Berkeley

Clean Energy Campus

Leading the way to a clean, electrified campus by 2028

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Clean Energy Campus
Why Now?

UC Berkeley's Clean Energy Target:
Zero Carbon Building Energy Use by 2035 or Sooner

Berkeley can lead the way to a clean electrified campus energy system by 2028

- 10+ years of campus climate action
- New system can be a replicable & scalable microgrid model
- Leverages Berkeley's brain-trust and provides a living lab
- Aligns with State and Federal energy and carbon goals

Existing energy system reaching end of useful life

- Natural gas cogeneration plant produces 90% of the campus energy
- End of life for existing system is in 5 to 10 years, and significant investment is required
- Uneven backup capabilities in different research buildings and lack of advanced controls

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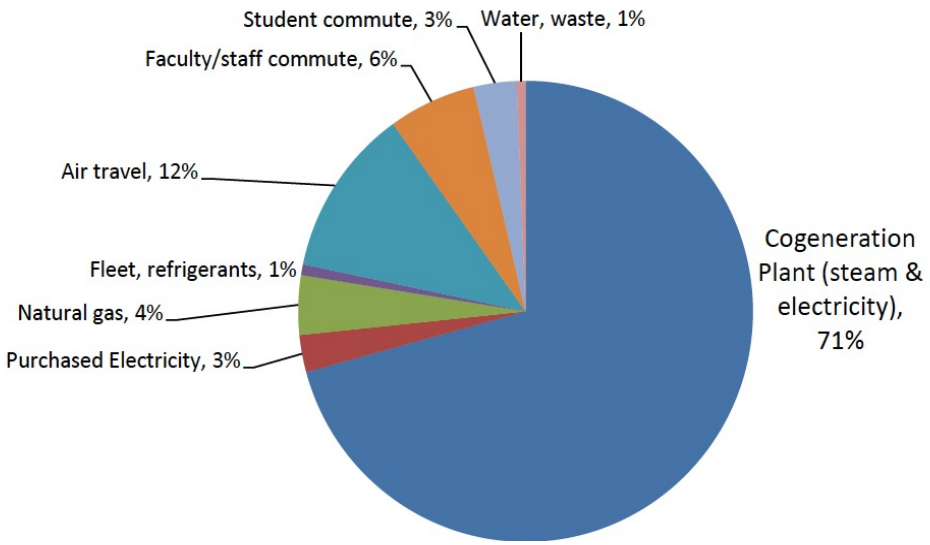
Today: Campus Greenhouse Gas Emissions & Main Campus Energy

About 75% of Campus Emissions Regulated by California Air Resources Board Climate Cap & Trade Program



Campus plant emits 135K metric tons CO2e

The Cogeneration Plant Burns 2.5M MMBtu of Gas Annually for Power and Steam

Campus Power Needs Today and Future

Main campus use today:

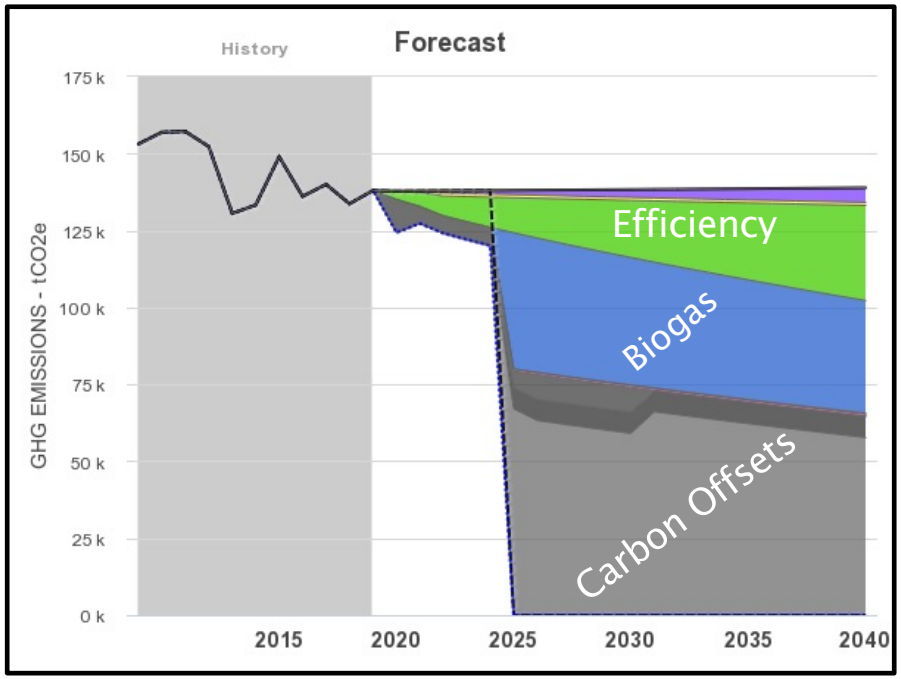
-31 MW. The current plant supplies about 22MW the remainder is purchased from PG&E.

