CAL STATE EAST BAY

CLIMATE ACTION PLAN
2018

Endorsed by the Senate Sustainability Committee January 8, 2018

Endorsed by Campus Sustainability Committee February 16, 2018

Approved by President Leroy Morishita April 30, 2018

Submission to Second Nature May 1, 2018

CAL STATE EAST BAY

Letter from the President

CAL STATE EAST BAY
Office of the President

In 2015, Cal State East Bay joined the American College and University President's Climate Commitment which affirmed our campus goal to achieve carbon neutrality. The Climate Action Plan details how we will achieve reducing our carbon footprint and the structures necessary for successful implementation at our campuses. As President of Cal State East Bay, I am proud that the climate action planning process has been integrated into all aspects of our educational initiatives. Faculty, staff and students have participated in the research, planning and discussion of how our university will achieve Carbon Neutrality by 2040—an important and essential goal.

The specific measureable and actionable tasks in this document outline how Cal State East Bay will lower our emissions going forward. Ensuring current buildings are as energy efficient as possible while designing new construction that lowers our environmental footprint are only part of the solution. We must act boldly, decisively and quickly if we hope to make an impact on the critical issues facing our environment and civilization.

I would like to acknowledge the leadership of Dr. Karina Garbesi and Ms. Jillian Buckholz for their capable stewardship of this project and thank the Climate Action Planning Task Force, Campus Sustainability Committee, research assistants and student contributors for their dedication to this living project. By working together, Cal State East Bay can accomplish the goals set by this ambitious and important plan.

Leroy M. Morishita
President

CALIFORNIA STATE UNIVERSITY, EAST BAY 25800 CARLOS BEE BOULEVARD, HAYWARD, CA 94542 CSUEASTBAY.EDU

TABLE OF CONTENTS

I. Introduction

Background

Sea level rise, global temperature rise, warming oceans, shrinking ice sheets, declining arctic sea ice, glacial retreats, extreme weather events, ocean acidification, and decreased snow cover are all evidence of our dramatically changing climate. According to 97% of the scientific community, climate change is a result of the increase of greenhouse gas (GHG) emissions in our atmosphere caused by human-induced activity[1]. The presence of these gases in our atmosphere trap heat near the Earth's surface instead of allowing this heat to radiate into space creating a "greenhouse effect[2]." Rising temperatures will cause the effects of climate change to worsen, having a detrimental impact on the natural systems of our planet and our world's most vulnerable populations. For the wellbeing of our planet, and future generations, it is imperative that action be taken at the global, regional, and local scale to reduce GHG emissions.

International Response to Climate Change

At the 1992 Rio Earth Summit the international community joined the United Nations Framework Convention on Climate Change (UNFCCC) with the specific goal to stabilize GHG emissions "at a level that would prevent anthropogenic (human induced) interference with the climate system[3]". Three years later, the UNFCCC committed to the Kyoto Protocol agreeing to specific GHG reduction targets[4]. In 2015, building on these previous commitments, most countries signed the Paris Agreement - the most ambitious internationally recognized pledge to mitigate climate change that includes support for developing countries[5].

Carbon Neutrality and the State of California

Climate warming is clearly evident in California (as shown in Figure I.1). Indeed, California has warmed more than any other state in the western United States (Figure I.2). Thus efforts to mitigate climate disruption will not only benefit the world, it will benefit the state.

---

[1] J. Cook, et al, "Consensus on consensus: a synthesis of consensus estimates on human-caused global warming," Environmental Research Letters Vol. 11 No. 4, (13 April 2016); DOI:10.1088/1748-9326/11/4/048002

[2] https://climate.nasa.gov/causes/

[3] http://unfccc.int/essential_background/convention/items/6036.php

[4] http://unfccc.int/kyoto_protocol/items/2830.php

[5] http://unfccc.int/paris_agreement/items/9485.php

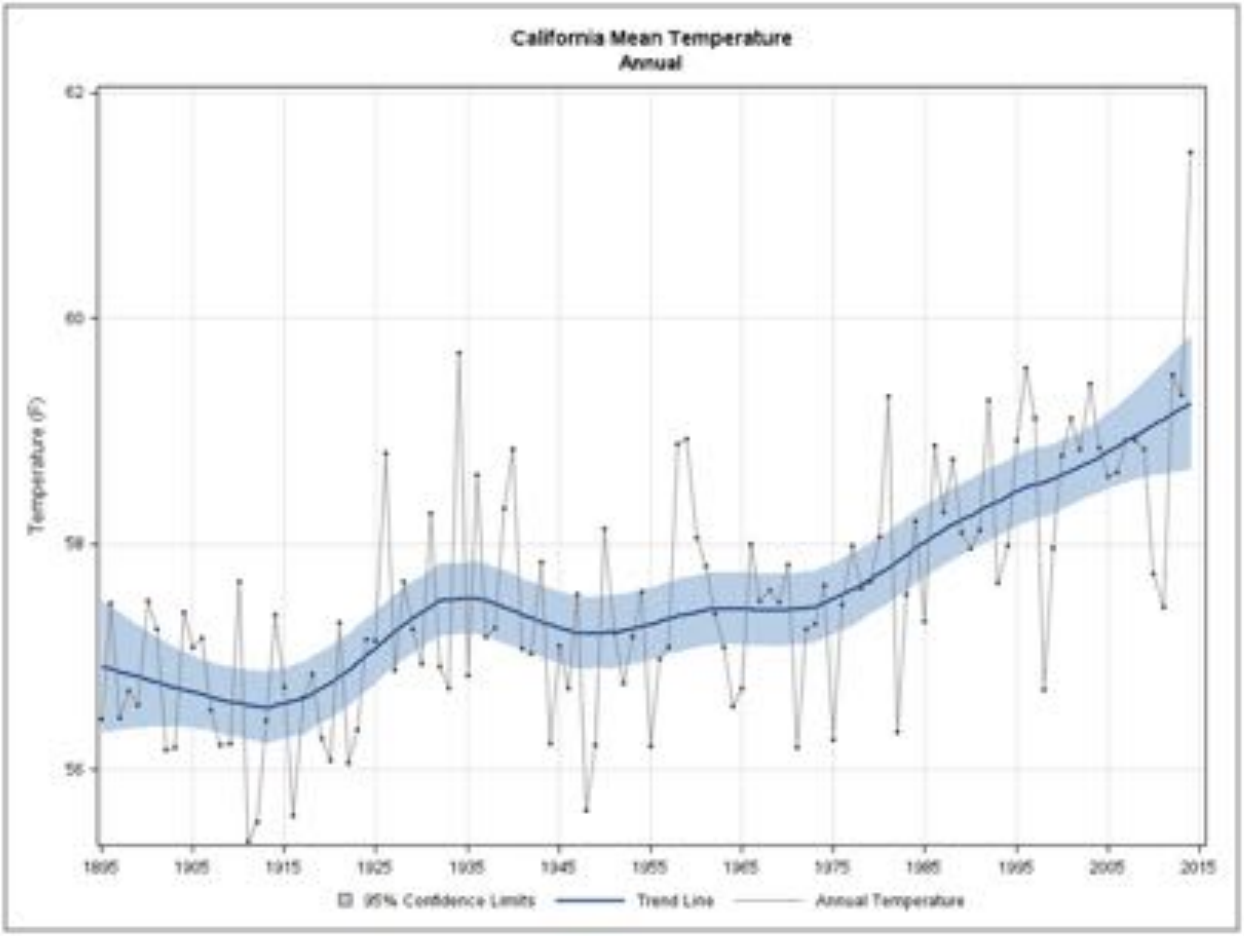


Figure I.1. Climate warming in California. The trend line shows the 10-year-running-average annual mean temperature statewide. Source: National Climatic Data Center, State Annual and Seasonal Time Series, National Oceanographic and Atmospheric Administration. Available online at https://www.ncdc.noaa.gov/temp-and-precip/state-temps/.

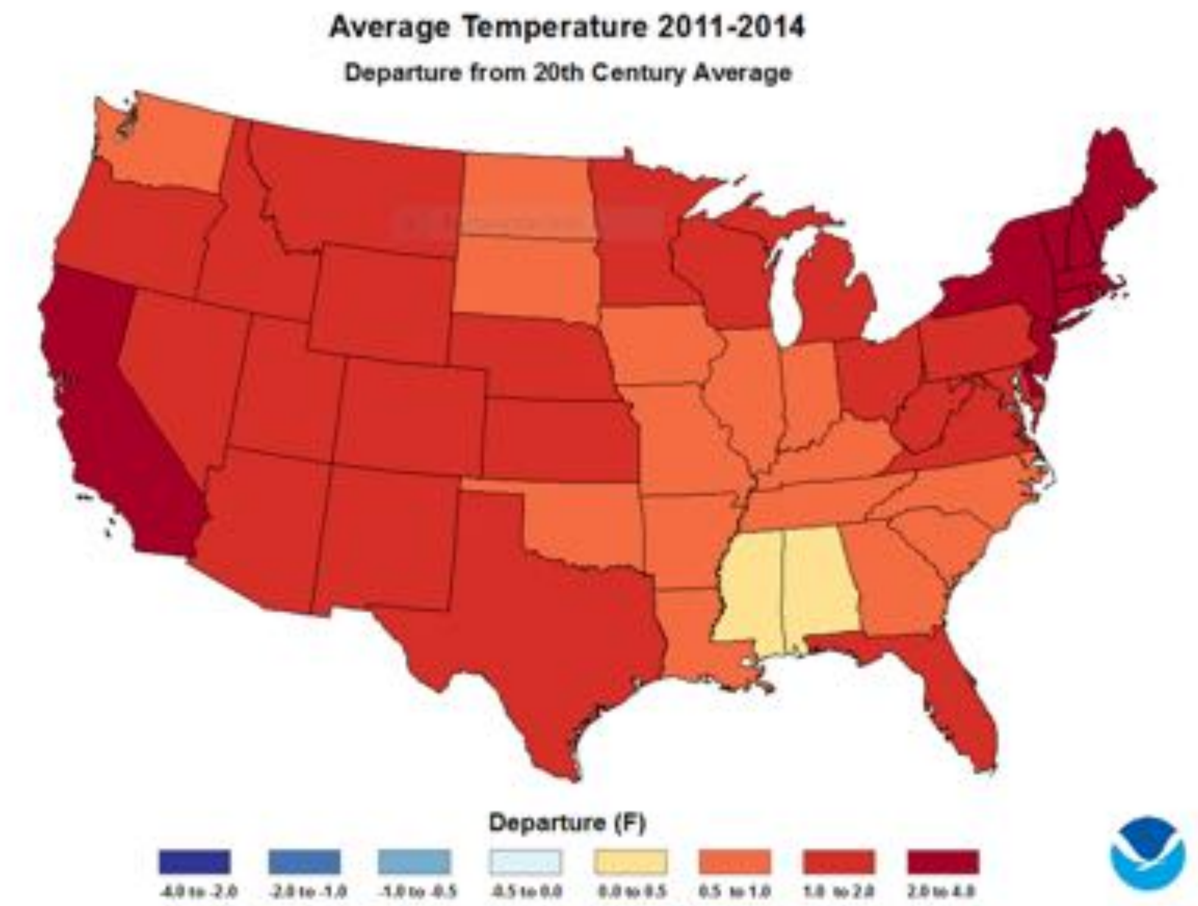


Figure I.2. Climate warming in California relative to other U.S. states. Source: National Climatic Data Center, State Annual and Seasonal Time Series, National Oceanographic and Atmospheric Administration. Available online at https://www.ncdc.noaa.gov/temp-and-precip/state-temps/.

The State of California has been leading climate change mitigation in the United States, passing legislation specifically related to this issue since 1988[6]. Most notably was the signing of Assembly Bill 32[7], California's Global Warming Solutions Act of 2006 by Governor Schwarzenegger, which states that California will reduce its GHG emissions to 1990 levels by 2020. Ten years later, Governor Brown signed Senate Bill 32[8] committing California to a more robust goal - the reduction of state GHG emissions to 40% below 1990 levels by 2030. These directives have motivated many California cities and college campuses to begin measuring GHGs and establish climate action plans to meet statewide legislation.

[6] http://www.climatechange.ca.gov/state/legislation.html
[7] https://www.arb.ca.gov/cc/ab32/ab32.htm
[8] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

City of Hayward Climate Action Plan

The City of Hayward, where Cal State East Bay is located, adopted a climate action plan in 2009. This plan was updated and incorporated into in the City's General Plan in 2014. Using a GHG emissions baseline from 2005, the City of Hayward's goals include a 20% emission reduction by 2020, 62.7% by 2040, and 82.5% by 2050.[9]

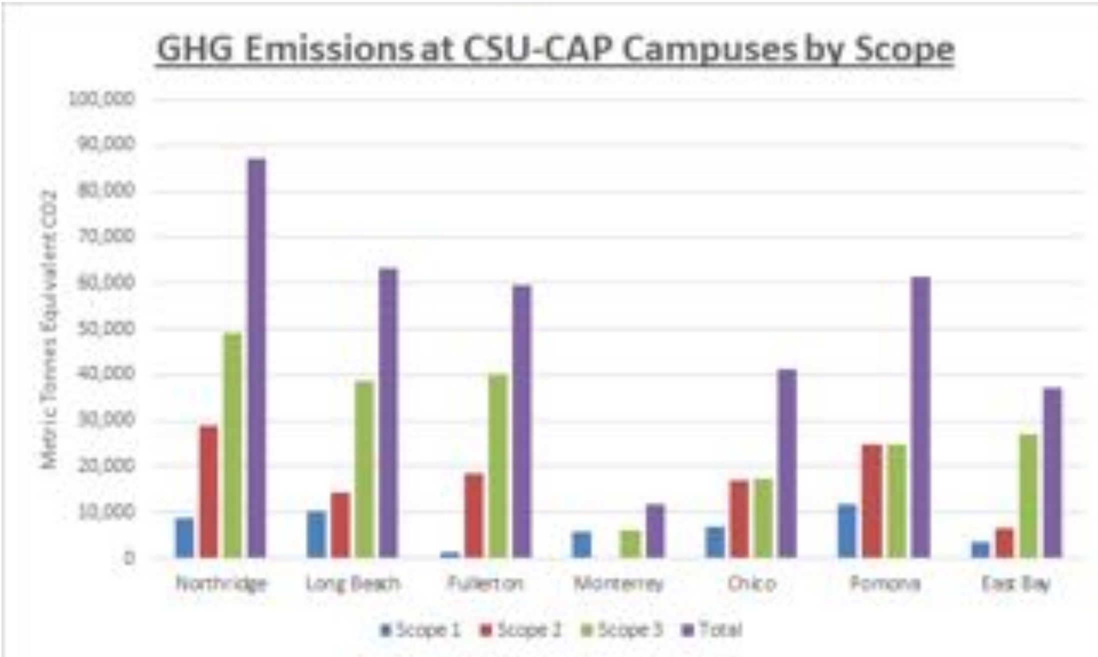
California State University Systemwide Sustainability Policy

In 2014, the California State University (CSU) System adopted a system-wide sustainability policy. This broad policy looks at academic and operational sustainability with directives in ten different areas: University Sustainability, Climate Action Plan, Energy Independence and Procurement, Energy Conservation and Utility Management, Water Conservation, Waste Management, Sustainable Procurement, Sustainable Food Service, Sustainable Building Practices, and Physical Plan Management. Consistent with AB 32, the CSU Sustainability Policy states "campus tracking reporting of their GHG inventory will be grounded in the American College and University Presidents' Climate Commitment guidelines or equivalent, with consideration to campus requested improvement."[10]

Cal State East Bay and the Carbon Commitment

Cal State East Bay is a medium-sized California State University (CSU) campus. Figure I.3 shows the University's emissions relative to those of other CSU campuses for common emissions sources, both in terms of total emissions and in terms of emissions per full-time equivalent student (FTES). As is evident from the figure, while Cal State East Bay's total emissions are lower than those of all other campuses, excluding Monterey Bay's. However, when viewed on a per FTES basis, our emissions actually exceed those of all other reporting campuses. This is due to Scope 3 emissions (primarily commuting), described in the following section.

[9] https://www.hayward-ca.gov/services/city-services/climate-action
[10] http://www.calstate.edu/cpdc/sustainability/policies-reports/documents/JointMeeting-CPBG-ED.pdf



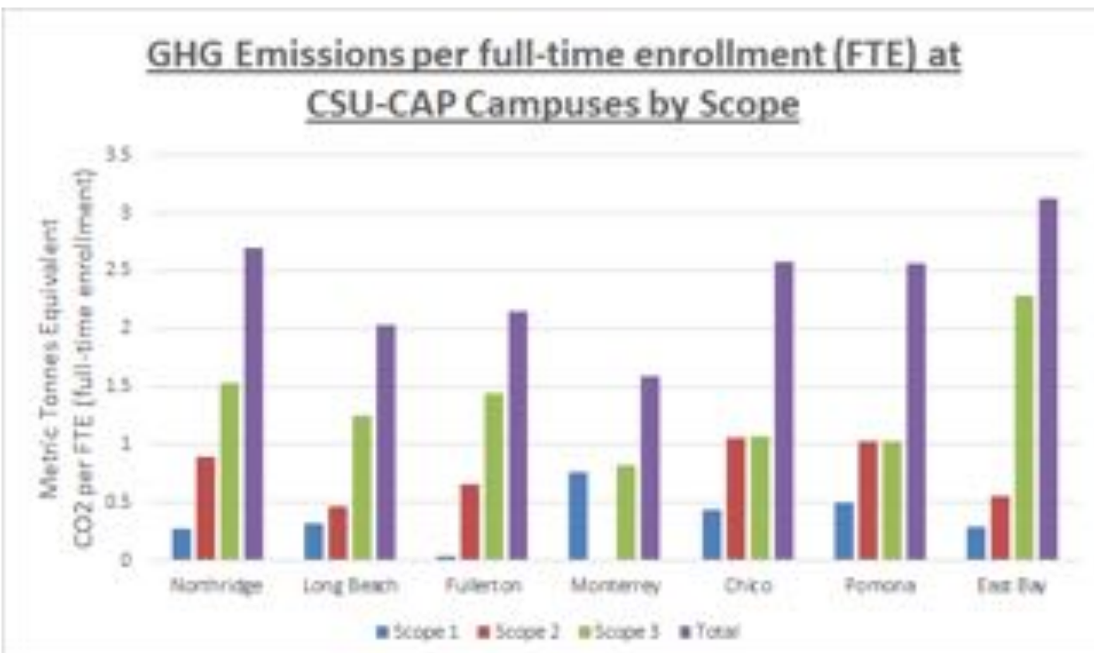


Figure I.3. Comparison of East Bay's and other CSU campuses' emissions profiles. Top: Total campus emissions. Bottom: Emission per FTE-student. Emissions reported here are a common subset of those reported by the CACP Calculator, that were selected by Second Nature from emissions reported to it by the different universities. Therefore Cal State East Bay emissions reported here, were based on the 2016 GHG Inventory, but are different because some categories are excluded. (Data were taken from the Second Nature Reporting Platform November 21, 2017, at http://reporting.secondnature.org/.)

On January 26, 2015, Cal State East Bay President, Leroy M. Morishita, signed the American College and University Presidents' Climate Commitment [ACUPCC] , which commits the campus to achieve carbon neutrality as soon as possible.

In October 2015 the ACUPCC was rebranded into the Climate Commitment, Carbon Commitment, and Resilience Commitment. The Carbon Commitment essentially reproduced the ACUPCC; hence ACUPCC signatories, including Cal State East Bay, are now referred to as Carbon Commitment signatories. This convention is followed throughout the rest of this report.

As a Carbon Commitment signatory, Cal State East Bay is required to[11]:

1. Develop a Climate Action Plan (CAP) to achieve carbon neutrality[12]
    a. Within two months of signing this document, create internal institutional structures to guide the development and implementation of the CAP
    b. Within one year of the implementation start date, complete a GHG emissions inventory and identify near term opportunities for GHG reduction. Report these in the first annual evaluation of progress
    c. Within two years of the implementation start date complete the CAP[13], which will include:
        i. A target date for achieving carbon neutrality as soon as possible
        ii. Interim target dates for meeting milestones that will lead to carbon neutrality[14]
        iii. Mechanisms and indicators for tracking progress
        iv. Actions to make carbon neutrality a part of the curriculum and other educational experiences for all students

[11] This section taken directly from the Carbon Commitment language, http://secondnature.org/wp-content/uploads/2015/09/Carbon-Commitment-Second-Nature.pdf

[12] The plan may be designed to augment an existing sustainability plan, written as part of a new sustainability plan, or as a standalone plan. An online guide is available that provides information on successful institutional structures, helpful templates on climate action plans, useful indicators of progress, guidance for reporting and much more.

[13] Due to the rebranding of the ACUPCC to the Carbon Commitment shortly after Cal State East Bay became a signatory Cal State East Bay was given a one-year extension on the Climate Action Plan due date, which is now May 1, 2018.

[14] Assistance for developing interim milestones and a number of example tangible actions are available online and are regularly updated.

v. Actions to expand research in carbon neutrality

d. Review, revise if necessary, and resubmit the CAP not less frequently than every five years

2. Submit an annual evaluation of progress

   a. Within one year of the implementation start date, and every year thereafter, complete an annual evaluation of progress

   b. Make the action plan, annual evaluation of progress (including GHG inventory), publicly available by submitting them to Second Nature's reporting system for posting and dissemination

"The [Carbon Commitment][15] is a high-visibility effort to address global climate disruption undertaken by a network of colleges and universities that have made institutional commitments to eliminate net GHG emissions from specified campus operations, and to promote the research and educational efforts of higher education to equip society to re-stabilize the earth's climate. Its mission is to accelerate progress towards climate neutrality and sustainability by empowering the higher education sector to educate students, create solutions, and provide leadership-by-example for the rest of society." (Second Nature, American College & University Presidents' Climate Commitment Mission and History, 2007).

Even before this climate action planning progress began, Cal State East Bay made significant strides toward reducing its carbon emissions. In 2004 the University installed a one megawatt photovoltaic system on its Hayward Campus, which was at that time the largest solar electricity system at any university in the nation. In 2012, it met its 2020 goal of reducing its on-campus GHG emissions back to their 1990 levels[16]. On the other hand, the University has been less successful fulfilling its commitment to educate all of its students on issues of climate neutrality. Accomplishments and shortcomings are reviewed in more detail by area in the following chapters.

[15] In October 2015 the ACUPCC was rebranded into the Climate Commitment, Carbon Commitment, and Resilience Commitment. The Climate Commitment integrates carbon neutrality with climate resilience and provides a systems approach to mitigating and adapting to a changing climate. The Carbon Commitment is focused on reducing GHG emissions and achieving carbon neutrality as soon as possible. The Resilience Commitment is focused on climate adaptation and community capacity-building to deal with a changing climate and resulting extremes.

[16] Sustainability Report 2014, The California State University. Available online: http://www.calstate.edu/cpdc/sustainability/policies-reports/documents/csusustainabilityreport2014.pdf

Approach

The CAP addresses Cal State East Bay's two campuses: Hayward (main) and Concord (satellite). The University also holds Continuing Education classes at the Oakland Center. However, because of the relatively small number of classes taught at the Oakland Center, and because Cal State East Bay does not own or maintain the building where it operates, the Center was excluded from the baseline Greenhouse Gas Inventory and is not considered in the CAP.

The CAP is comprehensive, addressing both direct and indirect sources of emissions, as required under the President's Carbon Commitment. Following the Greenhouse Gas Protocol, sources are broken into the following scopes.

- Scope 1: all direct emissions from sources owned or controlled by the campus
- Scope 2: indirect emissions from purchased electricity, steam, heating, and cooling
- Scope 3: all other indirect emissions upstream and downstream

Also in accordance with the Carbon Commitment, the plan address six greenhouse gases covered under the Kyoto Protocol to the United Nations Framework Convention on Climate Change: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6), which are bundled together for accounting purposes as equivalent CO_2 emissions (eCO_2). However, this first iteration of Cal State East Bay's CAP focuses primarily on means to eliminate fossil-fuel-related emissions, which constitute the vast majority of the whole.

The Campus Sustainability Committee (CSC), created in May 2015, oversees the climate action planning process for the University, as well as other campus sustainability issues. In AY2015/2016, the CSC created the Climate Action Planning Task Force to draft a CAP for approval by the CSC. The draft was based in significant part on work carried out by students in the Environmental Studies Senior Seminar class (ENVT 4800, Spring 2016), under the guidance of Professor Karina Garbesi and in collaboration with Cal State East Bay's Director of Sustainability, Jillian Buckholz. The CAP Task Force met monthly during the academic year to carry out its mandate. In addition, a recent Cal State East Bay graduate in Environmental Studies and student in the ENVT 4800 course (Brett Meleg), was hired as a Climate Corps Americorps Fellow to work with the CAP Task Force in order to complete the CAP in 2016/2017 academic year.

Cal State East Bay has integrated education into all aspects of its climate action planning process. The baseline Greenhouse Gas Inventory, completed in December of 2015, was conducted by the students of Environmental Studies 3480 (ENVT 3480, Applied Field Studies) again under the guidance of Professor Garbesi, Director of Sustainability Buckholz, and with the assistance of Facilities Management Staff. Preliminary research for this CAP was conducted in the Environmental Studies Senior Seminar Class (ENVT 4800) in the Spring of 2016. The following year, the Senior Seminar class conducted an energy audit of the Concord Campus, also in support of this CAP. In addition, several students continued on as research assistants throughout the development of the CAP.

