Curbing Climate Change and Driving Energy Efficiency at UCSB

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

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the INSTITUTE for ENERGY EFFICIENCY

BREN SCHOOL • UCSB

UNIVERSITY OF CALIFORNIA

Carbon Neutrality Initiative

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Executive Summary

In 2013, the University of California (UC) President Janet Napolitano introduced the Carbon Neutrality Initiative, a commitment to make all UC campuses carbon neutral with respect to scope 1 and 2 greenhouse gas emissions by the year 2025. Eliminating emission from scope 1 (on-site direct emissions) and scope 2 (indirect greenhouse gas emissions from consumption of purchased electricity/heat/steam) by the year 2025 will require significant planning efforts at each UC campus. UC Santa Barbara (UCSB) needs implementable greenhouse gas emissions reduction strategies in the short term to meet this ambitious goal. CarbNewt, a 2015 group project from the Bren School of Environmental Science & Management, successfully identified demand-side energy saving technologies, opportunities to reduce energy supply carbon intensity, as well as implementation strategies to help the UCSB campus meet its 2025 goal of carbon neutrality.

Our Bren Group Project is a 2016 continuation of CarbNewt, which will build upon the foundational work developed by its predecessors. Appointed by Dr. David Auston of the UCSB Institute for Energy Efficiency, this group project (referred to as Carbon Zero) aims to evaluate additional emission reductions options at UCSB, explore financial options for capital-intensive energy saving projects on campus, and develop an engagement strategy to generate more momentum and support for carbon neutrality efforts among the UCSB administration and student body. Additionally, we aim to provide recommendations to our client in regards to how to integrate the Carbon Neutrality Initiative into campus-wide decision making processes.

The goal of this project is to produce a report for the UCSB Institute for Energy Efficiency that includes actionable and implementable recommendations that can be utilized in the short term for planning efforts and core decision-making processes by parties on the UCSB campus responsible for moving carbon neutrality efforts forward. UCSB is well positioned among all UC campuses to meet the 2025 goal of net zero scope 1 and scope 2 emissions. With the development of a comprehensive strategy to achieve carbon neutrality by 2025, UCSB can attract top faculty, students, and funding by bolstering its reputation as a global leader in sustainability, as well as improve the university's ability to address further climate change mitigation efforts in the future.

Objectives

While the previous CarbNewt team addressed many of the "what" questions by informing what projects should be completed to achieve carbon neutrality at UCSB by 2025, Carbon Zero will strive to continue their work but also address the "how" questions, or how these projects can be successfully implemented given UCSB's constraints. Carbon Zero aims to inform UCSB leadership of the value of infusing sustainability criteria into the core decision-making process and steps to do so, using technological, financial, and communication strategies.

I. Technological Objectives

Building on the work of the previous CarbNewt team, we will assess efficacy of various technologies that UCSB can implement to reduce energy demand and generate renewable energy supply. Our analysis will include site recommendations for on-campus solar installment as well as comparing different scenarios for energy storage and hot water loop projects. Assessment will include how to incentivize the deployment of these projects given UCSB's constraints and evolution of projected costs.

II. Financial Objectives

We will develop and evaluate financial strategies to address the challenge of attaining upfront capital for carbon neutrality projects amidst competition for university funding. This may include estimating costs and developing financial models to account for up-front capital investments and costs of borrowing as well as considering creative financial strategies and partnerships. A crucial step will be to improve the Utility Conservation Revolving Fund analysis completed by the preceding project team, in light of new information. Additional considerations include the feasibility of implementing a student-based fee to fund carbon neutrality projects on campus.

III. Engagement and Strategic Communication Objectives

Our aim is to identify the key stakeholders at UCSB whose approval is required for the implementation of carbon neutrality projects, and develop communications strategies and content geared towards the specific audiences. Carbon Zero will facilitate coalition-building around carbon neutrality at UCSB to further engagement and support. Simultaneously, Carbon Zero will identify the best strategy for carbon neutrality engagement and generate communications content. We will accomplish this by conducting a social network analysis, message testing, and content workshops with key stakeholders. Furthermore, Carbon Zero will provide the value proposition and recommendations for incorporating carbon neutrality into the formal decision-making criteria at UCSB for long-term planning and capital allocations. This recommendation will include technological, financial, and communication elements, encapsulating Carbon Zero's findings.

Project Significance

The client for this project is the UCSB Institute for Energy Efficiency, with Dr. David Auston as the primary point of contact. The Institute for Energy Efficiency will utilize the results of the project to inform decisions regarding UCSB's optimal pathway towards achieving carbon neutrality by 2025. The project deliverables will aim to inform and motivate carbon neutrality efforts on the UCSB campus, and will target students, staff, faculty, and administration as an intended audience. The project results will particularly focus on strategies to increase the prioritization of the Carbon Neutrality Initiative by integrating it more concretely into the core decision making processes of UCSB administration.

With the passage of the Global Warming Solutions Act of 2006 (AB 32), the state of California has committed to significant greenhouse gas emission reductions by 2020 in order to reduce the state's contribution to anthropogenic climate change. UC President Janet Napolitano announced the Carbon Neutrality Initiative in November 2013, affirming the UCs commitment to meeting and exceeding AB 32 emissions reductions goals. The UC Carbon Neutrality Initiative commits the UC system to emitting net-zero greenhouse gases from its buildings and vehicle fleet by 2025.

