ENERGY EFFICIENCY PARTNERSHIP PROGRAM
BEST PRACTICE AWARDS APPLICATION FORM

Deadline: March 6, 2009

I. CONTACT INFORMATION

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Department: Facility Services
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II. PROJECT CATEGORY- see attached category descriptions

NEW CONSTRUCTION

___ Best Overall Sustainable Design
_X_ HVAC Design/Retrofit
___ Lighting Design/Retrofit

SUSTAINABLE OPERATIONS

___ Water Efficiency/Site Water Quality
___ Innovative Waste Reduction
___ Student Energy Efficiency
___ Student Sustainability Program

III. PROJECT/ PRACTICE INFORMATION

A. GENERAL QUESTIONS

Project/practice name: HVAC Technology Demonstration Projects
Project/practice location: Various
Implementation cost: $115,400
Estimated *annual* energy savings (as applicable): Saves 105,000 kWh fan and cooling energy per year, a 62% reduction, and saves 14,000 therms heating energy per year – a 32% reduction.
Estimated *annual* energy cost savings (as applicable): Saves $24,000 per year.

Description- Provide a detailed narrative describing the project or practice.

Cal Poly, as the host of the 2008 UC/CSU/CCC Sustainability Conference, worked in partnership with the CIEE's Public Interest Energy Research Program, Architectural Energy Corporation, Federspiel Controls, and CulinAire Systems to develop and implement a number of different HVAC technology demonstration projects. These projects were showcased at the conference in a series of walking tours that were very well attended. In addition, PIER Program staff were invited to present to the University's ESCO during the campus wide investment grade energy audit, to educate them about these new technologies, make PIER resources available, and look for opportunities for more wide spread adoption. Representatives from Federspiel Controls also presented to the CSU Energy and Utility Manager's Council to showcase their technology and help CSU Energy Managers learn an alternate method for modernization of their building mechanical systems. Demonstration projects included:

DART Ventilation Control System

Three locations were selected for conversion from constant volume to VAV using the Federspiel Advanced Control System to implement DART (Discharge Air Regulation Technique) – see:
www.federspielcontrols.com
These included the Education Building, the Student Health Center, and the Science and Mathematics Building. Each building already had Siemens Apogee DDC control of air handler start/stop, discharge air temperature, and economizer functions. Zone control of constant volume double duct mixing boxes or single duct terminal reheat units was accomplished by the building's original pneumatic controls. The Siemens system had no zone temperature sensors, and thus could only make control decisions based on the average return air temp for the entire building.

The DART project converted these systems to VAV using the Federspiel Advanced Control System. Battery powered digital temperature sensors were installed in about 50% of the zones, communicating back to the main Federspiel controller via a wireless mesh network. This provided critical zone temperature information back to the air handler in a simple, non-invasive, cost effective manner. The wireless approach avoided possible haz mat issues inherent in retrofit of terminal units above the ceiling, or running of network cable throughout the building. The wireless mesh network proved simple to configure - sensor battery life is self monitoring and self managing. Wireless mesh links are self healing and continuously updated to balance network traffic and optimize battery life – expected to be 4 to 8 years. Pneumatic stats remain in operation to control the zone terminal units and were repaired or recommissioned as necessary based on the wireless zone temperature data.

The Federspiel Advanced Controller was installed in the fan room and was connected to a wireless Ethernet hub to collect the zone temperature data. An Ethernet connection to the campus backbone provided remote access and diagnostics, and allowed integration with the Siemens DDC system. In addition, wireless sensors were installed to monitor discharge air temperature, mixed air temperature, and outside air temperature. The Federspiel Controller runs an algorithm to reset fan speed based on zone temperature. When all zones are within a programmable dead band, supply and return fans operate at minimum speed. When zones are outside of the dead band, fan speed is increased to provide heating or cooling as necessary.

Variable speed drives were installed on supply and return fans at all three locations, using ABB ACH 550 drives as per the Cal Poly campus standard. The drives communicate directly to the Siemens automation system, allowing full monitoring and control of all points in the drives. A very simple method was developed to integrate the Siemens and Federspiel control systems. The Federspiel controls system calculates a fan speed setpoint based on zone temperatures and sends a 4-20Vac output to the Siemens control panel, which relays the signal to the drives. A fixed speed differential between supply and return fans is used to maintain building pressurization. When the fans ramp down to low speed, the Siemens system increases the minimum outside air position of the economizer dampers, ensuring that minimum ventilation standards are maintained as per ASHRAE 62.1. After the morning warmup period, it was found that significant amounts of time are spent at partial or minimum fan speed, generating significant fan energy savings. Reduced air volumes also produce savings in heating and cooling energy. Based on pre and post energy monitoring, the actual energy savings were found to be:

Building	Fan Energy Savings	Heating Energy Savings
Science and Math	71.6%	24.0%
Education	52.4%	29.8%
Health Center	61.8%	31.0%

The Federspiel Advanced Control System provides a simple web interface, which was integrated into the Siemens Apogee front end transparently as an HTML link. The Federspiel system also has trend and alarm capabilities. Once the system was installed and commissioned, it worked seamlessly with virtually no occupant comfort complaints. By using the wireless zone sensors to simplify installation, capital cost is about half that of a conventional VAV conversion with DDC control of the zones. Please see the attached case study and data analysis as supporting documentation.

Kitchen Exhaust Hood Demand Ventilation Control
Commercial kitchens typically have high volume exhaust hoods over the cooking area that run at full speed whenever the kitchen is in operation, regardless of whether cooking is taking place or not. Three exhaust fans (9 hp total) serving the large hood in the Campus Dining main kitchen were retrofit with the Melink Intelli-Hood Exhaust Fan Control System. The Melink system utilizes both temperature sensors mounted in the exhaust duct and optical sensors that pass a light beam across the hood opening to detect heat, steam or smoke from cooking operations. When no cooking is detected, VFD's reduce fan speed to 50%. When exhaust temperatures rise, fan speed is increased. If smoke or steam is detected, fan speed in ramped to 100% until the air is cleared.

A simple user interface panel was installed on the kitchen wall that indicates current fan speed for each of three fans, and allows users to override the system if necessary. ABB ACH 550 variable frequency drives were installed to control fan speed. Pre and post retrofit monitoring and data analysis found that fan energy was reduced by 54.2%, and heating energy was reduced by 33.5%. After incentives, this project had a simple payback of 4 years. Again, once installed and commissioned, operation of the system was transparent to the kitchen staff. Please see the attached case study and data analysis as supporting documentation.

Relevancy to the Best Practices program- Describe the features of the project/practice that qualify it as a best practice of potential interest to other campuses (eg. replicability).

The HVAC technology demonstration projects implemented at Cal Poly are a great example of cooperation between the CSU, the PIER Program, and the Utility Partnership Program. The DART project demonstrated a cost effective alternative for retrofit of constant volume systems and implementation of DDC controls. Most campuses still have older buildings running constant volume HVAC systems that need to be upgraded with limited funds. The Kitchen Demand Ventilation project demonstrated that significant energy savings are possible on systems that are not normally considered – all campuses have kitchens utilizing constant volume exhaust systems. PIER has created a Google Earth map of all technology demonstration projects in California – see:
http://www.terradex.com/PublicPages/CIEE/pier-01.kmz
From the lessons learned on these demonstration projects, the campus hopes to implement these technologies on a larger scale.

Design integration- If appropriate, describe the ways in which this project/practice incorporated multiple disciplines and/or stakeholders into the design process. Describe how collaboration produced sustainable solutions or improved the project's performance.

To develop and implement these HVAC technology demonstration projects, a number of stakeholders were involved in design, planning, review, and coordination – these included:

- Campus Engineering Services and Electric Shop: Discussion of operation, maintenance and service issues, training on new technologies, safety features, code compliance, integration with existing Siemens DDC system, coordination for installation, outages, access, and assistance with M&V data collection.
- Campus Dining Maintenance and Kitchen Staff: Discussions of energy conservation opportunities, user behavior and awareness, system operation and maintenance.
- PIER and CulinAire Systems (Melink Rep): Identified a need to replace the existing kitchen exhaust fans before installing this control system, and were able to include this work in the cost of the project.
- Federspiel Controls: Worked with campus engineering staff and energy manager to improve sequences of operation, develop a fix for a Microsoft Internet Explorer bug, and implement a minimum outside air reset scheme to maintain fresh air ventilation rates. Based on campus feedback, we are continuing discussions about a possible future generation of controls that will provide full zone control using battery powered wirelessly networked pneumatic thermostats.

Load management- If appropriate, describe how the project/practice provides on-peak electricity demand reduction, or demand response capability.

Since the VAV functions of these systems is controlled by load conditions, peak demand savings cannot be claimed since 100% output could be required during peak hours. However, these HVAC Technology Demonstration Projects provide a demand reduction capability to reduce fan energy by approximately 70% during a demand response event.

B. DEPENDENT QUESTIONS- This section contains questions that are relevant ONLY for certain awards. If the award you are submitting under is listed, please address the question that follows.

