

Case Study: Opto 22 Energy Management

Faced with skyrocketing energy costs and with no relief in sight, industrial controls and automation company Opto 22 implemented its own technologies to address its energy management concerns.

Over the last several years, the dramatically rising costs of fuel and power in southern California, and across the nation, have made energy management a priority for businesses large and small. Opto 22, the maker of automation, remote monitoring, and data acquisition hardware, in efforts to trim its energy bills in the most cost-effective way, recently deployed its own products in its facilities in order to acquire relevant data and more closely monitor and manage its energy consumption. Here's how they did it:

May 12, 2006

Opto 22 President and CEO Mark Engman sent an email to Facilities Manager Vic Blakemore and others outlining the company's newly defined energy management plan and assigned individual responsibilities for its execution and completion. Opto 22's new energy management initiatives included everything from common sense tactics (like mandating that all employees turn off their computers before they head home) to comprehensive monitoring and control of all air conditioner units, chillers, and other HVAC, lighting, and energy-related equipment.

"For us, energy management has become a serious concern ever since the early part of this decade," says Engman. "In 2005, when oil prices really spiraled out of control, we began monitoring the situation even more closely and investigated ways to curb our energy bills. Then in 2006,

January energy costs went up 12%; February was up 11%; and with June's projection around 22%, we knew we needed to take major steps immediately."

Southern California Edison (SCE), which serves millions of customers in Riverside and ten other counties in the state of California, classifies Opto 22 as "TOU-8"—a large-sized commercial and industrial customer that registers power demands greater than 500 kilowatts. As a result, Opto 22 is subject to peak pricing, meaning that on any given day, if the company exceeds an established threshold, even briefly, it's charged a peak usage rate for the entire day.

May 15, 2006

Opto 22 Project Engineer Kelly Downey and R&D Engineer Tommy Leung began studying the company's lighting system, which is broken down into various zones. Initially, Downey focuses on how efficient the lighting was for each zone and the best ways to perhaps break these zones down into even smaller groups.



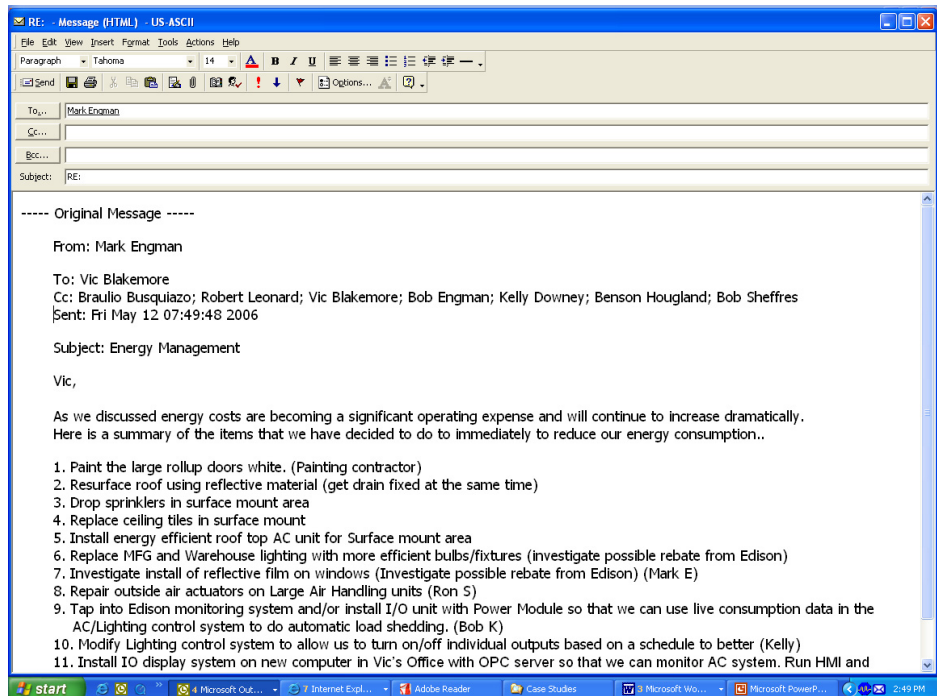
Opto 22's headquarters in Temecula, California

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For example, Downey studied which lights/zones were on at each time of the day, and if they in fact needed to be on during those particular times. Downey also hypothesized on how grouping the lights into smaller units could potentially cut back on their usage.