In order to achieve carbon neutrality at UCSB by 2025, comprehensive planning and implementation strategies will be needed in the short-term. However, UCSB faces many challenges to obtaining carbon neutrality including limited funding, a growing student body, and competition for prioritization. UCSB has already undergone extensive efforts to develop a more sustainable campus, and has been successful in cutting emissions, especially with regards to design and operation of green buildings. However, substantial efforts related to reducing emissions from energy generation, implementing new energy-saving technologies, and purchasing carbon offsets will be needed in order to meet zero net emissions. Funding of necessary projects will require innovative financial strategies.

Achieving carbon neutrality at UCSB offers the institution a unique opportunity to become a global leader in combatting climate change in higher education. In doing so, UCSB can continue to attract top faculty and staff and avoid the risk of falling behind other universities who are intensifying their carbon neutrality efforts. It also provides UCSB the potential to significantly reduce energy costs in the long-term.

This group project, Carbon Zero, aims to provide usable and relevant analysis detailing energy generation options, potential use of new technologies, costs of investments, and policy implications in order to inform decisions on the UCSB campus regarding pathways towards achieving carbon neutrality by 2025.

Literature Review

UCSB

I. University of California, Santa Barbara 2014 Climate Action Plan[1]

Summary:
The goals of the 2014 Climate Action Plan (CAP), are to develop a strategy to meet The Global Warming Solutions Act (AB32), enhance research, promote community service, operate facilities more efficiently, and meet University of California Office of the President (UCOP) emissions targets. Previous targets (2000 levels by 2014) have been met primarily via Statewide Energy Partnership (SEP) projects, The Green Initiative Fund (TGIF), Photovoltaic (PV) solar installation, and other projects. According to the CAP, meeting the 2020 target of 1990 level emissions will require a further investment in SEP projects, conservation initiatives, commuter reductions, and virtual travel. Meeting 2025 targets of carbon neutrality will inevitably involve the purchase of offsets and green energy (estimated at a cost of $7 million per year). However, some options for minimizing future purchases include implementation of Economic Incentive Programs (EIP's), increased funding, and strategic building/ landscaping. Currently, student funding for sustainability projects come from The Green Initiative Fund (TGIF) and the Student Services Renewable Energy Initiative (SSREI).

Analysis:
While the 2014 CAP outlines a fairly concrete strategy for achieving 2020 goals, the plan for reducing scope 1 and 2 emissions to zero by 2025 remains fluid. Somewhat problematic is the 1% projected growth rate (25,000 students by 2025) used in the 2010 Long-Range Development Plan (LRDP) and 2014 CAP, given UCOP's new mandates on increased student enrollment. It is within UCSB's best financial interests to maximize the efficiency of its sustainability initiatives and campus projects. By doing so, it avoids offset/green energy purchases while realizing greater utility savings in the future. EIP's and Utility Conservation Revolving Funds (UCRF's) are especially attractive methods for encouraging and funding such projects.

II. The University of California Annual Report on Sustainable Practices[2]

Summary:
The University of California (UC) has exceeded its 2014 goal of 10 MW of onsite solar generation. At UCSB, 625 kW are installed and 4,856 kW are planned for future implementation. UC-wide deep energy retrofits will require $560 million and save an estimated $59 million per year in utilities. Transportation is the second largest source of GHG emissions and 60% of UCSB employees commute in single occupancy vehicles. UC has reached state mandated water controls and its 20% sustainable foods goal. It has developed new LEED-based certification requirements for new buildings. UCSB has been recognized in the past for "optimizing waste management through stakeholder engagement," its

[1] University of California, Santa Barbara (UCSB) Office of Sustainability (2014) "Climate Action Plan 2014." Web. 16 May 2016.
[2] University of California (2015) "Annual Report on Sustainable Practices." Web. 16 May 2016.

Academic Senate's Sustainability Working Group, and reducing electricity consumption through student engagement. There exists a California Student Sustainability Coalition which is a UC-wide coalition of 235 sustainability groups. UCSB in particular has 40 different sustainability groups.

Analysis:
The UC system recognizes programs that creatively incentivize students, faculty, and staff to make sustainability changes. While UCSB has received recognition in the past, we are falling behind schools like UC Berkeley, Merced, and Riverside in a number of sustainability metrics. Reaching UCs 2025 goals will require a high degree of investment for Deep Energy retrofits. In addition, there is a need for further coordination at the campus level.

III. University of California, Santa Barbara Annual Utility and Energy Report: FY 2014/2015[3]

Summary:
UCSB spent a total of $11.4 million on utilities through the main utilities budget during FY15. An additional small percentage of utilities are paid for through a separate channel. Expenditure consisted of 77% on electricity, 11% on natural gas, 10% on potable water, and 2% on reclaimed water. UCSB has a bundled service, time-of-use (TOU) rate, electrical account with Southern California Edison (SCE). Electricity rates increased from FY14 to FY15 and are expected to increase at a rate of 3-4% between 2014 and 2020, making energy efficiency measures extremely important for the University. In 2015, UCSB became a covered entity under California's AB 32 Cap and Trade Program and received allowances based on past emissions.