II. Summary of Climate Action Plan

Getting to Carbon Neutrality

The University aims to achieve Carbon Neutrality by 2040, using three main strategies outlined in this report:

- reducing energy use through energy efficiency and conservation,
- replacing fossil-fuel energy sources with renewable energy sources, and
- offsetting emissions through on-site sequestration and purchased offsets

Figure II.1 shows the planned emissions reductions trajectories (“wedges”) and residual emissions. The means by which these reductions will be achieved are discussed in detail in later chapters. The projected residual emissions (red area) plots the University’s interim target trajectories from the current through 2040.

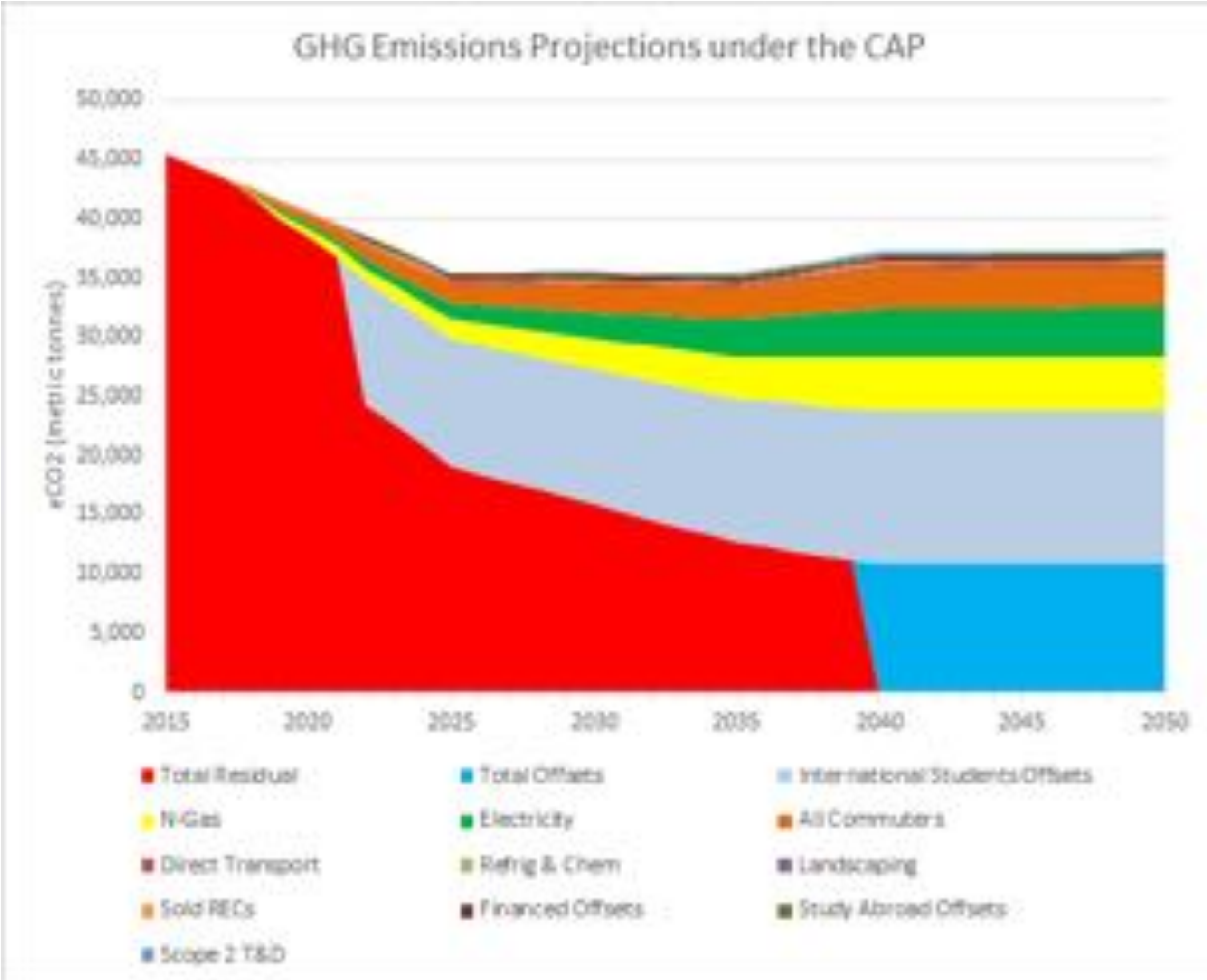


Figure II.1. Cal State East Bay GHG emissions reductions under the CAP scenario. The red area shows the residual emissions after reductions in place on any given date; all other wedges show University-initiated emissions reductions by source. The top-most boundary of all of the wedges shows projected business-as-usual emissions in the absence of a climate action plan.

Umbrella Policies

The “Umbrella Policies” listed in Table II.1 are the overarching guidance for this CAP. These directives will ensure that Cal State East Bay will meet the requirements of the Carbon Commitment and keep the University on track for documenting progress towards climate neutrality.

By adopting this CAP the campus commits to:

- annual reporting on progress,

- review and resubmission of this CAP on a regular basis,
- integration of climate action planning into all relevant aspects of the campus operations and their guiding documents,
- consider life-cycle analysis of GHG emissions in all planning, and
- build community partnerships to reach climate neutrality.

Table II.1: Cal State East Bay CAP Umbrella Policies

Proposed Policies		***Comments***
UMB1	**Target:** Carbon neutrality by 2040 (This would amend the 2009 Master Plan carbon neutrality target date of 2030, which is infeasible considering the fact that the Plan was never implemented given its almost immediate suspension and the fact that the Plan did not include commute emissions.)	2009 Master plan included carbon neutrality date of 2030. May not have included Scope 3 emissions (commuting). Plan was not implemented. Date does not appear viable.
UMB2	**Responsible parties will report annually on progress to meet carbon neutrality goals**	
UMB3	**Carbon Management Hierarchy:** Consistent with Second Nature's guidance for the development and implementation of climate action plans, the priority order for emissions is (1) reduce emissions with energy efficiency and conservation, (2) replace carbon energy sources with renewable energy, (3) neutralize emissions with offsets	This is the prescribed approach under the Presidents' Carbon Commitment.
UMB4	**The University will review, revise if necessary, and submit the climate action plan to Second Nature no less frequently than every five years**	
UMB5	**Annually the University will complete an evaluation of progress and submit to Second Nature**	
UMB6	**Integrate Climate Action Planning into other campus policies: e.g. Master Plan**	
UMB7	**The university will take a life-cycle planning approach to major projects.**	
UMB8	**Leverage partnership opportunities** to reduce GHG emissions at least cost and greatest benefit (e.g. with the CSU, the City of Hayward, the County of Alameda)	e.g. East Bay Community Choice Energy, Power Purchase Agreements negotiated through the CSU

Overview of Action Steps

Reaching carbon neutrality will require the implementation and tracking of specific, measurable, and actionable tasks. The “Action Steps” outlined in this CAP focus on key areas where campus emissions are the most prevalent: Energy, Transportation, Buildings, Housing, Procurement, and Landscaping. Education is also included, as Cal State East Bay is an institution of higher education and the Carbon Commitment specifically requires the integration of climate neutrality into the campus curricula. Additional areas for action include “Finance,” which outlines finance policies essential for implementation of the Plan, and “Offsets,” used to neutralize emissions that cannot be eliminated through efficiency improvements, conservation, or technology switching. The approaches planned for each of these areas are documented in the body of this report.

For each area Action Steps are specified, which include the following details related to Estimated Impact, Leadership, Estimated Resources, and Estimated Timeline of their implementation:

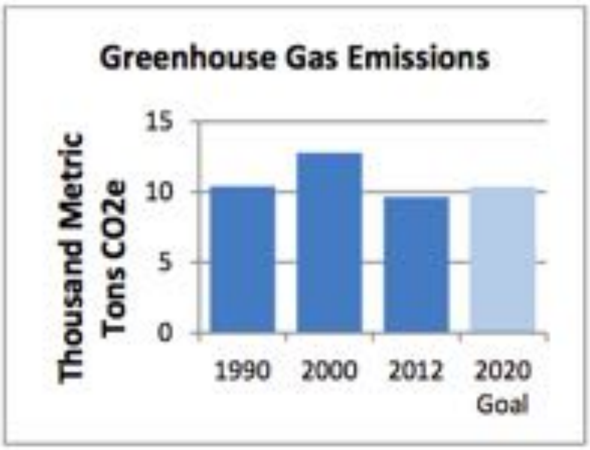
- Estimated Impact: GHG reduction potential, cost significance, and educational influence
- Leadership: Cal State East Bay division or department responsible for implementation and tracking progress
- Estimated Resources: approximate time to complete and cost implication
- Estimated Timeline: Immediate (by 2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).

Action Steps are listed in order of priority, based on a combination of their potential impact, cost, and ease of implementation. That is the higher impact, lower cost, easier to implement actions have higher priority.

III. Greenhouse Gas Emissions: Baseline and Projected

This section analyzes Cal State East Bay’s baseline emissions and those projected under this Climate Action Plan. Campuses use different baseline years, depending on when they started the planning process and the availability of data. A few campuses use 1990, with reference to the original GHG reductions baseline set out in the United Nations Framework Convention on Climate Change. The CSU Chancellors Office and the State of California both use 1990 as the reference year for their emissions accounting. Cal State East Bay uses AY2013/2014 as the baseline year, as established by our baseline GHG inventory, published December 2015. That inventory includes the first complete accounting of all Scope 1, 2, and 3 emissions for Cal State East Bay.

Cal State East Bay was not independently tracking GHG emissions in 1990. However, the CSU Chancellor's Office was carrying out intercampus emissions analyses based on a limited set of emissions sources. According to the Chancellor's Office data, in 2012 Cal State East Bay beat the CSU Sustainability Policy goal to reduce emissions back down to its 1990 level by 2020, as shown in Figure III.1.[17]



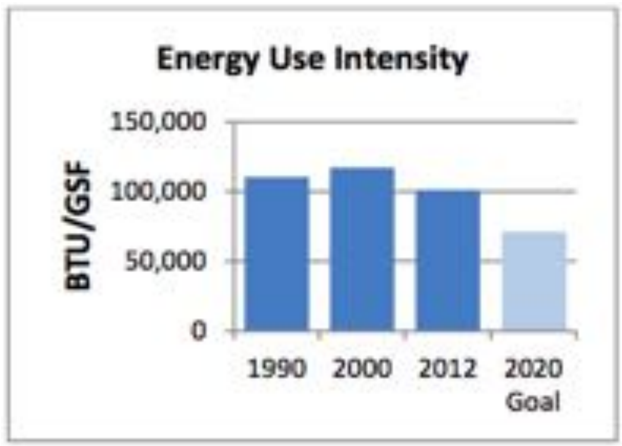


Figure III.1. Cal State East Bay's historic GHG emissions, with respect to the 2020 goal. The right hand plot shows historic changes in Building Energy Use Intensity (EUI) that facilitated meeting the goal. EUI is measured in British thermal units (BTU) per Gross Square Foot (GSF) (source: CSU Sustainability Report 2014). Note, once again, only a subset of total GHG emissions were being reported by the Chancellor's Office in this source, therefore the estimation of total emissions varies from those documented in other locations in this report.

[17] Figures sourced from The California State University Sustainability Report 2014

AY 2013/2014 Baseline Emissions

Overview

This CAP's GHG emissions accounting starts from the baseline year (AY2013/2014). For the purpose of this CAP, the GHG inventory reported in *California State University East Bay Academic Year 2013/2014 Greenhouse Gas Inventory* was revised to address assumptions detailed in the section on Grid Power Emissions Accounting. The results are presented in Table III.1, which reveals commuting as the single largest source of emissions, with student commuting accounting for 55% of total campus emissions (as shown in Figure III.2). This is not surprising based on the geographic setting of the University (the main campus is on a hill, and both campuses are in suburban areas) and the demographic makeup of the student population (91% live off campus[18] and many are older with families and off-campus jobs, making commuting needs complex).

[18] https://www.csueastbay.edu/ua/communications/files/pdfs/2012UniversityFactsSheet.pdf

Table III.1. Summary from the *AY2013/2014 Greenhouse Gas Inventory*, as calculated using the Clean Air Cool Planet Carbon Calculator: Revised as described in the Grid Power Emissions Accounting section of this report.

	Energy Consumption	CO_2	CH_4	N_2O	eCO_2
	Million Btu	kg	kg	kg	Metric Tonnes
Scope 1					
Natural Gas	67,116.2	3,558,500.9	318.1	6.4	3,568.3
Direct Transportation	3,173.6	227,669.4	42.5	14.5	233.0
Refrigerants & Chemicals	-	-	-	-	477.5
Agriculture	-	-	-	58.4	17.4
Scope 2					
Purchased Electricity	139,826.4	3,357,214.6	3,331.6	50.6	3,455.6
Scope 3					
Faculty / Staff Commuting	41,319.1	2,941,220.4	620.3	206.3	3,018.2
Student Commuting	354,041.2	24,975,784.5	5,252.8	1,711.0	25,617.0
Directly Financed Air Travel	841.0	164,014.3	1.6	1.9	164.6
Other Directly Financed Travel	693.5	49,469.8	9.7	3.3	50.7
Study Abroad Air Travel	1,007.7	196,541.2	1.9	2.2	197.3
International Student Travel	47,713.3	9,305,523.6	92.2	106.0	9,339.4
Solid Waste	-	-	(888.0)	-	(22.2)
Wastewater	-	-	-	57.5	17.1
Scope 2 T&D Losses	9,210.5	221,142.5	219.5	3.3	227.6
Offsets					
Non-Additional					244.7
TOTALS					
Scope 1	70,289.8	3,786,170.3	360.6	79.2	4,296.3

Scope 2	139,826.4	3,357,214.6	3,331.6	50.6	3,455.6
Scope 3	454,826.3	37,853,696.2	5,310.1	2,091.5	38,609.7
All Scopes	664,942.5	44,997,081.2	9,002.3	2,221.2	46,361.6
All Offsets					244.7
				Net Emissions:	**46,606.3**

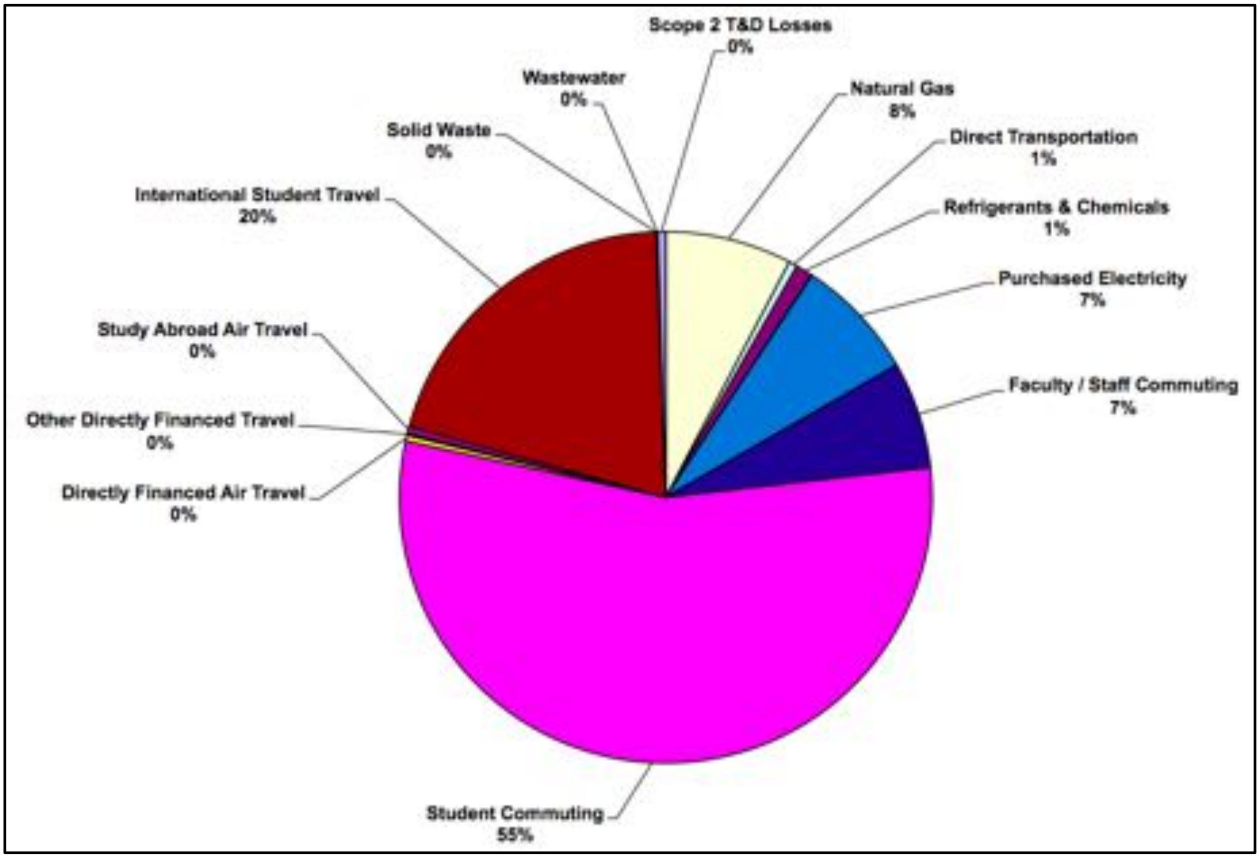


Figure III.2. Overview of AY 2013/2014 eCO_2 emissions by source type, expressed as percentages. Values showing as zero are finite but rounded to zero.

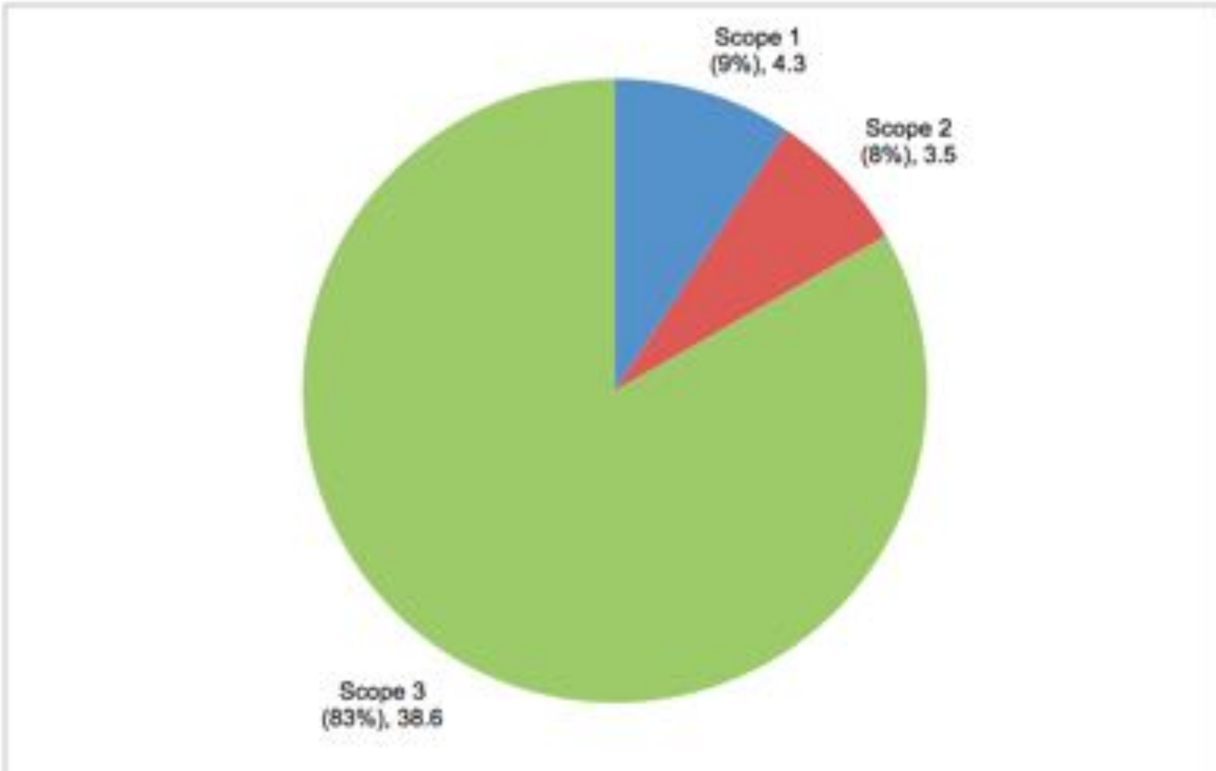


Figure III.3. AY 2013/2014 GHG Emissions by Scope presented in thousands of metric tonnes of eCO and as a percentage in parentheses.

It is important to note, however, that the most viable opportunities for emissions reductions may not come from the largest sources. For example, the University has far less control over emissions from commuting (the largest source of its emissions), than it has over emissions associated with its vehicle fleet and its building energy use. Therefore, while it is critical to aggressively pursue emissions from all sources to meet the Presidents' Carbon Commitment, the University will prioritize resources based on the potential for carbon emissions reductions.

If Scope 3 emissions, which are dominated by domestic commuting and student international travel, are removed from the analysis and only Scope 1 and Scope 2 emissions are considered, on-campus stationary energy use (i.e. natural gas use) and purchased electricity use make up 52% and 38% of GHG emissions, respectively, as shown in Figure III.4.

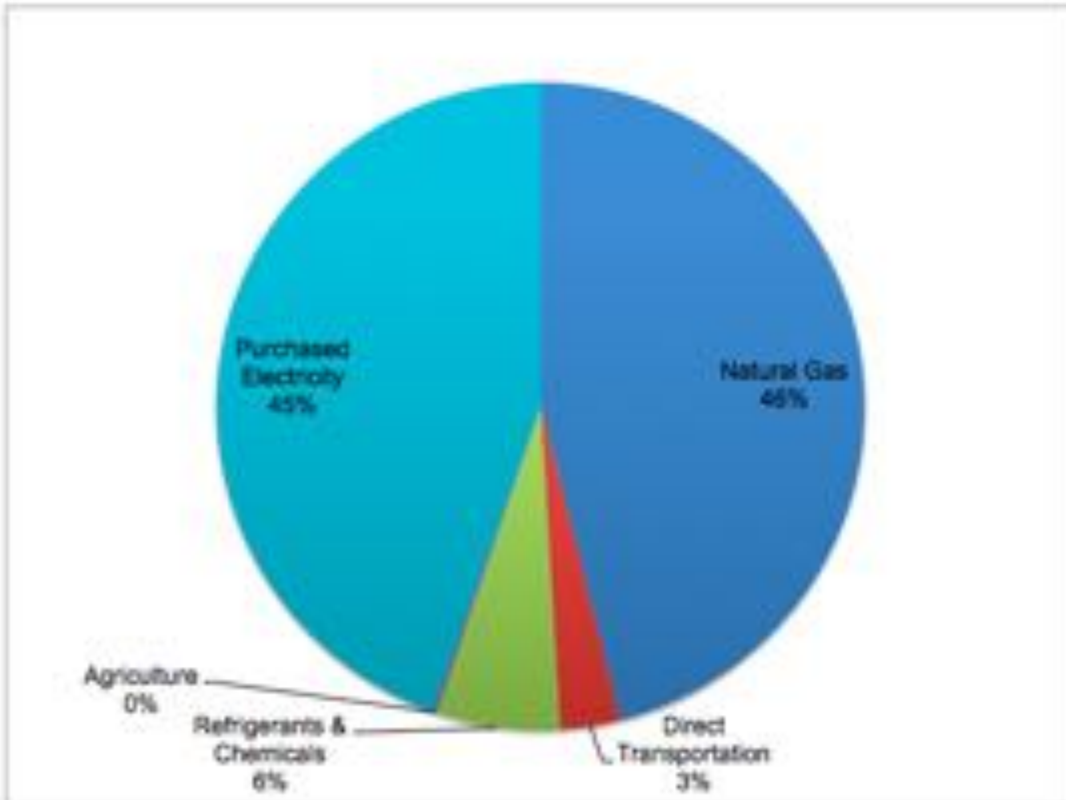


Figure III.4. Scope 1 and Scope 2 AY 2013/2014 Annual Emissions Summary in Percentage. Values showing as zero are finite, but rounded to zero.

Grid Power Emissions Accounting

Carbon emissions from electricity consumption are determined by the sources of electricity used in the fuel mix (e.g. coal, oil, natural gas, wind, solar, etc) and their associated efficiencies of electricity generation. To adjust for these distinctions, the CA-CP calculator allows for specification of a customized fuel mix for electricity. While electricity retailers in California must disclose the power content of their product to their customers (provided in the "Power Content Label"),[19] a portion of those sources are considered untraceable and are reported as "unspecified." Note that in the Shell Energy 2014 Power Content Label, shown in Table III.2, 24.1% of the power mix is unspecified. Shell Energy is the contracted source of Cal State East Bay's grid electricity through December 2019.

[19] California Energy Commission, http://www.energy.ca.gov/pcl/power_content_label.html.

Table III.2. Shell Energy 2014 Power Content Label

POWER CONTENT		
ENERGY RESOURCES	2014 POWER MIX Shell Energy Contract	2014 CA POWER MIX**
Eligible Renewable	34.5%	20%
-- Biomass & waste	3.8%	3%
-- Geothermal	3%	4%
-- Small hydroelectric	2%	1%
-- Solar	3.7%	4%
-- Wind	22%	8%
Coal	0%	6%
Large Hydroelectric	3.9%	6%
Natural Gas	32%	45%
Nuclear	5.5%	9%
Other	0%	0%
Unspecified sources of power*	24.1%	14%
TOTAL	100%	100%
* "Unspecified sources of power" means electricity from transactions that are not traceable to specific generation sources and ISO imports.		
** Percentages are estimated annually by the California Energy Commission based on the electricity sold to California consumers during the previous year.		
2014 Power Mix represents Shell Energy purchases from specific eligible renewable energy resources and ISO System Power on behalf of the California State Universities.		

