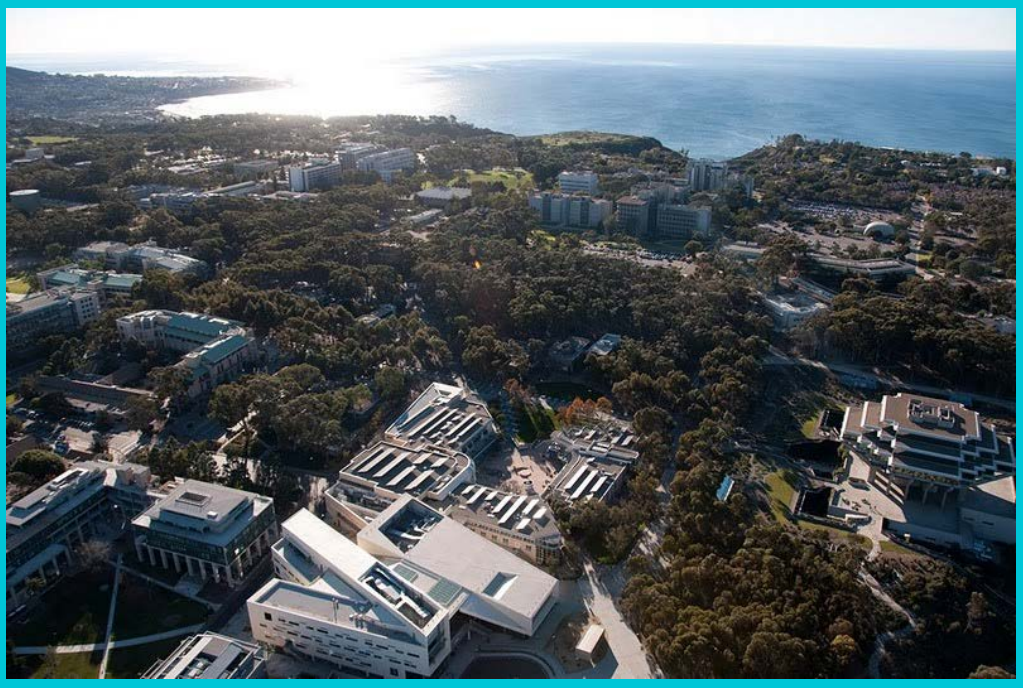

UC SAN DIEGO CLIMATE ACTION PLAN

February 2019

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Advisory Committee on Sustainability

Committee on Campus & Community Environment

Capital Project Management

Center for Energy Research

Design & Development Services

Environment, Health & Safety

Facilities Management

Physical and Community Planning

Housing, Dining & Hospitality Services

Student Sustainability Collective

Strategic Energy Initiatives

University Centers

UC San Diego Health

VC Office of Research Affairs

VC Resource Management & Planning

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AB32	Global Warming Solutions Act of 2006
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BTU	British thermal unit (kBTU...1000 BTUs)
CAP	Climate Action Plan
CEQA	California Environmental Quality Act
CNG	Compressed Natural Gas
CNI	Carbon Neutrality Initiative
CO2	Carbon Dioxide
CPM	Capital Project Management
DA	Direct Access
DDS	Design Development Services
EEM	Energy Efficiency Measure
EH&S	Environment, Health & Safety
ESU	Energy Services Unit
EUI	Energy Use Intensity
EV	Electric Vehicle
FM	Facilities Management
GHG	Greenhouse Gas Emissions
GRP	General Reporting Protocol
HDH	Housing, Dining & Hospitality Services
HVAC	Heating, Ventilation & Air Conditioning
kWH	Kilowatt – Hour
LEED	Leadership in Energy & Environmental Design
LRDP	Long Range Development Plan
MBCx	Monitoring Based Commissioning
MTCO2e	Metric Tons, CO2 Equivalent
MTS	Metropolitan Transit System
MWH	Megawatt – hour
NTCD	North County Transit District
NTPLLN	North Torrey Pine Living Learning Neighborhood
PPA	Power Purchase Agreement
PV	Photovoltaic (solar)
R-100	Renewable Diesel (100 %)
SANDAG	San Diego Area Governments
SSC	Student Sustainability Collective
SEP	Strategic Energy Program
SOV	Single Occupancy Vehicle
UCOP	UC Office of the President
WPP	Wholesale Power Purchase Program
ZEV	Zero Emission Vehicle

1. Executive Summary

UC San Diego has long been a leader in climate change research and education, starting with Dr. Charles Keeling's groundbreaking work, which showed that rising levels of atmospheric carbon could be correlated to fossil fuel emissions. Owing to this heritage, UC San Diego continues to be committed to being a good steward of the environment and reducing its carbon footprint.

Building on early student led efforts to promote sustainable practices, in November 2013, the UC President implemented a carbon neutrality initiative (CNI) to make University of California operations carbon neutral in scope 1 (direct) and 2 (indirect) emissions by 2025. The initiative also requires campuses to achieve full carbon neutrality including emissions from campus commuters and business air travel by 2050. As an interim step campuses are required to reduce greenhouse gas (GHG) emissions to 1990 levels by 2020, pursuant to the California Global Warming Solutions Act.

In 2008, UC San Diego approved the first campus Climate Action Plan (CAP) for implementing the University's climate strategy to meet State and UC climate policies and objectives, including:

- Reducing GHG emissions to 1990 levels by 2020.
- Achieving climate neutrality by 2025.
- Continuing to certify new and existing building under the LEED rating system.

UC San Diego's energy program has been nationally recognized for its leadership and innovation in applying state-of-the-art energy management practices to minimize campus environmental impacts. These efforts have resulted in reduced energy use and carbon emissions, despite its significant growth over the past several years.

Energy Research Park and Thermal Energy

Demonstration Iron Flow Energy Storage System

In addition to reducing its environmental footprint, UC San Diego has numerous academic and research programs focused on climate change education and finding clean energy solutions for the future. UC San Diego faculty are engaged in a variety of inter-disciplinary community based projects regarding climate change, combining both technical and social science expertise from across the campus. UC San Diego's "CNI Student Fellows" program provides students an opportunity to engage in projects ranging from climate action planning to carbon offset studies.

As the campus moves towards the future and meeting its carbon emission reduction goals, there are already new programs underway or planned to help meet the challenge, including additional energy efficiency retrofits, extension of the Mid-Coast Trolley to the La Jolla campus, expansion of the campus' electric vehicle infrastructure and new electric vehicle procurement options.

This 2018 update to the 2008 Climate Action Plan, provides a climate change mitigation strategy for meeting the UC carbon neutrality goals. The development of the updated CAP is based on work initiated by UC San Diego's Student Sustainability Collective (SSC), with support from campus staff. In March 2016 a "Carbon Neutrality Charrette" was held with students, faculty, staff, and community representatives. Results from this charrette, subsequent stakeholder meetings, discussions, review sessions, and proposed mitigation strategies included in the recently completed campus Carbon Reduction Plan were used to guide the development of the CAP.

While much of the focus of the CAP is on campus operations, the Plan embraces the vision of a student-centered university using experiential learning techniques to provide opportunities for students to gain real-world experience. Through involvement in the CAP process students will be able to learn by doing, gaining valuable problem solving and leadership skills as they tackle the complex, inter-connected issues involved in climate planning and achieving carbon neutrality. To this end it will be extremely important that students remain a cornerstone of the CAP process. Offering educational as well as research opportunities for students and faculty will be integral to successful CAP implementation.

Student Solar Forecasting Project Team

The 2019 CAP includes GHG emissions inventory results through calendar year 2017 as well as projected emissions forecasts and proposed mitigation strategies. As of 2017, the total campus emissions were 279,330 metric tons of CO2 equivalent ($MTCO_2e$), which included 200,219 $MTCO_2e$ scope 1 and 2 emissions. Total scope 1 and 2 emissions (with no mitigating actions) are forecasted to be approximately 203,415 $MTCO_2e$ by 2025.

EV Charging Infrastructure

The UC Carbon Neutrality Initiative provides the target by which the University must set its low carbon course for the next six years. This update to the campus' Climate Action Plan lays out a balanced approach for achieving the 2025 carbon neutrality goal that includes a recommended set of core "carbon reduction measures" that will help the University meet its GHG emission commitments, while also providing a cost effective approach to meeting the campus' future energy needs.

Because much of the campus's GHG emissions are from burning natural gas, these core measures alone will not get UC San Diego to carbon neutrality. To accomplish this, several scenarios were analyzed to determine the best option for getting there. In addition to carbon reduction and environmental drivers, the ability of each scenario to ensure the campus retains the same level of resiliency, redundancy, survivability and energy security that it has today were key values in the decision matrix.
All scenarios are based on the assumption that no changes will be made to the cogeneration plant until after 2032 when the debt service is fully paid. In all scenarios it is recognized that carbon offsets and

renewable energy credits will be needed to meet the 2025 carbon neutrality goal, however, over time it is envisioned that their role will lessen as the campus implements emission reduction measures.

Based on the analysis outlined in the Climate Action Plan (CAP), the recommended path for achieving carbon neutrality is a balanced "diversified" approach that includes implementing the core carbon measures mentioned above, in addition to eventual consideration for decarbonizing the cogeneration plant. Additionally, the campus may invest in localized energy generation projects, such as anaerobic digester(s) or a small-scale biomass power plant, assuming suitable sites can be allocated for these facilities. It is also projected that by 2025 as much as 40% of the campus' natural gas supply could be from renewable bio-methane gas supplied by the UC Energy Services Unit. To fully reach carbon neutrality, however, beginning in 2025 UC San Diego would need to consider purchasing carbon offsets to mitigate the emission impacts from onsite combustion of natural gas not replaced by bio-methane. The recommended emission reduction strategies are shown in the following wedge diagram, Figure 1.

