

California Institute of Technology

Caltech Energy Conservation Investment Program

Rebecca Caine

Senior Research Fellow

Sustainable Endowments Institute



Summary

Location: Pasadena, California

Full-time student enrollment: 2,175

Combined gross square footage of all buildings on campus: 3,907,208

Endowment: \$1,527,000,000
as of March 31, 2010

Type: Private

This case study was supported by generous contributions from: David Rockefeller Fund, HOK, John Merck Fund, Merck Family Fund, Roy A. Hunt Foundation, U.S. EPA Green Power Partnership and Wallace Global Fund.

The Caltech Energy Conservation Investment Program (CECIP) was initiated in 2009. It manages \$8 million within an existing fund in the school's endowment, which had been created to finance capital projects. Any member of the Caltech community may submit a project proposal, and projects are considered for approval as long as they have at least a 15 percent return on investment or a simple payback period of less than six years. Building energy use is carefully tracked, both before and after projects are implemented, allowing for determination of the precise cost savings resulting from CECIP. Savings accrue to the fund until the loan has been repaid, and then are directed toward the general operating budget. CECIP has financed 13 large-scale building projects, ranging from lighting replacements to complete mechanical and control system retrofits. As of August 2010, these projects have reduced the school's energy bills by \$1.5 million. They have achieved an average return on investment of 33 percent and an average payback period of three years.

History

Impetus for the Fund

Caltech, committed to sustainability in its operations, academics, and research, has developed a number of aggressive energy and carbon reduction goals, including the retro-commissioning of all major campus buildings by 2015.¹ To assist with funding this resolution, Caltech created CECIP, a green revolving fund to finance energy-efficiency projects.

The idea for CECIP was inspired by green revolving funds at Harvard University and other schools. CECIP was created to solve a specific problem with Caltech's funding structure for efficiency projects: Since the capital budget and the operational budget were separate, the savings from expensive energy-efficiency projects were often funneled into a different account than the one used to finance the projects. This made it difficult to afford projects that did not directly return their initial investment.

There were few barriers to initiating the fund, primarily because the Caltech president and director of facilities were both very supportive of sustainability efforts. Furthermore, Caltech

is engaged in extensive research and education on environmental issues, and thus it made sense for the school to be as sustainable as possible in its operations, "CECIP supports the mission and the image of Caltech in a positive, proactive way, according to John Onderdonk, manager for sustainability programs. "Sustainability and energy efficiency fit right in with that vision."

Incorporating CECIP into an Existing Endowment Fund

Before initiating the fund, John Onderdonk and Matthew Berbee, Caltech's energy manager, spent a few months talking with Caltech's Office of Financial Services to understand how best to incorporate the fund into the school's financial infrastructure. They were able to fit CECIP within an existing \$25 million endowment fund, the Capital Revolving Fund, which was started in 2002 to finance capital projects. The Capital Revolving Fund provides finances for construction projects during the period that previously pledged gifts are still being collected from donors. The fund is paid back as the donors' pledge money is received.

A portion of the Capital Revolving Fund was set aside for use by CECIP, specifically to finance energy-efficiency projects. Once these projects have been completed, the loan is returned to the revolving fund from the cost savings on the school's utility bill. After the loan has been repaid, the savings stop accruing to the revolving fund, allowing the school to benefit from the lower utility costs while maintaining the revolving fund's viability.

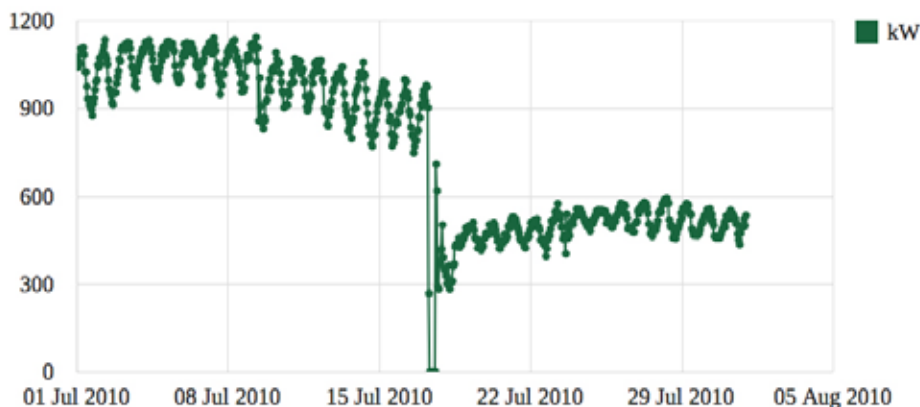
After the loan has been repaid, the savings stop accruing to the revolving fund, allowing the school to benefit from the lower utility costs while maintaining the revolving fund's viability.