In the *California State University East Bay Academic Year 2013/2014 Greenhouse Gas Inventory*, the worst-case assumption was made for the unspecified portion, assuming it was sourced from coal. This assumption was made because, while there is an incentive to disclose renewable energy content to the state of California, given the Renewable Portfolio Standard requirements, there is effectively a disincentive to report the use of dirty coal energy. This assumption was modified for purposes of this CAP accounting for practical reasons: The CSU Chancellor's Office (CO) staff estimates projected future carbon emissions factors for all campuses based on anticipated changes in state policy over time, for its own GHG accounting purposes, and shares them with the campuses.[20]

[20] CSU, State University Adminstative Manual, Appendix B. Available online: http://www.calstate.edu/cpdc/Facilities_Planning/Forms.shtml

Because there is no way to know the actual composition of the unspecified portion of the power mix, to enable the use of the CO’s data in the CAP projections included in this report, and for greater consistency in system-wide carbon accounting, for the purposes of this CAP, the authors decided to recalculate the AY2013/2014 inventory, using the CO’s assumption about the unspecified portion of the power mix. Table III.3 shows the differences in the assumed fuel mixes given the two different assumptions about the source of the unspecified portion of the mix.

Table III.3. The 2014 Shell Energy Custom Power Mix assuming the unspecified portion is 100% coal (CA-CP Custom Power Mix) and then with the assumption that the unspecified power mix reflects the State of California's average power mix (CA-CP Custom Power Mix Revised). Details described in footnote.[21]

ENERGY RESOURCES	CA-CP CUSTOM POWER MIX*	CA-CP CUSTOM POWER MIX REVISED**
Solar, Wind, Geo, and Small Hydro	35.3%	35.55%
Biomass and Waste	3.5%	4.62%
Large Hydroelectric	3.6%	5.56%
Nuclear	5.1%	8.01%
Natural Gas	29.9%	44.59%
Coal	22.5%	1.6%
TOTAL	100.0%	100.0%

* Assumes Shell Energy unspecified portion is 100% coal.

** Assumes Shell Energy unspecified portion is the State of CA's average power mix.

We note that even this recalculation does not make the CSU and Cal State East Bay numbers agree exactly because of other differences in the accounting systems. Cal State East Bay will continue to scale the unspecified sources across the statewide average with the understanding that the CSU may report different numbers.

[21] The fuel mix was customized by first aggregating fuel-types from the Shell Energy Contract into the categories used by CA-CP, and readjusting those shares to reflect the 93.4% of Cal State East Bay's electricity consumption coming from the power grid (that is, accounting for the 6.6% coming from on-site PV). Because geothermal and small hydro, are not included in the CA-CP Calculator, we included these non-carbon sources in CA-CP's 'solar and wind' category. Then the 6.6% of consumption from on-site solar was then added back into the solar category, thereby accounting for 100% of total consumption.

Greenhouse Gas Emissions Projections Modeling

In this CAP, the GHG future emissions projections modeling examines two main scenarios:

- **Business-as-usual (BAU) Emissions** from 2015 - 2050: models what we expect Cal State East Bay's future CO_2 emissions to be **in the absence of** a campus carbon neutrality policy, and
- **CAP Emissions** from 2015 - 2050: what we expect Cal State East Bay's future CO_2 emissions to be **as a result of the implementation of this CAP.**

Both scenarios take as their starting point the revised baseline GHG emissions in AY2013/2014 described in the previous section. As with the GHG Inventory, the modeling encompasses emissions from the Hayward Campus including campus residence halls (Pioneer Heights) and the Concord Campus. The assumptions that drive the BAU and CAP scenarios are summarized in Table III.4.

Table III.4. Assumptions applied in the BAU and CAP GHG emissions projections modeling.

	BAU Scenario	CAP Scenario Modifications from the BAU Scenario	Timing of GHG Reductions under the CAP
SCOPE 1			
Natural gas	Use is proportional gross square footage (GSF) of buildings and their energy use intensity (EUI). EUI depends on the year built, the climate zone, and the Carbon Emissions Factor (CEF) for natural gas.	Reduce space heating needs with building energy efficiency measures in new construction. Replace natural gas-fueled (N-gas) space and water heating applications with electric heat pump technology, fueled by renewables.	Linear reduction to zero by 2040
Direct Transportation (campus fleet)	Grows proportional to growth in student enrollment (FTES).	Transition campus fleet to 100% zero emission vehicles.	Linear to zero over 10 years
Refrigerants & Chemicals	Grows proportional to growth in FTES.	No reductions under the CAP.	Offset after 2040

Landscaping	Remains Constant	Discontinue use of synthetic fertilizers.	Linear reduction to zero over 5 years
SCOPE 2			
Purchased Electricity (emissions associated with on-site use)	Use is proportional GSF of buildings and their EUI. EUI depends on the year built, the climate zone, and the CEF for electricity.	Replace with renewables (on-site and off)	Linear reduction to zero by 2040
Renewable Energy Credits (RECs) from Hayward Campus Photovoltaic (PV) Systems	Assumes that we continue to sell the RECs from Hayward Campus PV systems.	Assumes the campus reclaims and retains its RECs from 2019 onward. (Existing RECs contract ends at that time)	Emissions drop discontinuously to zero in 2019
SCOPE 3			
Faculty / Staff Commuting	Proportional to full-time-equivalent number of faculty and staff.	Through a combination of incentives, reduce use of internal combustion engine vehicles for commuting by 25% by 2040.	Linear reduction of 25% by 2040
Student Commuting	Accounts for number of full-time-equivalent students, fraction of students living on campus. Projections from the Campus Master Plan	Through a combination of incentives reduce use of internal combustion engine vehicles for commuting by 25% by 2040.	Linear reduction of 25% by 2040
Directly Financed Air Travel	Grows proportional to growth in FTES.	Implement policy to offset by 100% (costs paid by CSU directly)	Reduction to zero in 2022
Other Directly Financed Travel	Grows proportional to growth in FTES.	Implement policy to offset by 100% (costs paid by CSU directly)	Reduction to zero in 2022

Study Abroad Air Travel	Grows proportional to growth in FTES.	Offset 100% within 5 years. Costs recovered from participating students. Offsets can be quantified and purchased here: https://co2.myclimate.org/en/cart	Reduction to zero in 2022
International Student Travel	Grows proportional to growth in FTES.	Implement policy to offset 100% within 5 years. Costs recovered from participating students. Offsets can be quantified and purchased here: https://co2.myclimate.org/en/cart	Reduction to zero in 2022
Solid Waste	Grows proportional to growth in FTES. [Linear growth to +20% by 2040]	No modifications under the CAP	Offset after 2040
Wastewater	Grows proportional to growth in FTES. [Linear growth to +20% by 2040]	No modifications under the CAP	Offset after 2040
Scope 2 T&D Losses	Proportional to grid electricity consumption. [Linear reduction to zero by 2040]	No modifications under the CAP.	Offset after 2040

The modelling results for the BAU scenario are presented in Figure III.5. As shown, domestic commuting and international student travel are expected to dominate emissions for the foreseeable future, followed by emissions from natural gas and grid electricity. The results of the CAP Scenario modeling are presented in a later section. We note here that the significant reductions in overall emissions from 2015 and 2025 are coming primarily from emissions reductions resulting from increasingly stringent Corporate Average Fuel Economy Standards for personal vehicles. The reasoning behind that assumption and the details of that portion of the model are described in the section: BAU CO_2 Emissions Projection Modeling from Transportation. With CAFE standards assumed to remain constant after 2035, and student growth assumed to continue through 2040, the model predicts an increase in emissions during that period, after which time all driving forces are assumed to remain constant.

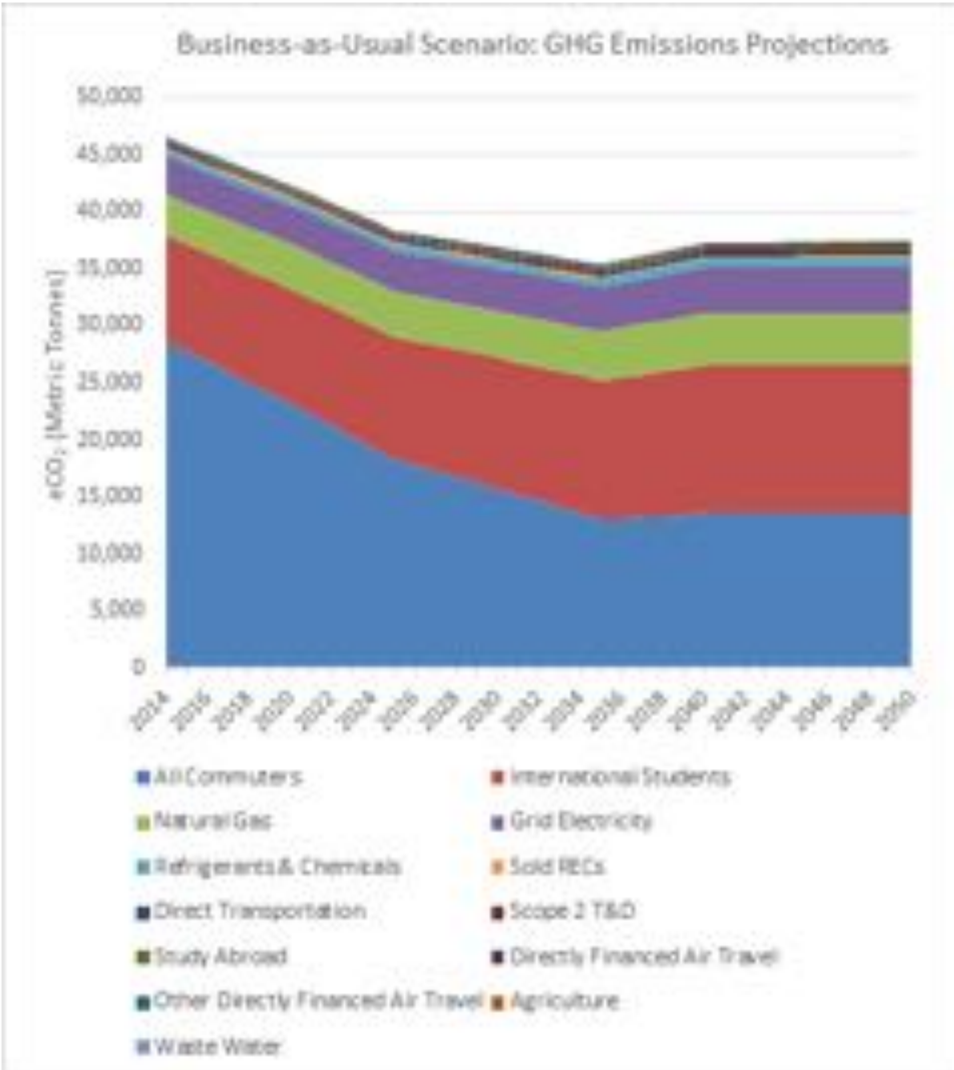


Figure III.5. GHG emissions projections: business-as-usual scenario. Includes emissions from the Hayward and Concord Campuses.

BAU Emissions Projection Modeling for Electricity and Natural Gas Usage

To project BAU carbon dioxide (CO_2) emissions from natural gas and electricity use on campus, the BAU model accounts for projected changes in the gross square footage (GSF) of buildings, including the retirement of old buildings and the introduction of new buildings. The model makes the following assumptions:

- All building types are built out to their "maximum buildout" square footage, as listed in the 2009 Master Plan;
- Building additions proceed linearly;
- The energy-use intensity (EUI) of new buildings improves over time to meet Title 24 requirements;
- The current contribution of on-site photovoltaics (PV) to campus electricity supply remains unchanged; and
- The relative contributions of free passive solar energy to space conditioning and day-lighting also remain at their current level.

The projected changes in the GSF of buildings are based on the 2009 Campus Master Plan. While this long range plan was designed to "direct the growth on campus for at least the next 20 years" (i.e., 2030 or beyond), it was suspended, but not replaced, due to legal challenges over the adequacy of its Environmental Impact Report. While still unsettled, the residual issues do not relate to building infrastructure, therefore, we assume that the Master Plan still constitutes the best framework from which to work. However, because of delays associated with the legal challenges, campus development was substantially slowed. Therefore, this analysis assumes that full buildout of the campus plans does not occur until 2040. As shown in Table III.5, at maximum buildout the total GSF of buildings is expected to almost double from its current value, with the most notable changes in built area being the addition of parking structures, residence halls, and warehouse space[22]. GSF on the Concord Campus is assumed to remain unchanged.

[22] The current value include the new SF Building.

Table III.5. Gross square footage (ft^2) by building type: 2015 and in 2040 (Assumes that maximum buildout specified in the 2009 Campus Master Plan is achieved in 2040)

Building Type	2015	Maximum Buildout
Academic	744,909	1,619,712
Dining	21,388	41,876
Medical Office	23,900	23,900
Office[1]	306,449	381,793
Parking Structure[2]	0	1,305,000
Rec Center / Student Union	126,998	126,998
Residence Hall	391,615	819,379
Retail	36,051	36,051
Science	205,320	525,320
Warehouse & Central Plant[3]	28,868	238,568
TOTAL	1,885,498	5,118,597

[1] The new SF building, which was built in late 2015 is excluded from 2015 GSF data because it usage started so late in the year. It is instead included in 2020 GSF totals.

[2] Parking structure GSF in 2040 was calculated as follows: 4,400 parking spots are accommodated (Chapter 5, Table 12, Cal State East Bay 2009 Master Plan), and 290 GSF per parking spot is assumed (based on the average GSF per parking space of parking structures in the CSU system, per data supplied by Michael Clemson, Energy Program Manager, Plant Energy and Utilities Department, Office of the Chancellor on 7/19/2017)

[3] "New central plant" in the Master Plan (Chapter 5, pg. 105) includes relocated and expanded buildings for facilities management and storage. The analysis assumes that warehouse and central plant have the same EUI and that existing warehouse remains with new central plant facilities added.

Given that the timing of the retirements of old buildings and the additions of new buildings are not specified in the Master Plan and is currently unknown (personal communication, Jim Zavagno, AVP Facilities Development and Operation, May 2017), we assume that net space additions and removals proceed linearly by space type through to maximum buildout in 2040 (Figure III.6).

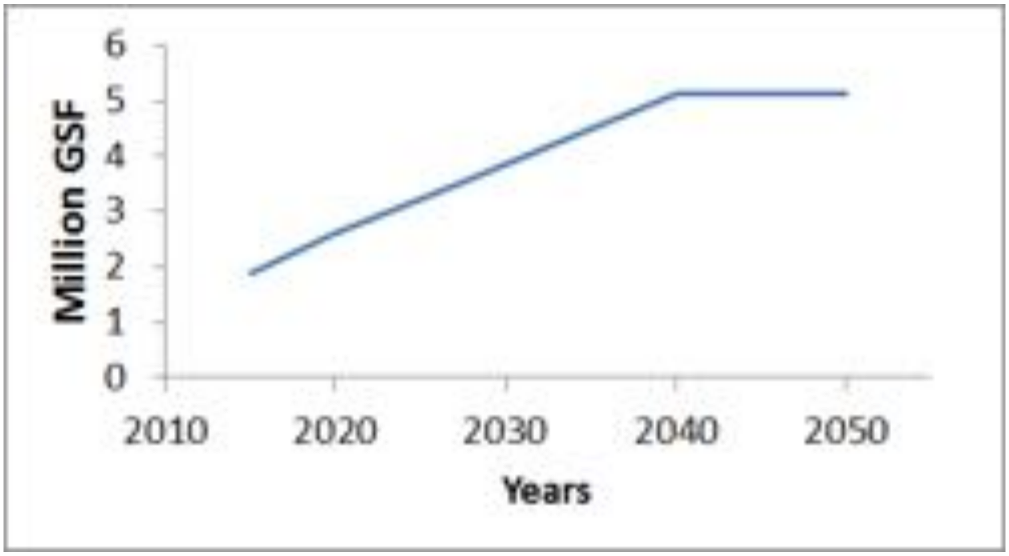


Figure III.6. Total Projected Campus GSF of Buildings on the Hayward Campus

The CSU Chancellor's Office projects the energy-use intensity (EUI) of buildings by campus building type, climate zone, and year, accounting for projected changes in the energy efficiency requirements of state building codes (Table III.6)[23]. These represent building efficiencies that the campus would have to meet, even in the absence of a campus carbon neutrality policy. EUI is measured in thousands of British thermal units per square foot (kBtu/ft^2). Our BAU model assumes that building EUI remains constant until the building is either retrofitted or replaced, at which time EUI changes accordingly.

[23] Source: http://www.calstate.edu/cpdc/Facilities_Planning/forms.shtml "CPDC-1-4-5-GHG-Emission-Worksheet"

Table III.6. Projected EUIs of Campus Building Types in thousands of British thermal units per square foot ($kBtu/ft^2$) for new buildings by year, and for retrofits (Rtro). The table values are for total energy use, including both electricity and natural gas.

Building Type	1978	1982	1995	2006	2013	2020	2027	2034	2040	Rtro
Academic	66	63	42	39	36	28	22	16	16	48
Dining	193	190	177	171	166	160	155	150	150	183
Medical Office	50	49	45	42	38	36	34	31	31	47
Office	52	51	48	45	42	41	39	37	37	49
Parking Structure	12	11	7	7	7	6	5	5	5	7
Rec Center / Std Union	83	80	54	49	42	32	24	16	16	65
Residence Hall	63	58	50	48	43	40	36	33	33	59
Retail	90	85	48	45	38	34	31	28	28	66
Science	70	66	44	42	37	29	23	17	17	53
Warehouse	30	27	22	21	19	18	16	14	14	26

[1] "CPDC-1-4-5-GHG-Emission-Worksheet": "EUI", CSU Energy Office, Available online at: http://www.calstate.edu/cpdc/Facilities_Planning/forms.shtml

The BAU model effectively tracks the stock of buildings on campus starting in 2015 and going through 2040. It aggregates the GSF of buildings by type and year ($GSF_{BT,y}$), assigning each its type-and-year specific EUI ($EUI_{BT,y}$). It then calculates the total annual building energy use (E) for each building type, using the following equation:

$$EUI_{BT,yr}\left(\frac{Btu}{ft^2}\right) \times GSF_{BT,yr}(ft^2) = E_{BT,yr}$$

It then sums these results for all building types to estimate the total building energy use in each year.

$$\sum_{BT=1}^{10} E_{BT,yr} = E_{yr}$$

To estimate the electricity use, the BAU model assumes that the fraction of total building energy use that comes from electricity (f_{el}), remains at the 2015 level (55%) reported by the CSU Chancellor's office.[24]

$$E_{el,yr} = E_{yr} \times f_{el}$$

Analogously, the amount of energy used in the form of natural gas is:

$$E_{ng,yr} = E_{yr} \times f_{ng}$$

where the fraction of the campus's energy coming from natural gas (f_{ng}) is 45%.

Given that the campus generates some of its own electricity from on-site photovoltaics (PV) on five campus buildings (E_{PV}), the total purchased electricity coming from the grid in any given year ($E_{grid,yr}$) is estimated from:

$$E_{grid,yr} = s_{el}\left(E_{el,yr} - E_{PV}\right) = s_{el}\left(E_{yr} f_{el} - E_{PV}\right)$$

The scaling factor (s_{el}) is included because the model up to this point had assumed a generic EUI representing the average of many buildings of the same type, rather than the actual EUIs of Cal State East Bay buildings. That is, the scalar makes the total purchased electricity in 2015 ($E_{grid,2015}$) agree with the actual metered electricity use. This scaling also accounts for the fact that outdoor lighting (e.g. parking lot and walkway lighting) is not independently metered on campus, so this analysis effectively attributes proportional shares to each building.

For natural gas, there is no correction needed for solar electricity generation, so the projected natural gas usage, corrected to scale correctly to 2015 usage is:

$$E_{ng,yr} = s_{ng} E_{ng,yr}$$

To project the carbon emissions coming from these sources in any given year, the purchased grid electricity is multiplied by that year's carbon emissions factor for electricity ($cef_{el,yr}$) and the

[24] Ibid.

natural gas usage is multiplied by the carbon emissions factor for natural gas ($cef_{ng,yr}$). Accordingly:

$$C_{el,yr} = E_{grid,yr} \times cef_{el,yr}$$

$$C_{ng,yr} = E_{ng,yr} \times cef_{ng,yr}$$

The Chancellor's office projects carbon emissions factors for each campus on its GHG Emissions Worksheet,[25] which are intended to address emission reductions from State Regulations (e.g. legislated progress under the Renewables Portfolio Standard) as well as the campus-specific electric service provider. Table III.7 shows the projected carbon emissions factors for electricity in pounds of carbon dioxide per megawatt-hour (lb-CO_2 / MWh) and for natural gas in pounds of carbon dioxide per therm (lb-CO_2 / therm).

Table III.7. Carbon emissions factors projected by the CSU Chancellor's Office for Cal State East Bay electricity and natural gas.

Years	**$cef_{e,yrl}$** (lb-CO_2 / MWh)	**$cef_{ng,yr}$** (lb-CO_2 / therm)[1]
2013	529	11.66
2015	529	11.66
2020	454	11.44
2027	425	10.63
2034	413	10.27
2040	413	10.27
2050	413	10.27

[1] Units of measure have been adjusted from the original for consistency.

[25] "CPDC 1-4.5 GHG Emissions Worksheet available online at: http://www.calstate.edu/cpdc/Facilities_Planning/forms.shtml

Figure III.7 shows the resulting BAU-projected Cal State East Bay electricity and natural gas usage out through 2050 and their associated CO_2 emissions in metric tonnes per year. As shown, projected emissions increase far less quickly than energy because of anticipated State-driven improvements in building energy efficiency and increased penetration of renewable energy in the grid mix. Despite these significant external contributions toward carbon neutrality, the figure makes clear that - **lacking a campus specific carbon policy - not only will the campus not achieve carbon neutrality, but emissions may well push back above 1990 levels in the late 2020s or early 2030s because of campus growth**. Specifically, the analysis indicates that this CAP must eliminate about 9,500 metric tonnes of CO_2 per year from these sources alone by 2040.

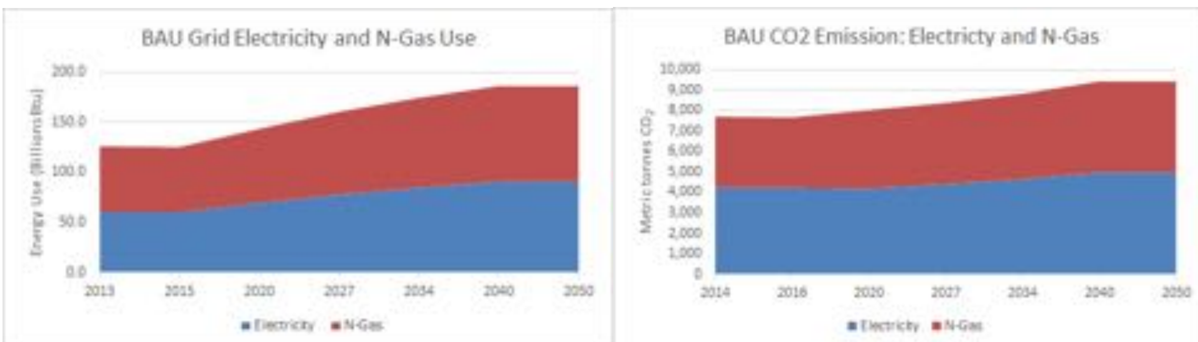


Figure III.7. Projected business-as-usual electricity and natural gas consumption on the Hayward and Concord Campuses combined, and associated CO_2 emissions.

BAU CO_2 Emissions Projections Modeling for Transportation

As shown in Figure III.2 above and mentioned previously, Cal State East Bay's Scope 3 GHG emissions are primarily transportation, specifically from:

1. Commuting by students, staff, and faculty
2. Other travel
    a. Financed travel (*i.e.,* reimbursed travel by faculty and staff for work)
    b. Study Abroad (Cal State East Bay students travelling for a semester abroad)
    c. International Students (*i.e.,* international students travelling to and from their home countries to study at Cal State East Bay)

BAU Projects Modeling for Commuting-Related Emissions

The BAU model projects CO_2 emissions from commuting by students, staff, and faculty, starting in the AY2013/2014 baseline year, out to 2050. It assumes that student, staff, and faculty populations grow as projected in Cal State East Bay's 2009 Master Plan, assuming that the maximum student population is achieved in 2040 and remains constant thereafter. The analysis also accounts for projected changes in the number of students living in on-campus residence halls, as shown in Table III.8. Only the non-residential students are assumed to commute. Therefore, while student enrollment is assumed to grow by 39%, the associated growth in student commuters is only 13%. Similarly, Table III.9 shows the BAU model inputs for faculty and staff, which needed no adjustments for on-campus residency because no such residency exists or is planned.

Table III.8. Student populations in 2014 and 2040, based on Campus Master Plan projections.

Year	Students resident in residence halls	Total student enrollment (FTES)[1]	Student Commuters
2014	1457	12940	11483
2040	5000	18000	13000

[1] FTE stands for Full Time Equivalency and is used for measuring and comparing the workload of students, faculty and staff. FTES is Full Time Equivalency Students.

Table III.9. Faculty and staff populations assumed in 2014 and 2040, based on Campus Master Plan projections.

Year	FTE-Faculty	FTE-staff
2014[1]	1457	12940
2040	5000	18000

[1]Based on Fall headcount.

