



# Univ. of California - Berkeley

## 25 MW CHP System

### Project Profile

combined heat & power on a university campus

#### Quick Facts

- Location:** Berkeley, California
- Capacity:** 24-26 MW combined-cycle (21.35 MW GE LM2500 gas turbine-generator configured with 5 MW Terry steam turbine-generator)
- System Online:** 1987
- Fuel:** Natural gas
- System Efficiency:** Approx 11,200 Btu/kWh heat rate for CC plant (30.5% electrical effic.), with overall thermal efficiency estimated at 50-55%.
- Waste Heat Use:** 185,000 lbs/hr of steam delivered to campus steam loop
- Availability:** 96% on average
- Financial Arrangement:** Long-term (30 year) lease arrangement for CHP plant and building between campus and PE-Berkeley Inc., with power sales agreement with PG&E. Original capital cost estimated at \$32-34 million. Economic benefits to campus from backup generation capacity and minimized utility costs

#### Project Overview

The University of California – Berkeley has a classic combined heat and power (CHP) system, based on the combination of a 21.35 MW General Electric gas powered turbine-generator and a 5 MW Terry Corp. steam-powered “bottoming cycle” turbine gen-set. The system was installed in the mid 1980s at a time when CHP (known as “cogeneration the time) was first being widely encouraged in California, and went online in 1987.

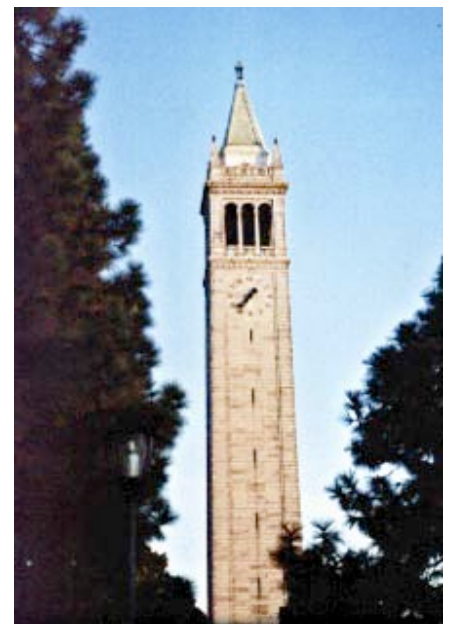
Waste heat from the gas turbine provides steam to replace one of the older boilers that was replaced to help make room for the CHP plant. Up to 185,000 pounds of steam per hour can be generated, or approximately 4MW<sub>TH</sub>. Supplemented by three additional conventional boilers, the steam loop provides heat to the entire central campus along with other buildings on the north, east, and south sides of campus including the stadium, Greek theater, and campus art museum.

The CHP system can operate using diesel fuel along with other campus generators as a backup power source, in the event of a failure

in PG&E’s supply of grid power. This enhanced reliability is important for campus laboratories and data systems, as well as for its role as an emergency shelter facility for the community.

In 1998, the CHP system was upgraded from “LM2500 PE” to “LM2500 PH,” with “full STIG” (steam-injected gas turbine). This means that increased rates of steam can be injected in the gas turbine to improve power output and efficiency, with the added benefit of reduced emissions.

Under an agreement with PG&E, the power generated by the CHP plant is delivered to the utility grid under a power purchase agreement – but of course the majority of the power is actually consumed locally on campus. UC Berkeley gets a low, but not special, electricity rate from PG&E’s “E20T” rate schedule because it connects with the grid at transmission level voltage, making for a more efficient connection to the grid.



Historic Campanile Tower

## UC Berkeley Campus CHP Plant



The classic CHP plant on the UC Berkeley campus helps meet campus energy needs, while also helping to provide enhanced reliability.

However the system is more than two-thirds of the way through its design life and the campus faces a choice about what to do in the future.

Other UC campuses have similar but more modern systems that are also saving energy and money.



### Emissions Considerations

The campus steam output from the three remaining conventional boilers has been de-rated from 100,000 pounds per hour to 80,000 pounds per hour, per boiler, due to emissions concerns and the reduction possible from the somewhat lower output. Emissions from the CHP plant itself are controlled through a comprehensive environmental plan that exceeds regulatory compliance. For example, the system currently operates with emissions of around 15ppm of oxides of nitrogen (NO<sub>x</sub>), even though the permitted limit is 20ppm. This compares to the original (1987) limit of 42ppm. The campus received quick approval for the facility by the local air district because the CHP system allows the aging conventional steam generation equipment to be operated as backup rather than as the primary sources of steam, thereby providing a “greener” overall solution.

### Looking Ahead – Future Cogeneration at UC Berkeley?

The 30-year lease agreement for the operation of the CHP plant expires in 2017, at which time the campus will be at a crossroads. The campus electrical load has grown to about 40 MW with several buildings added in recent years. The campus CHP and boiler plant can presently meet all of the campus thermal load but not all of the electrical load. This means that in theory the current CHP system could be replaced with a larger one, where more of the steam output could come from cogeneration and less from conventional steam boilers. The campus electrical needs would then be more fully met with onsite generation.

Ideally, the campus would design and commission a new CHP plant to come online by the time the old plant is decommissioned in 2017. Unfortunately, a new site immediately adjacent to the old one is not available, so a key issue is to identify a site for a new plant so that the old facility – dating back to the 1930s – can be decommissioned and replaced.

### Further information can be found at:

*PE-Berkeley, Inc.:*  
<http://www.deltapower.com/projects/california/berkeley.html>

*University of California:*  
<http://www.ucop.edu/facil/sustain/greenbldg.html>

*PRAC:* <http://www.chpcenterpr.org>

Version 1.2 9/23/08

### Contact Information

*Pacific Region CHP Application Center, UC Berkeley, Energy and Resources Group, Tim Lipman*  
2614 Dwight Way, MC 1782  
Berkeley, CA 94720-1782  
Tel/Fax: (510) 642-4501 / 5483  
Email: [telipman@berkeley.edu](mailto:telipman@berkeley.edu)