carbon neutrality initiative

Berkeley
UNIVERSITY OF CALIFORNIA

2025 Carbon Neutrality Planning Framework

A report to inform greenhouse gas emission reduction strategies

December 2016 (minor update August 2017)

Physical and Environmental Planning

Office of Sustainability and Energy

University of California
Carbon Neutrality Initiative

UC, a national leader in sustainability, has pledged to become carbon neutral by 2025, becoming the first major university to accomplish this achievement.

Global climate disruption is impacting the planet in ways never experienced in human history. Warmer temperatures are contributing to changing weather patterns that cause more intense storms and heavier rainfall in some places, while elsewhere drought is parching the land. Glaciers are melting at an accelerated rate and oceans are rising. The overwhelming scientific consensus is that climate change is being driven by the release of carbon dioxide into the atmosphere, primarily from the burning of fossil fuels.

The University of California has responded to this growing environmental crisis with direct action aimed at ending its reliance on fossil fuels. ***In November 2013, President Janet Napolitano announced the Carbon Neutrality Initiative, which commits UC to emitting net zero greenhouse gases from its buildings and vehicle fleet by 2025, something no other major university system has done.***

The initiative builds on UC's pioneering work on climate research and furthers its leadership on sustainable business practices. UC is improving its energy efficiency, developing new sources of renewable energy and enacting a range of related strategies to cut carbon emissions.

(UCOP website, retrieved Dec. 2016)

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PURPOSE

In the fall of 2013 UC President Napolitano announced that the UC System will be carbon neutral from building energy use and fleet vehicles use by the end of year 2025. This goal encompasses all the greenhouse gas (GHG) emissions from scope 1 direct emissions and scope 2 emissions from purchased energy. Scope 3 emissions include those emissions associated with the commute, business air travel, and other sources that are included in the GHG profile; these emissions have a current neutrality target of 2050.

UC Carbon Policy

The UC policy on Sustainable Practices calls for net-zero greenhouse gas emissions, carbon neutrality, from scope 1 and 2 emissions by 2025 and from scope 3 emissions by 2050 or sooner.

The policy also has an interim goal of 1990 emission levels by 2020 for scopes 1, 2 and 3.

The UC system is in an extensive planning phase for the carbon neutrality goal. UC Office of the President (UCOP) is preparing a carbon neutrality initiative strategic plan and in support of this each of the UC campuses are developing campus level carbon plan updates. Together these planning efforts intend to create roadmap to reaching the carbon neutrality goal, one that is reflective of each campuses unique circumstance and identifies joint system-wide efforts and opportunities. At Berkeley, the Physical and Environmental Planning office (PEP) and the Office of Sustainability and Energy are leading the campus carbon neutrality planning effort and have prepared this document to meet the first requested milestone from UCOP. This framework focuses on the carbon sources included in the 2025 neutrality goal and provides baseline energy and emissions data, identifies operational challenges and opportunities, and describes primary emissions reduction approaches. Using this framework, PEP and Sustainability will work with various stakeholders to develop more detailed strategies for reducing building and fleet emissions. To round out the Berkeley carbon planning effort at a later date, the campus will expand the planning process to include other carbon emissions sources of importance to the campus but outside of the 2025 goal, including scope 3 emissions sources and other related topics like adaptation and resiliency.

Reasoning for a phased planning effort at Berkeley

Berkeley is taking a phased approach to the carbon initiative planning for two reasons.
First, a major part of Berkeley's energy operations and electricity sourcing is changing and the full impact of this shift is still being determined. In 2017, in addition to steam energy, the campus will begin to use electricity from the on-site natural gas cogeneration plant instead of procuring the main campus power from the local utility. This change will also modify how we procure natural gas to run

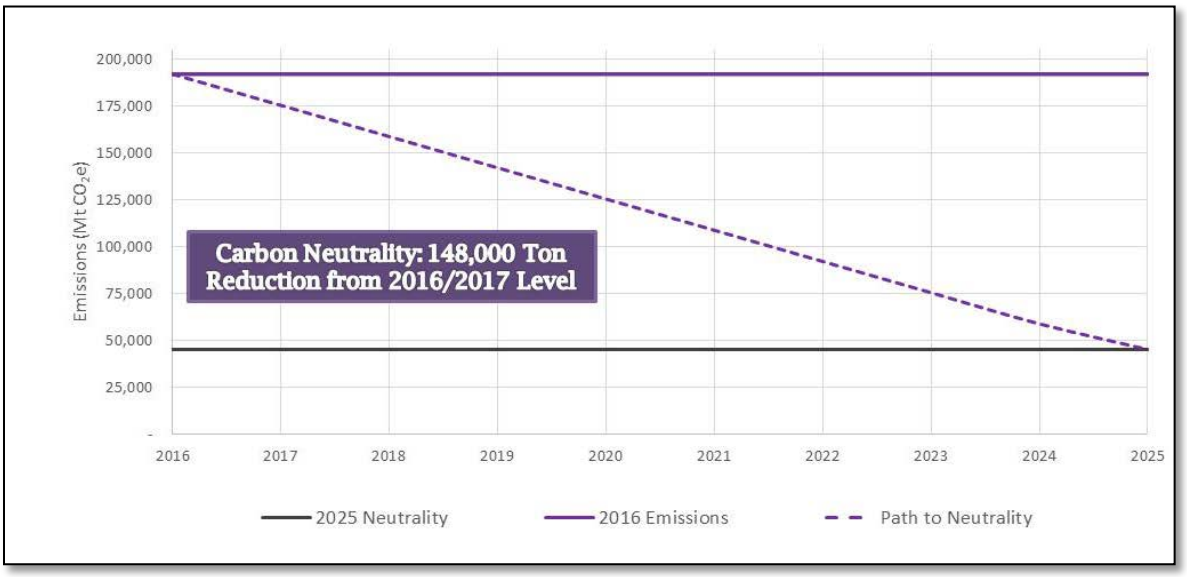
the plant, increases energy emissions by about 30%, and alters the campus approach to carbon reduction efforts in the short and longer-term. Second, carbon neutrality planning at Berkeley requires campus engagement at all levels. In the next year new people will be in key leadership positions including in the Berkeley Chancellor role. It is important that the planning includes these new decision makers. In time, the campus will have more information and new stakeholders to help plan and implement for net-zero emissions.

INTRODUCTION

This framework provides an overview of Berkeley's greenhouse gas emissions (GHG) profile over the next eight years and offers early guidance for Berkeley's path to carbon neutrality in scopes 1 and 2 per the UC 2025 goal. Expanding on Berkeley's early success in GHG reductions from campus operations, this framework identifies the opportunities, challenges, and high-level strategy approaches the campus can undertake to both reduce and de-carbonize building and fleet energy use. It will inform more detailed, future planning work to support the UC systemwide carbon neutrality initiative.

For Berkeley to get to net-zero carbon emissions from building and fleet energy use and meet the target, campus emissions will need to be reduced by about 150,000 tons. This reduction represents 80% of Berkeley's carbon emissions. The remaining 20% of Berkeley's emissions outside of the 2025 goal are associated with the campus commute, business air travel, waste, and water.

Berkeley's needed emissions reduction to achieve the goal



Berkeley's scope 1 and 2 carbon emissions are primarily associated with the energy used in buildings including electrical power and steam and natural gas used to heat and for lab processes. Emissions from the campus fleet and other small sources account for less than 2% of the emissions in these scopes. With expected campus square footage growth in the next decade, these emissions are expected to rise by 2% by year 2025 without mitigation. Berkeley has some programs underway to reduce carbon emissions but these efficiency and renewable energy supply efforts will simply curb this expected growth. Bolder reduction strategies and new funding sources are required if carbon neutrality is to be

achieved. This framework intends to help build this more robust effort by providing baseline data, identifying enabling factors, and outlining strategies.

