

Wireless pneumatic thermostats help UCSD reach sustainability goals by reducing greenhouse gas emissions by 538 tons/year



CASE STUDY SNAPSHOT

U.C. San Diego reduced electricity use in McGill-Mandler Hall by 27% and natural gas use by 51% using the Cypress Wireless Pneumatic Thermostat (WPT) to better control their HVAC system.

Building use: Multi-story building with a mixture of research labs, offices and classrooms

Building size: 125,000 square feet

Project area: 112,500 square feet

MBCx contractor: Eaton Energy Solutions

Annual energy savings: 538,900 kWh & 57,000 therms

Project cost (after rebate): \$14,600

Simple payback: 0.2 years

Benefits:

- Estimated annual utility bill savings of \$94,900
- Greenhouse gas emission reduction of 538 metric tons of CO₂e annually
- WPTs can be controlled and monitored remotely via the existing Johnson Controls Metasys building automation system (BAS)

The University of California at San Diego (UCSD) takes pride in practicing what it teaches – particularly when it comes to sustainability – and has a track record that leaves little doubt about its commitment. UCSD received the highest sustainability rating given to U.S. college and university campuses by the Sustainable Endowments Institute and is on target to surpass the University of California system's goals to reduce greenhouse gas emissions to 2000 levels by 2014, and further reduce them to 1990 levels by 2020.

One strategy the University uses to meet sustainability goals is to incorporate energy efficiency into every new building and renovation project, thus lowering operating costs, reducing environmental impact and saving money. UCSD installed wireless pneumatic thermostats (WPTs) in McGill-Mandler Hall to allow for centralized control of temperature set points through the existing building automation system (BAS). This project will reduce electricity use in the building by an estimated 27% annually and reduce natural gas use by approximately 51% annually.

Facility Profile: McGill-Mandler Hall

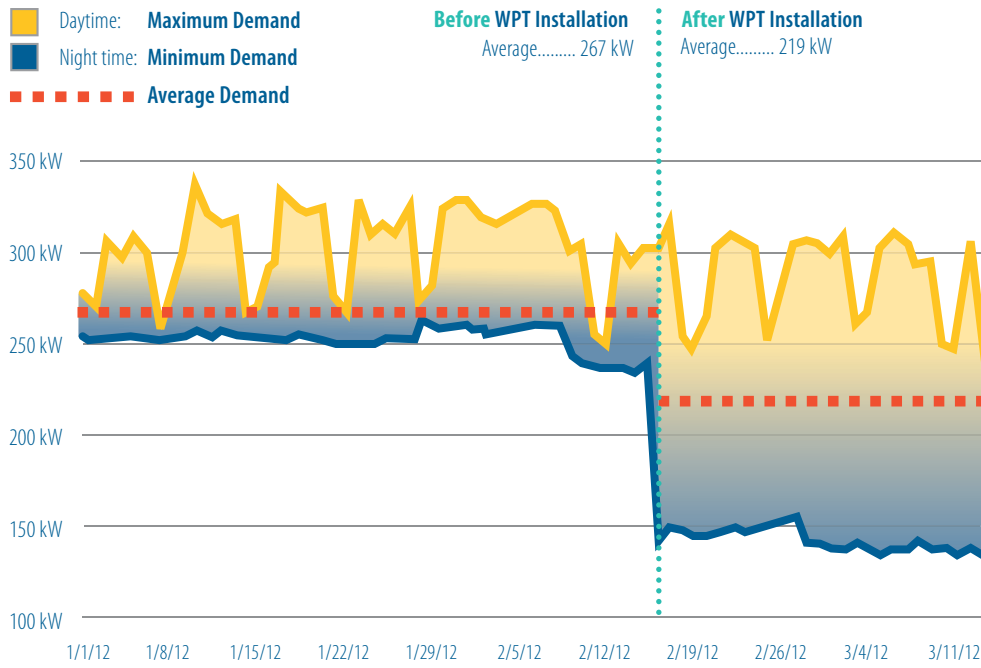
McGill-Mandler Hall is a concrete building with two multistory towers and a shared basement. The building, home to the UCSD Department of Psychology, is used mainly for research and includes lab, vivarium, classroom and office spaces. McGill-Mandler Hall is open seven days a week and is typically occupied from 8 am to 6 pm, with frequent after-hours occupants in the research areas.

