Achieving Carbon Neutrality at UCSB by 2025: A Critical Analysis of Technological and Financial Strategies

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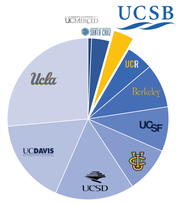
Introduction

In 2013 Janet Napolitano, the President of the University of California (UC), united the 10 UC campuses through the Carbon Neutrality Initiative. This initiative established a goal for each campus to identify and implement measures to reduce Scope 1 and Scope 2 emissions to zero by 2025. Achieving carbon neutrality would make the University of California the first major research university to accomplish this ambitious goal.

The University of California, Santa Barbara (UCSB) is a sustainability leader, and currently has the third smallest carbon footprint in the UC system. In November of 2015, UCSB's Chancellor, Henry Yang, pledged to support and lead the UC Carbon Neutrality Initiative, stating "we recognize the urgent need to act now and avoid irreversible costs to our global community's economic prosperity and public health." UCSB has a proven track record of making successful investments in energy efficiency and renewable energy technologies, and aggressive actions must be taken in order to achieve carbon neutrality by 2025.



Total UC Emissions:
1.2 Million Metric Tons CO_2e

Project Objectives

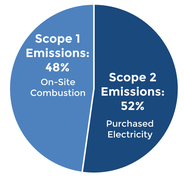
In order to develop a strategy for UC Santa Barbara to achieve carbon neutrality by 2025, UCSB's Chancellor's Sustainability Committee identified three objectives for this research project. Ultimately, this study identifies the most promising greenhouse gas (GHG) emission mitigation strategies and the optimal investment schedule that will enable UCSB to achieve carbon neutrality and reduce long-term operating costs with minimal capital investments. This project's specific objectives are as follows:

- Assess the efficacy of greenhouse gas mitigation strategies
- Estimate the implementation costs associated with the recommended strategies
- Recommend a deployment strategy for the identified strategies

Understanding the challenges of achieving carbon neutrality, our group developed a four-step approach in order to break the project into manageable pieces. Each step contains critical elements of our recommended carbon neutrality strategy. The steps are as follows: 1) reduce energy demand; 2) procure renewable energy; 3) analyze cost implications; and 4) create a deployment schedule.

What is Carbon Neutrality?

UCSB 2025 Projected Emissions



2025 UCSB Scope 1 and 2 Emissions:
42,000 Metric Tons CO_2e

As defined by the UC Office of the President (UCOP), carbon neutrality is achieved when a campus reduces Scope 1 and Scope 2 emissions to zero. While there are many potential strategies, reducing emissions as much as possible through energy efficiency, conservation, and renewable energy procurement are the most viable options. If necessary, purchasing carbon offsets to account for any remaining emissions is an accepted option for reducing emissions to zero.

GHG emissions can fall into three categories: Scope 1, Scope 2, or Scope 3. Scope 1 emissions are those associated with on-site combustion, or direct emissions. At UCSB, 98% of Scope 1 emissions are associated with the on-site combustion of natural gas for space and water heating. Scope 2 emissions are those associated with electricity purchased from the grid, or indirect emissions. UCSB purchases electricity from Southern California Edison for energy services such as lighting, air conditioning, and ventilation. Scope 3 involves all other indirect emissions. While UCOP intends for each UC campus to achieve carbon neutrality for Scope 1-3 emissions by 2050, this study focused solely on Scope 1 and Scope 2 emissions.

How Carbon Neutrality Can be Achieved at UCSB

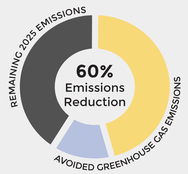
Steps 1&2 — Reduce Energy Demand & Procure Renewable Energy

As a vital first step, our group reviewed the multitude of energy efficiency and conservation strategies that UCSB could implement. Assessing the efficacy of each project required an in-depth look at how buildings are operated at UCSB, a literature review of proven strategies, and collaboration with UCSB Energy and Utility Services. To the right are the five energy demand-reducing strategies identified by this study.