Primary carbon reduction strategies

The framework includes a high-level overview of reduction strategies underway in some form on campus or at the system wide level. These strategies reflect what conceivably achievable between now and 2025. These include expanding the use of low and non-carbon energy supply for power and thermal needs, reducing energy use through building efficiency and behavior change, curbing growth-related emissions through improved green building and space utilization**,** increasing the alternative fuel fleet, and how to utilize carbon offset mechanisms. A combination of these strategies, with a particular focus on energy supply, will be the basis of a carbon reduction program in the near-term. Looking beyond 2025 is also necessary, as carbon neutrality needs to be sustainable in the years following the target date. Expanded consideration of the main campus energy options, emerging technologies, creative financing mechanisms, and more is part of a longer-term strategy.

What this framework does not include:

- Preferred GHG reduction scenarios or financial analyses. UCOP is developing a dashboard tool to help with this kind of scenario analysis, making it practical to wait until the systemwide tool is operational. Berkeley will develop a more specific set of strategies with financial analysis during the next year.
- A specific strategy for Cap and Trade compliance. Berkeley opted into Cap and Trade in 2015 in order to be eligible for the transition allowances provided to UC campuses. This was a preemptive measure assuming a large portion of the Berkeley's emissions would fall under carbon regulation. While Cap and Trade compliance requires some strategies similar to those presented to meet UC carbon neutrality goal, it has requirements better addressed outside of this framework.
- Emissions associated with future growth at the Richmond Field Station. This satellite property has its own planning track and greenhouse gas emissions associated with it will be accounted for separately as it develops.
- Planning or analysis of scope 3 emissions. Expanded metrics and discussion on carbon reduction strategies for commute, business air travel, waste and water, related academics

and research, procurement, resiliency and adaptation, and lifecycle will be considered in future planning phases.

Main challenges in reaching carbon neutrality include the following. They are shared for context and to note for later planning efforts.

- Financial constraints and debt capacity that make it difficult to plan and obligate for energy related capital projects and programs.
- Relatively low cost of electricity, steam, and natural gas make new and less tested renewable energy options less financially competitive.
- Berkeley is the oldest UC campus with buildings varying in age from the 1870s to 2016 and in type from classroom and office buildings to specialized science laboratories. The campus' deferred maintenance and capital renewal needs are widespread and implementing deep energy efficiency projects across this portfolio is complex.
- The campus natural gas cogeneration plant and steam distribution system is old, and system components are inefficient. To upgrade and/or replace the energy delivery system for the main campus is multifaceted capital initiative.
- Berkeley is a compact urban campus and is space and land constrained limiting locations available for on-site renewable energy installations.

Opportunities for achieving carbon neutrality. While there challenges, there are also complimentary prospects. These conceptual ideas are introduced for consideration in the future planning efforts.

- Developing more innovative business partnerships and financing mechanisms that can accelerate energy and carbon management projects. An example is Berkeley's power purchase agreement arrangement that provided a way for the campus to install one megawatt of solar panels with no local capital funding expense.
- As the main campus cogeneration plant and system is aging, there is a time-sensitive need to identify new opportunities for Berkeley to improve the energy delivery system and consider alternative fuel sources for the main campus.
- When UC renewable energy programs for electricity and biogas are fully realized, and with greater access to these supply programs, Berkeley could affordably reduce a significant amount of the emissions needed to get to carbon neutrality.
- Due to a relatively small amount of new building space planned in the next decade, and by finding strategic ways to improve existing space use, Berkeley has options for reducing per capita emissions and net-zero energy growth.

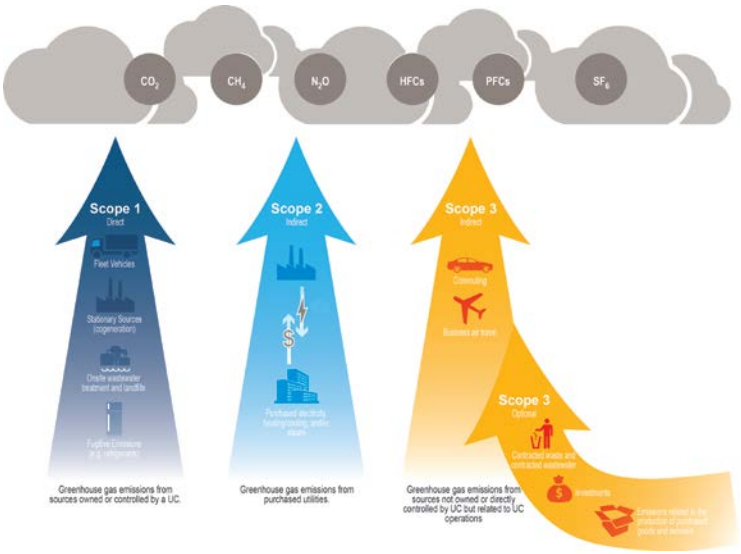
- Berkeley's compact and urban setting offers ways for the campus to collaborate with the city and region on issues of mutual concern like vehicle electrification networks and community choice electricity procurement programs.

Berkeley has an early track record of achievement in implementing climate action strategies, evidenced by meeting an initial greenhouse gas emissions reduction target two years ahead of schedule and by reducing campus emissions to levels lower than they were 25 years ago. With this experience Berkeley is well positioned to innovate in this next stage of climate action.

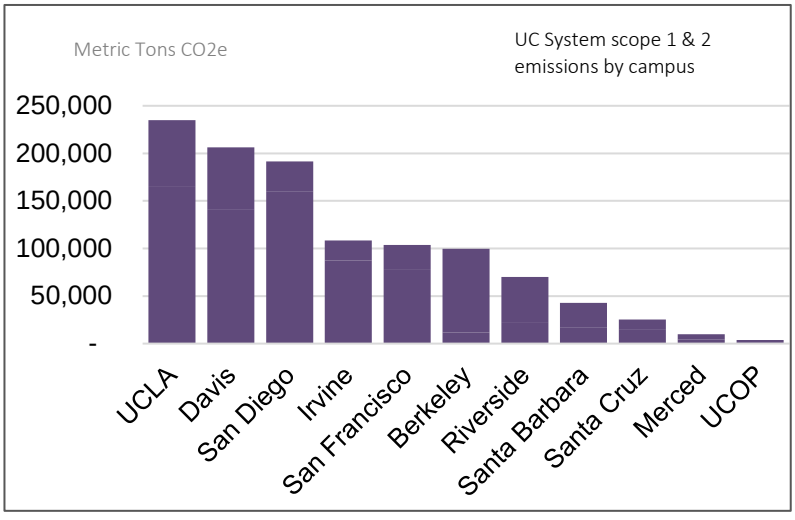
BACKGROUND

The University of California has adopted policies to aggressively reduce greenhouse gases generated as a result of University operational activities.

1. **By 2020**: Reduce scope 1, 2 and 3 emissions to 1990 levels, per UC Policy and in compliance with California AB 32, the California Global Warming Solutions Act. Berkeley met this goal in 2012, two years ahead of the campus' goal and eight years ahead the UC goal.
2. **Carbon Neutrality 2025:** Net-zero emissions from scope 1 and 2 emissions. For Berkeley this represents an 80% reduction of overall emissions.
3. **Carbon Neutrality 2050:** Net-zero emissions from scope 3 emissions. The remaining 20% of Berkeley's emissions are primarily association with transportation.



For UC to reach carbon neutrality from building and fleet energy use (scopes 1 direct emissions and scope 2 indirect emissions) the system as a whole will be required to reduce annual carbon emissions by 1.2 million tons. Even as one of the largest campuses in terms of population, Berkeley's emissions account for only 12% the UC systemwide reduction required to reach carbon neutrality. Relative to the other large UC campuses Berkeley releases significantly fewer emissions, largely due to not having a medical center.