The projects funded by CECIP are distinct from routine building upgrades. Before the revolving fund's creation, buildings would be rehabilitated and maintained. However, in the case of CECIP projects, Caltech energy and sustainability staff have more control over the project operations. CECIP projects, therefore, move faster and are more cost-effective, since they are largely coordinated within the school, thus avoiding delays and fees from external contractors. The CECIP program is also differentiated by precise measurement and verifications of savings from efficiency projects, and ultimately, by the success of these projects to produce sustained savings. By training Facilities staff on the design intent of efficiency projects, Caltech has increased the probability for success of its conservation measures.

Gathering Baseline Energy Data

A unique feature of CECIP is that loans are repaid based on actual energy savings, which are carefully tracked as they accrue following the completion of projects. This model was necessitated by the hesitation of members of the Office of Financial

Broad Center HHW Energy, July 2010



The Broad Center for Biological Sciences underwent retro-commissioning and air-handling unit optimization. Modifications were made on July 17 resulting in an immediate reduction of kW usage.

Services' endowment group when CECIP was first proposed. They were unsure that building efficiency projects would best be financed through a revolving fund, rather than by raising money through development requests, as had been the practice. They needed to know that it would be possible to track cost savings that resulted from projects and to return these savings to the fund.

“One of the common questions we heard,” said John Onderdonk, “was how are we going to guarantee that there will be an actual reduction in our utility bill due to the implementation of an energy-efficiency project. We were also asked how are we going to assign a dollar value to that reduction, and how can we guarantee that the savings will go back into the revolving fund for future investment. It was mainly a process of explaining how CECIP staff would track that important data.”²

To establish ways to measure the savings that would accrue following the implementation of energy-efficiency retrofits, meters were installed in all campus buildings before any projects had gotten underway. This allowed for clear baseline information to be gathered, which could be used to compare energy use before and after the retrofits. Onderdonk noted, “That’s really the crux of the entire program—the documentation and verification of savings; the assigning of a dollar value to the savings, so that it revolves back into a return to the endowment.”



First CECIP project. Photo taken during mid-project tests showing the new LED lighting on the second floor of the parking structure compared to the old T8 fluorescents on the third floor.

“That’s really the crux of the entire program—the documentation and verification of savings; the assigning of a dollar value to the savings, so that it revolves back into a return to the endowment.”

The first meters, installed before CECIP was created, were financed by the Facilities infrastructure budget; subsequent meter installation projects have utilized CECIP funds, and their installation is factored into the cost of a project.

Operations

Caltech Energy Conservation Investment Program Overview

Year created: 2009

Size: \$8,000,000

Source of capital: Endowment

Average payback period: 3 years

Administrator: Manager for Sustainability Programs and Energy Manager

Largest project financed:

Retro-commissioning of 8 buildings

Average return on investment: 33%

Total amount of money saved: \$1,500,000

Gathering Project Proposals

All faculty, staff, and students affiliated with Caltech can submit proposals for projects that will utilize the money in CECIP. Town hall meetings are conducted regularly during the academic year to discuss the efficiency projects that are currently underway, and to publicize

CECIP as a potential source of funding for the ideas of individuals or organizations. As of 2010, most of the project proposals have been generated by facilities staff members, especially Onderdonk and Berbee—in Onderdonk’s words, “the ones who are living and breathing [CECIP] on a daily basis.” However, the fund is quickly gaining popularity, and faculty and staff are beginning to propose potential CECIP projects as well. As Berbee said, “Now they understand that this is a viable, efficient and effective way to get a facilities efficiency improvement completed, that potentially would have been difficult to do otherwise ... because of typical funding constraints, or due to insufficient time or resources.”³

Approving Proposals

Before proposals can be approved, they must model the financial returns and the projected savings, taking into account project costs. This feasibility analysis is done either by Caltech employees or by third-party consultants. Caltech staff time is paid for using the departmental budget and is not included in the CECIP payback equation; whereas third-party

consultants often provide no-cost analysis in exchange for securing the project contract.