Analysis:
It is vital that UCSB continues to implement energy efficiency measures and increase its use of renewable energy in the face of legislation and increasing utility rates. Ensuring a positive relationship with Southern California Edison is also paramount to mitigate supply constraints during peak demand and negotiating favorable utility rates into the future.

Technology

IV. Purdue University Solar Endowment Campus PV Roadmap[4]

Summary:
Purdue University lays out a strategy for how to implement a solar PV project on its campus. The paper describes a hierarchy of how decision making is structured in the university including the key concerns and key responsibilities of main decision makers. The benefits and challenges of different sites (rooftop, parking area, or open land) are discussed including analysis of electrical infrastructure as well as current electrical rates and usage. Other unforeseen costs and risks of establishing the project include

[3] University of California, Santa Barbara (UCSB). "Utility & Energy Services (2015) UC Santa Barbara Annual Utility and Energy Report Fiscal Year 2014/2015." Web. 15 May 2016.
[4] Hutzel, William. *Purdue University Solar Endowment Campus PV Roadmap*. Rep. Lafayette: Purdue U, n.d. Print.

installation fees, permits, and zoning restrictions. Furthermore, this case study describes different federal policies and incentives to help finance the project.

Analysis:
This case-study will be a great reference for designing our decision making hierarchy for all groups involved with carbon neutrality at UCSB. Also, the benefits and concerns of solar site selection will be useful for our solar PV rooftop analysis. Although Purdue University is located in Indiana, most public university systems are struggling with the same types of problems for implementing solar PV projects, and so much of the information presented in this study is transferrable to UCSB.

V. UC Solar Project Development Program Initial Project Checklist- Building Mounted PV Arrays[5]

Summary:
This worksheet offers a checklist of considerations that should be assessed to determine the feasibility of installing a solar PV array on a UC rooftop. Important factors that determine the overall condition of the roof include its age, size, and maintenance history. Ease of access to the solar array for contractors to build and perform maintenance is another important consideration to make before solar panels can be installed. This worksheet also outlines electrical connection issues as well as planning concerns such as maintaining nearby vegetation and coherence with the university's LRDP.

Analysis:
This worksheet could be very helpful for our solar PV roof space analysis. It addresses the main concerns of the UC campus when determining best site selection for solar projects. We can use this worksheet to inform a ranking system to offer our recommendations for the best solar PV installation sites on campus.

VI. Advancing and Maximizing the Value of Energy Storage Technology: A California Roadmap[6]

Summary:
This report is the result of a collaboration among three key interests of California's utility infrastructure and policy – the California Independent System Operator (CAISO), the California Public Utilities Commission (CPUC), and the California Energy Commission. It directs a plan for California to reach its 2020 energy storage goal of 1.3 MW under Assembly Bill 2514 (A.B. 2514). The plan includes a comprehensive prioritized list of procedural actions for the major stakeholders: CAISO, CPUC, the Energy Commission, and Investor Owner Utilities (IOUs) such as SCE.

Analysis:
While the roadmap, published in 2014, does not go into specifics regarding the storage goals/targets and costs, it provides significant insight into the future of energy storage in California. Energy storage does

[5] Munn, Maric. "UC Solar Project Development Initial Project Checklist- Building Mounted PV Arrays." *UCSB Sustainability*. N.p., n.d. Web. 15 May 2016.
[6] California Independent System Operator (CAISO), California Public Utilities Commission (CPUC), California Energy Commission, et al. "Advancing and Maximizing the Value of Energy Storage Solutions: A California Roadmap." *CAISO* (2014). Web. 8 June 2016.

not always include batteries, as thermal and chemical storages are also possible. However, given the predicted reduction in battery cost over time, batteries will likely play the largest role in meeting statewide targets.

VII. International Renewable Energy Agency (IRENA) 2015 Battery Storage Report[7]

Summary:
Due to advances in PV, solar, and wind, demand for battery storage has risen dramatically in recent years. As sustainable energy markets grow, it will become necessary to integrate battery storage into grid systems both behind and in front of production processes. With these realities in mind, battery storage either has become or is becoming cost effective. Choosing a battery system can be complicated. Batteries have many different characteristics and potential applications: grid stabilization, short-term, or long-term storage. The United States and Japan are the primary leaders in the battery market, with California mentioned as the most ambitious state in the US.

Analysis:
Based on these factors, battery storage is becoming an increasingly attractive market. California has required utilities to procure 1.3 GW of primarily battery storage, and Southern California Edison procured 235 MW of battery storage in 2014. As a result, there may be an opportunity for UCSB to capitalize on the current environment. The report mentions that California subsidizes battery installations around $1.6/Watt, and that third party leasing can provide battery storage at no cost.

VIII. Assigned Commissioner's Ruling Proposing Storage Procurement Targets and Mechanisms and Noticing All-Party Meeting (R.10-12-007)[8]

Summary:
According to the *Rulemaking 10-12-007*, filed in 2010 under the California Public Utilities Commission (CPUC) and updated in 2013, Southern California Edison (SCE's) target's for battery storage procurements ramp up by 33% every two years. The targets start in 2014 with a goal of 90 MW, and total 580 MW by 2020. Battery procurement is further categorized into 3 different sections: Transmission (~50%), Distribution (~30%), and Customer (~10%). The Commissioner's order also includes an examination of the state of the energy storage market. The next energy storage auction is planned for June 30, 2016.