Since its move from Huntington Beach to Temecula in 1991, Opto 22 had been using an automated light system from Colorado-based Light Touch. Sometime around 2000, much of the lighting control was switched over to Opto 22's then flagship product, SNAP Ethernet I/O, in part, to provide proof of concept for the new hardware. In efforts to gain a better understanding of how the installed hardware was programmed and the precise control functions it was performing, Downey and Leung pored over numerous FactoryFloor control strategies (used to program the SNAP Ethernet systems) for the lighting systems and also at the various OptoDisplay screens serving as human-machine interfaces to these systems.

While this was taking place, Blakemore entered into discussions with SCE representatives to better understand the incentives and rebates Opto 22 might qualify for. Blakemore learned that SCE, in efforts to decrease demand on peak days, was offering energy curtailment incentives to its customers. One of these, aimed at manufacturers and large businesses, is earned by shutting down operations completely one day a week. This wasn't really an option for Opto 22, which ships several hundred thousand products a month, many of which customers need next day. However, one positive that did come out of early conversations with SCE was Opto 22 gaining access to www.sceenergymanager.com, a website designed to help SCE customers view, understand, and reduce their energy usage. By entering a login and password, customers can see exactly how much power they've used over any given time period up to thirty days. Blakemore, Engman, and the rest of Opto 22's energy management project team studied the company's energy usage statistics and made many startling discoveries, including the fact that the company was routinely exceeding 800KWH per day, with resulting peak pricing charges amounting to around \$30,000 a month for electricity alone.



Email from Opto 22 CEO Mark Engman outlining the company's energy management plan.

May 26, 2006

The project team began experimenting with 1/3 lighting, shutting off many of the overhead fluorescents and utilizing more sunlight.

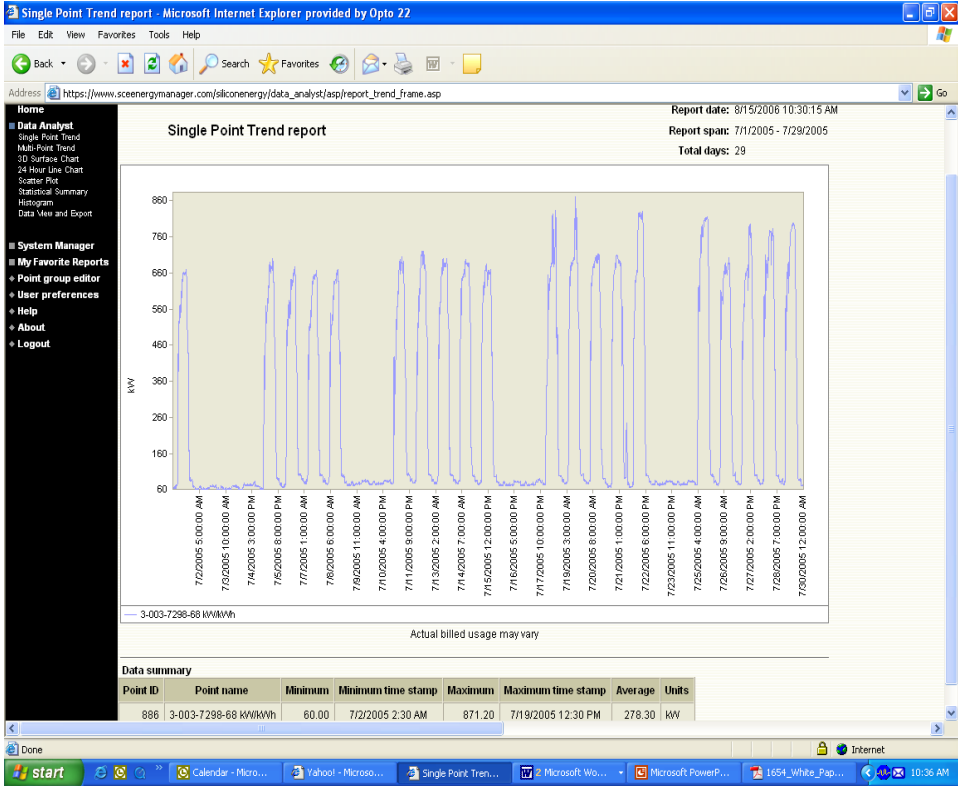
On the technical side, the project team began upgrading the HVAC controls by replacing all the serial-based *mistic* controllers with the newer, more powerful Ethernet-based Opto 22 SNAP PAC-S1 programmable automation controllers.