Though proposals are reviewed and catalogued by members of the Sustainability Council, the final sign-off is done by the vice president of facilities for projects up to \$100,000. For proposals over that amount, additional approval is required from the vice president for business and finance. In order for a project to be accepted, it must:

- Exhibit verifiable savings.
- Contain a plan for the periodic measurement of savings.
- Have at least a 15 percent return on investment or a simple payback period of less than six years.

Projects with a payback period longer than six years may still be approved by the vice president for business and finance.⁴ Projects with an expected one- to two-year payback period are given priority in order to ensure steady returns and maintain the green revolving fund's balance, allowing for longer-term projects to be financed. Once a project has been authorized, funds to cover the total cost of the project are released from the Capital Revolving Fund.

Repaying Loans As Savings Accrue

The costs associated with a project, including the initial costs incurred from installing building energy meters and identifying project opportunities, are repaid as utility savings accrue.

Through the use of energy meters, CECIP is at the forefront of using technology to track real-time utility use. In contrast, many green revolving funds at other schools simply repay loans in installments, similar to a mortgage payment, based on initial projections.

Through the use of energy meters, CECIP is at the forefront of using technology to track real-time utility use.

CECIP is able to use data on actual savings to repay loans because, unlike many other schools, Caltech's energy use does not fluctuate dramatically throughout the year due to changes in building use. At Caltech, research is conducted all hours of the day, every month of the year. Therefore, fund administrators can be confident that when they see a significant drop in energy use on building meters, it is not due to reduced building occupancy, but to a higher degree of energy efficiency.

Some typical energy fluctuation is present on building meters, but CECIP fund administrators use the established baselines to understand and model these fluctuations, and they are taken into account when energy reductions are measured. The models are further refined after projects have been completed and more data on energy use is gathered. Models are calibrated to within three percent of actual usage.

Performance

Pilot Project: Lighting Retrofit

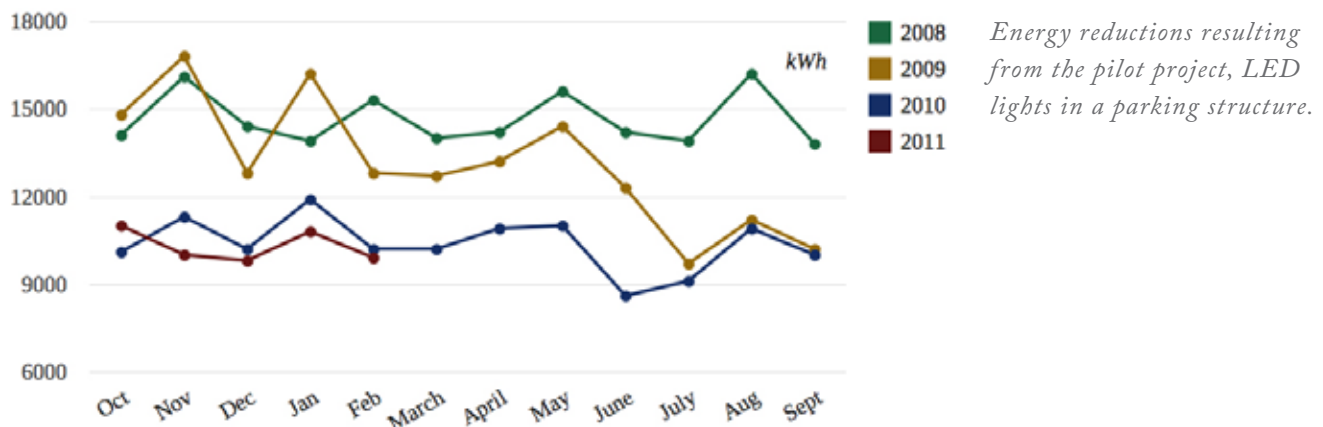
Upon approving the fund, Caltech's administration allocated \$500,000 from the Capital Revolving Fund, to be invested in the fund's pilot project. For this project, initiated in 2009, the lighting in two four-deck parking structures was retrofitted with energy-efficient LED lights. These retrofits cost a total of \$25,000. However, by working with the city of Pasadena's utility company, the project received \$11,000 in municipal rebates for utilizing an emerging technology, so Caltech spent only \$14,000. The new lights saved \$9,000 a year on utility bills, allowing the school's investment to be earned back in a year and a half.⁵