Analysis:
It is especially important that Carbon Zero is cognizant of SCE's targets, as Santa Barbara is attractively located within grid structure for energy storage (via Jordan Sager). A no-cost energy storage partnership with SCE could be mutually beneficial, and attribute significantly to achieving UCSB's emissions targets.

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[7] International Renewable Energy Agency (2015) "Battery Storage for Renewables: Market Status and Technology Outlook." Web. 16 May 2016

[8] Peterman, Carla J. "Assigned Commissioner's Ruling Proposing Storage Procurement Targets and Mechanisms and Noticing All-Party Meeting." *California Public Utility Commission (CPUC)* (2013): R.10-17-007. Web. 8 June 2016.

IX. UCSB Programming Report: Final Campus Hot Water Loop Program[9]

Summary:
By providing a detailed description of the installation of a centralized hot water loop at UCSB, this report provides important information about energy calculations, estimated emission reductions, and construction costs of installing such a project. Technical background of hot water loops and engineering considerations for affected buildings is also provided.

Analysis:
Although this 2011 project for a centralized hot water loop was never completed on campus, a new project of an individual decentralized system is currently being proposed. This paper can provide useful information about the buildings in need of a new hot water system and how we might start to think about calculating the energy and cost savings for a similar project.

X. UC/CSU/IOU Energy Efficiency Partnership[10]

Summary:
The UC, California State University (CSU), SCE and other IOUs Energy Efficiency Partnership was implemented in 2004 to establish a permanent framework for sustainable, comprehensive energy management programs. The program strives to accomplish energy savings, reduce peak demand, and meet all of the objectives of the California Public Utilities Commission (CPUC). The partnership has three main elements which include Retrofit, Monitoring-Based Commissioning (MBCx), and Training and Education (T&E).

Analysis:
The partnership is designed to save energy use and cost that is meaningful both to the UC, CSUs and the IOUs. As all UCs are striving to become carbon neutral by 2025, the financial incentives provided by this program are vital. With the potential Utility Conservation Revolving Fund proposal at UCSB, the university can benefit from additional funding through this SEP.

XI. Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2015[11]

Summary:
The U.S. Energy Information Administration (EIA) analyzed the levelized costs and levelized avoided costs for new generation resources across 22 U.S. regions. Levelized cost of electricity (LCOE) is a summary measurement of the competitiveness of different generating technologies while Levelized avoided cost of electricity (LACE) measures the avoided cost of the same technology to deem if the value exceeds the cost when determining a project.

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[9] Gawronik, Paul C., and Mark Peppers. *University of California, Santa Barbara Programming Report: Final Campus Hot Water Loop Program*. Rep. Corona: Goss Engineering, 2011. Print.
[10] UC/CSU/IOU Energy Efficiency Partnership (2006) "University of California and California State University Program. The Energy Efficiency Partnership with California's Investor-Owned Utilities." Web. 8 June 2016.
[11] U.S. Energy Information Agency. (2015) "Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2015." Web. 8 June 2016.

Analysis:
This study has useful figures for comparing the costs and benefits of various generation resources that UCSB could utilize towards achieving carbon neutrality. LCOE and LACE are convenient summary measures for differentiating generation technologies. However, it is important for UCSB to consider regional characteristics, economic viability, and capacity values for the university.

Finance

XII. Innovative Financing Models for Low Carbon Transitions: Exploring the Case for Revolving Funds for Domestic Energy Efficiency Programmes[12]

Summary:
This study focuses on how European and British governments can enhance low carbon investment with green revolving funds (GRFs), with a focus on the difficulties of funding capital-intensive energy saving projects under the political climate of austerity. The authors propose a generic GRF model and use data on the costs and benefits of domestic sector energy retrofits in the United Kingdom to determine levels of finance needed for different outcomes. The study concludes that even countries with limited resources available for investment in low carbon development could benefit from implementing GRFs for domestic retrofits under the political context of austerity.

Analysis:
This study is relevant to our work because of its focus on financial constraints and lack of political will to invest in greenhouse gas emissions reductions. The University of California's budget situation has some parallels to austerity measures in the European Union. The authors of the study emphasize the long term cost savings associated with GRFs, and the justification and rhetoric used in the article are applicable to efforts to generate support for investment in carbon emissions reductions at UC campuses. The authors provide a strong example of how to communicate the financial benefits and advantages of using a GRF to finance low carbon development.

XIII. Green Revolving Funds: An Introductory Guide to Implementation & Management[13]

Summary:
This publication functions as a guide for designing and implementing a GRF at a university or other institution. The Sustainable Endowments Institute launched "The Billion Dollar Green Challenge" in 2011 to encourage universities to invest in their own GRFs, and this report aims to inform and motivate careful planning of GRFs. The report explains the fundamentals of a GRF, different management considerations for the fund, potential seed funding sources, and actual examples of GRF implementation at universities. Common challenges and strategies to overcome barriers to GRF implementation are also addressed.

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[12] Gouldson, Andy, et al. "Innovative financing models for low carbon transitions: Exploring the case for revolving funds for domestic energy efficiency programmes." *Energy Policy* 86 (2015): 739-748.
[13] Indvick, Joe, Rob Foley, and Mark Orlowski. "Green Revolving Funds: An Introductory Guide to Implementation and Management." (2013): 1-27. *Green Billion*. The Sustainable Endowments Institute & The Association for the Advancement of Sustainability in Higher Education. Web. 13 May 2016.

