined information about rooftops for decision-makers, simplifying the site selection process and allowing for comparisons between buildings. UCSB staff or a third party solar company would have had to gather this information– costing valuable time and resources. By increasing available information about sites, we are also increasing the chances of selecting the best possible sites. This is critical, as it maximizes the potential savings of these projects, increases the chances of meeting the campus solar installation goal, and builds momentum for sustainability efforts.

Finally, due to the possibility for UCSB's demand for solar to exceed its 10.99 MW goal, it should be mentioned that these results were produced as a guidance document, with strict criteria to choose the best possible sites. If in the future, more sites for solar installation are needed, greater flexibility can be worked into the model to incorporate a larger range of sites for even later priorities.

Recommendations

- **Install solar panels to meet the estimated rooftop capacity of main campus by targeting high priority rooftops first**. UCSB should install onsite solar PV panels to the maximum extent possible, an additional 4.0 - 5.6 MW, to meet the estimated total solar capacity of the main campus. We recommend considering rooftops identified for high priority first and then moving down the priority rankings as rooftops become unavailable. Due to the challenges of obtaining high up-front capital, UCSB should take advantage of PPAs for most installation projects.

[44] EPA (2015) eGRID, U.S. annual non-baseload CO_2 output emission rate, year 2012 data. U.S. EPA, Washington DC.

- **Prioritize rooftops on the DM list with high solar insolation.** There are nine rooftops that have great solar energy potential but are listed on the DM list, which means they must compete with other campus projects for funding before they can be reroofed. These rooftops together have an estimated capacity of 2.1 MW which could result in the abatement of 720 $MTCO_2e$ emissions annually if they are reroofed. As "strategic priorities" are one of the objectives considered for projects to receive DM funding, we recommend that the 9 listed rooftops receive a higher priority for potentially receiving funds.

- **Incorporate solar rooftop potential in green building standards.** In 2012, the UC adopted goals for green building design as part of the UC Sustainable Practices Policy. The green building goals include a minimum of LEED Silver certification for all new buildings and a LEED Certified rating for all renovation projects that cost over $5 million.[45] We recommend that solar rooftop potential also be considered in the design and renovation of campus buildings. Flat, singly-ply material roof designs should be incorporated where possible. Additionally, rooftop obstructions that are spaced out block off significant amounts of roof availability that could be prime locations for solar panels. We recommend, when possible, to cluster rooftop obstructions together in order to maximize space for solar panels. Efforts can be focused on buildings without laboratories and kitchens, which generally have the least amount of rooftop obstructions.

- **Take advantage of sloped roofs with high solar potential.** Sloped roofs are not the preferred sites for solar installation because they are harder to access for installation and maintenance and they are often roofed with tile which can be difficult for installation. However, the campus has some sloped roofs which receive large amounts of insolation and have enough surface area to make the project cost-effective. These roofs will be good candidates for solar panels when all the available flat spaces are taken. This project identifies 7 sloped roof surfaces which together have a capacity of 0.78 MW.

- **Consider shading of solar panels when planting trees.** Trees planted by buildings provide many benefits including shading which can save energy by reducing demand for cooling. However, tall trees can cause significant amounts of shading on solar panels that can reduce the panels capacity. As a result, trees by buildings scheduled for solar installation are often removed. To avoid this unfortunate scenario, we recommend that the campus consider shorter tree species and other types of low vegetation to not exceed rooftop height for all new and current buildings being considered for solar installation.

[45] UCSB. "Sustainable Infrastructure Practices - Green Building Design." 1 July 2012. Web. 21 Feb. 2017

Finance

Energy efficiency is widely recognized as a preferred GHG emissions reductions strategy at the UC's due to the potential to reduce utility expenditures while lowering Scope 1 and 2 emissions. However, funding is often perceived as the limiting factor with regards to implementing energy efficiency projects at UCSB. In order to institutionalize a reliable source of funding for energy efficiency projects at UCSB, Facilities Management proposed the creation of a Utility Conservation Reinvestment Fund (UCRF). By evaluating the funding potential of the UCRF through 2025 with a scenario analysis, we determined that the UCRF can provide substantial funding for energy efficiency projects. The UCRF can be a key tool in eliminating lack of funding as a primary constraint on energy efficiency efforts at UCSB. If the UCRF is implemented, we recommend that the campus focus on addressing other constraints such as insufficient staffing within Facilities Management as well as the need to identify and plan additional energy efficiency projects.

Background

Energy efficiency and onsite renewable energy projects that reduce GHG emissions at UCSB have traditionally been funded through debt financing. Unfortunately, the potential to finance energy efficiency projects at UCSB with debt financing is currently constrained by the campus's debt limit, as well as the need to utilize limited capital resources for other competing priorities such as building and infrastructure improvements. Therefore, additional financial strategies must be considered to determine the most feasible and cost-effective methods by which UCSB can reduce Scope 1 and 2 GHG emissions through 2025 and beyond. The reality that the CNI is largely an unfunded initiative is one of the fundamental challenges facing all UC campuses. Innovative funding strategies will therefore be necessary to facilitate emission reductions efforts.

One of the most successful and proven methods to finance energy efficiency projects at universities is the use of Green Revolving Funds (GRFs) which reinvest utility savings from completed energy efficiency retrofits into subsequent energy saving projects. A similar fund at UCSB, referred to herein as the UCRF, has been preliminarily approved for implementation by Facilities Management in fiscal year (FY) 2018. Under close collaboration with UCSB Facilities Management staff, we evaluated the potential for the UCRF at UCSB to generate utility savings and reduce GHG emissions on campus through 2025.

In addition to analyzing the proposed UCRF at UCSB, we estimated the cost premium expected to result from alternative electricity procurement from UC's Wholesale Electricity Program (WEP), which aims to provide 100% clean electricity to UC campuses eligible for Direct Access electricity procurement by 2025. This

separate financial objective aimed to evaluate whether UCSB could possibly eliminate Scope 2 emissions from purchased electricity by 2025 by switching to Direct Access electricity procurement and buying electricity directly from the UC WEP. Results from our Direct Access cost analysis can be found in Appendix A. Our cost effectiveness analysis projects that Direct Access electricity procurement at UCSB would carry a substantial cost premium through 2025, except when utility escalation rates approach or exceed 4%. It is therefore unlikely that UCSB administrators would consider switching the campus over to Direct Access. Greening UCSB's purchased electricity supplies remains an important challenge that will require further analysis.

UCRF Scenario Analysis

GRFs for sustainability projects have become increasingly prevalent at university campuses. There are at least 79 GRFs at North American universities as of 2012.[46] A GRF operates as a funding pool that is firewalled for energy projects. Using a starting amount of capital, known as "seed funding," investments are made in energy efficiency projects. Then, the savings from these projects cycle back into the reinvestment fund and are reinvested in energy efficiency projects in subsequent years. Reinvestment funds are particularly attractive to university administrators because they can improve operational efficiency, decrease utility costs, and improve environmental performance at university campuses without a sustained source of capital inflow. An initial amount of seed funding is generally sufficient to achieve a functioning reinvestment fund that will be replenished annually by captured energy savings.

CarbNewt identified a reinvestment fund model at UCSB as a promising strategy to fund energy efficiency projects that will reduce natural gas and electricity consumption on campus and ultimately help move UCSB closer to the 2025 carbon neutrality goal. CarbNewt developed an optimized scenario using Solver in Microsoft Excel in which $48.3 million in energy efficiency projects at UCSB could be completed over a 2016-2025 timeframe with only $15.7 million in seed funding. Potential seed funding sources identified included the utility budget surplus, green donors, and sale of excess AB 32 allowances. This best case scenario would have required $5 million in seed funding in both FY 2016 and FY 2017.[47] CarbNewt's idealized reinvestment fund scenario would have required greater seed funding and an earlier implementation date than is possible. Our analysis intends to inform the campus what a reinvestment fund can likely accomplish given updated information

[46] Indvik, Joe, Robert Foley, and Mark Orlowski. "Green Revolving Funds: A Guide to Implementation & Management." (n.d.): n. pag. July 2013. Web. Jan. 2017.
[47] Bart, Kaysen, Maggass, Park, Watson, 2016. Achieving Carbon Neutrality at UCSB by 2025: A Critical Analysis of Technological and Financial Strategies. University of California, Santa Barbara Bren School of Environmental Science & Management.

regarding expected seed funding, planned energy efficiency projects, and fund structure.

Facilities Management at UCSB began discussions in FY 2017 about the creation of a reinvestment fund to finance energy efficiency projects at UCSB. See Figure 6 below for how UCSB's UCRF model is structured. As of February 2017, the UCRF had gained preliminary approval from the UCSB Office of Budget and Planning, but had yet to be formally implemented. Facilities Management staff at UCSB are hopeful that the UCRF can be officially established and made operational by the beginning of FY 2018.

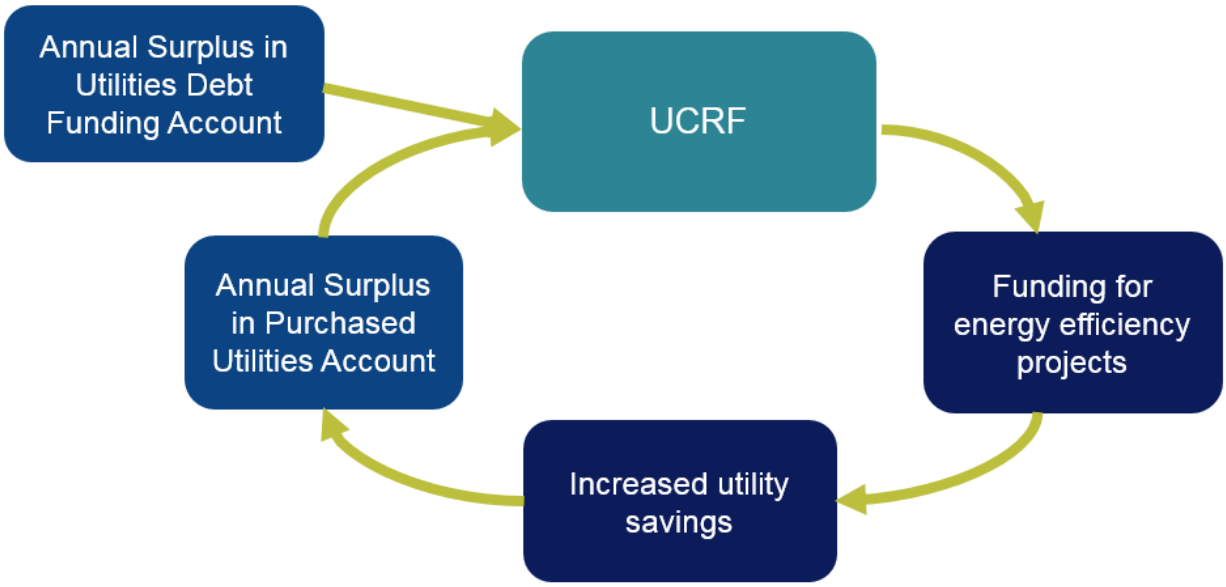

Figure 6: General Structure of the UCRF. The revolving mechanism is illustrated in the schematic above, which demonstrates how the UCRF can generate utility savings that replenish the fund over time for use in subsequent rounds of investment in energy efficiency projects.

After extensive consultation with UCSB Facilities Management staff, we determined that a scenario analysis of UCRF performance through 2025 would be the most practical contribution to ongoing efforts to formalize the UCRF. Given expected seed funding and other fund attributes provided by UCSB Facilities Management, we projected utility savings, energy efficiency investment, and GHG emissions reductions through 2025 over a range of scenarios that vary by utility escalation rate, energy efficiency project payback period, as well as availability of incentives for energy efficiency projects provided through the Statewide Energy Partnership (SEP). The SEP Program is a partnership between Investor Owned Utilities (IOUs) and public universities in California that offers financial incentives to campuses for energy efficiency retrofits. Although UCSB has relied heavily on SEP incentives in the past, there is uncertainty whether the program will continue through 2025. Our ultimate goal was to evaluate how much the UCRF can contribute to GHG emissions reductions at UCSB within the context of the 2025 carbon neutrality target.

Methodology

Setting Up the Model

To estimate the potential of the UCRF at UCSB, we examined current available seed funding sources. In its initial year (2017-2018), the fund would be "seeded" from the FY 2016 and FY 2017 Purchased Utilities Account surpluses (about $2.3 million in FY 2016 and $2.7 million in FY 2017), plus an annually occurring $350,000 from a Utilities Debt Funding Account. Further surpluses would continue to fund the UCRF.

The UCRF would grow by investing available funds in energy savings projects each year. These projects serve to grow the surplus and reduce GHG emissions, creating a positive feedback loop that generates a stream of annual funding that increases over time.

In order to simulate potential savings, we obtained a five-year project schedule from Facilities Management. For each project, the schedule includes costs, duration of project implementation, and annual electricity and natural gas savings. Initial utility rate parameters are provided below in Table 5.

Table 5: Utility Rate Parameters for Electricity and Natural Gas.

Utility Rate Parameters		
Price of Electricity (per kWh)	$	0.11
Price of Natural Gas (per therm)	$	0.70

We used utility escalation rates of 0%, 2%, and 4% in order to account for uncertain future utility rates. Due to uncertainty regarding availability of SEP incentives through 2025, we modeled our projections with and without SEP incentives ($0.25 per kWh; $1 per therm), which occur as one-time lump sums the year after a project was completed. Savings are assumed to accrue beginning in the year after project completion, and continue to accrue annually thereafter.

Additional Projects

After accounting for "scheduled projects," any remaining funds are assumed to be invested in "additional projects." Given the numerous factors surrounding the project approval process, and uncertainty regarding what exact projects would be proposed in the future, we simulated the financial and GHG savings characteristics of potential projects using theoretical parameters.

These parameters were created using data from a list of energy efficiency projects recommended by CarbNewt. To determine a suitable payback for hypothetical "additional projects," we calculated a weighted average payback of approximately 9.5 years from the remaining projects recommended by CarbNewt. To estimate variability around this average, we included bounds of ± 3.5 years. UCSB's energy manager confirmed the appropriateness of this range of 6 to 13 years for a hypothetical payback for the "additional projects." Potential incentives and annual utility savings for "additional projects" were also estimated using averages of data specified in CarbNewt's project list shown below in Table 6.

Table 6: List of Energy Efficiency Projects Recommended by CarbNewt. CarbNewt's list of potential energy savings projects at UCSB is shown below. Incentives are estimated using $0.24/kWh savings and $1.00 /therm savings.

CarbNewt Highlighted Project List

Project Type	Estimated Project Cost ($2016)	Estimated Total Incentives ($2016)	Electricity Savings (kWh/year)	Natural Gas Savings (therms/year)	Total Savings (per year)	Simple Payback w/ No Incentives (years)
Smart Lighting (Very-Low)	$ 525,159.96	$ 355,014.00	1,479,225	0	$ 162,714.79	3.23
Smart Lighting (Low)	$ 2,790,942.05	$1,392,018.48	5,800,077	0	$ 638,008.48	4.37
MBCx (UCSB Aggregate)	$ 3,334,765.85	$1,215,042.96	3,374,929	405,060	$ 614,278.27	5.43
Smart Lighting (Decks/Covered)	$ 322,425.99	$ 98,064.72	408,603	0	$ 44,946.32	7.17
Smart Lighting (Average)	$ 4,117,013.19	$1,180,384.32	4,918,268	0	$ 541,009.50	7.61
Smart Lighting (High)	$ 7,798,367.00	$2,049,496.32	8,539,568	0	$ 939,352.43	8.30
Deep HVAC (UCSB Aggregate)	$ 6,898,589.50	$1,704,565.20	5,742,505	326,364	$ 827,493.90	8.34
Deep LAB (UCSB Aggregate)	$ 14,873,635.04	$2,297,641.08	7,889,042	404,271	$1,110,357.24	13.40

Future Campus Growth

According to UCSB's LRDP, the campus has two periods of planned expansion that will occur from now until 2025. Specifically, these additions will occur in 2017-18 and 2019-20. Figures for the additional electricity and natural gas demand that will result from these planned expansions were obtained from Facilities Management, based on the expected square-footage of new buildings. These figures were incorporated into forecasts of BAU utility expenses and GHG emissions.

Estimating Emissions Savings

To calculate potential emissions savings, estimates for annual electricity and natural gas savings were converted to GHG savings in $MTCO_2e$ using the following factors in Table 7.

Table 7: GHG Conversion Factors for Electricity and Natural Gas.

GHG Conversion Factors	
Electricity Conversion Factor (MT CO_2e /GWh)	248
Natural Gas Conversion Factor (MT CO_2e /M therm)	5302

Utility savings from "scheduled projects" were multiplied by these figures each year to obtain GHG savings. To estimate these figures for "additional projects," we computed the average electricity and natural gas annual savings per dollar of annual savings among projects recommended by CarbNewt. We then multiplied these values by their respective conversion factor and summed them to obtain a figure for GHG savings per dollar saved.

We added together the GHG savings from "scheduled projects" and "additional projects" to calculate total annual GHG savings. Finally, we subtracted this figure from Scope 1 and 2 BAU emissions (51,381 $MTCO_2e$), which yielded GHG savings as a percentage of BAU.

Lessons from Green Revolving Funds at Other Universities

The revolving fund model for sustainability projects has become increasingly popular at colleges and universities in the United States. Because substantial resources are available that provide case studies and analysis of existing GRFs at universities in North America, we evaluated outcomes and performance at other academic institutions. The ultimate goal is to provide insight into best practices and potential difficulties for GRFs that could prove useful to Facilities Management and the Office of Budget and Planning at UCSB as UCRF planning efforts move forward.

Results and Discussion

UCRF Scenario Analysis

We present results of UCRF performance through 2025 for six different scenarios. Each scenario varies by utility escalation rate (0%, 2%, or 4%) as well as by inclusion or exclusion of SEP incentives for energy efficiency projects. Variability within each scenario results from a range of payback periods considered for "additional projects" identified by CarbNewt. Primary metrics used to track UCRF performance include utility savings, investment in energy efficiency projects, as well

as annual Scope 1 and 2 GHG emissions reductions through FY 2025. All monetary values are undiscounted.

Results across all six scenarios unsurprisingly demonstrate that low escalation rates lead to higher levels of investment in energy efficiency and GHG emissions reductions. More interestingly, high escalation rates lead to greatest utility savings. This suggests that when escalation rates rise, the effect of increases in savings per kWh/therm conserved overpowers the effect of less investment in energy efficiency resulting from declining utilities budget surpluses. Therefore, the UCRF can effectively hedge against the risk of future utility rate increases while maximizing emissions reductions among the range of escalation rates considered.

Our scenario analysis also demonstrates the importance of SEP incentives with regards to energy efficiency projects at UCSB. When average project paybacks are considered, exclusion of SEP incentives leads to a 18% decline in cumulative investment, 25% decline in cumulative savings, and 7% decline in GHG emissions reductions through 2025 when averaged across all six scenarios. Clearly the SEP program contributes considerably to energy efficiency funding at UCSB. However, it should be noted that significant utility savings and emissions reductions can still be realized as a result of UCRF implementation in the absence of SEP incentives.

Investment in energy efficiency and GHG emissions reductions are greatest when a 0% escalation rate is used and SEP incentives are included, and least when a 4% escalation rate is used and SEP incentives are excluded. Utility savings are greatest when a 4% escalation rate is used and SEP incentives are included, and least when a 0% escalation rate is used and SEP incentives are excluded. Although cumulative energy efficiency investment exceeds cumulative utility savings, annual savings would continue to accrue beyond FY 2025 in the absence of any additional energy efficiency projects.

Cumulative utility savings through FY 2025 ranged from $10.2 million (0% utility escalation rate with no SEP incentives scenario) to $24.2 million (4% utility escalation rate with SEP incentives scenario). Cumulative investment in energy efficiency projects through FY 2025 ranged from $17.3 million (4% escalation rate without SEP incentives scenario) to $35.4 million (0% escalation rate with SEP incentives scenario).

2025 GHG emissions reductions below BAU projections ranged from 7,965 $MTCO_2e$ (4% utility escalation rate without SEP incentives scenario) to 16,555 $MTCO_2e$ (0% utility escalation rate with SEP incentives scenario). This demonstrates that the UCRF has the potential to reduce 2025 BAU Scope 1 and 2 emissions at UCSB by 15 to 31% given expected levels of seed funding. Results for each scenario are presented below. Detailed scenario analysis results are also presented in tabular format in Appendix B.

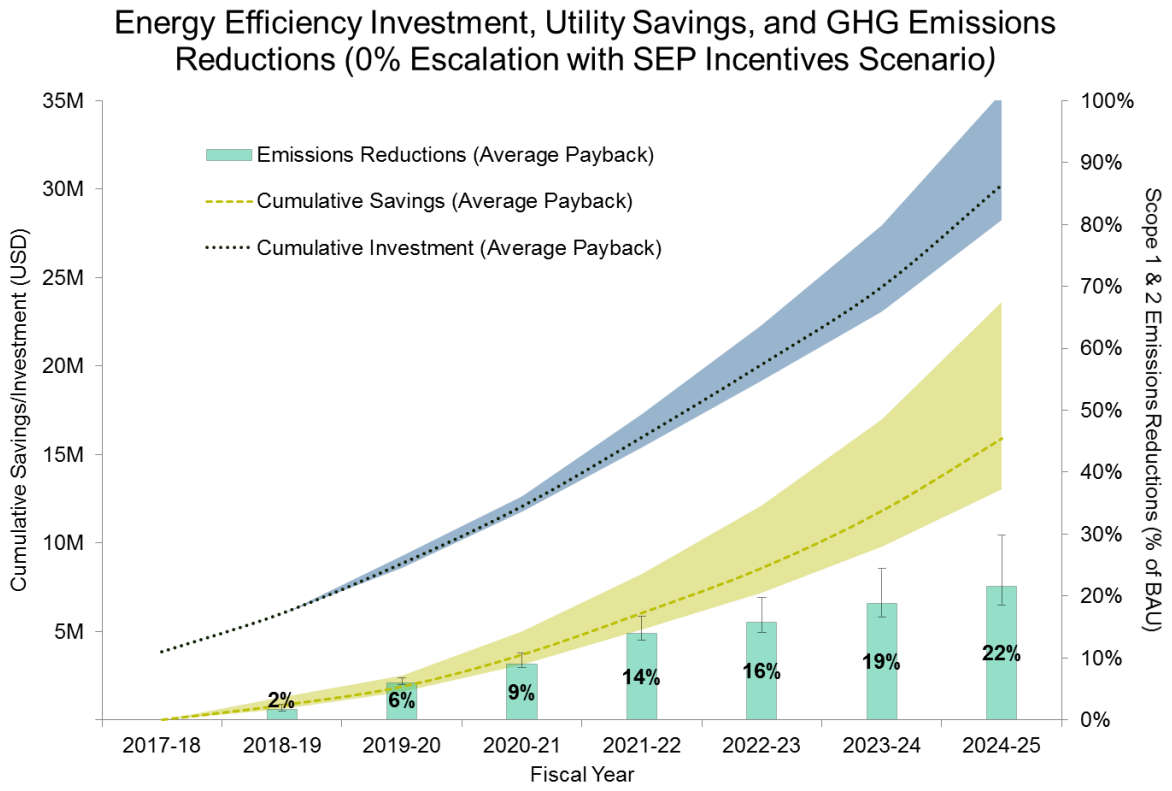

Figure 7: UCRF Performance for 0% Utility Escalation Rate with SEP Incentives Scenario. Cumulative UCRF investment in energy efficiency projects, cumulative savings, and annual GHG reductions as a percentage of BAU Scope 1 and 2 emissions are shown through 2025. Error bars for emissions reductions and variability around savings and investment lines represent a range of values resulting from consideration of slow, average, and fast payback periods for "additional projects."

For the 0% utility escalation rate with SEP incentives scenario (see Figure 7), cumulative utility savings through 2025 resulting from the UCRF ranged from $13.0 million to $23.6 million. Total UCRF investment in energy efficiency projects through 2025 ranged from $28.2 million to $35.4 million. GHG emissions reductions as a proportion of BAU emissions in 2025 ranged from 18% to 31%.

Although investment is likely perceived negatively as a cost burden, it is essential to note that the majority of UCRF funds used to invest in energy efficiency is generated by the fund's revolving mechanism that recycles savings from past projects for reinvestment in future projects. In the scenario above, around $30 million of investment in energy efficiency results from roughly $6.5 million in seed funding through 2025. Seed funding consists of the initial influx of funds from the campus purchased utilities account and debt funding account in FY 2018, as well as $350,000 from the debt funding account in each subsequent year.

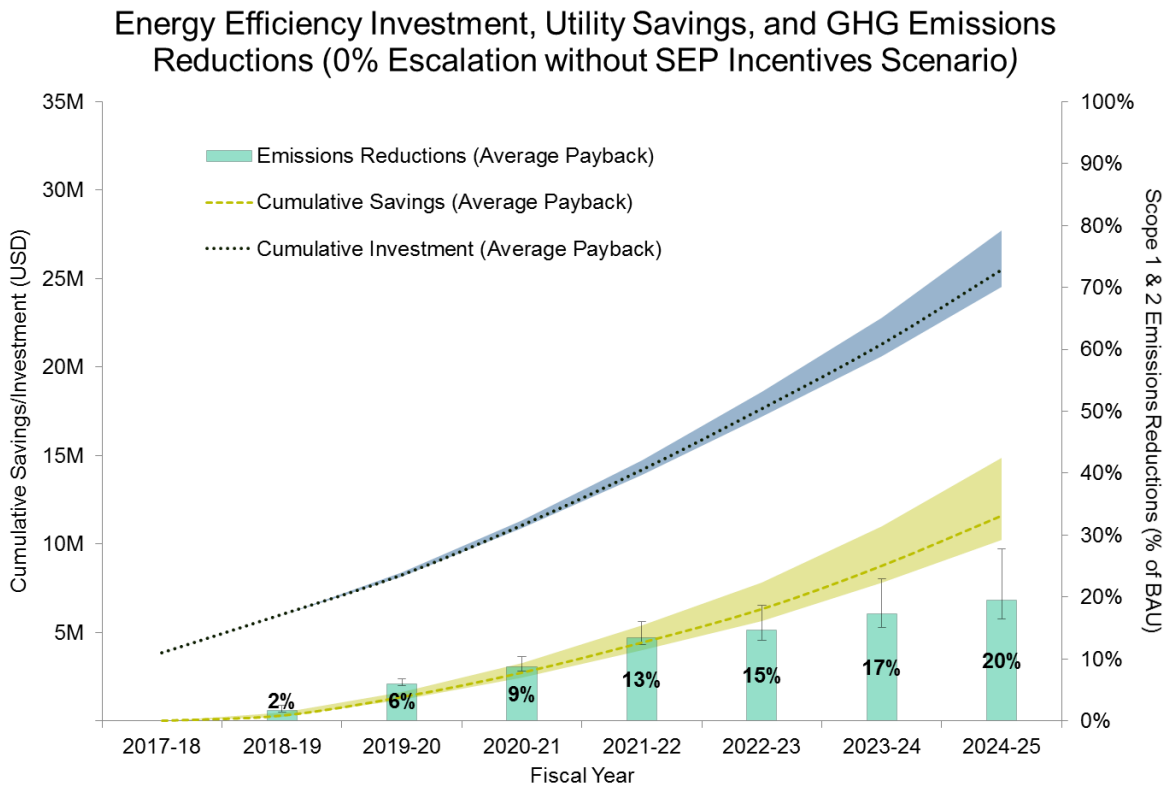

Figure 8: UCRF Performance for 0% Utility Escalation Rate without SEP Incentives Scenario. Cumulative UCRF investment in energy efficiency projects, cumulative savings, and annual GHG reductions as a percentage of BAU Scope 1 and 2 emissions are shown through 2025. Error bars for emissions reductions and variability around savings and investment lines represent a range of values resulting from consideration of slow, average, and fast payback periods for "additional projects."

For the 0% utility escalation rate without SEP incentives scenario (See Figure 8), cumulative utility savings through 2025 resulting from the UCRF ranged from $10.2 million to $14.9 million. Total UCRF investment in energy efficiency projects through 2025 ranged from $24.5 million to $27.7 million. GHG emissions reductions as a proportion of BAU emissions in 2025 ranged from 17% to 26%.

The range of variability for all three metrics is much narrower when SEP incentives are excluded. This is largely because a reduction in investment and savings levels leads to a greater than proportional reduction in variability based on differing payback periods for "additional projects." The revolving fund mechanism has a multiplier effect on variability because any dollar of investment is subsequently reinvested in new energy efficiency projects once utility savings begin to accrue.