The future electrified campus:

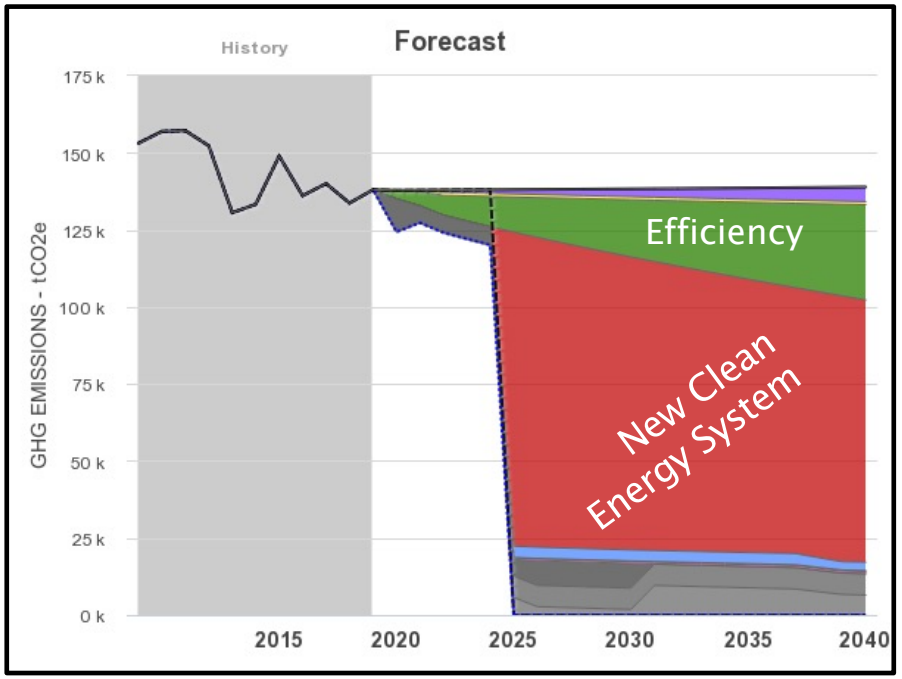
-70 MW.

Carbon Reduction Strategy

Neutrality solutions strategy achieved primarily by biogas and carbon offsets, UCB intends to move beyond this.



Berkeley Target: Decarbonized building energy system reduces carbon emissions and use of offsets to below CA Cap & Trade threshold



Thermal electrification: two priority system options. Updates to these studies underway.

12+ systems studied including a BAU – the thermal heating and cooling options selected to move forward:

- **Option 11c: New Central heat recovery. Reduces carbon emissions to 0.** Central electric heat pump plant supplying hot and chilled water. Plant powered through utility and on-site solar with 100% clean electricity.
- **Option 12: New Hybrid Nodal Heat Recovery. Reduces carbon emission 85% and below CA Cap & Trade regulation.** Replace north-side of campus with one or two electric heat pump plants supplying hot and chilled water. Plants, powered through the utility and on-site solar. The existing plant or modified system continues on the south-side of campus and to serve as a power plant for the whole campus in emergencies. Gas use to be fully phased out as more on site renewables are added for resilience.