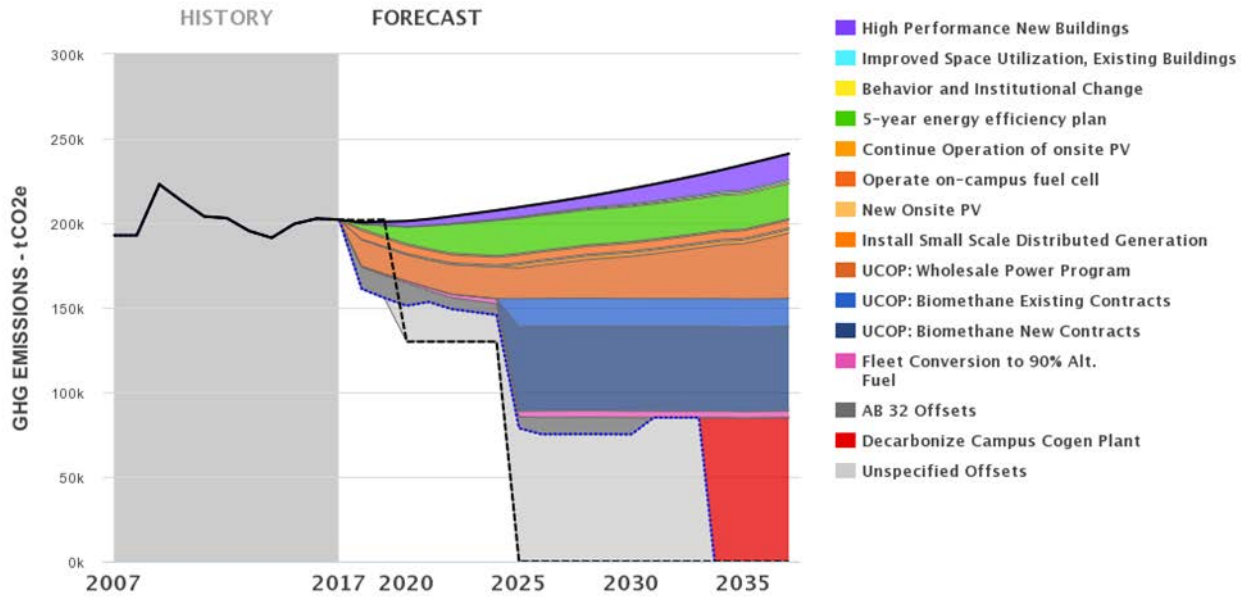


Figure 1: Scope 1 and 2 Greenhouse Gas Abatement Wedge

Continued support by campus leadership, faculty, students and alumni will be needed to help ensure that UC San Diego is able to meet its commitment to reduce campus climate impacts. Accomplishing the goals included in this Plan will be accomplished through an ongoing, iterative process that includes a wide range of campus stakeholders and senior leaders. While overall success in achieving the Plan's goals are a shared campus responsibility, implementation and tracking of individual actions are in most cases the responsibility of specific departments. The campus Sustainability Program Office is responsible for overall tracking and reporting on the Plan's progress. As a living document the Climate Action Plan will be continuously evaluated, assessed and updated to document progress and identify next steps.

2. Introduction

2.1. Background

In 1961 the University attracted the world's attention through the work of the Scripps Institution of Oceanography and Dr. Charles Keeling, who showed that rising levels of atmospheric carbon could be correlated to fossil fuel emissions. Since that time, the University has continued to be a leader in climate change research and education. UC San Diego has also aggressively pursued actions to reduce the campus' environmental footprint:

30 MW High Efficiency Cogeneration Plant

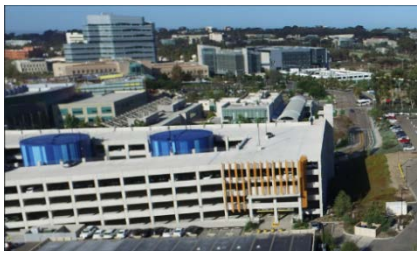
- Since 2001, UC San Diego's 30 MW cogeneration plant, recognized as one of the most efficient in the country, has provided over 80% of the La Jolla campus's energy, while producing 75% fewer emissions than conventional power plants.
- In 2002, UC San Diego became a charter member of the California Climate Action Registry (CCAR) becoming one of the first university's to publically report its Greenhouse Gas emissions. UC San Diego also was the first west coast university to join the Chicago Climate Exchange (CCX), voluntarily agreeing to reduce its emissions and participate in a carbon trading program.
- And, in 2007, UC San Diego along with the other UC campuses became a "charter signatory" to the American College and Universities Presidents Climate Commitment (ACUPCC), now known as the "Second Nature Carbon Commitment." As a signatory institution, UC San Diego is part of the "Climate Leadership Network."

2.8 MW Fuel Cell

For many years UC San Diego's energy program has been a model for other campuses to follow, consistently being at the forefront of applying sound energy management practices with new energy technologies to reduce its energy load, emissions and costs. Much of the University's success in implementing its energy program has been through partnerships with local utility, state and other public agencies, NGO's, student groups and research centers. Since 2008 the campus initiated several major actions that have helped to reduce campus emissions, despite significant growth. Most notably:

- Development and implementation of a comprehensive energy efficiency program that has resulted in the completion of over $100M in energy efficiency projects, saving the campus over $14M in annual energy costs.
- Establishing a highly innovative, world-class microgrid and "Energy Research Park" that serves as a living laboratory for integrating cutting-edge technology into campus operations. In addition to the cogeneration plant, the microgrid includes:
  - Over 2 MWs of solar generation (UC San Diego has another 1 MW of solar PV installed at several off-campus sites).
  - A 2.8 MW renewable energy fuel cell with a 300 ton absorption chiller that captures waste heat to provide the campus chilled water loop additional cooling capacity.

- A 2.5 MW/5MWH advanced energy storage system. In addition to this, a 250 kW/500 kWh energy storage system was commissioned at UC San Diego's off-campus receiving/distribution center.

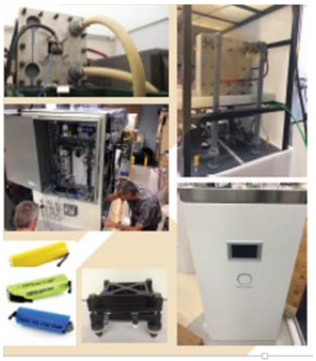


Thermal Energy Storage

- Increasing campus thermal energy storage capacity to more than 7 million gallons of chilled water.
- One of the largest and most diverse campus electric vehicle charging infrastructures in the country. The campus also has a four hose fast fuel compressed natural gas (CNG) station dispensing 100% renewably sourced fuel to campus fleet and the public.
- Converting the campus fleet to one of the greenest fleets in the country, with over 60% alternative fuel vehicles.
- Reducing commuter emissions through partnerships with local transit and UC San Diego Associated Students, as well as completion of several projects identified by a student led program to improve bicycle access and safety.

In addition to actions to reduce its environmental footprint, UC San Diego has numerous academic and research programs focused on providing climate change education and solutions to meet the growing challenge of supplying clean energy for the future…many of which are being tested under real world conditions as part of the campus' living laboratory. For example the Center for Energy Research (CER) has groups working in the clean energy space in several areas, including:

- Development of forecasting models for integrating renewable generation into the utility grid and predicting energy demand.
- Applying cloud tracking and solar forecasting models to promote economic penetration of large amounts of solar generation onto the utility grid.
- Investigation of green engineering strategies to reduce energy consumption in urban areas.
- Energy storage research to determine how to more efficiently capture and deliver the growing amount of intermittent renewable energy resources to the distribution grid.
- Improving energy storage and fuel cell technologies.

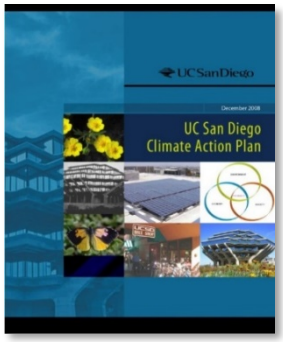


Energy Storage Lab

Faculty are also engaged in community projects like the inter-disciplinary "Deep De-Carbonization Initiative," which includes both technical and social science experts from across the campus.

In November 2013, the UC President implemented an initiative to achieve complete carbon neutrality in all scope 1 (direct) and scope 2 (indirect) emissions for all University of California operations by 2025. The initiative also requires campuses to achieve carbon neutrality including emissions from commuters and business air travel by 2050. As an interim step, all campuses are required by UC Climate Policy to reduce greenhouse gas (GHG) emissions to 1990 levels by 2020, pursuant to the California Global Warming Solutions Act of 2006. Additionally, campuses are required to:

- Exceed California Title 24 Energy Efficiency for new construction by 20% (30% when possible).
- Achieve LEED Silver certification (Gold when possible).
- Build new Labs to meet "LABs 21" energy efficiency guidelines.



In 2008, UC San Diego developed its first campus Climate Action Plan (CAP) for implementing the University's climate strategy to meet State and UC climate policies and objectives. Specifically, the 2008 CAP included the following goals:

- Reduce GHG emissions to 20% below 1990 levels by 2020 (AB 32).
- Achieve climate neutrality by 2025.
- Continue to certify buildings under the LEED rating system.
- Improve the energy efficiency of all electronic equipment.

As the campus moves into the future and towards meeting its carbon emission reduction goals, there are already many programs and projects in planning, design or construction including:

- Over $50M in energy efficiency retrofits.
- Extension of the Mid-Coast Trolley to UC San Diego, with service planned to start in 2021.
- Continued installation of new EV charging systems for both fleet and public use.
- Continuation of attractively priced electric vehicle dealer leasing and purchasing programs for UC San Diego faculty, staff, students, and retirees.
- Procurement of alternative fuel shuttles and other vehicles to replace aging fleet equipment.
- The North Torrey Pines Living Learning Neighborhood project. This high density mixed use project, which will be built to LEED Platinum standards as well as incorporate onsite renewable energy generation, is a prime example of the type of construction that needs to occur as the campus moves towards carbon neutrality.

While not yet programmed, there are also many other projects and initiatives on the horizon that will help reduce campus emissions.

2.2. Updating the Plan

This 2019 document, which is a complete revision of the 2008 Climate Action Plan, analyzes UC San Diego's current, historical, and projected emissions, then incorporates this analysis into a climate change mitigation strategy for meeting the UC carbon neutrality goals. The development of this updated CAP is based on work initiated by UC San Diego's Student Sustainability Collective (SSC), with support from campus staff. A carbon reduction plan developed by Burohappold Engineering forms the foundation for the proposed mitigation strategies and scenarios that are included in the CAP. A "Carbon Neutrality Charrette" was held in March 2016 with student, faculty, staff, and community representatives participating. Results from this charrette and subsequent stakeholder meetings, discussions and review sessions helped guide the development of the Carbon Reduction Plan and the CAP.

Striving to ensure that campus sustainability goals, including carbon neutrality, are core values of the ongoing campus transformation, a "Sustainable Building Charrette" was held in August 2018 to develop recommendations for incorporating new LEED and other emerging building standards such as WELL and ParkSmart into campus green building policy. The group will also develop recommendations for:

- Metrics to be used in measuring success of the campus green building program. These metrics will then be used in developing a life-cycle cost analysis model for campus projects.
- Ensuring that sustainability goals are incorporated into all campus real estate actions

The Sustainable Building Stakeholder group includes over 40 faculty, staff, researchers and students from across the campus, as well as green building experts from the San Diego community.

