Energy Audit and Efficiency Retrofit Report for

First Unitarian Church of Oakland
685 Fourteenth St.
Oakland CA, 94609
510.893.6129

Prepared by

Ben Thompson
Peralta Energy Group
Oakland, CA
510.459.0827
PeraltaEnergy.com

Disclaimer

The analysis contained in this report is intended to provide an estimate of potential energy savings that may result from modifications to mechanical and lighting systems in the facility. The actual savings that may result could vary from the estimates provided in this report. No warranty is made regarding actual energy or monetary savings, nor the cost of implementing measures that are described in this report. This report does not serve as a detailed engineering specification for recommended energy efficiency measures. Additional engineering design may be desirable or necessary in order to implement some of the recommendations.

Peralta Energy Group shall not be liable for differences between the *estimated* implementation costs and energy savings contained in this report, and the *actual* costs and savings that may be achieved as a result of the implementation of measures that are recommended.

1 Summary

The purpose of this building and grounds energy analysis is to identify opportunities for energy and cost savings and to quantify those opportunities where practicable. Observations and data collection were conducted between Feb. 21 and March 20, 2010.

The CA Energy Commission has established a preferred 'loading order' for energy measures. The loading order prioritizes certain kinds of energy measures over others, as follows:

- Energy conservation (*avoided energy use*)
- Energy efficiency (*persistent reduced energy use*)
- Time-of-use management (*time shifted energy use*)
- Demand response (*event specific energy use reduction*)
- Renewable self-generation (*clean on-site energy generation*)

Following CA Energy Commission and energy management industry protocols, recommendations are divided into three levels of measures:

- No-cost measures (NCM)
- Low-cost measures (LCM)
- Capital Investment measures (CIM)

No-cost measures involve no expenditures other than incidental internal labor costs. Low-cost measures require modest expenditures. Capital investment measures are those requiring higher-level expenditures but are justified based on the potential dollar savings that will result from lower operating costs.

1.1 Your Cost Reduction Opportunities

Your energy efficiency opportunities are summarized in the following table.

Efficiency Measure #	Measure Name	Annual Energy Savings and Cost Savings				Project Payback		Payback with Incentive			
		Peak Savings (kW)	Energy Savings (kWh)	Energy Savings (therms)	Total Cost Savings	Measure Cost	Simple Payback (yr)	Potential PG&E Incentive	Net Measure Cost	IRR 10 yr.	Simple Payback (yr)
NCM-01	computer power settings		876		$158	NA	0		$0	NA	0
NCM-02	ext. lamps photo cells		1310		$236	negligible	0		$0	NA	0
NCM-03	3rd floor furnace filters and balance dampers		1024	125	$353	NA	0		$0	NA	0
NCM-04	gas range pilots			312	$421	NA	0		$0	NA	0
LCM-01	relamp to CCCFL		1080		$194	$360	1.85	$96	$264	73.2%	1.36
LCM-02	occupancy sensors		725		$131	$450	3.45	$104	$346	36.10%	2.65
LCM-03	under sink water heater			240	$324	$250	0.77	$0	$250	129.60%	0.77
LCM-04	weather stripping			30	$41	$100	2.47	$0	$100	39.50%	2.47
CIM-01	relamp to LED		3066		$552	$1,290	2.34	$450	$840	65.3%	1.52
					$0				$0		
					$0				$0		
					$0				$0		
	Sub-totals	**0**	**8081**	**707**	**$2,409**	**$2,450**	**1.02**	**$650**	**$1,800**	**68.74%**	**0.75**
	GHG reduction lbs. CO_2		**4234.44**	**9506.32**							

Summary

Total *annual* dollar savings if all measures are implemented is $2,409, at a total cost of $1,800. Simple payback on investment is nine months.

Greenhouse gas reduction if all measures are implemented will be approximately 9509 lbs. CO_2 reduced from gas savings plus 4234 lbs. CO_2 reduced from electricity savings.

A number of the savings opportunities offer immediate savings at no cost. Of the no-cost measures (NCMs) identified, three have already been implemented. As soon as the light circuit for the front patio lights has been identified, this measure can be implemented. *An additional no-cost measure is signage on heating controls*. This was left off the above table since savings cannot be estimated.

