

Silicon Valley Power's Data Center-Focused Energy Efficiency Programs

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ABSTRACT

Silicon Valley Power (SVP), the City of Santa Clara's municipal electric utility, has the privilege of having some of the world leaders in technology in its service territory. This, combined with SVP's low rates and high reliability, has led to a proliferation of data centers within its 19 square mile service territory.

Recent regulatory changes in California have resulted in increased energy efficiency (EE) targets for municipal utilities (munis). SVP's annual energy efficiency goals increased to 25.7 GWh of first year EE savings for the 2007-08 program year. Historically, the EE results have averaged in the 10 GWh range. SVP and Lockheed Martin, who implements most of SVP's non-residential EE portfolio, designed aggressive programs to target the data center customer base. The tremendous growth in implementation of EE projects in the data center industry contributed 16 GWh of energy savings and helped SVP achieve approximately 25 GWh of EE for the program year.

This paper outlines SVP's approach to developing and implementing EE programs that target data center customers. The results of the data center-focused programs, along with brief descriptions of some of the key projects are presented. New program directions in this constantly evolving technology space are also touched upon.

Introduction

The EPA reported that U.S. data centers consumed 61 billion kWh in 2006, about double the consumption from 2000. This is equivalent to the amount of electricity consumed by 5.8 million average U.S. households. Under current trends, the EPA estimates this will exceed 100 billion kWh by 2011¹.

SVP service territory is home to some of the world technology leaders including Intel, Sun Microsystems, Agilent, and Yahoo! to name a few. These companies have a growing need for data center space. In addition, SVP's low rates and high reliability have attracted co-location providers to locate their data centers in Santa Clara. Data Center Knowledge, a leading source of daily news and analysis about the data center industry, in a recent article on their website indicated that some large new data centers are planned in Santa Clara including:

- Digital Realty Trust owns seven properties in Santa Clara and is developing new data centers there for Facebook and Yahoo!
- Terremark is moving ahead with its plans for a 50,000 square foot data center adjacent to its existing facility in Santa Clara.
- CRG West has begun construction on a 50 megawatt data center in Santa Clara.
- Equinix says it recently opened a phase II expansion of its center in Santa Clara, and reports that demand has been strong.

With the recent economic downturn, SVP has seen the slow down of several construction projects in

¹ EPA report to congress on Server and Data Center Efficiency, 2007

Santa Clara, but only one data center project has been delayed. The remainder of the projects, including those listed above, are still actively moving forward due to the steady increase in use of the internet. This makes them an increasingly attractive target for energy efficiency, where measures can be implemented at the time of construction and capital budgets can be utilized.

Recent regulatory changes have increased the EE targets for California munis. Taking this as an opportunity, SVP has designed EE programs that will address specific market segments in its territory. SVP’s aggressive program design, combined with the innovative Silicon Valley community, makes this an ideal place to run and monitor pilot programs targeting the data center market. This paper presents some of the high level features of SVP’s data center EE efforts.

Data Center-Focused Program Design

Data center technology follows Moore’s law and there are rapid changes with new technology innovations constantly evolving. Because of this, SVP must keep up with these changes and incorporate them into the program design criteria. Successful program design and implementation requires perseverance and speed to market for data center-focused offerings. SVP’s data center-focused program is designed around the existing core rebate and incentive programs.

Rebates and Incentives

SVP’s energy efficiency programs for data center customers are based upon the two main categories: prescriptive and calculated or measured. In addition, SVP customers can apply for the Energy Innovation Program, which provides funding for new energy efficiency technologies.

Prescriptive Rebates. These rebates are available for lighting, HVAC (heating, ventilation and air-conditioning) equipment, virtualization, PC power management, motors, and variable frequency drives (VFD). Table 1 shows typical rebates.

Table 1. Prescriptive Rebate Levels for Some Typical Measures

Measure Name	Rebate Level
Variable Frequency Drives	\$100 per horse power
Server Virtualization	\$215 per server
PC Power Management	\$15 per PC

Customer Directed Rebate (CDR). The calculated or measured type of rebate is based on payment per first year kWh savings and is limited to 80% of the project cost. The table below shows the rebate levels for this program.

Table 2. CDR Incentive Levels by Measure Type

Measure Type	Incentive Level
Lighting	\$0.06
HVAC	\$0.17
Refrigeration	\$0.17
Other	\$0.11

Energy Innovation Program. SVP will provide grants to customers who implement exceptionally creative uses of energy technology. Grant awards are paid either on a cents per kilowatt-hour basis or as a percentage of the project cost. Funding is limited to either 85% of the project cost or \$250,000 per year per customer, whichever is less. The Yahoo! Wireless sensor network adaptive cooling project and Sun Microsystems' modular cooling system project described below are examples of projects funded under the energy Innovation Program.