Projecting future GHG emissions from commuting also requires that assumptions be made regarding future vehicle emissions, which will depend strongly on whether future fuel efficiency standards are adopted. While the federal government under the Obama administration established new Corporate Average Fuel Economy (CAFE) standards in 2012 that require automakers to raise the combined average fuel efficiency of new cars and trucks from 27.5 miles per gallon in 2012 to 54.5 miles per gallon by 2025, the Trump administration has threatened to roll back those standards[26,27]. At the same time, the State of California has pledged to uphold them[28]. Given that automobile usage in California is governed by state rules, and given California's ongoing vigorous commitment to carbon emissions reductions, the BAU model assumes that those standards will be upheld.

On-road fleet efficiency always lags the efficiency of that year's CAFE standard, because only a portion of the vehicles on the road are new. Given that it is the average efficiency of the on-road fleet that determines emissions, an assumption had to be made about the relationship between the new and on-road average efficiencies. The BAU model assumes that the difference between the CAFE and on-road vehicle efficiency remains constant as the CAFE standards increase from 2014 to 2025. After 2025 the standard is assumed to remain constant and the fuel efficiency of on-road vehicles is assumed to increase linearly to the standard as old vehicles are taken off the road and replaced by new ones. Taking the average lifetime of vehicles as 10 years, that transition is assumed to take a decade. After that, the average on-road per mile emissions of personal vehicles is assumed to remain constant.

Table III.10 summarizes the results from the analysis described above and translates fuel efficiencies into CO_2 emissions using the following emission factor and conversion: gasoline combustion emits 8.907 kilograms of CO_2 per gallon of fuel burned. The third section of the table shows the projected average per mile efficiencies normalized to their 2014 value. As shown, per vehicle carbon emissions are expected to fall to 39% of their 2014 value by 2025. The BAU model assumes that the improvements in average per-car vehicle emissions occur linearly in the two periods (2014 - 2025 and 2025 - 2035), and remain constant thereafter.

---

[26] http://www.whitehouse.gov/the-press-office/2012/08/28/obama-administration-finalizes-historic-545-mpg-fuel-efficiency-standard
[27] We note that CAFE standards incorporate the effect of electric vehicles on fleet emissions.
[28] https://www.nytimes.com/2017/03/24/business/energy-environment/california-upholds-emissions-standards-setting-up-face-off-with-trump.html?_r=0

Table III.10. Planned CAFE standards for passenger vehicles (cars and light trucks combined), associated per mile CO_2 emissions, and CO_2 emissions normalized to 2014.

Fuel Efficiency	**miles/gallon (mpg)**		
	2014	*2025*	*2035*
At CAFE std	32.2	54.5	54.5
Of average on-road vehicle	21.4	36.2	54.5
CO_2 Emissions	**gram/mile (gpm)**		
	2014	*2025*	*2035*
At CAFE std	277	163	163
Of average on-road vehicle	416	246	163
Normalized CO_2 Emissions	**gpm-at-date / gpm-in-2014**		
	2014	*2025*	*2035*
At CAFE std	0.66	0.39	0.39
Of average on-road vehicle	1.00	0.59	0.39

Using these assumptions regarding vehicle emissions plus the student, staff, and faculty populations, the BAU scales commute emissions from their 2014 baseline value.

Figure III.8 shows the results of the BAU model for commute emissions for student, staff, and faculty commuting combined. As shown, despite substantial growth in the number of student commuters, improvements in vehicle efficiency standards would reduce overall commute emissions to less than half of their 2014 value, greatly reducing the campus carbon footprint, and the measured campus-based needed to achieve carbon neutrality. However, we note once again that achieving these reduction will depend on whether the federal government, or alternatively the State of California, maintain a commitment to these standards.

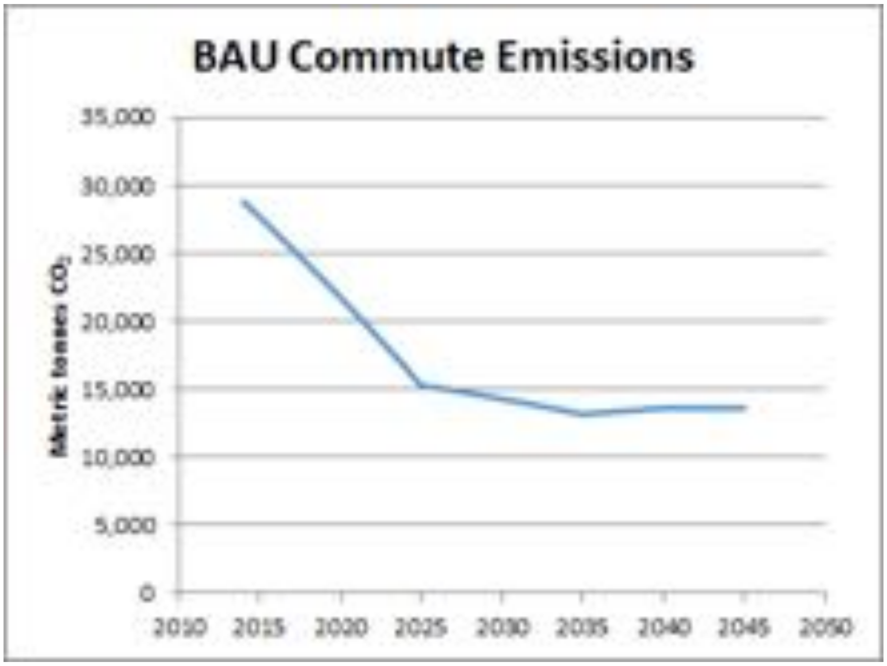


Figure III.8. Projected combined business-as-usual commute emissions from student, faculty, and staff commuting.

CAP Emissions Reduction Modeling

This section describes our GHG projections modeling assuming implementation of this CAP. Figure II.1 (above) shows the overall results of the CAP modeling, following the CAP assumptions outlined in Table III.4 (also above). Later chapters in this report justify the assumptions outlined in the table by quantifying large emissions reductions potentials achievable with commercially available technologies.

As shown in Figure II.1, carbon neutrality will be achieved by 2040 -- the target date -- using a combination of emissions reductions approaches, and offsets as a last resort. The red area represents the residual emissions expected after the implementation of the indicated reductions in any given year. All other plotted areas present the emissions reductions 'wedges' expected from the indicated sources. The following sections provide more detail on how emissions reductions are broken down between Scope 1 and 2 sources, and Scope 3 sources, respectively.

Scope 1 and 2 Carbon Neutrality Modeling

Figure III.9 illustrates the emissions reduction plan for Scope 1 and 2 emissions, according to the assumptions described in Table III.4. Achieved through a combination of mechanisms outlined in the Energy Efficient Buildings and Energy End-Uses chapter (energy efficiency improvements, technology switching, and switching to renewable energy), the vast majority of emissions reductions are expected to be achieved without need for offsets.

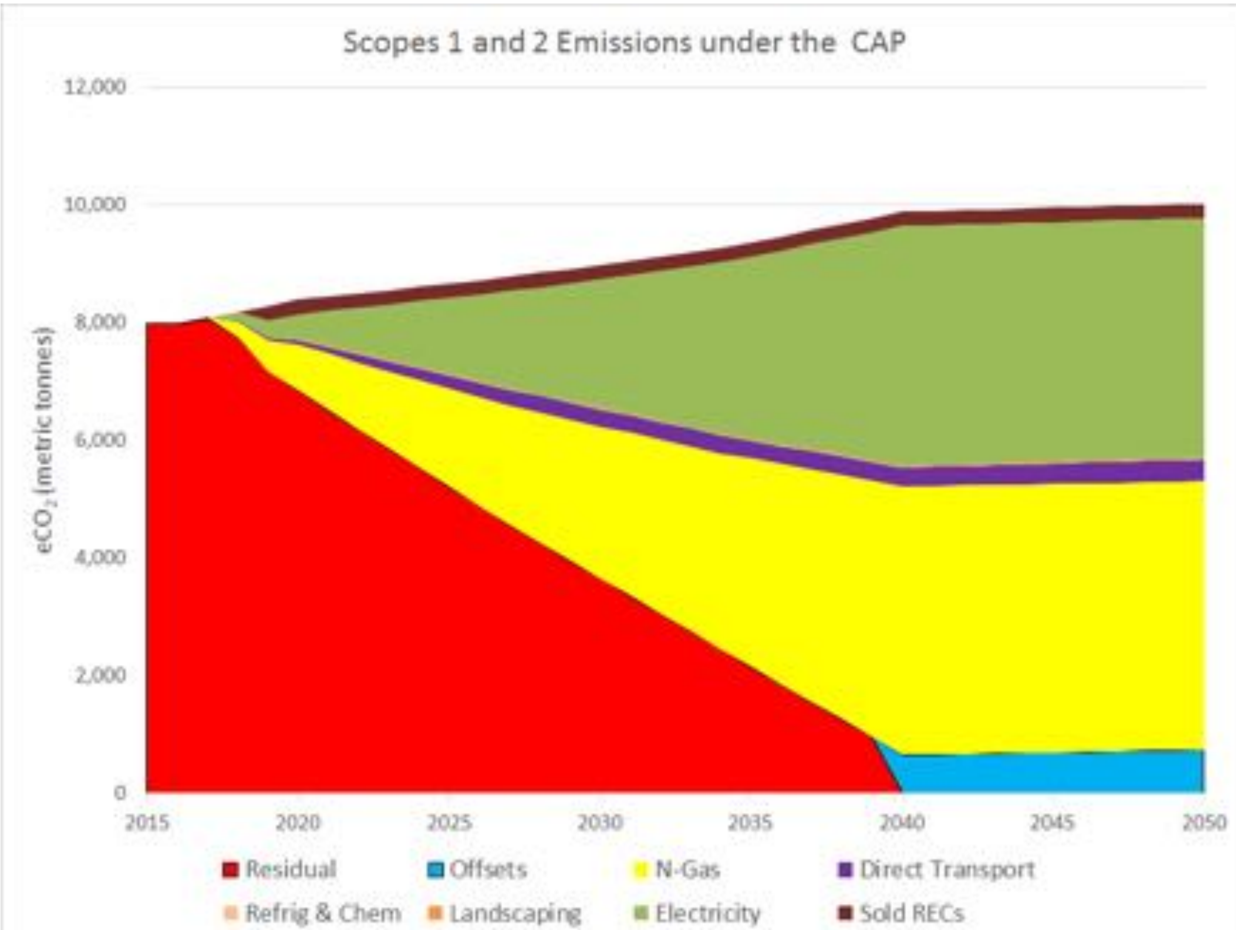


Figure III.9. Scope 1 and 2 emissions reductions under the CAP. The red area shows residual emissions, all other wedges show University-initiated emissions reductions under the CAP.

Scope 3 Carbon Neutrality Modeling

Figure III.10 illustrates the emissions reduction plan for Scope 3 emissions according to the assumptions described in Table III.4. Appendix A shows the assumed travel-related emissions under the BAU and CAP modeling assumptions; the difference between the BAU emissions and the CAP emissions determine the size of the GHG emission reduction wedge that is actively managed by the University. As described above, the only other Scope 3 emissions (those from solid waste, wastewater and transmission and distribution losses) are negligible by comparison and are not modified under the CAP.

While a collection of measures outlined in the Transportation Chapter are assumed to enable a linear reduction of 25% in total commuting mileage by 2040, offsets are responsible for the majority of emissions reductions related to transportation under the CAP. Some of these offsets are assumed to be covered by student fees (international student travel and study abroad), whereas others are assumed to be directly financed by the University (financed travel and residual emissions from commuting). Of note: offsets for international student travel and residual emissions from commuting constitute almost 100% of Scope 3 offsets. In addition, by 2040 the University will develop a policy to offset residual commute emissions (bright blue), ideally with a program designed to provide incentives for carbon-free commuting. **Of note, the total required offsets for international student travel (totalling 351,000 MTeCO_2 over all years modeled) are three times larger than total residual offsets for commuting. This fact highlights the need to include international travel into the University's CAP**. This can be visualized by comparing the areas of the light blue international student wedge (Figure III.10) toward the top of the plot with that of the brilliant blue "Offset" wedge at the bottom of the plot.

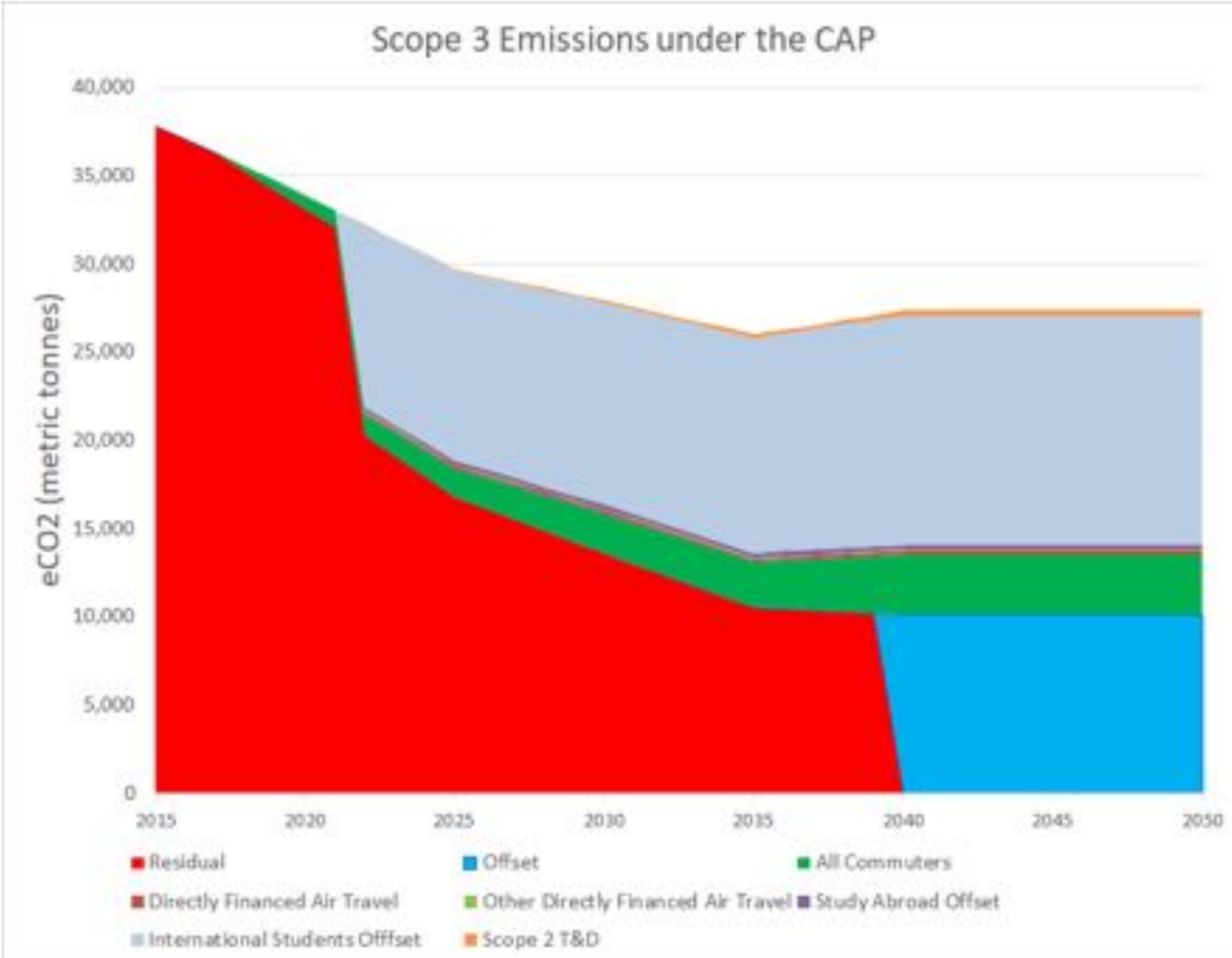


Figure III.10. Scope 3 emissions reductions under the CAP. The red area shows residual emissions, all other wedges show University-initiated emissions reductions under the CAP.

IV. Energy Management and Supply

Controlling energy-related GHG emissions is clearly the primary challenge of climate action planning. Energy use is by far the largest source of the University's GHG emissions, dominated by carbon emissions in the form of carbon dioxide (CO_2). The campus uses energy in buildings in the form of electricity and natural gas, and electricity is used for exterior lighting. The campus also uses energy in the form of liquid fuels: directly to run it vehicle fleet and its landscaping equipment, and indirectly through commuting.

Getting to carbon neutrality requires that the University administration:

- engage explicitly in demand-side and supply-side energy management;
- integrate carbon management into its daily and long-term decision-making framework;

- include the cost of carbon in all cost-benefit accounting and conservation culture must be infused into facilities operations; and
- implement the switch to renewable energy supply.

While Second Nature recommends the following loading order for carbon management, in fact, 1 and 2 must be pursued simultaneously:[29]

1. Avoiding or reducing emissions through efficiency & conservation
2. Eliminating emissions through switching to renewable (zero carbon) sources of energy
3. Sequestering or offsetting any remaining emissions.

With renewable energy now coming into cost parity with conventional energy sources,[30] it does not make sense to defer renewable energy investments until all efficiency opportunities are exhausted. With PV cost-effective now, a combination of efficiency and renewables will reduce our energy-related expenses in the long term. Moreover, the switch to renewables will take time. **Achieving carbon neutrality by 2040 requires immediate, aggressive, and ongoing simultaneous investments in efficiency, conservation, and renewables.**

This chapter focuses on the big picture of energy management and the shift to renewable energy supply. Later chapters address energy management approaches specific to transportation, buildings and end-uses, housing, procurement, and landscaping.

Switching to Renewable Energy

Switching to renewable energy will require a multi-pronged approach to achieve our carbon commitment, involving a mix of the following approaches:

1. Renewable energy systems may be installed on site: for example, photovoltaics, solar thermal energy systems, and small-scale wind systems. Indeed, the University already has more than 1 megawatt of on-site solar energy.
2. Low-carbon grid electricity products may be purchased from an electricity retailer.
3. The University could partner to install renewable energy systems off-site using a community shared solar model.

---

[29] Second Nature, Carbon Management and Greenhouse Gas Mitigation: http://secondnature.org/climate-guidance/sustainability-planning-and-climate-action-guide/building-blocks-for-sustainability-planning-and-climate-action/carbon-management-greenhouse-gas-mitigation/

[30] World Economic Forum (2017), Renewable Infrastructure Investment Handbook: A Guide for Institutional Investors, Available online: http://www3.weforum.org/docs/WEF_Renewable_Infrastructure_Investment_Handbook.pdf.

At minimum, in the near term, on-site renewable and low-carbon grid power should be pursued simultaneously.

On-site PV is a priority for a number of reasons:

- On-site solar provides deep reductions in GHGs, on-site PV affords protection against the volatility of the energy market, uses less water than conventional energy production, and provides clean energy research and educational opportunities.
- On site PV provides a highly visible statement regarding the University's commitment to carbon-free energy.
- On site solar has far higher certainty regarding avoided GHG emissions than electricity currently produced through the local utility (Pacific Gas and Electric Company) and direct access electricity contracts (like the current Shell Energy contract) because of the significant 'unspecified' portion of the power content, which could have high enough carbon content to offset the GHG reduction benefits of the renewable energy content (see section on Grid Power Emissions Accounting).
- PV parking canopy systems in parking lots can improve thermal comfort by providing much-needed shade.
- Hayward and Concord are both good sites for PV electricity production.
- The University is familiar with the technology, having more than a megawatt on its Hayward Campus currently.
- PV is now cost competitive with conventional electricity choices.

For the foreseeable future, grid power will be part of the University's power mix. Moreover, power sharing with the grid (net-metering) makes on-site renewables far more cost effective than non-grid-connected solar[31]. On-site PV also provides a long-term buffer against the price volatility of grid power. Therefore, it is a prudent strategy to pursue both low-carbon grid power and on-site renewables simultaneously. **Accordingly, as the University approaches the end of its current electricity procurement contract with Shell Energy, which ends in December 2019, Cal State East Bay will seek the highest feasible renewable energy content product with the least 'unspecified' power content.**

The community shared solar model may be more difficult to implement because it could require extensive collaboration and planning, but it might offer the leverage of larger-scale procurement

[31] If entirely disconnected from the grid, the University would have to have enough solar capacity and energy storage to supply all it needs during times with the least solar energy, wasting capacity at peak times. This would greatly increase capital costs.

and provide a means to switch to renewables without the GHG emissions uncertainties currently inherent in grid power. Community shared solar has taken a variety of forms, as described by the City of San Francisco's Environment Program:[32] "Community shared solar is the term most often used to describe solar photovoltaic (PV) systems that supply electricity to multiple customers within a geographic region (e.g., neighborhood, city, utility service area). In many ways, community shared solar is similar to on-site solar. Participants make upfront or ongoing payments to subscribe to a portion of a solar system or the rights to a portion of the system's output. Then, as the system produces electricity, participants receive credit on their energy bill based on their pro rata share. As with on-site solar, the electricity produced by the solar system offsets charges for the participant's monthly electricity use. Community shared solar does not require the solar system to be located on a participant's property, though, allowing multiple participants to invest in and benefit from a single, centralized PV system[33]."

East Bay Community Energy (EBCE) is a community power partnership that is currently under formation. Its goal is to provide lower carbon power to Alameda County customers than is available from the local utility (Pacific Gas and Electric Company). Given its location, the Hayward Campus will be eligible to obtain its power through EBCE, which anticipates starting service in Spring of 2018. With the University's power contract ending December of 2019, the University will have time to assess EBCE's function and available power product(s) as a possible means of reducing its carbon footprint from electricity before needing to enter into a new power contract.

As indicated in the business-as-usual modeling, the University's electricity supply is likely to continue to increase in its share of renewable energy as a result of California's Renewables Portfolio Standard (RPS) requirements, regardless of University Policy; however, that increase will not be enough to meet the President's Carbon Commitment in the absence of a University policy to pursue more renewable energy. The RPS program requires investor-owned utilities (IOUs), electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 33% of total procurement by 2020 and to 50% by 2030[34,35]. Therefore, the RPS alone would get the University only halfway to its goal of carbon

---

[32] SF Environment, A Department of the City and County of San Francisco, Community Shared Solar, 2102. Available online: https://sfenvironment.org/sites/default/files/fliers/files/community_shared_solar.pdf

[33] Such contracts are facilitated, for example, by Customer First Renewables. https://www.customerfirstrenewables.com/resources/aggregation/

[34] California Public Utilities Commission, California Renewables Portfolio Standard, http://www.cpuc.ca.gov/renewables/.

[35] California Energy Commission, Renewables Portfolio Standards, http://www.energy.ca.gov/portfolio/.

free energy by 2040. To meets it goal, the University must not only significantly reduce its energy use intensity, it must also vigorously pursue a more renewable energy supply.

As explained above, the current complete lack of information regarding the ‘unspecified’ portion of fuel mix creates very significant uncertainties regarding carbon emissions from grid electricity. This situation may be remedied by 2016 legislation (AB 1110) which requires electricity providers to disclose not only the fuel mix of their product, but also GHG emissions intensity,[36] but that legislation will not be implemented until 2020, and whether it indeed reduces the uncertainty remains to be seen. Unfortunately, such information will not be available before the current Shell Energy Contract expires in December of 2019. Therefore, to **reduce uncertainty in emissions from electricity supply, the University will seek suppliers who can guarantee the largest possible share of renewable energy AND the smallest possible share of ‘unspecified’ energy in their product mix**.

While the University should maximize on-site renewable energy, it must also balance its other sustainability values (e.g. ecological values). Therefore, simply covering all University land with solar panels would not be acceptable. The University will prioritize ecologically unproductive areas, such as those already covered by buildings and parking lots, maximizing the use of photovoltaics on all building surfaces, like walls and awnings, avoiding ecologically productive areas, especially those amenable to native species and food production.

As a starting point for understanding the potential for on-site solar to meet the University’s energy demand, we calculate the land area that would be needed to supply all of the University’s electricity in 2040 with photovoltaics: As shown in Table IV.1, the BAU model projects a grid electricity demand of about 27 million kilowatt-hours per year (kWh/yr) by 2040, for the Hayward and Concord Campuses combined. It also shows the panel area needed to provide that much power. The panel area calculations assume the following:

- a 15% PV panel efficiency, typical of today’s solar panels
- an 80% efficiency in converting the direct current PV-system output to AC power at the outlet, also achievable with today’s commercial energy technology according to the National Renewable Energy Laboratory,[37] and
- the Hayward and Concord Campuses both receive about 6 kilowatt-hours per square meter per day (kWh/m^2/day) of solar energy on average over the year[38].

[36] California Energy Commission, Power Source Disclosure, http://www.energy.ca.gov/pcl/.
[37] National Renewable Energy Laboratory. PV Watts Version 5 Manual. September 4, 2014. Available online: http://pvwatts.nrel.gov/downloads/pvwattsv5.pdf

Table IV.1. BAU-projected electricity demand and PV panel area that would be needed to provide 100% of that demand with solar energy.[39] (Note the BAU demand excludes that portion of campus energy currently supplied by on-site photovoltaics)

Years	BAU grid electricity consumed (kWh/yr)	Panel area needed (m^2)	Panel area needed (ft^2)
2014	17,633,250	67,098	722,232
2016	17,654,357	67,178	723,096
2020	20,328,243	77,353	832,615
2027	22,835,416	86,893	935,305
2034	24,879,703	94,672	1,019,036
2040	26,631,949	101,339	1,090,805

For comparison, Table IV.2, shows the University's current energy use for electricity and natural gas and the land areas of the University's two campuses.

