carbon neutrality roadmap

SONOMA STATE UNIVERSITY








carbon neutrality roadmap

The leadership shown by SSU President Judy Sakaki in signing the University Presidents' Climate Commitment on April 5, 2019, set in motion a series of efforts to not only substantiate our commitment, but to address climate change in ways that go beyond the boundaries of our own carbon footprint. We have charted a path to carbon neutrality by 2043 and started creating a Climate Action Plan to get us there. With clear targets in place, now students, faculty and staff will start working towards our goals to support the campus, our community, and the planet.

In the coming months we intend to synthesize ideas, strategies, comments and information from all stakeholders into concrete actions that will reduce our carbon emissions, improve the health and vitality of our campus and community, enhance our resilience to climate-related events, help us become better stewards of our environment, and inspire students to magnify our efforts here to greater effect around the world. The 1.5 degrees C tipping point is not far off, but we have the tools, creativity, and willpower to change our trajectory. Let's get to work!

Megan Varnadore

Megan Varnadore
Director of Resiliency and Sustainability Operations

TABLE OF CONTENTS

PREPARED BY:
Optony
EcoShift Consulting, a division of Blue Strike Environmental

EXECUTIVE SUMMARY

As a member of the 23-campus California State University system, Sonoma State University (SSU) is proud to serve a diverse student population on campus, its three environmental preserves, and satellite campuses. In 2019, President Judy K. Sakaki signed two seminal documents to guide the future of SSU towards sustainability, equity and community engagement. “Building Our Future: Strategic Plan 2025” highlights the university’s commitment to the core values of diversity and social justice; sustainability and environmental inquiry; connectivity and community engagement; and adaptability and responsiveness. The “Presidents’ Climate Leadership Commitment,” a program of Second Nature, committed SSU to draft a Climate Action Plan that lays out a pathway for achieving carbon neutrality, increasing regional resilience, and integrating sustainability across curriculum and research.

This document, the Carbon Neutrality Roadmap (CNR), addresses the carbon neutrality portion of the Climate Action Plan. The goal of the plan is to achieve carbon neutrality by 2043. Carbon neutrality is defined as reducing of campus greenhouse gas (GHG) emissions to zero (i.e., net zero emissions). This bold commitment necessitates ambitious strategic policies and programs that are outlined in this report.

APPROACH

The CNR ensures that the Climate Action Plan is an actionable, relevant document that can guide all efforts to meet SSU’s net zero emissions goal. The CNR includes tools needed to track progress towards its goals. SSU will provide updates on climate neutrality goals through Climate Action Plan reports required annually by the Presidents’ Climate Leadership Commitment to Second Nature.

REPORTING TO SECOND NATURE

As CNR strategies are implemented over time, progress is captured using the Climate and Energy Scenario Analysis tool (CESA). This progress is then reported to Second Nature through the STARS (Sustainability Assessment Tracking & Rating System) framework.

The following **four strategies** are needed for SSU to achieve carbon neutrality:

- Reduce building electricity consumption with energy efficiency. This will require a budgetary commitment towards new energy efficient technologies (lighting, HVAC recommissioning, and other various building systems).
- Achieve 100% building electrification (e.g., replace fossil fuel energy sources with heat pump water heaters). This will require a budgetary commitment towards new mechanical systems.
- Replace fossil fueled vehicles with electric options. This will require a budgetary commitment towards the purchase of new electric vehicles and infrastructure for charging.
- Implement behavior change actions with conscious focus on social and environmental impacts.

Beginning now, the campus must begin to align its budget core values towards the reduction of GHGs. To achieve carbon neutrality by 2043, the campus must start making a budget commitment towards those goals today.