In developing the recommended strategies included in the CAP, the first priority was given to avoiding carbon intensive activities, followed by reducing campus energy use, then replacing high-carbon resources with low carbon resources, with the last option being to offset those emissions that can't otherwise reasonably be eliminated. This order of prioritization will help provide more transformative and lasting climate reduction actions.

Solar Trees, Hopkins Parking Structure

Achieving the goals outlined in this Plan are arguably some of the most ambitious the campus has undertaken, requiring the support and active involvement of all members of the campus community. To this end, good communications will play a key role in making sure that there is campus wide knowledge of and commitment for the UC Climate Neutrality Initiative (CNI) and the campus' Climate Action Plan. One of the top strategies coming out of the Carbon Neutrality Charrette was that Carbon Neutrality should be included in both the University's Strategic and Capital Plans to ensure that the CNI objectives are included in future decision making.

Energy Efficient LEED Certified Buildings

Funding will be one of the major challenges. While many of the initiatives identified in this plan are required to meet statutory requirements or other UC policies (meeting Title 24 energy standards for example), or can be accomplished with no additional funding, others will need financial support. Fortunately many of the projects such as energy efficiency retrofits will result in direct cost savings, while others, like using benchmark-based, whole building energy performance targets for new construction will provide long-term life-cycle cost benefits. Seeking out other funding options, including public-private partnerships, low-interest loans, and grant opportunities will help. Partnering with local, regional, state and federal agencies will also help identify new sources of funding. Finally, options such as a "carbon tax" included in the utility rate structure may be considered.

The UC CNI provides the target by which the University must set its low carbon course for the next six years. This update to the campus' Climate Action Plan sets out a potential balanced approach for achieving the 2025 carbon neutrality goal. Included in the plan are a set of core carbon reduction measures that includes many programs and projects that are either already underway or planned. Because a majority of the campus' total GHG emissions are from the burning of natural gas these cores measures alone will not get the campus to the 2025 CNI goal. As described in the CAP, the recommended approach for achieving carbon neutrality is based on a diversified portfolio of options that considers the addition of small-scale distributed renewable generation, as well as the potential future de-carbonization of the campus cogeneration plant. Achieving carbon neutrality by 2025 will require some level of carbon offset procurement, with the actual amount required dependent on the level of emission reductions achieved through the core measures, and the planned procurement of clean grid power through the UC Energy Service Unit's (ESU) Wholesale Power Purchase Program (WPP)

as well as directed bio-methane…it is projected that by 2025 about 40% of the campus' natural gas supply will be provided by the UC ESU renewable biogas supplies, depending on cost and availability.

In November 2018 the La Jolla campus' updated Long Range Development Plan (LRDP) was approved by the UC Regents, while an updated Hillcrest Medical Center (HMC) Master Plan and LRDP are under development. This Climate Action Plan supports these documents by providing strategies that can be incorporated into the qualified greenhouse gas reduction analyses/compliance checklists included in the environmental impact reports for each of the LRDPs. UC San Diego's commitment to mitigating strategies will be an important part of demonstrating how future development through 2035 under the LRDPs will comply with State regulations and the UC Carbon Neutrality Initiative. It should be noted that because the Hillcrest Medical Center campus is undergoing a major redevelopment effort, the full scope of which is unknown at this time, only current emissions data was used in developing this CAP. As new information and data become available the CAP will be updated to reflect these changes.

UC San Diego Engineers for a Sustainable World

While much of the focus of the CAP is on campus operations, this Plan is also intended to embrace the vision of a student-centered university using experiential learning techniques to provide opportunities for students to gain real-world experience. To this end it will be extremely important that students and student groups remain actively engaged in the CAP process. Providing research opportunities as well as independent course work for both graduate and undergraduate students should also be considered in implementing the CAP. Including faculty and campus researchers in the process will be vital to finding innovative new technologies that can help UC San Diego meet its CNI goals. In addition to faculty, every effort should be made to engage all staff and alumni in the CAP roll out process.

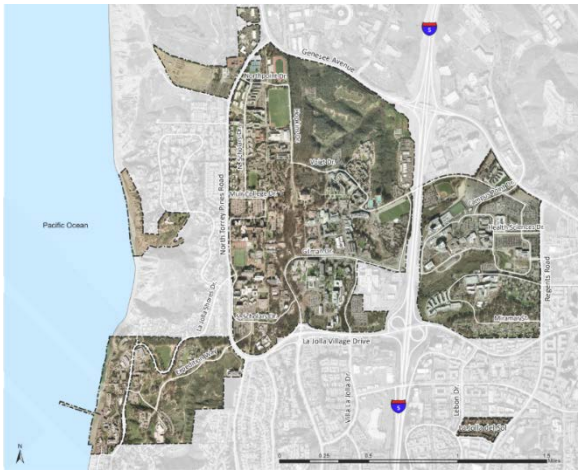
As the CAP evolves, continued support by campus leadership, faculty, staff, student groups and alumni will be needed to ensure that UC San Diego is able to meet its commitment to reduce campus climate impacts. The Climate Action Plan is intended to be a living document that will need to be continually evaluated, assessed and updated to document progress and identify next steps.

3. Greenhouse Gas Inventory

3.1. Scope of Emissions

UC San Diego Physical Scope

The UC San Diego (UC San Diego) main academic campus is located in the La Jolla community of San Diego, California. The university is located near the coast of the Pacific Ocean with the campus resting on approximately 1, 150 acres. Established in 1960, the University is organized into six undergraduate, three graduate and two professional medical schools. UC San Diego is also home to Scripps Institution of Oceanography and UC San Diego Health, the region's only academic health system, which in addition to its La Jolla facilities also includes the Hillcrest Medical Center.



La Jolla Campus

The La Jolla campus consists of over 630 buildings, with open space preserve lands covering about 335 acres. The San Diego Freeway passes through the campus and separates east campus, which includes Thornton Hospital, Jacobs Medical Center and Mesa graduate apartments from the central campus. The Preuss School, a college-preparatory school administered by UC San Diego, also lies on the eastern portion of the campus.

The layout of the main campus centers on Geisel Library, which is roughly surrounded by the six residential colleges and the School of Medicine. The six colleges maintain separate housing facilities for their students and each college's buildings are differentiated by distinct architectural styles. In addition to its academic and housing facilities, the campus features eucalyptus groves, the Birch Aquarium, and several major research centers. Scripps Institution also operates several open ocean vessels for marine research, which are berthed at the Nimitz Marine Facility located on San Diego Bay. Several large shake facilities used for earthquake simulations, are located 10 miles east of campus at Elliott Field Station.

UC San Diego Health's Hillcrest Campus is a comprehensive academic medical center housing several specialty care centers that allow the urban campus to serve as a major tertiary and quaternary referral center for San Diego, Riverside and Imperial Counties. These care centers include the area's only Regional Burn Center, a Comprehensive Stroke Center and one of only two Level I Trauma Centers in the county. The campus is also home to the Owen Clinic, among the nation's top HIV care programs. Today the Hillcrest campus comprises approximately 56 acres of which approximately 22 acres are developable, with the remainder being an environmentally sensitive area. The campus has about 1.1 million gross square feet (GSF) of built space that includes inpatient, outpatient, research/teaching, administrative and a small amount of residential services. The campus also has a central plant that provides heating and cooling for the surrounding buildings.

There is currently a complete update of the Hillcrest Master Plan underway. The reasons for this update include a need to replace the existing hospital to meet seismic code, replacement of outdated buildings, and a desire to bring the Hillcrest campus into alignment with UC system-wide sustainability policies. Included in the Master Plan is an increase in built space from approximately 1.3 million GSF to about 2.7 million GSF, which in addition to the facilities mentioned previously, will have a significantly increased residential component. The proposed build out will also include enhanced mass transit connections, greatly improved pedestrian and bicycle linkages, dedicated open space and facilities that promote healthy lifestyle choices.

Scope of Emission Sources

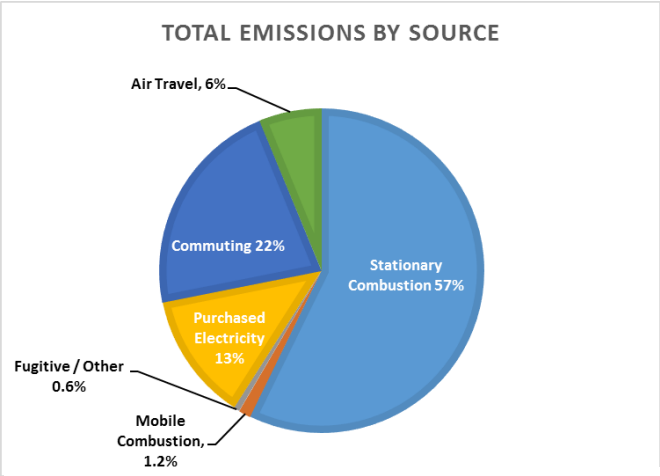


Figure 2: 2017 Scope 1, 2 & 3 CO2e Emissions

Annual emissions reporting to The Climate Registry (TCR) is the responsibility of UC San Diego's Environment, Health & Safety (EH&S) Department. As shown in Figure 2, UC San Diego's GHG emissions inventory includes emissions resulting from direct fossil fuel consumption, purchased utilities supplied to the campus through the local utility grid, commuter, business air travel, and other fugitive emissions including refrigerant use at facilities controlled by the University, including both the La Jolla and Hillcrest campuses, off-campus housing and other auxiliary facilities.

Each year, UC San Diego performs an audit of its emissions sources through "The Climate Registry." UC San Diego's annual GHG emissions inventory quantifies emissions in three categories:

Scope 1 – Direct Emissions: Stationary combustion; fugitive emissions; and campus fleet.

Scope 2 – Indirect Emissions: purchased electricity.

Scope 3 – University-funded air travel and student, staff, and faculty commuting.

3.2. Historical and Current Emissions

Historical Emissions

Since the 1990's and especially from 2004 on, UC San Diego has undergone a period of steady growth in campus population and infrastructure. Since 2004 there has been more than a 50% increase in gross square footage (MGSF). Despite this, as Figure 3 shows, the campus has decreased its emissions.