The new lights saved \$9,000 a year on utility bills, allowing the school's investment to be earned back in a year and a half.

The speed with which the loan was repaid "was definitely an eye-opener for the type of potential this program had for the future," according to John Onderdonk.⁶

Undertaking this project provided insight into how the process of administering an effective revolving loan fund would work.

South Wilson Energy Consumption 2008-2011



It also provided clarification for how such a fund would be structured financially, channeling capital from the fund to project investments, which result in utility bill savings that are then returned to the fund to repay the original.

The pilot project provided evidence to the Caltech administration that CECIP should be maintained and expanded. Once the savings from the initial LED lighting retrofit had been proven, Onderdonk and Berbee relayed their findings to the administration and the board of trustees, proposing ways that they could move forward with the green revolving fund and receiving a positive response. Onderdonk recalled that, “in one board of trustees meeting, after we made these presentations, a member of the board said, ‘Well, why can’t we do this faster? Why can’t we do more of these projects?’”

After this presentation, the administration designated an additional \$7.5 million from the Capital Revolving Fund to be used for CECIP loans. The number of energy-efficiency projects on campus grew to the point where the most

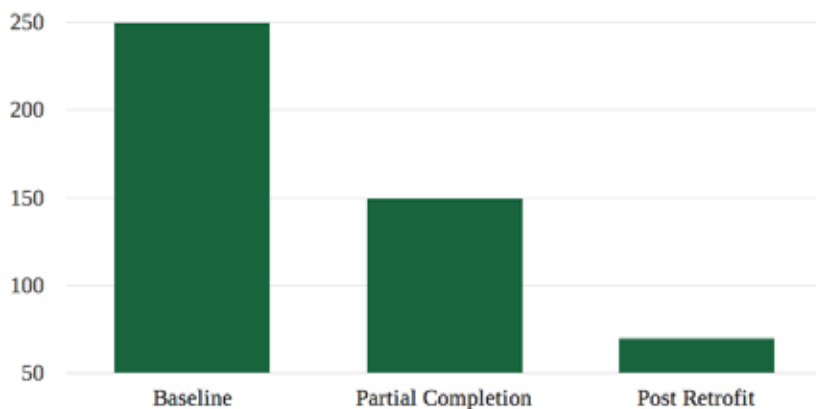
pressing issue with CECIP was a shortage of staff to handle the number of proposals it received.

Continuing Projects

As of 2010, CECIP has provided funding for the following projects:

- Comprehensive multi-building retrofit projects to improve mechanical and lighting systems, including installing energy-efficient lights, building automation controls, and variable-frequency drives for motors, correcting chilled water valves, fixing leaking steam valves, replacing fans, changing coils, and many other strategies to reduce resource use. Two have been completed; six more are underway.
- Low-cost, quick-payback mechanical and lighting upgrades. Seven have been completed; twenty more buildings are being upgraded.
- Simple lighting retrofits. One building has been completed so far; three are in progress.
- Awareness projects including online tools for campus community members to view real-time building energy use.

Data Center Hot/Cold Aisle Retrofit



■ GPM *Retrofits of the data center caused a 180 GPM chilled-water flow reduction with zero impact on operation. Post retrofit savings were only achieved through detailed measurement and verification which demonstrated that partial completion measures had not maximized savings.*

Professional Oversight

Caltech takes advantage of a network of professionals and energy experts to assist in project implementation. Some services, including those from engineering firms, energy-simulation companies, and lighting professionals, were offered for free to customers of Pasadena Water and Power, the local utility. They were essential in identifying potential energy-saving projects, determining the ideal scope for a proposal, and evaluating projects' potential to save money and energy.