Program Design Challenges and Solutions

Designing EE programs that target data centers presents a unique challenge due to some of the barriers to energy efficiency implementation that exist within the industry. Some of these challenges and the ways in which SVP is working to overcome them are shown below:

- Data centers are considered 'critical' to a customer's business operations and IT groups resist projects perceived as putting their data centers at risk. This is still a barrier to overcome, even in Silicon Valley, where people are often ahead of the curve in acceptance of new technologies and innovation.
- Communication gaps between IT and Facilities staff (who usually champion energy efficiency projects) can impede implementation of energy efficiency projects within a data center. The communications barrier and resulting "turf" wars" can be one of the more difficult challenges in moving a project forward. SVP works with customers to bring Facilities and IT staff together on these projects in an attempt to overcome this barrier.
- IT solutions have not historically focused on EE and "green" benefits, but on performance and first cost. This is a paradigm shift that needs to be adopted by companies and their staff. Early adopters who implement pilot projects and work with utilities to present case studies can help to break down the barriers to "green" IT implementation by sharing their experiences with others. Utilities can also provide incentive programs targeted at energy savings from IT projects to encourage thinking "outside the box" by making these projects more financially attractive. SVP's Energy Innovation Program pays up to \$250,000 per project for cutting-edge pilot projects, in addition to the \$1,000,000 annual incentive cap available per customer under other SVP programs.
- Co-location providers do not have the incentive to drive certain types of EE efforts, such as server virtualization or aisle separation since they do not own or control the equipment. SVP is working on implementing programs that target the "tenant" as well as the "landlord" at data centers.
- During new construction, speed to market often drives the use of "tried and true" designs rather than innovative, energy efficient designs. SVP tries to overcome this barrier by getting involved in the project early to provide design assistance, as well as incentives that offset the incremental costs.
- Utility rebates and incentives are perceived as "difficult" due to cumbersome forms and application processes. Simplified application forms and quick turnaround on application processing goes a long way in improving the customer experience.

- Data center technology is constantly evolving and keeping up with these advances is the key to running successful programs. SVP and Lockheed Martin keep up-to-date on the latest trends in data center technology such as virtualization, high efficiency power supplies and free cooling through various avenues for technology information sharing and networking. This is fostered by organizations such as the Silicon Valley Leadership Group (SVLG), the Critical Facilities Round Table (CFRT) and Pacific Gas and Electric (PG&E). Various forums, conferences, and pilot programs are sponsored by these organizations. SVP participates in and sponsors some of these events. In addition, SVP staff has participated in the U.S. Department of Energy's (DOE) Vision and Roadmap Workshop on Routing Telecom and Data Centers toward Efficient Energy Use.

Program Results

Energy efficiency measures implemented by SVP's customers have historically achieved around 12 GWh in first year savings and for the past several years, SVP has not spent its entire EE budget for customer rebates. For the 2007-08 program year, SVP's annual energy efficiency goals increased to 25.7 GWh of first year EE. SVP and Lockheed Martin designed aggressive programs to target the data center customer base. The tremendous growth in the data center program savings helped SVP achieve approximately 25 GWh of EE for the program year, contributing approximately 16 GWh of first year EE savings. In addition, the entire EE budget was expended for the 2007-08 program year. Table 3 below shows the results from data center projects for the 2007-08 program year.

Customer interest in these programs has been high, although some projects have been slow to start due to some of the barriers mentioned earlier. Some projects discussed in the 2007-08 program year may not be implemented until the end of the 2008-09 program year, but they are still moving forward. Customers who have participated in the programs have indicated an interest in pursuing additional projects within their data center facilities. Many customers are willing to share these projects and doing so through presentations and case studies has increased both awareness and interest in SVP's programs.

Description of Key Data Center Projects

Many of the data center projects involved modifications to the infrastructure, such as implementing innovative cooling solutions, high efficiency transformers, and server power management. Some of these projects are described below:

Yahoo! Wireless Sensor Network Adaptive Cooling. This project was initiated as part of the SVLG Data Center Pilot Program and the energy savings was rebated under SVP's Energy Innovation Program. An 8,000 square foot space within an existing Yahoo! data center was curtained off and cold aisle containment resulted in 1 GWh of first year measured energy savings. Some key features of this project include:

- Provide improved air flow management through the installation of cold aisle containment.
- Demonstrate the ability to reduce carbon footprint by 1,250 metric tons or greater.
- Reduced cooling energy by 21% using the SynapSense wireless control solution.
- Reduced the number of racks above ASHRAE recommended operating range from 34 to 15 while increasing supply temperature by 21°F.
- Annual Savings of \$563,000.

Table 3. Data Center-focused Program Results

Data Center Projects July 2007 to June 2008 Program Year			
Company Type	Technologies Applied	GWh Saved	Rebate
Co-location Provider A	Air Economizer	4.6	\$800,000
Co-location Provider B	Air Economizer	1.0	\$185,000
Sun Microsystems	Hot Aisle Containment, High Efficiency Cooling	1.4	\$231,000
Enterprise Data Center A	High Efficiency Transformers, UPS	1.5	\$162,000
Co-location Provider B	VFD – Chilled Water	3.0	\$306,000
Co-location Provider A	VFD – Chilled Water	1.5	\$153,000
Co-location Provider C	VFD – Chilled Water	2.0	\$200,000
Sun Microsystems	VFD – Chilled Water	1.0	\$99,000
TOTAL		15.9	\$2,136,000