The incandescent bulbs in the Starr-King room can be re-lamped to "cold cathode compact fluorescent lamps." This type of lamp has a long life, can be used with the existing dimmer switches, and is available in a decorative style similar to the existing bulbs.

Some lights must remain on continuously, or all night, for safety or security reasons. These lights can be replaced with LEDs. Fixtures that can be relamped to LEDs include the exit

signs in Hamilton Hall, continuously on bathroom lights, and some exterior lights.

The baseline gas use is accounted for by the range pilots and the gas water heater. Range pilots have already been turned off. Serious consideration should be given to installing an under-sink hot water heater in the kitchen only, and eliminating the conventional gas water heater since hot water demand is very low. This would bring baseline gas usage down to nearly zero (no gas usage in summer months except for events that use the range).

Some lighting circuits warrant the installation of occupancy sensors to automatically turn lights on and off when people enter and leave spaces. Areas that are recommended for occupancy sensors include: first floor women's restroom (the layout of the men's room is different and does not need sensors); first floor hallway between restrooms and stairway; third floor open area.

Weather stripping on select exterior doors and on older double-hung windows may slightly reduce seasonal gas usage.

Lighting maintenance costs can be reduced by searching the Internet for the best pricing on compact fluorescent lamps that fit the existing fixtures.

1.2 Implementation Planning

You are encouraged to seriously consider implementing the opportunities presented in this report. By doing so, your facility can be made more comfortable and less costly to operate, and you can reduce greenhouse gas emissions.

For some of the recommended efficiency measures, PG&E rebates may be available. These individual rebates, as well as additional incentives and tax credits (if applicable) are included in this report.

2 Project Team and Facility Information

2.1 Project Contacts

Ben Thompson Building Energy Consultant	Mobile: 510.459.0827 ben@PeraltaEnergy.com
Stephan Schneider Facility Manager	Mobile: 510.292.6576 rentals@uuoakland.org
Charla Weiss Church Manager	Office: 510.893.6129 office@uuoakland.org
Bret Andrews Green Sanctuary team contact	Mobile: 510.384.5373 nancbret@dslextreme.com

2.2 General Facility Information

Building is approximately 10,100 square feet of conditioned floor area. Offices, meeting rooms, program rooms and kitchen account for approximately half of the space. The social hall and sanctuary account for the rest.

The east wing and social hall are wood frame, stucco and masonry, substantially rebuilt in 1998. The east wing has a full ventilated attic that contains four gas furnaces and at least one separate mechanical ventilation system. The furnaces and ventilation system each has its own dedicated duct system. The furnaces appear to draw all makeup air from outside. No return ducts were found.

The social hall has a full basement. The basement contains three gas furnaces that serve the social hall and sanctuary

Sanctuary is steel reinforced masonry with a wood frame roof, substantially renovated in 2009. The sanctuary has no basement nor attic, but does have a crawl space. There is an attached 3 story bell tower.

Most of the interior lighting in the building is high efficiency fluorescent. However the Starr-King room has incandescent bulbs; the sanctuary has fluorescent exit signs instead of LEDs. Exterior lighting is high intensity discharge (HID) and halogen. The exterior lamp posts have HID lamps that are on 24/7. Other exterior lights are controlled by a photocell.

The kitchen contains an ice machine, commercial reach-in refrigerator, dish sanitizer and a commercial 6 burner gas range with continuous burning pilots.

Domestic hot water is gas storage located on second floor. Third floor kitchen has an electric on demand heater.

Offices have 7 desktop computer work stations and two copiers.

Building plans are available from renovation architects.

The building was originally built on 1891 and is an historical landmark.

2.3 Building Occupancy

Third floor offices : 56 hours per week, 6 days x 8 hours

Starr-King room: 28 hours/week, 7 days x 4 hours

Hamilton Hall: 14 hours/week

Wendte Hall: 20 hours/week

2.4 Energy-Using Systems

Lighting Systems

Almost all interior lighting is high efficiency compact fluorescent and T8 electronically ballasted fluorescent. Starr King room has 24 incandescent 60 watt lamps in wall sconces and a chandelier. These lights are controlled by dimmer switches. All exit signs are LED except for three signs in the sanctuary that have CLFs. Interior lights are controlled by a master timer that sweeps all lights off at 11:00 PM. Wall timers allow after hours operation in two hour increments. There are no occupancy sensors in the building.