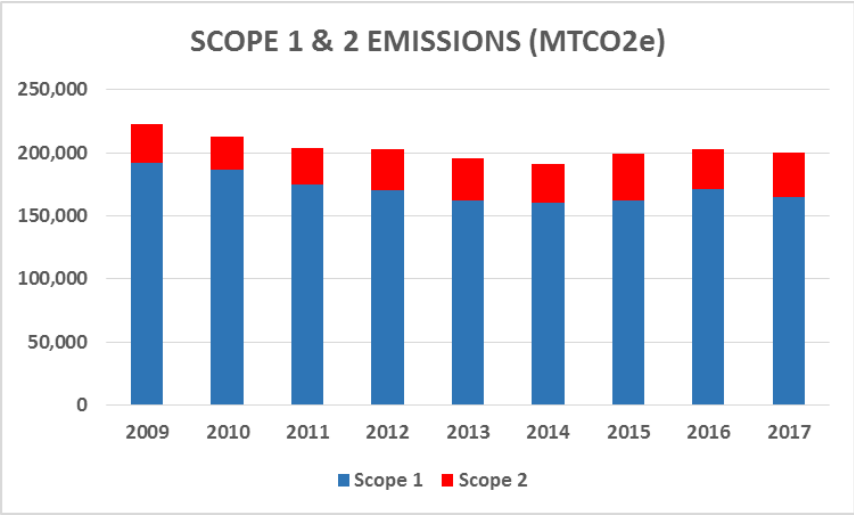


Figure 3: 2009 to 2017 Scope 1 & 2 CO2e Emissions

Implementation of an aggressive energy efficiency program, development of the campus microgrid and a strong commitment to reducing emissions from both the campus fleet and commuting, has enabled the University to reduce overall emissions since 2009. Figure 4 below shows the overall emissions by type during this period...there was an uptick in emissions starting in 2015, due to several new large facilities coming on line during this period, including the Jacobs Medical Center and Tata Hall.

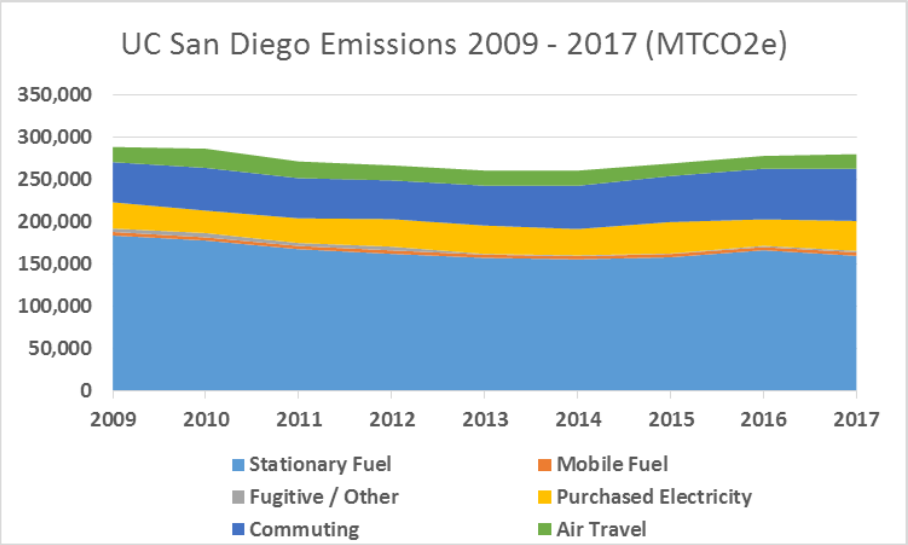


Figure 4: Historical GHG Emissions – 2009 to 2017

Since 2009 the campus completed about $100M in energy efficiency improvements, built a 2.8 MW directed biogas fuel cell and installed over 3 MWs of solar photovoltaic energy generation. As noted through 2014 this had helped the campus keep pace with growth.

Although commuting and air travel data back to 1990 is available, it is not thoroughly documented; however, the CAP uses the best estimations given the limited data available.

Current Emissions

Table 1 below summarizes UC San Diego's 2016 Scopes 1, 2 and 3 emissions reported to The Climate Registry (TCR). All emissions are reported in Metric Tons Carbon Dioxide Equivalent ($MTCO_2e$).

Table 1: 2017 Campus Emissions

GHG Emission Scope and Source - 2017 (Projected)	$MTCO_2e$	Percent of Total
Scope 1 – Stationary Combustion	159,607	57.2%
Scope 1 – Mobile Combustion	3,462	1.2%
Scope 1 – Fugitive/Other Emissions	1,737	0.6%
Scope 2 – Purchased Electricity	35,413	12.8%
Scope 3 – Commuting	61,564	21.9%
Scope 3 – Air Travel	17,547	6.3%
TOTAL	279,330	100.0%

Scope 1 emissions reported to TCR are calculated following a thorough analysis of current fuel and refrigerant consumption data for all UC San Diego operations and by applying fuel-specific emissions factors as prescribed by the TCR General Reporting Protocol (GRP).

Scope 2 emissions reported to TCR are calculated by applying the TCR Default Emissions Factor for the California sub-region. During calendar year 2016, UC San Diego's primary electricity transmission provider was the UC Energy Service Unit, who provides electricity to the campus via SDG&E's Direct Access program.

Scope 3 emissions reported to TCR include emissions resulting from University-paid business air travel and staff, faculty, and student commuting to and from campus. Air travel emissions calculations are based on estimated mileage calculations derived the Connexus travel system. Miles are converted to resultant GHG emissions using air travel emissions factors from the Clean Air Cool Planet Calculator. The UC Transportation Working Group and Climate Change Working Group expect to refine and standardize this calculation method for inclusion in further iterations of UC Climate Action Plans. Commuter emissions are based on accurate mode-split data derived from comprehensive campus surveys (actual counts) administered annually. Using guidance developed by the UC Transportation working group, GHG emissions for the entire population of the campus are calculated and updated annually. GHG-emitting transportation modes include single-occupancy vehicles, carpooling, vanpools, motorcycles, and public transit. These figures are adjusted for average ridership.

3.3. Projected Emissions

UC San Diego has experienced rapid growth over the past 10 years and is entering a period of even great growth. Today there are over 60,000 faculty, staff and students on UC San Diego's La Jolla, Hillcrest and other satellite facilities daily. This trend is expected to continue through at least 2035. The current UC San Diego 5 – 10 Year Capital Program was used to develop CAP projections through 2025. Currently there is 3,257,000 GSF of new development in planning, design and construction on the La Jolla campus.

A new La Jolla campus LRDP was approved in 2018. The Hillcrest Medical Center Master Plan and LRDP are now under development, with expected completion in 2019. Included in this planning effort will be the complete redevelopment and revitalization of the Hillcrest campus over the next 10 to 15 years. Because the full scope of this effort is unknown at this time, only current emissions data was used in developing projections for the Hillcrest campus. As new information and data becomes available the CAP will be updated to reflect these changes.

As noted, from 2009 to 2014 UC San Diego had reduced its emissions through energy efficiency, renewable energy generation, conversion of the campus fleet to low emission vehicles, and alternative transportation commuter programs, despite increased growth. However, as the campus continues to grow, these strategies will not be enough. As stated previously, over 3 million GSF of new development is currently in planning, design or construction. Reflected in the 2015 emission numbers, it can be seen that campus growth has started to outpace emission reduction measures so that, as Figure 5 show, campus growth is expected to increase campus emissions. UC San Diego's commitment to core carbon reduction measures and actionable mitigation strategies are needed now to ensure compliance with state and university policies.

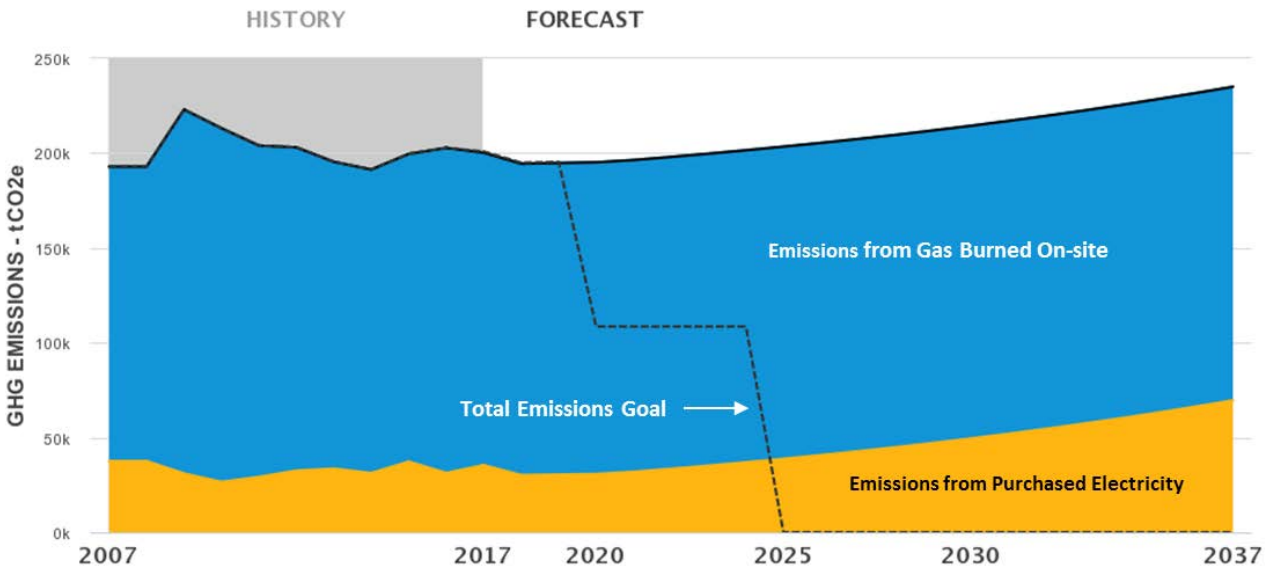


Figure 5: GHG Emissions Forecast (assumes no mitigation)

Emissions reduction targets

The Presidential Carbon Neutrality Initiative commits each campus to achieve carbon neutrality in scopes 1 and 2 emissions by 2025, and full carbon neutrality in scopes 1, 2, and 3 by 2050. Also, as described in the UC Sustainable Practices Policy, as an interim step each campus will reduce its greenhouse gas (GHG) emissions to 1990 levels by 2020. For comparison, projected emissions and the respective reduction goals for each of the target years are presented in Table 2.