[38] Based on National Renewable Energy Laboratory, NSRDB Dataviewer. Available online: https://maps.nrel.gov/nsrdb-viewer/.
[39] The analysis assumes that 100% of energy generated can be used to offset demand, as with today's net metered systems.

Table IV.2. Total Electricity and Natural Gas Energy Use in AY2015/2016 and Land Areas of the Hayward and Concord Campuses.

Campus	Campus Energy Use (millions kWh / year)*	Area of Campus (thousands m^2)	Area of Campus (millions of ft^2)
Hayward	33	810	8.72
Concord	1.2	1,561	16.8
Total	34.2	2,371	25.52

* Total energy use includes electricity and natural gas.

As described in the Energy Efficient Buildings and Energy End-Uses chapter, under the CAP provisions--with aggressive efficiency and conservation and heat pump technology replacing natural gas applications--this same amount of electricity (26.6 million kilowatt-hours in 2040) could provide ***all*** of the University's electric and thermal end-uses. **Therefore, 101 thousand square meters of panel area (about 1.1 million square feet) -- corresponding to about 15 megawatts of additional PV capacity -- could supply all of that projected demand under the CAP provisions in 2040.**

Getting to that capacity level, or its equivalent, will require either:

- **that the University acquire 680 kilowatts new PV capacity annually for the next 22 years (with on-site PV being the higher priority, but off-site PV being an option), or**
- **that the University acquire 1.2 million kilowatt-hours more energy from non-carbon energy supply each year, or**
- **some combination of the two.**

If all of that energy were to be supplied with on-site solar it would require almost 30% (844/2371) of the total combined land area of the two campuses. Given that may not be desirable, and that the physically smaller campus (Hayward) has the higher energy demand, a hybrid approach will be warranted in the long term that involves on-site PV, low-carbon grid electricity, and possibly off-site PV acquired through a community shared solar model.

An additional analysis was performed to determine how much PV capacity could be added to the Hayward Campus without ever exporting power to the grid at any time of day. This condition was modeled because a system this size or smaller is currently considered most cost effective by the CSU Chancellor's Office Energy Managers[40]. That condition is met as long as the power output of the PV system is always less than the campus load. Assuming a PV system that is 15% efficient by PV panel area and that has an 80% efficiency in converting the panel's DC

$$P_{sun}\left(\frac{kW}{m^2}\right) \times 0.15 * 0.8 \times A(m^2) < P_{load}\,(kW)$$

power into AC power at the load, this condition can be described mathematically as follows:

Where $P_{sun}(kW/m^2)$ is the clear-sky solar radiation at a given instant in time measured in kilowatts per square meter, $A(m^2)$ is the panel area measured in square meters, and $P_{load}(kW)$ is the campus's electricity consumption in kilowatts at that same instant.

Solving the equation for the panel area, the condition can be restated as:

$$A(m^2) < \frac{P\_load\ (kW)}{P_{sun}\left(\frac{kW}{m^2}\right) \times 0.15 * 0.8}$$

This condition was modeled by calculating the clear sky radiation at the Hayward Campus at 15 minutes intervals for a representative day on each month of the year (P_{sun}), and then calculating the panel area, that would just supply the instantaneous load for that 15-minute interval.[41] The smallest such A value of the entire year was then identified.

A 2 MW_{DC} system is the largest system size that will never exceed load on an instantaneous basis, given the campus's current load profile.

Early Opportunities for On-Site Solar

This section examines the early opportunities for on-site solar on the two campuses.

[40] Personal communication, Aaron Klemm and Karina Garbesi. We note that changes in State net-metering rules and utility rate schedules could change this conclusion in the longer term.
[41] Load data obtained from Evelyn Munoz, Hayward Campus Energy Analyst.

The Concord Campus

The Concord campus has low energy demand and large land availability. **As shown in Table IV.3, a net-metered 630 kilowatt system could supply all of the campus electricity needs immediately and would require a land area that is a tiny fraction of that available in student and faculty parking lots. Solarizing the Concord Campus is a near term priority of the Master Plan.** A marginally larger system could provide all of the campus's total energy needs, but doing so would first require that thermal applications (space and water heating) be replaced by heat pump technology. Ideally that action should be deferred until other more pressing projects are completed and the campus heating system is near the end of its lifetime.

Table IV.3. Parking Lot PV on the Concord Campus can easily supply that campus's energy needs.

PV System	Consumption (kWh/year)	System size needed to supply all power (MWdc)	Area needed to supply all power (thousands ft^2)
All Campus Electricity (PG&E)[1]	1,109,866	0.632	45
All Campus Energy (Electric & Thermal)[2,3]	1,201,658	0.684	49
Surface Lots Available		**PV Capacity (MWdc)**	**Available Area (thousands ft^2)**
Students and faculty parking lots[4]		3.258	232

[1] Annual energy use data (kWh/year) retrieved from Evelyn Munoz (Facilities) for AY2015-2016).

[2] Natural gas units (therms) have been converted to kWh for ease of computations.

[3] Calculation assumes factor of 4 reduction in thermal application energy use going from natural gas heating to heat pump heating using electric source

[4] Potential new PV System size and area derived through scaling of size and area in above calculations.

The Hayward Campus

As shown in Table IV.4, the Hayward Campus does not have as generous a land area to energy demand ratio. Therefore the ability to meet all on-campus energy needs with on-site renewable energy is more constrained on the Hayward Campus. However, as the analysis presented here shows, a very significant fraction of the Hayward Campus's energy use could be met on campus.

Here we take as proven cost effective the PV system parameters of a solicitation issued by the Chancellor's office in 2016. This solicitation called for PV systems that could be placed on rooftops and parking lots with at least 15,000 contiguous square feet of land, with a 20-year commitment for placement. Figure IV.1 shows the parcels outlined in green in the Hayward Campus Master Plan that meet that requirement. **As shown in Figure IV.2, a total of 579,000 ft^2 (53,800 m^2) of parking lot area on the Hayward Campus meet these requirements. That much parking lot area, if entirely covered in panels, would support an 8.1 megawatt system (53,800 m^2 x 150 W_{dc} / m^2), which could provide more than half of this campus's**

total electric and thermal energy demand in 2040 under the CAP[42]. In addition, Figure IV.2, shows that many existing buildings have large footprints, as would planned parking structures, that could also accommodate PV. Clearly the University can produce a majority of its energy on-site with no disruption to its Campus Master Plan.

Table IV.4 A comparison of the land areas and total electricity and natural gas energy use (TENG Energy) on the Hayward and Concord Campuses, and the ratios of energy use to land area.

Campus	Land Area (m^2)	TENG Energy (kWh)	Energy/Land (kWh/m^2)
Hayward Campus	722,000	34,065,702	47
Concord Campus	324,000	1,477,035	5
TOTAL	1,046,000	35,542,737	34

Near-term Priorities for University Solar Energy Projects

Given the results of the collection of analyses presented above, the near-term priorities for on-site solar energy systems are:

- **Installing 2.2 MW of PV on Hayward Campus parking lots**
- **Installing 680 kW of PV on the Concord Campus parking lots**
- **Installing solar water heating on student housing on the Hayward Campus, sufficient to offset demand**

[42] At a typical 15% panel efficiency, by definition, the panel produces 150 watts per square meter (W/m^2) of DC energy output when exposed to 1000 W/m^2 of solar input, the later being the standard input for panel rating. Therefore the typical rated DC output of such a panel is 150 W/m^2.

Land Use Parcel Plan (Fig. 2)

Figure IV.1. Master Plan parcel map for the Hayward Campus.

Parcel Measurements
(Table 2)

A total of 579,000 sf in open lots alone

Parcel	*SF*
P1 (potential parking structure[1])	225,000
P5 (potential parking structure)	120,000
P8 (potential parking structure)	79,000
P9 (potential parking structure)	104,000
P2	73,000
P3	19,000
P4	97,000
P6	258,000
P7	132,000
NEW [illegible]	7,000
O[illegible]UU	7,000
[illegible]AW	14,000
Science N	3,000
Science S	4,000
Student Health Services	13,000
VBT	13,000
TOTAL	1,168,000

[1] Table refers to Figures 29 & 31 in Cal State East Bay, Hayward Master Plan 2009, Chapter 5: Land Use.

Figure IV.2. Amount of rooftop and parking lot space on the Hayward Campus in GSF. Figure indicates which rooftops and parking lots are larger than 15,000 contiguous SGF that meet the PV solicitation by the Chancellor's Office in 2016.

In fact, PV can and should be incorporated in many ways on campuses as exemplified in Figures IV.3 - IV.5. PV on parking lots and parking structures are the easy, low-cost option. But PV can, and should, be incorporated in all news buildings, because when designed in from the beginning, PV can displace the cost of traditional building materials, and create a very visible showcase for the University's commitment to solar energy.

Figure IV.3. PV Canopies in parking lots can accommodate the majority of the University's needed energy under the CAP.[43]

Figure IV.4. Parking structures can accommodate as much PV as the land they occupy, with PV providing appropriate top-level shading and rain shielding instead of a traditional rooftop.[44]

[43] Many examples like these, of PV Parking Canopies, can be found online: http://www.dovetailsolar.com/Solar-Electric/Solar-Canopies.aspx; http://solarenergy-usa.com/2014/08/solar-energy-is-coming-to-a-stadium-near-you/

[44] Many examples of PV-topped parking structures, like these, can also be found online: https://www.galvanizeit.org/project-gallery/gallery/staples-garage1; http://solarprofessional.com/sites/default/files/articles/images/3__Kenyon-inset-2.jpg

Figure IV.5. Building-integrated photovoltaics, such as on this day-care center in Germany, can be used on new campus buildings with PV displacing the cost of wall and roofing material.

An investigation of the relative proportions of natural-gas thermal energy to electric energy used in different parts of the University reveals another priority for early solar energy investments. Table IV.4 below, documents electricity use and natural gas use in 2015 in various part of the campus. Natural gas is expressed in its reported units of measure (therms) and is converted to kilowatt-hours (kWh) in order to be able to compare the actual amounts of energy use directly. The results shows that while the Concord Campus obtains much of its total energy use from electricity, and the Hayward Campus (excluding the residence halls) has a relatively even split between the two sources, student housing (Pioneer Heights) get substantially more of its energy from natural-gas, which is for space heating and water heating. **While this result is not surprising, it reveals another early investment priority for solar energy: displacing thermal applications in student housing.** Given the likelihood of disproportionately high water heating demand in student housing (for showering and cooking), one of the first projects undertaken will be to replace natural-gas water heating with solar water heating. **With the rapidly falling prices of PV electricity, and the possibility of greatly reducing the total load using electric heat pump technology, it might be more cost effective, and a good opportunity to start experimenting with the use of heat pump technology for this purpose.** The alternative is a traditional solar hot water system.

Table IV.4. Electricity and Natural Gas Use in 2015 by Various Campus Locations.

	Electricity (KWh)	N-Gas (therms)	N-Gas (kWh)	Ratio N-Gas/Electricity
Hayward, Main	14,556,016	410,383	12,026,502	83%
Hayward, Pioneer Heights	2,022,153	107,667	3,155,241	156%
Concord	1,109,866	12,529	367,169	33%

Accomplishments

- In 2004 Cal State East Bay installed a 75,000 square foot, one megawatt photovoltaic system on its Hayward Campus, which was at that time the largest solar electricity system at any university in the nation[45] with a savings of approximately $135,000 annually.
- Since 2011, the University has housed a 1.4 MW fuel cell demonstration project on its Hayward Campus. While the electricity generated therefrom goes directly onto PG&E's grid, the waste heat is used to supplement heating energy needs in campus buildings saving an estimated 161,184 therms annually ($124,000 annual savings).
- Cal State East bay completed construction of its first LEED certified building in 2011; the Recreation and Wellness Center was certified to LEED Gold standards.
- In 2012 Cal State East Bay met its 2020 goal to reduce GHG emissions back down to their 1990 levels.[46]
- Built in 2015, the Student and Faculty Support Center achieved the LEED certification of Platinum and included a 100 kW of PV.
- In AY2016/2017 Cal State East Bay won a $42k Campus-as-a-Living-Lab grant from the CSU enabling the campus to implement more detailed building energy monitoring. This will improve the University's energy management capacity and its ability to more effectively carry out this CAP.
- To date, 32 dual-head electric vehicle charging stations have been installed at the main campus. Additionally, the University has added 7 GEM® electric utility carts to its fleet and various solar electric charging stations for these vehicles.

[45] Sunpower, *Cal State Hayward Goes Solar* https://us.sunpower.com/commercial-solar/case-studies/cal-state-hayward/
[46] Sustainability Report 2014, The California State University. http://www.calstate.edu/cpdc/sustainability/policies-reports/documents/csusustainabilityreport2014.pdf

The Action Steps

ENERGY		Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
ENG1	**Develop and maintain an operation and maintenance plan to reduce energy use, maximize equipment efficiency, and most effectively utilize deferred maintenance funds.** (The Campus will prioritize facilities upgrades that reduce operating costs and replace equipment at end of life. The campus energy team will engage in an ongoing process to seek opportunities to improve energy efficiency using energy monitoring data, periodic energy audits, continuous commissioning)	Significant GHG reduction potential; significant operational cost savings	Facilities	Staff time (high initially, tapering to moderate)	Near term
ENG2	**Install 680 kW of new PV, or other renewable energy capacity annually** (or acquire 1.2 million kWh more of renewable energy (RE) from the power grid each year, or some combination of the two)	Significant GHG reduction potential; potentially cost neutral	Facilities	Staff time (moderate and sustained)	Immediate to long term
ENG3	**Prioritize PV installations to: displace all Concord Campus Energy use (~630kW), on Hayward Campus parking lots (~8MW) long term**	Significant GHG reduction potential	Facilities	Staff/consultant time (moderate)	Immediate to long term
ENG4	**Install PV system of a size necessary to displace annual electricity use of the Concord Campus**	Very significant GHG reduction potential; low to moderate equipment cost with potential for Renewable Energy Credits (RECs); significant educational opportunity	Admin, Facilities	Staff time (moderate)	Near term
ENG5	**Prioritize purchase of high renewable power content, low unspecified power content, grid power.** Pursue possibility of aggregated group purchase of off-site renewable energy with other CSU campuses, the City of Hayward, or the County of Alameda	Significant GHG reduction potential; cost of power may be higher than current contract in the near term	Admin, Facilities	Staff/consultant time (low to moderate)	Near term
ENG6	**Institute on-going energy management training of building technicians**	Significant operational cost savings and GHG reduction potential	Facilities	Staff time (moderate)	Immediate
ENG7	**The campus information technology team will maintain all campus-owned computers, displays, and related technology to always operate in energy saver mode, unless needed for a documented exception.**	Low to moderate operational cost savings and GHG reduction potential	IT	Staff time (low)	Near term
ENG8	**Research emerging energy technologies for carbon savings** (e.g. PV-source heat pump replacing natural gas, thermal energy storage)	Possibly significant GHG reduction potential	Faculty	Faculty-student research time; potential significant cost	Near term

ENG9	**Investigate the potential for Cal State East Bay wind-power facilities**	Low to moderate GHG reduction potential; moderate educational value	Facilities	Faculty-student research time	Medium term
*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).					

V. Transportation

Background

The University's transportation emissions can be broken down into three main categories:

- emissions from commuting of students, faculty, and staff;
- emissions from international student travel to and from their home countries; and
- emissions from fleet vehicles owned by the University.

Commuting accounts for the largest source of GHG emissions at 62% (55% from student commuting and 7% from faculty and staff), while international student travel makes up 20%, and fleet emissions account for just 1% as shown in Figure III.2 Overview of Annual Emissions by Source Type. Due to the overwhelming proportion of commute emissions, much of the focus of this section will deal with mitigating that source.

While Cal State East Bay commuters utilize a combination of automobile, transit, and other transportation modes, according to a recent survey of students, faculty, and staff, 82.7% of students, 93.9% of faculty, and 96.44% of staff commute via personal vehicle[47]. Students and faculty tend to travel longer distances to and from campus (on average 22 and 21 miles round trip, respectively), while staff live closer (on average 13 miles round trip). Students present the greatest variability in commute modes with an estimated 7.9% using BART, 4.6% participating in carpools, 3% taking one or more buses, and 1.7% walking. No survey respondents reported bicycling as a mode of commute, although field observations indicate a small number of cycling commuters. However, that number is negligible and unlikely to change with any significance.

As noted in the Greenhouse Gas Inventory, the high incidence of personal vehicle commuting among the Cal State East Bay community is unsurprising given the location of the University:

[47] Based on the commuter surveys conducted by the ENVT 3480 class as described in AY2013/2014 Greenhouse Gas Inventory

both campuses are located in suburban environments; the main campus is located atop a fairly steep hill and the Concord campus is both hilly, suburban, and far from any main transit hubs. Further complicating student commuting is that a high percentage of Cal State East Bay students also work, attend part-time, and/or are older with families[48].

The main campus in Hayward is on a hill overlooking the city. Most commuters arrive via Mission Boulevard and either the primary entrance at Carlos Bee Boulevard or the less-traveled street of Harder Way. Either road results in a 500-foot elevation change making biking and walking more challenging as transportation modes. Additionally, Mission Boulevard, being a nine-lane thoroughfare, tends toward congestion especially around the morning and afternoon commutes and offers only limited bike lanes. From Mission Blvd., a sidewalk runs the full extent of Carlos Bee Blvd. to campus. Although Harder Way doesn't have a sidewalk, there is a decent paved shoulder that is used regularly by the public and Cal State East Bay students, faculty, and staff. Roughly north of the campus, wooded trails run between Memorial Park and East Avenue Park providing pedestrian and cyclists a scenic route to campus (trail area shaded green in Figure V.1.)[49]. These trails are relatively unknown to the campus community, and our research showed most cyclists use the surface streets. The bike route from the Hayward BART Station to the campus is also shown in Figure V.1 (orange line).

[48] http://www.csueastbay.edu/ceas/orientation/theCampus.html

[49] More information can be found about these trails at Redwood Hikes here: http://www.redwoodhikes.com/EastBay/Hayward.html

Figure V.1. Map illustrating the Cal State East Bay Hayward Campus and adjacent area. The orange line indicates the bike route from the Hayward BART Station while the green shaded area shows the location of hiking and biking trails running from Memorial Park (roughly northwest of the campus) to East Avenue Park (roughly northeast). Trail map courtesy of Velo Routes: http://veloroutes.org/bikemaps/?route=74948#

Local bus lines serve both campuses with Hayward receiving more frequent service with a bus arriving every twenty minutes. Cal State East Bay also provides shuttle service to and from the closest BART stations (Hayward and South Hayward BART Stations for the main campus, Concord BART Station for the Concord satellite campus).

As shown in Figure V.2 , there are a large array of approaches to reduce commuting and its associated emissions. These include mechanisms that allow remote access to campus (e.g. online courses and telework), parking-related incentives to reduce single-occupancy vehicle use and to increase the use of other lower carbon alternatives, as well as a range of other travel-reduction mechanisms that can be broken into four subcategories: mass transit promotion, creating affordable and accessible housing near campus, encouraging ride-sharing, and promoting bicycling.

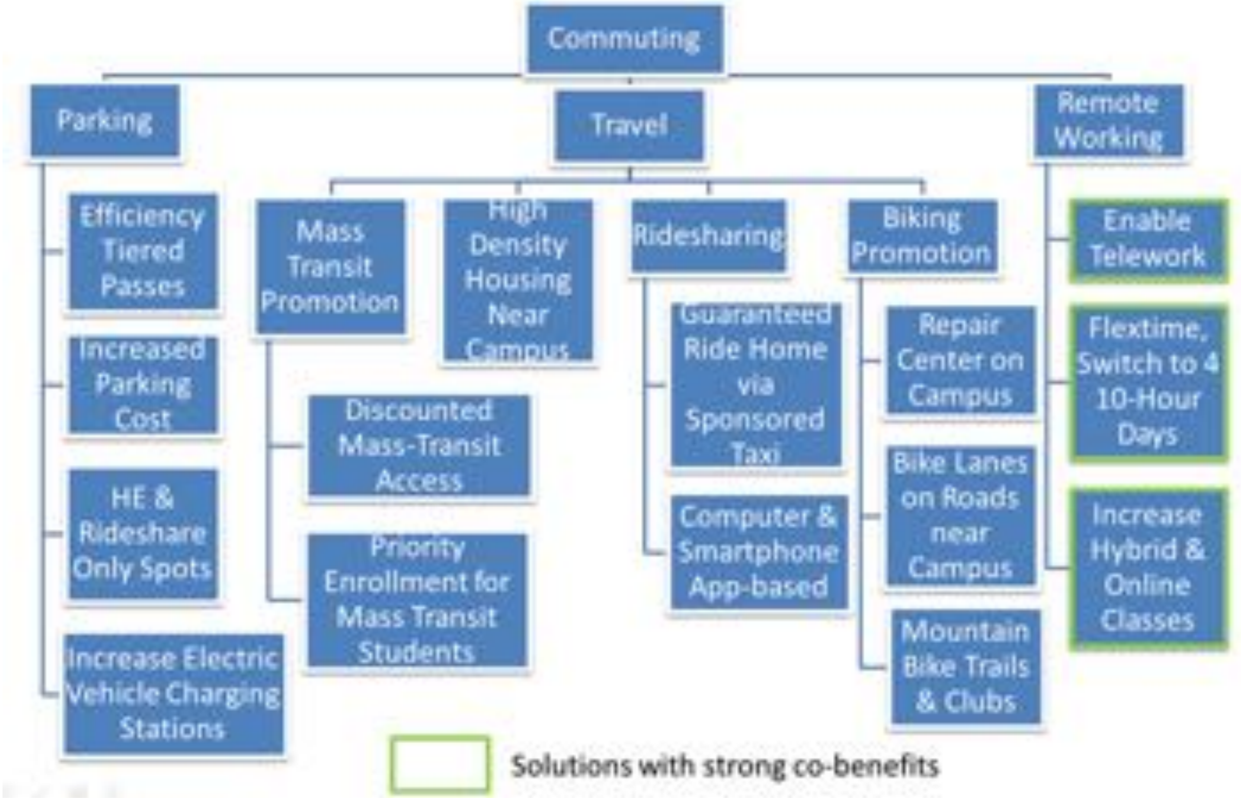


Figure V.2. A wide range of approaches are available to reduce commuting-related GHG emissions. This plot was compiled by ENVT 4800 Sp2016.

One can evaluate the most promising approaches by considering their relative costs versus the control that the university has over the success of the measure. This can be graphically imaged using a quadrant plot with cost on one axis and control/certainty on the other, as shown in Figure V.3. The analysis reflected therein shows that the least cost and highest certainty approach appears to be the increased use of online coursework, though the University should be cautious about its potential impacts on educational quality and computing related costs. The latter could include costs as diverse as the social and health impacts of further reducing social engagement, the costs of computing related technology, and energy use.

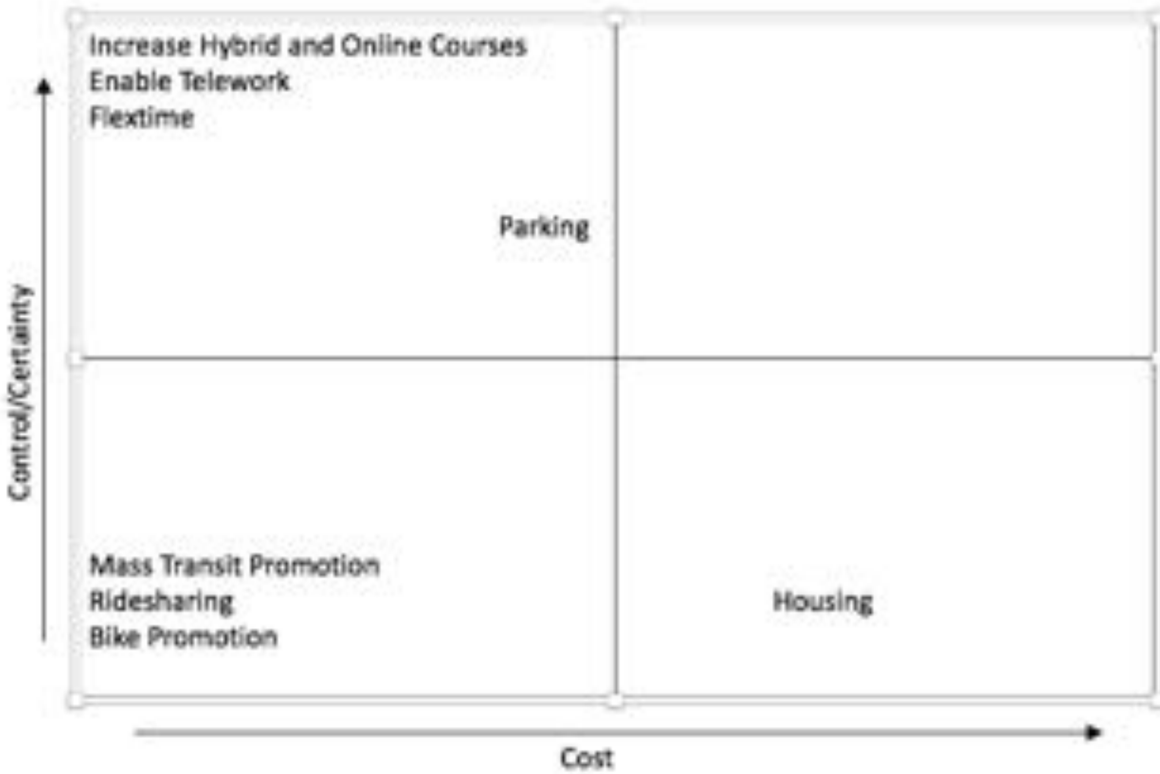


Figure V.3. Quadrant plot illustrating the relative cost and certainties of transportation emissions reductions options.