Pendant light fixture with CFL lamp.

Recessed style fixture with CFL lamp.

Continuously burning exterior lamp.

Hot water demand in facility is low. This heater may not be necessary and costs a minimum of $300/year to operate.

CFL base types: GX24Q-2 (notch offset top left). GX24Q-3 (notch offset top right).

List price (Internet) $2.42 (10+ count)

Some exterior lighting is controlled by a photocell. The two lamp posts in the plaza area are on 24/7. These lamps are high intensity discharge (HID) of unknown wattage. Other exterior lamps types are HID and halogen. The lamp over the church name sign and one of the lamps on the Castro Street side are not working (burned out?)

HVAC

General space heating is provided by central gas, ducted furnaces. There is no AC.

In the basement of the social hall there are three units. Two serve the sanctuary and one serves the social hall.

There are two additional furnaces that serve the first floor. Both are in the crawlspace of the east wing. The furnace that serves Starr-King room is located under the closet that is under the stairs. Access is via a floor hatch in the closet. The other furnace serves the nursery, bathrooms and entrance foyer and is located under the nursery. Access is via the social hall basement into the crawlspace.

Furnaces in the east wing attic serve the second and third floors. One unit serves the third floor. The second floor appears to be served by a single unit that has two fan cabinets and one heat exchanger. The exact configuration of the attic furnaces was difficult to evaluate due to the presence of multiple duct systems, including various ventilation systems (for general ventilation, range hood, and water heater make-up air.

Retro-commissioning of the attic furnaces and general ventilation systems by a mechanical engineer is recommended as several design problems were observed including the following:

- No return ducts. All make-up is from outside.
- Sharp corners in supply ducts result in low velocity air.
- Missing balancing dampers in some duct branches.
- No 'jump ducts' from private offices to main office.

The other furnace systems may have similar problems and were not examined in this study.

Electric space heaters were observed to be in use in the offices due to poor air flow from gas furnace. Use of these electric space heaters has stopped following replacements of furnace filters and adjustment of duct balancing dampers.

All furnace filters should be replaced on a schedule. Because the facility is adjacent to a freeway, the filters in the furnace that serves the office should be replaced three times during the heating season.

Process Equipment

Kitchen refrigerator is Hobart model DA2, SN 32-1060531, 48 cu ft, reach-in. Energy usage was measured at 37 kWh/week.

Other kitchen equipment includes an ice machine, high temperature dish sanitizer, and six burner commercial gas range with hood. There is no dish sprayer.

Office Equipment

Offices have 7 desktop computer work stations. Some are used only occasionally. Some were found to be turned on while unused, with no power saving options configured. Offices have two copiers that remain turned on but have power saving features. Office also has a hot/cold electric water dispenser.

Controls

All furnaces have programmable thermostats. Currently all furnaces are manually controlled except the third floor furnace. Occupants turn on furnaces as needed. Previously the furnaces ran on pre-set programs that resulted in over-utilization of heating. During this audit, one furnace fan was found to be in continuous operation over several days.

3 Site Energy Use and Costs

Gas and electrical service are provided by PG&E. There is no on-site generation.

Gas meter # 48501442, service ID# 2020173010

Elect meter # OPO722, service ID# 2020173005

3.1 Electricity Consumption

Electrical energy usage is relatively constant through-out the year. Average electrical expense is approximately $700/month. Electricity use spiked during renovation in summer 2009. Avg. cost of electricity over last two years: $0.18/kWh.