Once these five strategies were identified in Step 1, the next step was to identify the on-site potential for renewable energy generation and assess viable off-site procurement options. This study performed a campus-wide solar capacity appraisal, identifying a potential expansion of 9 MW within existing rooftop and parking lot spaces. Through the execution of power purchase agreements (PPAs), UCSB can install solar photovoltaics (PV) with zero capital investment.

Viable off-site renewable energy procurement options for the university include community solar arrays, direct access, and Southern California Edison's Green Rate program.

Greenhouse Gas Mitigation Strategies		Reduction Potential
Energy Demand Reduction		
LED & Controls Retrofits	Broad deployment of LED lighting with adaptive control technology has the ability to monitor occupancy, adjust for daylight, and dim lighting output to maximize comfort and avoid unnecessary energy consumption.	11%
HVAC Retrofits	Replacement or repair of existing HVAC equipment presents significant GHG mitigation potential, as aging equipment tends to function inefficiently.	7%
Lab Retrofits	A multi-faceted approach to laboratory buildings that includes air quality sensing to reduce the number of air changes per hour and optimize fan speeds during non-occupied hours.	12%
Monitoring-Based Commissioning	This process requires an engineer to fine-tune a building's energy systems to ensure they are functioning as intended. Additionally, the installation of submetering can provide building operators with high resolution data.	7%
Hot Water Loop	Installation of a hot water loop that mirrors the current chilled water loop could capture waste heat from the cooling process and distribute hot water between connected buildings.	10%
Renewable Energy Procurement		
Solar PV	Through solar PV PPAs, third-party contractors install, own, and maintain solar panels on campus in order to sell renewable energy to the university for a pre-determined price and duration.	13%



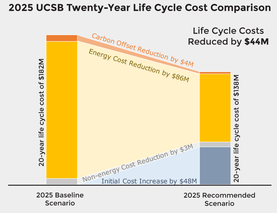
25,000 metric tons of CO_2e can be avoided in 2025 by implementing these greenhouse gas mitigating strategies.

Step 3 — Analyze Cost Implications

While UCSB typically make decisions using a simple-payback model, this study developed and utilized a Life Cycle Cost Analysis (LCCA) tool in order to quantify the discounted life cycle costs of each recommended strategy. In addition to up-front capital costs, this LCCA tool takes into account costs associated with ongoing energy expenses, operation and maintenance, and expected carbon offsets for each scenario.

The figure below is a comparison between UCSB's 2025 baseline scenario and our recommended scenario for reaching carbon neutrality. The baseline scenario assumes that UCSB does not implement any additional energy efficiency, conservation, or renewable energy projects over the next 20 years. Alternatively, our recommended scenario assumes that all five of the recommended demand-side strategies are implemented, and that on-campus solar capacity is maximized. The remaining 17,000 $MtCO_2e$ can be mitigated through the procurement of carbon offsets, renewable energy credits, or collaboration with utilities to purchase 100% renewable electricity. In our cost calculations, we assumed that the 2025 cost of carbon offsets will be $10/$MtCO_2e$.

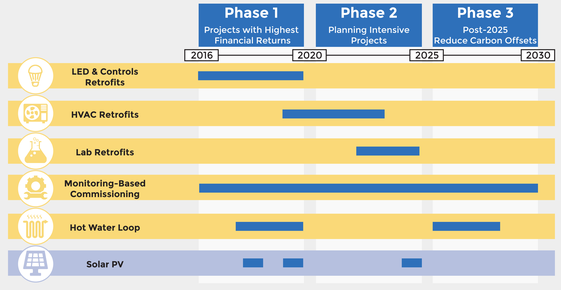
2025 UCSB Twenty-Year Life Cycle Cost Comparison



With an investment of **$48M**, UCSB can save **$44M** in total costs and **500,000 $MtCO_2e$** over a 20-year timespan