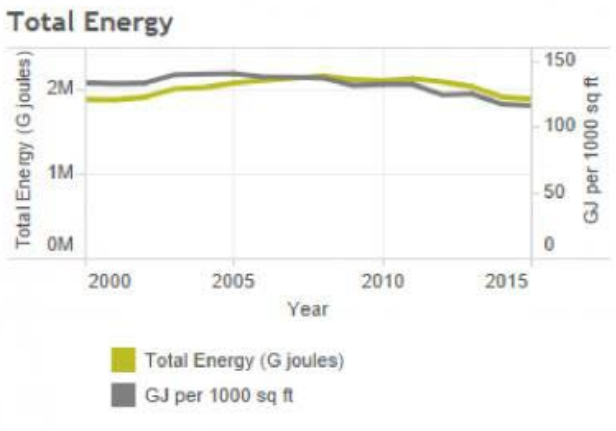
Highlights of Berkeley's Climate Action Program to Date

Berkeley has more than a decade of climate action experience that has been supported by the Cal Climate Action Partnership (CalCAP), a collaboration of administration, staff, and students advising on reducing greenhouse gas emissions. The early work of CalCAP was foundational and continues today through management by the Office of Sustainability and Energy and the Physical and Environmental Planning office. Berkeley's carbon management program includes on-going climate action evaluation and planning, annual greenhouse gas emissions inventories, student and faculty engagement, implementation of emissions reduction projects, and collaborative efforts with other UC campuses and organizations.

Berkeley's general approach to reducing emissions has been to make cost-effective efficiency investments on campus first, to add renewable energy supply when feasible, and to consider options such as carbon offsets or renewable energy certificates to close gaps. This strategy, along with the campus' utility provider providing less carbon intensive electricity as part of its state renewable portfolio standard mandate, has brought Berkeley's emissions to 1990 levels even though the campus has grown in square footage in this same period.

Berkeley's accomplishments related to reducing Scope 1 and 2 impacts to date include:

- Energy intensity per square foot has been reduced by 15% since 1990, while actual building space has grown.
- In the last decade Berkeley has added sixteen (16) LEED certified building projects with energy reduction features, representing over 10% of the total square footage.
- Since 2008 Berkeley has implemented energy efficiency measures that have reduced carbon emission by 15,000 tons.



- Today, 35% of the Berkeley vehicle fleet is green, either hybrid or powered by alternative fuels.
- In 2015, solar power was added at five campus locations and four more on-site solar installations are in planning.

Berkeley faculty, staff and students are also actively engaged in the UC carbon neutrality initiative. In 2015 Berkeley spearheaded the UC systemwide Cool Campus Challenge, engaging 20,000 UC

community members in carbon saving actions on campuses, and a number of Berkeley faculty contributed to Bending the Curve, an international report on ten scalable solutions to climate change.

UC Office of the President's Energy Strategies

UC Office of the President and the UCOP Energy and Sustainability Unit are focusing on the strategies to support the 2025 carbon neutrality goal. To support this one decision-making board and one advisory council have been established to guide this effort and Berkeley is represented in these groups:

- **Energy Services Governing Board** oversees the operations of the UC managed energy procurement programs for power and biogas.
- **The Global Climate Leadership Council** advises the President and other leadership to assure successful implementation of the plan for achieving carbon neutrality by 2025 with attention to UC's teaching, research and public service mission.

UCOP has three major energy related programs in support of the goal. It is important to note that Berkeley's access to these programs currently have limitations.

- **Providing wholesale electricity** options that offer more carbon-free electricity than current utilities provide to campuses. UC has become a wholesale power provider and participation in this option is available to some campuses and medical centers. Due to current state and other energy regulations, only a small portion of Berkeley's electricity purchases can be made through this procurement effort.
- **Biogas acquisition and development** to make available large quantities of biogas to offset campus use of natural gas at comparable pricing. This option is intended to serve all campuses including Berkeley. Meeting the large demand for this biogas in the next decade at cost-effective pricing will be challenging. UC guidelines established by the governing board currently limit Berkeley's access to this supply.
- **Continued and accelerated energy efficiency** measures through the strategic energy partnership with the investor owned utilities, an existing program that has successfully reduced energy demand across the system. Most campuses have and will be able to continue to participate in the available financing and incentive payments from the utility, though the availability and amount of the incentives will likely be reduced over time.

Berkeley is looking to the UCOP energy supply programs, particularly the biogas initiative, to help address a good portion of the emission reductions needed to meet carbon neutrality by 2025. As there are current limitations to Berkeley's access to these programs, the campus will explore how to gain more access and what other alternatives might be available.

GREENHOUSE GAS EMISSIONS & ENERGY SUPPLY PROFILE

Berkeley has been tracking energy and emissions data consistently for over a decade. This section provides an overview of these metrics and introduces what is expected in energy and emissions through 2025.

Berkeley's emissions profile to date

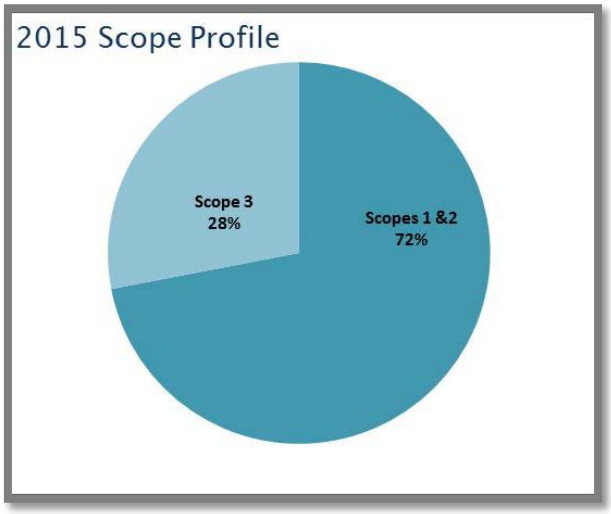
UC Berkeley reports on ten emissions sources and in three different categories:

- *Scope 1* - Direct Emissions: natural gas, campus fleet, emissions from refrigerants
- *Scope 2* - Indirect Emissions: purchased electricity, purchased steam
- *Scope 3* - Optional Emissions: business air travel, student commute, faculty/staff commute, solid waste, water consumption

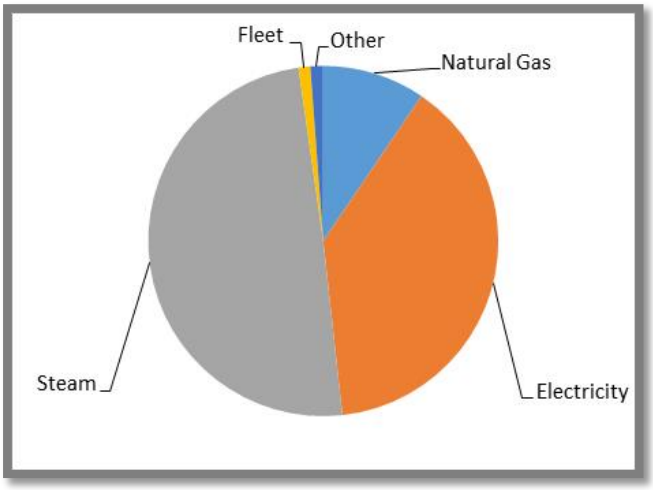
The campus reports its GHG inventory annually to The Climate Registry (TCR) and makes it available to the public through campus reporting. Third party verification of the inventory is completed as part of the reporting process. Emissions are calculated based on operational control criteria, standardized protocols for scopes 1 and 2 through TCR and the California Air Resources Board, and through various recognized methods for scope 3.