The outgoing *mistic* controllers consisted mainly of G4RA and G4RD brain boards used to communicate with a combination of digital I/O modules—for on/off and toggling control functions—and analog I/O modules—for regulating devices that have a range of possible states or values.

"All of these *mistic* controllers—the G4RDs, G4RAs and a few G4LC32 controllers—were still working properly but upgrading to the SNAP PACs made more sense due to their superior performance," says Downey. "Ethernet connectivity makes it easier to share the data across the company. And upgrading to Ethernet also gave us the option of adding OptoTerminal touchscreens to our architecture, which we knew we might need to do to provide an easier way to manually operate HVAC controls that are up in the ceiling."

The changeover from the serial-based *mistic* platform to the SNAP PACs was made much easier thanks to the ioProject Professional software suite, which includes an import utility that lets users convert their *mistic*-based OptoControl strategies and OptoDisplay HMI screens for use with Ethernet systems.

After the conversion to ioProject, Downey and Leung began experimenting with energy load changes and the other effects caused by on/off's of the lighting and HVAC systems in each area of the Opto facilities. Using ioDisplay (ioProject's HMI development application) to view and aggregate the data, the project team entered into a discovery phase that preceded several equipment adjustments and replacements, and changes to control strategies.



An SCE custom Energy Management Portal shows Opto 22 power consumption for the first four weeks of July 2005—before the company undertook its comprehensive energy management project. Notice that excluding weekends, the daily KWH regularly exceed the 750 mark and even reach as high as 871.

June 2, 2006

Downey sent out an email to all Opto 22 employees asking that they turn off their computers, monitors, desk fans, desk lights, and testing equipment each night before going home.

June 5, 2006

Through a combination of SNAP PAC/ioDisplay-enabled remote monitoring (combined with a little physical inspection) the project team was able to assemble a complete list of failed or malfunctioning HVAC devices, components and equipment. This included fans that wouldn't turn on, others that would stay on all the time, broken fan belts, failed fan coils, and burned-out motors. (Interestingly, with the exception of a few solid state relays, installed in 1991, nearly all of the Opto 22 hardware remained online and working properly.)

One recurring problem Downey and Leung encountered involved HVAC valves in the ceiling that were not opening up to deliver the cold water/glycol mixture for the air conditioning. The team immediately recognized this as an opportunity for significant energy savings. The rationale was that if the valves could be made to work properly, the cooling process could take place more quickly and the fans would not have to stay on as long before the temperature set point was met, thus saving energy.

Opto 22 Hardware Engineer Lloyd Romeo joined the project team specifically focused on accessing ceilings (in both the corporate and manufacturing halves of the Opto 22 facilities) and repairing and adjusting the hardware located there. Replacing some blown servo motors, used to open and close the valves, ensured that the water/glycol mixture got through, but Downey and Leung went a step further by creating new strategies that redefined the precise way these valves were controlled.

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Previously, the mistic hardware (specifically, the G4LC32s and G4RAs) used PID loops to continually adjust valve positions, thereby changing the amount of water flow. Unfortunately, this PID control was very imprecise due to the fact that setpoints were based on temperature readings taken from return air ducts. To correct this problem, Leung removed the temperature sensors in the return air ducts and instead, hung them from the ceilings. This resulted in much more accurate room temperature readings and allowed for a new, much simpler control strategy (created in ioProject for the newly installed SNAP PAC S) that opened and closed the valves fully.

"Not only was this new methodology less complicated, it cooled more efficiently, and decreased wear and tear on the valves," says Leung.