Analysis:
When planning and implementing a GRF, other universities' experiences and lessons learned should be carefully considered. The report is particularly relevant to our efforts because it discusses in depth potential seed funding sources for a GRF, and what other universities have done to build up GRFs over time. Another relevant takeaway is the conclusion that GRF implementation efforts seem to be more successful when tied to a specific sustainability goal like a carbon neutrality initiative. Finally, the high return on investment for GRFs (median ROI of 28% annually) that have already been implemented mean that a strong business case can be made for investment in GRFs as an alternative to traditional investment strategy utilized by universities.

Engagement and Strategic Communications

XIV. Making Invisible Work Visible: Using Social Network Analysis to Support Strategic Collaboration[14]

Summary:
The importance of understanding and mapping informal networks, which make "invisible" patterns (i.e. not on an organizational chart) visible but not necessarily formal is valuable to gaining a better understanding of information flow and influence in social networks. Social network analysis (SNA) is a "means of assessing the effects of decisions on the social fabric of an organization." Network diagrams can be effective tools in re-focusing executive attention because they equip high-level individuals within an organization with a better understanding of how their decision-making process affects how "work" (or influence or information transfer) is actually done. This insight is particularly impactful in settings with scarce resources to allocate because typically formal groups get more attention than informal/invisible relationships yet are just as, if not more, valuable.

Analysis:
While this paper took more of a company-based organizational approach, some of the findings related to invisible networks can be applied in an academic setting such as UCSB. It is useful to examine such invisible networks not represented on university organizational charts to better understand their value pertaining to information flow for campus initiatives. Particularly, it is important to apply invisible network analysis methodologies to understand information flow among students, which are unmapped outside of the academic-setting structure but are meaningful to the overall flow of information and influence, pertinent to the success of the UCSB carbon neutrality initiative.

[14] Cross, Rob, Stephen P. Borgatti, and Andrew Parker. "Making Invisible Work Visible: Using Social Network Analysis to Support Strategic Collaboration." *California Management Review* 44.2 (2002): 25-46. Web. 15 May 2016.

XV. Social Network Analysis: An Approach and Technique for the Study of Information Exchange[15]

Summary:
SNA can reveal how network structures affect different types of information flows, who controls the information, and how the information flows from one network to another. SNA also helps users to identify where information gaps occur, informing strategies for how to best address such impediments to information flows across identified audiences. Many attributes of social networks can be analyzed in SNA including patterns, relationship characteristics, strength of such relationships, types of social networks (egocentric or whole network approaches), and information impacts on social networks.

Analysis:
Conducting a SNA of UCSB, or a sample thereof, will help the team develop recommendations for moving carbon neutrality messaging through campus, taking into account that complex social networks may have different influences at various network, group, and individual levels. Taking the whole network approach will be most effective regarding carbon neutrality at UCSB. It can reveal who the key players are with regards to information provisioning across campus. An SNA can also point to where there are structural informational holes, which can then be addressed to inform best practices for sustainability-related outreach strategies.

XVI. Social Network Analysis: History, Theory, and Methodology[16]

Summary:
When designing a SNA, several variables must be defined such as the actors, vertices, and nodes (the linked social entities), their relations (a specific set of ties among actors), the actor attributes (or characteristics for grouping actors), and network boundary (sample population). The following steps include developing a theoretical framework, which can be informed by several different social theories, developing research questions, determining the network boundary, gathering data, structuring the data into matrices and visualizing the network, then running analysis and interpreting the results.

Analysis:
Prell's book provides a general framework of methodology for conducting an SNA. She outlines various approaches and theories that can inform each step of the SNA that will help Carbon Zero shape the scope of its SNA and analysis.

XVII. Accelerating Campus Climate Initiatives – 2009[17]

Summary:
This lengthy booklet offers creative strategies to effectively overcome challenges of implementing climate initiative plans in university settings. Information is offered in a problem and solutions

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[15] Haythornthwaite, Caroline. "Social Network Analysis: An Approach and Technique for the Study of Information Exchange." *Library & Information Science Research* 18.4 (1996): 323-42. Web. 15 May 2016.
[16] Prell, Christina. *Social Network Analysis: History, Theory and Methodology*. London: SAGE, 2011. Print.
[17] Kinsley, Michael, and Sally DeLeon. *Accelerating Campus Climate Initiatives*. Publication. N.p.: Association for the Advancement of Sustainability in Higher Education, 2009. Print.

framework with many case studies from campuses across the nation. The three fundamental challenges that all campuses experience – lack of people hours, capital, and information, are explored for a variety of topics including climate action planning, buildings & utilities, renewable energy, and carbon offsets. The authors encourage a whole-systems thinking approach to successfully implement complex projects with many moving pieces.