#	Description	Heating layout	Heating distribution	Heating generation	Cooling	Electricity
11C	New central electric heat recovery chillers and heat pump heating	■	Hot water	Heat pump	■	PG&E
12	Hybrid nodal electric heat recovery plants on north-side of campus. South-side served by gas cogeneration	■ ∷	Steam Hot water	Cogeneration Heat pump	▒ ∷	Cogeneration PG&E

Layout
- ■ Central
- ∷ Nodal
- ▒ Building

Heat Distribution
- Steam
- Hot water

Heat Generation
- Cogeneration
- Gas boiler
- Electric boiler
- Heat pump

Electricity Source
- Cogeneration
- PG&E

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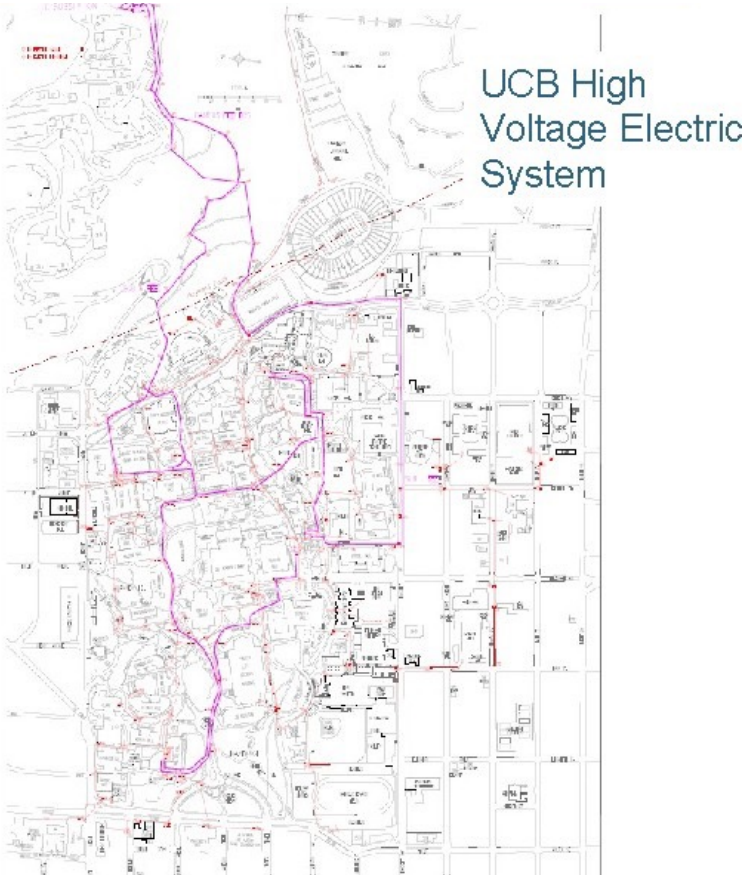
Campus electrical infrastructure requirements – campus needs to double its power availability for new system

Increased electrical capacity is required, potentially double what is available today.

- PG&E will need to increase their transmission capacity in order to provide more power to the campus (and Lawrence Berkeley National Lab, LBNL)
- Project will require PG&E to rebuild the high voltage towers and cables which run 5 miles from the El Sobrante substation in Orinda to the shared campus and LBNL substations
- If the capacity increase is large enough, it could require construction of a new substation
- Increased transmission capacity will also improve campus ability to export power from large on-site solar PV/battery systems.