Table 2: Emissions Reduction Targets

Year	Total Emissions In absence of Mitigating Measures ($MTCO_2e$)	UC Emissions Reduction Target ($MTCO_2e$)
2020	281,979	166,051
2025	295,889	57,508
2037	348,339	29,904

The first step in achieving the 2025 goal is avoiding and reducing emissions as much as possible, using the mitigation strategies described in Section 4 of the CAP. To meet both the interim emissions reduction goal of attaining 1990 emission levels by 2020, as well as the carbon neutrality goal by 2025 will require continued implementation of a diverse array of emission reduction strategies, including energy efficiency/conservation program implementation, increased renewable energy generation, and continued conversion of the campus fleet to low/zero emission fuels, as well as strategic purchases of carbon offsets and renewable energy credits. In addition, campus commitments to project level strategies that would further reduce carbon emissions, particularly in new construction, are important in order to facilitate compliance with state laws (AB 52, SB 52) and university policies (Presidential carbon neutrality policy) as documented through the California Environmental Quality Act (CEQA) process.

4. Mitigation Strategies

There is no one "silver bullet" solution to climate change. The set of recommendations analyzed in this plan tries to appropriately balance the following drivers:

- Environmental goals
- Infrastructure performance
- Capital and operational cost

A general approach has been taken that primarily seeks to directly reduce the University's carbon emissions and then offset that which remains. Given this, the recommendations in this report look to prevent emissions as much as possible while still meeting the University's critical research, safety, reliability, resiliency and cost effectiveness requirements. Reflecting these ideas, a set of "core carbon reduction measures" were developed, ranging from building efficiency retrofits to behavior change and improved space utilization. These measures form the basis of several scenarios that could be implemented to reduce campus emissions. While it is recognized that carbon offsets will play a role in meeting the 2025 carbon neutrality goal, their role should be reduced over time. A mix of offsets, including UC- Developed offsets are proposed, with an emphasis placed on ensuring a high level of verification and compliance.

4.1. Existing Building Energy Efficiency Planning

Management of the campus' energy efficiency program is a shared responsibility with Facilities Management (FM) having the lead for overall implementation and reporting. However, campus auxiliaries such as UC San Diego Health, Housing, Dining & Hospitality Services (HDH), and University Centers are responsible for implementing energy efficiency planning within their respective areas. To understand the potential for building upgrades, the current building stock was assessed in three ways:

1. Simple Building Audit.
2. Analysis of existing building energy data.
3. Interviews with key facilities and energy management staff.

The results of this process showed that:

- UC San Diego has a generally fair to high quality stock of buildings, in terms of building envelope and systems.
- The biggest energy users are the large laboratories, medical facilities and, to a lesser extent, office buildings on the central campus hot and chilled water loops.
- The 2008 Strategic Energy Plan (SEP) has delivered significant energy reductions and carbon savings, and should be continued. However, much of the low hanging fruit has been picked, meaning less cost-effective strategies remain. The worst performing buildings should be targeted first for the most cost-effective results.
- Opportunities remain for lighting as a cross campus strategy.
- There is opportunity for improved occupant feedback and data gathering.

Energy efficiency upgrades completed under the 2008 SEP has resulted in significant energy reductions, cost savings and carbon emissions avoided. The key strategies that were applied were:

- Variable Air Volume (VAV) retrofits.
- Monitoring-Based Commissioning (MBCx).
- Lighting upgrades.

Moving forward, existing buildings can achieve peak load and annual energy reductions through a range of Energy Efficiency Measures (EEMs). These EEMs can bring the building Energy Use Intensity (EUI), measured in kBTU/sf/year, down from current levels to realistically achievable targets. In order to make the largest and most cost-effective energy savings, the largest and most inefficient energy users should be targeted first. Because of their high ventilation requirement process loads, the largest energy users are generally the campus' over 900 laboratories. The most inefficient energy users are the older, under-renovated buildings. Therefore, the older laboratories that seem to be performing poorly should be targeted for energy savings first. Many of the older more inefficient mechanical systems in campus laboratories were targeted in the 2008 SEP. However, moving forward there is still more that can be done, and the SEP should be continued with particular focus on EEMs in the following categories:

- Lighting.
- Mechanical systems.
- Envelope.
- Monitoring Based Commissioning (MBCx).

Generally speaking, in older buildings that have not recently been renovated it will be more cost-effective to implement selected mechanical and lighting upgrades. Major envelope upgrades tend to have longer payback periods and may not be cost effective unless done as part of a larger renovation. Any package of measures would include a range of EEMs including mechanical, lighting and envelope upgrades. For minor renovations an ASHRAE level 2 or 3 audit should be completed, in order to determine the specific EEM package to be applied. The more poorly performing buildings will be targeted first for the largest and most cost-effective energy savings. Table 3 summarizes target EUIs to be input into the carbon model based on potential efficiency upgrades.

Table 3: UC San Diego Whole Building EUI Targets

Typology	Minor upgrade and retro-commissioning target	Major renovation target	UC target
Lab	380	292	292
Academic	196	74	74
Residential	68	58	58

Lighting Upgrades

LED replacement is an ongoing process that will be applied to all university buildings over the next several years to yield significant energy reductions.

Minor renovation, retro- and monitoring based-commissioning (RCx & MBCx)

Minor renovations are classified as upgrades that can be implemented without prolonged shut down of the building. Minor energy efficiency upgrades similar to the strategies implemented over the last 10 years as a resulted of the strategic energy plan, will include:

- Retro-commissioning of mechanical controls.
- Retro-commissioning of lighting controls.
- Minor mechanical system improvements.
- Minor exterior envelope treatments.
- Whole building Monitoring Based Commissioning.

Energy audits would be completed for each building to define the exact package of energy efficiency measures to be applied. Additional strategies associated with behavior change, controls and set-point optimization will also be considered. For replacing laboratory process equipment Labs21 (I2SL: Resources - Tool Kit) should be referenced as a guide for specifying the most energy efficient systems.

Major Renovation

For future major renovation projects when all systems are being replaced and modernized, building envelopes and systems would be fully upgraded where feasible. Following are examples of strategies that may be considered in the design of all major renovations:

Lighting:

- Centralized lighting management systems in buildings over 50,000 ft^2.
- Daylight enhancement systems such as Heliostats, light tubes, fiber-optics, internal or external light shelves, or refractive films.

Mechanical Systems:

- Automatic natural ventilation.
- Optimized HVAC zoning.
- Heat recovery on exhaust air.
- Right sizing of HVAC systems to ensure high operational efficiency.
- Insulated ductwork where practical.
- Shade all unshaded rooftop ductwork where practical.
- Create and enable economizer control on all VAV systems where feasible.
- If not already in place, install a comprehensive building energy management system.
- Occupancy based controls in all offices, classrooms and meeting rooms.

Building Envelope:

- Where practical, solar film or external shading can be considered to reduce solar heat gain.
- Application of highly reflective paint or reflective coating.
- Installation of phase change material (PCM) where heat gain would warrant mechanical cooling.

Major renovation measures for Laboratory Buildings

In addition to those noted above, the following core strategies should be considered in the design of all major laboratory renovations:

Mechanical Systems:

- Reducing air supply rates to the minimum allowed.
- Install auto-closing sashes and vertical and horizontal sash restrictors on large hoods.
- Enable sash-interlocked, constant face velocity fume hood control.
- Install heat/energy recovery on exhaust.
- Optimize HVAC zoning between wet labs, dry labs and office spaces.
- Insulate or replace all uninsulated chilled water and steam heat exchangers.

4.2. High Performance New Buildings

UC San Diego has consistently been a leader in designing and constructing highly energy efficient buildings, gaining significant recognition for integrating innovative mechanical and control system technologies into campus facilities. Often this has enabled these new buildings to achieve a 30% reduction above California Title 24 Building Energy Efficiency Code requirements, exceeding the UC Sustainable Practices Policy requirement of 20% above. UC San Diego has also been a leader in applying US Green Building Council Leadership in Energy and Environmental Design (LEED)) standards in the design of its facilities, with all new construction and major renovation projects required to achieve a minimum of LEED Silver certification, while striving to achieve a LEED Gold. Today the University has 37 LEED certified buildings, including 4 Platinum certifications.

Given the existing requirements for new construction projects, UC San Diego already has to meet a high standard in the design of its facilities. However, more can be done to reduce the energy and subsequent carbon impact of all new campus construction. Some key factors that need to be considered in the design of new facilities:

- Meeting Title 24 goals alone will not drive down carbon emissions.
- Energy efficiency is cheaper for new construction on a $/ft^2 basis because it is more cost-effective to include efficient features in a new design, as opposed to an existing building.
- It will be difficult to achieve "Net Zero Energy" (ZNE) design for new laboratory buildings and medical facilities, however, it may be achievable for less energy intensive administrative, academic and residential projects.

Design Development Services (DDS) in conjunction with Capital Project Management (CPM) are responsible for ensuring that all campus projects meet current State and UC energy efficiency requirements. In accordance with the UC Sustainable Practices Policy, UC San Diego has used Title 24 requirements as the baseline for meeting energy efficiency targets in new construction. However, benchmark-based, whole building energy performance targets, as described in UCOP's Sustainable Practices policy's alternative pathway for meeting Green Building design requirements, are now recognized as the best practice method for designing energy efficient buildings. Using energy performance targets provides a static baseline that allows for comparison of buildings over time, as well as enabling the capture of energy use and efficiency data for all building energy loads, not just the loads regulated by code. Performance targets also allow for the design targets to be carried through to operations.[1] If all new buildings planned were to meet the compliance targets set by UCOP (Table 3), the campus could reduce emissions from new growth by an average of 7,800 $MTCO_2e$ annually.

Moving forward new construction and major renovation projects should follow the alternative compliance pathway described in the UC Sustainable Practices Policy, with campus design standards adapted accordingly. Specifically, new construction projects will use the whole-building energy performance targets that correspond to the year of the project's budget approval. The whole-building energy performance target is expressed as a percentage of the sum of the Annual Electricity and Annual Thermal targets (converted to kBTU/gsf-yr) published as Table 1, UC Building Energy Benchmarks by Campus, Sahai, et al. 2014.

[1] Sahai, Rashmi, and Karl Brown. Benchmark-based, Whole-Building Energy Performance Targets for UC Buildings. Rep. University of California. Print.

Completed projects will demonstrate compliance based on the results of energy modeling that represents a best estimate of as-operated, whole-building energy use, before accounting for any on-site energy generation.

If as recommended, new construction projects are designed using benchmark-based, whole-building energy performance compliance targets, then it is estimated that an annual savings of 7,800 $MTCO_2e$ in annual emissions can be realized.