Analysis:
This paper examines problems and possible solutions for many of the challenges pertinent to UCSB's carbon neutrality initiative:

- Outlining the co-benefits of a climate initiative plan and how they can be best communicated
- How to most effectively work with a limited number of people hours and avoid duplicative actions on this initiative
- Devising strategies to get students to be more aware of and engaged with the initiative
- Dealing with a limited debt capacity and exploring alternative financing options

Data Management Plan

I. Describing the Research Data

To achieve our desired objectives, data will be gathered concerning campus groups, campus electricity use, building characteristics, expected cost benefit analyses for solar/storage, and other technologies. Prior information on energy usage, sustainability projects, and GHG production has been sourced from Jordan Sager, of the UCSB Energy Division, and Jewel Snavely, UCSB Sustainability Coordinator. Building characteristics will be sourced from Jordan Sager, with additional information being gathered by the Carbon Zero team as necessary. A LiDAR analysis of campus from the UCSB Department of Geography may be used for assessing rooftop solar capability, expected in the Fall 2016 quarter. Data from Carbon Zero's predecessor Group Project, CarbNewt, has been attained and will be implemented in analyses of the Utility Conservation Revolving Fund, sustainable energy project deployment schedules, solar payback periods, and more. Further research on solar/battery technology advancements, efficiencies, and pricing will be updated through a comprehensive literature review by the beginning of the Fall 2016 quarter. Information on campus stakeholders and relationships will be gathered through interviews and research, then organized and analyzed as the project progresses.

II. Data Standards

Data gathered through literature review will be stored as .pdf files in a central folder on Box. A master copy of data we receive throughout the project, in text or non-text, will be stored in the format they are received to protect against formatting errors. Any hard copy items will be scanned and uploaded as a .jpeg, or requested electronically, when possible. Evan Ritzinger will be responsible for ensuring that standards are applied and data are properly organized.

III. Metadata Standards

Data gathered through literature review will be grouped by technology in separate folders. Data acquired via our contacts will be stored according to that contact in order to facilitate smooth interpretation of data, and to allow for questions to be easily answered as needed. Contacts will be added as necessary to a designated 'contact list' in our group box account. Box automatically records who uploads the data so questions may also be answered internally, if possible. Our contact information will also be stored so that questions on data can be answered if desired for re-use in a separate context. When conducting interviews, notes on said interview will adhere to an interview template uploaded on Box.

IV. Data Sharing and Access

Data will be made available to the general public unless otherwise requested by the source. Most data are not proprietary and are currently open to the public. We anticipate that Microsoft Office and ArcMap will be required.

V. Intellectual Property and Reuse

Any data exclusively created by Carbon Zero will be assigned a Creative Commons license to allow for usability and accessibility of our results in the future. When new data is acquired from an external source, the Carbon Zero group will inquire about the right to redistribute to ensure compliance with the scientific community and the law.

VI. Data Archiving and Presentation

Data will be stored and eventually archived on Box. To minimize the size of archived data, only data that is required to replicate our results will be saved after the project's completion. Organization of our data will be reassessed at the time of project completion with the primary criteria of facilitating ease-of-use for future parties

Technical Approach to Solving the Problem

I. Technological Approaches

We will utilize the solar insolation campus map being developed by a team in the Geography Department to create recommendations for on-campus solar PV site placement. We can use the UC Solar Project Development Program Initial Project Checklist, which specifies rooftop characteristics and other planning considerations needed to install solar arrays as a guide. Rooftop and building data will be received from campus facilities. We can then develop a ranking system to recommend the best sites for solar PV installation taking into consideration the campus's LRDP, energy savings, and long-term cost by utilizing the Life Cycle Cost Analysis (LCCA) model created by CarbNewt. We can also analyze different scenarios for how the number of solar panels affect UCSB's ability to avoid paying taxes as an energy generator with SCE and other future scenarios that may occur due to changes in policy, costs of energy, or changes to the LRDP.

We aim to assess a number of energy storage scenarios including a possible partnership with a battery storage company. Cost, effectiveness, and any other important considerations of these different scenarios will be evaluated. An energy and cost savings assessment can also be completed for the new campus hot water loop program which may be implemented in the near future. Finally, we will determine how these projected costs and energy savings from solar installation, energy storage, and the campus hot water loot fit into UCSB's timeline for carbon neutrality and deployment of the Utility Conservation Revolving Fund.

II. Financial Approaches

A primary goal of the project's financial component will be to refine the current Utility Conservation Revolving Fund estimates completed by the preceding project team. Such an examination would involve the update, refinement, and addition of economic analyses performed by CarbNewt. Given new information and the rapidly changing pace of the politics and economics within the sustainable energy market, developing an updated deployment strategy is necessary.

We will evaluate strategies that UCSB can utilize to generate upfront capital for carbon neutrality projects, and explore other creative financial solutions. We will research and monitor other institutions' sustainability finance strategies, and evaluate the potential for such strategies to be adopted by UCSB. A willingness to pay study to assess UCSB students desire to establish a carbon neutrality quarterly fee or other tax to pay for projects will be considered. Finally, we will deliver a recommendation for how UCSB can obtain the capital it needs to install the projects necessary to be carbon neutral by 2025.

III. Engagement and Strategic Communication Approaches

This objective will consist of two parts: (1) Strategy and (2) Content. For the Strategy piece, we will conduct a social network analysis (SNA) of stakeholders involved in the decision-making process related to carbon neutrality projects. We hope that the SNA will reveal who the key influencers are on-campus; therefore, informing the strategy for how to imbed carbon neutrality concerns into the long-term planning and decision-making process at UCSB. The SNA will also inform Carbon Zero which audiences are best to prioritize for the Content piece, and ultimately, for who to conduct outreach to garner support for the carbon neutrality initiative and longer-term sustainability coalition-building.