With the exception of a small amount of greenhouse gas emissions from campus fleet, fugitive emissions and other sources, Berkeley's scope 1 and 2 emissions result from electricity, steam and natural gas used primarily in facilities on the main campus. A relatively small amount of emissions are associated with facilities off the main campus, including student housing facilities. About 75% of Berkeley's emissions are related to the above energy sources, with the remaining 25% associated with scope 3 emissions from transportation, waste and water.

2015 Emission scopes 1, 2 and 3



2015 Emission sources, scopes 1 & 2



Since 2009, Berkeley's emissions from scopes 1, 2 and 3 have been reduced 13% overall as a result of energy efficiency efforts, procuring progressively less carbon intensive electricity from the local utility, and reducing transportation fuel use . The following illustrates the source emissions for years 2009-2015.

Emission sources and metric ton CO2e emissions from scopes 1, 2 & 3: 2009-2015

	Scope 1: Metric Tons CO2e			Scope 2: Metric Tons CO2e		Scope 3: Metric Tons CO2e					
Calendar Year	Natural Gas	Fleet	Refrigerants/ Other	Purchased Electricity	Purchased Steam	Faculty & Staff Commute	Student Commute	Air Travel	Solid Waste	Water	Total Emissions
2009	11,822	1,550	387	57,385	65,275	14,713	3,224	20,761	1,066	760	176,943
2010	10,918	1,387	479	56,542	66,291	14,303	3,243	23,095	783	728	177,769
2011	11,154	1,452	1,132	44,311	67,687	10,260	829	21,134	721	630	159,309
2012	11,217	1,252	306	40,032	64,565	10,386	829	21,100	698	604	150,991
2013	12,190	1,384	389	42,307	61,516	11,477	882	21,394	656	591	152,785
2014	10,468	1,254	419	42,588	55,717	10,733	1,013	23,472	652	551	146,868
2015	10,509	1,190	401	43,012	54,807	14,870	4,271	23,786	625	535	154,005

Scope 1 & 2 emissions: 2009-2015

Calendar Year	Scope 1 metric tons CO2e	Scope 2 metric tons CO2e	Total Scope 1 & 2 Emissions metric tons CO2e
2009	13,759	122,660	136,419
2010	12,784	122,833	135,617
2011	13,738	111,998	125,736
2012	12,776	104,598	117,373
2013	13,963	103,823	117,786
2014	12,141	98,305	110,446
2015	12,099	97,819	109,918

- *Scope 1 & 2 emissions have been reduced 19% since 2009.*
- *Scope 2, Berkeley's largest source of emissions, has been reduced by 20% since 2009. This is the result of efficiency measures that have reduced energy use and the electricity from the utility becoming less carbon intensive resulting from meeting the State renewable portfolio standards.*

Berkeley's energy source profile and usage for scopes 1 & 2

The following table provides the energy and fuel sources used by the campus operations for years 2009-2015. Fugitive and de minimis combustion sources are not included.

Scope 1 & 2 energy and usage: 2009-2015

Calendar Year	Generators	Natural Gas	Fleet - Gasoline	Fleet - Diesel	Fleet - Biodiesel	Fleet - Ethanol	Purchased Electricity	Purchased Steam
	Gallons	MMBtu	Gallons	Gallons	Gallons	Gallons	kWh	MMBtu
2009	12,104	219,401	140,879	27,408	1,157		218,515,767	1,045,396
2010	11,722	202,515	127,892	22,672	2,296	556	215,307,772	1,061,669
2011	12,684	212,365	123,892	32,062	1,127	1,230	212,878,439	1,084,036
2012	12,212	208,034	99,943	33,874	2,764	694	217,366,655	1,034,039
2013	26,805	223,462	102,671	44,145	1,220	829	211,786,848	985,201
2014	14,927	193,462	90,258	42,372	1,347	788	213,634,104	892,337
2015	14,960	194,210	84,794	41,043	980	566	213,839,330	877,754

- *Since 2009 electricity use has decreased by 2% and for steam by 16%.*
- *The fleet began using small amounts of alternative fuels in 2009. Changes in the campus shuttle fleet vehicles primarily accounts for the shift in gasoline and diesel use in year 2012.*

Building Energy Source Detail

Steam and electricity - main campus: The main campus currently receives heat in the form of high-pressure steam from a cogeneration system located on campus. The cogeneration plant is owned and operated by a third-party. The central plant also includes three steam auxiliary boilers that are used if steam demand exceeds the cogeneration capacity and as back up. The third party sells electricity to the utility, Pacific Gas & Electric (PG&E) and sells the steam to Berkeley for main campus building heating, cooling, and process equipment. Berkeley in turn buys electricity for the main campus from PG&E. 97% of Berkeley's electricity is used on the main campus. The current energy services contract with the third-party ends in 2017, and the campus will start using both the electricity and steam produced by the plant.

Electricity for off-campus sites is provided through a Direct Access provider that recently became the UCOP wholesale power program. About 3% of Berkeley's electricity is procured through this source.

Natural gas is provided by PG&E/SPURR is used to heat buildings that are off the main campus steam system. Some natural gas is used on the main campus for lab processes and other small purposes.

Berkeley's growth and operational changes through 2025

Over the next eight years growth in energy use will be fairly minimal. While the campus will grow in square footage, this is not energy intensive space growth. Most of the growth will be associated with housing and office/classroom spaces, not energy intensive lab space, and efficient building will help curb energy use increases. The major growth impact for Berkeley's carbon emissions over the next eight years is related to operational changes at the cogeneration plant. In 2017 the campus will begin to use the electricity from the plant instead of procuring the main campus power from the utility (see below). Because the carbon content is higher from the electricity from the plant than from the utility, Berkeley's electricity emissions will increase. This makes the opportunities for getting to net-zero emissions by 2025 more challenging.

Major change to electricity supply for main campus in 2017

In 2017 the current cogeneration plan contract with the third-party vendor will end as will the power purchase agreement the third-party has to sell the plan electricity to PG&E. Due to these changes beginning next year Berkeley's main campus electricity will be supplied by the cogeneration plant. The main campus electricity accounts for about 97% of the power used by the campus. The operational change will effectively double the emissions of Berkeley's electricity as the power being produced will be exclusively from natural gas combustion. In contrast, PG&E's power-mix is significantly less carbon based with a mix of renewables, nuclear, and large-hydro power included.

Potential impacts to 1990 baseline emissions

As mentioned earlier in this section, UC has an interim 2020 goal that calls for emissions from scopes 1, 2 and 3 to be reduced to 1990 levels. Based on our current operations Berkeley met this goal in 2012. The campus is looking into how the changes in cogeneration operations will impact the 1990 baseline and the meeting of this target. Greenhouse gas protocols offer guidance on the

types of operational changes and circumstances in which historical emissions data may need to be adjusted in order to maintain meaningful comparisons over time. With further investigation, the campus will make a determination whether such an adjustment should be done in which case the meeting of this 2020 target will likely stay intact. If it is determined the baseline should not be adjusted upwards the campus will likely need to again consider the 2020 goal.

Projected scope 1and 2, non-mitigated emissions and energy use: 2017-2025

The following energy use and emissions projections reflect a business as usual/ no carbon mitigation effort. It does include the expected campus growth described above. At the time of the writing of this framework it is not yet known if the campus or another third-party will operate the cogeneration plant starting in 2017. As such it is yet to be established whether the cogenerated steam and electricity emissions will fall under scope 1 or 2. For the purposes of this analysis it is assumed these emissions will move to scope 1 from scope 2.