Six air handlers meet the building's ventilation needs. Chilled water and high temperature hot water from the UCSD campus plant provide cooling and heating. The building HVAC control system is an electric/pneumatic hybrid.



Case Study | UCSD McGill-Mandler Hall

McGill-Mandler Hall Building Electric Demand Before and after WPT installation



In early 2011, as part of a monitoring based commissioning (MBCx) program, Eaton Energy Solutions provided a thorough evaluation of McGill-Mandler Hall's HVAC system to identify opportunities to maximize operating efficiency and meet the needs of building occupants. Engineers identified a number of HVAC inefficiencies including the following:

- the majority of pneumatic thermostats were out of calibration;
- occupants and facility staff were manually controlling pneumatic thermostats and zone temperatures;
- air handler fans were operating 24/7;
- supply air temperature set points were constant throughout the year; and
- some of the air handler outside air economizers were not functioning properly.

Cypress EnviroSystems' WPTs offered a number of features that addressed these inefficiencies.

Wireless HVAC Retrofit

Traditionally, manual pneumatic systems are replaced with new wired direct digital control (DDC) systems. However, WPTs can provide most of the energy benefits of a traditional DDC installation at a fraction of the cost and with minimal occupant and wiring disruption. WPTs utilize a building's existing pneumatic system, replicating the functions provided by traditional pneumatic thermostats, while providing the added benefits of communicating zone-specific temperature and HVAC system information to a central control hub. The key benefit of WPTs over the existing system in McGill-Mandler Hall is that the WPTs allow both

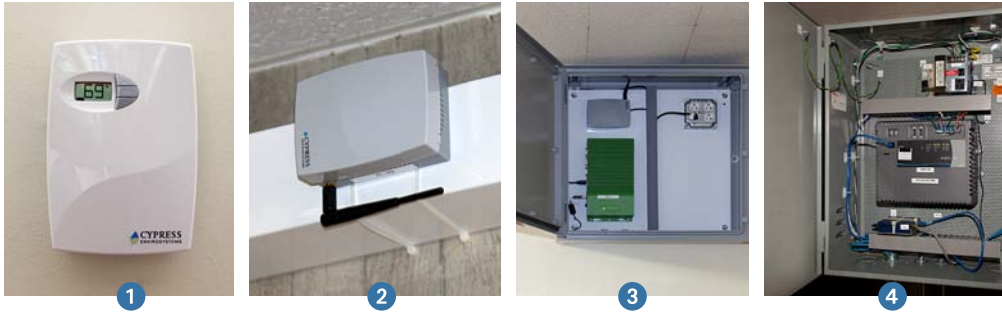
manual occupant control and centralized control of temperature set points. Facility managers can remotely monitor thermostat settings and zone temperatures, make changes, establish automated schedules, and diagnose problems through the centralized BAS.

The installation of the WPTs and components took about one month, and commissioning and programming took an additional month. The 250 existing pneumatic thermostats were removed and replaced one-for-one with WPTs, which were connected to the existing pneumatic piping, calibrated, and programmed. Wireless repeaters were installed at intervals throughout the building to support the transfer of the wireless signals from the WPTs to a Cypress EnviroSystems Green Box Controller. Three Green Box Controllers were installed and tied-in to the Johnson Controls' BAS via a LAN line.

WPTs were installed throughout the building to control the spaces served by five of the building's six air handlers. The sixth air handler serves the McGill Hall basement, where the pneumatic system was previously retrofitted with a DDC system that is also controlled by the BAS and was not retrofitted during this project.

To complement utilization of the new WPTs and address other problems identified in the MBCx process, a number of other supporting upgrades were included in the project: (1) installing new variable frequency drives (VFDs) on the air handler fans; (2) programming the Johnson Controls BAS to communicate with the new WPTs; (3) installing and calibrating three new outside air economizer dampers;





Components of the wireless HVAC system

- 1) Cypress EnviroSystems Deadband WPTs replaced existing traditional pneumatic thermostats one-for-one throughout the building.
- 2) Cypress EnviroSystems Repeater picks up the signals from the surrounding WPTs and directs them to the Green Box Controller.
- 3) Cypress EnviroSystems Green Box Controller communicates with the building's Johnson Controls Metasys BAS.
- 4) Johnson Controls Metasys System controller box. The Cypress system has been integrated with the building's pre-existing Johnson Controls BAS and allows the BAS to log data and control the WPT system.

and (4) programming the supply air temperature set point resets, occupied and unoccupied space temperature set points, and schedules for the spaces served by the WPTs. As a partner with Cypress EnviroSystems, Eaton Energy Solutions provided and installed the WPTs and components and performed the air handler upgrades with assistance from UCSD facility staff.