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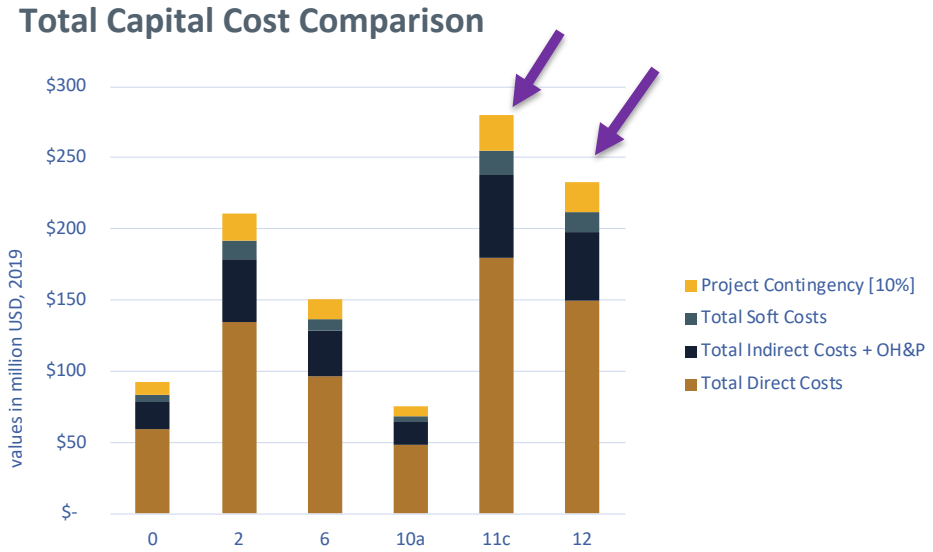
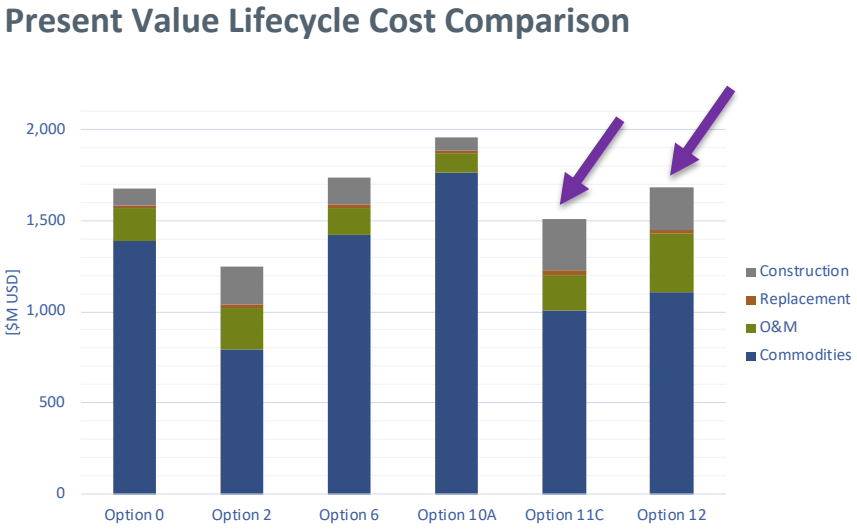
Projected thermal plant costs (2019), to be updated





Decarbonized systems cost less over the lifecycle

- Current plant produces steam and electricity with 30% supplemental power from grid required for campus operations. Current all in cost of $31M/year (costs increasing).
- The core system requirements - new electrified thermal plant(s) and hot water infrastructure to buildings will cost between $250-300M (2019) in upfront capital and a starting annual cost of $40-70M/year to operate (~60% commodity).
- **The capital costs and LCA will be updated** to reflect current costing for the core thermal system, and to include the additional costs for in building efficiency measures, advanced controls, on-site renewable energy and storage, and other resiliency measures.

IRAP: Planning underway

Underway: A Shovel Ready Integrated Resource & Activation Plan (IRAP) 2021-2022

Create blueprints to begin design and construction

Position campus for infrastructure stimulus and other new climate and energy funding

The IRAP is a 12-month process, completed fall 2022

Discover
Expert & stakeholder consultation

Plan
Technical, financial, legal & administrative; Public policy, partnerships & living lab strategy

Current IRAP Activities

- Financial strategy consultant now on board.
- New plant(s) placement options study underway
- Additional technical study consultant on-board early 2022
- Fundraising activities with University Development
- Seeking grant and public funding opportunities
- Developing living lab initiatives

Funding the IRAP
Three generous donors keen on implementing deep and transformational carbon reduction solutions have funded the first phases of this planning effort. Seeking additional donor support.

IRAP: Funding options & financial strategy underway

Ernst & Young's infrastructure advisory group selected financial consultant. EY's Ernst & Young's subcontractors are Barclays Capital and Momentum

Potential funding opportunities

- DOE demonstration projects
- Commission approved pilot
- Biden infrastructure stimulus
- Federal and state tax incentives
- CA Electric Program Invesment Charge Program (EPIC)
- State, city and local grants
- Strategic partners to scale proven technologies
- Air Quality Mgt. Districts
- Office of Business and Economic Development Tax Credits and California Ibank investments
- Gain credits from renewables production and sell to emitters
- Cap-and-Trade Program - Auctioned Greenhouse Gas Reduction funds investments into new projects
- State budget allocation

+ more...

Potential philanthropic funding

- Philanthropic foundation e.g., National Science foundation
- UC Berkeley foundation and alumni network
- Donor advisor funds

+ more

Potential financing mechanisms

- Power Purchase Agreements (PPAs)
- Project finance revenue bonds
- Finance backed by UC credit
- Public-private partnerships
- Equity and debt finance
- Transaction with utility
- Transaction with third party
- Green bonds
- Social bonds
- Sustainability bonds
- Impact bonds

+ more...

