Energy Analysis Report

---------- facility name ----------

----- facility city, state -----

Sponsored by

Pacific Gas & Electric Company

Submitted By:

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February 22, 2005

FINAL REPORT

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Disclaimer

The intent of this energy analysis report is to estimate energy savings associated with recommended upgrades to the HVAC, lighting and refrigeration systems at the -- facility -- . Appropriate detail is included in sections 2-4 of this report to make decisions about implementing energy efficiency measures at the facility. However, this report is not intended to serve as a detailed engineering design document, as the description of the improvements are diagrammatic in nature only in order to document the basis of cost estimates and savings, and to demonstrate the feasibility to construct the improvements. It should be noted that detailed design efforts may be required in order to implement several of the improvements evaluated as part of this energy analysis. As appropriate, costs for those design efforts are included as part of the cost estimate for each measure.

While the recommendations in this report have been reviewed for technical accuracy and are believed to be reasonably accurate, the findings are estimates and actual results may vary. As a result, PG&E and --- auditor --- are not liable if projected estimated savings or economics are not actually achieved. All savings and cost estimates in the report are for informational purposes, and are not to be construed as a design document or as guarantees.

In no event will PG&E or --- auditor --- be liable for the failure of the customer to achieve a specified amount of energy savings, the operation of customer's facilities, or any incidental or consequential damages of any kind in connection with this report or the installation of recommended measures.

Contacts

Site Contacts

The following ----- client ----- personnel assisted with the development of this report:

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1.0 Executive Summary

--- Auditor --- performed a site energy survey for the ------- facility ------- in --city -- , -- state -- to investigate opportunities for cost-effective, energy-efficient alternatives. A number of Energy Efficiency Measures (EEMs) have been identified and evaluated in this report. The mechanical and lighting systems at the site were investigated as part of this survey.

Pacific Gas and Electric Company is encouraging all customers to follow three steps to reduce electricity consumption:

1. Take no-cost, energy-saving actions.
2. Install low-cost, energy-saving measures.
3. Invest in energy-efficient equipment, appliance and building shell retrofits.

Consistent with PG&E’s 1-2-3 approach to conducting energy audits, the energy efficiency measures are presented no-cost, low-cost, and investment measures. The following tables summarize the measures that are recommended for this facility.

Recommendations for --- facility ---

EEM	Measure Description	Annual Electricity Savings (kWh)	Peak Electricity Savings (kW)	Annual Gas Savings (therms)	Annual Cost Savings	Estimated Installed Cost	Estimated Incentives	Net Cost	Simple Payback Period (years)	Measure Life (years)	Internal Rate of Return
	Combined measures have payback of 1.2 years										
1	Switch area lighting in zones during cleaning	19,011	0	0	$ 2,686	$ -	$ -	$ -	0.0	5	n/a
2	Install occupancy sensors to control 2nd floor lighting	2,830	0.6	0	$ 400	$ 1,322	$ 424	$ 898	2.2	8	42%
3	Install a Variable Frequency Drive on the centrifugal chiller	69,212	0	0	$ 9,780	$ 43,687	$ 29,069	$ 14,618	1.5	15	67%
	Total - Recommended	**91,052**	**0.6**	**0**	**$ 12,866**	**$ 45,009**	**$ 29,493**	**$ 15,516**	**1.2**		82%

Assuming Electricity Cost	$ 0.1413	/kWh	(Avg to date, this acct)
Assuming Gas Cost	$ 1.12	/therm	(Avg to date, this acct transport and avg procurement cost)

-Audit Company -
- Contact -
- Phone Number -

Incentives for - location - **Partnership Program**

Measure Type	Rate
Lighting	$0.15 /kWh
AC & Refrigeration	$0.42 /kWh
Motors / Controls / Other	$0.24 /kWh
Gas	$1.00 /therm

The incentive rates shown are reduced by 0% to account for costs of obtaining the incentive.

The remainder of this report details the recommendations for the ---------- facility ---------- . Section 2.0 documents existing conditions and historical energy use for the site. Section 3.0 provides descriptions of each measure, as well as providing information about how to implement the recommendations. The appendix, Section 4.0, includes details of the analysis and billing data for the site.