With average project payback and a 0% utility escalation rate, exclusion of SEP incentives results in a 16% decline in cumulative investment, 27% decline in cumulative savings, and 6% decline in cumulative GHG emission reductions compared to inclusion of SEP incentives.

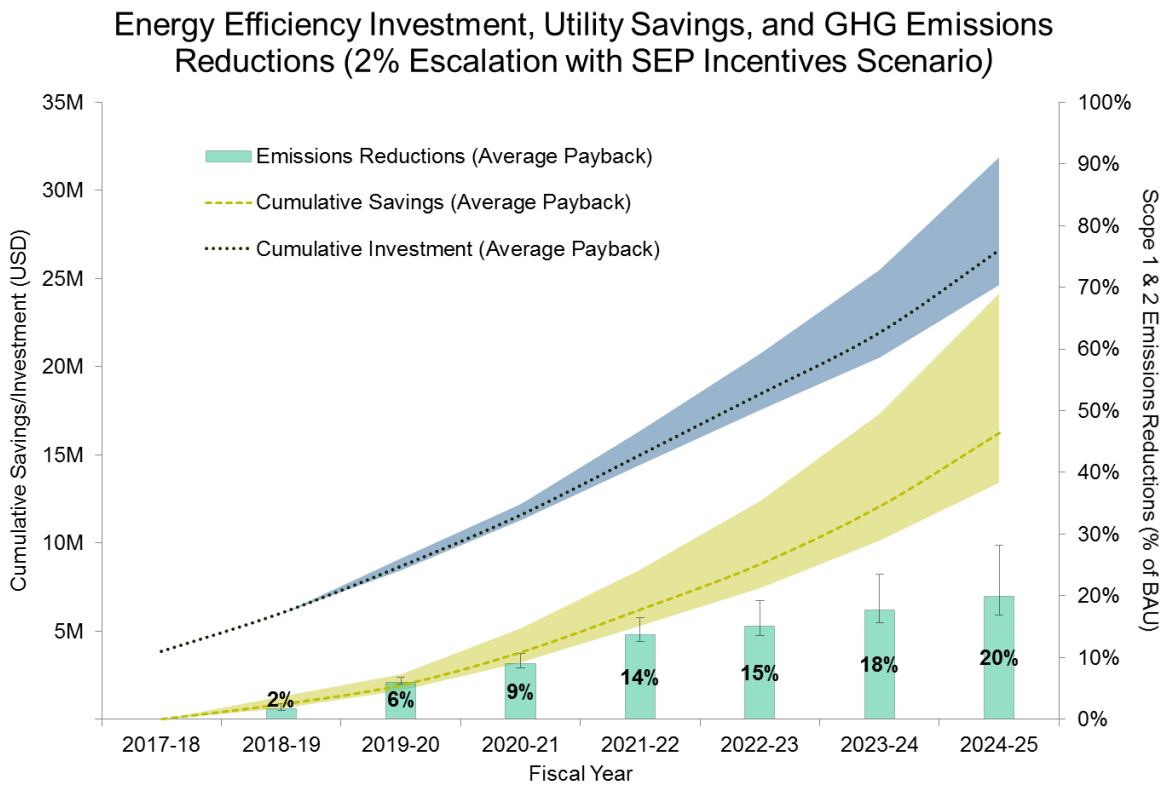

Figure 9: UCRF Performance for 2% Utility Escalation Rate with SEP Incentives Scenario. Cumulative UCRF investment in energy efficiency projects, cumulative savings, and annual GHG reductions as a percentage of BAU Scope 1 and 2 emissions are shown through 2025. Error bars for emissions reductions and variability around savings and investment lines represent a range of values resulting from consideration of slow, average, and fast payback periods for "additional projects."

Moving on to the 2% utility escalation rate with SEP incentives scenario (see Figure 9), cumulative utility savings through 2025 resulting from the UCRF ranged from $13.4 million to $24.1 million. Total UCRF investment in energy efficiency projects through 2025 ranged from $24.6 million to $31.9 million. Greenhouse gas emissions reductions as a proportion of BAU emissions in 2025 ranged from 17% to 28%.

Compared to scenarios in which a 0% utility escalation rate is used, a 2% utility escalation rate leads to a considerably smaller gap between cumulative investment and cumulative savings. This demonstrates that higher utility escalation rates generate increased savings resulting from UCRF-funded energy efficiency projects. When higher utility escalation rates are used, the increase in dollars saved per kWh/therm conserved is the dominating effect on utility savings. Higher escalation rates reduce investment in energy efficiency, and therefore less effectively reduce utility demand. This leads to a negative effect on cumulative utility savings. However, this effect is clearly dominated by the positive impact of high escalation rates leading to increased dollars saved per kWh/therm conserved. High escalation rates therefore lead to greater utility savings under the range of rates considered.

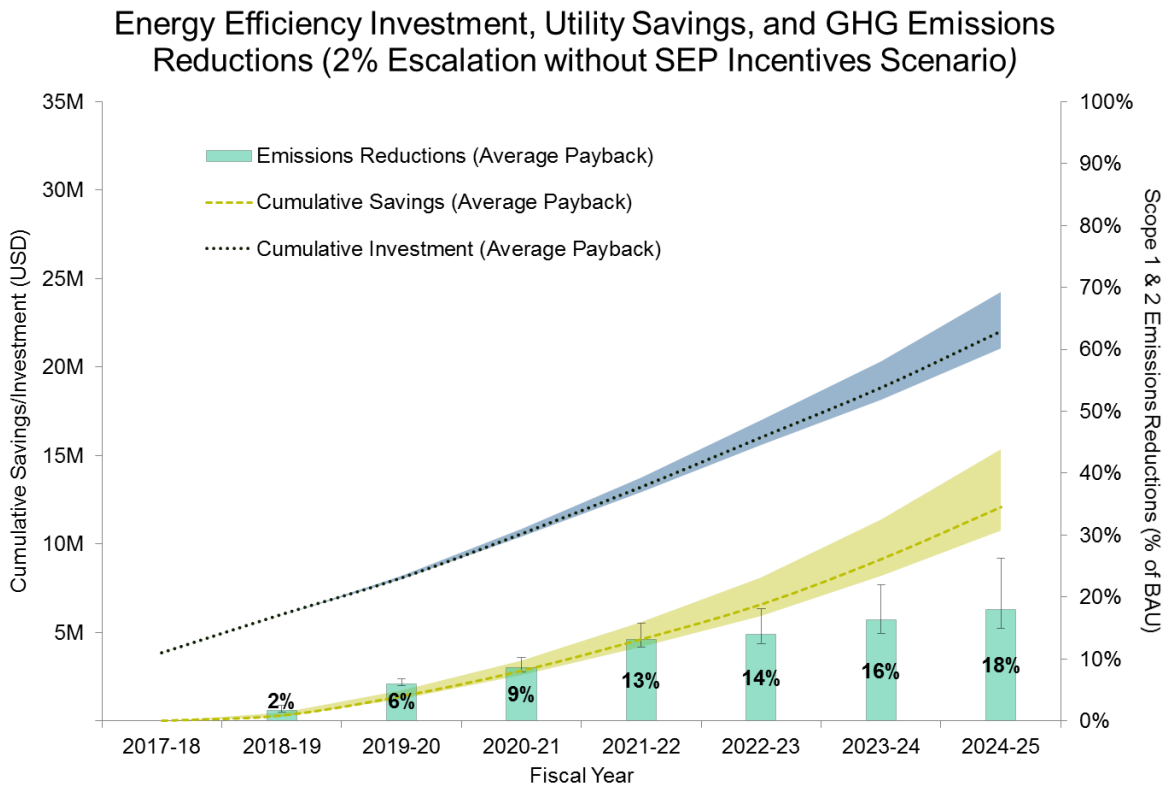

Figure 10: UCRF Performance for 2% Utility Escalation Rate without SEP Incentives Scenario. Cumulative UCRF investment in energy efficiency projects, cumulative savings, and annual GHG reductions as a percentage of BAU Scope 1 and 2 emissions are shown through 2025. Error bars for emissions reductions and variability around savings and investment lines represent a range of values resulting from consideration of slow, average, and fast payback periods for "additional projects."

Figure 10 shows the 2% utility escalation rate without SEP incentives scenario, cumulative utility savings through 2025 resulting from the UCRF ranged from $10.8 million to $15.4 million. Total UCRF investment in energy efficiency projects through 2025 ranged from $21.1 million to $24.2 million. GHG emissions reductions as a proportion of BAU emissions in 2025 ranged from 16% to 23%.

With average project payback and a 2% utility escalation rate, exclusion of SEP incentives results in a 17% decline cumulative investment, 26% decline in cumulative savings, and 7% decline in cumulative GHG emission reductions compared to inclusion of SEP incentives.

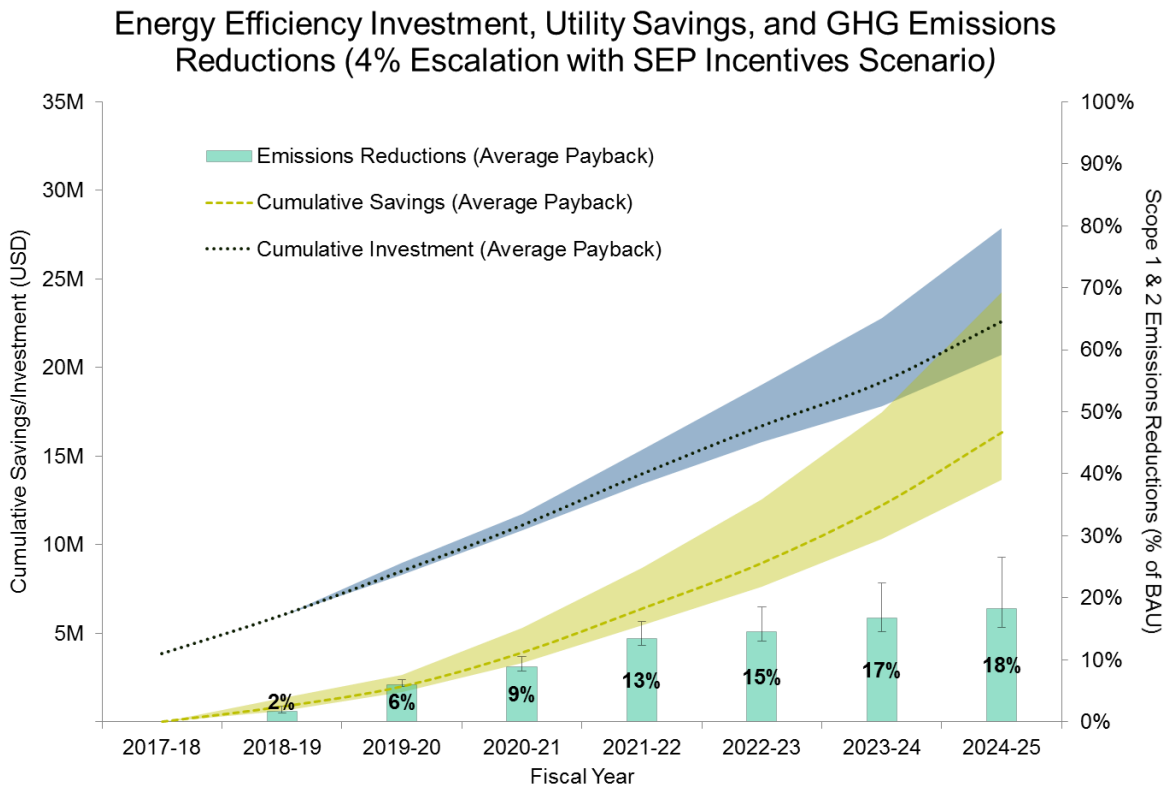

Figure 11: UCRF Performance for 4% Utility Escalation Rate with SEP Incentives Scenario. Cumulative UCRF investment in energy efficiency projects, cumulative savings, and annual GHG reductions as a percentage of BAU Scope 1 and 2 emissions are shown through 2025. Error bars for emissions reductions and variability around savings and investment lines represent a range of values resulting from consideration of slow, average, and fast payback periods for "additional projects."

Figure 11 shows the 4% utility escalation rate with SEP incentives scenario, cumulative utility savings through 2025 resulting from the UCRF ranged from $13.6 million to $24.2 million. Total UCRF investment in energy efficiency projects through 2025 ranged from $20.7 million to $27.9 million. GHG emissions reductions as a proportion of BAU emissions in 2025 ranged from 16% to 26%.

With a 4% utility escalation rate, the range of values for cumulative investment and savings begin to overlap. This never occurs for each of the four scenarios in which a 0% or 2 % utility escalation rate is used. This further demonstrates how cumulative savings rise when the escalation rate increases among the range of scenarios considered. This relationship begins to break down when utility escalation rates exceed 4%. When the utility escalation rates continue to increase above 4%, cumulative savings begin to decline.

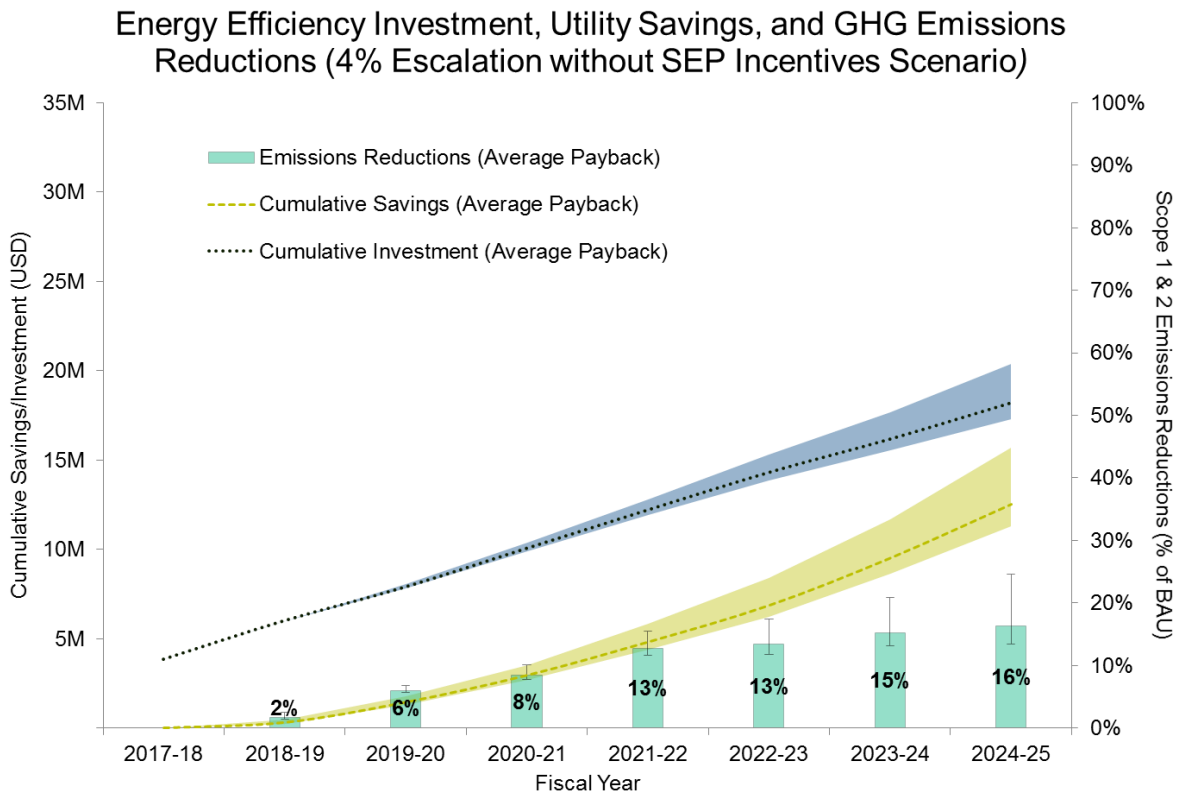

Figure 12: UCRF Performance for 4% Utility Escalation Rate without SEP Incentives Scenario. Cumulative UCRF investment in energy efficiency projects, cumulative savings, and annual GHG reductions as a percentage of BAU Scope 1 and 2 emissions are shown through 2025. Error bars for emissions reductions and variability around savings and investment lines represent a range of values resulting from consideration of slow, average, and fast payback periods for "additional projects."

Finally, Figure 12 above shows the 4% utility escalation rate without SEP incentives scenario, cumulative utility savings through 2025 resulting from the UCRF ranged from $11.3 million to $15.7 million. Total UCRF investment in energy efficiency projects through 2025 ranged from $17.3 million to $20.4 million. GHG emissions reductions as a proportion of BAU emissions in 2025 ranged from 15% to 21%.

With average project payback and a 4% utility escalation rate, exclusion of SEP incentives results in a 20% decline cumulative investment, 23% decline in cumulative savings, and 7% decline in cumulative GHG emission reductions compared to inclusion of SEP incentives. This final scenario, in which a 4% escalation rate is used and SEP incentives are excluded, results in the lowest levels of energy efficiency investment and GHG reductions among all six scenarios.

Lessons Learned from Green Revolving Funds at Other Universities

Trends and Performance at Other Universities

GRFs have risen in prominence at universities in North America due to the potential to improve operational efficiency as well as environmental performance in the context of constrained institutional budgets. As of 2012, over 70 active GRFs were in place at universities in the United States and Canada, collectively representing over $111 million in invested capital and over 900 completed energy efficiency projects.[48] Over 36 GRFs were initiated between 2011 and 2012 alone, demonstrating how quickly the GRF concept is taking hold. The average return on investment of GRFs at 76 universities surveyed by the Sustainable Endowments Institute in 2012 was 28%. Median payback period for energy efficiency projects at surveyed universities was 3.5 years.[49] The GRF model at universities is therefore well-proven to provide significant financial returns and deliver substantial energy savings.

In 2014, the first two GRFs were implemented at public universities in California. UCLA created the $15 million Energy and Sustainability Revolving Fund in late 2014, which remains to be the only GRF implemented by a UC campus.[50] Seed funding for the UCLA Energy and Sustainability Revolving fund was sourced from bond financing, although the fund continues to actively solicit donations to supplement fund size.[51] CSU Fullerton also initiated a $1 million GRF in 2014 in which annual energy savings are used to fund future energy efficiency projects.[52]

Budget offices at universities often express hesitation to approve the creation of GRFs because a new fund model represents risk and uncertainty. However, GRF performance at universities already demonstrate proof of concept as well as overwhelmingly positive performance. Institutions that have successfully implemented GRFs span a wide range in terms of institution size, location, wealth, and type, whether private or public. Therefore, the perceived risk associated with implementing the UCRF at UCSB is likely much greater than actual risk, as the GRF model is well-proven when revolving funds are carefully tailored to meet specific campus goals.

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[48] Sustainable Endowments Institute. 2012. "Greening the Bottom Line.": n. pag., 2012. Web.
[49] Ibid.
[50] Billion Dollar Green Challenge. 2016. "Billion Dollar Green Challenge Participants." Sustainable Endowments Institute, n.d. Web. Jan. 2017.
[51] Hewitt, Alison. "UCLA Creates Nation's Largest Self-replenishing Fund for Green Projects." UCLA Newsroom. UCLA, 28 Oct. 2014. Web. Jan. 2017.
[52] Billion Dollar Green Challenge. 2016. "Billion Dollar Green Challenge Participants." Sustainable Endowments Institute, n.d. Web. Jan. 2017.

Seed Capital

A prominent consideration prior to GRF implementation is where seed funding will be sourced from. The UCRF at UCSB is tentatively planned to receive seed funding from the end-of-year surplus from its Purchased Utilities Account as well as from any positive balance from a Utilities Debt Funding Account (both managed by UCSB Facilities Management). SEP incentives will also effectively subsidize the cost of energy efficiency projects at UCSB, and can be considered as a supplementary source of seed funding for the UCRF.

The most common sources of seed funding for GRFs at other institutions are general operating budgets and campus utilities accounts.[53] The UCRF therefore conforms to the most commonly utilized seed funding strategy employed at other universities. Although our UCRF scenario analysis does not incorporate additional sources of seed funding, UCSB administrators may wish to evaluate the potential for other seed funding sources to be utilized in the future. Other distinct funding sources for GRFs used by other institutions include[54]:

- Donations from alumni and other external parties
- University cash reserves
- Capital budgets
- University endowment
- Student government funding
- Student green fees
- Utility rebates
- State and federal energy efficiency grants and incentives

President Napolitano's Global Climate Leadership Council's (GCLC) Taskforce on Finance and Management is currently evaluating financial strategies for UC campuses with regards to the CNI. We do not recommend any particular sources of seed funding as our goal is simply to provide information with regards to GRF seed funding sources utilized by other universities. However, it is unclear at this time whether the UCSB Office of Budget of Planning will approve the use of seed funding not sourced from the two utilities accounts within Facilities Management identified above.

Project Selection and Criteria

Institutions generally specify explicit criteria that must be met in order for energy efficiency and other sustainability projects to receive funding from a GRF. The

[53] Sustainable Endowments Institute. 2012. "Greening the Bottom Line.": n. pag., 2012. Web.
[54] Indvik, Joe, Robert Foley, and Mark Orlowski. "Green Revolving Funds: A Guide to Implementation & Management." (n.d.): n. pag. July 2013. Web. Jan. 2017.

highest priority criteria are most commonly financial performance metrics, such as return on investment, internal rate of return, or net present value. Based on results from the 2012 Sustainable Endowments Institute survey of GRFs, nearly half of universities with GRFs specified a maximum payback period for GRF-funded projects (ranging from two to ten years with an average of six years).[55] In addition to financial performance metrics, overall project cost was often considered. Based on the size of each GRF, maximum capital costs for any single project may be specified.

Environmental benefits, such as GHG reductions, are also commonly an important criterion with regards to project selection, although financial performance criteria generally take precedent. Cost-effectiveness metrics such as emissions reductions per dollar of project cost are also sometimes employed. Although the primary goal of the UCRF is to reduce utility costs at UCSB, formalized consideration of GHG emissions reduction potential during project selection would help maximize the fund's contribution towards climate mitigation goals associated with the CNI. Additionally, some institutions also take into account any potential for campus community engagement and collaboration, as well as educational benefits. UCRF managers may need to determine whether engagement criteria can be an appropriate subcomponent of UCRF project selection.[56]

Building Buy-in

Perhaps the most crucial aspect of ensuring successful GRF implementation is engaging the crucial parties whose support will be needed for GRF approval.[57] For some institutions, thorough stakeholder engagement may extend to a significant portion of the campus community, including the student body and staff. However, this is most commonly the case at campuses with a decentralized utility and energy management structure. Because all main campus utilities at UCSB are charged to a single account managed by Facilities Management, the UCRF will likely require support and buy-in from a limited number of parties. Based on experiences at other universities with a centralized utilities budget structure, it is likely that the UCRF at UCSB will only substantially depend on support from Facilities Management and the Office of Budget and Planning. Because the UCRF proposal was initiated and championed by staff within Facilities Management, the Office of Budget of Planning is the key party from whom strong buy-in is needed.

When attempting to generate buy-in for GRF implementation from necessary parties, other universities have shown that it is important to frame the revolving fund model in a manner that builds the business case for energy efficiency and emphasizes the

[55] Indvik, Joe, Robert Foley, and Mark Orlowski. "Green Revolving Funds: A Guide to Implementation & Management." (n.d.): n. pag. July 2013. Web. Jan. 2017.
[56] Ibid.
[57] Sustainable Endowments Institute. 2012. "Greening the Bottom Line.": n. pag., 2012. Web.

cost savings potential. Energy efficiency projects are often perceived as simply another expense that strains campus budgets. However, GRFs may appear more attractive to budget officials when framed as a high-return investment opportunity. Emphasis on high return on investment and permanent annual savings are effective ways to build the case for the revolving fund model. Additionally, GRFs can be framed as an effective way to hedge against rising energy prices in the future.[58]

Potential Barriers and Difficulties

Although seed funding is often perceived as the primary limiting factor regarding GRF creation, perhaps an equally significant challenge is determining how to manage a new revolving fund given limited staff resources. Multiple university administrators reported concerns about trying to complete long lists of energy efficiency projects with insufficient staffing levels.[59] This concern is particularly relevant to UCSB, where there are currently fewer engineers within Facilities Management employed compared to before 2014.[60] Although there is the opportunity to contract out work related to energy efficiency projects, the cost of projects rise considerably when done externally. Additionally, UCSB budget rules and procedures would not allow for UCRF funds to be used to pay the salaries of newly hired full-time employees.[61]

Another challenge reported by other universities is the issue of identifying a sufficient number of energy efficiency projects to fund over time.[62] GRF managers also worry about running out of potential projects with a sufficiently low payback period. However, many GRFs that have been in operation for long periods of time continue to identify low payback projects. With regards to identification of potential projects, many universities utilize consultants to carry out detailed audits of campus buildings in order to assess energy efficiency improvement potential. Although energy efficiency projects identified by UCSB's energy manager as well as CarbNewt's final report are considered in our UCRF scenario analysis above, there will be a future need to systemize additional project identification as the aforementioned projects are completed.

Lessons Learned

A common recommendation provided by university employees with experience implementing GRFs is that there is great value in looking to other institutions as

[58] Indvik, Joe, Robert Foley, and Mark Orlowski. "Green Revolving Funds: A Guide to Implementation & Management." (n.d.): n. pag. July 2013. Web. Jan. 2017.
[59] Sustainable Endowments Institute. 2012. "Greening the Bottom Line.": n. pag., 2012. Web.
[60] Sager, Jordan. "Personal Interview." January 20, 2017.
[61] Carbon Zero. 2016. Informational Interviews. *University of California, Santa Barbara, Bren School of Environmental Science & Management*.
[62] Sustainable Endowments Institute. 2012. "Greening the Bottom Line.": n. pag., 2012. Web.

examples when designing and implementing a new revolving fund. Bren School alumnus John Onderdonk, now the Director of Sustainability Programs at Caltech, offers the following advice: "Don't reinvent the wheel, talk to other universities who have made this work and assimilate those programs into a custom program that will work at your school."[63] UCSB can therefore benefit from emulating GRF structures and protocols at other universities. As more information becomes available, UCLA's Energy and Sustainability Revolving Fund may provide useful insights that can inform UCRF planning at UCSB.

Finally, staff involved with UCRF management at UCSB may find value in integrating revolving fund efforts with the broader sustainability goals of the UC CNI. Other universities have reported that GRFs can be successfully leveraged to drive forward progress to strategic initiatives such as CAPs. Tying in revolving fund efforts to specific climate goals can help improve stakeholder buy-in among diverse groups as well as engage students. Although the UCRF at UCSB is being proposed primarily for operational efficiency measures, synergy with the CNI offers another compelling reason to budget officials as to why a revolving fund would be beneficial. Specific emphasis can be placed on the notion that the revolving fund model is one of the few cost-saving methods that reduces GHG emissions.

Recommendations

- **Identify additional energy efficiency projects to be implemented through 2025.** Funding has generally been assumed to be the primary limiting factor with regards to energy efficiency efforts at UCSB. Our analysis of UCRF outcomes through 2025 demonstrates that substantial levels of funding will be available for energy efficiency projects. Therefore, more projects will need to be identified, scoped, and planned if all available UCRF funding is to be utilized through 2025. Other universities have relied on detailed audits by private consultants as well as members of the campus community to identify potential energy efficiency projects.

- **Develop strategies to overcome Facilities Management staff constraints.** Even if additional energy efficiency projects are identified, effective implementation may be significantly limited by constraints regarding time and effort devoted to energy efficiency by Facilities Management staff. The five-year plan of "scheduled projects" is already ambitious given existing staffing levels within Facilities Management. Additional controls and mechanical engineers within Facilities Management could potentially facilitate the implementation of more energy efficiency projects at UCSB. However, UCRF funds will not be allowed to contribute towards the salaries of full-time permanent campus

[63] Indvik, Joe, Robert Foley, and Mark Orlowski. "Green Revolving Funds: A Guide to Implementation & Management." (n.d.): n. pag. July 2013. Web. Jan. 2017.

employees. Private contractors could be hired to implement energy efficiency projects at UCSB, but this is considerably more expensive. Limited staff time and effort clearly is an issue that needs to be addressed if UCSB is serious about fully utilizing UCRF funds for investment in energy efficiency.

