

City of San Diego

Point Loma-Hervey Branch Library

ASHRAE Level II Audit Report

August 2017

Prepared for
California Energy Commission

Prepared by
Center for Sustainable Energy



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Abbreviations and Acronyms

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers	HVAC	Heating ventilation and air conditioning
Btu	British thermal unit	IDS	Integrated demand-side management
Btu/hr	Btu per hour	kBtu	Thousand british thermal units
CBECS	Commercial Buildings Energy Consumption Survey	kWh	Kilowatt hour
CEC	California Energy Commission	LED	Light emitting diode
CFL	Compact fluorescent lamp	MMBtu	Million british thermal units
CFM	Cubic feet per minute	NBI	New Buildings Institute
CSE	Center for Sustainable Energy	PLH	Point Loma-Hervey Branch Library
EER	Energy efficiency ratio	SDG&E	San Diego Gas and Electric
EUI	Energy use intensity	SEER	Seasonal energy efficiency ratio
EUL	End of useful life	TE	Thermal efficiency
HPS	High pressure sodium	VAV	Variable air volume
HQI	Hydrargyrum quartz iodide	ZNE	Zero net energy

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I. Executive Summary

Introduction

The Center for Sustainable Energy (CSE) conducted an American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Level II audit for the City of San Diego’s Point Loma-Hervey Branch Public Library (PLH or PLH facility) as part of an Electric Program Investment Charge demonstration agreement (EPC-15-085¹) developed in partnership with the City of San Diego Environmental Services Department and funded by the California Energy Commission (Energy Commission). The purpose of this agreement is to conduct energy consumption baselines, identify and deploy energy conservation measures (ECMs) and integrate demand-side energy management solutions that, when combined with on-site renewable energy generation, achieve site zero net energy (ZNE) at three City of San Diego public libraries,² including the PLH facility. To help achieve the ZNE goal, CSE is identifying relevant ECMs to deploy at the facility and then installing several energy efficiency measures (EEMs) identified in Section III of this report, in addition to others that will be evaluated in the “ECM design” stage of this project. The City of San Diego is also installing solar photovoltaics (PV) at each library facility and may add energy storage and electric vehicle charging stations depending on available funding. Following the installation of energy efficiency and solar PV measures, CSE will measure and verify the facility’s real-time energy consumption and renewable energy generation for 12 months to determine if ZNE is achieved. The Executive Summary provides an overview of CSE’s findings, with further details provided throughout the report.

Importance of Zero Net Energy

California has set aggressive goals for increasing energy efficiency in existing buildings and for achieving ZNE targets for new and existing buildings. Specific to this project, the state requires all new nonresidential construction to be ZNE and 50% of existing commercial buildings to be retrofitted to ZNE by 2030. Local governments have large and diverse nonresidential building portfolios and are in a unique position to implement ZNE demonstration projects and integrated demand-side management (IDSM) solutions in commercial buildings.

Cost-effective ZNE that utilizes energy efficiency and IDSM needs further demonstration and analysis to determine market viability and long-term sustainable energy savings. Integrating energy efficiency, solar photovoltaics (PV) and energy storage to achieve ZNE in existing buildings requires further testing in real-world applications, as do financing mechanisms and revenue models that allow local governments to cost-effectively achieve ZNE goals in municipal building portfolios.

CSE is aligning its ZNE goals for this project with the Energy Commission’s “Zero-Net-Energy Code Building”³ definition:

¹ EPC-15-085: *The City of San Diego Public Library Zero Net Energy and Integrated Demand-Side Management Demonstration Project*, www.energycenter.org/sdzn3.

² Point Loma-Hervey Branch, Serra Mesa-Kearny Mesa Branch and Valencia-Malcolm X Branch.

³ California Energy Commission. 2013. *2013 Integrated Energy Policy Report*. Publication Number: CEC-100-2013-001-CMF.

A Zero-Net-Energy Code Building is one where the net amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single “project” seeking development entitlements and building code permits, measured using the Energy Commission’s Time Dependent Valuation metric. . . . A zero-net-energy code building meets an energy use intensity value designated in the Building Energy Efficiency Standards by building type and climate zone that reflect best practices for highly efficient buildings.