The Content piece will build on the Strategy piece and incorporate engagement with student organizations and possibly other key groups that may arise from the SNA as critical stakeholders. Carbon Zero will generate the content, test the messaging via focus groups and/or surveys, and identify the most strategic means of distribution. Existing distribution channels will be identified by the SNA, and we will likely expand on those channels and recommend new ones. Carbon Zero will collaborate with influential student groups on campus to workshop our content, their own content, and identify the best means of distribution to the greater student body.

Carbon Zero may also work with student organizations to determine metrics for student engagement such as event attendance, number of new student attendees, number of students studying carbon neutrality, etc. All of our findings and content will be shared with the Institute of Energy Efficiency, the Chancellor's Sustainability Council, and UCSB Sustainability, among others in the event they want to disseminate the information Carbon Zero provides.

The project will culminate with a cohesive strategy for incorporating carbon neutrality, into the long-term planning and capital project decision-making process at UCSB. This recommended strategy will incorporate elements from Carbon Zero's findings from the technology, financial, and communications objectives. The recommendations will be presented to David Auston, the Institute of Energy Efficiency, and all other interested parties.

Deliverables

The deliverables for the Institute of Energy Efficiency include a report detailing the project's findings and recommendations as well as a presentation for UCSB senior administration including but not limited to Chancellor Henry Yang, Executive Vice Chancellor David Marshall, Director of Finance and Administration Eric Sonquist, and Director of Capital Development Chuck Haines.

The academic deliverables required for completion of the Master's thesis project by UCSB Bren School of Environmental Science & Management include:

- Work Plan
- Website
- Final report
- Defense presentation
- Project brief
- Project poster
- Final presentation
- Data and metadata
- Recommendations for UCSB planning and financial decision-making process

Milestones

Spring Quarter 2016	
May 20th, 2016	- Draft Work Plan due to faculty, client and external advisors - Finalize external advisors (Lisa Leombruni and Jordan Sager)
June 1st, 2016	- Host Work Plan Review Meeting - Location: Bren 1st Floor Visitor Center with confirmed attendance from: Dr. Roland Geyer, Dr. David Auston, Dr. Lisa Leombruni

	(Separate meeting held with Jordan Sager) - Gain feedback on objectives, deliverables, and technical approach
June 10th, 2016	- Submit 1-page summary of work plan review meeting to Faculty Advisors - Final Work Plan due to faculty, client, and external advisors - Submit website link to to Group Project Coordinator - Submit peer/self evaluation to faculty advisors and Group Project Coordinator
Summer Internship Work	
Fall Quarter 2016	
November 18th, 2016	- Host Fall Review Meeting with faculty advisors, client, and external advisors
November 23rd, 2016	- Submit 1-page summary of fall review meeting to faculty advisors
December 9th, 2016	- Submit outline of final report to faculty advisors - Submit self/peer evaluation to faculty advisors and Group Project Coordinator
Winter Quarter 2017	
February 24, 2017	- Draft of final report due to faculty advisors
March 3rd or March 10th, 2017	- Master's Project Defenses at Bren
March 24th, 2017	- Final report due to faculty advisors, client, external advisors, and Group Project Coordinator - Submit Final Presentation Program Abstract to Group Project Coordinator - Submit self/peer evaluation to faculty advisors and Group Project Coordinator
Spring Quarter 2017	
April 14th, 2017	- Draft Project Brief and poster due to faculty advisors - Take group photo with faculty advisors - Submit Draft Final Presentation to faculty advisors for review
April 21st, 2017	- Final Project Brief and Project Poster due to faculty advisors and Group Project Coordinator and posted on Group Project website
April 24th, 2017	- Print Final Poster and Project Briefs
April 28th, 2017	- Master's Project Final Presentations

Management Plan

I. Group Structure and Management

The Carbon Zero project consists of five members: Charles Diamond, Evan Ritzinger, Lydia Rudnick, Dawnielle Tellez, and Emily Waddington. Roles have been assigned to each student for the entirety of the project. Charles Diamond will act as Financial Manager by estimating all costs associated with the project and constructing an appropriate budget. Evan Ritzinger is the Data Manager and Internship Coordinator. Evan will collect, organize, and store data received from clients and other external sources. Evan will also coordinate with our client regarding internship application submission and timeline constraints. Lydia Rudnick is the Project Manager. Lydia will organize the delegation of work within the team, track milestones of the project, create agendas, schedule meetings, and be the primary contact for faculty advisors and the project client. Dawnielle Tellez is the Outreach Manager. Dawnielle is responsible for creating the project website, updating online content, and coordinating all relations with the university and surrounding community. Emily Waddington is the Editor. Emily will edit all documents, deliverables, and content developed for the project. While these designations will be the primary role of each member, all members have agreed to collaborate on responsibilities when needed.

We have assigned a lead and second-in-command for each of our 3 objectives. Emily will be the lead for the technological piece of our project with Evan as the second. Charlie will be the lead on the financial piece with Evan as the second. Dawnielle will be the lead on the engagement and strategic communications objective with both Emily and Evan being the second on the project. Lydia will float between all three pieces of the project and other team members will help out as needed due to the interconnectedness of the three objectives.