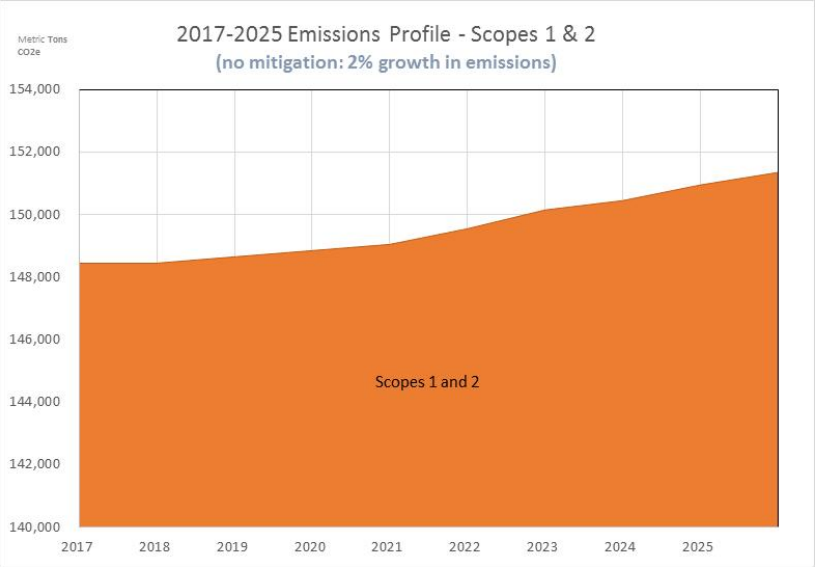
Projected, non-mitigated energy use, 2017-2025

The following energy use projections reflect a business-as-usual/ no carbon mitigation effort. It includes the expected campus growth described above.

	Scope 1							Scope 2
Calendar Year	Generators	Natural Gas	Fleet - Gasoline	Fleet - Diesel	Fleet - Biodiesel	Fleet - Ethanol	Cogeneration/ Auxiliary Boiler Natural Gas	Purchased Electricity
	Gallons	MMBtu	Gallons	Gallons	Gallons	Gallons	MMBtu	kWh
2017	15,000	205,000	86,000	42,000	1,000	600	2,468,100	31,000,000
2020	15,200	222,000	88,000	43,000	1,000	600	2,468,100	34,000,000
2025	15,400	253,000	91,000	44,000	1,100	600	2,468,100	39,000,000

Projected, non-mitigation emissions 2017-2025

The following emissions projections reflect a business-as-usual/ no carbon mitigation effort. It includes the expected campus growth described above.



- *Scope 2 emissions represent about 3% of the emissions.*
- *Berkeley's 10-year capital plan is considered along with estimated energy intensity of new and renovated square footage.*
- *Student population increases assumed and about 40% of new square footage is housing.*
- *No carbon mitigation efforts are included.*

Projected non-mitigated emissions by source for scopes 1 & 2: 2016-2025

The following table illustrates the change in overall emissions, and the shift emission scopes and the increase in emissions that will occur when the campus takes over the cogeneration plant in 2017.

	Scope 1: Metric Tons CO2e				Scope 2: Metric Tons CO2e		
Calendar Year	Natural Gas	Fleet	Refrigerants / Other	Cogenerated Electricity & Steam	Purchased steam	Purchased Utilities Electricity	Total Scope 1 & 2 Emissions
2016	10,900	1,250	500		54,800	40,000	107,450
2017	10,900	1,250	500	131,000		4,800	148,450
2020	11,800	1,250	500	131,000		4,500	149,050
2025	13,400	1,250	500	131,000		5,200	151,350

- *The projected 38% growth in emissions between 2016 and 2017 is primarily associated with the change in the source of the majority of electricity moving from PG&E to the cogeneration plant.*
- *A 2% growth in emissions is assumed from 2017 to 2025 based on capital program.*
- *No carbon mitigation efforts are included.*

Summary of Berkeley's energy and emissions profile out to 2025

This section describes Berkeley's profile looking out over a fairly short period, the next eight years. It is important to note that in a longer timeframe and looking beyond 2025 these patterns could change. For example, campus population and square footage growth requirements could shift, energy procurement options could be different, and new technologies could emerge and be cost competitive. In order to stay current on changes such as these and to aid in longer-range and capital focused planning, the campus will continue its practice of annually monitoring campus emissions, evaluating the impacts of emissions reductions efforts, and making course corrections as needed.

EMISSIONS REDUCTIONS STRATEGIES: 2017-2025

Berkeley's current efforts, plus significantly more will be required to reach carbon neutrality. This section provides an overview of the reductions that could be achieved between now and 2025 and considers what is technically and logistically realistic in the short-time frame. In this review it is confirmed that acquiring a greater supply of cost-effective renewable and less carbon intensive energy over the next eight years represents an expeditious path to carbon neutrality. While other measures like energy efficiency remain a valuable strategy for improving facilities and reducing energy use, the impacts in the short-term will not make a significant dent in the emissions. Not covered in-depth in this framework, but looking out beyond 2025, the campus will be considering upgrades and new options for the main campus energy delivery system. This major capital improvement has the opportunity to significantly reduce operational carbon emissions over the long-run. A brief description of this and additional strategy ideas for future evaluation are presented in the next section.

The following categories of strategies are discussed here and include descriptions of emissions savings potential of each.

A. Expanding the use of **low and non-carbon energy supply for power and thermal** needs including directed biogas, green power options from utilities, on-site solar photovoltaics and other natural gas use alternatives.
B. **Energy use reduction** through building level energy efficiency projects and energy saving behavior of facility occupants.
C. Curbing growth-related emissions through **green building practices and improved space utilization.**
D. Increasing the efficiency and using **less carbon intensive fuel use in the vehicle fleet**.
E. Refrigerants and **other small sources**.
F. Considerations for **carbon offset mechanisms**.

STRATEGY A: Expanding use of low and non-carbon energy supply in facilities

About 98% of Berkeley's scope 1 and 2 emissions are associated with the energy used in buildings including electrical power, and steam and natural gas used to heat and for lab processes. Beginning in 2017 about 90% of Berkeley's energy will be produced by the on-campus cogeneration plant. In order to frame the different approaches available for reducing

carbon emissions the following strategy discussion assumes this new cogeneration plant operational reality through 2025 and potentially beyond. The following provides a breakdown of Berkeley's energy sources, energy types, and the locations where the energy is utilized:

- The cogeneration plant uses natural gas to produce electricity and steam for the main campus. The plant also has natural gas auxiliary boilers used for steam production when campus steam demand exceeds the cogeneration capacity and when the cogeneration plant is off-line for maintenance or there is a problem.
- The remaining 10% of Berkeley's energy use is associated with:
    - Electricity that is purchased from several utilities to power off-campus buildings and to support main campus electrical needs at times when the cogeneration plant cannot meet electricity demand.
    - Natural gas used for heating off-campus facilities and to support main campus lab processes.

Between 2017 and 2025 energy use growth is expected to rise slightly. The following table provides average annual energy use estimates for the main and off-campus sites, by scope for years 2017-2025.

Energy sources, location of use, and volumes – average annual use 2017-2025

Energy Matrix	Annual Estimated Gas Usage to produce steam and electricity (MMBtu)	Annual Estimated Gas Usage to produce steam (MMBtu)	Annual Estimated Gas Usage for Heating & Labs (MMBtu)	Annual Estimated Electricity from Utility (kWh)
MAIN CAMPUS	scope 1	scope 1	scope 1	scope 2
Cogeneration (natural gas plant produces electricity and steam for the main campus)	2,420,000			
Auxilary Boilers; back up steam production.		56,000		
Natural gas use for lab processes			115,000	
Purchased electricity				16,500,000
OFF CAMPUS	scope 1	scope 1	scope 1	scope 2
Natural gas use for off-campus heating			115,000	
Purchased electricity for off-campus facilities				23,000,000
Annual Totals	2,420,000	56,000	230,000	39,500,000

Cogeneration Plant and Auxiliary Boilers - Acquiring directed biogas through UCOP: The campus natural gas cogeneration plant and overall steam distribution system is aging, and system components are inefficient. In past years various upgrades have been made to the plant, including recent turbine replacements that improved performance. There are no significant plant and steam distribution efficiency projects or equipment upgrades anticipated between now and 2025. The auxiliary boilers are also aging but there are potential opportunities to replace these boilers by 2025; this would bring some efficiency that is not reflected in the current estimates of energy use. Based on plans for the plant and boilers, and similar to other UC campuses with cogeneration plants, acquiring directed biogas as a replacement for some or all of the natural gas used through the UCOP program represents an expeditious path to neutrality. Note: utilizing directed biogas[1] does not actually mean biogas will be delivered to the campus for use in the plant or boilers; campus would be acquiring biogas that is sent into the natural gas pipeline.