Project Costs and Savings

Estimated annual energy savings from the project are anticipated to be 538,900 kWh and 57,000 therms. This represents an annual reduction in total building electricity use of 27%, natural gas use of 51%, and energy cost savings of about \$94,900. The majority of the project energy savings come from the reduced demand for heating and cooling, as well as reduced run hours for the air handler fans.

The total project cost was approximately \$295,700 before rebates were applied and \$14,600 after rebates. The Energy Technology Assistance Program rebates covered 32% of the project cost, and the UC/CSU/IOU Energy Efficiency Partnership Program (administered by SDG&E) is expected to cover 63% of the total project cost. The project's simple payback is 0.2 years. Without rebates, the simple payback would have been 3.1 years. The balance of the project cost will be covered by a low-interest revenue bond that will be repaid with energy savings. In addition to energy savings, the facility is likely to realize maintenance cost savings by being better able to identify and correct operational problems.

Demand Response

In addition to energy savings, the University anticipates using the WPT system to

PROJECT DATA

PROJECT SUMMARY

Site: McGill-Mandler Hall
Location: UC San Diego
Project area: 112,500 square feet
Built: 1970

ENERGY INFORMATION

Annual electricity use before retrofit: 2,561,500 kWh
Annual natural gas use before retrofit: 112,000 therms
Annual electricity savings: 538,900 kWh
Annual natural gas savings: 57,000 therms

PROJECT ECONOMICS

Annual utility cost savings: \$94,900
Total project cost: \$295,700

Utility & CEC incentives:

- SDG&E UC Partnership Program Rebate (expected) - \$186,300
- Energy Technology Assistance Program Rebate - \$94,800

Simple payback: 0.2 years (3.1 years without rebates)

EQUIPMENT INSTALLED

Basic project components:

- 250 Cypress EnviroSystems Deadband Wireless Pneumatic Thermostats
- 3 Cypress EnviroSystems Green Box Controllers
- 25 Cypress EnviroSystems "Wall Powered" or "24VAC Powered" Repeaters

implement demand response strategies. Previously, the HVAC heating and cooling setpoints were set by occupants. The new WPT system provides increased capability to monitor and control space temperature setpoints, which will allow implementation of a demand response sequence that conditions every zone as if it were unoccupied during a demand response event. This will cause the zone temperature setpoints to widen from 70 – 74 degrees F (occupied setpoints) to 66 – 78 degrees F in offices and 68 – 76 degrees F in labs (unoccupied setpoints).

Cypress EnviroSystems (www.cypressenvirosystems.com)

Cypress EnviroSystems saves energy and improves productivity in existing plants and buildings, using state-of-the-art non-invasive and wireless technologies to minimize disruption and cost, delivering payback of 18 months or less. Cypress' products include Wireless Pneumatic Thermostats, Wireless Gauge Readers, and Wireless Steam Trap Monitors. Cypress EnviroSystems is a subsidiary of Cypress Semiconductor located in San Jose, CA.