RESOURCES REQUIRED

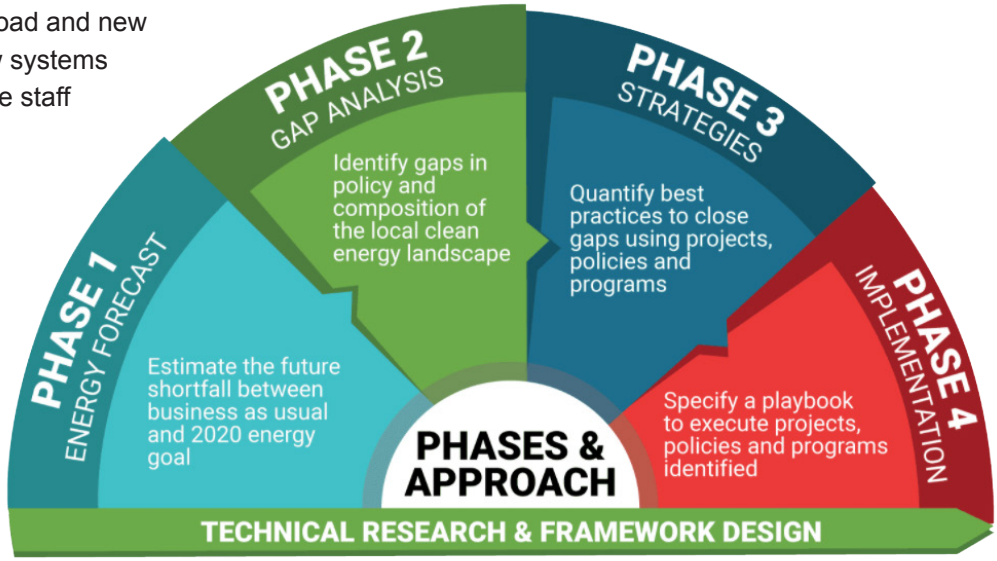
This report includes a thorough breakdown of all costs and benefits associated with the individual projects and the scenarios outlined above. Net Present Values (NPVs) for each scenario are also presented. The NPV is positive for all the scenarios and for the majority of individual projects. However, to achieve the benefits of positive NPV and GHG reduction, this CNR will require an investment by SSU. Depending on the pathway SSU takes, capital costs will range from an average of $1.4 million per year to $2.5 million per year. These costs include several large scale investments in the Central Plant and in building electrification. However, the **net present value of these investments is overwhelmingly positive, meaning that cost savings far outweigh the costs of implementation**. Cost savings accrue primarily from a reduction in energy used, and cost of maintenance savings.

The investments in many projects will become more costly the longer they are delayed. It will require a commitment from SSU to invest up front to realize the financial and GHG reduction benefits that these projects will bring. The greater the level of initial investment,the greater the financial and environmental reward. SSU has an opportunity to lead by example and take the necessary steps to reach carbon neutrality by 2043; in the process the campus can benefit from significant cost savings that could be used for other timely investments.

Implementing the CNR will also necessitate more staff and additional training for existing staff. Managing the recommended projects requires a dedicated FTE staff person. The additional workload and new technical expertise needed for the new systems will likely also require new maintenance staff and training for existing staff.

To assess the specific actions needed we divided the CNR into **four phases**:

1. Baseline and Emission Forecast
2. Framing the Gap Analysis
3. Scenarios and Individual Strategies for Implementation
4. Implementation Timeline and Budget



RECOMMENDED STRATEGIES

Recommended strategies were determined using specific, measurable, achievable, relevant, and timely (SMART) considerations. These specific measurements allow SSU to follow a concrete time frame for strategy completion driven by the feasibility and costs of each action. SSU utilized the Climate and Energy Scenario Analysis (CESA) tool to test and create various pathways to carbon neutrality. The recommended strategies (Figure A) are combined into scenarios that align growth, phasing, and infrastructure investment over various time horizons. These scenarios can be adjusted as market trends change and to account for budgetary uncertainty.

Three primary scenarios were developed, differentiated by the level of investment required. Level 1 scenario is based on the installation of six solar PV projects on campus property, full replacement of fleet with electric vehicles (according to the existing schedule), and over 60 energy efficiency measures from lighting to HVAC retrofits. It also includes vital repairs to HHW leaks and optimizing HHW controls. The Level II scenario includes all the measures from Level I, but adds additional energy efficiency measures including a series of retro-commissioning and building electrification projects. Level II also adds a heat recovery chiller to the central plant. Finally, the Level III investment includes projects in Levels I and II, but adds additional building electrification, and an air-source heat pump for full electrification at the central plant. The Level III scenario is the only one to achieve full carbon neutrality without the use of carbon offsets. For a complete breakdown of each scenario, refer to Phase 3.

