ProposalSpace

Cal Poly SLO Variable Chilled Water Pumping and Plant Optimization

2016 CHESC Call for Best Practice Award Nominations (California Higher Education Sustainability Conference)
California Higher Education Sustainability Conference Hosted By CSU Fullerton

This proposal has been submitted and may not be edited. If you need to make changes please contact the call administrator, Ms. Katie Maynard, at kmaynard@geog.ucsb.edu.

ProposalSpace ID: 592–24914
Status: Review Pending

Content

Project Name (required)
Cal Poly SLO Variable Chilled Water Pumping and Plant Optimization

Which category would you like to apply under (you may choose more than one) (at least one required)

- [ ] Sustainable Food Systems
- [x] HVAC Design/Retrofit and Commissioning
- [ ] Lighting Design/Retrofit
- [ ] Energy Efficiency in New Construction and Major Renovations
- [ ] Student Sustainability Leadership
- [ ] Sustainability in Academics (STEM)
- [ ] Sustainability in Academics (Arts, Humanities, and Social Sciences)
- [ ] Sustainability Innovations
- [ ] Sustainable Transportation
- [ ] Innovative Waste Reduction
- [ ] Water Efficiency/Site Water Quality

Project Location(s) (required)
Campuswide

Completion date or implementation period (required)
Feb 19, 2016 (commissioning still being completed)

Narrative of project goals and strategies (required)
Limit: 500 words | Word count: 499

As part of a $4M energy conservation project funded by PG&E On Bill Finance and a low interest CEC loan, Cal Poly implemented retrofits of multiple mechanical systems in 14 buildings and the central plant. The goal of the project was to maximize return on investment within the payback criteria of the loans, modernize chilled water pumping systems, optimize chiller plant operation, upgrade boiler contols, and pilot wireless pneumatic thermostats. PG&E acted as prime contractor, using AECOM for design/project management and local subcontractors for construction. Measures included:

- Installation of VFD's in 4 buildings, modification of chilled water pumping and control valves in 14 buildings
- Implementation of most open valve and differential pressure reset strategies to minimize pump energy and maximize delta T
- Optimization scheme for central chiller plant cooling tower fan control
- Upgrade of central plant boiler combustion controls with VFD's and O2 trim
- Installation of Cypress wireless digital/pneumatic thermostats in 3 buildings

Cal Poly's central chiller plant was originally constructed in 1997 and later upgraded with additional chillers and a 1.6M gal thermal energy storage tank. The plant's 2,550 tons of cooling capacity serves 21 buildings totaling 1.1M GSF. Newer buildings are designed in "boosted secondary" configuration, with variable speed pumps, 2 way control valves, and high delta T coils to minimize pumping energy. Older buildings still had constant speed pumps, 3 way control valves, 10 degree coils, and hydraulic decouplers to provide for building recirculation. This resulted in significant wasted pumping energy, low system delta T, and reduced storage capacity of the TES tank. This project retrofit all constant flow buildings to variable flow as follows:

- Installed VFD's and 2 way control valves in 4 buildings

- Installed chilled water pump bypasses in 14 buildings with 2 position control valves for operation on plant differential pressure under part load conditions without operating building tertiary pumps

- Installed DP transmitters across furthest coils, resetting DP setpoint and pump speed to maintain the most open control valve at 95% open

- Updated the sequence of operation of central plant secondary pumps

To optimize central plant cooling tower operation, an optimization scheme was implemented that can enable the second cooling tower and vary condenser water flow (even if not needed for load) to increase evaporative area and achieve adequate heat rejection with minimal fan energy.

The Central Boiler Plant, consisting of three 600 hp hot water boilers, was upgraded with digital O2 trim fuel/air controls and combustion blower VFD's. Combustion control was previously performed by mechanical linkage, making fine adjustment difficult and allowing fuel air ratio to vary with load or as weather changed. The new controls result in improved combustion efficiency and reduced emissions.

To achieve better zone temperature control and energy savings in buildings with obstacles to full DDC conversion (hazmat and cost), 204 Cypress wireless digital/pneumatic thermostats were installed in three buildings and integrated into the campus EMS via BACnet. These allow separate heating and cooling setpoints with deadband to reduce over-heating and over-cooling to a single setpoint, as well as remote monitoring for scheduling, alarming, implementation of zone setback strategies, and improved supply air temperature reset.

Relevancy to the Best Practice Program (required)

Limit: 300 words | Word count: 219

The variable flow chilled water pumping retrofits were a direct result of the Best Practices Award Program of the 2014 CSU Facilities Managment Conference, using a solution pioneered by CSU San Bernardino. All buildings connected to the central chiller plant are now variable flow with two way valves, achieving a standard critical for proper operation of the chiller plant and TES. The project resulted in a significant savings in both building and central plant pumping energy, as well as a significant improvement in system delta T. The aggregate campus delta T previously could be as high as 13 degrees on a hot day, but dropped to as low as 6 degrees in mild weather due to bypassing of constant flow buildings.