- **Consider sharing UCRF-generated savings with other campus budgets in order to build buy-in for the UCRF with the Office of Budget and Planning.** If it is determined that it is infeasible to implement sufficient energy efficiency projects in order to fully utilize available UCRF funds, a portion of the annual purchased utilities budget surplus could be allocated elsewhere within the campus budget. At some universities with GRFs, a certain portion of project savings are used to replenish the reinvestment fund each year, while the remaining savings are allocated elsewhere. Although this would reduce potential investment in energy efficiency, a similar strategy could be employed to build the business case for a reinvestment fund and generate greater enthusiasm within the Office of Budget and Planning. Unused UCRF funds could potentially be reallocated to other budgets within Facilities Management for example.

- **Learn from other universities that have successfully implemented GRFs.** A recurring theme among GRF case studies at universities is that there is no need to reinvent the wheel. Many GRF managers reported that it was extremely helpful to look to other campuses as examples when implementing revolving funds at their own institutions. UCLA is the only UC campus to create a revolving fund. Although campus size and organizational structure is considerably different at UCLA, lessons can be gleaned by UCSB staff and administrators involved with UCRF implementation efforts. Because UCLA has successfully implemented a revolving fund that is used to finance energy efficiency, the perceived risk of utilizing the revolving fund structure at UCSB should be effectively lowered. Engagement with UCLA staff who are involved with GRF management could benefit UCRF planning efforts considerably.

Strategic Communication & Engagement

The main motivation for this study was to research why the CNI was not gaining momentum at UCSB, given that UCSB researchers and decision-makers have already identified feasible technological pathways to achieving carbon neutrality. Though these pathways are known, CNI projects are slow to be implemented and they are often held up in UCSB's decision-making process. Thus, we sought to understand why it is so challenging for CNI-related projects to reach approval and implementation, what barriers exist to overcoming these challenges, what potential solutions are available, what change is actually feasible, and what form the change could take considering the various groups across campus that are influencing and controlling these decisions.

The general decision-making process at academic institutions, like UCSB, is different than that of other large organizations, such as governments or corporations. In a university setting, voters do not dictate leadership roles nor do individually-penned memos take immediate effect; rather, bottom-up coalitions often engage top-down decision-makers. With over 23,000 students at UCSB,[64] students comprise the majority of campus yet the minority of formal decision-making roles. Their influence, however, is an influential lever in the overall decision-making process.

One of our interests in this study was to research the impact that student engagement could have on the progress of the CNI. Our strategic communication and engagement approach was to provide UCSB's administrators and students with information to help leverage knowledge of UCSB's administrative system, current attitudes, and culture, with bottom-up coalition-building tactics to further engage top-down decision-makers. We identified behaviors and activities with the highest potential impact given current attitudes, beliefs, barriers, and opportunities across campus groups. Each action we recommend to campus stakeholders is guided by carefully chosen research questions and criteria. This approach will help UCSB overcome two key challenges. First, how to raise awareness and engagement levels across campus, among students, administrators, and faculty. Second, how to prioritize the many options UCSB has for leveraging the support of campus groups to both align their goals and facilitate progress towards the CNI.

Background

To date, UCSB has taken steps to incorporate plans for the CNI into the CAP, which outlines campus's long-term climate strategy. In March 2007, UC president, Robert C. Dynes, instituted the CAP process after he signed the American College and

[64] University of California Santa Barbara. 2017. *About UC Santa Barbara*. Web. Accessed 22 March. 2017.

University Presidents Climate Commitment (ACUPCC) on behalf of all UC Chancellors.[65] Current UC President Janet Napolitano continued the CAP process. In late 2016, she required that all UC's submit the latest iteration of their CAP in draft form detailing their plans for achieving carbon neutrality.[66] UCSB Sustainability staff conducted considerable outreach to specific decision-making units on campus and incorporated public comment into the 2016 draft CAP. Beyond the outreach to relevant stakeholders for the proposed 2016 CAP, however, there have been limited strategic communication and engagement efforts surrounding the CNI at UCSB.

University of California, Office of the President

To understand the implications of the CNI for UCSB, it is important to first know how UCOP envisions campuses meeting carbon neutrality because it influences how UC decision-makers approach the initiative. The CNI consists of two overarching goals; primarily, reaching carbon neutrality through practical implementation in operations and infrastructure; and secondarily, aligning the CNI with the UC's core mission of teaching and research. Furthermore, UCOP strives for the CNI to garner recognition for the UC's contributions to climate research and education.

To help execute UCOP's vision for the CNI, President Napolitano formed the UC GCLC in 2014 to advise UC leadership on achieving carbon neutrality.[67] The following year, the GCLC approved 15 research and engagement projects to support the carbon neutrality goal,[68] including the UC's Faculty Climate Action Champions and Carbon Neutrality Student Fellows. Student fellows have undertaken communication outreach at their specific campuses. UC also launched the Cool Campus Challenge, a system-wide competition that encouraged both UC and CSU students, staff, and faculty to take personal actions to reduce their respective campus's carbon emissions.

During this project, we collaborated with sustainability staff at UCOP, the GCLC, and CNI fellows as they develop student engagement plans for other UC campuses.

TomKat UC Carbon Neutrality Project

As one of the world's largest academic systems, understanding the sheer scale of the CNI, means of system-wide collaboration, and resource costs to the UC's is a major undertaking. To begin to answer these questions, in 2016, UCSB's IEE partnered with the National Center for Ecological Analysis and Synthesis (NCEAS)

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[65] Second Nature. 2017. *Carbon Commitment Charter Signatories.* Web. Accessed 4 Feb. 2017.
[66] Carbon Zero. 2016. Informational Interviews. *University of California, Santa Barbara, Bren School of Environmental Science & Management*.
[67] UC Office of the President. 2014. "*Napolitano focuses on sustainability, forms global climate council."* Web. Accessed 4 Feb. 2017.
[68] University of California. 2015. Annual Report on Sustainable Practices.

to launch the TomKat UC Carbon Neutrality Project funded by the TomKat Foundation and UCOP.[69] With Project Director, Dr. David Auston, also our client for this project, TomKat has aimed to help understand how to best support and implement the CNI across the UC system through the Natural Gas Exit Strategies and Net-Zero Communication Strategy working groups. One of the Principal Investigators for the Net-Zero Communication Strategy is Dr. Lisa Leombruni, also one of our advisors for this project.

We developed our strategic communication and engagement methodology for UCSB with guidance from Dr. Leombruni and provided information and insights to the TomKat Communication Working Group to ensure cohesiveness.

University of California, Santa Barbara

UCSB is a recognized leader in higher education sustainability, but with this dedication to environmental issues comes a proliferation of sustainability-related initiatives that are not clearly interconnected. It is important that UCSB ensures the messages of these initiatives are not competing nor confusing to its students, administrators, and faculty, who are bombarded with so much information that it can result in the unintended consequence of little, to no action.[70] In addition to the CNI, UCSB participates in the six other UC-wide sustainability initiatives: the Global Food Initiative, a Zero Waste Program, a Green Buildings Policy, sustainable purchasing goals, transportation policies, and a water conservation initiative.

Finally, UCSB has had a history of grassroots environmentalism that persists today. Spurred by the infamous 1969 oil spill off its coast,[71] Santa Barbara was the birthplace of the environmental movement, which shaped national and state politics and influenced the culture of environmentalism at UCSB. In 1970, UCSB started the first Environmental Studies Program in the nation and continues to rely on grassroots movements to push through environmental initiatives on campus. For example, recently the UC-wide Fossil Free UC movement took hold at UCSB, aiming for 100% divestment from fossil-fuel related funds in the UC's General Fund endowment.[72] The key to its groundswell of student support is that it was student-driven from the start. At the time of this report's publishing, the UCSB petition to the UC Regents had over 2600 signatures.[73]

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[69] National Center for Ecological Analysis and Synthesis. 2016. *Work Group: TomKat UC Carbon Neutrality Project*. Web Accessed 4 Feb. 2017.
[70] Hartomo, T., Cribb, J. 2002. Sharing Knowledge: A Guide to Effective Science Communication. pp. 29. *Csiro Publishing*.
[71] Clarke, K. C. & Hemphill, J. J. "The Santa Barbara Oil Spill: A Retrospective." *Yearbook of the Association of Pacific Coast Geographers*, vol. 64 no. 1, 2002, pp. 157-162. *Project MUSE*, doi:10.1353/pcg.2002.0014.
[72] Fossil Free UC - UCSB, 2017. Web. Access. 5 Feb, 2017.
[73] Ibid.

Methodology

We divided our communication research into four phases, each with guiding research questions that built upon one another to answer our most pressing question: How can the CNI be achieved by 2025 at UCSB? Our project builds off two previous Bren group projects that researched behavior change and identified energy efficient and renewable technologies. While their contributions added valuable depth in these specific areas, we sought to understand how they could be best applied and furthered within the current landscape of UCSB decision-making and the context of administrator attitudes towards the CNI. Per our client's request, we were tasked to research the decision-making process on campus that leads to plans, policies, and project approval that could lead to practical implementation of the CNI as well as research the impact of student engagement.

Phase 1 launched exploratory research into current progress and awareness of the CNI across campus. We identified critical audiences on campus whose current awareness, attitudes, and incentives affect not only how campus leaders, decision-makers, and influential groups perceive the CNI at UCSB, but also how they prioritize the initiative and their likeliness to act. Without awareness of the CNI, one cannot feel connected to it, have a sense of ownership of it, prioritize it, nor be compelled to support or act on it. Phase 2 and 3 of our research sought to further understand where these breakdowns occurred across groups involved in CNI-related decision-making process, how those gaps could be bridged, and what an engaged campus would mean for the CNI. Lastly, in Phase 4, we created a strategic communication and engagement pathway for how our client and other CNI supporters can leverage UCSB's decision-making process and key influencers to efficiently and effectively further progress towards the CNI. Not only will our Theory of Change help move the needle closer to carbon neutrality, it will aid sustainability proponents in laying the groundwork for transforming sustainability-thinking from a cultural movement to a campus requirement, shaping the long-term legacy of environmental impact of UCSB.

Phase 1: Theory of Change

We first developed a "Theory of Change" to clearly outline what changes will need to happen at UCSB in order for the CNI to take hold, how that change will occur, and what is the most feasible pathway to do so. Theory of Change is the process of determining long-term goals and working backwards to identify changes needed and actions taken by certain stakeholders to accomplish determined goals.[74]

[74] Taplin, D., Clark, H., Collins, E., Colby, D. 2003. Theory of Change, Technical Papers. *ActKnowledge*, *Center for Human Rights.*

Research Questions
1.1 What is the current level of progress towards the CNI?
1.2 How are policies, plans, practices, and projects approved and implemented at UCSB and who is involved in making those decisions?

To identify progress and processes related to the CNI and assess a baseline for our Theory of Change, we began by conducting informational interviews with key informants based on their high level of involvement and knowledge of the CNI and campus sustainability. Additionally, our client, Dr. David Auston, provided some starting suggestions.

We employed snowball sampling methods to ensure we identified the appropriate social systems and networks. We utilized this informal method of reaching the target population because of the explorative, qualitative, and descriptive nature of Research Question 1.1 and 1.2. [75, 76] Table 8 lists the informal interviews conducted. The information we collected helped to define the scope of this research and to identify key decision-makers around campus for Phase 2.

Table 8: Informational Interview Information. The interviews were conducted from March – November 2016 (n=15).

Number of Interviews	UCSB Department
4	Sustainability
2	Bren School of Environmental Science & Management
1	Geography
1	Facilities Management
1	Budget & Planning
6	Undergraduate Students

Phase 2: Managing for Sustainability

In order to understand how to further progress towards the CNI, we first had to understand how the UCSB decision-making process currently stands and what norms exist that may influence how decision-makers perceive the CNI.

[75] Denzin & Lincoln, 2005; Limb & Dwyer, 2001

[76] Atkinson, Rowland, and John Flint. "Accessing hidden and hard-to-reach populations: Snowball research strategies." *Social research update* 33.1 (2001): 1-4.

Research Questions

2.1 How does UCSB decision-making governance and norms facilitate sustainability initiatives on campus?

2.2 Are there any barriers within UCSB decision-making and governance towards implementing the CNI at UCSB?

We utilized semi-structured interviews with key decision-makers and snowball sampling methods for Phase 2. We conducted 23 interviews with 25 interviewees. The below graphic (Figure 13) shows the departments that we consulted and interviewed. We determined Phase 2 interviewees based on Phase 1 key informants, who identified these individuals as key influencers on campus or for their unique knowledge of UCSB's decision-making process. The 25 individuals we interviewed collectively oversee more than 90% of the campus budget.

We developed an interview guide[77] informed by Phase 1 findings and literature review, shown in full in Appendix C and in short in Table 9 below. Two researchers, one leading questions and the other keeping time and taking notes, completed each interview, which lasted approximately 30 to 45 minutes. We recorded all interviews[78] and maintained interviewees' anonymity after completion.

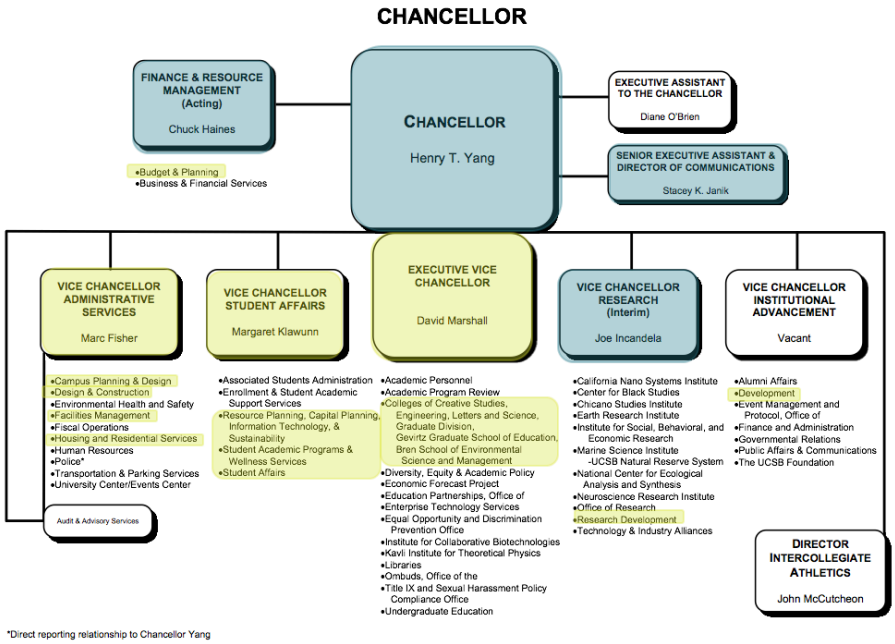

Figure 13: UCSB Organizational Chart. Yellow highlighted areas indicate units interviewed during Phase 2. Blue indicates that we consulted the unit but were not able to complete an interview.

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[77] UCSB's Human Subjects Committee determined that this research was exempt from the Institutional Review Board.

[78] Though all interviews were recorded, the recording device malfunctioned during one interview, resulting in 24 out of 25 full interview recordings.

Table 9: Sample of Semi-Structured Interview Instrument Questions.

Questions
How familiar are you with the CNI at UCSB?
Are you involved with any projects related to the CNI?
If yes, what are you looking for when you get these projects? Are there certain criteria with which you assess each project?
Do student opinions matter in your decision-making process, and if so, how?
What do you think are current challenges & barriers? What do you think are the best solutions to these?

We structured our analysis by coding and employed the content analysis software, NVivo, to identify trends and patterns within interviews.[79] Coding is a way to organize and sort qualitative data. Codes included apriori and emergent codes. Apriori codes are determined prior to analysis, based on theory, literature, and our Phase 1 findings. Emergent codes are ideas, concepts, actions, relationships, and meanings that arise during the process of analyzing the interviews.[80] Table 10 shows samples of our apriori and emergent codes and a full codebook can be found in Appendix D. Figure 14 shows our multi-step coding process in NVivo.

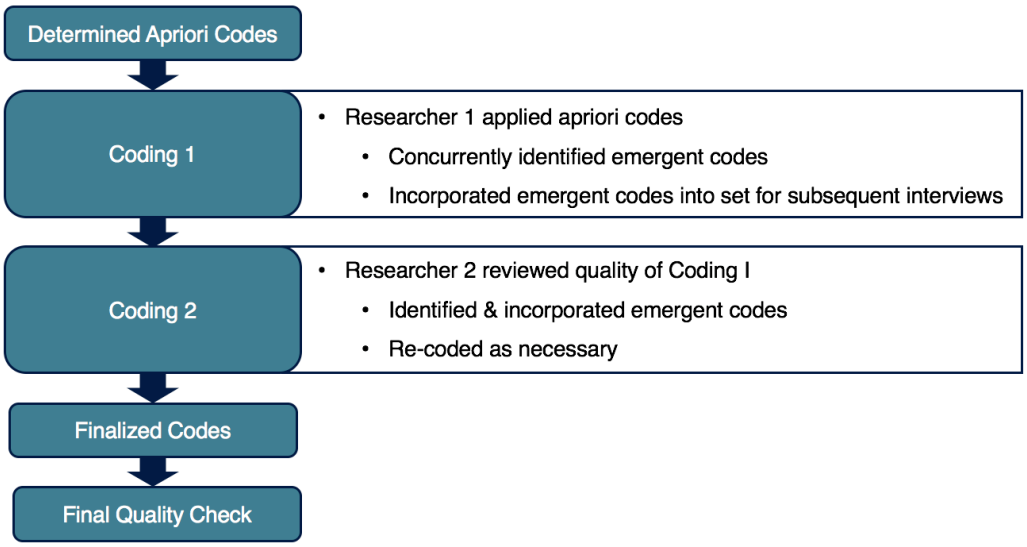

Figure 14. Interview Analysis Coding Process. The multi-step coding process ensured inter-coder reliability, data validation,[81] and overall quality of coding. Finalized codes (codebook) are located in Appendix D. Sample codes below (Table 10).

[79] Stemler, S. 2001. An Overview of Content Analysis. *Practical Assessment, Research & Evaluation.* Volume 7, Number 17, June 2001.
[80] Ibid.
[81] Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002). Content analysis in mass communication: Assessment and reporting of intercoder reliability. Human Communication Research, 28, 587-604.

Table 10: Sample of Both Apriori and Emergent Codes Used in NVivo to Code Phase 2 Semi-Structured Interviews. Apriori codes were based on interview instrument questions while emergent codes were identified during the process of analyzing the audio recordings and notes from interviews.

Awareness, Engagement
1. Level of familiarity with Carbon Neutrality Initiative (CNI) at UCSB
a. Expert
b. Familiar
c. Have heard of it, but not very familiar
d. Have not heard of it, unfamiliar
Decision-Making Process
1. Decision-making evaluation criteria
a. Financial
b. Political feasibility
c. Alignment with current goals
i. UC system – teaching & research
ii. UCSB
1. Adherence to campus planning (LRDP)
2. Other needs of campus
3. Adherence to climate action plan (CAP)
2. Student opinion
a. Critical
b. Matters
c. Somewhat matters
d. Doesn't matter
e. Unsure

We coded in NVivo based on audio recordings and interviewer notes. Figure 15 shows an example of a coded interview. We were unable to interview every identified key decision-maker on campus as some individuals declined to be interviewed or were unavailable. For some, we identified a "proxy," another individual who previously held the same position or had similar knowledge of the roles, policies, procedures, and norms. Though many of the interviewees held several titles at UCSB, we interviewed and coded data according to only their roles relevant to this study.

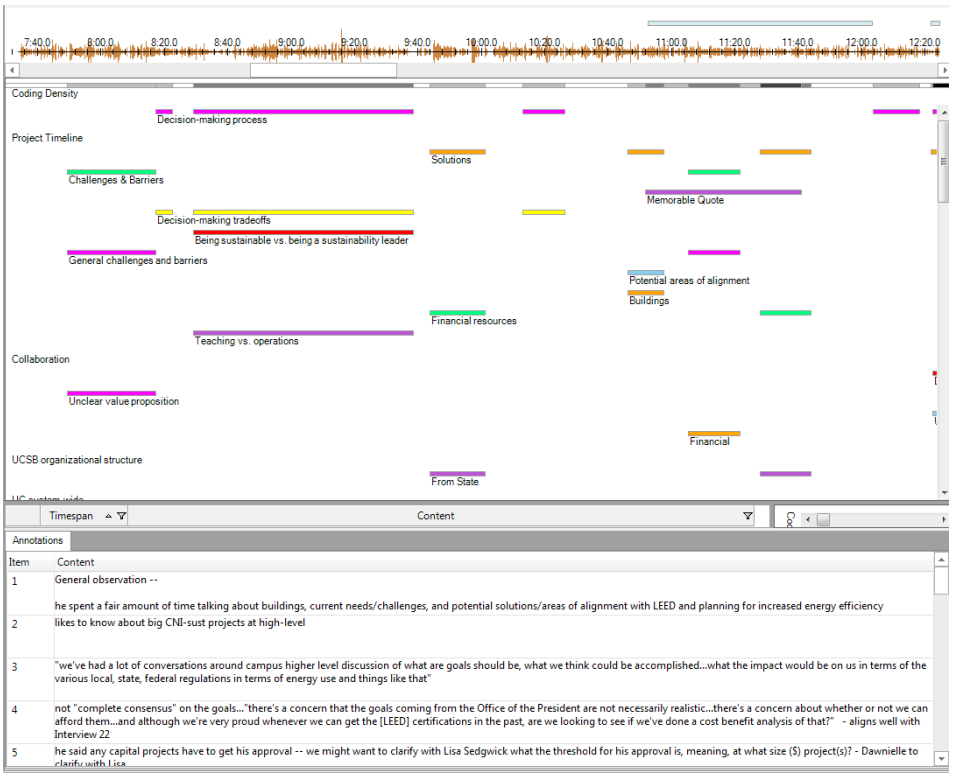

Figure 15: Example of a Coded Interview from Phase 2. Audio recordings and notes from interviews are recorded in NVivo. One interviewer performs a detailed code and a second interviewer performs data validation of codes. Annotations are noted for further analysis.

We designated independent variables, or "attributes," to characterize interviewees (selected list in Table 11, full list in Appendix E). Some attributes were self-reported during the interview process, such as level of familiarity and involvement with the CNI. We determined other independent variables based on anecdotal evidence, expert knowledge, and coding results. After finalizing independent variables and codes, we performed counts to compare common themes across groups to assess dependent variables such as similarities or differences in awareness and attitudes.

Table 11: Select Attributes Used as Independent Variables for Phase 2 Interviews to Characterize Interviewees.

Hierarchy
0 – UCOP
1 – Chancellor, Executive Vice Chancellor, Assistant Chancellor, etc.
2 – Vice Chancellors
3 – Deans
4 – Associate Vice Chancellors
5 – Chairs/Co-chairs of Committees
6 – Executive Directors
7 – Faculty
8 – Junior Staff
Familiarity with CNI
• Expert • Familiar • Have heard of it, but not very familiar • Have not heard of it, unfamiliar
Connectedness
• High • Low

Phase 3: Audience Research

During Phase 2, almost all interviewees identified student opinion as important or critical to the decision-making process to approve a project on campus. We built off this finding of the importance of student opinion through focus groups and a campus-wide survey. These methods aimed to identify the best ways to engage select student audiences on campus and what that level of engagement may look like.

Research Questions	
3.1	How do you engage audiences to make sustainability-related changes on campus?
3.2	What is the impact of demonstrating student support on UCSB's decision-making process?

Focus Groups

We conducted focus groups, and did so for two primary reasons: 1) to collect rich data that we might not have uncovered in a survey 2) to inform relevant questions in our survey. We held four focus groups (Table 12) including a pilot, each consisting of

a set of participants with unique interests, challenges, opportunities, communication channels, and incentives that could result in actions towards furthering additional carbon neutrality projects at UCSB. We recruited students via targeted email outreach. Two Carbon Zero researchers co-facilitated each focus group, which lasted approximately one hour. The focus group instruments are included in Appendix F.

Table 12: Focus Groups and Associated Topics and Target Audiences. We held one pilot focus group and 3 official focus groups. The focus groups were conducted from January 2016 – February 2017.

Focus Group	Topics	Target Audiences
Pilot (n = 15)	Communication channels, resonating messages, feasibility	Undergraduate Environmental Studies students
Graduate Students (n = 6)	Laboratories, temperature set points, sustainable energy management, faculty engagement, alignment of CNI with research goals	Graduate student researchers who work in laboratories
Environmentally-Minded Students (n = 7)	Communication channels, resonating messages, feasibility, recruitment of fringe students	Undergraduate Environmental Studies students, members of environmental organizations
General Students (n = 13)	Alignment between social, cultural, and environmental goals, general student awareness levels and engagement	General undergraduate student population

Student Survey

Based on feedback from focus groups, we developed a survey instrument and sent it to the entire undergraduate and graduate student population. The survey with associated data analysis techniques can be located in Appendix G and a selected list of questions seen below in Table 13.

Table 13. Sample Student Survey Questions.

Questions
What aspects of carbon neutrality are most important to you?
Please rank the following University of California sustainability initiatives in order of their importance to you.
When it comes to showing your support for a cause, what actions are you most likely to take on campus?
Do you think that UCSB's achievements and positive reputation in sustainability add value to your experience as a student?

We utilized SurveyMonkey software and sent the survey via email to the entire student body at UCSB through the Office of Student Life. We had 852 respondents to the survey with a wide representation of students from 49 majors that included both graduate and undergraduate students. We analyzed survey results with both summary statistics and more advanced statistical tests as described in the Results section.

Phase 4: Strategy

Taking the qualitative and quantitative data and insights gathered from Phases 1, 2 and 3, we developed a strategic communication plan for aligning desired outcomes of the CNI with current campus goals, priorities, and stakeholder attitudes. We developed this plan with an emphasis on fostering practical implementation to reach the 2025 goal related to Scope 1 and 2 emissions, while retaining benefits on-campus.

Research Questions
4.1 How can the CNI be achieved by 2025 at UCSB?
4.1.1 How should audience outreach be prioritized to further progress towards the CNI?
4.2 What are the best practices to inform UCSB and other campus sustainability offices?

Based on our findings in Phases 1, 2, and 3, we will develop a CNI Student Toolkit to help increase awareness of the CNI, boost student involvement, and maximize opportunities for students to make change. Our recommendations aim to help close the information gap that has led to lack of engagement and collaboration among key groups – UCSB administrators, faculty, and students.

Results and Discussion

Phase 1: Theory of Change

Our Phase 1 system assessment was guided by two main research questions: 1) What is the current level of progress towards the CNI? 2) How are policies, plans, practices, and projects approved and implemented at UCSB and who is involved in making those decisions? We attempted to answer these two questions through informational interviews with individuals, both administrators and students, with knowledge of the CNI and the administrative process of UCSB.

UCSB System Assessment

Through our informational interviews, we found that outside of a few select groups, such as UCSB Sustainability, the Chancellor's Sustainability Committee, and environmental student organizations, there is limited awareness and action surrounding the CNI across the wider campus. We also discovered that historically, UCSB sustainability has evolved through the hard work and dedication of select campus administrators and students who have utilized grassroots movements to implement sustainability-related projects. The CNI is viewed as a top-down mandate on campus, directly conflicting with UCSB's norm of consultative decision-making and grassroots sustainability approach; thus, campus stakeholders do not feel a sense of ownership towards it. For there to be effective implementation on UCSB's campus both administrators and students must transform a top-down mandate into a bottom-up movement. Below in Figure 16 we identified the general framework for how sustainability-related campus groups share information and collaborate around the CNI.

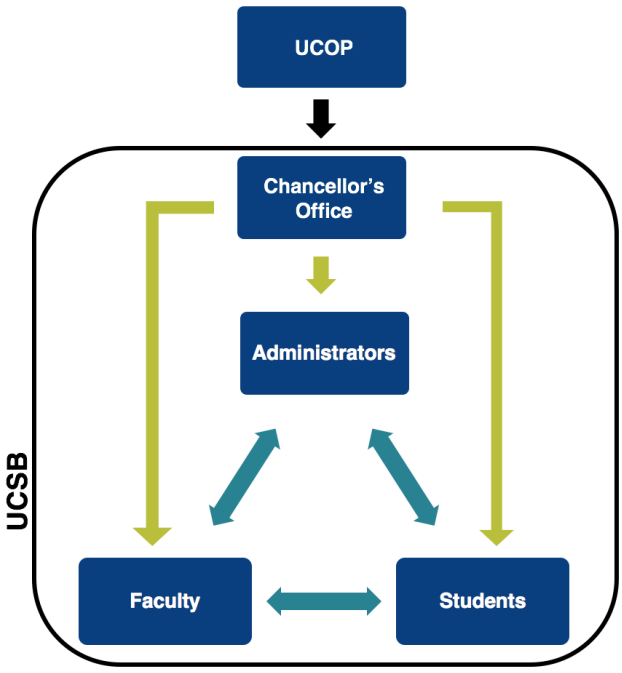

Figure 16: Existing CNI Communication and Engagement Pathways at UCSB. A simplified schematic of collaborative relationships among key campus groups and decision-makers involved in CNI information-sharing and the planning process for implementing CNI-related projects.