SCENARIO	KEY CHARACTERISTICS	CONSIDERATIONS	IMPACT
LEVEL I	6 Solar projects with installations in 2022, ‘24, ‘26 and ‘30 Fleet Replacement with EVs according to existing schedule Lighting and HVAC retrofits completed over next ten years, plus base central heating upgrades[1]	Follows SSU’s standard HVAC and fleet replacement schedules Additional cost considerations (price premiums) Benefits of improvements accrue more slowly Will not achieve carbon neutrality without offsets	Achieves 18% GHG reductions by 2043 Total GHG Reductions = 52,950 MT CO2e
LEVEL II	6 Solar projects with installations in 2022, ‘24, ‘26 and ‘30 Fleet Replacement with EVs according to existing schedule Lighting and HVAC retrofits, plus retro-commissioning and building electrification; plus base central heating upgrades1 and partial CUP electrification	Higher investment required relative to the Level I approach Additional cost considerations (price premiums)	Achieves 49% GHG reductions by 2050 Total GHG Reductions = 97,863 MT CO2e

[1] *The base heating hot water plant upgrade is a deferred maintenance project that includes repairing leaks, heat exchanger replacements and system optimization to reduce heating hot water temperatures. Since little is known about the extent of the leakage in the system, costs have not been estimated for this project. Furthermore, this project appears as the first central plant project in all Investment Level Scenarios since it will be required before other central plant and electrification projects are completed.*

SCENARIO	KEY CHARACTERISTICS	CONSIDERATIONS	IMPACT
LEVEL III	6 Rooftop Solar projects with installations in 2022, '24, '26 and '30 Fleet Replacement with EVs according to existing schedule Lighting and HVAC retrofits, plus retro-commissioning and building electrification; plus base central heating upgrades1 and full CUP electrification	Higher investment required each year relative to the Level I Phased approach Additional cost considerations (price premiums) Benefits accrue more rapidly than Levels I or II Achieves full carbon neutrality without the use of offsets by 2043	Achieves 100% of GHG reductions by 2043 Total GHG Reductions = 146,689 MT CO2e

Figure A: *Key Characteristics with each Scenario*

BACKGROUND

For the purposes of carbon accounting, carbon emissions can be divided into three scopes known as Scope 1, Scope 2 and Scope 3.[2]

Scope 1

Carbon emissions relating directly from fuel burned on campus (primarily natural gas for heating) or university-owned vehicles.

Scope 2

Carbon emissions associated with energy purchased by SSU and generated elsewhere, (primarily grid electricity used on campus).

Scope 3

Carbon emissions resulting indirectly from SSU operations such as those associated with student, faculty and staff commuting, faculty and staff travel, waste, food purchasing or other procurement activities.

The Presidents' Climate Leadership Commitment does not specifically define the parameters for carbon neutrality accounting which leaves flexibility in defining which scope emissions to include in the planning process. SSU has included all Scope 1 and 2 emissions in this CNR. Although Scope 3 emissions are more difficult to quantify, SSU remains committed to prioritizing behavioral change programs and policies which address these emissions. Specific Scope 3 strategies are outlined on page xxx.

PRIORITY ON CARBON REDUCTIONS VS. OFFSETS

The CNR prioritizes solutions that result in carbon reduction rather than carbon offsets. This decision was made for three reasons. First, the spirit in which the commitment was made sought to challenge the campus community to develop its own solutions, rather than simply pay for offsets produced by others. Second, there is significant difficulty in determining the additionality of carbon offsets. Additionality is the concept of whether purchased carbon offsets actually resulted in carbon emissions reductions that would not have happened without the investment used to purchase the offsets. Third, there are important local benefits in the form of air quality improvements, energy cost savings and campus resilience that can be achieved through carbon reduction strategies that require investments on campus. Accordingly, carbon offsets are not included in any of the scenarios.

[2] *https://www.epa.gov/greeningepa/greenhouse-gases-epa#:~:text=Scope%201%20GHG%20emissions%20are, combustion%20and%20fleet%20fuel%20consumption.*

BENEFITS AND OUTCOMES

ALIGN WITH LOCAL CLIMATE ACTION PLAN

Align with the priorities to be outlined in the 2022 Climate Action Plan.