4.3. Renewable Energy

4.3.1. Onsite Renewable Energy

Osler Solar Array

UC San Diego has 3.5 megawatts of solar photovoltaic (PV) generating capacity installed at a combination of on-campus and off-campus sites, including the Hillcrest Medical Center, Nimitz Marine Facility, Elliott Field Station and the Trade St. Shipping & Receiving Center. Approximately 2.5 MWs are directly owned by the University, while 1 MW is owned by a third party with both the electricity and the associated renewable energy credits (RECs) being purchased by UC San Diego through a Power Purchase Agreement (PPA). The existing arrays include a combination of roof mount, parking canopy and ground mount systems. The planned renewable energy strategy builds on the existing deployment of PV arrays and sets a realistic goal of up to 4 MWs of new PV generating capacity by 2025, subject to funding availability. Where appropriate, solar thermal systems will be used for generating domestic hot water.

In addition to the above, the campus will consider the following for possible inclusion in the renewable energy strategy:

- **Anaerobic digestion:** Two options are being considered for composting campus food and other organic waste. Under the first the campus, through a third party would construct a large digester on campus owned property to process all organic waste and generate biogas for campus use or direct energy generation. Feedstock for the plant could be augmented by organic waste from the surrounding community. A second alternative would be construction of small distributed digesters to handle organic waste and generate energy. A small scale pilot digester was built by Engineers for a Sustainable World at the Rogers Community Garden to handle a limited amount of campus food waste.
- **Ground mount photovoltaic arrays:** Expansion of the existing ground mount solar array at Elliott Field Station. This would allow for lower costs achieved through the economies of scale from building a single large system. The renewable power generated could be credited to the campus either through the RES-BCT tariff or the UC Energy Service Unit's Direct Access program.
- **Satellite power generation:** Investment in small-scale power provision, in the form of biomass CHP and a second biogas-powered fuel cell, which would not only increase the campus renewable energy generation but would also improve campus resilience through diversity of fuel and method of power provision. It also allows the university to become acquainted with developing technology, especially in the area of biomass energy generation.

- **Research Opportunities:** A number of technologies have been identified as providing future potential small pilot projects that can help reduce campus greenhouse gas emissions. These should be considered for further investigation.

Possible funding could be provided either through Power Purchase Agreements with a third party providers for existing buildings, or through new capital construction projects, such as was done with the Osler Parking Structure and NTPLLN projects. At a minimum all new projects should have roof area allocated for solar photovoltaic and/or solar thermal systems.

4.3.2. Renewable Energy Procurement

Five Points Solar Project

As a Direct Access (DA) customer, UC San Diego obtains its purchased electricity via the UC Energy Services (ESU) Unit Wholesale Power Purchase Program (WPP). In addition to procuring clean grid electricity on behalf of UC campuses the UC Energy Services Unit has commissioned 80 MWs of solar generation in central California. As a DA customer UC San Diego is able to benefit from this clean energy resource. Through the WPP, by 2021, all grid power purchased by the campus will be 100% carbon neutral. In addition, starting in 2025 it is anticipated that approximately 40% of the campus' supply of natural gas will be from directed biogas also procured by the ESU.

4.4. Campus Fleet

Management and reporting of campus fleet operations is the responsibility of UC San Diego Fleet Services. Due to aggressive actions over the past several years to increase the number of alternative fuel vehicles in the campus fleet inventory, overall emissions from "mobile combustion" have decreased by about 12% even though the size of the fleet has increased by over 20%...leading to regional and national recognition for being one of the greenest fleets in the country. As a result, the campus Fleet's carbon footprint has decreased from 4% to less than 2% of the university's total GHG emissions. Today the Fleet consists of over 60% alternative fuel vehicles, including:

- Both full speed and plug-in hybrid electric vehicles (PEVs).
- Compressed Natural Gas (CNG) vehicles that use 100% renewable CNG ("Redeem" program).
- Diesel vehicles that are currently using R-100 renewable diesel.

The campus has a four hose fast fill CNG fueling station and an inventory of more than 150 Level 2 EV charging stations, as well as 4 DC fast chargers (DCFC). To meet the increasing demand for EV charging capacity, the University plans to have over 200 EV chargers available for fleet as well as workplace/public charging. As additional funding becomes available, the campus will continue to convert its fleet to alternative fuel vehicles to reduce even further the fleet's contribution to overall campus scope 1 emissions. Of particular note, the four DC fast chargers are directly supplied by electricity from an onsite solar photovoltaic system integrated with battery energy storage.

Solar Integrated Fast Chargers

As additional clean transportation alternatives become available, the University will continue to strive to be at the forefront of adopting these new technologies. Of particular interest, the campus is actively

exploring opportunities for electrification of the campus fleet, including the addition of electric shuttle buses, as well as Hydrogen Fuel Cell Electric vehicles.

This CAP forecasts an average annual reduction of over 3,000 $MTCO_2e$ in fleet emissions by 2025 through continued conversion to alternative fuel vehicles as sufficient funding becomes available.

The following actions will help the campus meet the goal of reducing fleet emissions to less than 1% of the total campus footprint:

- Continued updating as necessary of the "Acquisition and Disposition of University Vehicles Policy" which requires that all new vehicles "reduce greenhouse gas emissions to the lowest level possible, while increasing fuel economy and reducing operating costs."
- Ensure that all new passenger vehicles purchased for campus business meet the EPA's Smart Way/Smart Way Elite certification standards.
- Continue to expand and update the University's alternative fueling infrastructure including increasing the number of EV DC Fast Chargers, smart charging capable EV chargers, and investigation of on-campus renewable hydrogen production capability.

UC San Diego has already made significant progress in "greening" the campus Fleet, however, to continue this trend will require new and innovative sources of funding, and dedicated staff time to work on strategic planning, vehicle procurement programs, fueling infrastructure projects, and identification of new technologies for implementation.

4.5. Commute Options

In 2016 commuting accounted for approximately 22% of the campus GHG emission. To help reduce this impact, UC San Diego has developed a "Mobility Vision" where a majority of students, faculty and staff use alternative forms of transportation to get to and around the campus. This vision is tailored to the campus' unique mix of topography, layout, transportation infrastructure and climate. In addition to the environmental benefits, the vision promotes increased use of "active transportation" modes such as walking and bicycling, which have the added benefits of physical, social and mental health improvements as well as reduced transportation costs, and in many cases time savings. Other benefits that can be derived include reduced traffic, lowered parking congestion, and reduced campus parking infrastructure investments. Responsible use of "personal mobility" devices is also included in the plan.

The UC Sustainable Practices Policy includes several sustainable transportation goals that all campuses, including UC San Diego will need to meet to reduce their environmental impacts from commuting. Specifically, the campus will need to:

- Reduce its percentage of employees and students commuting by SOV by 10% relative to its 2015 SOV commute rates.
- By 2050, strive to have no more than 40% of its employees and no more than 30% of all employees and students commuting to campus by SOV.

In addition, to be consistent with State goals to increase the use of electric vehicles and the UC Sustainable Practices Policy UC San Diego will strive to:

- By 2025, have at least 4.5% of commuter vehicles be "Zero Emission Vehicles" (ZEV).
- By 2050, have at least 30% of commuter vehicles be ZEVs.

Over the past several years, UC San Diego has had an aggressive alternative transportation program that has resulted in a 20% reduction in single occupancy vehicle trips to campus since 2009. Alternative transportation options include:

- Public transit via local/regional bus networks, and the North County Coaster rail system.
- Vanpools and carpools, jointly managed by the University and SANDAG.
- Campus shuttle system that helps move people to/from and around campus.
- Bicycling and walking…the University has recently completed several high priority projects that were identified in the 2012 Bicycle and Pedestrian Master Planning Study that have improved campus "bikeability" and "walkability" making both safer and more accessible.

The University has also made a significant investment in promoting the use of alternative fuel vehicles for commuting, so that today there are over 400 EV drivers on campus, with that number growing rapidly. To support the growing demand for EVs, the University has already installed more than 150 level 2 chargers, and 4 DC fast charges, with many more planned. Other initiatives include:

- Providing low cost options through local dealers for UC San Diego affiliates to buy or lease EVs.
- Making the campus renewable CNG station available to all campus affiliates and the public.

Going forward the campus plans to continue promoting the use of alternative transportation options by increasing the number of publically available charging stations to over 200, as well as expanding the campus affiliate purchasing and leasing programs. Power supplied for the EV chargers will be from the 100% clean grid power provided by the Wholesale Power Purchase Program.

Working closely with local and state agencies, the campus has several projects underway that are expected to significantly increase the use of alternative transportation options by the campus:

- Gilman Drive Bridge: The recently completed Gilman Bridge provides a much needed link between the main campus and the east campus medical research and teaching facilities, improving pedestrian and bicycle access between the two.

Gilman Bridge

- I-5 Express Lanes/Direct Access Ramps (DAR): This project will provide I-5 High Occupancy Vehicle (HOV) lanes direct access to a reconfigured Voigt Bridge, incentivizing increased carpooling to campus by providing HOVs a direct entry point to campus.
- Light Rail Transit Mid-Coast Corridor Transit Project: This project extends San Diego Trolley service to UC San Diego via the Mid-Coast Trolley Blue Line. Construction began in fall 2016 with service anticipated to start in 2021. Addition of the trolley will provide direct public transit link for over 25% of campus commuters.
- Coastal Rail Trail: The recent completion of the Coastal Rail Trail through the UC San Diego campus along Gilman Drive provides a regional connection for bicycle commuting and creates a connection between the north, central and south San Diego County regions.
- Bike Sharing: UC San Diego recently established a campuswide bike sharing program through a third party provider. This program has greatly improved campuswide bike mobility.

The current La Jolla campus Long Range Development Plan (LRDP) calls for building enough new housing so that 50% of eligible students can be housed on campus. This additional housing will reduce the need for students to commute to campus, while also decreasing the campus' transportation impacts on the region. Although commuting emissions will be reduced as a result of more on campus residents, the impacts of increased campus infrastructure will need to be taken into account.

Funding will always be the greatest challenge for transportation and the most affordable modes of transportation are not always the preferred option. Convenience of mass transit programs will always be a significant barrier to new ridership transitioning away from automobile use, expanding the services and infrastructure when possible on campus will help improve their convenience and use. Funding options include subsidies from parking fees as well as student fees, however, both of these are limited resources. Most likely, future financial models will be a hybrid of partially subsidized transit supported by user fees.

Another challenge is that many of the public transportation decisions are outside of UC San Diego's control. Campus leaders will need to continue to work with other agencies and groups to expand public transportation to the area. A strong partnership between the campus and the two regional transportation agencies MTS & NCTD and the two major government bodies that most affect transportation infrastructure, SANDAG and the City of San Diego, needs to be maintained. This strengthened partnership will continue to yield alternative forms of funding and create new opportunities for UC San Diego.