Accomplishments

An excellent first step, Cal State East Bay has already undertaken a number of transportation measures resulting in reduced GHG emissions.

Current Alternative Transportation Achievements

- 32 EV (electric vehicle) charging stations installed. Just two years ago, Cal State East Bay had increased EV charging stations to 14.
- 4 vanpools providing transportation to the main campus for staff/faculty
- 4 shuttles serving the Hayward BART station to the main campus
- 1 shuttle serving the Castro Valley BART station to the main campus
- 1 shuttle serving the Concord BART station to the Concord campus

- 1 Campus Loop Shuttle making stops around campus and at University Village Student Housing
- 6 Zipcar car-share locations
- 2 Zagster bike-share locations

The Action Steps

TRANSPORTATION		Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
TRAN1	**Increase online coursework and opportunities for telework**	Significant GHG reduction potential	Academic Affairs and IT	Staff time (moderate), Software cost and maintenance (low), Co-benefits (high)	Immediate to long term
TRAN2	**Enhance and encourage the use of alternative transportation modes**	Significant GHG reduction potential	Transportation Planning	Staff time (low to moderate incremental cost)	Immediate to long term
TRAN3	**Pursue subsidized transit passes for students, staff, and faculty** (including AC transit and BART)	Moderate to significant GHG reduction potential	Transportation Planning	Staff time (moderate)	Near term
TRAN4	**Encourage the use of alternative transportation modes with faculty and staff by implementing an Employee Cash Out Program** (offer cash instead of a subsidized parking pass)	Moderate GHG reduction potential; low cost depending on the conditions of the plan; potential employee co-benefits (health, financial, job satisfaction)	Finance and Administration	Staff time (low, incremental initial investment)	Near term
TRAN5	**Offset carbon emissions from all study abroad and international travel by 2022:** investigate adding the cost to the program fee that covers carbon emissions from airfare to and from the origin/destination city.	Moderate to significant GHG reduction potential; no cost implications	Admissions, University Extension	Staff time (low)	Near term
TRAN6	**All state-funded travel will be carbon neutral or 100% offset by 2022**	Low GHG reduction potential; but more predictable outcome than most transportation measures and high education value for the University community	Administration and Finance	Staff time (low cost)	Near term
TRAN7	**No net increase in the number of parking spaces for fossil-fueled vehicles**.	Moderate GHG emissions reduction potential	Facilities	Staff time (no cost)	Immediate

TRAN8	**Maintain at least 50% greater EV charging station capacity (relative to total number of parking spaces) than the statewide electric vehicle (EV) proportion as reported by the state.** So, for example, if 10% of the state's on-road fleet is EVs, then 15% or our parking spaces will be for EVs.	Low to moderate GHG reduction potential; potential educational value	Parking	Staff time (moderate), utilize grants for EV charging stations	Near term to long term
TRAN9	**All new-to-campus fleet vehicles must be electric, bio-fueled, or other RE-powered**	Low GHG reduction, reduced operational costs	Procurement	Potentially higher initial cost	Immediate
TRAN10	**No personal vehicle/parking passes for first year residence hall students**: supplement with electric or other ultra-efficient car-share vehicles	Low direct GHG reduction potential but sets the habit of becoming more comfortable with relying on alternative transportation	Admin	Staff time (low)	Near term
*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).					

Planned Alternative Transportation Projects for Fiscal Year 2017-2018

- Encourage carpooling and vanpooling with:
  - Preferred parking spaces and free or preferred parking rates for carpooling and carbon neutral vehicles
- Installation of 12 EV charging stations for a total to 44 EV charging stations at the end of 2017 - more than any other CSU campus
- Additional vanpool to the San Jose area for a total of 5 vanpool service areas
- Addition of another Zagster bike-share location for a total of 3 stations (12 bikes)

Cal State East Bay will implement measures to reduce vehicles miles driven by:

- Surveying students, faculty, and staff to determine their alternative commuting needs and obstacles and pursue policies to address them;
- Promoting ride-sharing with free or greatly reduced parking fees for carpoolers and an increase in vanpools for faculty, staff, and students;
- Seeking opportunities to increase the affordability and convenience of alternative travel options to and from the greater community through, for example, partnerships with the city and transit authorities;
- Disseminating information to assist with use of bike-share, bus, shuttle, and route planning;

- Creating transit incentives such as alternative transportation competitions;
- Increasing on-campus housing for students (see Chapter VII, Housing);
- Disallowing personal vehicles for first year students living in on-campus housing.
- Seeking out and supporting affordable nearby housing opportunities for faculty;

Despite these efforts, there are likely to be large residual emissions over which the University has no direct control, which therefore must be offset. Emissions for which the University has direct responsibility, namely state-sponsored travel, will be offset using the general fund immediately. Carbon offset fees will be charged on international student travel and study abroad to cover round-trip emissions from air travel from the city origin/destination. These fees will be used by the University to purchase offsets for international student travel. Finally, any residual transportation emissions remaining in 2040 will be offset at that time.

While the total number of metric tons needed to be offset is likely to be large, the per-trip offset cost is low (generally about $10 per round-trip flight for example), and it is imperative that the University remediate travel-related emissions, as they are the University's largest cause of damage to the global environment.

VI. Energy Efficient Buildings and Energy End-Uses

Background

Energy use in buildings and exterior lighting is the primary source of on-campus GHG emissions. Many factors can reduce the energy use of buildings and lighting at a given site:

- building design,
- space conditioning technology,
- efficiency appliances and other energy end-use technologies (e.g. lighting, space conditioning, water heating, information technology, cooking)
- use of controls technologies that turn applications off when they are not needed or wanted, and
- building operations and management.

Achieving carbon neutrality requires that all new buildings be designed to be, at minimum, zero net energy (ZNE), or preferably net energy positive, since such gains are lower in cost in new construction than in renovation[50]. In a ZNE building, the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site. California's Energy Efficiency Strategic Plan sets a goal of requiring all new commercial buildings to be ZNE starting in 2030. The experience the University gains with ZNE buildings prior to that time can make important contributions toward achieving the State's efficiency goals. This is true not only of experience with the design, performance, and management of such buildings, but also through the educational opportunities they will provide.

This chapter demonstrates that efficiency, conservation, and technology switching can readily cut projected BAU energy use in half, even ignoring potentially significant space conditioning savings from passive solar design.

Using fairly conservative assumptions for energy savings potentials described in the following sections, and temporarily ignoring the potential for significant energy saving from passive solar design, we can reasonably assume that 30% energy savings in current electricity end uses and 70% savings in space and water heating applications can be achieved. Together these applications constitute the vast majority of Scope 1 and Scope 2 emissions. **The net result, shown in Figure VI.1, is that in 2040 energy use under the CAP provisions, is half of what it is expected to be under BAU.**

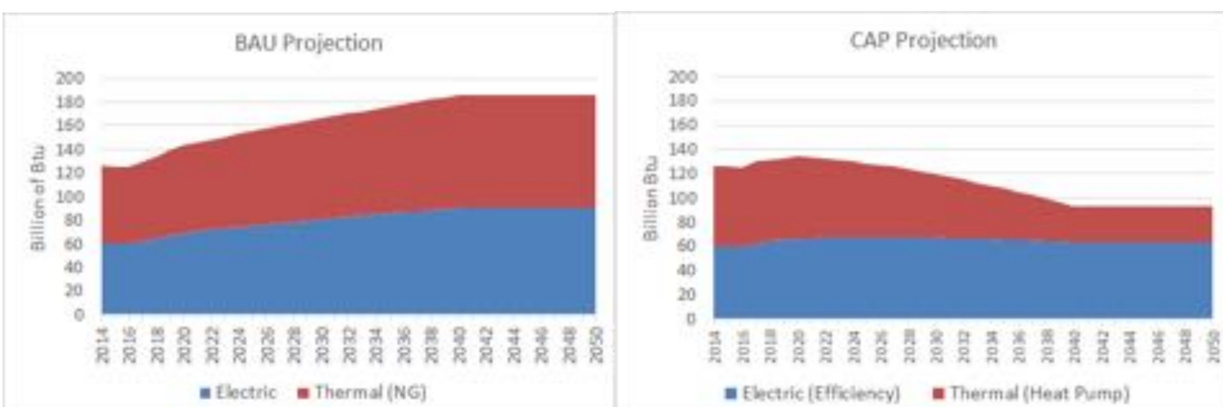


Figure VI.1. The projected energy use impact of replacing space and water heating with electric heat pump technology. The plot on the left shows the BAU scenario for electricity and natural gas. The plot on the right shows what energy use would be under the CAP (with the 30% electricity savings and thermal applications replaced by electric heat pump technology).

[50] ZNE requires that the building project generate as much energy as the building uses in all forms (electricity and fuels) on an average annual basis.

Energy Efficient Building Design

To minimize the use of exogenous sources of energy, ZNE buildings employ the principles of passive solar design. Building elements are oriented and designed to maximize the use of passive solar heating, cooling, and ventilation. The building shell should be well insulated; glazing should be super-efficient, provide maximum daylighting potential, and shading, where necessary, to avoid excess heat loading. Thermal mass or phase change materials are used to buffer large diurnal temperature swings. Passive solar design of buildings need not result in increased costs. With intentional design, significant gains can be achieved at the same or lower cost than conventional buildings. For example, a Math, Statistics, and Computer Science Building at the University of Canterbury, in New Zealand, that employed passive solar design achieved 24% energy savings, while costing 15% less than a conventional building and at the same time boosting occupant-self-rated productivity by 10%[51].

More aggressive architectural design decisions can reduce building energy by 60% or more[52] relative to conventional buildings, so, in the long term, the replacement of old buildings with new can greatly reduce EUI. **Referring back to Figure VI.1, this suggests that if all campus buildings were designed to be ultra-efficient, current electricity and natural gas end uses could drop to below 40 Billion Btu at maximum buildout of the campus, even despite an anticipated 40% growth in the student body. This is only about 1/5th of the expected energy use in 2040 under business as usual. Clearly, very large energy savings are possible.**

In ZNE buildings, energy services that cannot be provided by the design of the building alone (e.g. contributions to natural lighting, ventilation, and heating) are provided with on-site renewable energy. The goal is to displace not only non-renewable sources of electricity (a straightforward task given the State's two decades of experience with net-metered PV systems), but also to displace carbon-based fuel sources (meaning natural-gas in the case of Cal State East Bay). By far the largest uses of natural gas on campus are for space heating, with water

[51] Ministry for the Environment, New Zealand, Passive Solar Design Guidance. Available online: http://www.solaripedia.com/files/1115.pdf.

[52] Based on studies of residential buildings (Emanuele Naboni et al., Defining the Energy Saving Potential of Architectural Design, *Energy Procedia* 83 (2015) 140 – 146.) and sky-scrapers (Raji, Babak; Tenpierik, Martin J.; van den Dobbelsteen, Andy. "An assessment of energy-saving solutions for the envelope design of high-rise buildings in temperate climates: A case study in the Netherlands". *Energy and Buildings*. 124(15): 15 July 2016, Pages 210-221. Available online: https://doi.org/10.1016/j.enbuild.2015.10.049)

heating a far distant second. There are three theoretical possibilities for displacing natural-gas use on campus:

1. Replace natural gas with a bio-fuel
2. Use offsets
3. Replace natural gas with electric heating technology run on renewable energy

Replacing natural-gas with biofuels is both impractical and unsustainable in the long term; the campus lacks access to a large and sustainable source of biofuels, and biologically productive lands are better used for food production and to sustain ecosystem services than for fuel production. Offsets are considered a last resort under the Carbon Commitment, and they will be needed to cover transportation energy use that cannot be eliminated in other ways. That leaves replacing natural gas with electricity. Though not yet common, highly efficient commercial technology already exists for that purpose: namely heat pumps.[53]

Replacing Natural Gas with Renewable Energy for Space and Water Heating

After reducing energy demand for space heating and water heating with passive solar building design and efficient space and water heating technologies, there are two obvious approaches to greatly reduce or eliminate carbon emissions from residual energy demand:

1. Replacing natural-gas heating applications with active solar technologies (such applications use the sun directly to heat water or air for space heating, domestic hot water heating, or high temperature hot water application like sterilization)
2. Replacing natural-gas heating with electric heating and using renewable electricity as the energy supply.

With current technology there may be a great advantage to the second approach if natural-gas heating is replaced with electric heat pump technology, because this technology greatly reduces the amount of energy needed to supply the heat demand, as described later in this section. The drawback of using heat-pump technology is that it mandates the use of refrigerants, which may themselves be potent greenhouse gases. Deciding on which approach is preferable will require analysis of the relative costs, space requirements, and GHG emissions implications which is

[53] For example Carrier sells commercial combination chiller-heat pump systems in a wide range of types and capacities (up to about 4 megawatts) and sustainable refrigerant options: http://www.carrier.com/building-solutions/en/cn/products/commercial-products/chillers/

beyond the scope of this report. Because active solar heating is a well-understood technology, particularly for water heating applications, the remainder of this section is devoted to discussion of heat pump technology and its energy implications.

Heat pumps are basically refrigeration systems (i.e. vapor compression systems) run in reverse: heat is moved from a low temperature reservoir (e.g. from outdoors in winter time) to a high temperature reservoir (i.e., to the heated interior of the building). At the same time, the 'waste' heat from operating the heat pumps is added to that delivered indoors. In this way, more energy is delivered to the building than the energy used to operate the system -- typically much more.

Figure VI.2 illustrates a typical heat pump system and its energy flows, expressed in kilowatts (kW). As illustrated, 4 times as much energy is delivered to the building than is used in the form of electricity. That quantity (heat power delivered to or from the building ÷ electric power consumed) is referred to as the coefficient of performance (COP). Run in the opposite direction (for cooling), the waste heat from the electric power is not useful and is therefore rejected outdoors. In that case it does not benefit the interior space, so the COP for cooling is 3, while the COP for heating is 4, for the same technology.

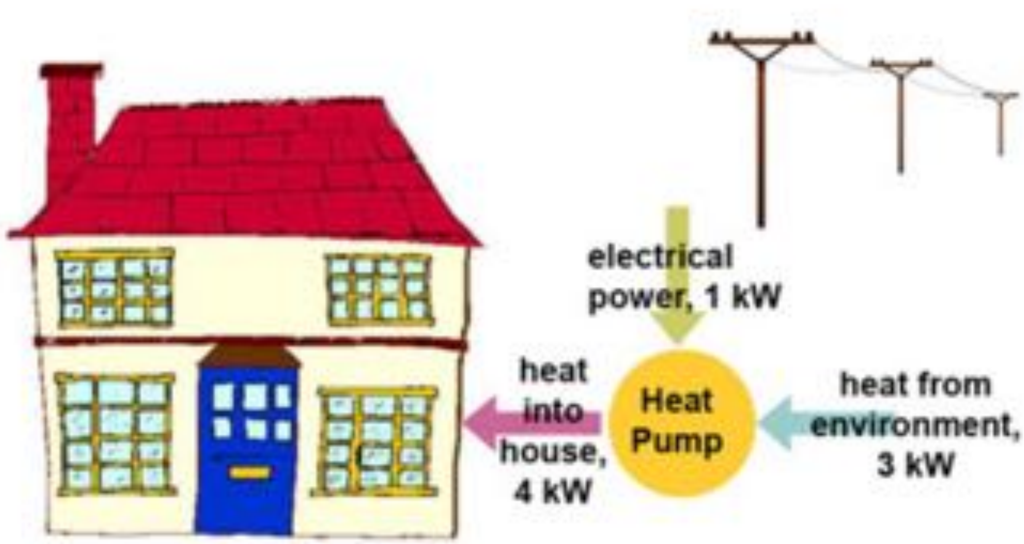


Figure VI.2. Heat pumps deliver more heat energy to the building than they use. Source: **http://www.powerknot.com/2011/03/01/cops-eers-and-seers/**

Coefficients of performance for commercial heating range between 3 and 6,[54] with typical values ranging between 3 and 4. Heating with fuel combustion can be at best nearly 100% efficiency (meaning that all of the heat of combustion is delivered to the interior space). The implication of this is that replacing natural gas heating with electric heat pumps will eliminate two-thirds to three-quarters of the University's heating energy demand, or more with advanced technology, greatly reducing the land-area requirements and cost for on-site PV, or other renewable energy sources. **A typical mid-range of 3.5 COP for heating, will reduce heating energy use by 71% with respect to the best natural gas technology.**

Table VI.1 shows the average breakdown of natural gas end-uses at U.S. universities, the energy savings potential of advanced end-use technology, and the fraction of original natural gas consumption that would remain after implementation of currently available, commercial energy efficient technologies. The net effect would be a 67% reduction in the energy use of what are currently natural-gas end uses from switching to heat pump heating and induction cooking alone, even assuming no improvements on other natural gas end-uses. **The results provide a potent reason for the University to both investigate and experiment with heat pump applications on site.**

[54] See for example: Thermodynamics Team D, University of Wisconsin, Green Bay, http://blog.uwgb.edu/chem320d/efficiency-of-heat-pumps/.

Table VI.1. Natural gas use in U.S. educational institutions. The breakdown by end-use is based on average national data, since the University currently lacks the submetered data on the different natural gas end uses on campus.

End-Use	Billion cubic feet	Percent of total consumption	Energy savings potential	Fraction remaining after CAP measures
Space heating	207	72.9%	71%	21%
Water heating	53	18.7%	71%	5.4%
Cooking	10	3.5%	50%	1.8%
Other	14	4.9%	0%	4.9%
Total	284	100.0%		33%

Source: Energy Information Administration, Commercial Building Energy Consumption Survey, Table *E8. Natural gas consumption and conditional energy intensities (cubic feet) by end use, 2012*. Available online: https://www.eia.gov/consumption/commercial/data/2012/c&e/cfm/e8.php

Other Electric End-Uses: Lighting, Computing, and Cooking

Very significant energy efficiency gains are possible in other end-uses as well. This section addresses three additional electric end-uses: lighting, computing, and cooking. The fraction of electricity that is typically used by these and other end-uses at US educational institutions is shown in Table VI.2. Mechanisms to obtain energy savings from other end uses are described in the Procurement section.

Table VI.2. Electricity Consumption by End Use in Education in the United States.

End Use	Trillion Btu	Percent
Cooling	90	20%
Lighting	78	17%
Computing	78	17%
Ventilation	68	15%
Refrigeration	40	9%
Office Equipment	21	5%
Space heating	10	2%
Cooking	4	1%
Water heating	3	1%
Other	66	14%
Total	458	100%

Source: Energy Information Administration, Commercial Building Energy Consumption Survey, *Table E3. Electricity Consumption (Btu) by end use, 2012*. Available online: https://www.eia.gov/consumption/commercial/data/2012/c&e/cfm/e3.php

Based on the results described in this section, it is not at all unreasonable to expect that the University could reduce its electricity use by 30% through technology switching, efficiency improvements, and improved operations. Moreover, these energy savings can be obtained with no reduction in service and likely with associated cost savings.

LED Lighting

LED walkway lighting on the Concord Campus.

As shown in Table VI.2, Lighting is the second largest end-use of electricity in the U.S. education sector, following closely after cooling. It is likely to constitute a larger relative share at Cal State East Bay, because of the region's mild summer climate relative to the nation as a whole. Thus, lighting likely constitutes the University's largest electricity demand.

LED lighting is progressively taking over the lighting market because of its increasingly high quality, high efficiency, rapid cost reductions, and design flexibility. Moreover, its lighting efficiency (efficacy) is expected to increase dramatically over the coming decades, providing large lighting energy demand savings for the University. These advances were not included in the BAU model because the campus has control over how actively and early it pursues these opportunities.

This section examines projected improvements in efficacy and lighting cost reductions of LED replacements for linear T8 Fluorescent lamps -- the workhorse of University lighting. LED replacements are already more efficient than Fluorescent T8's according to the US Department of Energy (DOE), as shown in Table VI.3. DOE anticipates that the efficacy of LED lamps will improve by 50% by 2030, relative to 2015. For LED-integrated fixtures (i.e. luminaires) efficacy is expected to improve by even more. This means that by 2030 the University could expect to save between about 40% and 55% of its lighting energy, while receiving the same level of service as is currently delivered by its fluorescent lamps. If high end, more efficacious technologies are used the savings should be even greater.

Table VI.3. Mean Efficacies (lumens per watt) of Conventional Fluorescent T8 Lighting and LED Lighting: Past and Projected

	2013	2015	2030	2030/2015
Linear Fluorescent [1]	79			
Linear LED lamp [2]	86	91	132	1.5
Linear LED Luminaire [2]	98	106	181	1.7

[1] Navigant Consulting, Energy Savings Forecast of Solid-State Lighting in General Illumination Applications, U.S. Department of Energy. August 2014. *Table D.2 Commercial Sector Conventional Technology Performance 2013.* Available online: https://energy.gov/sites/prod/files/2015/05/f22/energysavingsforecast14.pdf
[2] Ibid. *Table E.6 Average LED Lamp and Luminaire Efficacy Projections by Sector and Submarket.*

Moreover, switching to LED lighting should also produce significant cost savings that can be used to support the University's shift to carbon neutrality in other applications.[55] Table VI.4 shows the US Department of Energy's projections for lighting cost reductions; lighting hardware costs are expected to be about 70% below 2015 levels by 2030, even ignoring energy cost savings. Additional savings occur because LED lamps last twice as long as fluorescent lamps (cutting equipment investments for lighting and staff time for lamps replacements in half). Indeed, the LED costs savings are materializing so fast market wide that LEDs are expected to dominate the general service lighting market by 2020, making up 55% of the indoor lighting market at that time.

[55] LED lighting cost is expected to fall by 70%

Table VI.4. Current and projected lighting costs for LED general service linear fixtures (dollars per kilolumen, $/klm)

	2015	2020	2030	2030/2015
LED Lamp	$89	$60	$28	31%
LED Luminaire	$89	$62	$30	34%

Source: Navigant Consulting, Energy Savings Forecast of Solid-State Lighting in General Illumination Applications, U.S. Department of Energy. August 2014. Page 52.

The University can set an example by pursuing early investment in LED lighting, and parking lot lighting may be a good place to begin. Parking lots constitute a large fraction of University lighting energy, as shown by the results of a recent student energy audit on the Concord Campus (Figure VI.3). Conversions of high pressure sodium (HPS) lighting in parking lots may provide a particularly good high-visibility, high return investment opportunity.

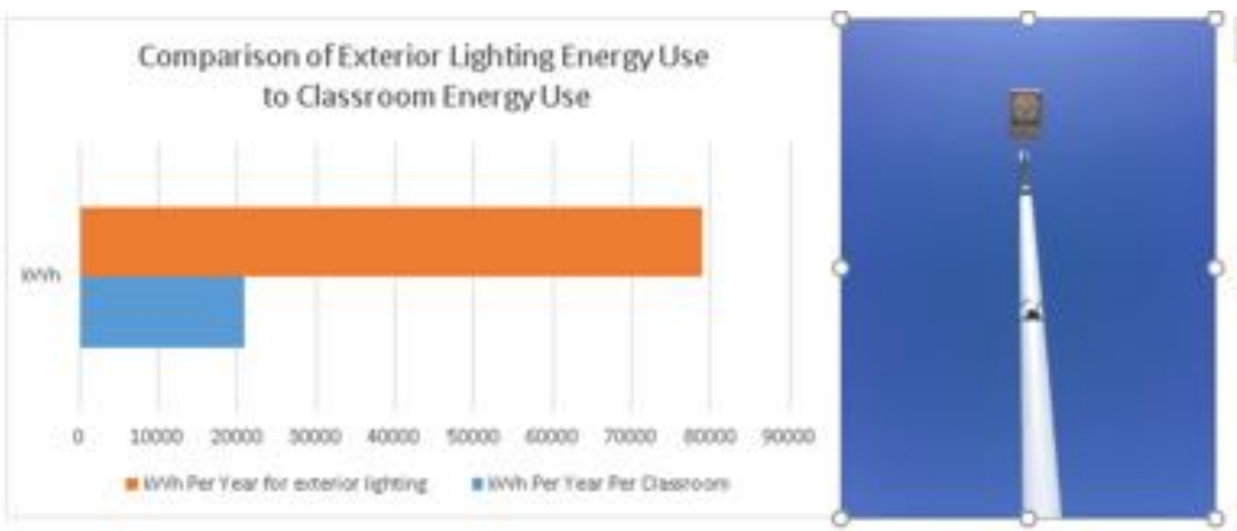


Figure VI.3. Exterior lighting dominates lighting energy use on the Concord Campus, according to a Spring 2017 Energy Audit Conducted by students in the Environmental Studies Senior Seminar. That use is dominated by the 250-W high-pressure sodium lights with inefficient magnetic ballasts shown at right.

Automated Lighting Controls

Automated lighting controls can also yield large energy savings with associated cost savings. Controls turn lights off when they are not needed or wanted. Many kinds of lighting controls are now in wide use including automated schedulers, occupancy sensors, daylighting controls (photosensors), timers, and dimmers. These may work in combination with other technologies to provide appropriate services when needed. For example, multi-level lighting in stairwells may include low-level emergency lighting that is always on, with high level lighting triggered by occupancy sensors.

A meta-study of 88 modeling and case studies of the energy reduction potential of lighting controls in commercial buildings[56] reported savings ranging between 28% and 50%. In combination, switching to LED and using controls can result in very significant energy savings. **Given the 40% - 55% energy savings and the 28% - 50% controls savings, net savings potential over conventional lighting ranges from 57% at the low end to 77.5% at the high end, without any diminution of service.** While the University has implemented lighting controls in some areas and a small fraction of its lighting is LED, substantial savings potential is likely remaining. An audit will be needed to better quantify that potential.