ENERGY SAVING STRATEGIES	BEFORE RETROFIT: Traditional pneumatic thermostats	AFTER RETROFIT: Cypress Envirosystems Wireless Pneumatic Thermostats (WPTs)	OUTCOME
<p>Scheduling and occupancy override</p>	<ul style="list-style-type: none"> No schedule for air handler fans; all running 24/7 because there was no way for users to turn the system on in the case of unexpected occupancy Zone temperature set points same for all hours 	<ul style="list-style-type: none"> Fans managed by schedule to reduce fan operation during evening and night time hours Night time and weekend setback of space temperature set points Occupants can override night time setback by pushing an override button on the WPTs Note: Strategy not used for two AHUs that serve lab/research areas requiring 24/7 ventilation 	<ul style="list-style-type: none"> Fans run fewer hours, reducing fan electricity use Less heating and cooling energy is required during periods of low occupancy
<p>Set point enforcement</p>	<ul style="list-style-type: none"> Thermostats controlled manually by zone occupants or facility staff Majority of thermostats out of calibration 	<ul style="list-style-type: none"> Temperature set points established through BAS and enforced for each zone WPTs have automatic self-calibration, and remote diagnostics allow facility staff to identify issues from BAS 	<ul style="list-style-type: none"> Centralized control of set points reduces unnecessary heating and cooling Issues can be identified and addressed quickly, reducing wasted energy from broken or incorrectly calibrated equipment
<p>Supply air temperature (SAT) reset</p>	<ul style="list-style-type: none"> Constant supply air temperature of either 55 or 60 degrees maintained by all fans 	<ul style="list-style-type: none"> Supply air temperature now programmed in BAS to reset from 55 (or 60) up to 70 degrees F as average zone temperature decreases from 74 to 70 degrees F 	<ul style="list-style-type: none"> Reduces amount of chilled water and natural gas, thus reducing the cooling and re-heating energy that is needed
<p>Deadband control</p>	<ul style="list-style-type: none"> Thermostats did not allow for deadband control 	<ul style="list-style-type: none"> WPTs programmed to allow deadband of 70 degrees heating set point / 74 degrees cooling set point during occupied hours Allows temperature within zone to fluctuate within the deadband setting 	<ul style="list-style-type: none"> Reduces heating and cooling energy because thermostat not trying to achieve precise zone temperature Reduces simultaneous heating and cooling
<p>Economizing</p>	<ul style="list-style-type: none"> Economizing on three air handlers not functioning properly 	<ul style="list-style-type: none"> Outside air dampers repaired, temperature sensors recalibrated 	<ul style="list-style-type: none"> Reduces heating and cooling energy because HVAC system is able to better control use of outside air





“The wireless pneumatic thermostats were very simple to install and continue to provide great benefit. With almost no disruption to building occupants, we were able to significantly improve the heating, ventilation, and air conditioning control of the building, allowing us to save a lot of energy, and making it much easier for our HVAC operators to manage the building.”

Anna Levitt, Assistant Campus Energy Manager

250 manual
pneumatic

thermostats were replaced one-for-one with WPTs. The installation of each WPT took about 30 minutes. Because the WPTs utilize the building's existing pneumatic system, installation is typically quick and easy. The old thermostat is removed, and pneumatic piping is attached to the new thermostat and is calibrated and commissioned. Battery life of each WPT is expected to be approximately five years.

T A K I N G T H E N E X T S T E P

Additional case studies on wireless pneumatic thermostats

- **County of Santa Clara Wireless Thermostat Retrofit – Part A**
<http://www.cypressenvirosystems.com/files/pdf/WirelessThermostatsFinal4%2013%2009%20from%20SCC%20v2.pdf>
- **County of Santa Clara Wireless Thermostat Retrofit – Part B**
http://www.cypressenvirosystems.com/files/pdf/CountyofSantaClara_EnergySavings_Final.pdf
- **St. Joseph's Hospital Video**
<http://www.cypressenvirosystems.com/video/?channel=221516&tags=St.%20Joseph's%20Hospital>
- **The Boston Consulting Group's "Evaluating the carbon-reducing impacts of ICT"**
http://www.bcg.com/expertise_impact/publications/PublicationDetails.aspx?id=tcm:12-59512

Applicable utility incentives

Contact your utility representative for information specific to your utility. Incentives for wireless HVAC controls projects may include:

- Customized incentive programs providing rebates based on documented kWh, kW and therm savings
- Demand response (DR) programs paying incentives based on the amount of kW load a building can shed when called upon to do so
- Automated DR programs providing additional incentives for customers that automate their equipment's response to a requested load shedding event

Financing assistance

- California Energy Commission low interest loans for energy efficiency projects
- Utility on-bill financing
- Financing from energy service companies (ESCOs)



Energy Solutions is an energy efficiency consulting firm working to create large-scale environmental benefits by developing and implementing innovative, market-based approaches to increase sustainability through energy efficiency, water efficiency, and renewable energy initiatives. Energy Solutions developed and implements the Energy Technology Assistance Program (2010-2012). Funding has been provided by the American Recovery and Reinvestment Act of 2009 and is administered by the California Energy Commission.