The addition of EV charging infrastructure, growth in the number of EV drivers, and completion of the Light Rail Transit expansion will help the campus reduce the impact of commuter related emissions. Even with the projected campus growth UC San Diego remains committed to meeting its goals.

4.6. Air Travel

In 2017 emissions from business air travel accounted for a little more than 6% of UC San Diego's total emissions. For the campus to achieve its carbon reduction goals, it will need to find ways to mitigate these emissions. In keeping with the concept that the first priority in reducing emissions is avoidance, the campus will look for new and innovative ways to reduce air travel miles. For example, video conferencing is now readily accessible and should be considered first before planning in person meetings. In addition, an outreach program to faculty and staff educating them on the importance of reducing air miles and options available for not traveling will be explored.

Beyond reducing air miles, the campus is exploring options for offsetting carbon emissions through the establishment of an internal program where the cost of carbon offsets would be included in the cost of the travel. The funds from the offsets would be used to directly support campus carbon reduction programs. The campus may also want to explore adopting commercial available air travel offset programs such as the Good Traveler.

As described in UC San Diego's 2008 Climate Action Plan the University committed to reducing GHG emissions 7% per year through 2020, with a decrease of 5% per year from 2021 – 2050. In addition to GHG emissions, reductions in travel miles will also provide significant savings in travel costs.

4.7. Space Utilization

Campus Planning, in addition to individual departments on a case-by-case basis are responsible for space management. While a space utilization study has not been completed for the campus, it can be reasonably assumed that at least 10% and perhaps as much as 20% of existing campus space is currently under-utilized. By making better use of this space, the University can avoid new construction and reduce the associated carbon emissions from reduced overall operational energy consumption. A strategy of improved space utilization would be a win-win solution for the entire University.

Space is normally under-utilized for the following reasons:

- Space lying idle because space resource cannot be efficiently matched to space need. This is normally due to a lack of centralized space management and separately managed departments.
- Inefficient space design, such as a large number of cellular offices and a small number of shared working environments.

These inefficiencies could be combatted with the following strategies:

- A centralized space management system that can match available resources to need.
- Redesign of inefficient spaces to allow for a greater number of people to work in a smaller area. Any such redesign should provide an opportunity to improve space programing and staff interaction, where possible, not to increase occupant density to a detrimental extent.

As well as the above measures, the following steps can be taken to better utilize space:

- Flexible work options that allow some staff and faculty to work from home.
- Hot desking, in which a slightly reduced number of work stations are shared, on the assumption that not all staff are present at the same time.
- Maximized use of outdoor space for common areas, dining, fitness, and classroom facilities. This measure is not likely to avoid new construction but may reduce indoor operational energy use.
- Minimized computer labs: These spaces could be minimized with a push towards work stations with plug-in areas without desktops, encouraging more laptop use, which saves energy. A certain number of computer labs will be maintained, however, for those staff and students who do not have access to laptops.

The following assumptions were assessed in studying the potential benefits of improved space utilization, as well as the financial and carbon costs involved:

- Lab space is under-utilized by at least 10%, and a centralized space management system could better match needs to resources, thereby reducing the need for construction of new labs.
- The functionality of outdoor space could be improved with better lighting, Wi-Fi hotspots, electrical connections, shade structures, and furniture.
- Establishment of flexible work options for administrative staff -- supported by investment in laptops, secure VPN connections, docking stations and an increased software library would allow more staff to work from home and reduce the need for new construction.

Based on the results of the study, the following measures are recommended:

- Completion of a space utilization study to determine extent and location of under-utilized space.

- Development of a centralized space management system so that space needs can be better matched with available space resources.
- Consolidation of certain academic and administrative spaces into shared work spaces.
- Implementation of a flexible work program combined with "hot-desking" for administrative staff and selected faculty.
- Development of more outdoor spaces for increased academic and administrative use, coupled with expansion of computer touchdown spaces to reduce the need for computer lab space.

Implementing these suggested strategies could result in a total emission average annual emission reduction of over 600 $MTCO_2e$ /yr.

4.8. Behavior and Institutional Change

Changing institutional structures and people's behavior can significantly reduce carbon emissions in a variety of ways. Like improved space utilization, institutional and behavior change are potential win-win measures when it comes to reducing capital investment and carbon emissions. Energy conservation can be accomplished through programs that inform energy consumers of current and historical consumption levels, provide them with examples of energy-saving measures and activities, and give frequent, even real-time, feedback on how their energy use compares to social norms. In addition, a successful program builds on making users "energy aware" by motivating individuals to get involved, identifying and supporting committed individuals, and rewarding users for reducing energy waste. The following broad types of measures are included in this plan for further investigation and implementation:

- Institutional change: Changes to University departmental structure, management structure, management operations or policy.
- Behavior change drivers: Establishment of systems or programs that encourage/compel staff, students and faculty to adjust their energy consumption habits.
- Behavior change actions: Those personal actions that directly save energy or can directly result in carbon emission reduction (e.g. campus commuting).

Institutional Change Strategy

A number of intuitional change opportunities have been explored. The following summarizes key recommended strategies:

- Appoint representatives in each building to be responsible for monitoring energy use, and providing information on carbon reducing alternatives, such as commuting options.
- Set up financial structures so that lab managers and building operators can be financially responsible for their own energy costs. Consider adding a carbon tax to utility rates.
- Include energy efficiency requirements beyond Energy Star in University-wide and any departmental or college sustainable purchasing requirements.
- Review data handling infrastructure with a view to consolidate server rooms. Also consider cloud-based data management for selected processes.

Behavior Change Strategy

A behavior change strategy is a crucial component of any carbon reduction plan. A concerted and sustained effort will be made to transform campus culture to one of personal climate responsibility. This will have a two-fold benefit:

- Higher success rate of the carbon reduction measures by focusing attention on the problem.

- Enabling further carbon emission reductions to be made through changing personal habits.

A coordinated behavior change program should include the following elements:

- Promoting a mindful campus:
  - Manual operation of windows: Facilitate passive design by promoting the use of manually operable windows in non-laboratory buildings to take advantage of passive cooling.
  - Turning off lights: Promote culture of awareness around lighting energy savings until all lights can be upgraded with occupancy sensors.
- Increasing awareness:
  - Include regular carbon neutrality/resiliency section to the UC San Diego Sustainability newsletter and social media detailing progress made towards 2025 and 2050 goals.
  - Permanent website front page carbon section/link.
  - Prominent energy/carbon dashboards in all buildings over 50,000 square feet.
  - Showcase campus STARS (Sustainability Tracking, Assessment and Rating System) report.
  - Emphasize sustainability during orientation to encourage students to commit to the University's carbon neutrality goals at the earliest opportunity.
  - First Year Residential Program: Use the growing high rate of first year students living in on-campus housing to stress sustainable practices in residential hall and council programming.
  - Embrace Adaptive Thermal Comfort Criteria: Encourage acceptance of raised set points in targeted areas to reduce cooling and heating energy.
  - Sustainability and building energy management training for building and facilities staff.

A number of programs on campus promote behavioral change and reduce energy waste, such as the Green Office and Green Labs certifications programs, EcoNauts and residential hall energy efficiency competitions. However, more aggressive efforts will need to be taken in order to meet the emissions reduction goals needed to achieve carbon neutrality.

4.9. Carbon Offsets

Assuming that the University adopts the strategies described in this CAP, that starting in 2025 at least 40% of the campus' natural gas supply is from biogas, and that direct access purchased grid power is 100% renewable, then the campus will need to purchase about 75,364 $MTCO_2e$ of carbon offsets in 2025, at an initial cost of about $1.7M, to achieve carbon neutrality. Measures that retain value for the campus, such as additional energy efficiency or renewable energy projects, are preferable to purchasing offsets. However, options for investing in projects that support research, student projects and enhanced carbon sequestration on UC land through UC developed offsets is being is being pursued through a UC systemwide initiative.

Table 4: Current Value of Carbon Offsets

Offsets	2025 Projected Cost ($/MTCO2e)
"Golden Offsets"	$21.80
"UC Developed Offsets"	$23.90

Note: Weighted average includes a mix of offsets that includes Gold Standard and UC developed

Carbon offsets can be purchased in compliance and voluntary markets. UC San Diego currently participates in the California cap-and-trade compliance market using carbon offsets to cover approximately 8% of its compliance obligations. In 2017, the campus bought 11,902 MTCO2e in compliance offsets. While further evaluation of the proper mix of offsets that will need to be purchased to meet the CNI goals is needed, the campus preference is to maximize the use of "UC developed" offsets. Based on the projected 2025 costs shown in Table 4, this would result in an estimated 2025 weighted cost of $23.05 per $MTCO_2e$, with an annual escalation of about 2%.

5. Scenario Analysis and Recommendations

As stated in the introduction, there is no one solution that will enable UC San Diego to meet its goals, but rather several different measures and approaches will need to be implemented if the campus is to become carbon neutral in a cost effective, operationally supportable manner. To accomplish this will require an appropriate balance of the following drivers:

- Environmental goals
- Infrastructure performance
- Capital, operational and carbon costs

In preparing this Plan, a general approach was taken that primarily seeks to directly reduce the University's carbon emissions and then offset that which remains. To accomplish this the Plan attempts to lay out a strategy that enables the University to prevent emissions as much as possible while still meeting the University's academic and research missions. In analyzing the possible options to be included in any final strategy and as described in the previous sections, a core set of measures were developed that include the following elements:

- Continuing to pursue aggressive energy efficiency for new and existing buildings.
- Procuring clean grid electricity from the UC Wholesale Power Purchase.
- Improved space utilization, institutional culture and behavior change.
- Expanded campus fleet conversion to alternative fuels.
- Additional on-site distributed renewable energy generation.
- Continued commitment to reducing commuter and air travel related emissions.

Because over 60% of the campus' total GHG emissions are from the burning of natural gas, primarily at the campus' cogeneration plant, these core measures alone will not get the University to carbon neutrality. To accomplish this, several scenarios were developed and analyzed to determine a recommended approach for achieving carbon neutrality. In addition to the previously mentioned drivers, the ability to maintain the following key campus values was included in the decision process:

- Resiliency
- Redundancy
- Reliability
- Safety

These key values along with the core measures form the basis of the scenarios that were analyzed to determine the best approach for addressing campus carbon neutrality. While it was recognized that carbon offsets will be needed to meet the 2025 carbon neutrality goal, over time it is envisioned that their role will lessen as the campus implements the selected emission reduction measures.