We note that lighting controls can confer other benefits and opportunities as well. For example, occupancy sensors on nighttime path lighting can improve campus safety by alerting the location of others on the path while avoiding unnecessary light pollution. Lighting color controls, enabled by LED and lighting control technology, can also improve the health and environmental quality by providing the appropriate color of light at the appropriate time to maintain proper circadian function.[57]

Computing and Office Equipment

According to the Energy Information Administration, computing is the next largest source of electricity consumption in U.S. educational institutions. Energy audits conducted by students in the Environmental Studies Senior Seminar in Spring 2016 and Spring 2017 suggest that large potential energy saving exist in this area.

---

[56] Alison Williams, Barbara Atkinson, Karina Garbesi , Erik Page , and Francis Rubinstein,Lighting Controls in Commercial Buildings, LEUKOS; 8(3) January 2012, pg. 161–180. Available online: https://ees.lbl.gov/sites/all/files/lighting_controls_in_commercial_buildings.pdf.

[57] See for example: David Holzman, *What's in a Color? The Unique Human Health Effects of Blue Light,* Environ Health Perspectives, 2010 Jan; 118(1): A22–A27. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2831986/.

A total of 66 computer-lab computers were investigated in Spring 2017 on the Concord Campus, examining the power savings settings for the computers and their associated monitors. The findings, documented in Table VI.5, indicate that far greater savings could be obtained simply from better management of the computers. Almost ¾ of the computers themselves had no power saving enabled, meaning that if the computer is switched on, it will stay in active mode regardless of whether it is being used or not. More than ⅓ of the monitors had no power saving enabled, and those that did, had unjustifiably long lag times to auto off, most set at 45 minutes, others at 30 minutes, whereas 10 minutes should be more than ample.

Table VI.5. Computer and Monitor Power Saving Settings on the Concord Campus, audited in Spring 2017.

Overall Monitor and Computer Power Settings						
Power Setting (auto-off) on Monitors				Power Setting (auto-off) on Computers		
	30 Minutes	45 Minutes	Never		Never	Not Specified
Number of Monitors	12	31	23	Number of Computers	48	18
Percent of Monitors	18%	47%	35%	Percent of Computers	73%	27%

In the Spring of 2016, students document which computers were ENERGY STAR® or not in the library and computer labs. Of 138 computers studied, only 36% were ENERGY STAR® (Figure VI.4). Moreover, the students found that most of the ENERGY STAR® computers examined did not have their energy saving features enabled.

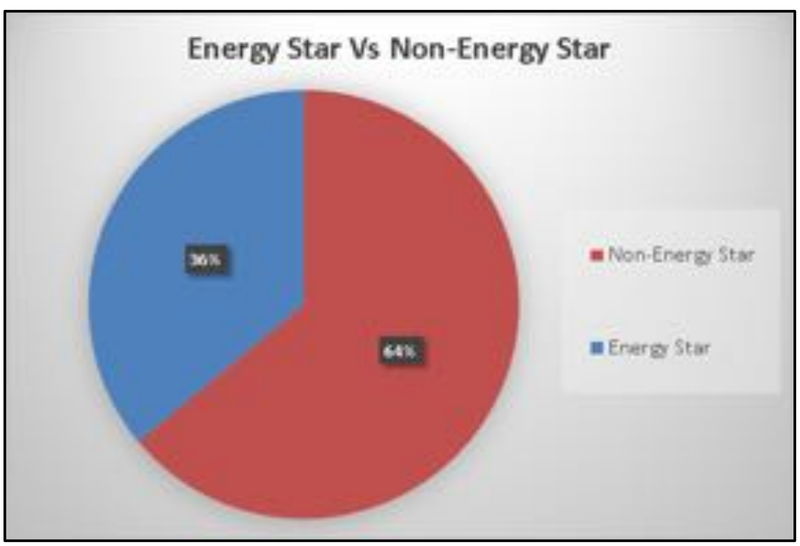


Figure VI.4. Percentage of Computers in the library and computer labs on the Hayward Campus that are ENERGY STAR®, based on a Spring 2016 audit (n = 138).

These findings lead to the development of a new procurement and IT policy presented in the Procurement Chapter.

Cooking

Cooking is an end-use that is expected to grow disproportionately to student enrollment because of plans to increase on-campus residency. It is another end-use in which large energy and GHG savings potential exist, specifically from switching from gas cooking to electric induction cooking. Induction cooking is high performance using about half of the energy use, and both cookers and ranges are now commercially available.

Accomplishments

In addition to installing significant solar energy capacity and implementing energy efficiency retrofits, discussed in other sections, the University has achieved the following accomplishments in the buildings area:

- From 2006 to 2008, retrofit lighting and lighting sensor projects were completed in various buildings on both the Hayward and Concord campuses. Additionally, the building management system (BMS) and controls were upgraded allowing for improved energy use across each campus.
- In 2011 an energy efficient boiler was installed at the Concord Campus.
- Completed in 2011, the Recreation and Wellness Center, on the Hayward Campus, was built to LEED Gold standards. The building includes the following passive solar design features:
    - A prominent external glazing shading system
    - An advanced ventilated trombe wall system for passive temperature control
    - Solar thermal space heating
- New cooling towers and motors were installed in Meiklejohn Hall and the Music Building in 2012 saving an estimated 37,378 kWh annually.
- 2013 saw the replacement of 25 old furnaces with 95% high efficiency models in the Calaveras Residence Hall.
- In 2015, windows and furnaces were upgraded in Pioneer Heights Residence Hall.
- Completed in December, 2015, the Student and Faculty Support Building, on the Hayward Campus, is certified LEED Platinum. Incorporating many sustainable features, GHG reducing measures include:
    - 50% energy reduction below Title 24 requirements

- a 100 kW PV system
- LED lighting and controls

- A SMART Room was constructed in the Art & Education Building in 2017 with LED lighting and WattStopper light controls (self-dimming and motion sensors).

The Action Steps

Action Steps presented here relate to building design and management and space conditioning. Other end-uses in buildings are incorporated in the energy section.

BUILDINGS		**Est. Impact**	**Leadership**	**Est. Resources**	**Establishment Timeline (*)**
BLDG1	**Design all new buildings to be Zero Net Energy (ZNE) starting immediately.** The design process will consider the criteria and potential certification under the following: LEED, Living Building Challenge, Passive House Institute US	Significant operational cost savings and GHG reduction potential over lifetime of building	Facilities	Staff/consultant time (significant initial)	Immediate
BLDG2	**No new natural-gas consuming equipment** for space and water conditioning starting in 2022. For example, solar thermal systems, PV-driven heat pump systems, or off-set.	Significant GHG reduction potential	Facilities and Procurement	Staff time (moderate initial); likely higher initial cost	Near term
BLDG3	**Replace space heating, water heating, and cooking equipment with ultra efficient fossil-fuel-free technologies** (e.g. heat pump technology)	Significant GHG reduction potential	Facilities and Procurement	Staff time (moderate initial); likely higher initial cost	Long term (sustained effort through 2040)
BLDG4	**Maximize PV production on all new buildings.**	Moderate GHG reduction potential, cost savings over lifetime of system	Facilities	Staff/consultant time (moderate initial)	Immediate

BLDG5	**Track building energy performance with computerized monitoring systems** (building energy-use monitoring) to enable more effective building energy management and GHG emissions reductions tracking	Moderate GHG reduction potential, moderate operational cost savings from more effective energy use	Facilities	Staff/consultant time (moderate initially, low later)	Near term
BLDG6	**Post climate action educational display prominently in all main buildings.** Signage will state Cal State East Bay's climate neutrality goal, and graphically display the building's progress thereto, starting with the baseline monitoring year. Longer term goal to incorporate real-time dashboard of overall GHG savings on main buildings	Significant educational and motivational impact	Facilities	Staff time (low)	Near term

VII. Housing

Background

According to the AY2013/2014 Greenhouse Gas Inventory, Pioneer Heights is responsible for about 12% of the University's electricity consumption and about 17% of its natural gas consumption. Located on the southeast edge of the Hayward Campus, Pioneer Heights is the main on-campus residential student housing complex at Cal State East Bay[58]. Pioneer Heights was constructed in three phases: Phase I was completed in 1989; Phase II was completed in 2006; and Phase III was completed in 2008. Pioneer Heights is comprised of 11 buildings (residential, office, and dining) and includes approximately 400,000 square feet of building space. Current capacity is approximately 1,600 residents, but the Cal State East Bay Master

58 Cal State East Bay leases additional housing off-campus. Since these buildings are not owned or maintained by the campus they are excluded from the CAP.

Plan anticipates expanding housing to support 5,000 residents, substantially increasing the percentage of resident students.[59]

Accomplishments

Since Phase I of Pioneer Heights was constructed in 1989, some effort has been made to improve the efficiency of on-campus housing at Cal State East Bay.

- All windows and furnaces in Sierra were replaced in 2015 (Phase I)
- All windows and furnaces in Sonora were replaced in 2016 (Phase I)
- As a result of a water use analysis study completed by a course funded by the CSU System Campus as a Living Lab (CALL) Grant in AY2013/2014, all shower heads in Pioneer Heights were replaced with low-flow shower heads (1.5 gpm) and aerators were installed on every sink faucet.
- All new appliances purchased for the residence halls, since AY2012/2013, are ENERGY STAR® rated.

The Action Steps

HOUSING		**Est. Impact**	**Leadership**	**Est. Resources**	**Establishment Timeline (*)**
HOUS1	**Switch to Solar Water Heating in Pioneer Heights.** Investigate options (solar thermal collectors versus PV).	Significant reduction in natural gas demand in residence halls and associated GHG reductions (currently N-gas accounts for 60% of the Hayward Campus's residence hall energy use.)	Facilities	Moderate up-front cost	Near term

[59] Source: AY 2013/2014 Greenhouse Gas Inventory
http://www.csueastbay.edu/oaa/sustaineb/files/docs/GHGREPORT%202015_12.21.15_FINAL.pdf

HOUS2	**Institute policy to increase campus housing to 5,000 student residents by 2032 and encourage first year students to live in residence halls (consistent with master plan)**	Significant GHG reduction potential from both commuting and zero net energy housing, but increases the challenge of achieving carbon neutrality; potential increase in water use on campus	Admin	Staff/consultant time (significant); high cost	Long term
HOUS3	**Investigate potential for building low-cost faculty housing** on or near campus. Co-benefit of attracting qualified faculty on state salary given prohibitive Bay Area housing prices	Moderate GHG reduction potential from commuting and zero net energy housing, but increases the challenge of achieving carbon neutrality; potential increase in water use on campus; potentially significant co-benefits in attracting and retaining new faculty	Admin	Staff/consultant time (significant); high cost	Near term

*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).

In addition to all measures that apply to buildings and energy use outlined in the associated chapters, there are three main actions that Cal State East Bay will take in the near term to significantly reduce energy demand in Housing and improve efficiency.

Installing solar hot water heaters at Pioneer Heights will dramatically decrease the demand for natural gas to heat water in housing, which currently accounts for 60% of the Hayward Campus natural gas usage. While there may be a moderate up-front cost, the project would require little staff time and significantly contribute to the campus climate neutrality goals.

In compliance with the Master Plan, Cal State East Bay will continue on the path to increase on-campus residents to 5,000 and encourage first-year students to live on campus. As emissions from commuting are the main contributor to campus GHG emissions, increasing on-campus residents will have a significant GHG reduction potential.

Similarly, investigating the development of ZNE buildings for low-cost faculty housing would have a significant GHG reduction potential because faculty would not need to commute to campus. Housing for faculty has a co-benefit of attracting qualified faculty on a state salary in an area that has a high cost of living.

VIII. Procurement

Background

Energy efficient procurement policies are widely used, easy to implement, and can have a profound impact on University GHG emissions from a broad range of electricity and natural-gas using appliances and equipment. The most widely used policy is to simply require the purchase of ENERGY STAR® products, for all products that fall under ENERGY STAR® certification. These include lighting products, office equipment, electronics, heating and cooling equipment, water heaters, building products and commercial food service equipment[60]. More rigorous certification is available for electronic equipment: EPEAT-certified products must meet ENERGY STAR® efficiency standards as well as other environmental standards. Because of their energy savings, energy efficient products often have lower life-cycle costs than the conventional alternatives, saving the University money as well as energy and reducing GHG emissions. ENERGY STAR® and other certifications provide an easy and quality assured mechanism for the University to identify preferred products.

Accomplishments

- 100% Recycled Copy/Print Paper[61] Policy approved by the Campus Sustainability Committee
- Tracking of recycled content in purchases and green products
- Paperwork reduction through adoption of campus purchasing portal, Campus Marketplace, with 13 other CSU campuses.

[60] ENERGY STAR® is a joint US Department of Energy, US Environmental Protection Agency program that certifies energy efficient products. A full accounting of ENERGY STAR® products is available online: https://www.energystar.gov/products?s=mega.

[61] Paper is included in the CAP because emissions related to paper transport are taken into consideration in the Greenhouse Gas Inventory.

The Action Steps

PROCUREMENT		Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
PROC1	**Adopt Electronics and Appliance Procurement Policy** (in progress) that requires: Bronze EPEAT® or higher for EPEAT®-rated products, ENERGY STAR® for everything else if available, and Suppliers to deliver electronics with conservation and energy efficiency features enabled and as the auto-default	Moderate GHG reduction potential, moderate operational cost savings	Procurement	Staff time (low)	Immediate
PROC2	**Initiate accounting of carbon emissions from procurement (e.g. using the Economic Input-Output Life Cycle Assessment (EIP-LCA) tool)**	Significant GHG reduction potential	Procurement	Staff time (significant initially to low in the long term)	Near term
PROC3	**Investigate policy for locally sourcing materials to reduce transportation energy use associated with procurement**. E.g. Purchase majority of construction materials within 250 miles	Moderate GHG reduction potential, potential for higher cost of goods	Procurement	Staff time (low)	Near term
PROC4	**Establish 100% Recycled Copy/Print Paper Policy** (in progress)	Low GHG reduction potential; increased cost of paper	Procurement	Staff time (insignificant)	Immediate
PROC5	**Continue to move away from the use of paper-based processes with digital processes**	Low GHG reduction potential; moderate monetary cost savings potential	Procurement	Staff time (initial investment high)	Near term
*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).					

IX. Landscaping

Background

Landscaping contributes to University GHG emissions both directly and indirectly through irrigation, energy use, and applied synthetic fertilizers. Water-related energy use consumes 20% of the State of California's electricity, as the processes of extraction, treatment, and conveyance are energy-intensive[62]. Likewise, it takes sizable quantities of water to produce energy to cool the machinery that extracts fuel, therefore conserving water and energy use in all processes including landscaping reduces carbon emissions.

Landscape-based climate mitigation can take a number of forms:

- GHG emissions can be reduced directly by
    - Reducing the fertilizer use
    - Reducing water use
    - Reducing the use of fossil-fuel consuming landscaping equipment
- Landscaping can be used to modify local micro-climates, reducing the need for space conditioning
- Landscaping can be used to sequester carbon (for example by reforesting).

Landscaping can provide significant co-benefits to the University community, for example, improving thermal comfort, enhancing campus aesthetics, providing a sense of place and habitat for native species. Community food gardens can build community through shared labor, shared fruits of that labor, and celebration of multi-cultural heritage through that sharing. Greenspace is proven to improve mental health and productivity.

On-Site Carbon Sequestration

The Hayward and Concord campuses include large areas of open space that could be used to capture carbon and other benefits, as shown in Figures IX.1 and IX.2.

---

[62] Source: United States Environmental Protection Agency https://www3.epa.gov/region9/waterinfrastructure/waterenergy.html

Figure IX.1. Hayward Campus open space includes 130 acres in the enclosed polygon (marked by white dots and line segments).

Figure IX.2. Concord Campus open space includes approximately 300 acres, as marked.

In Spring 2017, students in the Environmental Studies Senior Seminar course conducted an assessment of the campuses' potential to sequester carbon by replanting mixed oak woodland, indigenous to California's Central Coast. Based on a literature review, the students found that mature mixed oak woodland ecosystems support an estimated 71 metric tonnes per hectare (Mte/ha) of live tree biomass, and another 73 Mte/ha in understory vegetation, downed woody material, and soil horizons, yielding a total of 144 Mte/ha (or 57.6 Mte/acre) of stored carbon in the ecosystem[63]. This implies that Cal State East Bay's 430 total open space acres could sequester a total of 24,768 Mte of organic carbon (430 acres x 57.6 Mte/acre). Having been obtained from CO_2 in the atmosphere, this much carbon indicates that 90,800 Mte of CO_2 would be absorbed, net, in its capture[64]. Assuming 100 years until ecosystem maturity, this implies a long-term average uptake of about 900 MTeCO_2/year.[65]

With a current total GHG emission rate of 45,000 - 50,000 MTeCO_2/year, it is clear that sequestering carbon with native woodlands would make only a small dent in University emissions. However the co-benefits of restoring these marginalized lands would be significant -- particularly given the rapid loss of this iconic ecosystem to housing tracts, vineyards, golf courses, and other development, statewide.

Campus Food Production and Local Composting

On-site food production and composting can model low carbon food production methods as well as producing numerous co-benefits for the campus. Energy-related emissions are reduced by eliminating the need for transportation of those foods. They can also be reduced by the use of low-carbon food productions approaches, for example with low or no mechanization and/or low or no carbon-emission equipment. Proper compost management of landscaping wastes, food production wastes, and food wastes can reduce or eliminate methane emissions from those sources, thereby reducing their GHG footprint, while at the same time providing effective, non-toxic, and sustainable source of soil amendment.

[63] Tom Gaman (20008), *An Inventory of Carbon and California Oaks,* California Oak Foundation. Available online: http://californiaoaks.org/wp-content/uploads/2016/04/CarbonResourcesFinal.pdf.

[64] The ratio of the molecular weights of CO_2 to C is 44.01/12.01. Therefore the net CO_2 captured is 3.66 times more massive than the carbon in the ecosystem.

[65] We note that if reforested land was instead used for timber production with a faster growing species, with timber grown, harvested, and sequestered into building materials, making room for new net ecosystem uptake, the total sequestration rate could be significantly increased, but the other ecosystem values would not be realized. Moreover, it is not clear that fast growing timber could be sustainably produced on university land.

The food production program could take many forms that are no mutually exclusive. These included teaching gardens, community gardens and a community supported agricultural approach that allows excess production to be sold to the campus community and beyond. In addition the plots can be managed as multi-cultural heritage gardens, and serve as a foundation for the sharing of multicultural food and traditions. Success will require the dedicated focus of at least a small cadre of faculty (one affinity hire in sustainable food production) and staff.

Accomplishments

- Facilities Development and Operations (FDO) completed a water conserving landscape design in 2014 in response to the state of California's mandate to eliminate wasteful water use practices. More than 12 acres, primarily on the Hayward campus but also two sites on the Concord campus, were analyzed with functional inputs from the academic departments. The finalized designs are on file and include site inventories, plant selection and placement, function of space, academic department inputs, etc.
- For the past decade the campus had been restoring native vegetation, most notably along the Carlos Bee entrance to the Hayward Campus and in two recent gardens: The California Native Botanical Garden (2013) and the Waterwise Botanical Garden[66] (2014), both located near Robinson Hall.
- FDO instituted an ongoing turf conversion program to convert large expanses of turf grass when not serving as sports fields.
- FDO is currently working with Bay Area Air Quality Management District (BAAQMD) to obtain and test low emission or zero emission lawn and garden equipment for future transition away from traditional gas-powered equipment.

The Action Steps

As with transportation, there is no single measure from which the majority of GHG savings will come. For maximum impact, the broad array of actions itemized below with be utilized and explored covering the range from reductions in fertilizer use and water use, converting to zero emission landscaping equipment, and landscaping for sequestration and microclimate benefits.

[66] Source: CSU Sustainability Report 2014

	CLIMATE AND PLANET FRIENDLY LANDSCAPING	Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
LAND1	**The University will adopt SITES certification criteria in developing landscaping projects**	Moderate general environmental benefits	Facilities	Staff time (low)	Near term
LAND2	**The University will adopt Bay Friendly Landscaping practices**	Moderate operational cost savings from energy, water, and labor reductions; moderate GHG reduction potential; environmental benefits.	Facilities, CSC	Staff time (high initial, then low)	Near term
LAND3	**University will discontinue use of synthetic fertilizers within 5 years**	Minimal GHG emissions reduction, moderate general environmental and health benefits, significant symbolic impact	Facilities	Staff time (low)	Immediate
LAND4	**Newly purchased equipment to be electric, battery-powered, biofueled, or other RE-powered when commercial grade equipment is available**	Operational cost savings from reduced equipment maintenance, low GHG reduction potential, potential health benefits	Facilities	Staff time (low)	Near term
LAND5	**Carbon sequestration: Restore native woodland on open space on the Hayward and Concord campuses.**	Significant ecological benefits, moderate GHG reductions; Cost implications need to be studied (possible cost benefits if offsets from sequestration are certified)	Facilities	Staff time (significant)	Medium to long term
LAND6	**Continue turf conversion project using Bay Friendly Landscaping policies.**	Operational cost savings from energy, water, and labor savings; environmental benefits.	Facilities	Staff time (moderate)	Immediate
LAND7	**Increase tree cover in parking lots and other locations on campus. Use high albedo paving surfaces (permeable where possible).**	Moderate GHG reduction potential; significant co-benefits including mitigation of heat island effect, positive aesthetic impact; significant environmental comfort and health benefits	Facilities	Monetary cost (moderate initial cost)	Near to medium term
LAND8	**Pursue the development of on-campus organic food production** in the form of multi-cultural heritage gardens, that serve as a foundation for the sharing of multicultural food and traditions.	Minimal GHG reduction potential; significant co-benefits.	Academic Affairs, Facilities	Staff and faculty time (2 FTE) Moderate initial cost	Near to medium term
LAND9	**Continue to investigate the potential for on-campus composting** consisting of food waste and landscape debris with finished product for use as landscaping amendment	Low GHG reduction resulting from decreased transport of materials to waste facility and decrease in need for synthetic fertilizer; operational cost savings as finished compost used in place of purchased fertilizer	Facilities	Staff time, additional staffing may be needed	Near term
*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).					

X. Education

Background

Cal State East Bay has twice committed itself to educating all students on the issue of carbon neutrality. First in 2007 in the Academic Senate's Sustainability Resolution (06-07 BEC 9), which resolved "to make climate neutrality and sustainability a part of the curriculum...for all students". And again, in 2015, when President Morishita signed the Carbon Commitment.

While it has made major strides in the past two years toward universal education on sustainability, and while students have been included actively in the development of this CAP and the associated Greenhouse Gas Inventory, the University has yet to address its commitment to universal education on climate neutrality.

While the campus's adoption of sustainability as an Institutional Learning Outcome (ILO)[67] requires an associated one-course Sustainability Overlay for all students, it does not guarantee an increased focus on carbon neutrality, since education in that area is *not required*. The student learning outcomes for the Overlay requirement, which starts with the AY2018/2019 Catalog, specifies only that students will be able to:[68]

1. Identify the environmental, social, and economic dimensions of sustainability, either in general or in relation to a specific problem;
2. Analyze interactions between human activities and natural systems;
3. Describe key threats to environmental sustainability; and
4. Explain how individual and societal choices affect prospects for sustainability at the local, regional, and/or global levels.

Certainly courses focused on climate neutrality could comply with the Overlay requirements, but it is unclear how many will materialize addressing the issue.

In addition, Cal State East Bay has been participating in conversations on the development of a California State University Systemwide Sustainability Minor that would be adaptable to any CSU campus. At Cal State East Bay, the Academic Senate's Ad Hoc Committee on Sustainability is pursuing a model that would include a climate neutrality course as a requirement for the minor. While far from meeting the requirement for universal education on the subject, it could constitute a significant first step involving multiple faculty and departments in the process. This will

[67] http://www.csueastbay.edu/faculty/senate/committees/capr/11-12-documents/ilo-final-draft.pdf
[68] http://www.csueastbay.edu/faculty/senate/files/docs/cic/cic-15-16/15-16-docs/15-16-cic-42-overlay-outcomes.pdf

ultimately be essential to achieving the broader goal. There is a far larger faculty knowledge gap on the specific issue of climate neutrality than on the more general issue of sustainability.

Faculty Engagement

Apropos of faculty engagement in carbon neutrality and sustainability coursework, this can be incentivized by explicitly recognizing work focused on the University's ILOs in the retention, tenure, and promotion process. Currently, there are no such incentives. Their inclusion has been the subject of the the Academic Senate's Ad Hoc Committee on Sustainability, which will require the collaboration of Senate's Faculty Affairs Committee and the approval of the Senate itself.

Faculty hiring to increase the number of new hires who can support the University's ILOs is also essential to build and maintain the capacity necessary to carry out the University's mission. The University's Affinity Hires Program was successfully engaged in that during the past three years, but such hires have been at least temporarily suspended.

Committee work related to carbon neutrality acts as a form of faculty development in the subject area. There are three formal channels in which faculty are currently engaged. The Academic Senate's Ad Hoc Committee on Sustainability is composed of ten members: nine faculty and one student. The duties of this committee are to make policy recommendations to the Academic Senate to achieve the University's academic sustainability commitments and goals, promote sustainability as a focus of curricular and co-curricular activities, promote opportunities for sustainability research and scholarship, and report to the Senate annually on the work of the Committee[69]. Additionally, faculty hold four seats on the Campus Sustainability Committee (CSC)[70] and participate in the CSC CAP Task Force, whose goal is to meet the requirements of the Carbon Commitment. Lastly, faculty also serve as subject matter experts on issues related to sustainability throughout the academic year during events and through various committees, and lead curricular sustainability efforts in the classroom.