During our system assessment of campus, we found two critical communication gaps that need to be addressed - namely between UCOP and UCSB administrators, and between campus administrators and students.

- **Between UCOP and UCSB administrators** - Top administrators perceive that the CNI was instituted without the necessary consultation with each campus. Thus, decision-makers at UCSB do not have a sense of ownership over the CNI's goals. This hinders their individual sense of commitment and understanding of the CNI's value proposition to their respective campuses, among other factors. As a result, the CNI is without committed buy-in from senior administrators. Instead, they are turning towards other campus groups to take the lead on facilitating progress.

- **Between UCSB administrators and students –** Administrators at UCSB want to involve students in the decision-making process, but struggle to strategically engage the student population or retain students on important committees. Students are interested and want to be involved, but lack ownership over the CNI because it is unclear what roles are available to them and what actions are needed of them to make the greatest impact towards achieving the initiative.

Although we identified Faculty as a key group in UCSB decision-making, the areas we identified most relevant to them within the CNI fall under Scope 3 (business travel and commuting). Because our research focused on Scope 1 and 2 implementation on campus, we interacted with faculty in terms of their administrative roles only. Additionally, we discovered that to comprehensively align the CNI with education would require a separate analysis given the distinct governance for both teaching and research, though our strategic communication methodology can also be applied to those areas.

Important campus stakeholders are currently left without a clear call to action, resulting in lack of visible progress towards the CNI. This further perpetuates a lack of wider campus engagement, prioritization, and likeliness to act. The single greatest challenge facing the CNI's successful implementation, or at least significant progress towards this ambitious goal, is overcoming the communication breakdown between campus decision-makers and students. Because we found both groups to be supportive of the CNI and willing to act if they understood what their impact could mean, we believe that bridging the information gap will lead to a considerable increase in engagement, and thus, progress in the CNI. We researched, refined, and developed recommendations regarding these gaps in Phases 2, 3, and 4 of our communication and engagement methodology.

UCSB Administrative Process

To address our second research question, we consulted 15 key informants who are knowledgeable of how sustainability projects and initiatives move through campus. Their input helped us to identify the campus groups and individuals we should interview for Phase 2 of our research as well as learn how the decision-making process works.

We found that UCSB's general decision-making process is complex, de-centralized, and consensus-based. Through our interviews, we heard anecdotal evidence that UCSB requires the largest majority consensus of the UC's when vetting campus policies, plans, and practices. Whether the proposed project is a state of the art new building or a small community garden, a number of individuals and groups must be consulted, their opinions weighed, and approval garnered before the project completes the formal approval process. For top-level administrators, namely Chancellor Henry Yang and his closest advisors - policies, plans, practices, or projects affecting a significant portion of campus must demonstrate broad consultation before they will even consider the proposal. Navigating the bureaucratic and political landscape is a constantly evolving practice when attempting to get a project off the ground, let alone implemented and maintained. Given the complexity of UCSB's decision-making process, it remains difficult for sustainability projects to gain approval, especially those with high capital costs and upfront investments like many related to the CNI.

As a result, the attitudes and perceptions of decision-makers greatly influence the process at all levels. In order to understand how decisions are made at UCSB pertaining to the CNI, we must also understand how administrator's attitudes and perceptions of the CNI influence both their personal decisions and the overall campus process. We determined that in order to achieve its carbon neutrality goal, UCSB must embed carbon neutral principles into its long-term vision for the university, including the policy, planning, and financial decision-making processes.

We incorporated these findings and themes into a Theory of Change for UCSB to further engage campus groups around the CNI and promote action towards achieving its carbon neutrality goals. First, the campus should address the information gaps, particularly the gap between administrators and students, to begin to raise the level of awareness and engagement across campus. Second, both administrators and students have the ability to leverage their unique channels and available resources to influence the decision-making process. Their influence can help advance the CNI at UCSB and further embed sustainability criteria in campus planning. Though this Theory of Change addresses the more immediate needs of campus to reach its 2025 carbon neutrality goals, it also lays the critical groundwork needed for achieving the 2050 goal with respect to Scope 3 emissions. This Theory of Change guided our research questions and approaches in Phases 2 and 3 and is answered in Phase 4.

Phase 2: Managing for Sustainability

We identified and conducted 23 semi-structured interviews with 25 key decision-makers around campus. Utilizing our interview instrument, we were able to assess attitudes towards the CNI, challenges, possible solutions, and opportunities for student engagement at varying levels of the decision-making process on campus. Across 23 interviews, we totaled over 1,000 identifications that fit one of our 200 codes for common themes. Through counts, we identified the most frequent codes that arose across all interviewees as well as across our independent variables used to characterize participants.

Top Codes for Challenges Across Interviews

During each interview we asked respondents whether they perceived any challenges or barriers towards implementing CNI-related projects or policies on campus. Figure 17 below shows the range of challenges perceived across all interviews. Overwhelmingly, financial challenges and an unclear value proposition, or the value the CNI brings to campus or the individual, are stated a total of 138 times over the 23 interviews. Respondents also noted that the way the decision-making process works or navigating the complex approval process is a possible barrier (UCSB Governance). Competing priorities were also mentioned many times. UCSB has a

tight budget and sustainability projects compete for funding with other needs of the campus. Additionally, general awareness and engagement were perceived as a barrier towards CNI implementation.

Of interest, was that participants noted that a potential barrier is a lack of urgency, but this was only mentioned a few times. As of the time of our interviews, very little movement with regards to the CNI on campus had happened. Thus, a healthy sense of urgency is needed with the 2025 deadline looming. One UCSB administrator noted, "nine years in UC time is like tomorrow."[82] Instilling a sense of urgency with regards to policies and projects is necessary in order to make the CNI successful.

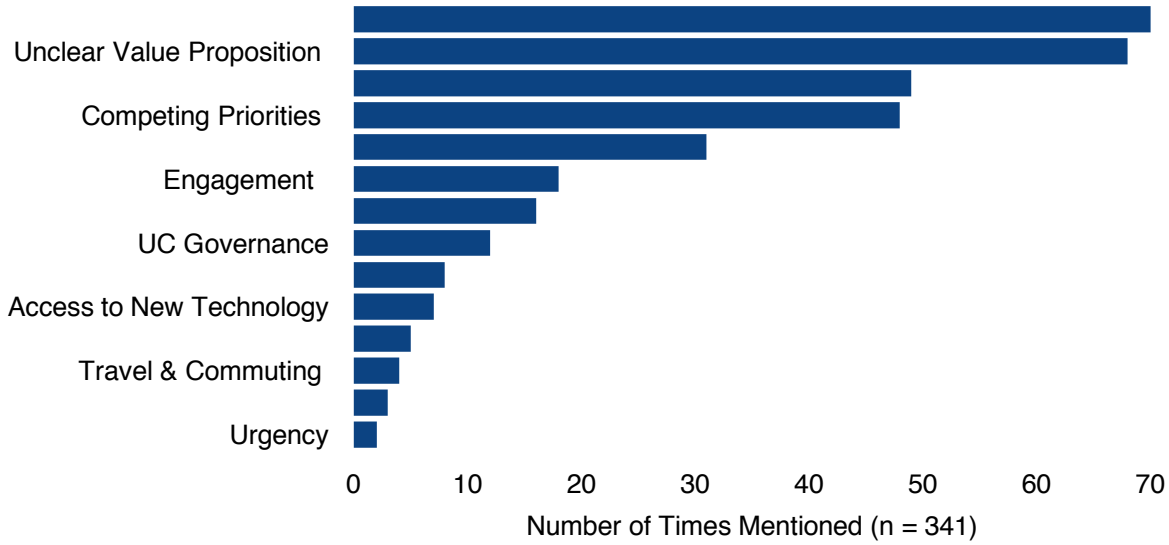

Figure 17: Perceived Top Challenges from Phase 2 Semi-Structured Interviews. Challenges are related to implementing CNI-related projects and policies on UCSB's campus.

Top Codes for Solutions Across Interviews

The solutions most frequently mentioned included buildings as a source of potential alignment and increased engagement on campus (Figure 18). We looked into ways to increase engagement within the student population during Phase 3. Financial resources were perceived as both a challenge and a potential solution. Aligning the CNI with the core mission of the UCs of teaching and research was also perceived as a potential solution. Aligning with the core mission is one of the drivers behind UC President Janet Napolitano instituting the CNI and will be important going forward. It is interesting to note that increased awareness was perceived as a solution as well, but not as high as increased engagement. This bolsters our hypothesis that it is important to engage audiences to act on campus, rather than just increase

[82] Phase 2 Semi-Structured Interviews, UCSB. Received by Carbon Zero, 2016.

awareness of the CNI across stakeholders, and we looked into this with Research Question 3.1 during Phase 3.

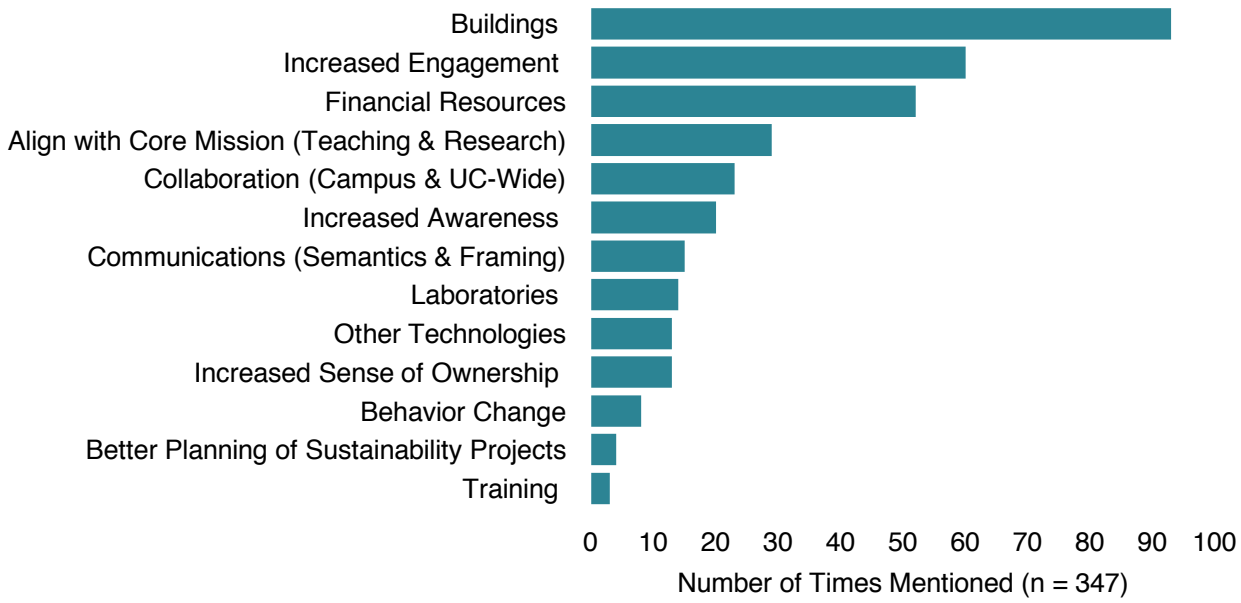

Figure 18: Perceived Top Solutions from Phase 2 Semi-Structured Interviews. Solutions are related to challenges or barriers mentioned during interviews.

Does Student Opinion Matter?

We asked each interview subject whether student opinion matters in the decision-making process at UCSB and found that it overwhelmingly does. These results gave us a clear indication that student engagement is critical to the CNI and solidified our interest in researching student engagement on campus. Shown in Figure 19, 14 interviewees stated that student opinion iss critical and 8 said that student opinion matters when making a decision on campus. One UCSB administrator spoke to the necessity of student support, "I don't think you can do anything without students being behind it…Any good change on this campus is student led. When you try to make big changes without their input, it backfires."[83]

[83] Phase 2 Semi-Structured Interviews, UCSB. Received by Carbon Zero, 2016.

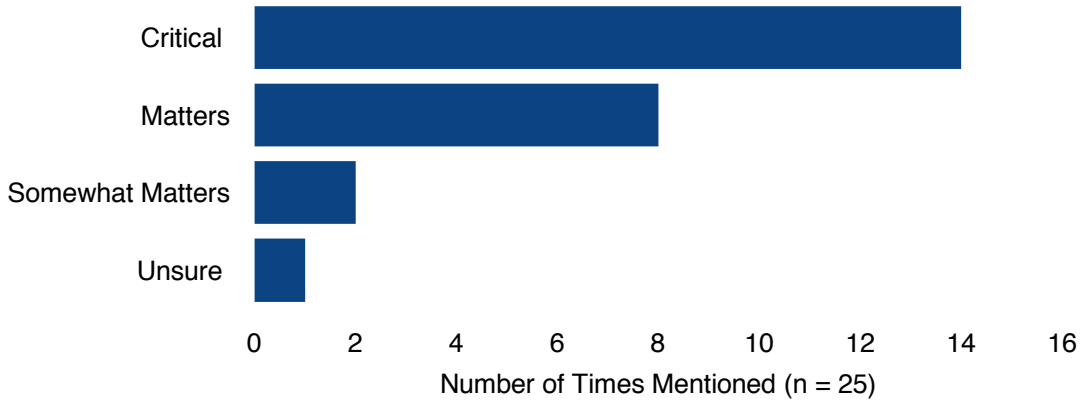

Figure 19: Interview Respondents Perspective on Student Opinion. Key decision-makers answer the question, "Do student opinions matter in the decision-making process at UCSB?"

Personal Attitudes Towards CNI

At the end of each interview, we asked subjects their personal opinion of UCSB's adoption of the CNI and found that most administrators personally support the initiative. Their answers are seen in Figure 20. It is important to link their personal support with the roles they hold on campus. As one UCSB administrator stated, "if people believe they can make a difference, they will try to make a difference."[84] Having positive attitudes towards the CNI is the first step. The second step is to actively engage campus administrators, help alleviate some perceived challenges, and subsequently propose possible solutions that will help overcome the current inactivity with regards to the CNI.

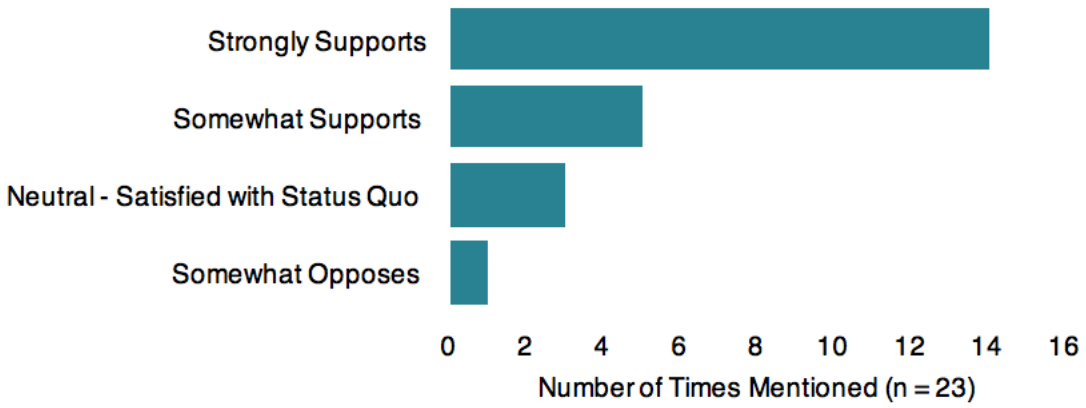

Figure 20: Interview Subjects Personal Opinions on the UC CNI.

[84] Phase 2 Semi-Structured Interviews, UCSB. Received by Carbon Zero, 2016.

UCSB Hierarchy

When comparing interviewees across the UCSB hierarchy, we found notable similarities as well as differences in the perceptions of the challenges of the CNI and possible solutions. Table 14 shows the most common codes found for the upper levels of the UCSB hierarchy. Table 15 shows the most common codes for the lower levels. Hierarchies were designated based on their position within UCSB's organization. Similarities across the UCSB hierarchy included the challenges of finding funding for completing the CNI, an unclear value proposition, competing priorities of the campus, and navigating UCSB's governance. There are also similarities across hierarchies with regards to buildings and increased engagement as possible solutions.

Of interest, UCOP stated that the top challenge they perceive is that the UCOP directive is possibly unclear to the campuses. In addition, UCOP and the Chairs or Co-Chairs of Committees noted that student engagement in particular is an important solution. Interestingly, only UCOP and Deans stated that a possible solution is to align the CNI with the core mission of the university. This point was one of the drivers of the initiative, yet there is a lack of knowledge about this among UCSB administrators. There is a distinct difference in the perceived challenges and solutions across the UCSB hierarchy. In order for UCSB to complete the CNI, perceived challenges and solutions need to align with the actual challenges and solutions of the initiative. Administrators at different levels should be on the same page regarding the best way to move the initiative forward.

Table 14: Top Codes from Phase 2 Semi-Structured Interviews for Challenges and Solutions for Upper UCSB Hierarchy. The top 3 codes for challenges and solutions are listed for UCOP, UCSB top-level administration, Vice-Chancellors, and Deans.

Role / Issue	University of California Office of the President (UCOP)	Top-Level Administration	Vice Chancellors	Deans
Challenges/ Barriers	1. Unclear Value Proposition (UCOP Directive) 2. Evaluation Criteria 3. Competing Priorities	1. Financial 2. UCSB Governance 3. Lack of Awareness/ Personnel Turnover	1. Unclear Value Proposition 2. UCSB Governance 3. Financial	1. Financial 2. UCSB Governance 3. Competing Priorities
Solutions	1. Align Core Mission (Teaching & Research) 2. Increased Engagement (Students) 3. Buildings	1. Financial Resources 2. Buildings 3. Collaboration	1. Buildings 2. Financial Resources 3. Increased Engagement (General)	1. Buildings 2. Increased Engagement (General) 3. Align Core Mission (Teaching & Research)

Table 15: Top Codes from Phase 2 Semi-Structured Interviews for Challenges and Solutions for Lower UCSB Hierarchy. The top 3 codes for challenges and solutions are listed for the Associate Vice Chancellors, Chairs/Co-Chairs of Committees, Executive Directors, and Junior Staff.

Role / Issue	Associate Vice Chancellor	Chairs/Co-Chairs of Committees	Executive Directors	Junior Staff
Challenges/ Barriers	1. Financial 1. Unclear Value Proposition – UCOP Directive 2. Competing Priorities	1. Unclear Value Proposition 2. Financial 3. UCSB Governance/ Lack of Awareness/ Lack of Faculty Engagement	1. Unclear Value Proposition 2. Financial 3. UCSB Governance	1. UCSB Governance 1. Financial 2. Unclear Value Proposition
Solutions	1. Buildings 2. Financial Resources	1. Increased Engagement (Students) 2. Financial Resources 3. Increased Awareness (General)	1. Buildings 2. Laboratories 3. Increased Engagement (General)	1. Buildings 2. Increased Engagement (General) 3. Financial Resources/Other Technologies

Level of Familiarity with the CNI

Our first question on our interview instrument was for the interview subject to state their familiarity with the CNI. Interviewees reported their familiarity on a spectrum from an expert, to having never heard of it. There were notable differences between experts on the CNI compared to those who had never heard of it, mostly centering around differing perceptions regarding the challenges and who needs to be engaged.

The five most common codes for the associated interviews are listed in Table 16. Those who were self-reported experts on the CNI saw student opinion being critical, challenges being financial, an unclear value proposition for the university, and the top solution they reported was to increase engagement of the student population. Those who reported being familiar with the initiative agreed that the main challenges are financial, an unclear value proposition, and competing priorities. They also noted solutions being buildings and finding funding. Those who have heard of it, but are not familiar saw the challenges being a lack of awareness. They saw solutions as buildings, general increased engagement, and aligning the initiative with teaching and research.

It is also interesting to note the differences between those who are experts with the CNI and those who are unfamiliar. The experts were focused on student opinion and engagement while those who are unfamiliar were more focused on a lack of awareness and subsequently increasing general engagement on campus. We continued to see common perceptions that barriers are campus funding, the unclear value of the CNI, and problems with the decision-making process. In order to integrate the CNI within campus, we attempt to address these issues through strategies and tactics in Phase 4 of our research.

Table 16: Top Five Most Common Codes Based on Self-Reported Familiarity with CNI. "ND" signifies no data.

Expert	Familiar	Have heard of it	Have not heard of it
Student Opinion Critical	**Challenges** Financial	**Challenges** Competing Priorities	**Solutions** Increased Engagement (Students)
Challenges Financial	**Challenges** Unclear Value Proposition	**Challenges** Lack of Awareness	**Solutions** Align Core Mission (Teaching & Research)
Challenges Unclear Value Proposition	**Challenges** Competing Priorities	**Solutions** Buildings	**Attitudes** Align with Campus Goals
Challenges UCSB Governance	**Solutions** Buildings	**Solutions** Increased Engagement (General)	ND
Solutions Increased Engagement (Students)	**Solutions** Financial Resources	**Solutions** Align Core Mission (Teaching & Research)	ND
* 7 interviewees	* 11 interviewees	* 6 interviewees	* 1 interviewee

We included additional analyses in Appendix H where we looked into buildings as a solution as well as how the level of institutional knowledge of the interviewee impacted the top codes noted.

Phase 3: Audience Research

Results from the the first two phases of our analysis indicated that student support is critical to the success of the CNI. The student focus groups allowed us to gather data in an informal setting about ways to garner support from different groups of student audiences. We were able to gather rich data that would otherwise be inaccessible from a student survey. For example, we learned how, due to a culture of working long hours in labs, graduate students often leave their lights on to make it

appear they are still working even when the room is empty. Findings from the focus groups helped inform our student survey questions.

We administered the campus-wide student survey in order to bridge the gap between administrators and students identified in Phase 1 of our research. It is clear that to be successful, administrators and students need to build momentum from the bottom-up and identify ways that students can feel more ownership of the CNI. Results from the survey aim to help administrators and students effectively identify and activate different student audiences based on what CNI topics are of interest to them, how they receive their communication, and better ways they wish to be engaged.

The campus-wide survey received 852 student respondents from 49 majors as well as a wide representation of both undergraduate and graduate students. For simplicity of analysis, majors were divided into five main disciplines: Environmental Studies, Social Science, Natural Science, Humanities & Arts, and Engineering, Math & Computer Sciences.

Level of CNI Familiarity

Overall, 49.4% of students somewhat or highly agree that they are familiar with the CNI, while 35.5% of students somewhat or highly disagree that they are familiar with the CNI. But how does this familiarity break down by graduate status and area of study? According to a Two Way ANOVA, CNI familiarity does not differ significantly depending on graduate level (graduate v. undergraduate) ($F(1)=0.01$, $p=0.94$). CNI familiarity does, however, differ significantly depending on discipline ($F(4) = 9.04$, $p<0.001$). Figure 21 shows familiarity broken down by discipline. Further analysis with Tukey's Post Hoc Testing demonstrates that Environmental Studies students are significantly different from all other disciplines ($p<0.001$ for all disciplines). Both graduate and undergraduate students majoring in Environmental Studies are more familiar with the CNI than other disciplines.

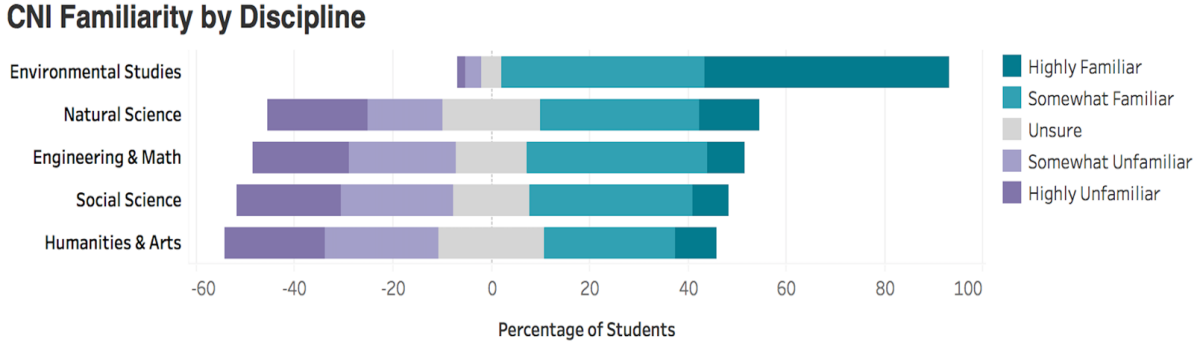

Figure 21: Student Familiarity of the CNI by Discipline. Students reported on their familiarity of the CNI in a campus-wide survey of UCSB students. Responses ranged from "Highly Familiar" to "Highly Unfamiliar" (n=830). Tukey's Post Hoc Testing reveals that CNI familiarity for Environmental Studies students is significantly different from all other disciplines ($p<0.001$).

Primarily, Environmental Studies students are receiving communications about the CNI at the moment, but campus-wide familiarity by different student groups is necessary to generate larger amounts of support.

Student Interest in Carbon Neutrality Topics

Students reported the most interest in solar power and renewable energy (13% of all interest), energy efficiency technologies (11%), divestment from the fossil fuel industry (10%), and green buildings (10%). Financial strategies to achieve carbon neutrality received the least amount of student interest (6%).

Interest in topics varied by discipline, although not statistically significantly, with students being more interested in topics that reflect their major (Figure 22). For example, Engineering & Math students are more interested in energy efficiency technologies, green buildings, and solar power and expressed less interest in more social topics such as divestment or environmental justice issues. Environmental students on the other hand, are interested in both science-related topics such as solar power as well as social issues like divestment and environmental justice.

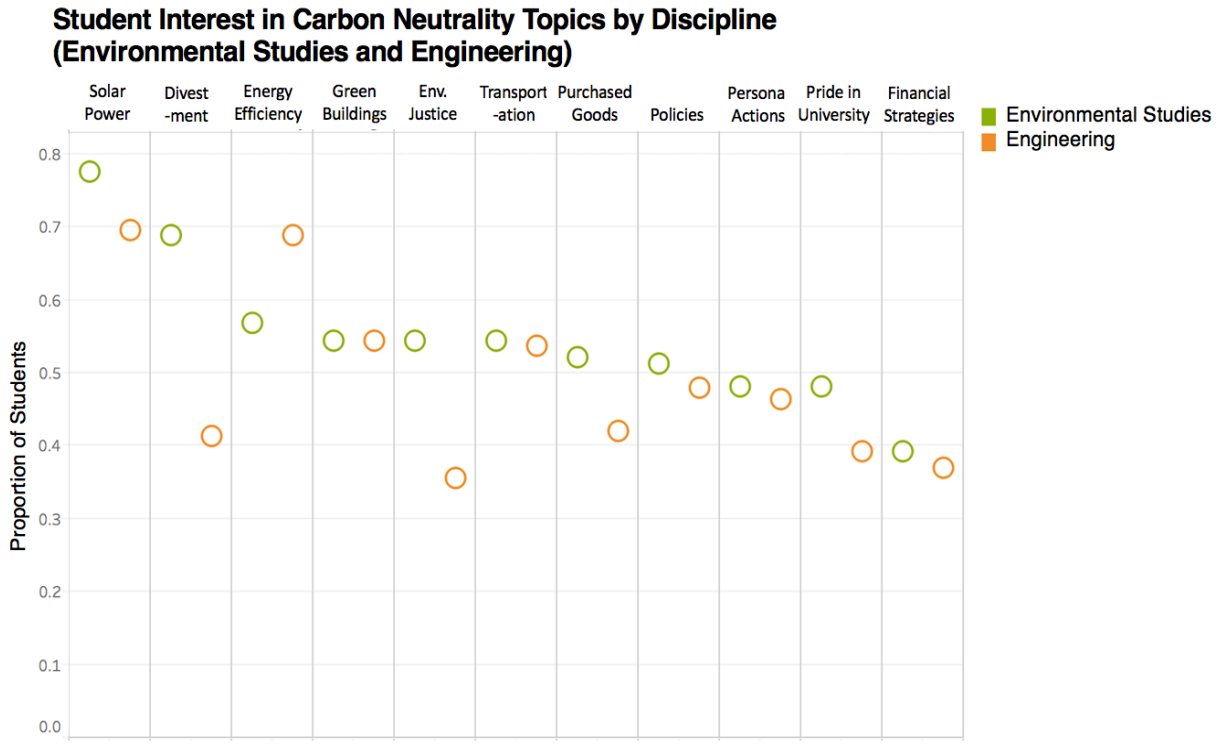

Figure 22: Interest in CNI Topics for Environmental Studies and Engineering Students. Interest in different CNI topics varied, with students generally being more interested in topics that reflect their major. Based on survey data of the UCSB student body (n=263).