In reviewing the options, UC San Diego has determined that the most cost effective and reasonable strategy for achieving carbon neutrality is to use a diversified approach that includes the core carbon reduction measures, procuring offsets and eventually considering de-carbonization of the cogeneration plant after 2032. De-carbonization could take one of several paths, including:

- Complete electrification using clean electricity from the UC Wholesale Power Purchase Program (WPP), possibly augmented with clean energy supplied by the San Vicente Energy Storage project, which UC San Diego and the University of California have the potential to participate in.
- Conversion to 100% bio-methane supplied by the UC Energy Services Unit.
- A hybrid approach with clean electricity provided to the campus by the WPP and 100% bio-methane used for campus boilers and other heating requirements.

Over time it is envisioned that new technology, such as renewably produced hydrogen for augmenting the natural gas supply, may also be adopted. In the meantime, other options to be considered include:

- Small scale distributed energy generation using renewable resources.
- An Anaerobic digester to handle campus organic waste and provide renewable energy.
- A Seawater Air Conditioning System to augment campus cooling.

This approach suggests that the University seeks to balance the following goals:

- Reduced purchase of offsets.
- Increased campus resilience through:
    - Diversification of fuel type and power production.
    - Diversification of heating and cooling sources.
    - Increase in thermal and energy storage.

This approach would enable the university to continue the use of the cogeneration plant so that it does not become a stranded asset.

Also considered in this scenario are the results of the detailed "Campus Energy Systems" report that was completed as part of the Hillcrest Medical Center (HMC) Master Planning Study. In analyzing the projected energy requirements for the proposed re-development of the HMC campus, several options were considered, taking into account the following criteria:

- Operational requirements.
- Life-cycle costs.
- Alignment with overall masterplan buildout and phasing.
- Ability to achieve carbon neutrality goals.
- Need to provide a high degree of redundancy, reliability, and resiliency.

The report includes possible strategies for providing on-site renewable energy generation, including installation of about 1.4 MWs of solar photovoltaic generation capacity, which could support from about 2% - 5% of total annual energy use. The report also presented several options for replacing the existing Hillcrest Medical Center central plant based on the assumptions that as much as 40% of the natural gas supply could be from bio-methane resources and that the grid electrical supply would be from 100% renewable energy. Possible scenarios analyzed included various combinations of conventional chiller and steam plants, plants with heat recovery chillers and heat recovery steam generation, cogeneration, and all-electric plants with point of use steam/high temperature hot water generation. Thermal energy storage and battery energy storage capacity is also considered.

The disadvantage of the proposed diversification strategy is that it fails to meet the carbon neutrality goal through on-site measures. However, it does present a broader strategy that gives flexibility and addresses the important factors of energy infrastructure resilience and survivability in the long term, as well as addressing carbon neutrality in the short term.

Recommended Strategy:

Figure 6 represents the proposed strategy presented as a wedge diagram. This shows the impact of various measures on total university scope 1 and 2 carbon emissions between 2015 and 2037. While detailed modeling has been conducted for the years up to 2025, for the years beyond greater assumptions were used in generating the wedge profiles. While this strategy is the "recommended" path, this should only be considered as a very general plan for achieving carbon neutrality – as campus priorities change and new technologies are developed, the specific details will continue to evolve and should be further evaluated for inclusion in future CAP updates.

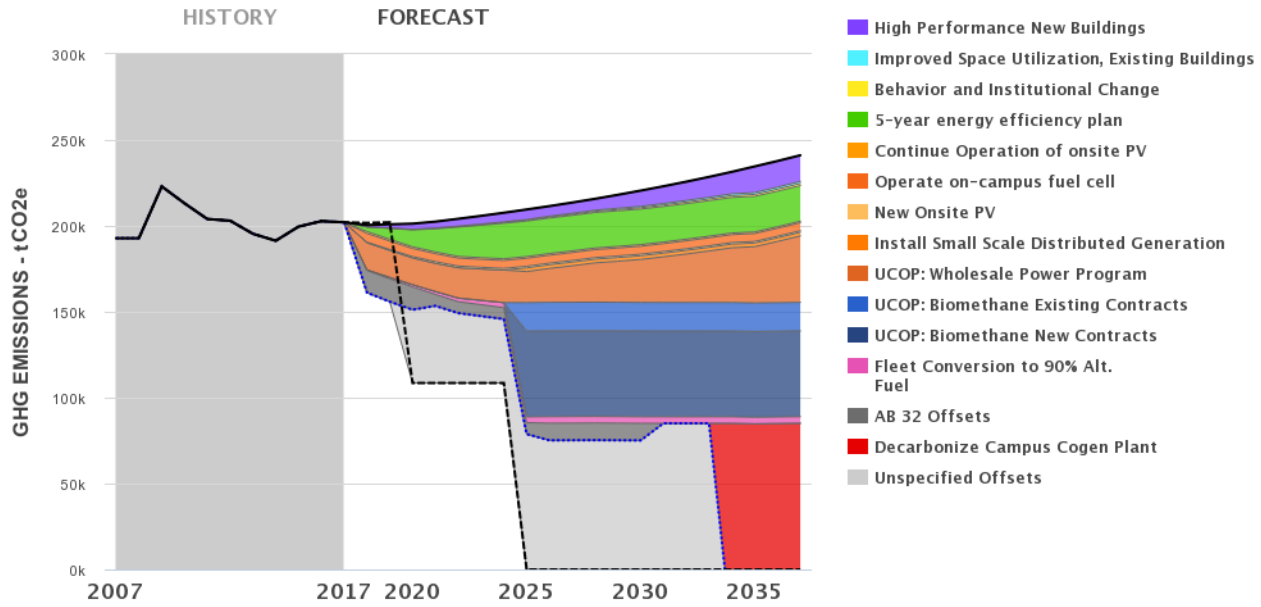


Figure 6: UC San Diego Scope 1 and 2 Greenhouse Gas Abatement Wedge through 2037

6. Water and Waste

Scope 3 emissions from the import of both potable and recycled water to the campus as well as campus generated waste sent to landfill are not currently included in this Plan. However, it is acknowledged that there are GHG emissions related to both and there are currently UC systemwide efforts to evaluate and quantify these emissions. Meeting the UC goals noted below will help reduce the potential future impact of these emission sources:

- Reduction of growth-adjusted potable water consumption by 36% by 2025.
- Achieve zero waste by 2020. For purposes of meeting this reduction goal, a 90% diversion of municipal solid waste is considered minimum compliance.

UC San Diego has both a Water Action Plan (updated 2017) and a Solid Waste Diversion (under review) to help guide the campus in meeting these goals.

7. Future Opportunities

In addition to actions currently identified for CAP implementation, there are a range of measures that provide GHG mitigation opportunities that are not currently feasible for implementation. This includes emerging technologies being developed through UC and UC San Diego research programs that could feed into future GHG emission reduction projects, but are not yet technically or economically feasible. These measures will be monitored as part of CAP implementation and adopted as part of the CAP portfolio when/if they become available. Some opportunities that might be on the horizon include:

- **Advanced Energy Storage.** The Center for Energy Research (CER) is working on adapting energy storage technology to optimize renewable energy integration into microgrid operation, reducing operational costs and GHG emissions.
- **Solid oxide fuel cell (SOFC) technology.** CER investigators are actively working on innovative concepts to improve the durability and system efficiency of SOFCs.
- **Optimization of materials that store and convert energy at a high efficiency.** Researchers with UC San Diego's Laboratory for Energy Storage & Conversion (LESC) are conducting basic and applied research to design and develop more efficient energy storage systems and materials.
- **Carbon emission capture from fossil fuel combustion.** UC Irvine researchers are pursuing work to demonstrate "at-scale carbon sequestration" of emissions from natural gas powered energy plants. UC Irvine researchers have also implemented a pilot project to inject renewable hydrogen into the campus natural gas supply.
- **Carbon Sequestration.** Researchers from several UC campuses are pursuing work in the capture and long-term storage of carbon. Opportunities include sequestration in biomass through biochar, organic mulch or other materials applied to soil supporting campus community gardens and vegetated/forested areas.

8. Implementation and Monitoring

8.1 Implementation

As mentioned previously CAP implementation will consider the following drivers, based on funding and technology availability:

- Environmental goals
- Infrastructure performance
- Capital, operational and carbon costs

Additionally, any decisions regarding future carbon reduction strategy implementation will ensure that the campus maintains at a minimum the same level of resiliency, redundancy, reliability and security currently provided.

8.2 Monitoring

The progress of the CAP will rely on annual monitoring and management. Annual tracking through inventory and reporting of GHG emissions by source will be used to compare forecasted emissions against predicted emission reductions based on completed mitigation measures. Metrics collected as part of the monitoring process will be used to update and calibrate the CAP. Updated information will be reflected in periodic updates completed on a 3 year cycle. Emerging technologies and other project opportunities will be assessed annually to determine if new CAP actions should be adopted.

9. Climate Resilience and Adaptation

In addition to implementing actions to abate GHG emissions, UC San Diego will need to establish the resiliency to withstand climate change-induced disruption to its facilities, systems, and community and to mitigate the impacts of climate change. This will require actions that develop the capacity to anticipate, adapt, and continue to thrive in the face of these changes. Ensuring that any measures or strategies that are implemented continue to provide the same level or higher of redundancy and reliability will help increase the overall resiliency of the campus.

UC San Diego's teaching, research, and health care mission are critical to the communities that it serves. The University must continuously monitor changes in the external environment and develop the adaptive capacity to avoid or minimize climate-related disruption to UC San Diego's mission and operations. Climate related risks to the University's mission include:

- Severe weather events and wild fires.
- Increased temperature, humidity and persistent or severe drought.
- Loss of urban forest and natural habitat areas.
- Sea level rise.
- Economic and social impacts related to these potential risks.

As part of annual CAP monitoring and reporting, UC San Diego will assess short term impacts and long term trends that may affect the University's mission and recommend actions such as contingency planning and emergency planning, systems and facility needs, and community needs.

The impacts of climate change are not limited to the campus as they will affect communities throughout the San Diego region. One of UC San Diego's strategic goals is to "support and promote just and sustainable forms of economic development, shared prosperity, and social and cultural enrichment regionally and globally." Helping to build community capacity to deal with a constantly changing climate and resulting extremes directly supports this goal. By supporting community resilience, UC San Diego will seek to engage the underrepresented communities on the campus and in the region that are most adversely affected by the changing climate—typically those of low-income.

UC San Diego will create institutional structures to guide development and implementation of community partnerships in climate change planning and resilience building. These structures will enable UC San Diego to better support community resilience by aligning our campus' academic, research and operational climate change efforts with community goals by taking actions to make resilience a part of the curriculum and other educational experiences for all students and taking actions to expand research in resilience.