Sun Microsystems High Efficiency Chilled Water Plant. In 2007, Sun Microsystems built 72,000 square feet of data center space in 14 rooms, all cooled by a high-efficiency chilled water plant. Today, this data center appears to have achieved excellent energy efficiency. This cooling solution was achieved through a combination of hot aisle containment and an efficient chilled-water cooling system. The chilled water plant was put into operation in June 2007 and was commissioned six months later by a third party. Although additional rebates are not available from SVP, in order to maximize energy savings, Sun intends to implement an industry best practice and re-commission the space following a planned Building Management System (BMS) upgrade in late 2008

Sun Microsystems Modular Cooling Systems With Aisle Separation. The separation of rack and room cooling is at the core of Sun’s solution for data center cooling. These new decoupled systems localize cooling at the heat source, resulting in more predictable cooling airflow patterns and savings of 40% in combined fan and pump power. The decoupling greatly increases the overall heat-density capacity of the data center, while reducing the power required by cooling systems. The new cooling solution also limits the need for the more complicated and costly raised floor design, enabling Sun to realize savings of up to \$50 per square foot.

As a part of an SVLG pilot study known as the “Sun Chill Off”, four commercially available modular, scalable server rack cooling solutions were installed in different sections of Sun’s data center in Santa Clara. These included: APC’s ACRC100 InRow Cooling Units, Vette/IBM’s Rear Door Heat Exchanger, Liebert®’s XD cooling system, and Rittal’s LCP+. The study shows that as server density increases, closely coupled cooling solutions are more efficient than traditional data center cooling with raised floor.

Co-location Provider A & B Air Side Economizer Implementations. The Mediterranean climate in Santa Clara makes it an excellent location to take advantage of “free cooling” by implementing economizers

for energy savings. Several air-side economizer projects have been completed or are in various stages of completion at co-location facilities within Santa Clara. These projects have energy savings of 1-3 GWh per project, depending on the size of the facility. Air side economizers are very cost-effective in both new construction and retrofit type applications in climate zones like Santa Clara. Areas in warmer climate zones will see less savings and longer payback periods.

Co-location Provider A, B, C & Sun Microsystems High Efficiency Cooling Equipment Incentives. Several data center projects have taken advantage of SVP's prescriptive rebates for high efficiency cooling equipment. These implementations typically involve the use of VFDs for motors and drives, chillers, and packaged AC units.

Sun Microsystems High Efficiency Transformers. One customer installed high efficiency transformers at its data center and received \$60,000 in incentives through SVP's CDR program, based on energy savings over standard transformers. The customer realized over 540,000 kWh in first year energy savings.

Enterprise Data Center C & D Server Power Management Software. Two data center customers are looking at implementing intelligent switching of server power to reduce consumption. Vendors such as PowerAssure and Cassatt provide technology that makes this possible. These technologies monitor power usage by the servers and create usage profiles based on trend data. Real time usage is compared to these profiles and servers are shut down during low utilization periods. They are then brought up when the profiles anticipate increased usage. Some of the products can be integrated into existing building energy management systems and perform predictive cooling requirement adjustments. Once implemented, SVP will provide rebates based on the measured energy savings.

New Programs and Future Outlook

To date, the majority of projects implemented within data centers in Santa Clara have been cooling-related projects due to the significant energy savings that they provide. However, SVP is constantly looking to add to its portfolio of data center-focused programs. To this end, virtualization and PC power management software were recently added as prescriptive rebates, making it easier for customers to take advantage of them. SVP has recently contracted with Quantum Energy Services & Technologies (QuEST) to provide a third party Data Center Optimization Program.

Server Virtualization Prescriptive Rebate. A server operating at low processor usage still uses most of its rated power. Typically, a data center has a large number of servers operating at low processor usage most of the time, with occasional spikes. Server virtualization software allows multiple applications to be shared across servers. This can offer significant energy savings through elimination of multiple machines that host the same application. SVP initially rolled out the server virtualization rebate under the Customer Directed Rebate program. Over time, SVP adopted an average savings of 1958 kWh per virtualized server based on savings measurements performed by both SVP & PG&E and rolled this into a prescriptive rebate program. This eliminated the need for pre- and post-measurement and verification of each virtualization project and makes the rebate easier to administer.

PC Power Management Software Rebate. While not data center specific, this prescriptive rebate falls under the category of IT programs. It rebates PC power management software that can turn computers and peripherals off when not in use.

Data Center Optimization Program. The Data Center Optimization Program (DCOP) continues the innovation that has been the hallmark of the SVP efficiency programs. This program introduces the concept of the Data Center Energy Efficiency Continuum (DCEEC) to recognize that there is an optimal order to implementing energy efficiency in data centers to prevent projects from delivering sub-optimal savings. For example, implementing virtualization after improved cooling control strategies would leave behind additional savings from virtualization-based cooling load reduction. The program takes a systems approach to energy efficiency in the facility to optimize energy savings.

The DCOP program is focused on enterprise data centers under 10,000 square feet and will be administered by QuEST and focuses on enterprise data centers less than 10,000 square feet, which have traditionally not participated in SVP's programs. This program will officially be launched on December 1, 2008.

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