These results highlight that there are a wide variety of topics covered under the CNI that can be applied to every discipline. The CNI is an issue that the whole student body can support if only they are engaged with issues that are interesting to them. Topics of interest to each discipline can be found in our Student Audience Engagement Tool in Appendix I.

One of the causes of student disengagement may be reflected in student interest in topics that fall in Scope 3 of the CNI, which the UC system is only beginning to tackle. Students are interested in environmentally-friendly transportation (9%), which is a topic not covered in the 2025 CNI goals. Additionally, reducing emissions from purchased goods (8% of all interest) and UCSB's divestment from the fossil fuel industry (10%) are topics that received a lot of student interest, yet these topics are not covered under the CNI at all. This misalignment with student interests demonstrates one of the biggest struggles of the CNI, the top-down nature of the initiative. Traditionally, environmental movements on campus were born from student passion, a bottom-up approach, and so past initiatives did not struggle with this issue of appealing to student interests.

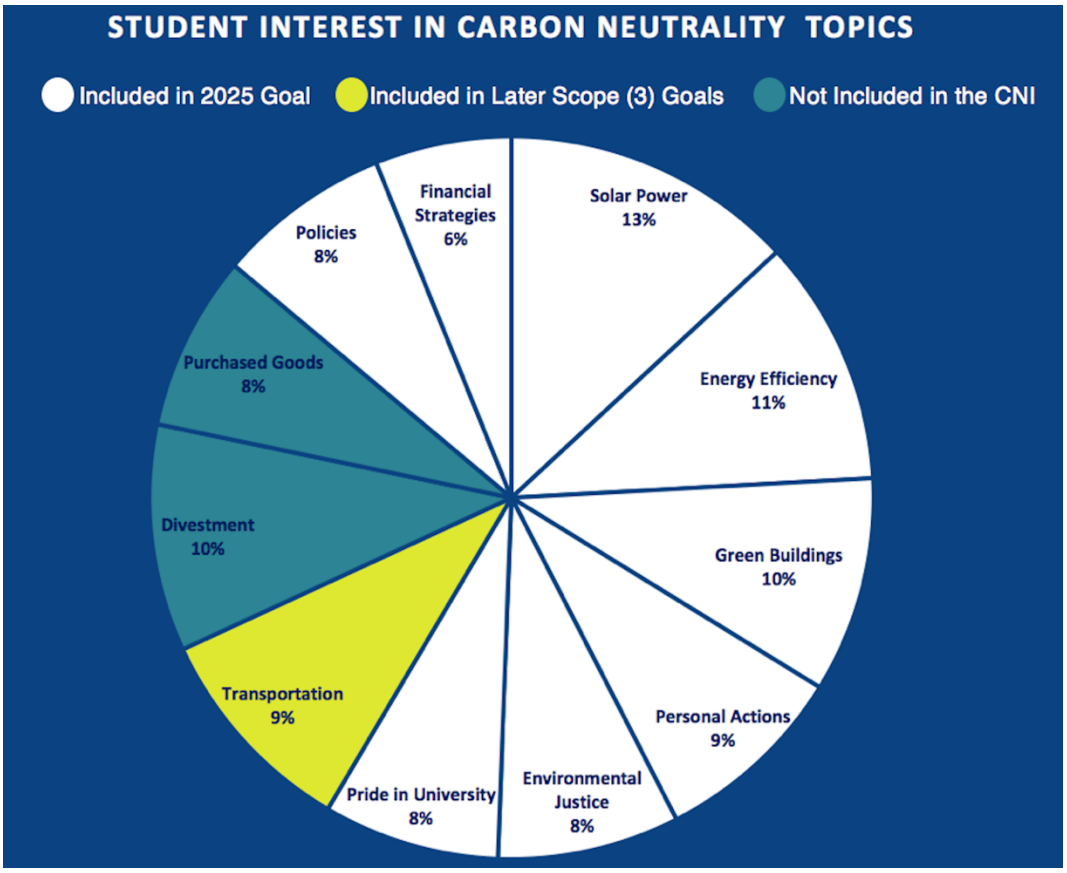

Figure 23: Student Interest in Carbon Neutrality Topics as They Relate to the CNI. Some topics that students are interested in are not included in the 2025 goals or not included in the CNI at all. Based on survey data from the UCSB student body (n=714).

Willingness to Take Action

The majority of students (74.3%) expressed that they somewhat or highly agree that they will take some form of action to show support for the CNI. Analysis with a Two Way ANOVA reveals that willingness to take action does not differ significantly depending on graduate status ($F(1) = 0.99$, $p=0.32$) but it does for discipline ($F(4)=2.43$, $p=0.05$). According to a Tukey's Post Hoc Test, willingness to take action for Environmental students is significantly different from all other disciplines except for Humanities students ($p=0.24$). Environmental students are the most likely to act to further the CNI and Engineering & Math students are the least likely to act (Figure 24).

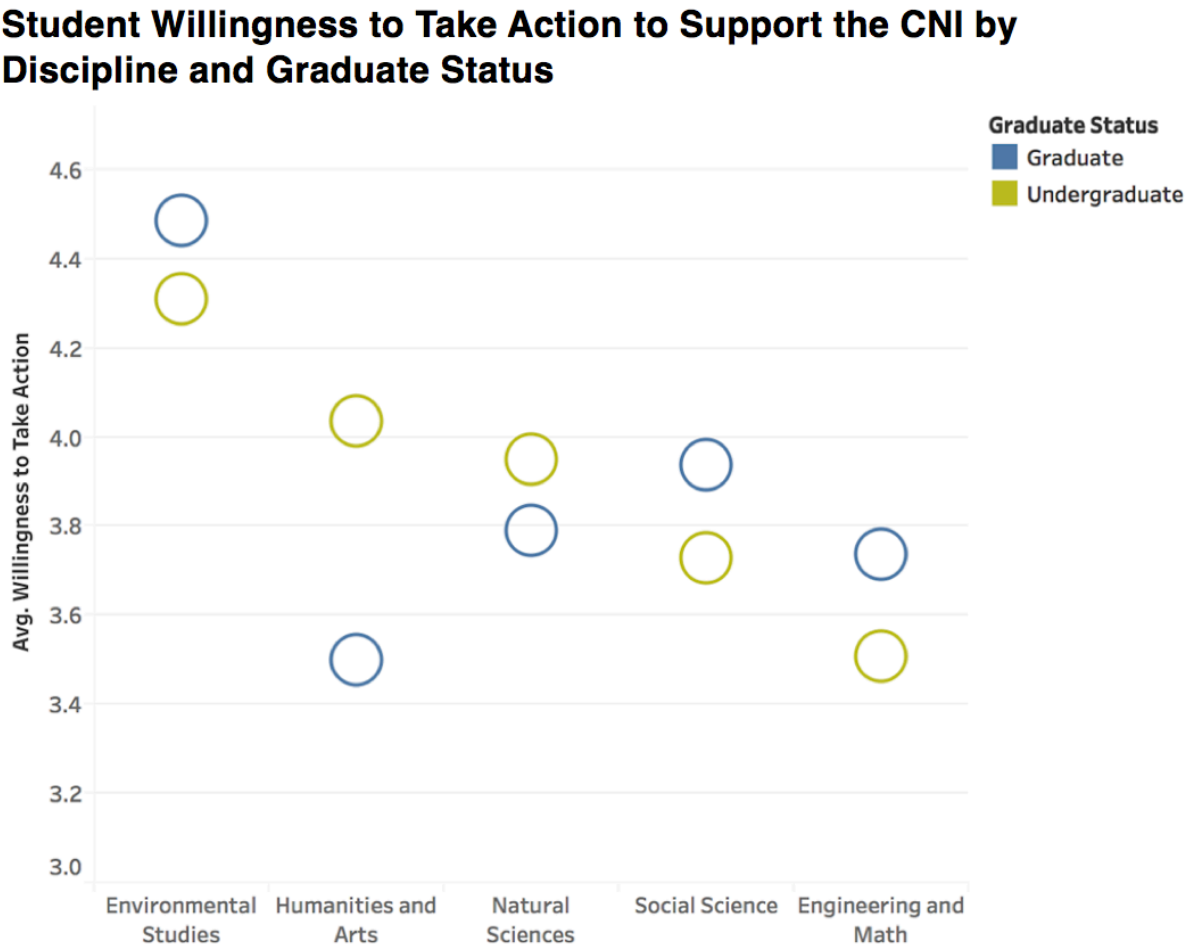

Figure 24: Student Willingness to Take Action to Support the CNI Based on Discipline and Graduate Status. Willingness to take action was measured on a scale from 1 to 5 (low to high). Based on survey results from the UCSB student body (n=678). Two Way ANOVA reveals that willingness to support the CNI does not differ significantly depending on graduate status ($F(1)=0.99$, $p=0.32$) but it does for discipline ($F(4)=2.43$, $p=0.05$).

Students who are involved in a sustainability related campus organization are 345% more likely to take action to further the CNI than students who do not belong in a

student organization according to an Ordered Logistic Regression. Interestingly, students who are involved in organizations that are not related to sustainability are 8% less likely to take action than students not involved in any organization at all.

Although eventually CNI communication strategies should expand to include engagement of the entire student body, early strategies should aim to engage Environmental students first, who are more likely to take action. Engaging students in sustainability organizations in the beginning is also recommended as these students are more likely to take action and are already organized.

Student Actions to Show Support

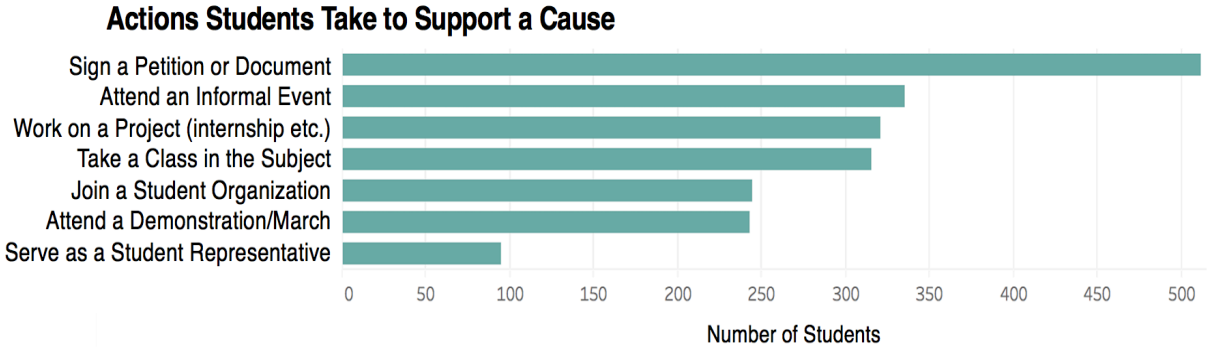

Figure 25: Actions Students Take to Support a Cause. The actions students are most willing to take when supporting a cause. Based on survey data of the UCSB student body (n=658).

The most popular action students take to show their support is signing a petition or other document (512 students). Attending an informal or informational event, working on a specific project for an internship or class, and taking a class in the subject were the next most popular actions. To further support for the CNI, actionable goals for any engagement strategy should align with what students are actually willing to do. A common frustration expressed by students in the focus groups, was that they want to engage with the CNI but are unsure what action to take. Rallying students around signing a document such as a resolution is feasible given student's overwhelming preference for signing documents. Informational and informal events about CNI topics should be increased. Classes that focus in topics that are covered by the CNI should eventually be accessible to all students, and aimed towards the specific interests of the students in that discipline.

Serving as a student representative in campus committees was the least popular action with only 95 student respondents. This reflects what we learned from our faculty interviews, that it can be challenging to find student representatives to sit on campus committees. Faculty have expressed that student participation in committees can be hugely influential and is one of the biggest avenues students have to articulate their opinions. However, this opportunity which could be used to further the CNI is not being taken advantage of by the students. This misalignment

can be addressed by communicating to students the effectiveness of sitting on committees for furthering the CNI's goals.

Incentives to Support the CNI

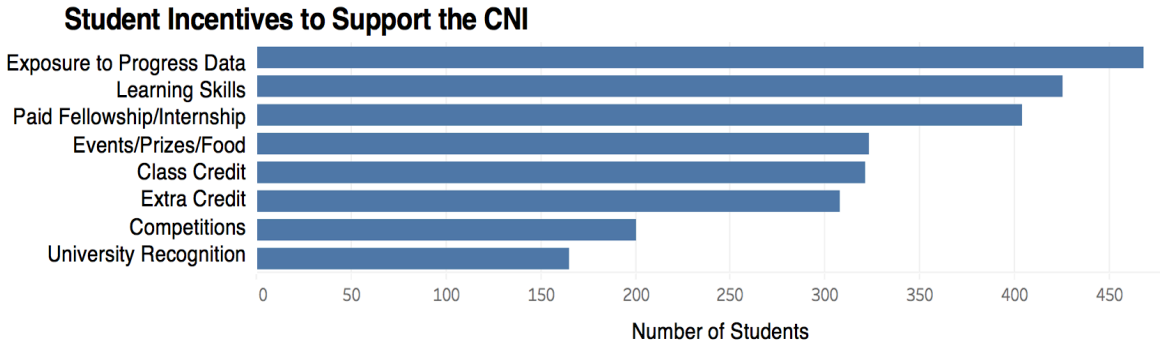

Figure 26: **Student Incentives to Take Action to Further the CNI.** UCSB students selected preferable incentives that would encourage them to support the CNI. Based on survey data of the UCSB student body (n=663).

Overall, the incentives that received the most votes were seeing real numbers to measure the campuses progress (n = 468), learning new skills and/or gaining experience for resumes (n = 425) and student fellowships or paid internships (n = 404). Students in focus groups expressed a desire to make the CNI more tangible and seeing timely statistics about the campuses energy use and emissions is one way of making the goals and results of the CNI more palpable for students. Frequent exposure to data about the campus's energy use and GHG emissions is critical for student engagement. This data could be imbedded in campus practices that are already taking place such as weekly emails. Although students may already be interested in a topic, our results show that they are incentivized by improving their skills. Future steps aimed at getting students involved in the CNI should incorporate skill-building.

Interestingly, competitions among universities and departments which was the second lowest incentive (n = 200), was how students were engaged in this topic in the past. Many students have heard about the CNI through competitions among dormitories to reduce electricity use, but the results indicate that they do not consider it an effective incentive.

Incentives to support the CNI varied widely by graduate status. A Chi-squared contingency table showed that there is a significant association between graduate status and incentive ($X^2(7)= 33.05$, $p<0.001$). Seeing numbers to measure progress was among the most popular for both graduates and undergraduates. However, undergraduates are more influenced by fun events and prizes as well as receiving class credit and extra credit. To successfully interconnect all groups of students in the CNI, methods of engagement should align with incentives that work for each

group, especially for graduates and undergraduates. Incentives for each of these groups are provided in the Student Audience Engagement Tool in Appendix I.

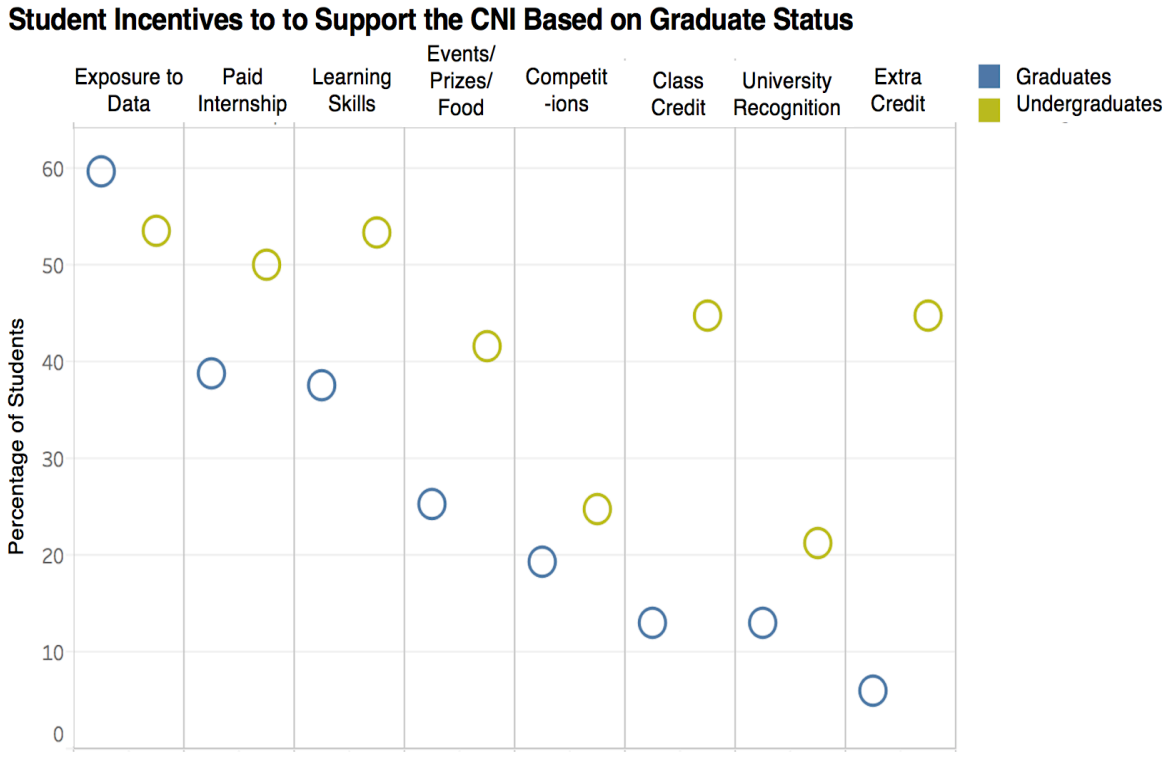

Figure 27: Incentives to Support the CNI by Graduate Status. Incentives varied widely based on graduates status (graduates v. undergraduates). A Chi-squared Test for Association shows that there is a significant association between graduate status and incentives ($X^2(7)= 33.05$, $p<0.001$). Based on survey data of the UCSB student body (n=663).

Communication

Which forms of communication are most effective in getting student attention is important to consider, so that time and resources are not wasted on ineffective methods. Social media (n = 403), emails (n = 403), and learning from friends (n = 374) were the most popular forms of effective communication among students. We recommend that the CNI create a presence on social media through applications like Facebook and Twitter. These sites could be monitored by student sustainability organizations, or could be a great way to get non-environmental students involved (such as Communication students who want to build skills and manage a social media account).

Tabling and canvassing were the least effective means of communication (n = 132). We advise that students trying to further the CNI move away from these methods and towards more effective forms of communication.

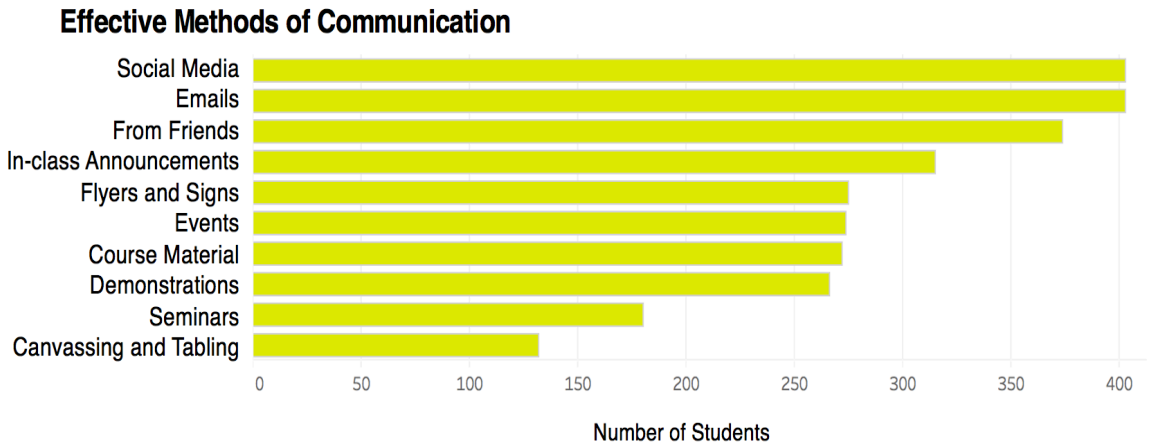

Figure 28: Effective Methods of Communication. UCSB students ranked which methods of communication were the most effective for getting them to pay attention to environmental causes. Based on survey data of the UCSB student body (n=662).

Ranking of the CNI

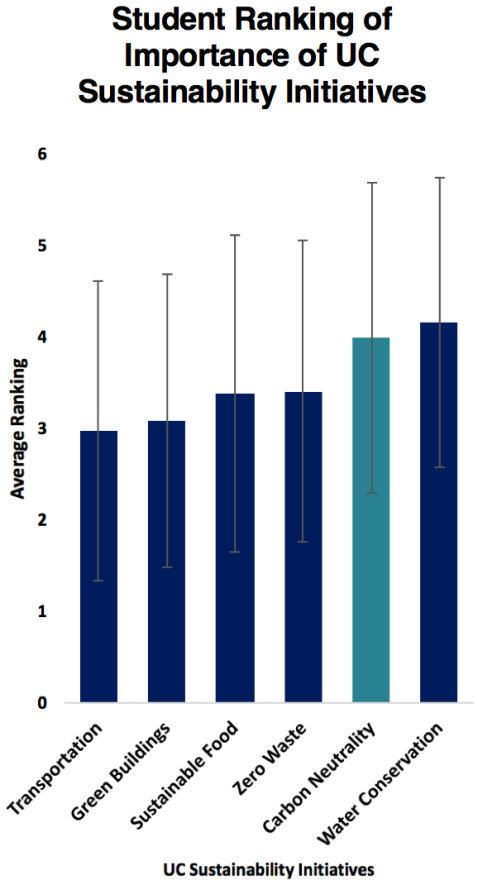

Figure 29: Ranking of UC Sustainability Initiatives. Six UC-wide sustainability initiatives were ranked in importance by UCSB students. Error bars show one standard deviation. Based on survey data of UCSB student body (n=707).

Among a ranking of six UC sustainability related initiatives, the CNI came in second in importance behind water conservation. However, two of these UC initiatives, green buildings and transportation, fall under the umbrella of carbon neutrality, yet are treated as separate initiatives. Students in focus groups expressed that they are bombarded with so many sustainability messages on campus that they can feel overwhelmed and confused. We recommend combining the green buildings and transportation initiatives under the CNI to streamline messaging.

Support for Sustainability

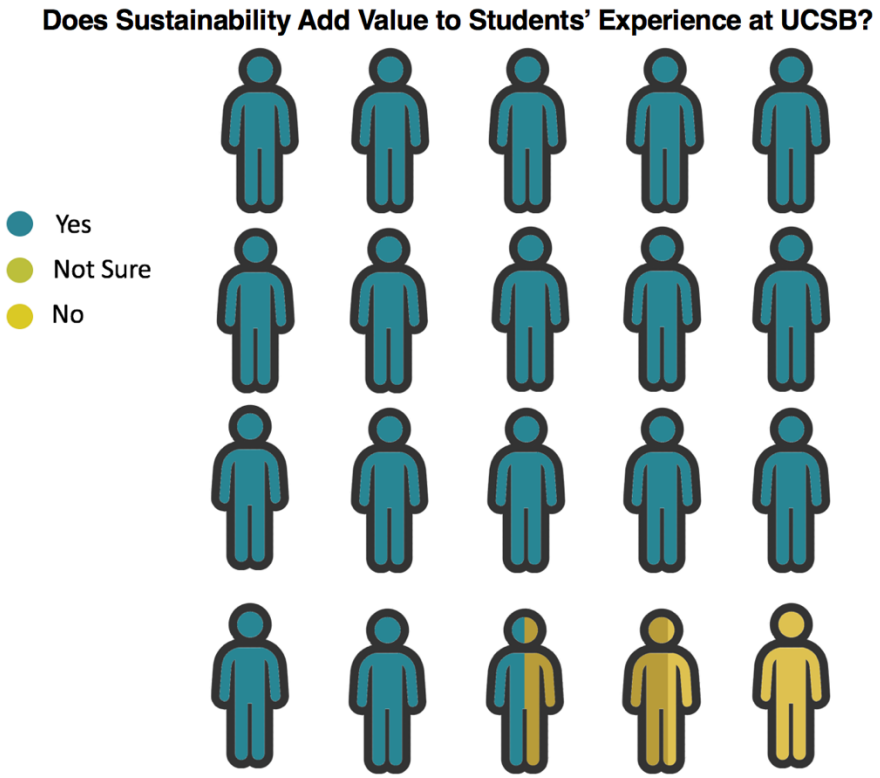

Figure 30: Does Sustainability Add Value to Students' Experience at UCSB? Based on survey data of the UCSB student body (n=677).

Of all respondents, 87.15% of students thought that UCSB's achievements and positive reputation in sustainability added value to their student experience. A small portion of students do not receive any value from sustainability (6.65%) and another small portion are unsure (6.20%). Sustainability is often argued in terms of financial savings or gaining resources for the university, yet the irrefutable value that it provides to UCSB students' overall experience cannot be denied.

Phase 4: Strategy & Tactics

Through Phases 1, 2, and 3 we identified a Theory of Change for UCSB, researched campus decision-making and administrator's perceptions of the CNI, and surveyed students on campus to determine processes to engage certain audiences. By gathering and assessing this information, we developed recommendations for administrators and students to ensure that the CNI brings meaningful, positive impacts to UCSB:

Recommendations

Students

- **Utilize known pathways to make change**. **Directly influence UCSB's environmental impact, CNI planning, and sustainability legacy through committee membership.** In Figure 33 below, we highlight a number of ways that students can increase awareness, engagement, and demonstrate support for the CNI that are all valuable in unique ways to campus. Students expressed that signing a document is their preferred method of action for supporting a cause. Rallying student support around signing a document such as a resolution is effective as well as feasible given student's overwhelming preference for signing a document. Also, through our interviews, we found that serving on a committee is one of the most direct ways that students can interact with campus administrators and faculty and thus impact the decision-making process. Through this channel, students are able to make their voices heard both as individuals and as representatives of all students. Student committee members have the opportunity to shape committee outcomes, including policies and plans that have significant, long-term implications for how UCSB carries forward its sustainability strategies and legacy. However, we found that serving as a student representative was the least popular action from our student survey. We recommend that students take advantage of this influential pathway to further integrate themselves into the administrative process.

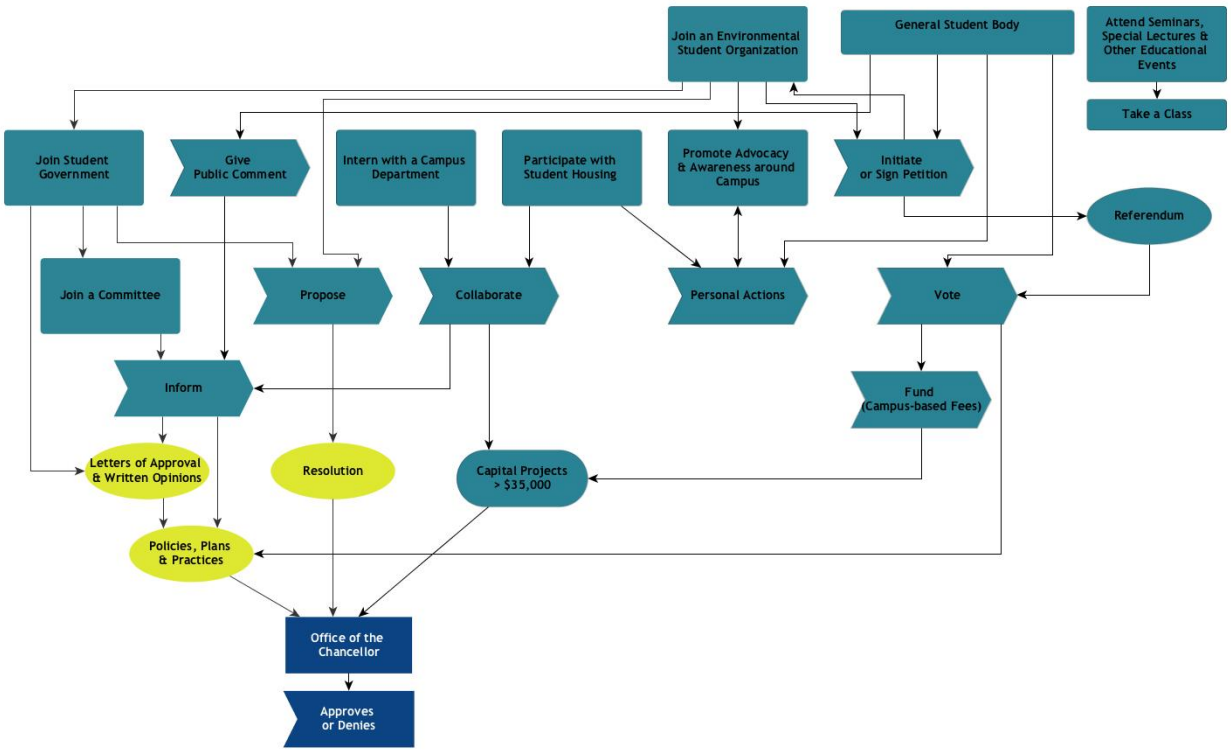

Figure 31: Student Pathways to Change. A schematic that highlights the main ways students can get involved and further CNI goals at UCSB.

