UCR College of Engineering- Center for Environmental Research & Technology

Energy Efficiency Improvements for Building HVAC System

Yujie Cao, Andrew Yu, Luis Duarte, and Sadrul Ula

Bourns College of Engineering, Center for Environmental Research and Technology (CE-CERT), University of California at Riverside, CA 92521

INTRODUCTION

The Administration Building of UCR's CE-CERT is located at 1084 Columbia Avenue, Riverside, California. This 6,500 square feet office building has typical electrical load consisting of air conditioners, office equipment, lighting, refrigerators, computers, and other plug loads. However, the main power usage is from 16 roof mounted Heating Ventilating and Air Conditioning (HVAC) units. As these units turn on and off as needed, during certain period of the month, all 16 units come on at the same time creating a large peak demand . Electric utilities bill the user a peak demand charge based on a 15 minutes rolling average. There is a significant potential for electrical saving when a user can manage to reduce this monthly peak.

In this project, a sensing and control system was designed and implemented for peak reduction in this building. Commercially available hardware and software where adapted to control run times of these 16 HVAC units.

Roof View of HVAC Locations at the Administration Building

There are 16 HVAC units of different sizes mounted on the roof of the administration building. Sensors are placed at each of the HVACs thermostat circuit for controlling purposes.

ACKNOWDGEMENT

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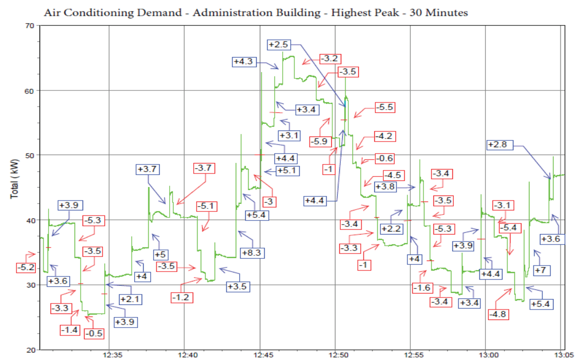
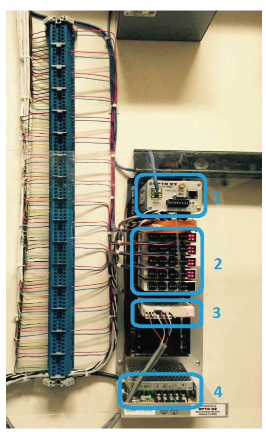
Individual HVAC Demand at Administration Building



This figure shows the total power demand of the individual HVACs coming on and off on a hot summer afternoon. The power increase due to an individual HVAC turning on is shown in blue, while the power reduction is shown in red when an individual HVAC is turned off. At 12:45 pm, all 16 HVACs turned on resulting in a cumulative peak of about 65 kW. However, within 5 minutes the peak was below 50 kW continuing to go down.

A smart controller was designed and implemented to utilize the fact that coincidental peak usually do not last that long and may occur only a few times a day.

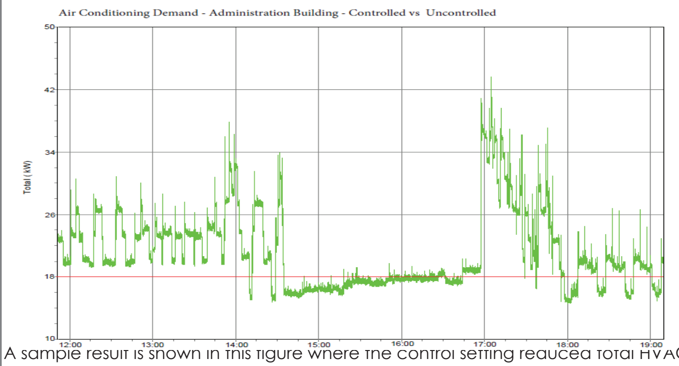
HVAC Control System for the Administration Building



This figure shows the HVAC Controller installed in the electrical room of the Administration Building. The 16 pairs of wires shown on the left part of the figure control the thermostat signals.

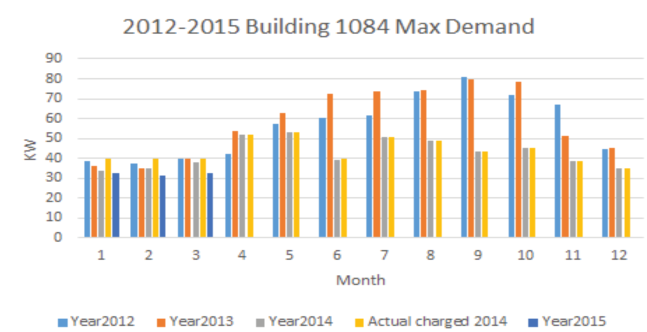
The hardware part of the control system contains four components: (1)The first component is the brain of the control system that is responsible for transmitting data and automatically making control decisions; (2) The second component is the cluster of smart relays that turn on and off the HVAC thermostats; (3) The third component is the power monitor that measures real time power usage information; and (4) The forth component is the power supply for controller component.

Reduce Peak Demand by CE-CERT Controller



A sample result is shown in this figure where the control setting reduced total HVAC power demand from 26 kW to18 kW over a two and one-half hours.

Peak Demand Reduction



Compared to years 2012 and 2013, for every month of the year, peak demand is lower in 2014 and 2015 due to the controller actions. For the month of January through March 2014, the reduction was so steep that the utility company had to charge a higher minimum demand charge(shown in yellow) which was higher than the actual peak demand.

Conclusion

In this project, UCR CE-CERT students designed and implemented a controller for peak electrical demand reduction for a research/industrial building. Commercially available hardware and software were used to control 16 roof mounted HVAC system. The peak demand reduction was documented and reflected in the local utility's monthly bill. The technology developed and demonstrated here is also applicable in larger electrical energy using systems like water districts, pipelines, etc. This can potentially have a significant impact on electrical efficiency improvement throughout the state of California and beyond.