CONTRIBUTE TO GLOBAL CLIMATE ACTION

Decrease greenhouse gas emissions by 100% by xxx.

PROMOTE LOCAL ECONOMIC DEVELOPMENT

Produce green jobs in the solar and the energy efficiency industries.

ENHANCE DISASTER RESILIENCY

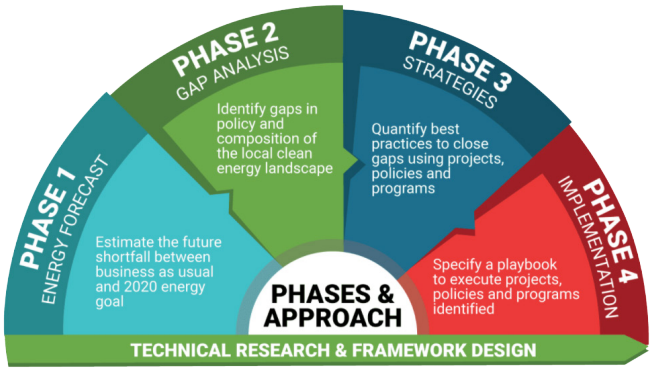
Continue operation of critical facilities and services during disasters.

REACH CSU GOALS

Share best practices with other CSU campuses.

PLANNING PROCESS

PHASE 1



PHASE 1: BASELINE & EMISSIONS FORECAST

An emissions baseline represents the amount of emissions in a baseline year (in this case 2020), and an emissions forecast provides a projection of the amount and sources of emissions SSU would most likely generate through 2043. The baseline and forecast serve as reference points for reduction targets and inform the strategy and action selection process. This is referred to as a business-as-usual (BAU) scenario. Under a business-as-usual scenario, as shown by the black line in **Figure B**, in which SSU does not change its operations in any way, emissions are projected to decrease by 6,000 metric tons (MT), from a high in 2023 of 10,757 MT, to 4,702 MT by 2043. The reduction is due to the assumption that California's renewable portfolio standards (RPS) will be realized by electricity providers. (The dip in 2021 represents the effect of COVID-19 on campus activities. An increase in emissions is expected, as full campus functions return to 2019 levels.)

Though the decrease in emissions from RPS is significant, it is clear that SSU will not achieve its carbon neutrality goal without significant operational changes. For example, SSU's current energy efficiency levels represent a significant challenge to achieving its carbon neutrality goal. The current level of building efficiency creates both challenges and opportunities in relation to achieving carbon neutrality. Challenges arise if important investments are not made; however, opportunities exist to harmonize investments in maintenance with emission reduction goals. Further, though student enrollments are currently below normal levels, this trend is not expected to continue. Eventual campus growth could easily result in increased carbon emissions, if nothing is done to mitigate those emissions . However, the revenue that also results from growth, can be leveraged to realize the significant rewards discussed in this report, including the move toward a carbon neutral future.

COVID CONSIDERATIONS

The COVID virus has had significant impacts on campus life and operations at SSU, the most significant of which will be realized in financial year (FY) 2021. Electricity use in FY2020 fell by 43% from 2019, and natural gas usage fell by 21%.Consumption totals in both categories are expected to fall further in FY2021 before rising in 2022 and 2023 as normal campus activities begin again.

Additionally, SSU can build on its track record of successful energy management achieved during past campus growth. To date, SSU has effectively managed carbon emissions related to campus growth through strategic energy efficiency improvements and renewable energy development. Since xxx, building energy use intensity (EUI) has decreased while building square footage has increased indicating that campus energy usage has remained stable despite growth. Additionally, in 2022, SSU will build a 5 MW solar array to meet a portion of its electricity demand with 100% renewable energy.