2.0 General Project Information

The ----- facility ----- was constructed in 1964 and comprises approximately 70,000 sq. ft. of conditioned space. The facility is two stories, although it was designed to have a third story installed at a later date. The --- facility --- consists primarily of -product- and other patron resources. There are a number of offices and open office space for - facility - staff, some small assembly areas and a computer server room.

------------------- facility building photograph --------------------

The building is constructed of brick. There is a large amount of window area in the building allowing day-lighting to the facility. These windows are single pane, but they are tinted and the upper windows on the Southern wall have fins to reduce solar heating.

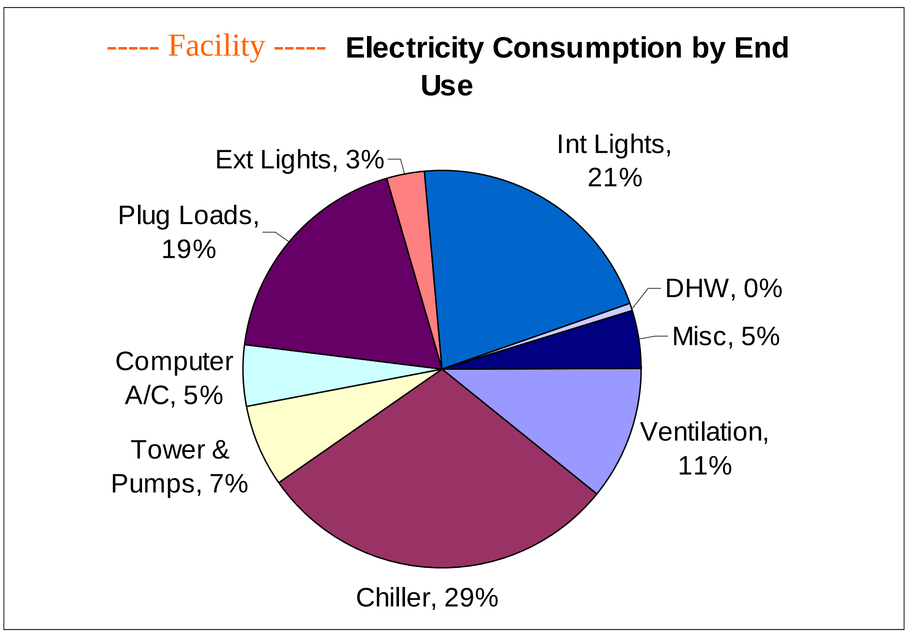
Historical Energy Use

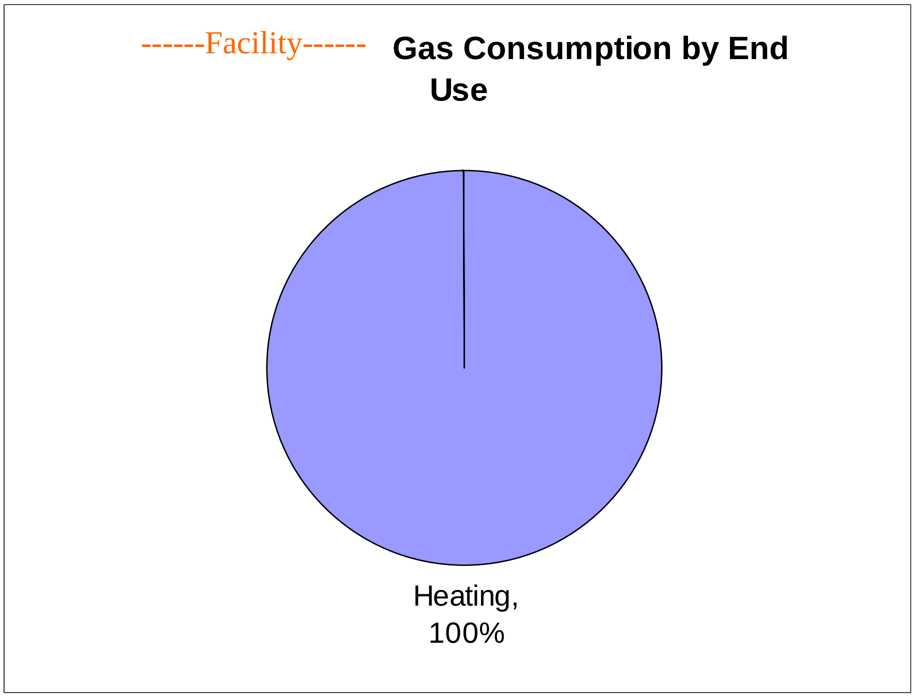
The --- facility --- is on PG&E's A10S X electric and GNR-1 gas rate schedules. Natural gas is not procured from PG&E, but PG&E provides transport and delivery of natural gas to the facility. Cost impacts of energy efficiency measures were determined using the average annual cost per energy unit from the following table.