To help with more complex building retro-commissioning projects, Caltech also contracts with a professional engineering firm, which it selected by issuing a request for proposals. This firm helps to research and evaluate projects, and it produces portfolios of potential projects that the school could choose to utilize.

Performance Data

Of the 13 projects that had been proposed by 2010, all 13 projects had been funded, and four had been completed.⁷ These projects encompassed 83 distinct energy-saving measures.⁸ Since CECIP is not a standalone fund, it does not carry its own balance or earn interest, and it maintains a consistent level of funding. Currently, half of the allocated \$8 million is funding active projects; the other half is invested within the endowment, but can be quickly accessed if needed. The projects CECIP has financed have reduced Caltech's energy bills by \$1.5 million.⁹

The CECIP projects have an average annualized return on investment of 33 percent, with an average payback period of three years.¹⁰

The CECIP projects have an average annualized return on investment of 33 percent.

All projects completed in 2009 cost \$624,000 after receiving a municipal rebate; they saved \$409,000 per year, and will be paid back in 1.5 years. The projects from 2010 cost \$3,340,000 after the rebate, saved \$929,000 per year, and will be paid back in 3.6 years.¹¹

Savings in utility accounts are returned to the Capital Revolving Fund at the end of every fiscal quarter. Once the initial cost of a project has been repaid, the continued savings on utility bills remain in Caltech's utility budget. Through this model, the fund maintains its \$8 million green revolving fund available for funding projects, while also allowing the school to financially benefit within an average of three years from efficiency improvements. A recent Caltech report outlines projects that have been identified, proposed, funded, and completed as of August 2010.¹²

Lessons Learned

The Future of CECIP

Two years into Caltech's retrofits, there are many opportunities to take advantage of "low-hanging fruit" projects. According to Matthew Berbee, these will be relatively easy to implement, such as installing more efficient motors and repairing building systems. Eventually, more complex projects will be undertaken, including large-scale complete building controls and air-conditioning renovations.

Recommendations for New Funds

For other schools thinking of starting their own revolving funds for energy-efficiency projects, John Onderdonk advises not to "reinvent the wheel." However, it is critical to adapt a fund's structure to its specific context within a school. According to Onderdonk: "Caltech is a unique place; the culture here is very different from other schools that I have researched. It's been helpful to take ... programs and ideas from other schools, but I have to adapt those to function within the specific Caltech culture."

Fortunately, the economics of a green revolving fund are sound, and it is difficult to argue with a model that provides consistently high returns.

Regarding cost savings, John Onderdonk said, "everyone speaks that language, so if you've got that figured out, then fortunately you don't have to do a lot of translation." Matthew Berbee notes that Caltech's green revolving fund is "a very powerful model," which he expects to see other schools adopt once they realize that they are capable.



Sustaining the savings through continuous training of technicians and maintenance personnel.

Endnotes

- 1 “Sustainability Statement – Sustainability at Caltech,” accessed December 8, 2010, <http://sustainability.caltech.edu/suststate>.
- 2 John Onderdonk (Manager for Sustainability Programs at California Institute of Technology). Interview by Rebecca Caine, June 2010.
- 3 Matthew Berbee (Energy Manager at California Institute of Technology). Interview by Rebecca Caine, June 2010.
- 4 Caltech Energy Conservation Investment Program (CECIP). Caltech Sustainability Office, March 20, 2009.
- 5 Onderdonk, John, “Caltech Energy Conservation Investment Program” (presentation, AASHE Conference, Denver, Colorado, October 2010).
- 6 Matthew Berbee in conversation with Rebecca Caine.
- 7 John Onderdonk via email, August 5, 2010.
- 8 John Onderdonk via email, August 5, 2010.
- 9 John Onderdonk via email, August 5, 2010.
- 10 John Onderdonk via email, August 5, 2010.
- 11 John Onderdonk, presentation at AASHE Conference.
- 12 http://sustainability.caltech.edu/documents/45-caltech_ecm_master_checklist8-24-10.pdf