The new HVAC control strategy also addressed the operation of thirty small fans used to cool the corporate side of the building. Previously, many of these fans were operating all day long in efforts to maximize cooling. But after they swapped out the control hardware, mapped out the building's many different zones, and made their repairs and other improvements, the project team was able to create new energy-conscious control strategies with provisions that turn these fans turn on and off only enough to cool each area down to its predefined setpoint. Essentially, each area of the building is assigned an optimal temperature level; and the new ioControl strategy dictates that the fans responsible

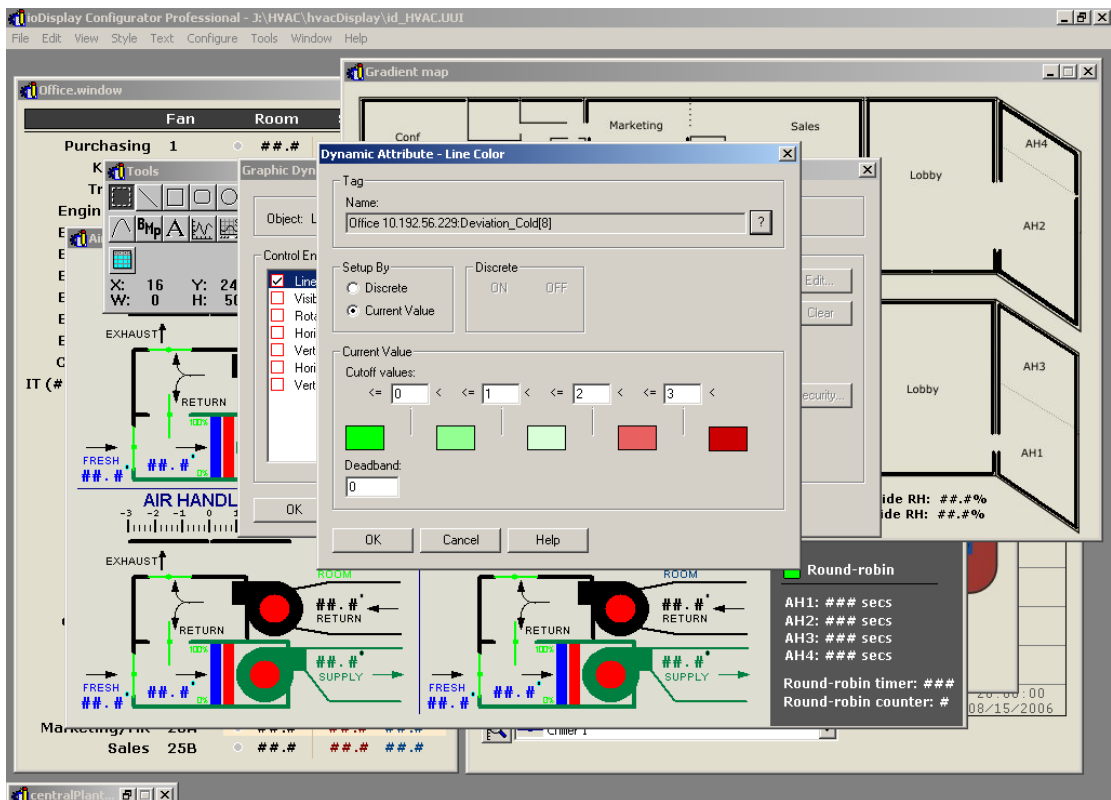
for cooling each area to turn on and off throughout the course of the day to keep the actual temperature within two degrees of the setpoint. Now, the fans turn on and off as needed instead of running 10 hours a day, which helps the company avoid SCE's costly peak pricing.

On the manufacturing side of the Opto 22 facility, four air handlers—very large HVAC units containing a blower, filters, dampers, and other components—handle the cooling. Like the fans on the corporate side, these air handlers had been running constantly and were one of the major reasons Opto 22's energy bill was so excessive. The new ioControl strategies addressed this problem by dictating that only one large air handler and one small air handler can operate at any given time.