As mentioned earlier, one of the major programs UCOP has undertaken to address the carbon reduction goal is to develop and acquire large quantities of biogas to offset campus use of natural gas with a palatable premium on pricing. Due to the state of the industry in general, meeting the UC demand for biogas by 2025 will be challenging but possibly feasible. This option intends to serve all campuses including Berkeley but does so currently in varying degrees. At present internal UC guidelines set up for this program have limits on Berkeley's access to this supply. If UC can secure enough volume in time, Berkeley's access could be expanded. The following offers a simple overview of the carbon reducing impacts biogas can have towards meeting the target at Berkeley; if all of the natural could be replaced with biogas Berkeley would be 90% of the way to the goal.

Potential carbon mitigation through directed biogas for the plant/boilers in 2025

Directed Biogas starting in 2025 (carbon free alternative to natural gas; provided through UCOP program)	**Annual Carbon Emissions Reduction** *metric ton CO2e*	**Potential to help meet the 2025 target**
Current allotment from UCOP	**1,300**	**1%**
Mid-Level allotment (50% supply for cogeneration plant/boilers)	**67,000**	**45%**
High-Level allotment (100% supply for congeneration plant/boilers)	**134,000**	**91%**

[1] Biogas refers to a gas produced by the breakdown of organic matter in the absence of oxygen. Biogas is produced by from materials such as manure, sewage, municipal waste, green waste, plant material, and crops and has biogenic related emissions. *(Source: Wikipedia)*

The amount of biogas Berkeley may want to pursue is connected to longer range plans, beyond 2025, for the cogeneration plant and the campus thermal system. Depending on the direction the campus goes, there might be less demand for natural gas and biogas with an upgraded system. As some of the biogas contracts require long-term commitments, Berkeley will want to right-size the fuel plan to these infrastructure decisions.

Carbon-free electricity options from utility providers: About 20% of the electricity needs of the campus are procured from utilities. These utilities include UCOP for Berkeley's Direct Access accounts off the main campus, and PG&E for the main campus and for other off-campus locations. Alameda County is currently considering formation of a community choice aggregation option that could replace some of the PG&E provision of electricity for the campus in the next few years. Considering the current trends with utilities, including the three mentioned above, it is highly likely that Berkeley will have easy and cost-effective options to procure 100% renewable or 100% carbon-free power starting in year 2025 or earlier from these providers.

Purchased electricity carbon mitigation from utility provider in 2025

Purchased Electricity in 2025 (100% renewable or 100% carbon-free electricity options from utilities)	**Annual Carbon Emissions Reduction** *metric ton CO2e*	**Potential to help meet the 2025 target**
	3,000	**2%**

On-site solar photovoltaics: The campus is in process of completing installation of five solar PV systems on campus property. These systems in total will produce about 1MW of power. The campus plans to install another 1.5 MW of on-site solar over the next eight years. The majority of these installations will be done through power purchase agreements, providing opportunity for the campus to expand solar with little up-front capital. As the installations will be both on and off the main campus, different electricity sources and carbon savings will be impacted by these improvements. While these installations make small carbon reduction impacts, their visibility and educational value are important for supporting the overall carbon neutrality initiative.

Solar photovoltaic carbon mitigation on-site in 2025

2.5 MW On-Site Solar PV Electricity in 2025 (installed on and off-main campus facilities)	**Annual Carbon Emissions Reduction** *metric ton CO2e*	**Potential to help meet the 2025 target**
	500 - 1,000	**1%**

Natural gas use alternatives: To date the campus has not developed guidance on how natural gas used for thermal needs for off-site facilities and for lab processes can be mitigated by renewable supply. There might be opportunities in the future, though, for these core natural gas accounts to acquire biogas as well from UCOP or other sources.

STRATEGY B: Energy use reduction through efficiency projects and behavior change

During the last decade the campus has focused on building level energy efficiency projects through the Strategic Energy Partnership program (SEP), a UC system incentive based partnership with local utilities. The SEP efficiency projects primarily include monitoring-based commissioning, new lighting, and HVAC system upgrades. The SEP energy efficiency projects have been supported by utility rebates and in combination with the campus energy management efforts are providing 15,000 ton savings of carbon emissions annually. While most of these carbon savings have come from physical improvements to energy systems in campus facilities, some have resulted from faculty, staff, and students taking action to reduce energy use through education and motivational programs. During a time when Berkeley was offering a robust energy saving behavior program the campus was seeing a 3% reduction in electricity use as a result of people choosing conservation options. UC systemwide engagement programs like the 2015 Cool Campus Challenge, reveal a potential for carbon saving actions by community members that could provide emissions savings for as low as $15 a ton. Many of the more straight-forward and inexpensive efficiency projects and programs on campus have been implemented. Numerous studies though, including a deep energy efficiency study done by UCOP, show that there is more potential on the Berkeley campus. Implementing some of these deeper-dive strategies can be complex, more disruptive to building occupants, and higher cost.

Due to current constraints both the infrastructure and behavioral energy saving efforts have been scaled back for the time being. Additionally, with the cogeneration plant changes taking place in 2017, the campus will likely receive less SEP incentives than previously, reducing the number of viable efficiency projects to pursue. Today the energy efficiency program is now more closely integrated with the campus capital renewal effort providing additional criteria as well as benefits on which to evaluate and prioritize projects. Berkeley's longer-term efficiency decisions, beyond 2025, will likely be more connected to the future plans for the plant and thermal system. Building level energy efficiency improvements will need to be integrated with the improved energy delivery system.

The following offers a sample of the carbon reducing potential that different levels of investment in energy efficiency can have towards meeting the target at Berkeley.

Potential carbon mitigation through energy efficiency in 2025

Building-level energy efficiency improvement projects in Capital Renewal program (lighting, HVAC, commissioning, etc.)	**Annual Carbon Emissions Reduction** *metric ton CO2e*	**Potential to help meet the 2025 target**
Current investment	**500**	**1%**
Mid-Level investment (investment similar to campus 2008-2012 program)	**2,000 - 3,000**	**2%**
High-Level investment (deep efficiency, 25% to 50% or more than mid-level program)	**4,000 - 10,000**	**3-7%**
Energy saving behavior change programs	**500 - 1,000**	**1%**

STRATEGY C: Curbing growth related emissions through green building practices and improved space utilization

Over the next eight years growth in energy use will be fairly minimal. Most of the square footage growth will be associated with housing and office/classroom spaces, not energy intensive lab space, and efficient building design will help curb energy use and keep emissions increases at a minimum. On the main campus, electricity emissions from new growth can be curbed in part by the planned on-site solar power installations; while both steam and additional electricity growth can be curbed through biogas in the cogeneration facility. New buildings off the main campus energy system will likely have opportunities for 100% renewable or non-carbon based electricity from utility providers by 2025. See the discussion above under Strategy A for the associated emissions reduction possibilities.

There are also likely ways the campus could improve space utilization to accommodate campus programs, potentially minimizing overall square footage growth and the emissions associated with it. The UC system is launching a new physical space management database program called ICAMP. This database tool will offer improved opportunities to study options and determine how space optimization could reduce the campus carbon footprint. The use of space on campus and decision making around it is complicated as there are many competing needs for facilities. Having improved information on the opportunities and challenges associated with the use of existing space will be helpful for advancing strategies in support of the neutrality goal.