[3] *https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx.*

[4] *Figures based on SIMAP inputs from FY2019, and utility bills from FY2020.*

EMISSIONS FORECAST

Figure B: SSU Emissions Sources & Scopes

- Onsite renewable generation
- Natural gas usage
- Fertilizer usage
- Annual solid waste volume
- Employee travel information
- Liquid fuel usage in campus vehicles
- Staff/student commute data
- Capital Improvement Plan
- A 1% increase in student and faculty population

Figure B: SSU Emissions Sources & Scopes

Figure C: BAU Energy Use and Emissions (2020-2050)

Figure C represents emission reductions from the BAU and the three investment levels. The initial dip and rise are the effects of COVID and the recovery period. The black BAU line shows a steady decrease in emissions as grid suppliers gradually source electricity from renewable generation. The blue line shows investment Level I. Reductions in GHG from renewable energy installations, fleet replacement and some energy efficiency retrofits accelerate the BAU pathway. The green line shows the effects of investment Level II. GHG reductions from this scenario are realized from additional energy efficiency measures (especially HVAC retrofits, building electrification, and central plant projects). The red line shows the effects of investment Level III. As can be seen, the investments are similar to Level II through 2030, but then increase to accelerate the achievement of carbon neutrality, which is realized by 2043. These additional investments include a full suite of building electrification and additional investments in the central plant.

BRITISH THERMAL UNITS

(Btu) are units of energy equivalent to the amount of heat required to increase the temperature of one pound of water by one degree. By measuring energy use in Btu, it is possible to combine energy from energy, natural gas, and vehicle use into one common metric. kBtu is equivalent to 1,000 Btu.

PHASE 2

PHASE 2: FRAMING THE GAP ANALYSIS

As part of this process, SSU reviewed current policies and programs and produced a comprehensive, annotated list of high-impact strategies that could be analyzed and prioritized based on feasibility, financial considerations, health benefits, and equity. Figure D outlines strategies and considerations focused primarily on energy use and fleet management which contribute the largest percentage of GHG emissions. Broad sustainability strategies such as procurement, food and waste were also considered. Although these sectors contribute very little to reducing GHG emissions, they are mentioned in this CNR and will serve as foundational elements for the upcoming 2022 Climate Action Plan.

KEY FINDINGS:

- Buildings represent the largest component of SSU energy and emissions
- Powering buildings on clean electricity is one of the most cost-effective ways to reduce emissions
- Adopting clean vehicle technology will have a major impact on reducing transportation emissions
- Without further action, SSU will not meet internal greenhouse gas reduction goals and is not aligned with statewide goals or scientific consensus on avoiding the worst impacts of climate change

STRATEGIES & CONDITIONING

POLICY	STRATEGIES	CONSIDERATIONS
Green building policy **Fleet purchasing policy** **Disaster planning policy**	Adopt requirements for EV charging installations Target net zero emissions in all facilities Eliminate natural gas use in all facilities Right size the fleet so vehicles are used more efficiently and therefore replaced more frequently, allowing for faster adoption of electric vehicles Transition to electric or hybrid vehicles Focus on energy resiliency	Are there ways to promote SSU as a leader in the state?
Resolution to commit to 100% renewable energy	Install rooftop solar Improve Building Energy Management Systems Increase energy efficiency in buildings and waste water treatment	How many projects can SSU implement each year given the allocation of staff and funding? What are the trade-offs to investing more money upfront versus phasing projects over a longer period of time?

		What role do renewable energy credits play in helping SSU reach its goal and what type of credits should be considered?
Adopt new approaches to financing	Streamline the internal Green Revolving Fund process Consider Pilot Projects Align Capital Improvement Plan budget Access third party financing Consider Public Private Partnerships	How can the SSU align the annual budget with the strategies in the CNR?

Figure D: *Strategies and Considerations for carbon neutrality*

PHASE 3

PHASE 3: PART 1: SUMMARY OF SCENARIOS

As part of this process, SSU reviewed current policies and programs and produced a comprehensive, annotated list of high-impact strategies that could be analyzed and prioritized based on feasibility, financial considerations, health benefits, and equity. Figure D outlines strategies and considerations focused primarily on energy use and fleet management which contribute the largest percentage of GHG emissions. Broad sustainability strategies such as procurement, food and waste were also considered. Although these sectors contribute very little to reducing GHG emissions, they are mentioned in this CNR and will serve as foundational elements for the upcoming 2022 Climate Action Plan.