Best Overall Sustainable Design:
Please describe the design of the building envelope, focusing on its effect on the facility's overall energy-efficiency.

Water Efficiency/Site Water Quality:
Please provide an estimate of the annual amount of water saved or treated.

Best Overall Sustainable Design; HVAC Design; HVAC Retrofit; Lighting Design/ Retrofit; and Water Efficiency/ Site Water Quality, if applicable:
Please describe how the project/practice has been received by building occupants. Describe what has been met with satisfaction or dissatisfaction, and why.
In regards to the DART system, building occupants have not really noticed the change, which says volumes about the effectiveness of the system. Comfort and air quality complaints have not increased in any of the buildings retrofit, and the systems have been operating trouble free for almost a year. The Kitchen Ventilation system, apart from a couple of warranty issues, has also operated seamlessly without impact to users. Lessons learned include:

- Discuss control integration options with your controls staff early – the are many options with a range of cost implications.
- Before installing VFD's, make sure all motors are inverter duty rated (one set of old air handler motors were left in service and immediately suffered a motor failure).
- Investigate grounding methods in older buildings to ensure VFD's and motors can be grounded as per the NEC.
- Involve all stakeholders early, educate and train users and maintenance staff, make sure to get complete O&M manuals.

IV. ADDITIONAL INFORMATION

Please provide any additional information necessary to assist the selection team in understanding and evaluating the project. Supplemental information in the form of photos, drawings, etc. may be submitted.

If you are submitting in the Best Overall Sustainable Design category, you must submit several pictures of the project for the selection committee to adequately evaluate the building design.

V. SUBMISSION DIRECTIONS

Please submit proposals (electronic transmission only) by March 6, 2009 to:

Andy Coghlan
Sustainability Specialist
University of California, Office of the President
Email: andrew.coghlan@ucop.edu
Phone: 510.987.0119

Please visit the UC/CSU/CCC Sustainability Conference webpage at <http://sustainability.ucsb.edu/conference/index.php> for information about this year's conference.

UC/CSU/CCC SUSTAINABILITY CONFERENCE 2009
UC Santa Barbara
June 21st – June 24th

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PROJECT CATEGORIES

NEW CONSTRUCTION/MAJOR REHABILITATION

1. **Best Overall Sustainable Design -** This category is for best overall sustainable design for a new building or major building renovation. The building should show outstanding implementation of sustainability principles and energy efficiency measures. The building design must have been completed between January 1, 2004 and January 1, 2008. Building must not be a previous recipient of an Energy Efficiency Partnership Program award.

2. **HVAC Design/Retrofit -** Projects in this category should demonstrate leadership in HVAC equipment selection, distribution system design, and controls specification. Laboratory designs and retrofits are included in this category. Examples include: appropriate equipment sizing; energy efficient equipment selection; maximizing the benefits of local climate; air distribution system innovation; and fume hood control innovation.

3. **Lighting Design/ Retrofit -** Projects in this category should demonstrate leadership in a new design or retrofit of lighting delivery systems and lighting control systems. Examples include: energy efficient fixture selection and deployment; utilization of daylighting technologies; and use of advanced lighting control technologies.

SUSTAINABLE OPERATIONS

1. **Water Efficiency/ Site Water Quality -** This category highlights outstanding water efficiency projects that have measurable and documented savings. Additionally, projects that significantly improve or protect site water quality may submit under this category. Water efficiency applicants with documentation or calculations of associated energy savings will be given special consideration throughout the review process. Examples of water quality projects include bioswales and riparian zone restoration.

2. **Innovative Waste Reduction Programs -** This award will spotlight a program, organization, or group that has demonstrated significant leadership in waste reduction and recycling efforts. Award candidates in this category should be engaged in campus-wide programs that seek to leverage student, staff, faculty, and community interest and commitment to reduce waste and increase recycling. Programs should be able to demonstrate innovative strategies and programs in reducing waste while maximizing their collections of recyclables to lead the campus to achieve zero waste goals.

3. **Student Energy Efficiency -** This award will spotlight a program, organization, or group that has demonstrated real leadership in student-led energy efficiency and conservation efforts. Award candidates will be engaged in campus activities that seek to leverage student interest and commitment to sustainability in order to increase energy awareness on campus; realize environmentally-friendly campus policies and commitments; and involve students in efficiency activities that compliment their campus' goals and that result in measurable energy savings.

4. **Student Sustainability Programs -** This award will highlight a program, organization, or group that has demonstrated real leadership in student-led

environmental sustainability efforts. Award candidates will be engaged in campus activities that seek to leverage student interest and commitment to sustainability.