STRATEGY D: Increasing efficiency and alternative fuel use in the vehicle fleet

Carbon emissions associated with the campus vehicle fleet, including the shuttle program, are responsible for 1% of Berkeley's emissions. While a small emissions contributor, focusing on improvements to the fleet has advantages. First, the fleet is one of the more visible and public facing components of a carbon emissions reduction program, offering opportunities to showcase the use of alternative fuels and new technologies. Second, due to the current age of the vehicle fleet, up to 80% of the vehicles could be replaced over the next decade. If half of these vehicles were replaced by standard gas/electric hybrids and a fifth were replaced with zero-emission low speed vehicles, fleet emissions could be reduced by 20%. Additionally the campus shuttle vehicles are on a lease program with the current lease period ending in 2022; there are opportunities to increase the use of biofuels or consider electric, hydrogen or other zero emission shuttle vehicles. As an example, if the shuttle fleet became zero emissions, along with the vehicle fleet becoming less carbon intensive as described above, overall fleet emissions could be reduced by 35%.

Potential carbon mitigation through fleet improvements in 2025

Fleet vehicle emissions savings in 2025 (assumes some of the fleet is replaced by alternative fueled and more efficient vehicles)	**Annual Carbon Emissions Reduction** *metric ton CO2e*	**Potential to help meet the 2025 target**
	400	**<1%**

Besides associated costs, these improvements could be fairly easy to achieve because Berkeley already has a procurement and fleet management process in place that could be adapted to help departments identify more sustainable vehicle options.

STRATEGY E: Refrigerants and other sources

Refrigerants and other small scope 1 sources make up less than 1% of Berkeley's emissions profile. Emissions from refrigerant releases occur infrequently and happen during some maintenance processes and when there is equipment failure. As a practice the campus already tries to minimize these types of releases and moves to less harmful refrigerants when available during equipment replacements. The other small scope 1 emission sources are from lab and welding gases, dry ice, and small equipment fuel use like lawn mowers. These emissions are less than 300 tons a year. The overall strategy to reduce emissions from refrigerants and these

other sources is to take advantage of opportunities as they arise, particularly when new equipment purchases occur.

STRATEGY F: Carbon offset mechanisms

Berkeley has considered options such as carbon offsets or renewable energy certificates (RECs) to close gaps between what has been achieved through campus initiatives and reaching a GHG reduction target in a proposed timeframe. They have been considered as a last measure, not a primary strategy. In 2012, a working group of the CalCAP steering committee developed early guidelines reflective of Berkeley's values for these mechanisms if a reduction target is not met through campus related programs. While an update to this guidance is needed and the UC system is working to develop criteria as well, this summary of principles offers a thoughtful starting point from which to build.

2012 Berkeley principles for REC and offset acquisition

	Renewable Energy Certificates	Carbon Offsets
Certified/ Verified	**REC products will be third-party certified and verified.** In some instances the campus may seek more stringent criteria for selection than the certification process requires.	**Carbon offsets will be third-party certified and verified.** In some instances the campus may seek more stringent criteria for selection than the certification process requires. The exception to this includes developing our own local project or one related to campus research and learning for which the size or scope does not warrant independent certification and verification.
Location	**Products will be located in North America and more specifically in the U.S. in order to take advantage of using regional emissions rates for where the REC is generated**. Location is important as it relates to increasing renewable energy deployment nationally, and providing more financial advantage and emissions reduction value for the campus. Investment in California products could be a bonus but is not a priority.	**Invest mostly in national offset projects, such that a percentage of them comply with California Air Resources Board (CARB) adopted compliance offset protocols.** Some offsets could come from experimental and international projects, including UC Berkeley research projects and community weatherization programs that may not meet the certification requirements. Investment in California products could be a bonus for supporting in-State development by may not be a priority.
Pricing & Sourcing	**Acquire cost-effective products that meet quality standards. More expensive REC products may be acquired if necessary to satisfy our criteria and represents a best practice. Pursue options such as pooled purchases with other public agencies and the other UC campuses that may reduce costs.** Prices of RECs vary widely based on different factors including age, type, and location of the renewable energy facilities, whether the product is blended or site specific, etc. An example of a potentially more complex and potentially higher quality product to consider includes a "forward" REC which may require multiple year commitments or investment in projects not yet built.	**Acquire cost-effective products that meet quality standards. More expensive offset products may be acquired if necessary to satisfy our criteria and represents a best practice. Take advantage of the competitive pricing resulting from UC system-wide purchasing of compliant offsets for those UC campuses under Cap & Trade.** Offset prices vary widely and it can be expected that offsets that meet the California Cap and Trade (CARB) criteria will be more expensive than offsets sold in the voluntary market. Another example of a potentially more complex and potentially higher quality product to consider includes a "forward" offset which may require multiple year commitments or investment in projects not yet built.
Type of Product	**RECs from the less impactful renewable energy sources such as wind, solar, geothermal and some biomass and small hydro will be prioritized.*** More stringent environmental review and criteria for REC products that go beyond those required by Federal or State law or by a certifying program such as Green-e will be considered.	**A percentage of the offests will comply with California Air Resources Board (CARB) adopted compliance offset protocols (Urban Forest, Forest, Ozone Depleting Substances and Livestock Manure Digesters).** Consider offset projects that which due to their small scale may not be certified but have local benefit, have a connection to campus research, or have a learning component. Consider not investing in livestock (feedlot industry) related manure digester offsets that support a carbon intensive industry and have negative animal welfare implications.

**Some types of hydropower, biomass, and municipal solid waste can be less desirable. Hydropower dams may drastically alter river habitats and fish populations; biomass facilities may emit significant quantities of smog-forming pollutants; and burning municipal solid waste may release heavy metals and other toxins into the environment.*

The above considers choices in a non-regulated situation such as the UC carbon neutrality initiative. The California Cap and Trade regulatory system has stringent criteria and particular carbon offset projects that can be used for compliance purposes. Up to 8% of the carbon obligation of a regulated agency can be met through select carbon offsets. Since Berkeley is regulated, depending on the need to procure carbon allowances for compliance in 2025, the following offers the emissions that could be reduced on an annual basis through the regulated carbon offsets purchases.

Cap & Trade carbon offset acquisition – 2025

Cap & Trade compliance carbon offsets starting in 2025 (assumes campus will procure the maximum allowed to meet regulation)	**Annual Carbon Emissions Reduction** *metric ton CO2e*	**Potential to help meet the 2025 target**
	11,000	**7%**

SUMMARY TABLE: carbon reduction strategy potential

Berkeley's 2025 carbon reduction strategy options	Annual Carbon Emissions Reduction *metric ton CO2e*	Potential to help meet the 2025 target
RENEWABLE ENERGY SUPPLY		
Directed Biogas starting in 2025 (carbon free alternative to natural gas; provided through UCOP program)		
Current allotment from UCOP	**1,300**	**1%**
Mid-Level allotment (50% supply for cogeneration plant/boilers)	**67,000**	**45%**
High-Level allotment (100% supply for congeneration plant/boilers)	**134,000**	**91%**
Purchased Electricity in 2025 (100% renewable or 100% carbon-free electricity options from utilities)		
	3,000	**2%**
2.5 MW On-Site Solar PV Electricity in 2025 (installed on and off-main campus facilities)		
	500 - 1,000	**1%**
ENERGY USE REDUCTION		
Building-level energy efficiency improvement projects in Capital Renewal program (lighting, HVAC, commissioning, etc.)		
Current investment	**500**	**1%**
Mid-Level investment (investment similar to campus 2008-2012 program)	**2,000 - 3,000**	**2%**
High-Level investment (deep efficiency, up to 50% or more than mid-level program)	**4,000 - 10,000**	**3-7%**
Energy saving behavior change programs		
	500 - 1,000	**1%**
ADDITIONAL MEASURES		
Fleet vehicle emissions savings in 2025 (some of the fleet is replaced by alternative fueled and more efficient vehicles)		
	400	**<1%**
Cap & Trade compliance carbon offsets starting in 2025 (assumes campus will procure maximum needed to meet regulation)		
	11,000	**7%**

EMISSION REDUCTION OPPORTUNITIES FOR THE FUTURE

This section introduces longer-term carbon reduction initiative ideas including a brief discussion on possibilities for the main campus energy system and an introduction to ideas generated at a Berkeley carbon neutrality planning charrette in spring 2016. The campus, along with the UC system will continue to better understand the potential of these ideas in the coming years.