Dr. Roland Geyer and Dr. James Frew are the faculty advisors for the project. Dr. Geyer and Dr. Frew will monitor the progress, provide recommendations and assistance as needed, and evaluate the project. Dr. Geyer will meet with students weekly during the 2016 Spring Quarter, 2017 Winter Quarter, and 2017 Spring Quarter until the completion of the project. During his sabbatical in the Fall of 2016 he will stay involved with the project through email and occasional meetings. Dr. Frew will meet weekly with students during the Fall 2016 Quarter and will join meetings during the 2016 and 2017 school years via skype or in-person when available.

Our client is the UCSB Institute for Energy Efficiency (IEE) represented by Dr. David Auston. We will meet with our client several times a quarter to ensure that project work is aligning with expectations. External advisors are Jordan Sager and Lisa Leombruni. Jordan is the Energy Manager within the Physical Facilities department at UCSB and was an external advisor for the CarbNewt Group Project at Bren. Dr. Lisa Leombruni is the Communication Program Manager at the Bren School and involved with the communications outreach for the Carbon Neutrality initiative at UCSB. External advisors will attend Spring and Fall review meetings. The team will meet with external advisors several times each quarter to discuss aspects of the project.

II. Meeting Structure

Our group will meet weekly on Mondays from 2:15 pm – 3:15 pm during the 2016 Spring Quarter. Our group will also meet weekly on Wednesdays from 11:30 am – 12:30 pm during the 2016 Spring Quarter with Dr. Geyer along with Dr. Auston or Dr. Leombruni, when available. These weekly group meetings will be used to discuss project objectives, refine the scope, develop our project work plan, and evaluate progress made on the project. Lydia Rudnick will arrange meeting locations and times. Agendas for the following meeting will be discussed as a group and Lydia will finalize agendas and add them to the Carbon Zero Box Google Doc for member access. Lydia or Emily will take notes during the meeting and Lydia will ensure tasks are delegated and communicated clearly through weekly to-do emails.

III. Guidelines for Interacting with Faculty Advisors, Clients, and External Advisors

Lydia Rudnick will be the main contact for project faculty advisors, Dr. Geyer and Dr. Frew. Lydia will also be the main contact for client representative, Dr. David Auston. Lydia will book all meetings and notify attendees in a timely and professional fashion. Dr. Auston will attend meetings periodically throughout each quarter to stay up to date on the project. Lydia will send email status updates and reports if Dr. Auston cannot attend in-person meetings.

External advisors include Jordan Sager and Dr. Leombruni. Charles Diamond will be the main contact for Jordan Sager and Dawnielle Tellez will be the main contact for Dr. Leombruni. Scheduling will be handled by Lydia Rudnick. The team will meet with external advisors at least once per quarter. Charles and Dawnielle will send email status updates and reports to their respective advisors to keep them updated with important project milestones. Evan Ritzinger will be the main contact for Dr. Auston to coordinate all internship-related activities.

IV. Systems to Ensure that Critical Tasks Are Completed on Time

Lydia Rudnick as Project Manager will track all project progress. Team members will report weekly on progress and status of tasks. If a team member feels they cannot finish a task on time, other team members will assist him/her to ensure that the task is completed. Tasks will be managed through weekly emails and reminders.

V. Procedures for Documenting, Cataloguing and Archiving Information

The team will utilize the storage tool, Box. The team will also use Google Docs for editing documents. Materials will be accessible to all team members and faculty advisors. All team members have made google calendars and Lydia will send out weekly to do emails to keep the project on track.

VI. Overall Expectations of Group Members and Faculty Advisors

Team members and faculty advisors are committed to the success of the project. Students should be respectful of both Dr. Geyer's and Dr. Frew's time and communicate meetings and respond to emails in a timely fashion. Students should ensure that the scoping of objectives and deliverables of the project

satisfy the Bren program and the needs of the client. Students will keep a clear line of communication with Dr. Geyer and Dr. Frew regarding project updates and any conflicts within the group. Dr. Geyer and Dr. Frew will provide advice and input to ensure that the project satisfies all Bren requirements and the needs of the client.

VII. Conflict Resolution Process

Conflicts that arise within the team will first be managed within the team. Lydia Rudnick should be kept notified of any problems that arise within the team. The primary method for settling conflicts will be discussion between group members and within the entire group. If the conflict cannot be resolved within the team, the faculty advisor will be asked to help in finding a resolution to the conflict. If problems arise where a team member is not equally contributing to the project, a meeting will be scheduled with the faculty advisor and/or the Group Project Coordinator, Casey Hankey, to resolve the problem.

Budget and Budget Justification

The project's financial manager, Charles Diamond, will use Bren's financial shadow system (Grand Unified System) to track project expenses. He will manage and update the project budget as necessary. Charles will create a monthly expense report and communicate expenses to the other project team members. Purchase orders will be used to buy project supplies and services when feasible, though reimbursement is possible for certain expenses. The budget below will be updated as the project's financial needs become more specifically identified. The printing budget ($200) is credited to Evan Ritzingers's Bren printing account, and is managed separately from the project budget ($1,300).

Final Poster	$300
Conferences/ Field trips	$350
Presentation Expenses	$50
Administrative Supplies	$50
Data/ Software/ Research Costs	$200
Project Briefs	$200
Meeting Refreshments	$50
Business Cards	$100
TOTAL	**$1300**
Printing*	$200

* Printing budget is fixed at $200 and credited to Evan Ritzinger's Bren printing account.

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