- **Target audiences willing to engage with the CNI and employ informal communication methods.** Social media, action-oriented emails, and peer-to-peer communication were listed as the most effective methods of communication to get students to act. Target specific audiences with opportunities for them to develop skills while also supporting a CNI-related activity. Plan events related to the CNI and use social media, emails, and in-class announcements to spread information. Students want information, but they mostly want opportunities to engage in a meaningful way.

- **Reach out to campus administrators if you support a project**. Campus administrators value student opinion when deciding on a project that impacts campus. By reaching out to campus administrators in charge of these decisions, students can directly impact campus activities.

Students are an influential yet under-utilized stakeholder group in UCSB decision-making. Many students are ready and willing to engage in CNI activities if their potential impact and roles are simply made more clear to them. While administrators also want more student engagement in UCSB decision-making, they have greater means to improve processes to facilitate and sustain increased student involvement year after year if they employ the following recommendations:

Administrators

- **Recruit, engage, and retain more students on committees through targeted outreach and clear guidelines.** First, target the students whose interests align with the goal of the committee (See Student Audience Engagement Tool in Appendix I). They are more likely to join the committee and engage in it throughout the duration of their membership. Additionally, lead recruitment outreach efforts with the skill-building opportunities that committee membership provides. Second, present clear guidelines of roles, expectations, and any limitations (i.e. non-voting, non-agenda setting) to student committee members before finalizing selection. Third, if possible, establish protocols for incorporating student opinion, whether formally or informally, into committee outcomes (e.g. Letters of Approval, written opinions, etc.). This last step will ensure student committee members are engaged in their roles and that committee outcomes adequately represent their intended stakeholder groups.

- **Streamline messaging of the CNI at the UCOP level.** Students at UCSB have communicated that they feel overwhelmed and confused by the quantity of sustainability messaging they encounter on campus. UCOP currently has several sustainability initiatives, the green buildings and transportation initiatives in particular, that fall under the umbrella of carbon neutrality. We recommend that UCOP combine these campaigns under the CNI to reduce confusion and focus attention, action, and resources on attaining the broader goals of the CNI.

- **Target CNI messaging to environmental students and organizations first and encourage them to utilize their informal peer-to-peer routes of communication.** Analysis of the campus-wide survey demonstrates that environmental students are statistically more willing to support the CNI. In addition, students in environmental organizations are 345% more likely to support the CNI than students not involved in an organization. Students majoring in Environmental Studies and who are a member of a sustainability organization are clearly the first actors. Students are most likely to receive effective communication about causes through informal means such as social media and learning from friends. Rallying a group of passionate environmental students and encouraging them to spread the message across campus through peer-to-peer channels is the most effective strategy identified by our survey for improving CNI communications among students. After initial engagement of environmental students, students in other disciplines can be included by appealing to topics that and incentives that interest them (See Student Audience Engagement Tool in Appendix I).

- **Take advantage of "low hanging fruit" opportunities that can have big impacts on incentivizing students to take action.** The incentive to support the CNI that received an overwhelming response and reached across all student audiences was exposure to data about the emissions and energy savings of the campus. This result makes clear that frequent exposure to data about campus energy use and GHG emissions is critical for student engagement. The data that is already tracked and reported for the CAP and sustainability review boards could be embedded in campus practices that are already taking place such as weekly emails. The second most popular incentive for students was learning new skills. Any CNI project that involves student recruitment should have skill-building incorporated into its objectives and outreach. To incentivize non-environmental students to get involved, skill-building can be applied to areas of interest for each discipline. For example, Communication students could manage a CNI social media account.

- **Align UCSB's core mission of teaching and research with topics of the CNI that resonate with students.** Students express the most interest in the carbon neutrality topics of solar power, renewable energy, and energy efficient technologies. UCSB has nationally recognized Engineering and Environmental programs that could employ the power of student interest to further the CNI. By harnessing student interest for sustainable energy topics through internships, fellowships, or class projects, UCSB can simultaneously achieve leadership in environmental research and push forward the goals of the CNI.

- **Incorporate zero-net energy building criteria and emissions benchmarking into the planning, design, and retrofitting processes and long-term vision at UCSB.** As one of the most valuable and relatable assets on campus, investing time and resources into UCSB's building stock is not only good for campus management from a long-term cost-effectiveness standpoint, it also is a top priority that decision-makers and students care deeply about. Campus cannot become carbon neutral if it continues to build carbon-producing buildings, which remain on campus for decades.

Conclusion

Our goal for this project was to identify specific areas where we could help advance the CNI at UCSB. Through informational interviews with key informants during Phase 1 of our communication methodology, we determined spaces where we could research and develop recommendations for implementable actions to aid campus administrators and students passionate about the CNI. We identified solar PV, the UCRF, and communication and engagement as three areas with large potential for furthering the CNI conversation. We began this research under the assumption that these three areas were distinct; however, we found links between these assessments that were not previously identified.

One of the motivators for both the solar and financial assessments was campus budget constraints and the difficulty of acquiring capital funding for sustainability projects. Through our communication research we discovered that campus administrators perceive funding the CNI as both a challenge and potential solution. We believe our recommendations for increasing onsite solar PV and financing energy efficiency through the UCRF may help to alleviate concerns among campus administrators of the perceived high cost of the CNI.

Through a campus-wide survey we discovered that students are interested in both solar PV and energy efficiency projects on campus. Campus administrators can harness their interest and utilize positive student opinion to gain support for specific projects. As we highlighted, campus administrators stated that student opinion is critical during the decision-making process. Campus administrators and students can unite to support and implement solar PV, energy efficiency, and green building projects. We provided recommendations for specific student audiences to engage as well as incentives to use to incite action. Students on campus are interested and willing to engage with the CNI, but need to be provided information on how they can make a meaningful difference as well as information on avenues by which they can voice their opinions. We identified these avenues and will provide this information to both administrators and students in order to influence the decision-making process.

One question we were interested in answering is whether or not student opinion actually does matter in the decision-making process at UCSB. As stated numerous times, it overwhelmingly does. Clearly, the step necessary to make the CNI a reality, is to engage and coordinate with one of the most important, if not the most important, stakeholders on campus: the students. As one UCSB administrator stated, “when students speak, it carries a lot of weight…we recognize that they are the future. It’s their future.” This result links the distinct parts of our project in ways we had not anticipated. While the UC CNI is a top-down mandate from UCOP, UCSB students are interested and passionate about sustainability initiatives and they have the opportunity to align with campus administrators to integrate the CNI into the fabric of UCSB.

We believe that through our research into solar PV, the UCRF, and the decision-making process, we identified ways that UCSB can better integrate the CNI into campus. While our goal for this research was to help move the needle in three distinct areas, we believe we have found ways to align numerous stakeholders who hold different interests, but who all hold the same goal of achieving the CNI at UCSB.

Appendix A: Cost Effectiveness Analysis of Direct Access Electricity Procurement

Background

Currently, UCSB purchases and receives electricity from its local investor-owned utility (IOU), Southern California Edison (SCE), in the traditional "Bundled Service" approach. Bundled Service refers to the combination of all necessary electricity services, including generation, transmission, and distribution to end-use customers.[85] The alternative approach, "Direct Access," decouples generation, transmission and distribution. It allows customers to choose the source of their electricity generation, while still receiving their distribution and transmission via their local utility[86] (Figure 34). Under Direct Access, customers must purchase their electricity from a registered Energy Service Provider (ESP), an individual or company that contracts directly with its customers to provide electricity supplies.[87] Direct Access benefits the customer as it gives them greater flexibility to choose cheaper and/or greener electricity supplies because of competition between ESPs in California's energy market.

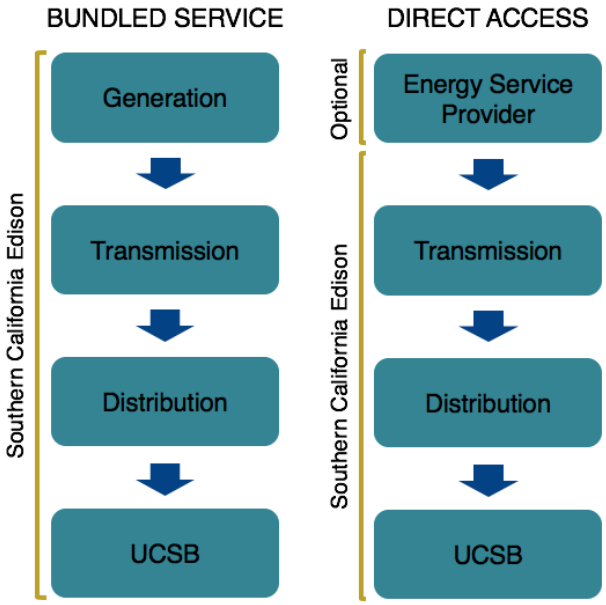

Figure 32: Comparison of Electricity Procurement through Bundled Services versus Direct Access.

[85] NV Energy. 2016. "NV Energy: Glossary." Web. 20 Oct. 2016.
[86] Pacific Gas & Electric. 2016. "Electricity—Direct Access." 2016. 20 Oct. 2016.
[87] Ibid.

Switching to Direct Access from Bundled Service can entail considerable uncertainty and switching costs. Customers wishing to enroll in Direct Access must enter a state-wide lottery.[88] Additionally, there is a considerable amount of red tape, such as paperwork and fees, involved in applying for Direct Access that requires expertise in California energy markets as well as significant time investment. As a result, most small-to-medium customers are deterred from pursuing Direct Access. For larger customers such as UCSB, Direct Access can be an attractive option. However, there is some doubt whether UCSB would be able to successfully switch back to Direct Access due to the uncertain lottery process.

In March 2014, the University of California became a registered ESP allowing its Wholesale Electricity Program (WEP) to provide energy via Direct Access to UC campuses who wish to participate. UC Irvine and its medical center, UC San Diego and its medical center, UC San Francisco and its medical center, UC Santa Cruz, UC Merced, and a number of other University accounts began receiving electricity through Direct Access from the UC WEP in early 2015.[89] So far, the UC WEP has procured 80 MW of solar photovoltaic energy under power purchase agreements, securing enough solar electricity for the next 25 years to supply 60% of the UC's electricity demand.[90] Through the UC WEP, the University can exert more control over its energy portfolio by keeping costs consistent, increasing price transparency, and expanding renewable sources at a rate higher than that of California's IOUs, thus providing a cheaper, more reliable, and greener option for its campuses.[91]

Over the past decade, UCSB has switched between Direct Access and Bundled Service numerous times. Most recently in 2012, UCSB chose to switch back to Bundled Service from Direct Access because it was more cost effective.[92] Now with the goal of carbon neutrality by 2025 coupled with the creation of the UC WEP, UCSB is examining whether Direct Access could be a more preferable option both financially and environmentally.

Methodology

Ex-post Cost Effectiveness Analysis

An ex-post cost effectiveness analysis was performed to evaluate whether UCSB's purchased electricity expenditures for its main campus would have been lower in

[88] Southern California Edison. 1 May 2010. "Southern California Edison: Customer Choice Services." Web.
[89] University of California. 2015. "University of California to Supply Electricity to Select Campuses, Medical Centers." Web. Dec. 2016.
[90] University of California. 2015. Annual Report on Sustainable Practices.
[91] University of California. 2015. "University of California to Supply Electricity to Select Campuses, Medical Centers." Web. Dec. 2016.
[92] Niu, Josephine. "UC To Provide Electricity to Five Campuses." The Daily Nexus, 26 Jan. 2015. Web. Dec. 2016.

2015 if UCSB was on Direct Access. SCE utility invoices for UCSB's main campus for all months in 2015 were obtained from UCSB's Facilities Management in order to determine UCSB's actual electricity expenditures under Bundled Service in 2015. To assess what UCSB's electricity bill for its main campus would have been under Direct Access in 2015, estimated expenditures were broken down into three components based on information from representatives of UC's Wholesale Electricity Program (WEP)[93]:

1. **Cost of electricity generation**: Actual rates paid by UC campuses under Direct Access to UC in 2015 were provided by UC's WEP.
2. **Cost of electricity delivery**: Delivery costs were assumed to be equivalent for Direct Access and Bundled Service.
3. **Power Charge Indifference Adjustment (PCIA):** Parties that leave Bundled Service for Direct Access can be charged an exit fee by IOUs for up to 20 years. The exit fee varies by IOU and year of departure from Bundled Service. Based on actual exit fees charged by SCE in 2015 (which range from $6 - $9/MWh), an average of $7.50/MWh was used in this analysis.[94]

The three cost components were summed for all months in 2015 to estimate a total expected energy bill for UCSB's main campus in 2015 had UCSB been on Direct Access. A direct comparison between actual UCSB main campus electricity expenditures under Bundled Service in 2015 and estimated electricity expenditures under Direct Access could then be made.

Ex-ante Cost Effectiveness Analysis

Electricity expenditures for UCSB's main campus were projected for the years 2017-2025 for both Bundled Service and Direct Access. Six total scenarios were considered based on varying projected annual electricity consumption and utility escalation rates. First, two bounding scenarios for projected annual electricity consumption through 2025 for UCSB's main campus were selected.

1. **High Energy Efficiency scenario**: Assumes that UCSB follows the optimal deployment schedule for energy efficiency projects recommended by the 2015-16 CarbNewt Bren Group Project team. This idealized scenario represents a lower bound for projected annual electricity use at UCSB through 2025.
2. **Business as Usual scenario**: Assumes that UCSB does not implement any energy efficiency projects through 2025, and accounts for increased electricity consumption resulting from planned main campus growth. Only currently

[93] Clark, Cynthia. "Student Question Regarding Direct Access at UCSB." Received by Charles Diamond, Nov. 2, 2016.
[94] Lancaster Choice Energy. 2016. "City OKs Power-selling Project." Antelope Valley Press, 15 Nov. 2016. Web. 20 Nov. 2016.

planned onsite solar photovoltaic installations are considered. This scenario represents an upper bound for projected annual electricity use at UCSB through 2025.

Projected annual electricity use for both scenarios was calculated by CarbNewt.[95] In addition to the bounding scenarios for electricity use, the utility escalation rate was assigned three possible values (2%, 2%, and 4%) to reflect uncertainty in future SCE electricity rates through 2025. The utility escalation rate is the nominal electricity rate increase per year. The three escalation rate values were selected based on suggestions from UCSB facilities and budget and planning staff, as well as projections by UC Davis's Energy Efficiency Center.[96] Assigning three different escalation rates to the two electricity use bounding scenarios resulted in six total scenarios that represent a wide range of future conditions regarding electricity consumption at UCSB and SCE electricity rates.

Projected electricity expenditures under Bundled Service for UCSB's main campus for 2017-2025 were then calculated as follows:

1. The price per MWh of purchased electricity in 2015 was calculated by dividing the total expenditures on electricity in 2015 by the total amount of electricity consumed (MWh) in 2015.
2. For each of the six scenarios, the $/MWh value calculated above was then increased by the appropriate escalation rate each year through 2025 and then multiplied by the appropriate electricity use in each year to provide an annual electricity expenditure through 2025.

$$Electricity\ Expenditure\ in\ Year\ X\ = \$/MWh_{Year\ X} \times Electricity\ Use_{Year\ X}$$

3. Each annual electricity expenditure was then discounted using a 5% rate with 2017 as the base year. UCSB uses a 5% discount rate when evaluating capital project costs.
4. A present value of total electricity expenditures between 2017-2025 was then calculated by summing the discounted annual electricity expenditures.

Projected electricity expenditures under Direct Access for UCSB's main campus for 2017-2025 were estimated in a similar manner as Bundled Service. For Direct Access however, only delivery costs (which are still paid to SCE under Direct Access) were subject to the utility escalation rate used above. Generation costs projections through 2022 were provided by the UC WEP. Generation costs from 2022-2025 were estimated by assuming the same level of Direct Access rate

[95] Bart, Kaysen, Maggass, Park, Watson, 2016. Achieving Carbon Neutrality at UCSB by 2025: A Critical Analysis of Technological and Financial Strategies. University of California, Santa Barbara Bren School of Environmental Science & Management.

[96] Cook, Jonathan, A. Smidebush, and S. Gunda. "The Future of Electricity Prices in California." *UC Davis Energy Efficiency Center* (2013). Web.

increase as experienced between 2020-2022. These are likely high-end estimates, which are appropriate in order to ensure conservative Direct Access cost effectiveness estimates. PCIA are assumed to stay constant at $7.50/MWh through 2025. A present value of total electricity expenditures between 2017-2025 for UCSB under Direct Access could then be calculated for all six scenarios and directly compared to the Bundled Service estimates.

Avoided Emissions Analysis

Avoided emissions over a 2017-2025 timeframe resulting from a switch to purchased electricity via Direct Access were assessed for a total of four different scenarios. Firstly, the scenarios varied by projected annual electricity use. Two different electricity use projections were used, and are identical to the "High Energy Efficiency" and "Business as Usual" scenarios utilized in the ex-ante cost effectiveness analysis. Secondly, the scenarios varied based on two differing emissions factor projections by UC WEP[97] staff for electricity procured through Direct Access. These two emissions factor projections for Direct Access electricity from the UC reflect an upper and lower limit, and thus seemed important to include given uncertainties regarding future renewable energy procurement by the UC WEP. Projected emissions factors for SCE supplied electricity were taken from CarbNewt's Final Report calculations. Difference in emissions factor multiplied by annual electricity consumption provided an estimate for avoided emissions from Direct Access in each year through 2025 for each scenario.

Table 17: Projected Emissions Factors for Bundled Service and Direct Access. The emissions factors for SCE Bundled Service and UC Wholesale Electricity Program supplied electricity (upper bound and lower bound) are projected through the year 2025.

Year	Bundled Service Emissions Factor [$MTCO_2e/MWh$]	DA Emissions Factor (Upper bound) [$MTCO_2e/MWh$]	DA Emissions Factor (Lower bound) [$MTCO_2e/MWh$]
2016	0.256	0.277	0.277
2017	0.251	0.159	0.000
2018	0.245	0.139	0.000
2019	0.240	0.119	0.000
2020	0.235	0.099	0.000
2021	0.229	0.079	0.000
2022	0.226	0.060	0.000
2023	0.222	0.040	0.000
2024	0.218	0.020	0.000
2025	0.214	0.000	0.000

[97] Clark, Cynthia. "Student Question Regarding Direct Access at UCSB." Received by Charles Diamond, Nov. 2, 2016.

Results

Ex-post Cost Effectiveness Analysis

Results of our ex-post cost effectiveness analysis show that UCSB would have paid 16% more in electricity expenditures in 2015 had it switched from SCE Bundled Service to Direct Access procurement from the UC WEP. Actual purchased electricity expenditures under Bundled Service for UCSB's main campus in 2015 totaled $8,230,754, whereas estimated expenditures under Direct Access were substantially higher at $9,582,365. Results of this ex-post cost effectiveness analysis are displayed in the table below.

Table 18: Ex-post Cost Effectiveness Analysis Results. Results of the ex-post cost effectiveness analysis for Direct Access and Southern California Edison (SCE) Bundled Service electricity procurement in 2015.

Results of Ex-Post Cost Effectiveness Analysis of UCSB's 2015 Electricity Expenditures	
SCE Bundled Service Electricity Costs in 2015 (Actual)	$ 8,230,754
Direct Access Electricity Costs in 2015 (Estimated)	$ 9,582,365
Difference	$ 1,351,611
Percent Difference	16%

Ex-ante Cost Effectiveness Analysis

Results of the ex-ante cost effectiveness analysis show that the present value (using a 5% discount rate) of UCSB main campus electricity expenditures for 2017-2025 were lower under SCE Bundled Service for all scenarios where a 0% or 2% utility escalation rate was used. The present value of electricity expenditures under Direct Access was marginally lower for both scenarios in which a 4% utility escalation rate was used. Therefore, Bundled Service is the more cost effective purchased electricity option for UCSB through 2025 unless the escalation rate nears 4% through 2025. Results of our ex-ante cost effectiveness analysis are displayed in the Table 19 below.

Table 19: **Ex-ante Cost Effectiveness Analysis Results**. Direct Access and Southern California Edison (SCE) Bundled Service electricity procurement for 2017-2025 for six scenarios varying by projected annual electricity use and utility escalation rate. Present values of electricity costs were calculated using a 5% discount rate and use 2017 as a base year. The more cost effective option for each scenario is highlighted in yellow.

Present Value of UCSB's Projected Electricity Expenditures (2017-2025)				
	High Energy Efficiency Scenario		Business as Usual Scenario	
Utility Escalation Rate	Direct Access	Bundled Service	Direct Access	Bundled Service
0%	$ 50,174,749	$ 43,584,926	$ 73,575,894	$ 63,667,567
2%	$ 52,855,178	$ 48,605,993	$ 76,506,677	$ 71,442,519
4%	$ 53,853,908	$ 54,224,481	$ 79,288,828	$ 80,188,484

Figures 35 and 36 below show forecasted annual undiscounted electricity expenditures at UCSB under Direct Access and Bundled Service for three different escalation rates (0%,2%,4%) and two different electricity consumption scenarios (high energy efficiency and business as usual). Bundled Service electricity procurement is more cost effective for all years through 2025 when a 0% or 2% utility escalation rate is used. When a 4% utility escalation rate is used, Direct Access electricity procurement becomes more cost effective after 2020 for both electricity consumption scenarios. Given that UCSB Office of Budget and Planning officials must see near-term cost saving potential in order to authorize a major change in university purchasing such as with utilities, it is unlikely that a switch to Direct Access procurement would be considered given its significant cost premium that results when a low or medium escalation rate is used.

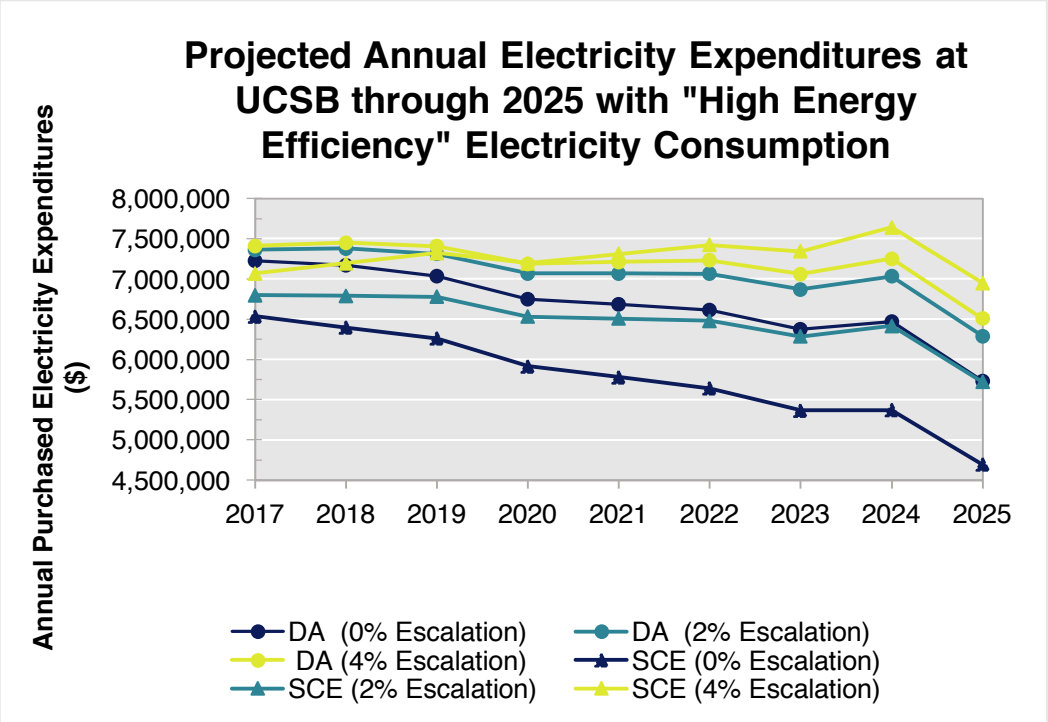

Figure 33: **Projected Annual Electricity Expenditures at UCSB (High Energy Efficiency Scenario)**. Projected annual electricity expenditures (undiscounted) at UCSB through 2025 for Direct Access and Bundled Service under a "High Energy Efficiency" electricity consumption scenario. Three different utility escalation rates are used (0%, 2%, and 4%).

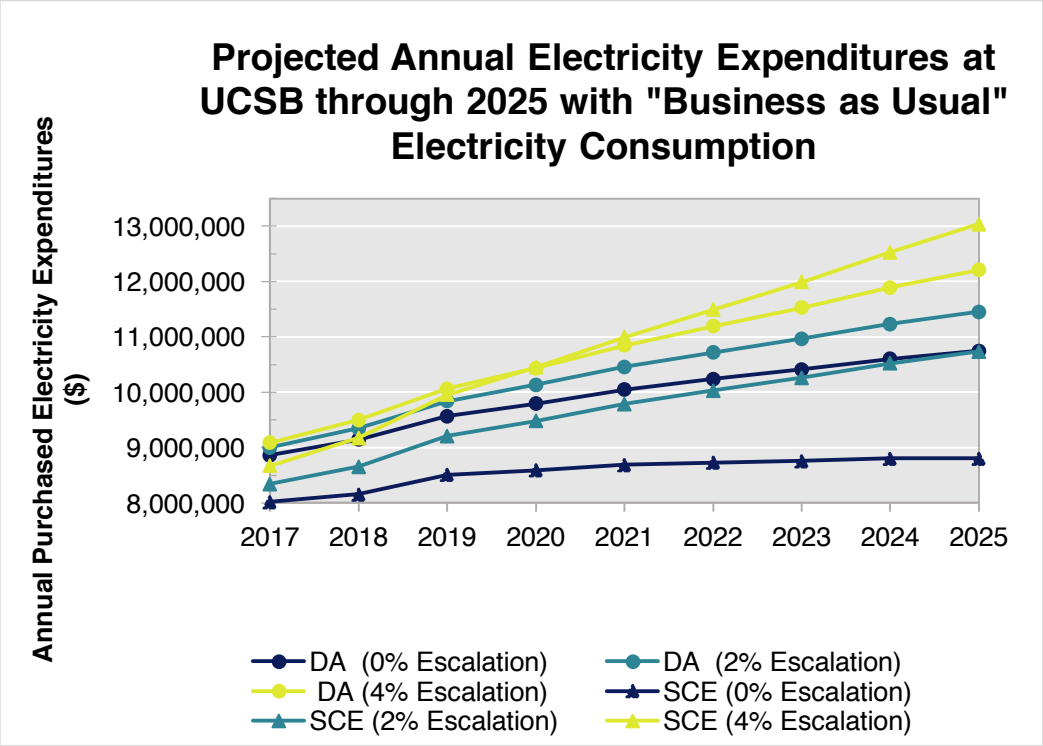

Figure 34: **Projected Annual Electricity Expenditures at UCSB (BAU scenario)**. Projected annual electricity expenditures (undiscounted) at UCSB through 2025 for Direct Access and Bundled Service under a BAU electricity consumption scenario. Three different utility escalation rates are used (0%, 2%, and 4%).