Prorated Billing Data

	[redacted] ------- Facility ------- [redacted]			
Electric	Facility Size		70,000	s.f.
	Annual Electric		989,737	kWh
	Annual Monthly Peak		241	kW
	Annual Electric Expenditure	$	139,866	$
	Average Electric Cost	$	0.1413	$/kWh
	Electric Use		14.1	kWh/s.f.
Gas	Annual Gas		17,965	therm
	Annual Gas Transport Cost*	$	5,591	$
	Average Gas Transport Cost	$	0.311	$/therm
	Client's Average Gas Cost Incl. Procurement**	$	1.123	$/therm
	Gas Use		0.26	therm/s.f.

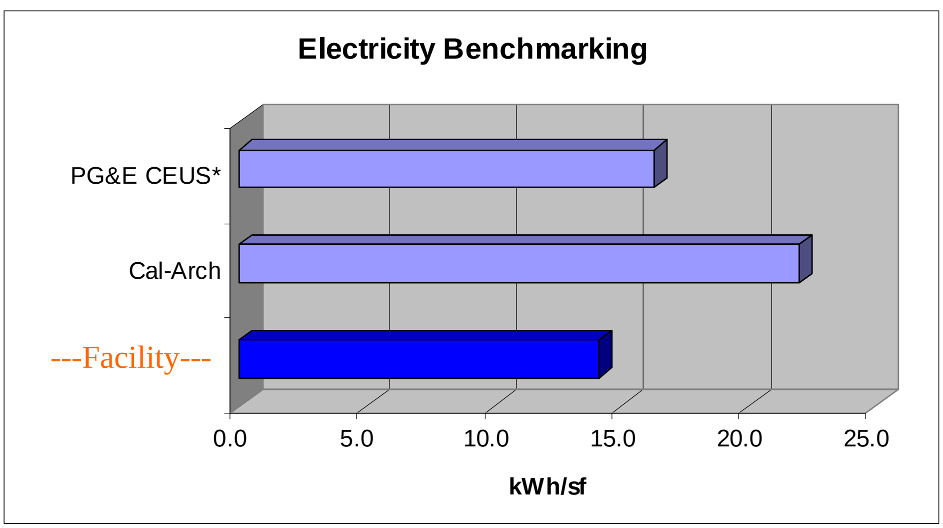
Procurement costs for natural gas are based on an analysis of procurement costs at the ----- facility ----- during the 2003 – 2004 fiscal year. An energy balance was conducted to match estimated energy use to historical use at the site. An end-use breakdown based on that analysis is shown in the following charts.