Main campus energy options

The campus intends to operate the current cogeneration plant for the foreseeable future, through 2025, and possibly some years beyond. As the system is aging there will be requirements and opportunities for Berkeley to improve the efficiency of the energy delivery system and consider alternative fuel sources for the main campus. An energy options study conducted recently looked at multiple options for an upgraded system. Possibilities reviewed range from a baseline of overhauling the current centralized plant, to distributed hot water, centralized electric boilers, heat recovery, and various other enhancements. Additionally the study looked at building related energy efficiency upgrades required to optimize these potential delivery systems. The study revealed that carbon savings of 40% to 60% below the baseline scenario, over a 30 year period, could be achieved with the energy option strategies recommended for further study. Berkeley's future energy delivery choices can certainly be a major component in reducing and sustaining carbon emissions in over the long-run. This type of major capital improvement will have its own planning process and as the campus moves forward with evaluation of the main campus energy options, the carbon content of the options will continue to be an important consideration.

Berkeley's carbon neutrality planning charrette

In spring of 2016 a series of carbon neutrality charrettes were held on each UC campus to bring together stakeholders to discuss priorities and strategies for reaching carbon neutrality. The charrettes intended to inform campus carbon action planning as well as systemwide planning. At Berkeley about 30 people attended the campus charrette including faculty, staff, and students. Part of the charrette focused on generating carbon reduction strategy ideas. The following summarizes the discussion offering ideas for further exploration.

Summary of Berkeley's carbon neutrality charrette strategy topics

Strategy Topic	What existing strategies are already implemented or initiated on campus?	What new/expanded strategies should be pursued? How will they help your campus reach carbon neutrality by 2025?	Additional Strategy Ideas
Behavior change and institutional culture	• Green teams and green department certification • Cross collaborative partnerships, committees with working groups and advisory boards	• Elevate sustainability communications, feedback loops and reporting success • More faculty engagement to influence executive leadership and implement changes in their own departments	• Scale up behaviors from individual to institution • Leverage leadership from the departmental level • CNI information at new staff orientations
Research and teaching curriculum	• Berkeley has various related student projects and competitions (global and internal): examples from Haas and Blum Center; Big Ideas • Multi-disciplinary coursework already exists to build on • Student Environmental Resource Center programs • DeCAL courses • Climate course list • Climate Faculty Champion program	• Develop interdisciplinary carbon neutrality framework for teaching and research; Faculty Champion could lead this effort. • Develop interdisciplinary carbon neutrality course threads (pre-set) for students • Provide new structures and incentives for faculty to dedicate time/resources to the carbon neutrality initiative • Align these CNI related processes with the new campus budget process and the undergraduate initiative	• Find continued funding for Faculty Climate Champion program and develop related work-program that supports the selected strategies • Expand the climate list of courses as part of the course thread idea • Build on relationships faculty have already with larger community • Elevate faculty leadership on CNI to bring it more institutional support • Develop more project-based course work for students
Emerging technologies and renewable energy options	• Waste heat capture • Maintaining Cogen • On-site solar • On-site solar thermal	• Broad Thermal Strategy: a) Renewable on-site thermal generation + storage b) Electrify everything else • More on-site solar energy and consider wind • Solar thermal/cooling • Energy Storage, including thermal energy • Develop gravity energy from strawberry creek hydro or stored thermal • On-site waste water treatment and composting for biogas energy generation • Offsite biogas production • Bioenergy development on UC forested lands • Carbon sink on UC Lands	• Nuclear (on-site): thermal electric • Water pump storage/energy • More waste heat capture • Heat wells, geothermal heating • Carbon capture and sequestration

Strategy Topic	What existing strategies are already implemented or initiated on campus?	What new/expanded strategies should be pursued? How will they help your campus reach carbon neutrality by 2025?	Additional Strategy Ideas
Energy demand reduction	• Resistance to lower air change Rates current barrier • Lighting retrofits	• Reduce air exchange rates with a particular focus in lab buildings • Look to a centralized guidelines from UCOP on air exchanges for all campus on air change rates for consistency and to assist fire marshals • Reduce exhaust stock velocities by extending stacks	• Exchange of strategies between lab managers and across campuses
Fleet, transportation and alternative fuels	• Campus owned vehicles • National car buying guide	• On-demand vehicle go-around services. • Vehicle sharing on campus Electric • Overhaul facility maintenance fleet • Campus policy for purchasing vehicles that supports CNI (life cycle, embodied energy, alternative fuel)	• Store materials on campus to allow use of smaller maintenance trucks or vehicles • Incentives for non-car transportation
Future growth; policy and planning	• LRDP has Design Review Committee and there is Seismic Review Committee – potential for Carbon Neutrality Committee • Administrative space use maximized to leverage academic space • Allow campus to be a test-bed	• Develop Carbon Neutrality Review committee – campus level and/or UCOP • Optimize existing space use through understanding energy and occupancy data • Account for existing space before more growth occurs • Engage faculty in project review • Green building committee that includes faculty and staff and have it be a part of facilities manual at UCOP • Develop a LRDP policy that supports pushing the envelope • Assess every project as an energy saving/renewable project (occupancy data, energy use)	• Pilot research in operations • Standardize procurement • Standardize equipment • Potentially involve faculty/staff review of green building, and have it be a part of facilities manual at UCOP • Challenge the sophistication of newer buildings and lack of institutional knowledge Assess building carbon neutrality costs • All new buildings include cutting edge technology

SUMMARY

For Berkeley to meet the carbon neutrality goal in the next eight years campus emissions will need to be reduced by almost 150,000 tons. Berkeley has some programs underway to reduce carbon emissions but these efficiency and renewable energy supply efforts will simply curb expected growth. Reaching carbon neutrality is a far larger undertaking. The campus will need to work with UCOP and the other UC campuses to find cost-effective tactics, primarily with known and available technologies, to meet this target by 2025.

With 90% of Berkeley's scope 1 and 2 emissions associated with the energy from the campus cogeneration plant, an expeditious path to neutrality by 2025 is the replacement of most or all of the natural gas with biogas provided through the UCOP program. Critical to knowing whether biogas is a feasible option for Berkeley will be the actual availability of the biogas and whether it will be affordable. The remaining 10% of Berkeley's scope 1 and 2 emissions can potentially be addressed through efficiency and energy saving measures, procuring carbon-free electricity from utilities and through solar installations, fleet fuel use reduction, and carbon offsets to close the final gap. Again affordability of these measures will be important. Thinking beyond 2025 is also necessary, as carbon neutrality needs to be sustainable in the years following the target date. Expanded consideration of the main campus energy options, emerging technologies, creative financing mechanisms, and more is part of a longer-term strategy.

This framework is intended as a foundation on which to build a Berkeley vision of a carbon neutral campus and a course of action to get there over time. It is also intended to inform the UC system carbon neutrality strategic planning effort. With Berkeley's baseline energy and carbon emissions data now outlined, and challenges, opportunities, and primary mitigation strategies described, the campus is better positioned to move forward in its planning effort in partnership with UCOP and the other UC campuses.

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