Avoided Emissions Analysis

Cumulative avoided emissions from 2017-2025 resulting from a switch to Direct Access ranged between 82,326 $MTCO_2e$ and 190,180 $MTCO_2e$ for the four scenarios considered. Cumulative avoided emissions were lowest for the scenario utilizing a “High Energy Efficiency” electricity use and higher estimated emissions factors for Direct Access. Cumulative avoided emissions were greatest for the scenario utilizing a “Business as Usual” electricity consumption and lower estimated emissions factors for Direct Access.

Table 20: **Projected Avoided Emissions Resulting from UCSB Switching to Direct Access.** Projections to 2025 for four scenarios which vary by annual electricity use and Direct Access emissions factors to reflect lower and upper bounds.

Present Value of Benefits of Avoided Emissions (2017-2025) Resulting from UCSB Switching to Direct Access		
	High Energy Efficiency Scenario	Business as Usual Scenario
Utility Escalation Rate	Cumulative Avoided Emissions ($MTCO_2e$)	Cumulative Avoided Emissions ($MTCO_2e$)
Lower Bound DA Emissions Factor	129,018	190,180
Upper Bound DA Emissions Factor	82,236	125,949

Estimated annual greenhouse gas emissions reductions through 2025 resulting from a switch by UCSB to Direct Access electricity procurement are shown against business as usual Scope 1 and 2 emissions[98] in figures 37 and 38 below for upper and lower bound Direct Access emissions factors. In all scenarios considered, a switch to Direct Access effectively eliminates all Scope 2 emissions from purchased electricity, as the UC WEP has committed to providing 100% clean energy by 2025 (emissions factor =0).[99] Within each figure, the lesser reductions in the “high energy efficiency” scenario compared to the “business as usual” scenario represents emissions reductions that would have resulted from energy demand reduction in the “high energy efficiency” scenario.

[98] UCSB Office of Sustainability. 2016. Climate Action Plan 2016 Draft. Santa Barbara, CA.
[99] Clark, Cynthia. "Student Question Regarding Direct Access at UCSB." Received by Charles Diamond, Nov. 2, 2016.

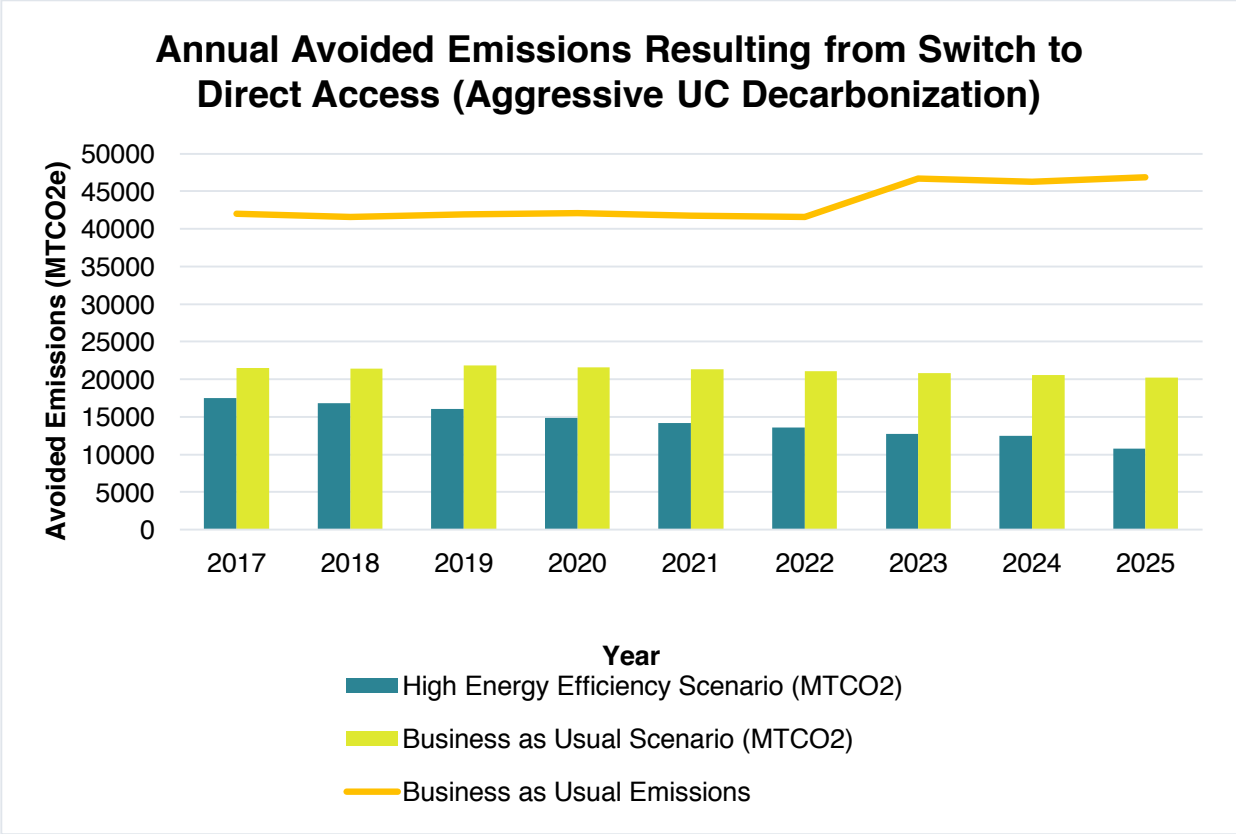

Figure 35: **Projected GHG Savings from UCSB switching to Direct Access (lower bound DA emissions factor)**. A lower bound for Direct Access emission factors is used, which represents an aggressive decarbonization scenario by the UC Wholesale Electricity Program. BAU Scope 1 and Scope 2 emissions are represented by the solid orange line.

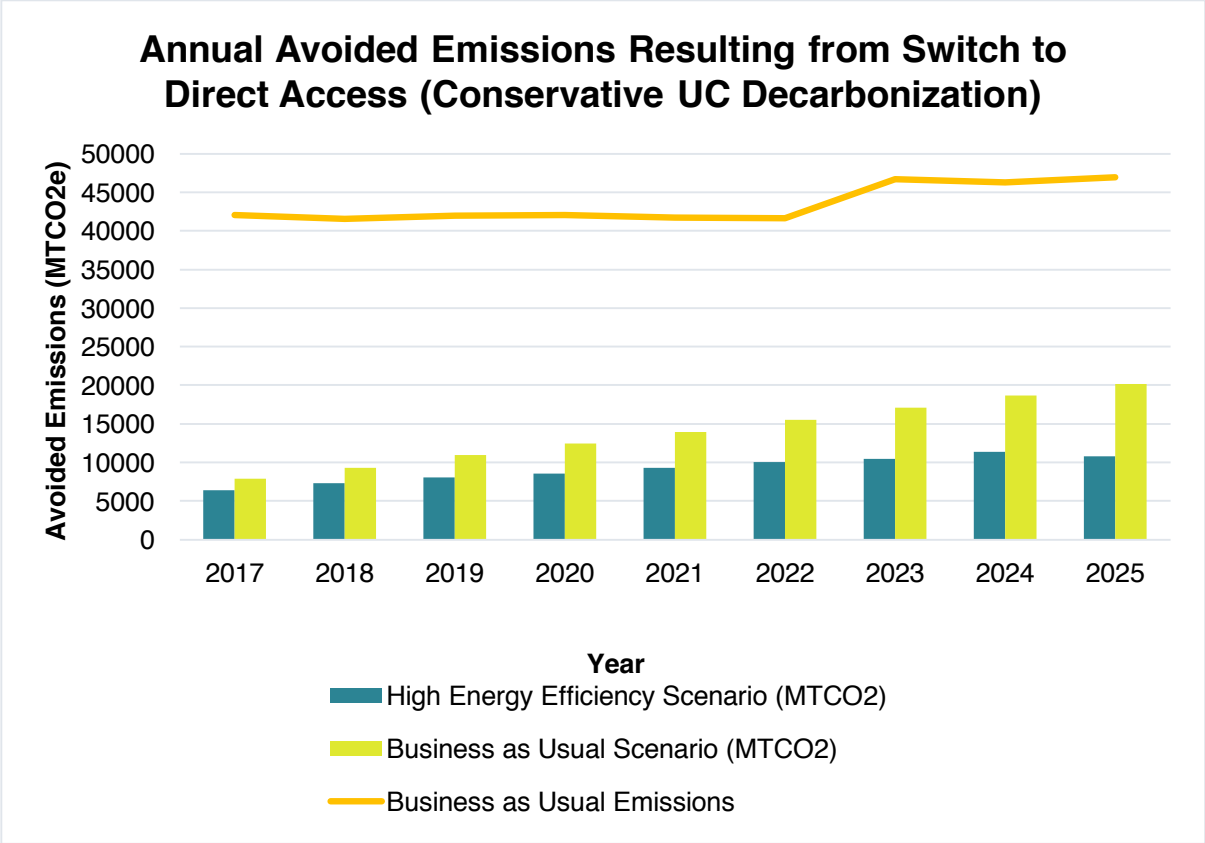

Figure 36: **Projected GHG Savings from UCSB switching to Direct Access (upper bound DA emissions factor)**. An upper bound for Direct Access emission factors is used, which represents a conservative scenario with regards to decarbonization by the UC Wholesale Electricity Program. BAU Scope 1 and Scope 2 emissions are represented by the solid orange line.

While emissions reductions are significant, a switch to Direct Access that results in increased utility costs would likely be untenable for the UCSB Office of Budget and Planning. Therefore, other options to reduce emissions from purchased electricity at UCSB should be evaluated. There is the potential possibility that UCSB and other UC campuses not on Direct Access could potentially obtain Renewable Energy Credits (RECs) from the UC WEP while remaining on Bundled Service. No conclusive recommendations can be made regarding this topic however, as complete information is currently unavailable. President Napolitano's Global Climate Leadership Council's Taskforce on Finance and Management may be able to provide clarification regarding this topic in the future. Other options to reduce emissions from purchased electricity that should be evaluated for UCSB include Community Choice Aggregation as well as Southern California Edison's green power options. As discussed below in further detail, any cost premium associated with green electricity procurement will reduce the utility budget surplus at UCSB, which in turn would limit funding for the UCRF.

Appendix B: Results of UCRF Scenario Analysis

Annual investment, utility savings, and GHG emissions reductions are displayed for all six scenarios under slow, average, and fast payback periods for additional unplanned energy efficiency projects that are funded with the UCRF. Maximum values are highlighted in yellow for each metric. Minimum values are highlighted in orange.

With Incentives

Investment Figures

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	Total
0%									
Lower	$ 3,832,994	$ 2,168,380	$ 2,609,776	$ 3,154,510	$ 3,644,415	$ 3,745,413	$ 3,916,597	$ 5,167,811	$28,239,897
Average	$ 3,832,994	$ 2,168,380	$ 2,822,648	$ 3,225,468	$ 3,912,823	$ 4,123,934	$ 4,382,639	$ 5,767,873	$30,236,760
Upper	$ 3,832,994	$ 2,168,380	$ 3,283,871	$ 3,379,209	$ 4,618,548	$ 5,026,845	$ 5,666,246	$ 7,458,280	**$35,434,373**
2%									
Lower	$ 3,832,994	$ 2,168,380	$ 2,446,188	$ 2,831,913	$ 3,149,617	$ 3,075,933	$ 3,032,475	$ 4,108,967	$24,646,468
Average	$ 3,832,994	$ 2,168,380	$ 2,663,317	$ 2,905,737	$ 3,421,121	$ 3,452,414	$ 3,487,272	$ 4,689,812	$26,621,048
Upper	$ 3,832,994	$ 2,168,380	$ 3,133,765	$ 3,065,689	$ 4,143,789	$ 4,360,438	$ 4,784,190	$ 6,396,004	$31,885,249
4%									
Lower	$ 3,832,994	$ 2,168,380	$ 2,282,600	$ 2,502,927	$ 2,631,826	$ 2,354,657	$ 2,048,696	$ 2,885,690	$20,707,770
Average	$ 3,832,994	$ 2,168,380	$ 2,503,987	$ 2,579,674	$ 2,905,483	$ 2,725,006	$ 2,481,067	$ 3,423,277	$22,619,867
Upper	$ 3,832,994	$ 2,168,380	$ 2,983,658	$ 2,745,961	$ 3,643,673	$ 3,630,161	$ 3,770,988	$ 5,097,714	$27,873,529

Savings Figures

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	Total
0%									
Lower	$ -	$ 609,211	$ 980,091	$ 1,535,823	$ 1,986,392	$ 2,078,592	$ 2,628,790	$ 3,206,403	$13,025,304
Average	$ -	$ 822,084	$ 1,051,049	$ 1,804,231	$ 2,364,913	$ 2,544,635	$ 3,228,853	$ 4,086,753	$15,902,516
Upper	$ -	$ 1,283,306	$ 1,204,789	$ 2,509,956	$ 3,267,824	$ 3,828,241	$ 4,919,259	$ 6,618,434	$23,631,810
2%									
Lower	$ -	$ 621,396	$ 1,019,687	$ 1,589,766	$ 2,055,932	$ 2,127,574	$ 2,701,477	$ 3,302,949	$13,418,781
Average	$ -	$ 838,525	$ 1,093,511	$ 1,861,270	$ 2,432,413	$ 2,582,371	$ 3,282,322	$ 4,171,031	$16,261,443
Upper	$ -	$ 1,308,972	$ 1,253,463	$ 2,583,938	$ 3,340,436	$ 3,879,288	$ 4,988,514	$ 6,788,664	$24,143,276
4%									
Lower	$ -	$ 633,580	$ 1,060,067	$ 1,642,663	$ 2,118,450	$ 2,153,024	$ 2,726,340	$ 3,309,814	$13,643,936
Average	$ -	$ 854,967	$ 1,136,814	$ 1,916,319	$ 2,488,798	$ 2,585,394	$ 3,263,927	$ 4,120,766	$16,366,985
Upper	$ -	$ 1,334,638	$ 1,303,100	$ 2,654,510	$ 3,393,953	$ 3,875,316	$ 4,938,364	$ 6,737,529	**$24,237,410**

GHG Savings Figures ($MTCO_2e$)

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	Total
0%									
Lower	-	682	3,002	4,454	6,859	7,527	8,851	9,807	41,183
Average	-	907	3,227	4,888	7,549	8,480	10,121	11,585	46,758
Upper	-	1,395	3,715	5,960	9,219	10,952	13,557	16,555	**61,353**
2%									
Lower	-	682	3,002	4,414	6,741	7,288	8,448	9,188	39,763
Average	-	907	3,227	4,835	7,389	8,156	9,572	10,738	44,824
Upper	-	1,395	3,715	5,881	8,974	10,455	12,708	15,239	58,367
4%									
Lower	-	682	3,002	4,374	6,620	7,041	8,025	8,525	38,270
Average	-	907	3,227	4,782	7,227	7,821	8,995	9,824	42,783
Upper	-	1,395	3,715	5,801	8,725	9,942	11,809	13,804	55,191

No Incentives

Investment Figures

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	Total
0%									
Lower	$ 3,832,994	$ 2,168,380	$ 2,159,587	$ 2,739,112	$ 3,024,564	$ 3,281,930	$ 3,426,720	$ 3,911,677	$24,544,965
Average	$ 3,832,994	$ 2,168,380	$ 2,230,545	$ 2,810,069	$ 3,133,642	$ 3,459,817	$ 3,653,165	$ 4,203,803	$25,492,415
Upper	$ 3,832,994	$ 2,168,380	$ 2,384,286	$ 2,963,810	$ 3,383,773	$ 3,872,834	$ 4,194,897	$ 4,927,036	$27,728,011
2%									
Lower	$ 3,832,994	$ 2,168,380	$ 1,988,295	$ 2,416,514	$ 2,539,302	$ 2,627,325	$ 2,584,034	$ 2,910,201	$21,067,045
Average	$ 3,832,994	$ 2,168,380	$ 2,060,672	$ 2,490,338	$ 2,650,063	$ 2,805,213	$ 2,804,103	$ 3,187,749	$21,999,512
Upper	$ 3,832,994	$ 2,168,380	$ 2,217,487	$ 2,650,290	$ 2,904,979	$ 3,221,409	$ 3,338,832	$ 3,892,902	$24,227,274
4%									
Lower	$ 3,832,994	$ 2,168,380	$ 1,817,003	$ 2,087,529	$ 2,033,514	$ 1,928,333	$ 1,659,906	$ 1,778,172	**$17,305,829**
Average	$ 3,832,994	$ 2,168,380	$ 1,890,798	$ 2,164,276	$ 2,145,626	$ 2,104,537	$ 1,868,453	$ 2,029,407	$18,204,472
Upper	$ 3,832,994	$ 2,168,380	$ 2,050,689	$ 2,330,562	$ 2,404,676	$ 2,520,558	$ 2,385,715	$ 2,692,351	$20,385,926

Savings Figures

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	Total
0%									
Lower	$ -	$ 224,014	$ 980,091	$ 1,265,544	$ 1,522,910	$ 1,667,700	$ 2,152,656	$ 2,416,250	**$10,229,164**
Average	$ -	$ 294,972	$1,051,049	$ 1,374,621	$ 1,700,797	$ 1,894,144	$ 2,444,783	$ 2,829,326	$11,589,691
Upper	$ -	$ 448,713	$1,204,789	$ 1,624,752	$ 2,113,813	$ 2,435,877	$ 3,168,016	$ 3,867,165	$14,863,125
2%									
Lower	$ -	$ 228,495	$1,019,687	$ 1,329,022	$ 1,607,323	$ 1,758,116	$ 2,282,711	$ 2,556,692	$10,782,046
Average	$ -	$ 300,871	$1,093,511	$ 1,439,783	$ 1,785,211	$ 1,978,186	$ 2,560,259	$ 2,950,520	$12,108,341
Upper	$ -	$ 457,687	$1,253,463	$ 1,694,699	$ 2,201,407	$ 2,512,915	$ 3,265,412	$ 3,969,932	$15,355,516
4%									
Lower	$ -	$ 232,975	$1,060,067	$ 1,393,921	$ 1,692,125	$ 1,843,218	$ 2,398,822	$ 2,662,800	$11,283,927
Average	$ -	$ 306,771	$1,136,814	$ 1,506,033	$ 1,868,329	$ 2,051,765	$ 2,650,057	$ 3,014,876	$12,534,646
Upper	$ -	$ 466,661	$1,303,100	$ 1,765,084	$ 2,284,351	$ 2,569,027	$ 3,313,001	$ 3,968,761	$15,669,984

GHG Savings Figures (MTCO2e)

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	Total
0%									
Lower	-	682	3,002	4,344	6,648	7,165	8,375	9,212	39,427
Average	-	907	3,227	4,690	7,213	7,883	9,302	10,523	43,746
Upper	-	1,395	3,715	5,484	8,524	9,603	11,598	13,817	54,135
2%									
Lower	-	682	3,002	4,302	6,527	6,925	7,976	8,607	38,022
Average	-	907	3,227	4,634	7,049	7,558	8,758	9,695	41,829
Upper	-	1,395	3,715	5,396	8,269	9,095	10,746	12,512	51,129
4%									
Lower	-	682	3,002	4,261	6,405	6,680	7,560	7,965	**36,555**
Average	-	907	3,227	4,577	6,883	7,224	8,190	8,814	39,823
Upper	-	1,395	3,715	5,308	8,012	8,573	9,853	11,115	47,972

Appendix C: Semi-structured Interview Guide for Phase 2 of Communications Analysis

Carbon Zero Staff/Faculty Interview Guide

Introduction

- Thank you so much for taking the time out of your busy schedule to meet with us. Is now still a good time? The interview should only take 30 minutes.

- We understand that reaching carbon neutrality is a very ambitious goal and presents all sorts of challenges. While we believe that carbon neutrality can bring forth many benefits for UCSB, we know that the path forward must be impactful, but more so feasible and actionable given current campus attitudes.

- We would love your feedback on where you believe carbon neutrality best fits within UCSB's priorities, and how you see the university moving carbon neutrality projects forward.

- It would be helpful if we could record the interview, but we also are able to take detailed notes instead, whichever you prefer.
  - Your name will never be associated with your responses.
    - *If recording…*
      We will transcribe the notes from the recording within the next 24 hours and erase the original recording.
  - All transcribed notes will be organized by a numbered system and hosted on a secure drive on a desktop in Bren Hall that only our research team has access to.
  - When analyzing the interviews, we will be looking for patterns.
  - The full transcript will never be used publically. We will only draw from segments of the transcripts.
  - By graduation, June 2017, the full transcript data will be destroyed.

START RECORDING

Identifying Current Knowledge (baseline)

1) **How familiar are you with the Carbon Neutrality Initiative / Climate Action Plan at UCSB?**

   We just want a snapshot of current understanding across campus, there's no right or wrong answer.

Follow-up clarification questions if necessary:

- Have you previously heard of Carbon Neutrality/Climate Action Plan from co-workers or campus communications? If so, how long ago? What did you learn from them?
- Were you aware that Chancellor Yang had signed the pledge for UCSB to reach carbon neutrality by 2025 as part of the UC-wide Carbon Neutrality Initiative prior to today?
- Did you know that UCSB is pursuing Carbon Neutrality/Climate Action Plan in addition to internal sustainability and energy initiatives?

Purpose: To identify the interviewee's current level of knowledge on the Carbon Neutrality Initiative.

Personal Involvement with CNI

---

2) **Are you involved with any projects related to the Carbon Neutrality Initiative? Please list without going into too much depth on each.**

   Projects include: sustainable energy projects, building projects, long-term planning and design projects, LEED buildings, energy efficiency, renewable energy, education initiatives, etc.

   NOTE: Won't take as much time for those with little experience; make sure to reign in those with lots of experience to keep the interview moving.

   Purpose: To understand the interviewee's current level of engagement and if their role pertains to the CNI formally (i.e. within their job description or unit's responsibilities) or informally (i.e. it is more of a personal passion project or motivated some other way) or both.

Time Spent on Carbon Neutrality Projects

---

3) **How much of your time do you estimate you spend working on** _____*(insert most applicable word based on previous answers: sustainable energy management, campus building design and planning, LEED, energy efficiency, energy procurement, etc.)***?**

   Purpose: To inform Phase 2 Questions 1 - how UCSB can facilitate sustainability initiatives. This will provide information about who the biggest drivers of the initiative are on campus to understand the current management situation. We can also find out if key players are experiencing time constraints.

General Process / How Projects are Selected

You just described a series of projects you're working on, which is really helpful. We're also trying to understand the life of a carbon neutrality project: what it takes to bring it from initial idea to new university policy and implementation. To that end…

4) **We'd like to get a sense of the role you play in each of those projects. Can you now describe in more detail how you're involved with each of these projects?**

   For instance, **do you:**
   - Do you initiate (or develop) any of these projects?
   - Do you bring these projects to new units or groups that otherwise might not have been working on them (or interested/engaged?)
   - Do you provide final approval on any of these projects?
   - Do you work on financing these projects?

   Purpose: To learn about each interviewees role in the formal or informal network, who they interact with, and how much power they have within the network to influence passage of carbon neutrality projects. This information will be used for our Phase 4 Strategy: which audiences should do what to get the biggest emission reductions at UCSB.

Formal vs. Informal Role of Individual in Decision-Making Process

We're interested in learning more about how both informal and formal networks work together in UCSB's decision-making process, and if your role varies from one to the other at all.

5) **How do sustainable energy management projects get to your desk?**

   Purpose: To gain knowledge about the processes and communication that lead to carbon neutrality projects moving through the formal or informal network (Phase 2, Research Question 2).

Formal vs. Informal Communication Networks in Decision-Making Process

6) **What other on-campus units (i.e. departments, offices, committees, etc.) do you most frequently collaborate with?**

   Follow-up for clarification if necessary:
   - How, and to what extent?
   - Does this collaboration happen for every project? (i.e. how consistent is the collaboration)

- At what stage of the project do you collaborate?
- Are you currently managing any projects?
- Do you usually initiate the collaboration or do they?
- Does the nature of your collaboration change? If so, how? (i.e. by project, by year, by staff within that unit, etc.)

Purpose: To better understand the structure of the formal and informal networks that lead to project passage (Phase 2, Research Question 2).

Literature: In an evaluation of cooperation in a major university sustainability project, Waring found that faculty non-affiliated with the sustainability project cooperated less with each other than faculty that were affiliated with the project. Also, physical scientists are often less likely to cooperate in short-term multi-disciplinary projects like sustainability projects than social scientists. This may be due to cultural differences in department environments. Characteristics that affect faculty participation include project durations, funding, and hours required to complete the project. [100]

In a social network analysis to assess communications and networking of climate change professionals in the Pacific Islands, Corlew found that most climate change professionals were shown to wear "multiple hats" and participate in a diverse array or work. This leads to less isolation among different groups within the network. She also found that the density (number of professionals) of the network does not necessarily correlate with the strength of the connections within the network.[101]

Facilitating Sustainable Energy Management through Decision-Making Criteria and Uncovering Best Practices

General Criteria

7) What are you looking for when you get these projects? Are there certain criteria with which you assess each project? Is there anything that "makes or breaks" the project for you?

Purpose: To inform Phase 2 Question 3, the best practices for passage of carbon neutrality projects for UCSB and other campuses. We want to know what are the characteristics that make certain projects more attractive than others.

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[100] Waring, Timothy M. "Cooperation across Organizational Boundaries: Experimental Evidence from a Major Sustainability Science Project." *Sustainability* 6 (2014): 1171-190. Web.

[101] Corlew, Laura Kate. "Using Social Network Analysis to Assess Communications and Develop Networking Tools among Climate Change Professionals across the Pacific Islands Region." *Psychosocial Intervention* 24 (2015): 133-46. *Elsevier*. Web.

Literature: Projects are more likely to be selected when they have co-benefits for the university but problems arise because the value of co-benefits are often subjective. Some common co-benefits include new education or research opportunities, increased prospective student interest, the ability to attract top faculty and secure funding and donor money, cost savings from projects, and the ability to comply with regulations.[102]

Projects with shorter pay-back periods are more likely to be selected. Energy efficiency projects are often subject to a double standard of needing to have very quick payback periods while other projects are not.[103]

8) Do student opinions matter in your decision-making process, and if so, how?

Purpose: We want to know how important student engagement is to senior officers and how influential student opinion is in deciding to take on carbon neutrality projects. This will help to gauge the importance of student outreach for Phase 3 Question 2 of our research plan- what is the impact of demonstrating student support on UCSB's decision-making process.

Literature: At Middlebury College in Middlebury Vermont, students took the initiative in organizing an advisory team of staff to analyze if carbon neutrality was possible in a 10-year time span and demonstrated campus support by gathering 1,200 signatures in a petition. The effort to pass the climate initiative succeeded mostly due to students showing they were willing to put in hard work.[104]

UCSB's Administrative Culture and Attitudes on Carbon Neutrality

As a reminder, your answers will remain anonymous, though the overall transcript will be released. Your name will not be attached in any way.

9) What do you think about…

- Carbon neutrality / Climate change
- UCSB's commitment to carbon neutrality
- Is it worth the "tradeoff" – the "sacrifices" to achieve carbon neutrality at UCSB

Purpose: To understand people's values so that we may engage them in a more effective manner to create change. This directly informs Research Question 1 of

[102] Kinsley, Michael, and Sally DeLeon. *Accelerating Campus Climate Initiatives*. Snowmass, CO: Rocky Mountain Institute, 2009. Print.
[103] Ibid.
[104] Ibid.

Phase 3- How do you engage audiences to make changes on campus. This question is less targeted to allow interviewees to express their opinions.

Literature: In analyzing the culture of universities in addressing sustainability challenges Hart concluded that the most important cultural factors in multi-disciplinary groups linking sustainability knowledge with action are mutual respect, flexibility, and a focus on solutions. University groups are more successful in problem solving when they are engaged with stakeholders and do not frame solutions too narrowly. A culture of systems thinking should be encouraged for the most effective problem solving.[105]

To create a campus culture of sustainability a paradigm shift in organizational thinking is necessary; yet, most universities focus on executing single individual sustainability projects or make broad commitments.[106]

The University of Michigan created The Sustainability Cultural Indicators Program to assess student, staff, and faculty attitudes toward sustainability. They dispensed two questionnaires for faculty and students where questions were divided into three categories to address sustainability knowledge, behavior, and attitudes. Staff and faculty were more likely to become engaged in sustainability by devoting resources (mostly funding) and not time, while students were more likely to engage in projects that involved time commitments and not money.[107]

10) What might you change about this?

Follow-up for clarification if necessary:
- What do you think are current challenges/barriers?
- What do you think is the best solution to these?