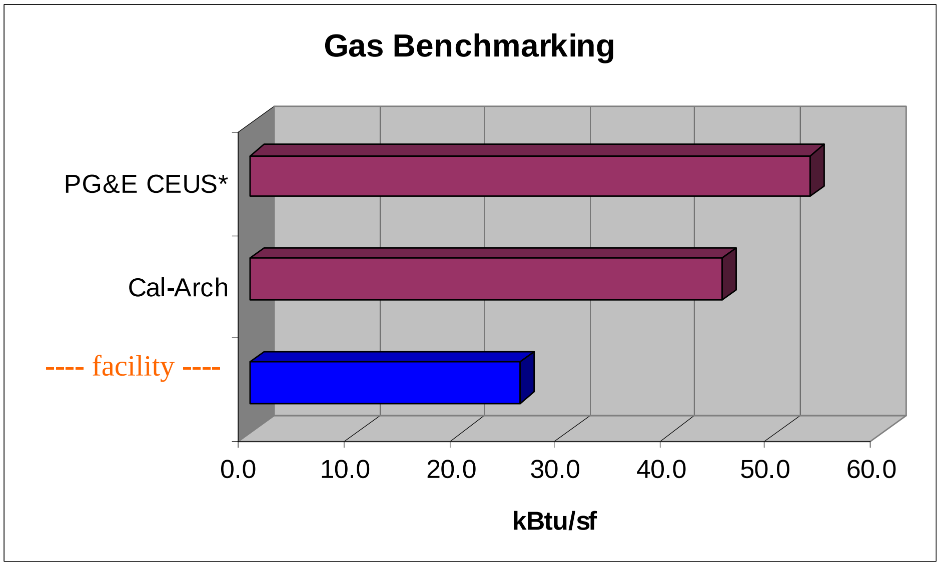




Energy Use Benchmarks

Benchmarking compares the energy use of a facility to those of similar size and purpose. Typically we compare facilities with survey data of similar facility types in facility state . To put facilities of different size on an equal footing, the energy use is compared on a "per square foot" basis.





PG&E CEUS is average end use intensity from PG&E's 1999 Commercial Building Survey Report (Commercial End Use Survey). Cal-Arch is average end use intensity from the California Building Energy Reference Tool. (URL: http://poet.lbl.gov/cal-arch/). The Cal-Arch data compares the --- facility's --- energy usage to other facilities in the facility area combined climate zone that do not fall under the sixteen listed building types. The PG&E CEUS data compares the --- facility's --- energy usage to all building types in the combined -facility area- climate zone.

The benchmark shows lower than average electric and gas usage. The ---facility--- has had a number of energy conservation measures previously installed including high efficiency lighting, variable frequency drives on the HVAC fans, an Energy Management System and air side economizing. The low benchmarks can be attributed to the efficient operation of the facility compared to other facilities in the area.

Building Occupancy

The ---facility--- is open from 10:00 am to 8:00 pm Monday through Thursday, 10:00 am to 6:00 pm Fridays and 10:00 am to 5:00 pm Saturdays. Janitorial staff arrive at 4:00 am to begin cleaning each day, and facility staff arrive at 8:00 am.

Lighting Systems

The vast majority of lighting at the facility is manually switched fluorescent lighting. The client has retrofitted all of the fluorescent lighting to high efficiency T-8 type lamps with electronic ballasts. Motion sensors control lighting in offices on the first floor. Exterior lighting consists of high pressure sodium and metal halide lamps at the entrances and providing security lighting.

Mechanical Systems

The -product area- and all offices are conditioned by a large, variable air volume air handler, AHU-1 (a.k.a. Supply Fan) located in the first floor mechanical room. AHU-1 has one, 40 hp supply fan providing conditioned air to the space and a 25 hp return fan. Both the supply and return fans are controlled by variable frequency drives (VFDs). Chilled water is supplied to AHU-1 by a nominal 230 ton Trane centrifugal chiller installed in 1987, also located in the first floor mechanical room. Client staff indicated that the chiller's impeller was replaced to lower the capacity to 180 tons. Chilled water is circulated by a 10 hp constant speed pump. Condenser water is circulated to the cooling tower located in the mechanical room by a 10 hp constant speed pump. Heat is rejected to a 175 ton Baltimore Air Coil cooling tower with a 25 hp VFD controlled fan motor. The server room has a dedicated, 8 ton DX cooling unit with a remote condenser located on the roof that was installed in 1987.

Heating hot water is provided by a Parker natural gas-fired boiler with a capacity of 1.08 MBtuh output, installed in 1997. There is also a 70 hp Ray Burner natural gas-fired boiler installed in 1973 that is used only as a backup. Domestic hot water is provided by a 50 gallon electric hot water heater.

