Kings County Courthouse

Hanford, California

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Implementation of ice-based thermal energy storage system results in more than $100,000 in annual energy savings, helps civic landmark achieve LEED Silver certification.

Challenge

The Kings County Courthouse was a compound of old, windowless buildings with outdated plumbing, electrical and HVAC systems. On the outside, the buildings lacked a civic appearance, a compelling design to surrounding streetscape and adequate parking. On the inside, separate holding areas created chaos and small entrances forced people to line up outside. Additionally, judges, the judicial staff, defendants and inmates were all ushered through the same entrance, creating potentially dangerous situations. The Kings County Courthouse sought to implement a safer environment, and enable the facility to adhere to state mandates for new government buildings to achieve LEED® (Leadership in Energy and Environmental Design) certification.

A four story, 144,000-square foot building, Kings County Courthouse is LEED Silver certified and has won numerous awards for its redesign, including Outstanding Project Achievement Award, New Buildings by the Western Council of Construction Consumers and American Institute of Architects (AIA) Orlando Honor Award.

Solution

Working with integrated design firm, DLR Group, Kings County took a centralized integrated design approach for the project with chiller plant design, daylighting harvesting, bioswales, building orientation, centralization and transportation all playing an important part.

Creating an optimal chiller plant design

To create an optimal chiller plant design, the engineering consultants engaged Trane to help evaluate mechanical system options based on their energy use and a full comparative life-cycle cost analysis. A smaller cooling load, due to the south facing orientation of the building, allowed for a reduced sized chiller plant. Thermal energy storage (TES) was considered to shift load from daytime hours, when energy costs are higher, to less expensive nighttime hours. To take advantage of this energy price differential, the design team evaluated the option of employing a chiller plant with ice -based thermal energy storage to create cooling and store it for daytime consumption. The decision was made to move forward with a chiller plant design incorporating a combination of energy-efficient Trane water-cooled Series R helical rotary chillers and a CALMAC® thermal storage system to enable load shifting and provide energy cost savings.

Determining the right combination to maximize savings

To maximize energy savings, several system configurations were evaluated. These options included turning off the chillers in the peak rate periods in the summer (using only the ice storage tanks to meet cooling loads), and using a combination of chillers and thermal energy storage to meet summer cooling loads. The design team evaluated a thermal energy storage system for the two conditions based on the peak load profile of the building, and analyzed the cost effectiveness and redundancy of various chiller and storage combinations.

It was determined that a cooling system, using both chillers and ice storage tanks to meet peak loads, provided the best return on investment. This avoided "over-sizing" the cooling system with chiller capacity. Adding thermal energy storage also offered operational flexibility, allowing the chiller and storage to meet cooling loads in the summer, while using energy storage to meet most, or all, of the cooling loads in the cooler months.

Balancing utility and equipment costs

Conventional cooling system sizing for peak design day load typically includes a safety factor for unexpected loads. For example, a 500-ton peak load may require the installation of 600 tons of cooling equipment. In this case the ice storage is the safety factor, with the system requiring just 500-tons of cooling equipment. To achieve this, two options were evaluated. The first paired two 250-ton chillers with energy storage for 2500 usable ton-hours, with the chillers meeting 200 tons of the cooling load and the energy storage meeting up to 300 tons of the load. The second option paired two 305-ton chillers with energy storage for 3,000 usable ton-hours, with the chillers meeting 100 tons of the cooling load and the energy storage meeting up to 400 tons of the cooling load.

The preferred option was the thermal energy storage system with fewer ice tanks (2500 usable ton-hours) and the smaller chillers, as this would provide sufficient redundancy if one of the chillers was not functional and would be less cost intensive. The sizing of the ice storage and the chillers struck a balance between utility costs and the costs of the equipment. On most days, the size of the TES system ensures that the chillers do not need to run during the day. On the hottest days, the chillers will run in the mornings, so that the ice will be conserved for the highest-cost afternoon cooling hours.

CALMAC thermal energy storage shifts load to less expensive nighttime rates to help reduce energy costs.

Results

The updated Kings County Courthouse's integrated centralized design was successful in providing a civic presence and critical security measures while addressing vital relationships between the building and the ecosystem. The design team was able to successfully reduce costs to meet budget without impacting the design schedule. The thermal energy storage system enabled the courthouse to enroll in utility incentives for energy performance and permanent load-shifting, saving 26 percent in energy costs or more than $100,000 annually. The redesigned Kings County Courthouse also met the county's objective to achieve LEED Silver certification.