Delivery approach (including P3 and non-P3 structures) will impact the types of funding and financing available

IRAP: additional technical study - novel technologies & a decarbonized microgrid at scale

Moving from a natural gas microgrid system to a renewable energy microgrid is key to **operational resiliency** and addressing the climate crisis

The next technical study in 2022 will leverage studies already conducted and address resiliency solutions. This study will consider equipment requirements, plant build-out phasing, in-building required improvements, security, advanced controls, large equipment efficiency and best-fit renewable technologies.

In parallel, a study is underway by PG&E on power transmission and distribution requirements, to understand needs for doubling power supply to the campus.

Additional on-site technologies to be analyzed:

- Solar photovoltaics + Battery storage (30+MW in hill campus)
- Geothermal potential on-campus studies underway
- Water Reuse facility on-site
- Advanced Utility + Building Controls
- Fuel cells, Hydrogen and More

IRAP: Thermal plant & equipment location – southeast campus

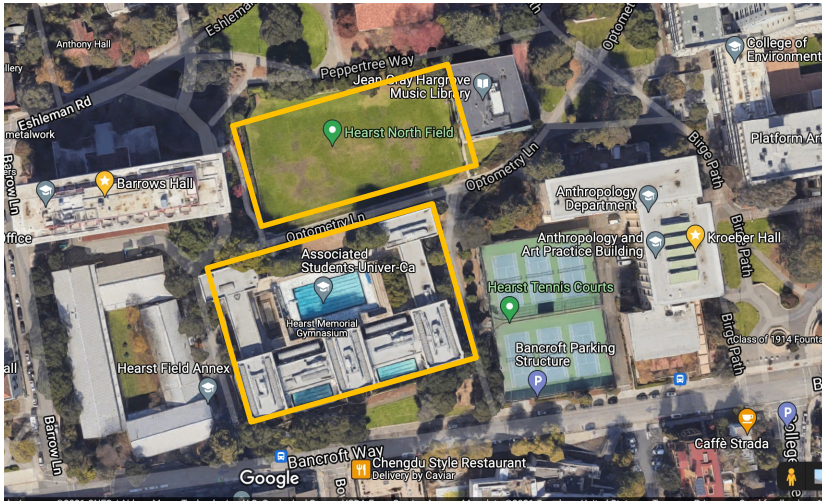
Test-fit study is underway to determine if all or most of the needed thermal plant equipment can be accommodated in these two locations.

North Field
The electric heat pump plant systems would be installed underground and at ground level and the play field would be retained by rebuilding it on the one-story roof of the new facility. The site could include living lab components including a sustainability collaborative center and a ground level view into the plant machinery and operations.

Hearst Gym – basement + structural seismic upgrade of the historical building designed by Julia Morgan
Portions of the Hearst Gym basement would also be used to house some of the thermal plant equipment. Hearst Gym's seismic structural work will ready the basement both for the equipment and for the building's planned restoration and expansion.

The test-fit study will also scope what electrical distribution and energy storage can be accommodated at these locations.

A number of campus sites have been considered to locate the plant(s) and equipment. The **preferred location** is North Field and the basement of Hearst Gym.



Research and learning through living labs

Living Lab
This is a unique opportunity for mutually beneficial project partnerships between the energy operations enterprise and the research and teaching enterprise that advance Berkeley's mission.

Example of initiated living labs:

The Role of Geothermal
The Underground to Realize a Zero-carbon UC Campus Energy System. The goal is to understand combined underground heat/cold storage and heat pump technology as part of the campus energy system strategy.

CalConnect
Using advanced controls of buildings, solar panel arrays and an EV charging station to provide electric load flexibility and reliability. This project will help the campus improve building control options, a key optimization element of the new clean energy system.

Engagement highlights

- Government and Community Relations department with EY and consulting firm Lewis-Burke Associates are socializing federal and state funding opportunities
- Strategic meetings underway with leaders of agencies including California Energy Commission, Bay Area Rapid Transit and Pacific Gas & Electric
- Engagement has been initiated with UCOP Finance and the Global Climate Leadership Council
- Consulting with UCB faculty, including Academic Senate CAPRA and DIVCO as well as the Capital Planning Committee and the Chancellor's Advisory Committee on Sustainability
- Meetings with student organization like BERC and members of the UC Green New Deal

Current Activities

Convening a campus advisory group composed of administration, faculty, student, and finance staff members to provide input and advice to project

More student engagement including co-curricular learning opportunities through student consulting teams and a case competition

Continuing consultation with faculty and researchers and co-development of living labs