The chiller, boilers and AHU-1 are controlled by a Siemens energy management system (EMS). The system has a limited graphical user interface for display, while control is performed by programming in DOS. The EMS can be accessed remotely by a modem connection. The EMS starts the mechanical equipment at 6:00 am and shuts the equipment off at 8:00 pm Monday through Friday. The equipment is shut off at 6:00 pm on Saturdays. The boilers are enabled to run from October through April, and operation is locked out if the outside air temperature is higher than 55°F. The EMS resets the hot water set point based on outside air temperature. The EMS heating set point is 68°F and the cooling set point is 72 °F. The chiller is locked out from November through March. The chilled water temperature is set to run at 45 °F when outside air temperatures are above 75°F, and the chilled water temperature is reset to 55°F if the outside air temperature is below 75°F.

3.0 Energy Efficiency Measures

Energy Analysis Methodology

An energy survey was performed on-site to collect nameplate and operational data for mechanical equipment, the lighting systems, and to identify any potential energy efficiency measures. During the site visit, an engineer collected the following data:

- A sample inventory of lighting fixtures
- Mechanical system nameplate specifications and control means
- Observations and photographs of unusual conditions or controls

Spreadsheets models were used to estimate energy savings from potential EEM's in mechanical and lighting systems. More information about specific methods is provided below in this section.

Energy Balance

In order to estimate potential energy savings, an energy use baseline is necessary. The baseline conditions represent how the facility operates without the proposed energy efficiency measures in place. The collected information was used to perform an energy balance at the facility. The usage of the various components of the lighting and mechanical systems were estimated and compared with the utility bills. These estimates were adjusted using engineering judgment until a good agreement was found between historical energy use and the estimated baseline use found through engineering calculations.

Spreadsheet Simulations

Weather

Weather data for --- facility area --- was summarized into 5-degree bins for the analysis.

Chiller Bin Simulation

The chiller plant model uses a bin method approach to estimate the energy use of the respective equipment. Weather data and estimated building loads were summarized into 5-degree bins and included in the simulation. Chiller part load curves were obtained from the York Works energy simulation computer program to estimate equipment performance. This allowed us to estimate cooling energy consumption at interior loads and outdoor air temperatures at off design conditions.

The chiller model was used to estimate the base case energy consumption and to estimate incremental savings for each of the proposed measures. The results of this base case model were compared to the energy balance to assure accuracy of the simulation models.

Lighting Spreadsheets

A sample lighting count of the -product area- was taken on-site and the existing wattage for each fixture was multiplied by the corresponding estimated annual hours of operation. The energy consumption was then extrapolated to the total - product - area to determine the energy consumption of lighting in the public areas of the -facility-. This determined the baseline lighting usage for the public areas. For the offices, the actual lighting count was taken on-site and the existing wattage for each fixture was multiplied by the corresponding estimated annual hours of operation to determine the baseline energy consumption.

For the proposed case, the proposed annual hours of operation were multiplied by the fixture wattage to determine the proposed lighting usage. Subtracting the proposed usage from the baseline usage provided the total lighting savings.

No-Cost Measures

EEM 1. – Switch -area- Lighting in Zones During Cleaning

-Client- staff indicated that lighting in the facility is manually switched on at 4:00 am during cleaning of the facility. The majority of -facility- staff do not arrive until approximately 8:00 am. By energizing only the lighting in areas with activity rather than switching all the lighting on in the facility, the facility could save lighting energy. Saving only one hour of lighting energy consumption per day can amount to real energy savings. Estimated savings for this measure assume -client- can reduce the public area lighting energy operation by one hour per day using a zone switching strategy.

EEM Implementation

Implement zone switching of library lighting during cleaning periods to only energize lighting in areas being cleaned. Train janitorial staff to clean by zone and switch off lighting in unoccupied zones until library staff arrive in the mornings.

