This innovative project integrates the design of two new facilities with a dedicated central plant, in an ambitious effort to approach net-zero energy use in a multi-building campus expansion. The two facilities located in close proximity to one another — the Maintenance and Operations Complex, and the Horticultural and Animal Sciences Center — together have been dubbed the MOHC project. The decision to build a new plant for the MOHC was driven in part by the great distance to the main campus central plant, and the high cost that would have been incurred by bringing hot and chilled water infrastructure to the site. The project team took advantage of this opportunity by integrating several innovative renewable and energy-efficient technologies into the design of the plant and the new facilities.

This project will showcase multiple approaches to net-zero energy use, including a photovoltaic (PV) array, a solar thermal array, hot water storage, and an absorption chiller.

Pierce College and the Los Angeles Community College District selected the design/build firm gkkworks for the Maintenance and Operations (M&O) Complex, the central plant, and related utilities infrastructure. Diffenbaugh was chosen as the design/build firm for the Horticultural and Animal Sciences Center. From early on in the design process, gkkworks brought a strong integrative design approach, working in close collaboration with the mechanical, plumbing, and electrical design/build subcontractors, and with the LEED consultant, to refine the building envelope and carry out whole-building energy analysis to reach the project’s near net-zero energy goal.

The design team carefully considered how each potential technology would integrate with the others to attain the most cost-effective, low-energy solution. The final design solution includes a solar PV array to be mounted on canopies above the M&O parking lot, providing a maximum output of 190 kW, which is estimated to generate 265 MWh per year. Energy-efficient interior lighting, LED exterior lighting, together with natural daylighting, will reduce the required solar PV capacity, making the overall system more cost effective.

One of the most innovative features of the project is the design of a new renewable central plant to be located between the M&O complex and the Horticultural Center. The plant will include a solar thermal array, hot water storage, a cooling tower, supply and return pumps, and a hot-water powered absorption chiller. The solar thermal array will consist of 300 vacuum-tube heat-pipe collector modules mounted on the roof of the M&O complex. Absorption plates in each tube will collect heat at 92 percent efficiency at a temperature at or above 200°F, using radiant heat transfer. Each tube is vacuum-sealed, inhibiting convective heat loss. The solar array system is expected to generate the equivalent of 16,000 therms of natural gas per year.
Water heated by the solar array will be stored in a 45,000-gallon hot water storage tank, and used to power the 130-ton capacity absorption chiller. The hot water storage will enable load shifting, thereby reducing overall peak electrical demand and the high associated peak load charges. The capacity of the storage tank is estimated to offset an electric cooling load of 165 MWh per year, and reduce peak demand by 175 kW. In addition, hot water from the tank will be used to offset natural gas demand for domestic hot water and space heating.

Unlike conventional refrigeration chillers which use electricity to power a vapor-compression cycle, in an absorption chiller cycle, heat is supplied to a liquid solution, generating vapor as the temperature rises. A phase-change process reduces the temperature of the vapor that is then used to cool the building chilled water, which is distributed to variable air volume boxes (VAV) in the building.

**Advanced controls and monitoring systems will be used to assure good energy performance, and to increase equipment longevity.**

A number of sophisticated systems will be implemented to control and monitor the ongoing performance of the complex. All three buildings will be connected to a district-wide enterprise energy management system (EEMS) to optimize controls for occupant comfort and low energy consumption. In addition, a condition-based monitoring system will be deployed to monitor the condition of mechanical and electrical systems, and to provide early detection of system faults and equipment problems. The monitoring system will document the signatures of various pieces of equipment, and by monitoring the rate of change of these signatures, can provide early detection of problems, reducing equipment failures, downtime, and costly overhauls.

**LESSONS LEARNED**

Bill Reifsteck, Director of Integrated Services at gkkworks, says that through creative brainstorming and an integrated design approach, a design team can add value to the project beyond client expectations. Preliminary building orientation studies, for example, allowed the team to take advantage of prevailing winds for natural ventilation and decrease cooling loads. Careful site planning and thorough analysis of ground conditions led to $100,000 in avoided excavation costs; cost savings were then applied toward more energy-efficient solutions.

The design team also involved government agencies early on to familiarize them with the innovative engineering concepts planned for the project. The team met with the fire department to personally explain the below-grade rainwater capture system. The team also met early on with the Department of State Architects (DSA), the agency responsible for permitting many campus buildings. Although the MOHC did not require DSA approval, the team was interested in presenting the complex to the DSA as a model for future net-zero campus projects. Partly as a result of this interaction, the DSA has become a proponent of net-zero strategies for new projects that come up for approval.