California Says "Go" to Energy-Saving Traffic Lights

Traffic lights made from LEDs, or light-emitting diodes, are much more energy efficient than the old-fashioned incandescent lamps they usually replace. They're also more costly to purchase, so they're perfect for funding assistance from state energy offices.

Rolling blackouts hit California beginning in January 2001. As homeowners purchased thousands of compact florescent bulbs and shifted their electricity use away from peak hours, businesses felt the impact too. Millions of dollars in lost productivity were attributed to the disruption of electric service.

When the steady flow of power was restored, the blame was placed at the feet of power generators who legally manipulated supplies and prices in the newly restructured electricity market. One positive consequence was California's Peak Load Reduction Program (PLRP), made possible by three state legislative bills passed in 2000 and 2001. Californians consider it a direct response to the energy shortages during those years.

The PLRP was multidimensional. It affected homes, businesses, municipalities, utilities, hospitals, schools, and farms. It aimed to reduce energy consumption throughout the state, particularly during peak periods. It provided low-interest loans and other incentives for energy-efficient equipment, real-time electric meters for commercial customers, sunlight-reflective roofing materials, energy consumption monitoring plans, low-interest loans, and many more demand-reducing measures. Many such measures were managed in the offices of the California Energy Commission.

LED traffic lights constitute one of the great success stories that resulted from the PLRP. LEDs, or light-emitting diodes, are used in familiar applications such as cell phone readouts, flat-panel computer monitors, and reading lamps on airplanes. They are also common in larger outdoor installations, including roadway message boards, railroad signals, and traffic lights. Some public agencies are starting to use LEDs in highway exit signs because of their longevity and low maintenance costs.

Credit: City of Redlands

A worker installs a red LED traffic lamp at an intersection in Redlands, California.

Traffic control is one of the best possible uses of LED lights. They produce light only of the desired colors, such as red, amber, and green. With no need to filter the light through a lens, true colors are produced more efficiently, with less energy wasted on heat. LED lights consume roughly 10% of the power consumed by incandescent lamps. Their energy use is 8–25 Watts, depending on size and color, compared to a range of roughly 67–150 Watts for incandescent lamps. LED lights also look brighter.

Equally important is their longevity. When stoplights burn out, replacing them is inconvenient at best, and the loss of traffic control can be dangerous. LED traffic lights can last as long as ten years, compared to roughly two years for their conventional counterparts. Those advantages make LEDs well suited for other hard-to-access applications, including highway signs and water buoys.

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LED lamps burn out gradually, as their pixels expire individually.

Battery Backup

A related safety benefit is the adaptability of LED traffic lights to battery backup systems. Because the lights use so little electricity, they can be equipped with batteries to keep them going for two hours or more in the event of a power outage. Yellow LED lights are also deployed as emergency flashers by highway work crews.

When LED lights go out, they go gradually. As a signal ages, it loses brightness. As different colors degrade at different rates, the maintenance crew can measure their brightness and plan a coordinated strategy to replace units as needed, rather than rushing to replace them all.

In California, electricity consumption is greatest on hot summer afternoons. The "peak load" occurs between 2:00 p.m. and 6:00 p.m. on weekdays from June through September. Traffic lights are part of the problem. The state has an estimated 40,000 intersections with 1.8 million traffic lamps. (That's counting all red, amber, and green lamps, as well as the walk and don't walk signs, the "walking person" and "hand" symbols, and directional arrows.) By early 2004, about half the lamps in California had been replaced with the LED type, the state estimates. The resulting energy saving—approximately 60 megawatts—is enough to power nearly 60,000 homes.

Among many other responsibilities, the Energy Commission administers the State Energy Program (SEP). "SEP activities are a relatively small part of it all," says Virginia Lew, manager of the commission's efforts to support LED traffic lights. She estimates that direct federal funding now represents perhaps 5% of the commission's funding for energy conservation projects such as LED traffic signals. A greater part of energy conservation funding comes from the federal Petroleum Violation Escrow Account than from SEP, Lew said. "Still, federal money, including SEP funds, has been an important contributor to many forms of energy conservation in California, including LED traffic lights."

No other state has been as aggressive as California in encouraging LED traffic lights. But the technology has penetrated about 30% of the traffic light market nationwide, according to a DOE study completed in November 2003 by Navigant Consulting. LED lights have been installed on a broad scale in many large cities, including New York City, which completed a $28.2 million replacement project in 2004. LED lights are common in new intersections throughout the United States and in cities in Europe, Japan, and Taiwan.

Their use in California received a big boost from the PLRP, but LED traffic lights predate that program by several years. The first state loan for LEDs was to the City of Hanford in 1994. Initially, the state had a low-interest loan program, which was followed by $11 million in grant funding made available by the PLRP. The state's grant money has run out, but loans are still available. Other incentives were offered in the past by Pacific Gas & Electric, Southern California Edison, San Diego Gas & Electric, and the Sacramento Municipal Utility District.