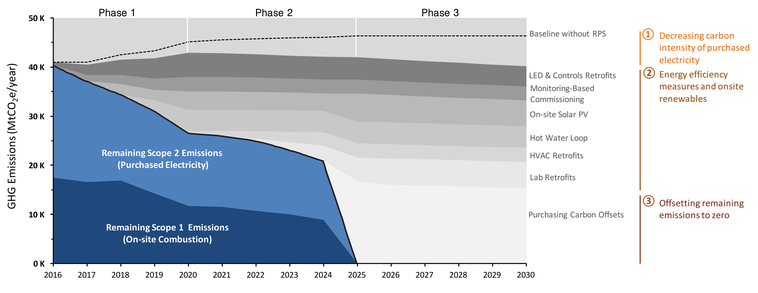
Step 4 — Create a Deployment Schedule

Achieving carbon neutrality at UCSB has the potential to reduce utility expenditures while improving campus operations. However, technological maturity, labor availability, capital costs, and regulatory context must be considered when determining an implementation plan. Taking these constraints into account, we developed a deployment schedule that prioritizes projects with high returns on investment such that utility savings can be rapidly generated, captured by a green revolving fund (GRF), and reinvested into additional energy efficiency projects on campus. While these strategies require $48M in capital investments, we found that by establishing a GRF and leveraging avoided utility cost streams, this amount can reduced to below $16M. The blue bars in the figure below represent our recommended timing for each project.



Carbon Neutrality Can be a Reality

Strategies to Achieve Carbon Neutrality at UCSB by 2025

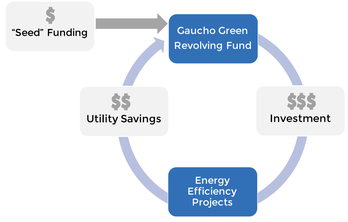


Recommendations

We recommend that UCSB invest as much capital as possible early in the carbon neutrality process, and that they establish a green revolving fund to capture and reinvest avoided utility costs into new energy efficiency projects. As mentioned in Step 4, this mechanism will reduce required capital investments from $48M to below $16M.

Our analysis shows that achieving carbon neutrality for Scope 1 and Scope 2 emissions can reduce UCSB's long-term operating costs, improve campus resiliency, and assist in the recruiting of high caliber students and faculty. However, achieving this goal will require aggressive investments and ongoing efforts to ensure that promising GHG mitigation strategies still under development are considered as they gain feasibility.

Recognizing the imperative to act on climate mitigation and the leadership of President Napolitano and Chancellor Yang, the University of California, Santa Barbara should make the investments necessary to achieve carbon neutrality of Scope 1 and Scope 2 emissions by 2025. As a living laboratory for sustainability, it is within the scope of our mission to act as a global leader on this challenging endeavor.



Acknowledgements and References

It was a privilege to work with such forward-thinking and dedicated individuals. UCSB is a particularly special environment to work in and the Chancellor's Sustainability Committee was supportive throughout the entire process. Special thanks to Jordan Sager for providing technical expertise and David Auston for encouraging our work throughout the entire process.

- Sangwon Suh – Advisor
- David Auston – Executive Director, Institute for Energy Efficiency
- Jordan Sager –Campus Energy Manager, Facilities Management
- Jewel Snavely – Sustainability Coordinator; The Green Initiative Fund, Grants Manager
- David McHale – Associate Director, Utility & Energy Services
- Karl Brown – Deputy Director, California Institute for Energy and Environment (CIEE)
- Mo Lovegreen – Executive Officer, Department of Geography; Director, Campus Sustainability
- Katie Maynard –Event Manager; Sustainability Coordinator
- Mark Rousseau – Housing & Residential Services
- Bruce Tiffney – Chancellors Sustainability Committee, Co-Chair
- Max Stiefel & Claire Dooley – 2015 CNI Fellows

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