3.2 Natural Gas Consumption

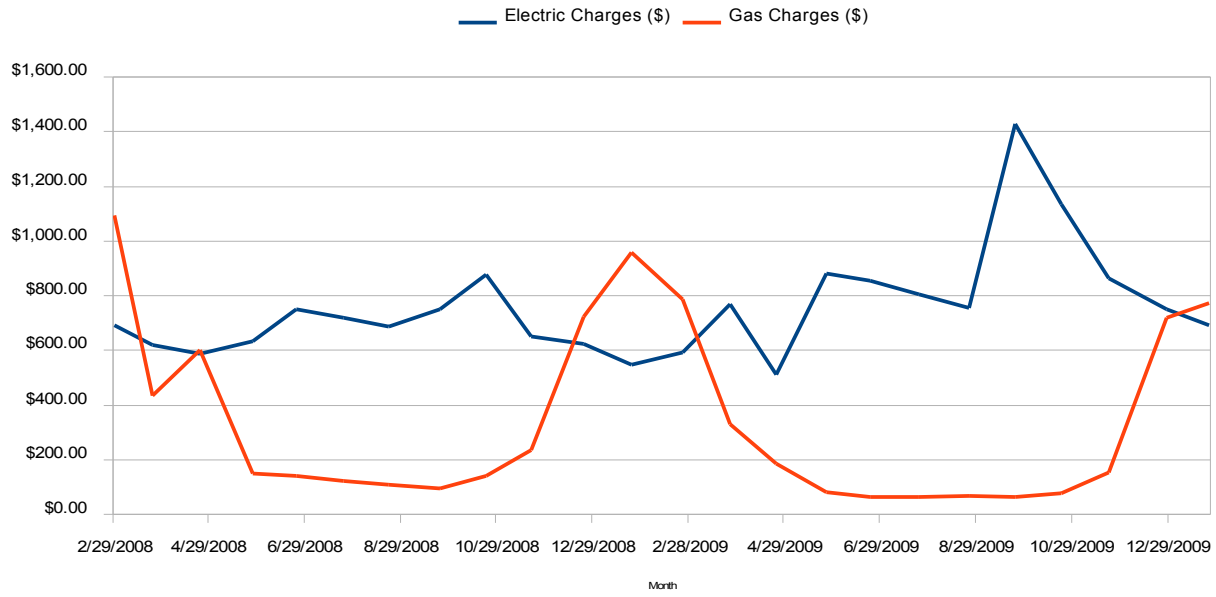
Gas baseline expense is approximately $70/month. This is accounted for by the pilots in the range and the water heater operation. Gas use spikes during the heating season.

Avg. cost of gas over last two years: $1.22/therm.

3.3 Total Cost of Energy

Average annual energy expenses for 2008 and 2009 were $13,168.

Average monthly energy expenses for 2008 and 2009 were $1,098.

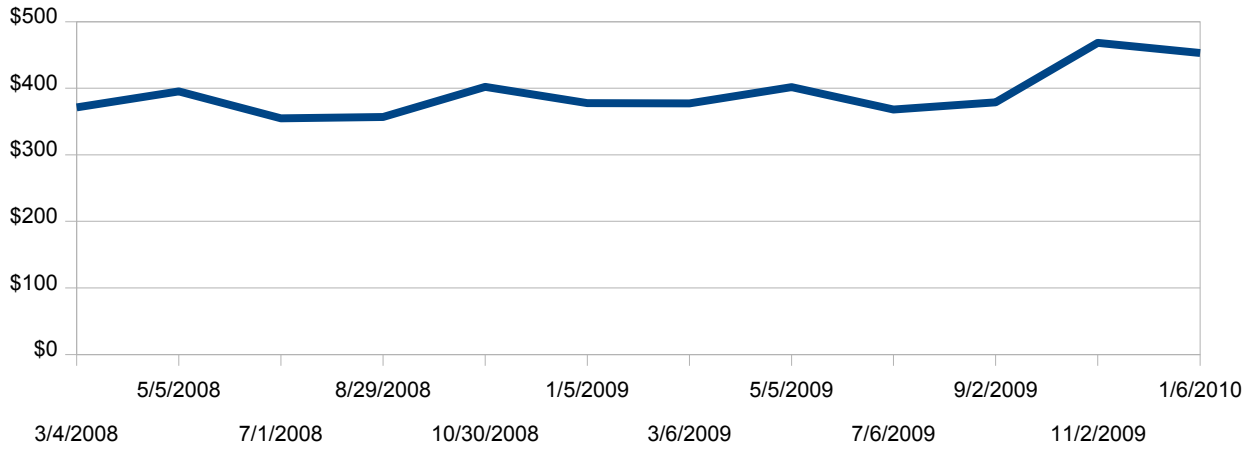


3.4 Energy Use Benchmarks

The facility has been benchmarked in EPA Portfolio Manager and automated data feeds are set up between PG&E and Portfolio Manager. This allows energy use to be tracked over time. Current Portfolio Manager score is 74 on a 0 – 100 scale where 100 is most efficient. The facility can earn an Energy Star label for efficient buildings if the score goes over 75.