The system now runs at a 20 degree delta T, and through ongoing commissioning and experimentation, should be able to go higher. This allows more ton-hours of cooling energy to be stored in the TES tank, and for central plant chillers to be run more fully loaded during TES tank recharge. This reduces the amount of time necesary to recharge the TES tank, reducing energy and demand charges during part-peak periods. Chillers are locked out from operating during peak periods. This approach to integrated retrofit of buildings to achieve central plant optimization could be adopted by any campus with a central plant.

Collaborative design and implementation (required)

Limit: 300 words | Word count: 255

The design team required deep engagement and ongoing support by the AECOM engineers, Siemens programmers, campus operating staff, project management, and the energy manager to understand the wide variety of building and plant systems being affected. Multiple layers of control functionality had to be understood and integrated into these new sequences due to;

- The nature of the campus' distribution system - some buildings being higher than the top of the open TES tank, require static pressure monitoring at their highest point and a reset strategy for building tertiary pumps to ensure positive pressurization when operating.

- A mix of 5 chillers in the central plant of three different makes and models - configured in two series/parallel sets of 300 ton chillers (two screw and two centrifugal), and the newest 1,350 ton variable speed chiller that serves as the lead unit.

- Campus 24/7 operation that results in chillers delivering cooling directly to campus at night while simultaneously recharging the TES tank, making the need to recharge the tank as quickly as possible even more critical.

- Implementation of the new building tertiary pumping control scheme that sought to turn pumps off and serve cooling load from plant DP when adequate, then close the bypass and stage on the pump and modulate the VFD when needed to satisfy the worst zone - without compromizing building pressurization or central plant secondary pump operation.

This was accomplished with regular team meetings, lots of RFI's, careful and critical review of plans/specs/submittals/sequences of operation, many long debates on the whiteboard, and ultimately effective design collaboration to achieve the desired goal.

Education and Outreach

Limit: 300 words | Word count: 104

While this project was under way, tours of the central plant and building systems were given to mechanical engineering classes to provide direct understanding and visualization of these complex concepts, enriching student experience. A mechanical engineering studetn Master's Thesis was also undertaken during the same period to model the operation of the central chiller plant and determine the optimum sequence for staging of the five central plant chillers - with different efficiencies and delta T's - to achieve optimal recharge of the TES tank during offpeak periods with the lowest total operating costs. The thesis is complete and is undergoing defense by the student before implementation.

Total project cost (required)

$1.4M

Quantitative Savings and Benefits

Strong proposals will have quantitative savings in at least one of the following areas, but it is unlikely that any proposal will have savings in all of the below areas.

Number of people reached by your program

NA

Estimated annual energy savings in kWh

1,000,000

Estimated annual energy savings in therms

47,000

Estimated greenhouse gas emission reductions in metric tons CO2e

610 metric tons CO2 (based on 0.0003655 tons/kWh and 0.0052954 tons/therm as per CSU 1-4)

Estimated annual water savings

NA

Estimated annual waste reduction

NA

Estimated annual cost savings

$128,000/year (based on $0.105/kWh and $0.50/therm)

For the Energy Efficiency in New Construction and Major Renovation category, provide estimated annual energy savings as compared to Title 24 in percent better than baseline.

NA

Percentage of total food and beverage purchases that is local (under 250 miles) in origin and/or meets one or more third party-certified sustainability criteria (e.g. USDA certified organic). List the third party-certified sustainability criteria included

NA

List any green business or green restaurant certifications that this project achieved

NA

12. Additional environmental, social, and/or economic sustainability benefits

Limit: 300 words | Word count: 1

NA

Supporting document

no file

Second supporting document

no file

Persons

Primary Contact

Your Proposal must include 1 primary contact.

Dennis K Elliot, PE, CEM

Name (required)

Dennis K Elliot, PE, CEM

Campus (required)

Cal Poly State University

Department (required)

Facilities Management and Development

Job Title (required)

Director of Energy, Utilities, and Sustainability

Phone (required)

(805) 756-2090

Email (required)
delliot@calpoly.edu

Speakers

Your Proposal must include at least 1 but not more than 2 speakers.

Dennis K Elliot, PE, CEM

Name (required)
Dennis K Elliot, PE, CEM

Campus/Organization (required)
Cal Poly State University

Department (required)
Facilities Management and Development

Job Title (required)
Director of Energy, Utilities, and Sustainability

Post-nominal titles
no answer

Biography (required)
Limit: 150 words | Word count: 100

Dennis Elliot is the Director of Energy, Utilities, and Sustainability for Facilities Management and Development at Cal Poly SLO, and a part-time lecturer in the Mechanical Engineering Department. He is a registered Professional Engineer and a Certified Energy Manager. Dennis manages the University's utility procurement, energy and water conservation programs, and acts as the University Engineer for strategic planning, operations, and new construction. Dennis also mentors the Green Campus intern program, and serves on all three campus sustainability committees. Dennis has served in a variety of energy related positions at the University over the course of his 30 plus year career.

Phone (required)
(805) 756-2090

Email (required)
delliot@calpoly.edu