Measure Summary

EEM	Measure Description	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Cost Savings	Estimated Installed Cost	Incentives and Rebates	Net Cost	Simple Payback Period (years)
1	Switch area lighting in zones during cleaning	19,011	0	$ 2,686	$ -	$ -	$ -	0.0

Low-Cost Measures

EEM 2. – Install Occupancy Sensors

Although -client- has installed occupancy sensors in offices and non-public areas of the first floor, lighting in offices on the second floor is manually switched. The annual lighting energy in the non-public areas of the second floor can be reduced by approximately thirty percent by using occupancy sensors in these areas.

There are two types of occupancy sensor technologies, passive infrared, and ultrasonic. Infrared sensors are triggered by movement of a heat source, such as a person, within a space. The sensor must have a direct line of sight to occupants in order to detect motion. Ultrasonic sensors emit high-frequency waves and are triggered by disturbances in the returning signals. Ultrasonic sensors do not need a direct line of sight, however, they often receive false triggers from wind-blown curtains or papers.

As the name implies, dual-technology occupancy sensors combine both infrared and ultrasonic technologies in a single sensor. This creates a sensor with the accuracy of an infrared sensor and the sensitivity of an ultrasonic sensor.

EEM Implementation

Install dual-technology occupancy sensors in meeting rooms and offices on the second floor. See Appendix A for full facility recommendations on occupancy sensor placement.

Measure Summary

EEM	Measure Description	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Cost Savings	Estimated Installed Cost	Incentives and Rebates	Net Cost	Simple Payback Period (years)
2	Install occupancy sensors to control 2nd floor lighting	2,830	0	$ 400	$ 1,322	$ 424	$ 898	2.2

Investment-Grade Measures

EEM 3. – Install a Variable Frequency Drive (VFD) on the Centrifugal Chiller

Data from ASHRAE shows that most building chillers operate less than 2% of the time at full load. While centrifugal chillers are equipped to unload using inlet guide vanes, they will unload more efficiently using a VFD to control the motor speed in conjunction with the inlet guide vanes. According to Trane, the -client's- chiller's manufacturer, installing a VFD to control the chiller's motor speed will improve the unloading capacity of the chiller up to 50% and improve the average part load efficiency by 20% to 25% resulting in energy savings.

--- facility --- **Centrifugal Chiller**

Energy savings can be further increased by switching from a constant condenser water temperature to a condenser water reset schedule based on an approach to the outdoor wet-bulb temperature. Care should be taken not to go below the manufacturer's minimum recommended condenser water temperature and to provide a sufficient difference between the leaving condenser water temperature and the chilled water supply temperatures to prevent refrigerant stacking in the condenser. However, employing a condenser water temperature reset is a common approach to optimizing energy savings in conjunction with variable speed control of a centrifugal chiller. According to the US Department of Energy, for a one degree reduction in condenser water temperature, chiller efficiency improves by 1.5%.

EEM Implementation

We recommend installing a VFD on the centrifugal chiller and implementing a condenser water temperature reset control strategy. Installation of the VFD will require integration with the current chiller controls, and we recommend that the -client- work with the chiller manufacturer on the VFD installation.

Measure Summary

EEM	Measure Description	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Cost Savings	Estimated Installed Cost	Incentives and Rebates	Net Cost	Simple Payback Period (years)
3	Install a Variable Frequency Drive on the centrifugal chiller	69,212	0	$ 9,780	$ 43,687	$ 29,069	$ 14,618	1.5

Measure Analyzed but not Recommended

In addition to the measures recommended and discussed above, we analyzed the savings and payback for another measure.

We considered replacing the computer room DX cooling unit. The existing cooling unit was installed in 1987 and is nearing the end of it's useful life. Replacing the cooling unit with a new, high efficiency cooling unit would result in energy savings. Due to the high cost associated with installing a new DX cooling unit, the measure did not have a favorable payback as an energy project alone. However, as the computer room DX unit is approaching the end of its useful life, we highly recommend that the -client- install a high efficiency cooling unit with an EER of at least 11.0 when they replace the existing cooling unit.

4.0 Appendices

4.1
Appendix A: EEM Calculations

4.2
Appendix B: Supporting Information