3.5 Water Use

Water expenses have been even during the past two years at approximately $200/month. Usage in the early winter of 2009/2010 is slightly higher. The reason is unknown. The chart below shows dollar amounts for two month periods.



All toilets in the facility are high pressure low flow. There is an outdoor irrigation system for landscaping. That system is not used.

4 Energy Opportunities

4.1 Data Collection Methodology

An energy survey was performed on-site to collect nameplate and operational data for mechanical equipment, the lighting systems, office and kitchen equipment in order to identify potential energy efficiency measures. The following data was collected:

A partial inventory of lighting fixtures and controls.

Mechanical system nameplate specifications and control means.

Observations and photographs of conditions and controls.

Spreadsheet models were used to estimate energy savings that may result from energy efficiency measures.

4.2 Mathematical Modeling Assumptions

Energy savings calculations are based on energy cost rates of $0.18/kilowatt-hour and $1.35/therm. (Future gas prices are assumed to be higher than past two years. Electricity is assumed to remain level in the near term.) Computer energy savings are based on average work-station energy use and estimated reductions in operating hours. Lighting savings is based on actual wattage of existing lamps, actual wattage of replacement lamps, actual light operating hours and calculated reduced operating hours. Heating savings is based on estimated reductions in heating load. Baseline gas savings assumes that conventional gas

storage water heater is eliminated (or turned completely off) and range pilots are lit on 'as-needed' basis. Greenhouse gas reductions are calculated at CPUC ClimateSmart emissions rates of 0.524 lbs. CO_2/kilowatt-hour and 13.446 lbs. CO_2/therm of gas.

4.3 No-Cost Measures

NCM-1: Computer Power Settings

During inspection, three computer work stations were found to be on when unused. The power options on all work-stations were checked. Those that had no power saving options configured were set to enter 'stand-by' mode after 30 minutes of inactivity. Whenever work-stations are replaced, power savings options should be enabled.

NCM-2: Exterior Photocells on Globe Lamps

The globe lamps on the front patio were found to be in continuous (24/7) operation. The lighting circuit has not yet been located. Once located, photocell controlled socket adapters should be installed. This negligible cost qualifies this as a 'no-cost' measure.

NCM-3: Re-balance 3rd Floor Ducts

Electric space heaters were observed to be in use in the offices because the furnace was not supplying enough heated air. The furnace filters were found to be dirty and were replaced. Duct balancing dampers were adjusted to direct more of the heated air to offices and less to spaces that are usually vacant. The result has been discontinued use of electric space heaters and lowering of the furnace thermostat.

Consider moving the thermostat location from the open area to the office in order to further reduce heating load and achieve additional savings.

NCM-4: Stove and Oven Pilots

The stove and oven (gas range) pilots account for approximately 312 therms ($421) of baseline gas usage per year. Since the range is rarely used, the gas valve behind the range has been turned off in order to cut off the pilot lights. Gas can be turned on as-needed. However ALL OF THE PILOTS MUST BE RE-LIT EACH TIME THE GAS IS TURNED ON. FAILURE TO DO SO IS A SIGNIFICANT SAFETY HAZARD.

NCM-5: Signage on Heating Controls

Signs should be placed prominently near heating controls and on doorways reminder users to turn off heat and fans when vacating rooms. This measure was not listed on the energy savings table because actual savings cannot be estimated.

4.4 Low-Cost Measures

LCM-1: Re-lamp to CCCFL

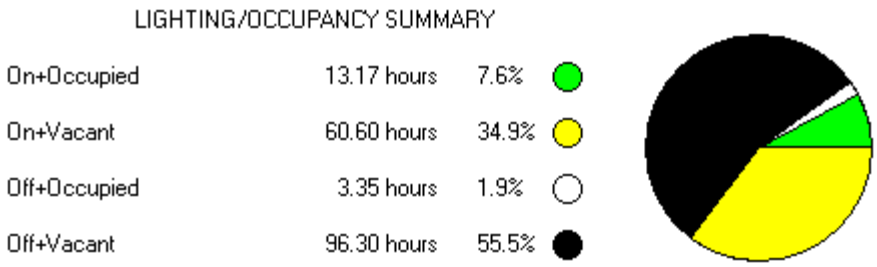
Cold cathode compact fluorescent lamps (CCCFL) should be installed in the Starr-King Room. Each lamp (bulb) will conserve approximately 45 watts. A lamp style similar to those now in use can be ordered on-line. A PG&E rebate on this type of lamp is available.