Augmenting this, and reducing energy consumption even further, was a new "Round Robin Strategy," created to run each of the four air handlers in succession, but each for only a very short duration of time.



The SNAP-PAC S



An ioDisplay screen shows a gradient map with deviations in temperature set points and actual temperatures indicated by various colors.

To complement the new strategies, sophisticated ioDisplay HMI screens were created showing the layout of Opto 22 corporate offices and manufacturing facilities, all of the different areas within each of these two halves of the building, these areas' respective temperature set points, and their actual temperatures. A color-coded gradient map was designed to indicate how closely the actual temperature in an area matches the predefined setpoint. Specifically, three different shades of green indicate temperatures at exact setpoint or one or two degrees off, while deviations of 3 degrees or more are designated by different shades of red. Another ioDisplay screen offers a graphical representation of how individual HVAC equipment (air handlers, chillers, etc.) is functioning. Blakmore uses all of these new screens to obtain at-a-glance information on HVAC operation and he and his staff can now investigate firsthand whenever and wherever they spot problems. As Blakmore explains, "ioDisplay gives us an easy way to identify trouble spots and confirm when and how hard the HVAC equipment is working. Plus we use it to receive, view, and acknowledge visual alarms we get whenever temps drift more than a few degrees from our setpoints."

With regard to lighting, the project team again used ioDisplay to identify a number of lights on in unused areas and others that remained on long after everyone in the company had gone home for the day. A few simple adjustments to on/off setpoints within the ioControl strategies corrected this longstanding problem. Similarly, after examining the Opto 22 sprinkler system, also now automated and controlled by the SNAP PACs, the project team adjusted on/off times to make sure the company's many acres of lawn, trees, flowerbeds, and bushes were watered at the optimal time—in this case, late afternoon, after the intense Temecula heat had decreased a bit.