[69] Sustainability Committee Bi-Laws: http://www.csueastbay.edu/faculty/senate/files/docs/ad-hoc-sustainability/pols-and-procs/cah-sustain-pols-procs-16-17-cah-1.pdf
[70] http://www.csueastbay.edu/oaa/sustaineb/committments/csc.html

Accomplishments

Being in transition to semesters with one full year to go before curriculum is finalized, it is too early to predict the degree to which carbon neutrality will be incorporated in the curriculum, and it is largely irrelevant to examine the degree to which it is included today. The accomplishments to date that indirectly support the development of curriculum and faculty engagement of the issue of climate neutrality include:

- The passage of the Senate Sustainability Resolution (06-07 BEC 9)
- The signing of the President's Carbon Commitment (Jan 25, 2015)
- The Sustainability Overlay Requirement (15-16 CIC 5)
- The work of the Senate Ad Hoc Committee on Sustainability

Co-Curricular Education

The Office of Sustainability hosts an annual paid internship program, Sustainability Ambassadors (SA), which is supported by student fees. The purpose of the SA program is to provide students with the skills to design, track, and implement an on-campus sustainability-related project or program. SAs are trained on professional and leadership skills and are required to submit their projects to local sustainability-related professional events like the This Way to Sustainability Conference hosted annually by Chico State and the annual California Higher Education Sustainability Conference. While not all SA projects are focused on climate change, SA students lead the collection of emissions data for annual GHG inventory reporting.

Throughout the academic year numerous events are hosted on campus by the Office of Sustainability, other campus departments, academic offices, Associated Students Inc., and various student clubs and organizations. AY 2016/2017 highlights include the speakers series featuring climate leaders Wei-Tai Kwok and Winona LaDuke (co-hosted by the Office of Sustainability and the Office of Diversity, Leadership, and Employee Wellness), the book discussion and day of service surrounding Bill Nye's *Unstoppable: Harnessing Science to Change the World* (a collaboration between the Center for Community Engagement and the City of Hayward on "Book-to-Action"), and several other sustainability events with a focus on climate change held throughout Earth Week (organized by student clubs and organizations, and campus departments).

Campus as a Living Lab

The CSU System offers an annual Campus as a Living Lab (CALL) Grant[71], which is intended to connect faculty with facilities staff to work together to address a specific sustainability-related campus issue through coursework. Cal State East Bay faculty have been grant recipients over the past few years, focusing on projects such as: water use assessment in the residence halls, feasibility of on-campus composting, and energy monitoring of campus buildings. Use of the campus as a living lab occurs outside of the formal grant program as well. Several campus sustainability initiatives, like the GHG inventory, climate action plan, and Sustainability Tracking, Assessment & Rating System (STARS), were started in a course.

The Action Steps

The Plan incorporates a wide range of strategies to improve and expand education on carbon neutrality, from curriculum planning and development to faculty development and co-curricular activities, as outlined in the table below.

EDUCATION AND FACULTY DEVELOPMENT		Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
EDU1	**Pursue fulfillment of commitment** to educate all students on carbon neutrality (per the 2007 Senate Sustainability Resolution and the President's Carbon Commitment)	Highly significant educational impact. Moderate direct GHG reduction potential, but possibly large indirect GHG reductions through changing students behaviors and attitudes over their lifetime.	Academic Senate	Transition cost in faculty time developing courses that embed carbon neutrality into GE offerings; Academic Senate time for developing learning outcomes for carbon neutrality coursework	Medium term
EDU2	**Facilitate student learning on climate neutrality issues** through involvement in research, hands-on-learning, campus-as-a-living-laboratory, community engagement on issues of climate mitigation and adaptation, carbon-neutrality internship placements, and freshman learning communities	Significant educational impact, especially for diverse student population, as under-represented minorities benefit most from high impact learning practices such as theses. Significant GHG reduction potential from "Campus as Living Lab" projects.	Faculty, Office of Sustainability, Center for Community Engagement	Faculty time (incremental cost)	Near term

71 https://www2.calstate.edu/impact-of-the-csu/sustainability/Pages/Campus-as-a-Living-Lab.aspx

EDU3	**Include recognition of work on University ILOs in the RTP process** (this indirectly supports carbon neutrality work through the Sustainability ILO)	Moderate	Academic Senate	Insignificant marginal effort	immediate
EDU4	**Pursue an interdisciplinary sustainability minor that includes education on carbon neutrality**	Moderate but important stepping stone	Academic Senate	Moderate	near term
EDU5	**Pursue faculty hires to support universal education on carbon neutrality**	Significant and essential to maintain momentum	Academic Affairs	Insignificant (faculty will need to be hired regardless)	immediate to long term

XI. Finance

Background

In the past the University's carbon abatement investments have been largely opportunistic. If investments were cost saving (such as with energy efficiency projects) or cost neutral (as with solar energy investments) in the near term and favorable opportunities presented themselves, we took advantage of them. Specifically, the use of financial tools such as Energy Services Agreements (ESAs) and Power Purchase Agreements (PPAs) are in wide use including by Cal State East Bay to fund energy efficiency retrofits and renewable power projects. For example, a PPA made the install of the one megawatt PV system at the main campus possible, and the University currently benefits from energy efficiency projects completed through the arrangement of an ESA. These are advantageous financial tools, as the vendors install and maintain the equipment while the benefitting organization avoids increased capital and operational expenses, which can be more cost effective than direct investments. Other financial benefits are realized through consolidating and leveraging purchasing power toward aggregate renewable energy purchases and Strategic Energy Partnership Programs (SEPP) and should continue to be pursued.[72]

The University's investment portfolio managed by Cal State East Bay Foundation has not yet divested from the fossil fuel sector[73]. Doing so would not only have important educational, environmental, and social benefits but may also have a small positive return effect[74]. Cal State East Bay can look to Chico State University, Humboldt State University, Stanford University, and San Francisco State University for information on their recent fossil fuel divestment processes and outcomes.

While the previously mentioned financing methods are advantageous in the pursuit of incremental reductions in the University's carbon footprint, it is necessary to dedicate substantial and sustainable funding sources in order to meet the President's aggressive commitment of carbon neutrality. Consistent with duties as fiduciaries and the unique leadership roles within

---

[72] Excerpt from Climate Action Writers' Group presentation November 18, 2016

[73] Note that emissions associated with the University's portfolio of investments are currently not quantified in the GHG inventory.

[74] https://www.impaxam.com/media-centre/white-papers/beyond-fossil-fuels-investment-case-fossil-fuel-divestment

the university system, financial officers must pursue collective actions toward GHG reductions and aggregate renewable energy programs to achieve the stated imperatives.

Accomplishments

- With the use of a Power Purchase Agreement, Cal State East Bay installed a 1.01 megawatt photovoltaic system which generates enough energy to offset approximately 7% of the University's energy usage saving Cal State East Bay $120,000 annually in electricity bills[75].
- The new highly energy efficient Student and Faculty Support building completed in 2015 saves the University more than $100,000 in annual energy costs[76].

The Action Steps

FINANCE		Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
FIN1	**Financial Analysis of Carbon Neutrality Plan** An analysis of the most cost effective actions to achieve carbon neutrality, to account for and prioritize projects based on project implementation costs, potential long-term financial costs/benefits, and GHG reductions	Significant: Enabler of entire Climate Action Plan	Administration and Finance Division	Staff time (significant initial investment)	Near term
FIN2	**Ensure Annual Budget & Staff Time** for GHG-reduction efforts. Best practices include the use of an energy efficiency revolving fund in which costs savings resulting from energy efficiency improvements are reinvested in further improvements	Significant GHG reduction impact in that this enables fulfillment of the Climate Action Plan; potentially significant energy cost savings from energy efficiency projects	Administration and Finance Division	Staff time (moderate investment)	Near term
FIN3	**Incorporate the cost of carbon, along with other project costs, in the cost-benefit analysis of new infrastructure projects**: Use the most recent mean price (dollars per metric ton) from the California Cap-and-Trade Program Auction. Currently available in the Summary of Results Report on the California Air Resources Board website: https://www.arb.ca.gov/cc/capandtrade/auction/auction.htm#proceeds	Significant educational impact for staff because it serves as constant reminder to incorporate carbon neutrality in all project planning. Moderate GHG reduction potential	Facilities	Staff time (low incremental cost)	Immediate

[75] https://us.sunpower.com/sites/sunpower/files/media-library/case-studies/cs-california-state-university-hayward-goes-solar-sunpower-powerguard.pdf
[76] https://chesc.org/best-practice-awards/2016-best-practice-award-winners/

FIN4	**Divest from fossil fuel investments:** (focused on companies with major investments in coal, oil, gas, and/or unconventional fossil fuels (e.g. oil shale and tar sands). Co-benefit: prudent to protect the University from excessive volatility in fossil energy prices. (see for example NYT, 3-10-2017) Amend the Cal State East Bay Education Foundation Investment Policy accordingly	Significant educational and ethical impact. Important PR messaging impact. Moderate GHG reduction potential because of small endowment currently. Potential longer-term higher investment returns given the global shift toward alternative sustainable energy sources	Cal State East Bay Education Foundation Board of Directors	Staff time (low)	Near term
*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).					

XII. Offsets

Background

In cases where it is impossible or cost-prohibitive to eliminate emissions on campus, offsets can be used. In their most common form an offset is essentially a means to pay someone else to reduce their emissions. The State of California recognizes qualifying offsets of two types: Compliance Offsets (which apply to regulated large emissions) and voluntary offsets of qualifying Early Action Offset Programs. Offsets purchased by Cal State East Bay would fall under the latter category. The California Air Resources Board (CARB) has approved three Early Action Offset programs, which in turn certify purchasable offsets:[77]

- The Verified Carbon Standard (VCS)
- The Climate Action Reserve
- The American Carbon Registry (ACR)

Certified offsets are currently purchasable. Three major players and their product certifiers are documented in Table XII.1.

[77] The State operates a "Compliance Offsets Program" for regulated large emitters and an Early Action Offsets Program for voluntary offsets. Offsets purchased by Cal State East Bay would fall under the latter category. Program description available online: https://www.arb.ca.gov/cc/capandtrade/offsets/earlyaction/credits.htm

Table XII.1. State-approved vendors of certified offsets

Vendor	Certified by
CarbonFund.org (CA)	VCS, CAR, ACR and others
Terra Pass	VCS, CAR
Native Energy	VCS, CAR

Various co-benefits can be achieved with offsets programs. Figure XII.1 shows the four main types of offset credits issued by CARB under its Cap-and-Trade program including both compliance and voluntary offsets. Note that Native Energy sells offsets that are also aligned with Cal State East Bay's social justice goals with projects, for example, that have brought wind farms to schools and renewable energy to Native American tribes. Carbon offsets have also recently been approved by the American Carbon Registry for wetland restoration in the Sacramento Delta and San Francisco Estuary.[78] Investment in wetland restoration in the Hayward shoreline, for example, could achieve co-benefits of climate adaptation in our local community. Offsets are available for purchases by 'businesses' (suitable for Cal State East Bay) with prices depending on the vendor and the nature of the project between about \$5 and \$15 per Mte-eCO_2. Offsets can in theory also be generated internally, for example through an on-site forestry sequestration project. But if that approach is taken, the offsets should be certified to ensure their long term viability[79].

[78] American Carbon Registry, *Restoration of California Deltaic and Coastal Wetlands, Version 1.0,* April 2017. http://americancarbonregistry.org/carbon-accounting/standards-methodologies/restoration-of-california-deltaic-and-coastal-wetlands/california-wetland-restoration-methodology-final-2017.pdf

[79] Reforestation offsets, if not certified, are highly vulnerable to failure because the trees must remain in the ground and the forest plot remain intact over the very long term to fulfill their sequestration promise.

Figure XII.1. Offsets credits issued by CARB as of September 13, 2017.[80]

Offsets can also be used to keep the University on track to meeting its carbon neutrality target. If GHG monitoring reveals that the University has missed an interim target in any given period, offsets can and will be used to maintain the required progress. This policy is critical to stay on track and provides the essential impetus to do so.

Accomplishments

- ENVT 4800 Senior Seminar Course, Fall 2016, completed preliminary research of the Oak Woodland Restoration Project
- Connected with Department of Earth and Environmental Sciences Assistant Professor Patty Oikawa Ph.D., a carbon sequestration expert with extensive experience in wetland restoration of the Hayward Shoreline and Sacramento Delta and the use of such to mitigate climate change
- Received CALL grant to pursue oak woodland restoration as a means of offsetting CSUEB greenhouse gas emissions. Oak woodland restoration on Concord campus will begin in 2018 under supervision of Professor Oikawa.

[80] ARB Offset Credits Issued (updated September 13, 2017). Available online: https://www.arb.ca.gov/cc/capandtrade/offsets/issuance/arb_offset_credit_issuance_table.pdf

The Action Steps

OFFSETS		Est. Impact	Leadership	Est. Resources	Establishment Timeline (*)
OFF1	**True-up Emissions Policy.** To ensure emissions reduction efforts meet targets the University will assess and true-up missions every three years and purchase certified offsets as needed to meet with target. All emissions remaining in 2040 will also be offset with certified products.	Significant GHG reduction potential; monetary cost savings, because offsets are only used to help achieve emissions reductions targets if the offsets cost are lower than achieving those same reductions through efficiency improvements or renewable energy.	CSC, Accounting	Staff time (insignificant incremental cost beyond the annual GHG inventory, which must be conducted regardless)	Near term
*Establishment Timeline is defined as follows: Immediate (2018); Near term (by 2025); Medium term (by 2030); Long term (by 2040).					

XIII. Climate Action Management

This CAP will serve as a guiding document for California State East Bay to reach its goal of becoming carbon neutral by 2040. Cost, funding, incentives, and resource availability together with external factors including technology will dictate the timing of project implementation. Many of these factors are out of our direct control; thus this plan is intended to be a living document and will be adapted as necessary.

Future Milestones

Consistent with the CAP scenario modeling presented in Chapter III (Table III.4) the following intermediate milestones have been established.

- Eliminate carbon footprint from international student travel, study abroad, and state-sponsored travel within 5 years (by 2022)
- Eliminate carbon footprint from the campus fleet within 10 years (by 2027)
- Eliminate the carbon footprint from current natural-gas and electricity applications (by 2040)
- Reduce carbon footprint from commuting 25% below baseline level by 2040
- Achieve carbon neutrality by 2040, eliminating all residual emissions with offsets at that time

Achieving these milestones will require active management by the Office of Sustainability and the active cooperation of all units. The responsibilities of the different units are outlined in The Action Steps of the individual chapters. GHG emissions will be inventoried annually. Tri-annually (every three years) the University's emissions will be 'trued-up' to ensure that we stay on track. If interim emissions reductions targets are missed (shown as 'Residual' emissions in Figure II.1), the University will use offsets to stay on target. If targets are beaten, they may be used to make up for missed targets in later years.

Achieving the milestones will require a host of actions, many under the mandate of Facilities Development and Operations. Key actions include:

- Installing 630kW of PV on the Concord Campus within one year;
- Installing an additional 2.2 MW of PV on site at the Hayward Campus within 3 years, and a total of 3.5MW within 5 years;
- Continuing to either install 680 kW/year of solar capacity university-wide thereafter through 2040, or obtain its equivalent by other means outlined in this report; and
- Replacing 24,000 therms/year of natural-gas applications with carbon-free options, initiating major projects within 2 years.

Appendix A

Travel Related Emissions: Business-as-Usual vs. Under Climate Action Plan

	SCOPE 3 BAU MTeCO2					SCOPE 3 CAP Emissions MTeCO2				
YEAR	All Commuters	Financed Travel	Study Abroad	International Students	ALL SCOPE 3 BAU	All Commuters	Financed Travel	Study Abroad	International Students	ALL SCOPE 3 CAP
2014	28,635	215	197	9,339	38,610	28,635	215	197	9,339	38,610
2015	27,491	218	200	9,459	37,586	27,491	218	200	9,459	37,586
2016	26,330	222	202	9,580	36,552	26,330	221	202	9,580	36,547
2017	25,154	225	205	9,702	35,503	25,154	224	205	9,702	35,494
2018	23,961	228	208	9,826	34,439	23,700	227	208	9,826	34,165
2019	22,751	231	210	9,951	33,361	22,256	229	210	9,951	32,848
2020	21,524	234	213	10,079	32,266	20,822	232	213	10,079	31,543
2021	20,280	237	216	10,207	31,159	19,399	235	216	10,207	30,244
2022	19,019	241	218	10,338	30,035	17,985	0	0	0	18,163
2023	17,739	244	221	10,470	28,895	16,582	0	0	0	16,751
2024	16,441	247	224	10,604	27,739	15,190	0	0	0	15,350
2025	15,125	250	227	10,739	26,566	13,810	0	0	0	13,960
2026	14,931	253	230	10,876	26,516	13,470	0	0	0	13,611

2027	14,733	257	233	11,015	26,466	13,132	0	0	0	13,264
2028	14,533	260	236	11,156	26,414	12,795	0	0	0	12,917
2029	14,330	263	239	11,298	26,362	12,461	0	0	0	12,572
2030	14,123	266	242	11,443	26,308	12,127	0	0	0	12,229
2031	13,913	270	245	11,589	26,252	11,796	0	0	0	11,888
2032	13,700	273	248	11,737	26,196	11,467	0	0	0	11,548
2033	13,484	276	251	11,887	26,138	11,139	0	0	0	11,210
2034	13,264	279	254	12,039	26,078	10,813	0	0	0	10,874
2035	13,041	283	258	12,193	26,018	10,489	0	0	0	10,539
2036	13,139	286	261	12,348	26,281	10,425	0	0	0	10,464
2037	13,238	289	264	12,506	26,548	10,360	0	0	0	10,387
2038	13,339	293	268	12,666	26,818	10,294	0	0	0	10,310
2039	13,441	296	271	12,828	27,091	10,227	0	0	0	10,231
2040	13,544	299	274	12,991	27,368	10,158	0	0	0	10,151
2041	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2042	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2043	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2044	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744

2045	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2046	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2047	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2048	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2049	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744
2050	13,544	299	274	12,991	27,368	10,158	0	0	0	21,744

Glossary

American Carbon Registry (ACR)	Non-profit that registers voluntary carbon market projects for the California compliance market.
American College and University Presidents' Climate Commitment (ACUPCC)	Agreement that commits the campus to achieve carbon neutrality as soon as possible. rebranded in Oct 2015 as Climate Commitment, Carbon Commitment, and Resilience Commitment.
Business as usual (BAU)	The level of emissions that would result if future development trends follow those of the past and no changes in policies take place.
California Air Resources Board (CARB)	Air quality regulation agency for the State of California.
Carbon Commitment	Effort undertaken by a network of colleges and universities to eliminate net GHG emissions from campus operations, promote climate research and education.
Carbon dioxide equivalent (eCO2)	Measure used to compare the emissions from various greenhouse gases based upon their global warming potential. For example, the global warming potential for methane over 100 years is 21.
Carbon emissions factor (CEF)	Measure of the average amount of a specific pollutant or material discharged into the atmosphere by a specific process, fuel, equipment, or source. It is expressed as number of pounds (or kilograms) of particulate per ton (or metric ton) of the material or fuel.
Carbon neutrality	Achieving net zero carbon emissions through GHG

	reductions, GHG avoidance, purchase of offsets or some combination of those actions.
Clean Air Cool Planet (CA-CP)	Non-profit, science based organization providing climate tools including the commonly used carbon calculator recommended by the ACUPCC for the purpose of calculating greenhouse gas emissions.
Climate Action Plan (CAP)	The roadmap that outlines the specific activities an institution will take to reach carbon reduction goals
East Bay Community Energy (EBCE)	Community-governed power supplier for Alameda County businesses and residents providing electricity generated from a high percentage of renewable sources such as solar, wind and geothermal.
Energy unit intensity (EUI)	EUI is a measure of a building's energy use in British thermal units (BTU) per Gross Square Foot (GSF).
Environmental Studies 3480, Applied Field Studies (ENVT 3480)	Field based research course in Environmental Studies.
Environmental Studies 4800, Senior Seminar (ENVT 4800)	Advanced seminar in Environmental Studies focusing on projects and reports of environmental concern.
Full-time equivalent students (FTES)	Full-time equivalent students differs from headcounts. FTES enrollment is a measure of instructional units associated with a given headcount.
Greenhouse effect	Incoming solar radiation from the sun is absorbed by land, water, etc. Some of that energy is reflected back out to the atmosphere but a portion is reabsorbed by greenhouse gas molecules essentially trapping

	radiation within the atmosphere and resulting in an overall warming of the planet.
Greenhouse Gas (GHG)	Gases that contribute to climate change, the largest contributors being carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6), which are bundled together for accounting purposes as equivalent CO_2 emissions (eCO_2).
Gross square footage (GSF)	The total square footage of a building.
Institutional Learning Outcome (ILO)	Shared, campus-wide articulation of expectations for all degree recipients.
Kilowatt (KW)	Unit of power; one thousand watts of power.
Kilowatt-hour (KWh)	Unit of energy; one thousand watts of power used in one hour of time.
Metric tonnes of carbon dioxide equivalent ($MTeCO_2$)	Standard unit of measurement in which carbon dioxide emissions and their equivalents are reported. A metric tonne, as opposed to the short ton, is equal to 1,000 kilograms.
Photovoltaic (PV)	The technology used for conversion of solar radiation into electric energy.
Second Nature	A non-profit organization that assists institutions of higher learning to create and achieve climate goals.

Acknowledgements

Primary Authors
Dr. Karina Garbesi, Director of Environmental Studies
Jillian Buckholz, Director of Sustainability
Brett Meleg, Climate Action Plan Coordinator and Climate Corps Americorps Fellow

Climate Action Planning Task Force
Dr. Karina Garbesi, Director of Environmental Studies (Chair)
Jillian Buckholz, Director of Sustainability (Co-Chair)
Brett Meleg, Climate Corps Americorps Fellow (Coordinator)
Brenda Amaral, Alternative Transportation Lead
Dr. Cristian Gaedicke, Faculty, Engineering
Erik Pearson, City of Hayward, Environmental Services Manager
Loralyn Perry, Energy and Utilities Manager
Erik Pinlac, Associated Students, Inc., Interim Executive Director

Research Assistants
Brett Meleg, Alan Yee, and William Konijn

Student Contributors from Environmental Studies Senior Seminar
Justin Brown
Jason Cederquist
Justine Cuevas
Stephanie Da Silva
Tiffany Dong
Teresa Gamber
Shelby Hoerner
William Konijn
Tong Lin
Bryan Little
Keely Lucientes
Danielle McAvenia
Brett Meleg
Jambaldorj Olonbayar
Jacqueline Ortiz
Crystal Shahan
Justin Smith
Anthony Somphanith
Jaamal Spencer
Nicolette Tang
Warren Wong
Alan Yee

Guest Review
Dr. Erik Helgren, Chair, Physics Department, Cal State East Bay

Campus Sustainability Committee

Debbie Chaw, 2015 - 2018
Co-Chair, Vice President of Administration and Finance

Dr. Edward Inch, 2016 - 2018
Co-Chair, Provost and Vice President of Academic Affairs

Jillian Buckholz, 2015 - 2018
Director of Sustainability

Jesse Cantley, 2017 - 2018
Interim Executive Director of University Communications

Martin Castillo, 2015 - 2018
Associate Vice President of Campus Life

Jomarie Ching, 2017 - 2018
Associated Students, Inc., Director of Sustainability

Brian Cook, 2015 - 2018
Associate Vice President of University Extension

Mary D'Alleva, 2015 - 2018
Director of Center for Community Engagement

Hendrix Erhahon, 2015 - 2016
Associated Students, Inc., President

Dr. Cristian Gaedicke, 2015 - 2018
Faculty, Engineering

Dr. Karina Garbesi, 2015 - 2016
Faculty, Environmental Studies

Dr. Vish Hegde, 2015 - 2016
Faculty, Management

Simon Lam, 2018
Interim Associate Vice President of Facilities Development and Operations

David Lopez, 2016 - 2017
Associated Students, Inc., Director of Sustainability

Julie Mielke, 2015 - 2018
Presidential Nominee

Dr. Patty Oikawa, 2017 - 2018
Faculty, Earth & Environmental Sciences

Erik Pearson, 2015 - 2018
City of Hayward Environmental Services Manager

Samantha Quiambo, 2017 - 2018
Associated Students, Inc., President

Dr. Michelle Rippy, 2017 - 2018
Faculty, Criminal Justice Administration

Dr. Charles Roberts, 2016 - 2018
Hayward Unified School District Chief Facilities Officer

Dr. Ryan Smith, 2016 - 2018
Faculty, Physics

Dr. Dianne Rush Woods, 2015 - 2018
Chief Diversity Officer

Jim Zavagno, 2015 - 2017
Associate Vice President of Facilities Development and Operations

Endorsed By

Ad Hoc Committee on Sustainability of the Cal State East Bay Academic Senate:

Dr. Stevina Evuleocha, College of Business

Dr. Karina Garbesi, College of Letters, Arts, and Social Sciences

Dr. Ryan Heryford, College of Letters, Arts, and Social Sciences

Dr. Patricia Oikawa, College of Science

Sharon Radcliff, Library

Dr. Enrique Salmon, College of Letters, Arts, and Social Sciences

Dr. Ryan Smith, College of Science

Dr. Semih Yilmaz, College of Education and Allied Studies