LCM-2: Occupant Sensors

Occupancy sensors automatically turn lighting on when people enter a space and turn lighting off again when the space is vacated. Sensors can be adjusted to provide a delay period after vacancy to avoid a 'flickering' effect if people are coming and going within a short period. Spaces appropriate for occupancy sensors include the supplemental lighting in the first floor women's restroom; first floor hallway; and third floor open area. (The first floor men's room is configured in such a way that the 'continuously on' emergency lighting provides enough light so that supplement lighting is rarely turned on.) PG&E rebates are available.

Lighting data loggers were left in select locations for approximately one week to determine opportunities for cost effective use of occupancy sensors. The graphs below show the results. Significantly sized yellow areas show opportunities.

First Floor Hallway. Occupancy sensor recommended..



Second floor hallway. Lights used very little. Sensor not recommended.

LIGHTING/OCCUPANCY SUMMARY

On+Occupied	0.15 hours	0.1%
On+Vacant	0.42 hours	0.2%
Off+Occupied	11.98 hours	6.9%
Off+Vacant	160.57 hours	92.8%

First floor ladies restroom. Occupancy sensor recommended.

LIGHTING/OCCUPANCY SUMMARY

On+Occupied	5.67 hours	3.3%
On+Vacant	51.15 hours	29.5%
Off+Occupied	1.83 hours	1.1%
Off+Vacant	114.58 hours	66.1%

Third floor open area. Occupancy sensor recommended.

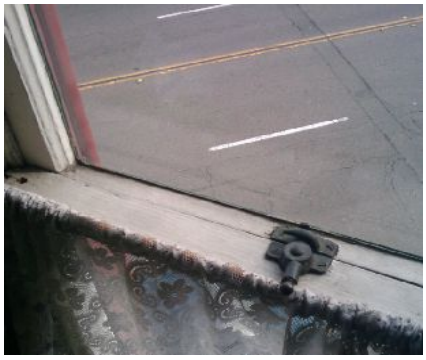
LIGHTING/OCCUPANCY SUMMARY

On+Occupied	16.70 hours	9.6%
On+Vacant	23.17 hours	13.4%
Off+Occupied	9.03 hours	5.2%
Off+Vacant	124.18 hours	71.7%

LCM-3: Under-sink Water Heater

Because hot water demand in the facility is very low, serious consideration should be given to eliminating the conventional gas storage water heater. An under-sink electric 'on-demand' heater can be installed in the kitchen.

LCM-4: Weatherstripping

Weather stripping can be installed on select exterior doors such as those to the rear patio. Old double hung windows can be weather stripped where the upper and lower sash meet. Windows that are never opened can be caulked with rope or silicon caulk. Energy savings from this measure cannot be estimated accurately. Savings are assumed to be 1% of the annual heating season load.	 Old double-hung window.

4.5 Capital-Intensive Measures

CIM-1: Re-lamp to LED

Select lighting fixtures can be re-lamped with LED lamps. Recommended fixtures include the 'continuously on' restroom lamps; exit signs in Hamilton Hall; exterior ramp lighting; front patio lamp posts. PG&E rebates are available for some fixtures.

4.6 Demand Response and Grid Reliability Measures

Demand response is a method of temporarily reducing energy use in a building as a result of a request from power providers (PG&E) during times of peak demand. Energy customers that implement demand response systems receive a preferential (reduced) rate on their energy use.

PG&E does not offer demand response programs for facilities where peak demand is under 200 kilowatts. This facility does not qualify.

4.7 Self-Generation Measures

No self generation measures such as solar hot water, photo-voltaic or wind systems are recommended at this time.

4.8 Not Recommended

Refrigerator replacement was considered and is not recommended. Replacing the existing refrigerator would cost approximately $2500 and would save approximately $118/year.