LEVEL I SCENARIO

The Level I Investment Scenario accelerates the reduction of GHG, from a BAU case; however, by 2043 the reductions from the BAU case largely catch up with those from Level I. Reductions primarily come from solar installations on campus, and the replacement of the campus fleet with electric vehicles. It also includes lighting and HVAC retrofits in many campus buildings. The investment cost for Level I is $29.9 million, which occurs mostly between the years of 2022 (when the SunPower project will be initiated) and 2030. The fleet replacements (including golf carts) are scheduled to happen during the regular replacement cycle of current vehicles, and therefore are not considered in the budget. What is considered, however, is the electrical charging infrastructure that will be required to keep the new vehicles charged.

Importantly, this scenario (and the others as well) also includes an unbudgeted assessment and repair of heating and hot water (HHW) leaks and HHW control optimization. Currently little is known about the extent of the leaks, and to adequately assess the costs for repair, a full study is required. The cost of the study and repairs have therefore not been included in the initial investment for Level I. However, this measure must be accomplished in order for later interventions to be effective. Under this Scenario it is recommended for completion in 2025.

As outlined in **Figure F**, the Level I Scenario would accelerate the reduction of GHG for SSU compared to the baseline. The acceleration reduces GHG by 52,950 MT. The cost of this reduction is $171/MT of CO2 reduced. Moreover, the NPV for the scenario is $9.1 million, which means the discounted cash flows are net positive by this amount, signifying a highly cash-positive investment.[5]

LEVEL II SCENARIO

The Level II Investment Scenario accelerates the reduction of GHG further, and has the added benefit of maintaining a lower total of GHG emissions than the BAU well beyond the year 2043. Level II reductions come from all projects in Level I, but also include a series of retro-commissioning projects, two significant HVAC retrofits, over a dozen building electrification projects, and one additional central plant project. This is one of the more expensive projects from the menu, costing $2.4 million. Under this scenario the first phase of the central plant electrification project would occur in 2025, while the HHW leak repair and optimization project mentioned under Level I would be required in 2022. The most significant investments under this scenario happen between the years of 2022 and 2030, with two additional large projects (the HVAC retrofits mentioned above, each costing about $1.3 million) being added in 2035 and 2040. The total cost of the series of Level II projects is $36.1 million.[6]

The series of Level II investments brings overall reductions of 97,863 MT at a cost of $105 per MT of reduced CO2. The NPV for Level II is slightly higher than that of Level I, at $10.3 million, indicating additional projects that aggregate to positive returns. The reason is the added value of maintenance and energy cost savings that accrue to the additional energy efficiency projects included in this scenario.

LEVEL III SCENARIO

The Level III Investment Scenario adds additional investments to those found in Levels I and II, and reduces GHG emissions to zero in 2043 and beyond. Level III reductions come from nearly all projects in Levels I and II, but also include two dozen additional building electrification projects, and a final central plant project that adds an air-source heat pump for full electrification. This heat pump and one of the building electrification projects (at Sauvignon Village), are the two most expensive projects from the menu, costing $2.8 and $3.2 million respectively. However, they bring large benefits from a GHG reduction perspective as they transfer energy usage from large quantities of natural gas, to electricity, which can then be supplied from renewable sources. These investments are scheduled to take place in 2035 (heat pump) and 2039 (building electrification). The full cost of all projects in the Level III recommendations is $53.3 million[7], over 20 years.

[5] *NPVs for all of the Scenarios are calculated using the same financing pathway. The pathway consists of PPAs for all solar PV projects, cash for all electricity efficiency projects and capital improvements (vehicle charging infrastructure), and a business-as-usual expense for fleet replacement to electric vehicles according to existing replacement schedule. This pathway does not necessarily represent an optimized financing structure. For example, the use of low and zero interest borrowing for early energy efficiency projects will raise scenario NPVs.*

[6] *This does not include the cost of base heating hot water upgrades (required for central plant electrification). This is being treated as deferred maintenance cost - upgrades are required regardless of carbon neutrality targets.*

[7] *This does not include the cost of base heating hot water upgrades (required for central plant electrification). This is being treated as deferred maintenance cost - upgrades are required regardless of carbon neutrality targets.*