Purpose: To inform our recommendations for possible improvements to UCSB's Climate Action Plan/strategy for achieving carbon neutrality (Phase 4 Question 1) and to an extent, to help uncover best practices that can be shared among the UC's (Phase 2 Question 3).

Optional

11) Do you have any suggestions for other contacts we should talk to?

[105] Hart, D. D., K. P. Bell, L. A. Lindenfeld, S. Jain, T. R. Johnson, D. Ranco, and B. McGill. 2015. Strengthening the role of universities in addressing sustainability challenges: the Mitchell Center for Sustainability Solutions as an institutional experiment. *Ecology and Society* 20(2):4.
[106] Sharp, Leith. "Green Campuses: The Road from Little Victories to Systemic Transformation." *International Journal of Sustainability in Higher Education* 3.2 (2006): 128-45. Web.
[107] Callewaert, John. "Advancing a Culture of Sustainability at the University of Michigan." *Implementing Campus Greening Initiatives*. Ed. Walter Leal Filho. N.p.: Springer, 2015. 165-82. Print.

Closing

12) Is there anything else you would like to add?

13) Do you have any questions for me?

Thank you again so much for your time. Please reach out to us if you have any questions. We're happy to share our final report with you in Spring Quarter.

STOP RECORDING

Appendix D: Apriori and Emergent Codes used in NVivo for Phase 2 Analysis

AWARENESS, ENGAGEMENT

1. Level of familiarity with Carbon Neutrality Initiative (CNI) at UCSB
    a. Expert
    b. Familiar
    c. Have heard of it, but not very familiar
    d. Have not heard of it, unfamiliar
2. Level of involvement with CNI at UCSB
    a. Highly involved
    b. Somewhat involved
    c. Not involved
    d. Not very involved, wants to be more involved

DECISION-MAKING PROCESS

3. Role in UCSB administrative decision-making process (policies, proposals, projects, plans, etc.)
    a. Initiates – before formal administrative process begins
    b. Consults key groups – before formal administrative process begins
    c. Introduces to staff – start of formal administrative process
    d. Informs key groups (including communications & reporting)
    e. Manages – within formal administrative process only
    f. Gives letter of consent or feedback
    g. Approves or denies
    h. Implements (including planning, designing, construction)
    i. Maintains
    j. Oversees budget
    k. Other – Admin/Managerial

ecision-making evaluation criteria (“Make or break” question)

inancial

olitical feasibility

lignment with current goals

UC system – teaching & research

UCSB

Adherence to campus planning (LRDP)

Other needs of campus

Adherence to climate action plan (CAP)

as project been vetted

tudent opinion
Critical
Matters
Somewhat matters
Doesn't matter
Unsure
Threshold to demonstrate sufficient student support

14) Decision-making tradeoffs/opportunity costs
    a. Teaching vs operations
    b. Research vs operations
    c. Environment/sustainability vs safety (EHS, OSHA, etc.)
    d. Being sustainable vs being a sustainability-leader (extra money)
    e. Increasing HVAC efficiency vs. Thermal comfort
    f. Short-term vs long-term capital allocation
    g. Cost of green energy vs. non-green energy
    h. Providing sustainability-related opportunities to students vs impeding their academic progress
15) Project shelved/lost momentum/"died"
16) Project Timeline

CHALLENGES & BARRIERS

17) Financial
    i. High student fees
    ii. Increasing length of acceptable payback period
18) Unclear value proposition
    a. Individual (role or impact)
    b. UCSB-level CNI
        i. Complacency - others are satisfied with status quo
        ii. Best fit at UCSB
    c. UC-level
        i. UCSB's positioning relative to other UC's
        ii. UCOP directive
            1. Scope & Scale of CNI issues
            2. Goals
            3. Evaluation criteria (i.e. what constitutes successful CNI?)
                a. Carbon offsets
            4. Accountability (i.e. what will happen if UCSB doesn't reach carbon neutrality in time?)
    d. General timeline feasibility
19) Governance

a. UC
    i. UCOP and UC relationship
    ii. UC's responsibility to state and taxpayers

b. UCSB
    i. Decentralization, siloed
    ii. Consensus-based
    iii. Lack of central sustainability authority
        1. Grassroots sustainability legacy
        2. No formal Office of Sustainability
    iv. Bureaucratic, slow
    v. Conservative/Risk Averse

20) Lack of time availability
21) Lack of awareness
    a. Terminology - people don't understand what it means
    b. Insufficient information-sharing
        i. Too many existing environment/sustainability messages at UCSB
        ii. Lost in emails
        iii. Lack of follow through (i.e. energy efficiency incentive program from past GP)
        iv. Institutional knowledge
            1. Personnel turnover
                a. Students
                b. Staff
                c. Committee makeup
                d. Uncertainty of other campus chancellors
22) Lack of engagement
    a. Chancellor
    b. Senior officers
    c. Faculty
    d. Students
23) Competing priorities
24) Technology – expensive, don't have what we need yet, etc.
25) Personal Behavior Change
26) Travel & commuting
27) Lack of student pragmatism
28) Lack of staff/committee pragmatism
29) Lack of urgency
30) Lack of ownership

SOLUTIONS

31) Potential areas of alignment
    a. Laboratories

i. Energy efficiency
ii. Purchasing
iii. Chilled-water loop

b. Buildings
i. Space allocation
ii. New Buildings
1. Design & RFPs
iii. Retrofits
iv. Faculty recruitment
v. Faculty retention
vi. Zero-net energy buildings
vii. LEED buildings
viii. Maintenance
ix. Energy Efficiency
x. Adjusting temperature - Comfort
xi. Better data collection
xii. Compliance
xiii. Data Centers

c. Core Mission (Teaching and Research)
i. Sustainability general education requirement

d. Video Conferencing

e. Reputation

f. Health & Safety

32) Financial resources
a. From State
b. From UCOP
c. From students
d. From UCSB
i. UCRF
ii. TGIF – like fund for building retrofits, energy efficiency projects
e. From alumni
f. From “green” donors (i.e. Donald Bren-size gift)
g. From partnerships
i. Public – private (e.g. solar PPA)
ii. Utilities (e.g. SEP)
h. Other external source

33) Increased awareness
a. Senior decision-makers (i.e. Chancellor, CFO, EVC)
b. Staff
c. Faculty
d. Students

34) Increased engagement
a. Senior decision-makers (i.e. Chancellor, CFO, EVC)
b. Staff

c. Faculty (also recognizing faculty)
d. Students
    i. Ability to invoke change
        1. Have students join committees

35) Ownership
a. Senior decision-makers (i.e. Chancellor, CFO, EVC)
b. Staff
c. Faculty
d. Students

36) Collaboration
a. Forums/Meetings/Events
b. UC system-wide

37) Training

38) Communications
a. Changing from “carbon neutrality”
b. Better reporting

39) Behavior Change

40) Other Technologies

41) Better planning of sustainability projects

ATTITUDES

42) Goals
a. Stretch goal
b. Alignment with campus goals
    i. Education and research goals
        1. Aligns
        2. Somewhat aligns
        3. Does not align
        4. May align if further actions are taken
    ii. Sustainability and environmental leadership goals
        1. Very Important
        2. Somewhat important
        3. Unsure
        4. Not very important
        5. Not important

43) Personal
a. Strongly supports
b. Somewhat supports
c. Neutral - satisfied with status quo
d. Somewhat opposes
e. Strongly opposes

MEMORABLE QUOTE

MISCELLANEOUS

44) Distinctions between grad students and undergrads
45) Example of formal policy not communicated well
46) Example of successful alignment of CNI-related topics and other campus priority, area, project, etc.
47) Example of successful student-led project_iniative_policy_change to policy
48) Leverage our location, climate

Appendix E: Attributes (Independent Variables) for NVivo Coding

Gender
- Male
- Female

Hierarchy
- 0 - UCOP
- 1 – Chancellor, EVC, CFO, etc.
- 2 - VC's
- 3 – Deans
- 4 – Associate VC's
- 5 – Chairs/Co-chairs of Committees
- 6 – Executive Director's
- 7 - Faculty
- 8 – Junior Staff

Level of Institutional Knowledge
- High
- Low
  - Justification: Expert knowledge from interviewer, anecdotal evidence from interviewee, and determination based on level of inter-departmental interaction

Familiarity with CNI
- Expert
- Familiar
- Have heard of it, but not very familiar
- Have not heard of it, unfamiliar

Level of involvement with CNI at UCSB
- Highly involved
- Somewhat involved
- Not involved
- Not very involved, wants to be more involved

Technical vs. Administrative
- Technical
- Administrative
  - Justification: Combination of hierarchy, department and job title.

Influence on Decisions

- High
- Low
    - Justification: Based on expert knowledge of interviewer and NVivo code approves or denies, manages, gives a letter of consent or feedback, or initiates.

Direct Line of Chancellor Yang (Formal and Informal)

- Yes
- No
    - Justification: Anecdotal evidence from interviews. Also if they are noted as Hierarchy: 0,1,2,3 and 5.

Connectedness

- High
- Low
    - Justification: Based on the number of times a person was mentioned within interviews. Also used the expert knowledge of the interviewer.

Willingness to Participate/Volunteer for sustainability/environment, etc.

- Yes
- Maybe – further action needed
- No
    - Justification: Personal question from interview in the Attitudes section Interviewees often would mention anecdotal evidence.

Appendix F: Focus Group Instrument

I. Graduate Students – Labs, faculty engagement, recruitment

Hypothesis: Graduate students may be the gateway to affecting change in laboratories as they spend the most time in their labs, have a clearer connection to lab managers, and a more collaborative relationship with their faculty versus UCSB Sustainability and Facilities (i.e. top down).

Awareness/Attitudes

- How familiar are you with the Carbon Neutrality Initiative?
- How would you describe the general attitude of your lab towards sustainability?

Barriers/Challenges

- What are do you think are some of the barriers to furthering sustainability in your labs?
    - *If they don't bring up any of the following, suggest:*
        - Time constrains/competing priorities
        - Funding
        - Safety
        - Fear of interrupting research (e.g. strangers in labs)

Information

- How would you characterize your relationship with the lab managers and/or faculty advisors with regards to lab operations and equipment purchasing?
    - How is lab management structured?

Potential Solutions

- What sustainability issues do you think could be applied for your lab, such as any low-hanging fruits?
    - How would you feel about widening the ambient temperature range in labs?

Likeliness to Engage

- Have you participated in any advocacy on campus? How do you get communication about advocacy issues or sustainability?
    - Would you be interested in something?

Time Permitting

- Did the UC-system and/or UCSB's sustainability reputation have any influence on your decision to attend UCSB?
    - What are some of the biggest factors that influenced your recruitment?

II. Undergraduates – Environmentally Engaged Students

Hypothesis: Through our informational-interviews, students have influence on decisions made on campus. Targeted environmental campaigns initiated by students can have a big impact on whether a project goes through. We want to test what are some of the biggest barriers towards starting a student-led initiative is and what topics they may be most interested in.

Awareness/Attitudes

- How familiar are you with the Carbon Neutrality Initiative?
- How would you describe the general attitude of the campus towards the carbon neutrality initiative?

Barriers/Challenges

- What are the biggest barriers towards starting a carbon neutrality-related petition, proposal, campaign etc. on campus?
    - What are potential solutions to those barriers?

Likeliness to Engage

- What types of forums, petitions, events would you most likely attend or participate in?
    - Would you be interested in sitting on a UCSB committee?
- Are there any climate-related areas and/or potential projects on campus you are really excited about?
    - *Suggest the following if needed*
        - Onsite solar
        - Climate justice
        - Energy efficiency
            - Labs
        - Finance
        - Green buildings/LEED

Generating Support

- How can you garner more support for carbon neutrality on campus?
- What are you looking for when you are finding a new campaign within your student group?
    - How do you choose which topics to pursue?

- Would an informational toolkit be helpful to sparking more on-campus student engagement and action around the Carbon Neutrality Initiative?

Time Permitting

- Did the UC-system and/or UCSB's sustainability reputation have any influence on your decision to attend UCSB?
    - What are some of the biggest factors that influenced your recruitment?

III. Undergraduates – Focus in Social & Cultural Advocacy

Hypothesis: Students can make a difference on campus. We want to test to see if involved students on campus, whether in social, cultural, or other groups would be interested in supporting an initiative regarding the environment.

Awareness/Attitudes

- How familiar are you with the Carbon Neutrality Initiative?

- How would you describe the general attitude of the campus towards environmental sustainability?

- What do you think environmental sustainability's role is on campus?

Barriers/Challenges

- What do you see as the challenges/barriers for sustainability?

- How do you have a more inclusive path towards sustainability on campus?
    - What will be the impact on campus, if any?

Synergies

- Do you see any alignment between environmental advocacy and the organizations you are a part of?
    - What about climate justice? Environmental justice? Equity-issue?

- What are you looking for when you are finding a new campaign within your student group?

- Do you ever collaborate with other groups? If so, how?
    - Examples: E-coalition, climate coalition, other social/cultural groups

Time Permitting

- Did the UC-system and/or UCSB's sustainability reputation have any influence on your decision to attend UCSB?
    - What are some of the biggest factors that influenced your recruitment?

Appendix G: Student Survey Sample and Student Survey Research Questions

GENERAL QUESTIONS

1. What is your education level?
    - Undergraduate
        - freshman
        - sophomore
        - junior
        - senior
    - Graduate
        - Masters
        - PhD

2. Please select your primary academic department?
    -all academic majors

3. Are you currently involved with any student organizations on campus?
    - Yes
    - No
    - Unsure

3a. [skip logic] If yes, are you involved with any student organizations that are related to sustainability?
    - Yes
    - No

3b. [skip logic] If yes to 3, Please list the campus groups you are involved with.

CARBON NEUTRALITY & ENVIRONMENT

4. Please rate your level of agreement with the following statement: I am familiar with the Carbon Neutrality Initiative.
    - Highly disagree
    - somewhat disagree
    - unsure
    - somewhat agree
    - highly agree

[skip the following questions if the respondent selects “haven’t heard of it”]

If you are familiar with the Carbon Neutrality Initiative how did you hear about it?

- emails
- flyers and signs hung around campus
- course material
- in-class announcements
- social media
- hearing about it from friends
- seminars
- events
- other:

Provide information about the CNI after this question to help inform the next questions.

5. What aspects of carbon neutrality are most important to you? (Please select all that apply)

- solar power and renewable energy
- personal actions you can take to reduce emissions (like turning off lights etc.)
- energy efficient technologies
- green buildings (LEED)
- social/environmental justice issues
- pride in being part of a university with a sustainable reputation
- financial strategies to fund carbon neutrality projects
- policies to promote carbon neutrality
- environmentally-friendly transportation
- UCSB divesting from fossil fuel companies
- reducing emissions from purchased goods and supplies (including equipment, lab supplies, text books, food, etc.)
- other:

Please rank the following University of California initiatives in order of their importance to you:

- Carbon Neutrality
- Sustainable Food
- Green Building
- Zero Waste
- Water Conservation
- Environmentally-friendly transportation

STUDENT ENGAGEMENT / STUDENT ACTION

7. When it comes to showing your support for a cause, what actions are you most likely to take? (Please select all that apply)

- attending a demonstration or march
- attending an informational or informal event
- signing a petition or other document to show your support
- working on a specific project (for a class, internship, or volunteer) to further the CNI
- joining a student organization working on the cause
- serving as a student representative on a UCSB committee to represent the cause
- taking a class focusing on the subject
- other:

8. Which of these incentives do you think would be effective in inspiring you to take action to further UCSB's carbon reduction goals? (pick all that apply)

- learning new skills and/or gaining things to put on your resume
- competitive contests between other universities/dorms/departments on campus
- Fun events/prizes/ free food
- Seeing numbers to measure the campuses progress
- student fellowships, paid internship, or other financial incentive
- getting class credit (project, independent research)
- getting extra credit (attend an event etc.)
- receiving recognition from the university for your efforts (student of the month etc.)
- other:

6. What forms of communication are effective in getting you to pay attention to environmental causes on campus? (Pick all that apply)

- emails
- flyers and signs hung around campus
- course material
- in-class announcements
- social media
- hearing about it from friends
- people canvassing and tabling on campus
- on-campus demonstrations
- seminars
- events
- other:

CONCLUDING QUESTIONS

9. Please rate your level of agreement with the following statement: I am likely to take some form of action to show my support for the Carbon Neutrality Initiative. (Pick one)

- highly disagree
- somewhat disagree
- unsure
- somewhat agree
- highly agree

11. Do you think that UCSB's achievements and positive reputation in sustainability add value to your experience as a student?

- Yes
- No
- Not sure

Research Questions

1. Is level of CNI familiarity affected by education level or area of study?

Purpose: To understand how current communications about the CNI have reached certain groups. Is knowledge about the CNI mostly focused in a small subset of the UCSB population or is information being uniformly spread? This will help us to establish a baseline of knowledge on campus as well as consider which groups to target in our communication strategy.

2. Are students more likely to take action to further the CNI based on education level or area of study?

Purpose: We can design our communication strategy to target certain groups of students who are more likely to take action for the CNI.

3. How does involvement with student organizations affect likeliness to take action to further the CNI?

Purpose: To identify if students involved in groups will be more likely to take action, especially students involved with non-sustainability related organizations who we hypothesize could be an audience receptive to the CNI. Since student groups are already organized, they can be effective in leveraging support for the CNI, and our communication strategy can help inform them.

4. Are students more interested in topics of the CNI that are covered under scope 3 rather than in scopes 1 and 2?

Purpose: To explore the disconnect between student's interest and the parts of the CNI that are currently being tackled (scope 1 and 2). We hypothesize from our focus groups that students are more interested in topics that fall under scope 3 of the CNI (carbon-friendly transportation, divesting from fossil fuels, reducing emissions from purchased goods).

5. For graduates v. undergraduates (or by individual year of education level) we can answer the following questions. Are there significant differences in these preferences based on education level?
-what are the most effective forms of communication?
-what aspects of the CNI are most exciting to them?
-what actions are they most likely to take?
-what incentives work best for them?

Purpose: To understand the motivations and likely actions of individual audiences to target them with our communication strategy. We hypothesize that education level will influence motivations and graduates v. undergraduates will need different incentives to become involved with the CNI.

6. We can answer the following questions based on area of study. Are there significant differences in these preferences based on area of study?
-what are the most effective forms of communication?
-what aspects of the CNI are most exciting to them?
-what actions are they most likely to take?
-what incentives work best for them?

Purpose: To understand the motivations and likely actions of individual audiences to target them with our communication strategy. We hypothesize that area of study will influence motivations and students studying environmental studies will need different incentives to become involved with the CNI than other students.

7. Do students feel like UCSB's sustainability achievements add value to their experience?

Purpose: To determine if we can use the CNI as a value proposition for upper administration who are concerned with enriching the overall experience of students at UCSB.

9. Does familiarity with the CNI affect how students rank it compared to other UC initiatives?

Purpose: To understand if students who are familiar with the CNI still do not think it is a main priority compared with other campus initiatives.

Appendix H: Additional Analyses of Phase 2 Interview Codes

Buildings as a Potential Area of Alignment

One of the emergent codes discovered through our interviews, buildings, is a potential low-hanging fruit that aligns many aspects of campus in varying ways. Buildings were mentioned as a solution 93 times across 18 of the 23 interviews. In order to dive into the nuances of this emergent code, we detailed the specific solutions that are mentioned in relation to buildings, shown in the Figure below. Respondents spoke of energy efficiency, new buildings, and retrofits as areas where the campus can move closer to the goal of carbon neutrality. Buildings are a potential area of alignment as they relate to all of the large stakeholders on campus: students, administrators, and faculty, as well as aligning with the core mission of teaching and research. Buildings also represent an opportunity to capture energy savings through technology implementation, a topic researched in depth by our group project predecessors, CarbNewt.

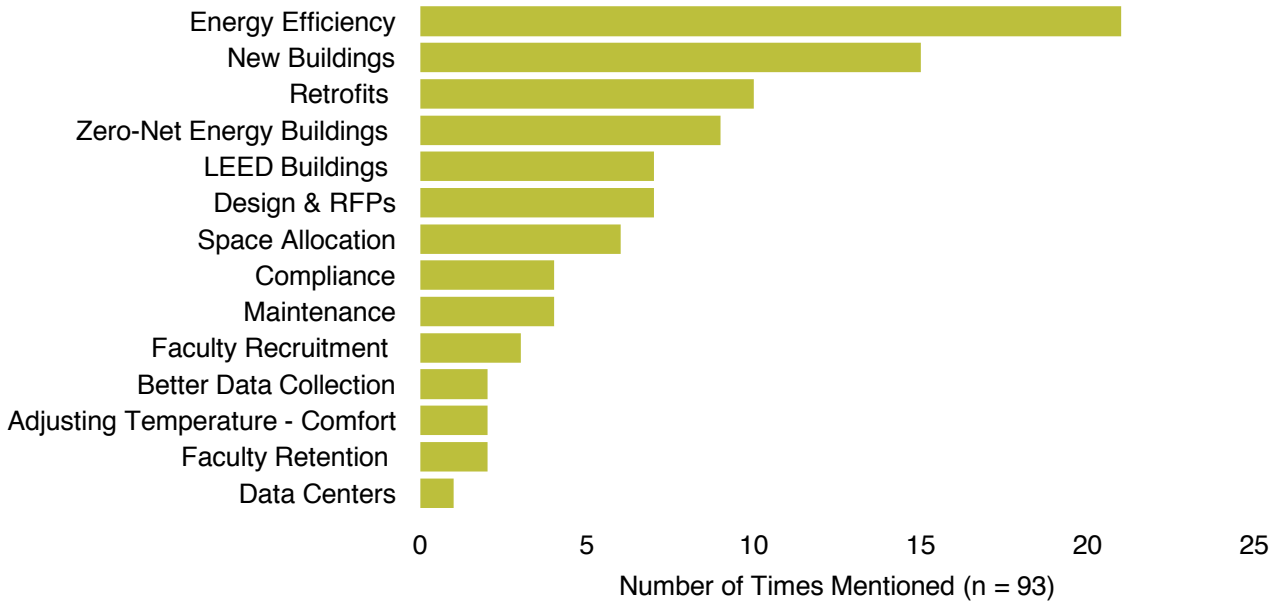

Figure 37: Specific Building Solutions Mentioned During Phase 2 Semi-Structured Interviews. Buildings were noted as a potential area of alignment towards completing the CNI at UCSB. Buildings have been mentioned during 18 of the 23 interviews conducted.

Level of Institutional Knowledge

One independent variable we utilized to characterize interviewees is their level of institutional knowledge. This was determined by anecdotal evidence during the interview, the expert knowledge of the interviewer, and the amount of inter-departmental interaction that the subject has based on their position. Fourteen of our interview subjects are characterized as having high level of institutional knowledge and 11 as low in comparison. We identify the top 10 most common codes from NVivo based on this variable which can be seen in Table 21. Similar themes are seen at both a high and low levels of institutional knowledge. The theme of having the core mission of the university act as a lever came up with interview subjects with a high level of knowledge, but did not come up as frequently with subjects with a lower knowledge. Individuals with a high level of knowledge also saw a lack of awareness and an unclear UCOP directive as challenges. Individuals with a comparably lower level of institutional knowledge spoke more commonly to how decisions are made on specific projects and how important funding and alignment with current goals are when deciding on a project. They also spoke to UCSB governance as a challenge for CNI implementation. Finally, those with a high level of institutional knowledge also perceived student engagement as a potential solution, while those with a lower level of institutional knowledge note that just general engagement is important.

Table 21: Ten Most Common Codes Based on Level of Institutional Knowledge. Level of institutional knowledge is based on anecdotal evidence from interviews, expert knowledge of the interviewers, and the level of inter-departmental interaction of interviewees based on their position. The number in parentheses is the number of times the code is mentioned over the 23 interviews with 25 individuals.

High	Low
Solutions Buildings (65)	**Challenges** Financial (33)
Challenges Unclear Value Proposition (50)	**Challenges** Unclear Value Proposition (33)
Solutions Financial Resources (42)	**Solutions** Buildings (33)
Challenges Financial (41)	**Challenges** UCSB Governance (28)
Challenges UCSB Governance (35)	**Challenges** Competing Priorities (20)
Challenges Competing Priorities (31)	**Decision-Making Evaluation Criteria** Alignment with Current Goals (18)

Solutions
Increased Engagement (Students) (30)

Solutions
Align Core Mission (Teaching & Research) (26)

Challenges
Lack of Awareness (24)

Challenges
UCOP Directive (22)

* 14 interviewees

Solutions
Increased Engagement (General) (17)

Decision-Making Evaluation Criteria
Financial (15)

Solutions
Financial Resources (14)

Solutions
Other Technologies (11)

* 11 interviewees

Appendix I: Student Audience Engagement Tool

Student audiences are separated by graduate level (undergraduate v. graduate) as well as discipline. For each audience the topics of interest, preferred methods of communication, incentives, and preferred routes of action are listed in order by number of votes. This tool is made with survey data of the entire UCSB student body (n=852).

By Graduate Level		
	Undergraduate	**Graduate**
Topics of Interest	Solar power and renewable energy Energy efficient technologies Green buildings Environmentally-friendly transportation Reducing emissions from purchased goods	Solar power and renewable energy Energy efficient technologies Environmentally-friendly transportation
Preffered Methods of Communication	Social media Emails Hearing about it from friends In-class announcements Course material Flyers Demonstrations Events	Emails Hearing about it from friends Social media
Incentives	Learn new skills and things to put on resume See real numbers to measure progress Fellowship or paid internship Class credit Extra credit Fun events, prizes, free food	See real numbers to measure progress Fellowship or paid internship Learn new skills and things to put on resume
Preffered Routes of Action	Sign a petition or other document Take a class focusing on the subject Attend an informational or informal event Work on a project (class, internship, or volunteer) Join a student organization	Sign a petition or other document Attend an informatinal or informal event Work on a project (class, internship, or volunteer) Attend a demonstration or march

By Discipline		
	Engineering, Math & Computer Science	**Environmental Studies**
Topics of Interest	Solar power and renewable energy Energy efficient technologies Green buildings Environmentally-friendly transportation	Solar power and renewable energy Energy efficient technologies Divestment from fossil fuel companies Social & environmental justice Environmentally-friendly transportation Reducing emissions from purchased goods Policies to promote carbon neutrality
Preffered Methods of Communication	Hearing about it from friends Emails Socil Media Flyers	Social media Course material Hearing about it from friends In-class announcements Emails Demonstrations Events
Incentives	See real numbers to measure progress Learn new skills and things to put on resume Fellowships and paid internships Fun events, prizes, free food	Fellowships and paid internships Learn new skills to put on resume See real numbers to measure progress Class credit Extra credit Fun events, prizes, free food
Preffered Routes of Action	Sign a petition or other document Attend an informational or informal event Work on a project (class, internship, volunteer)	Sign a petition or other document Work on a project (class, internship, volunteer) Take a class focusing on the subject Attend an informational or informal event Join a student organization Attend a demonstration or march

By Discipline Continued		
	Humanities & Arts	**Natural Science**
Topics of Interest	Solar power and renewable energy Environmentally-friendly transportation Divestment from fossil fuel companies Energy efficient technologies	Solar power and renewable energy Energy efficient technologies Divestment from fossil fuel companies
Preffered Methods of Communication	Emails Social media In-class announcements Hearing about it from friends Flyers Events	Emails Hearing about it from friends Flyers In-class announcements Events
Incentives	See real numbers to measure progress Learn new skills to put on resume Fellowships and paid internships Fun events, prizes, free food Extra credit Class credit	See real numbers to measure progress Fellowships and paid internships Learn new skills to put on resume Class credit Fun events, prizes, free food Extra credit
Preffered Routes of Action	Sign a petition or other document Attend an informational or informal event Take a class focusing on the subject Work on a project (class, internship, volunteer)	Sign a petition or other document Take a class focusing on the subject Work on a project (class, internship, volunteer) Attend an informational or informal event

Discipline Continued	Social Science
Topics of Interest	Solar power and renewable energy Energy efficient technologies Divestment from fossil fuel companies Green buildings Environmentally-friendly transportation Social & environmental justice Personal actions to reduce emissions
Preffered Methods of Communication	Emails In-class announcements Hearing about it from friends Events Emails Course material
Incentives	See real numbers to measure progress Learn new skills and things to put on resume Extra credit Fellowships and paid internships fun events, prizes, free food Class credit
Preffered Routes of Action	Sign a petition or other document Attend an informational or informal event Take a class focusing on the subject Attend a demonstration or march Work on a project (class, internship, volunteer) Join a student organization

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