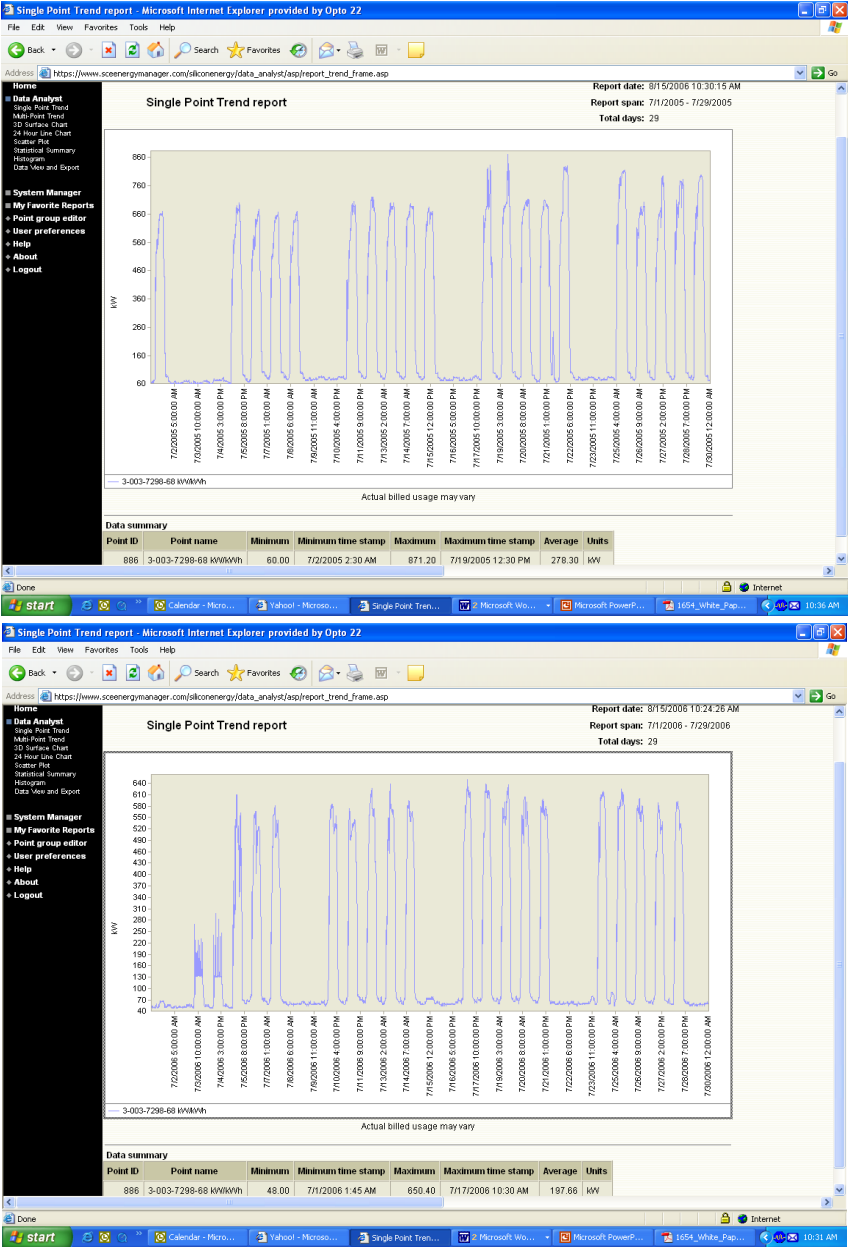
June 6 — June 30, 2006

Attention shifted to the HVAC dampers, adjustable vents used for controlling airflow and draft. These dampers can either be set to open, allowing in outside air, or closed, to allow the inside air to recirculate.

According to Leung, the Cyrano control strategy (originally designed for the *mistic*

system) used for this procedure wasn't appropriate for use during the summer months, when temperatures in Temecula are often deceptively cool in the AM, but then rapidly rise into the nineties by noon.

"We now use ICTD probes connected to analog input modules on our I/O rack to take periodic outdoor temperature readings every morning. If the temperature is below a certain threshold, the SNAP PAC executes a "pre-cool" strategy and opens the dampers completely, flushing out the old stale air in the building and giving us a running start on cooling the facility."



Opto 22's July 2006 energy consumption compared with figures from exactly one year prior show average daily KWH dropping from 278.30 to 197.66 for a 29% reduction.

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Leung explains that once the PAC receives an outside temperature reading above 70 degrees, the SNAP PAC closes the dampers completely.

“This part of the strategy stretches our energy dollar by helping us avoid the counter-productive practice of sucking in warm air and blowing it through the building. This way, the chillers don’t have to work as hard to remove the heat from the building in the morning. It saves quite a bit of energy.”

July 11, 2006

Opto 22’s energy management project enters its final phases as contractors arrive to tint all of the company’s sun-facing windows. This includes the floor-to-ceiling windows in the engineering area, which catch the intense afternoon sun.

July 29, 2006

Blakemore and the rest of the project team, along with Engman, declare Opto 22’s energy management efforts a success, as SCE’s Energy Manager website reveals Opto 22’s daily KWH hours for the first four weeks of July (excluding weekends) measured between 575 and 650KWH. For the same period in 2005, these figures ranged between 660 and 871 KWH. The overall average for July was 197.66, down from 278.30 in 2005. August 2006 saw an even greater reduction. Weekday readings dropped even lower—ranging between 525 and 588KWH—and the overall monthly average was 192.13.

“The bottomline is, all of this reduced energy consumption equals money saved,” Engman says. “In spite of almost monthly double-digit price increases this year, cost-wise, we’ve been able to keep our overall bill at approximately the same level.”

About Opto 22

Opto 22 develops and manufactures hardware and software products for applications in industrial automation, remote monitoring, and data acquisition. Using standard, commercially available Internet, networking, and computer technologies, Opto 22’s input/output and control systems allow customers to monitor, control, and acquire data from all of the mechanical, electrical, and electronic assets that are key to their business operations. Opto 22’s products and services support automation end users, OEMs, and information technology and operations personnel. Founded in 1974 and with over 85 million Opto 22-connected devices deployed worldwide, the company has an established reputation for innovation, quality, and reliability.

Opto 22 products are sold through a worldwide network of distributors, partners, and system integrators. For more information, contact Opto 22 headquarters at 800-321-6786 (951-695-3000) or visit the website at www.opto22.com.