The California Energy Commission now lists approximately 87 cities, counties, and public agencies that have secured state or federal grants or loans to pay for installing LED traffic signals. Project costs for municipalities have ranged from $3,000 in the exclusive residential town of Woodside, on the San Francisco Peninsula, to more than $2.6 million in San Diego. The state's Department of Transportation (Caltrans) has spent more than $20 million for LED traffic lights, of which $2.6 million came from a state grant.

The high cost of LED traffic lights hindered even greater market penetration in the past, Lew says. The price of a typical red 12-inch LED lamp is about $60—roughly 20 times that of a comparable incandescent. LED lamps once cost $200–$300. Costs related to installation are low, particularly when the change is done as part of a scheduled service routine.

Efficiency Offsets the Expense

The higher cost of LED lamps is well justified by their energy efficiency, greater longevity, reduced maintenance costs, and safety benefits. Even so, without funding assistance, many municipalities could not afford them. To qualify for funding under the state's current loan program, a project must promise "simple" payback (loan amount divided by annual dollar savings) within 10 years. With their greater energy efficiency and reduced maintenance demands, LED lights qualify easily. The loans are usually repaid from the energy savings alone.

"Public funding has made LED lights more affordable, not only in the obvious way, by subsidizing the purchase," says Lew. Because of the greater demand, more manufacturers emerged. Prices decreased as the market became more competitive. Caltrans lists approximately 10 pre-qualified suppliers of LED traffic lights that meet California specifications (see link under "Resources").

When a California city or county applies for state funding for LED traffic lights, the application requires an estimate of the expected energy savings. Doing the math is pretty simple. Multiply the number of existing, incandescent lamps by their wattage, and compare the product to the expected result of replacing them with lower wattage LED lamps. The energy savings are also easy to verify, because traffic intersections typically have their own electric meters. Each meter generates a separate "bill" for that intersection.

The state contracts with Nexant, an engineering consulting company, to study the effectiveness of California's many peak-load energy-reducing efforts. In a report completed in June 2003, the firm evaluated whether LED lights had lived up to their billing as energy savers. It considered 55 LED projects, most of which were in cities where multiple traffic signals were converted. The average success rate in meeting their cost savings expectations was 94%.

Situated 30 miles from Fresno in central California, the City of Hanford was the first municipality to use the state's low-interest loans for LED traffic lights. In 1994, it borrowed $60,500 to outfit 20 intersections with new red lights and pedestrian signals. Their durability has been impressive, says public works director Gary Meisenheimer. A decade later, the city is beginning to see the need for replacement. Eight years of lower energy bills recouped the full loan amount, he says. Two years ago, the city purchased green LED lights for 28 intersections. "We liked them so much, we spent our own money on them," he says.

Credit: City of Redlands

LED lamps are used in all kinds of traffic lights including "walk" and "don't walk" signals.

In the City of Pasadena, principal engineer Jim Valentine admits that that if a municipality fails to plan properly, LED lamp replacement costs could be surprising. "At least some of the money we're saving on energy should be set aside for new modules," he said. Pasadena secured a state a loan of $76,024 and at the same time obtained a grant for the same amount. The funds paid for 762 green LED lamps, of which 8 to 12 were installed per intersection. "At first, a few people said that they were too bright, especially at night," said Valentine. The complaints quickly subsided. "I don't know if the lights got dimmer, or people just got used to them," he says. Pasadena is saving approximately $40,000 per year in electricity costs.

Santa Barbara has converted all its traffic lamps to LEDs. The city saves 70%–80% on related electricity costs, says facility manager Michael Grimes. More important is that different color lamps degrade at different rates, which allows the city to spread replacement costs over several years.

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The June 2003 report from Nexant compared the technology to other energy saving elements of the state's PLRP. LED traffic signals provide "one of the most sustainable solutions to the energy crisis," the report said. "Participants expect to continue using LED traffic signal modules, and perhaps other technologies as well. This sustainability factor, combined with the educational and psychological impacts made in urban planning, should be equally considered when evaluating the success of LEDs, especially in comparison to some of the shorter term peak load demand solutions."

For more information, contact:

John P. Butler
Staff Services Manager
California Energy Commission
Grants & Loan Office
1516 9th Street, MS-1
Sacramento, CA 95814
916-654-4204
jbutler@energy.state.ca.us
www.energy.ca.gov

EERE Information Center
877-EERE-INF (877-337-3463)
www.eere.energy.gov

Produced for the
U.S. Department of Energy (DOE)
Energy Efficiency and Renewable Energy

U.S. Department of Energy
Energy Efficiency and Renewable Energy

1000 Independence Avenue, SW
Washington, DC 20585

By the National Renewable Energy Laboratory,
a DOE National Laboratory

DOE/GO-102004-1916
May 2004

Printed with a renewable source ink on paper containing at least 50% wastepaper, including 10% postconsumer waste.

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