Using this definition and applying it to innovative upgrades to existing municipal facilities, this project will demonstrate to the Energy Commission, the City of San Diego, other public agencies, policymakers and relevant industry stakeholders the application of multi-technology integration efforts that maximize cost and energy savings. Further, it will serve to build political and community motivation for similar projects across municipal and commercial building portfolios.

Audit Findings Summary

To establish the PLH’s existing conditions, CSE conducted a comprehensive walk-through of the facility to document existing appliances, equipment, fixtures, energy efficiency features and overall building characteristics on Jan. 9, 2017.

Following the on-site assessment, CSE developed a preliminary energy consumption profile including 12 months of the PLH’s electric and natural gas utility data, accessing the facility’s ENERGY STAR Portfolio Manager profile and energy use intensity (EUI) score. The PLH facility consumes just over 1,471,241 kBtu of energy annually consisting of more than 409,000 kWh/yr. in electricity and approximately 1,811 MMBtu/yr. in natural gas.

Figure 1 shows that **electricity accounts for about 87% of PLH’s overall energy consumption**. Electricity is consumed primarily for lighting and heating, ventilation and air conditioning (HVAC) peaking during the summer months to meet an increased air conditioning demand. The PLH facility consumes natural gas for both space and hot water heating, with the annual peak of natural gas use generally occurring in the winter months when the demand for space heating is greatest.

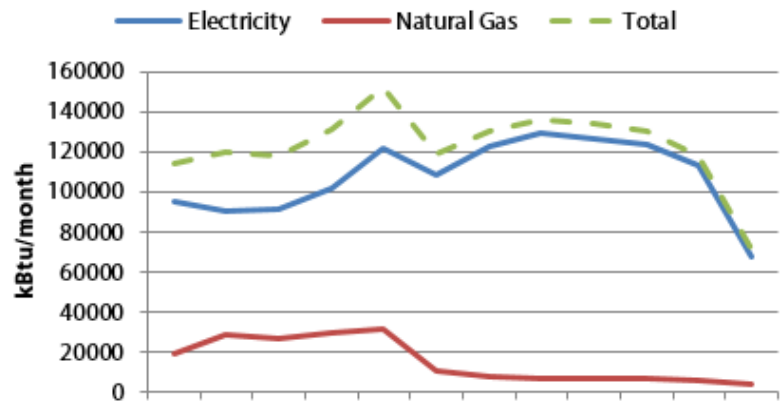


Figure 1: Point Loma/Hervey 2015-2016 Energy Consumption

After evaluating the January 2017 walk-through data and conducting a preliminary energy assessment of historical utility consumption data, CSE identified high-level opportunities to improve the efficiency of the PLH facility’s building/equipment operations systems and the overall comfort of occupants. After analyzing these opportunities in more detail, CSE recommends the following targeted EEMs based on the energy savings potential for the PLH facility equipment and fixtures.

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
EEM-1	Install Occupancy Sensors (LTNG-1)	0	4,383	0
EEM-2	Replace Existing Fixtures with LED Equivalents (LTNG-4,5,6)	16.1	50,286	0
TOTAL		16.1	54,669	0

Table 1: Potential Energy Savings from Recommended Energy Efficiency Measures

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive	Measure Life (yr.)	Net Measure Cost	Investment Rate of Return	Net Present Value	Simple Payback (yr.)
EEM-1	\$1,311	\$5,700	\$0	8	\$5,700	16%	\$3,128	4.3
EEM-2	\$15,043	\$47,515	\$4,275	11-16	\$43,240	34%	\$130,111	2.9
TOTAL	\$16,355	\$53,215	\$4,275	8-16	\$48,940	33%	\$133,238	3.0

Table 2: Potential Cost Savings from Recommended Energy Efficiency Measures

When combined, these measures would reduce the library’s electricity consumption by about 13.4% and bring the EUI down from 70.4 to approximately 62.1 kBtu/ ft².

II. Existing Site Conditions

The Point Loma/Hervey Branch Library (PLH or PLH facility), located at 3701 Voltaire Street, is a branch of the San Diego Public Library System serving the Point Loma neighborhood and surrounding communities. The library is in the southwest region of the City off I-8, see Figures 2 and 3. This region sits in California Climate Zone 7. The facility receives both electricity and gas service from San Diego Gas & Electric (SDG&E) with one meter for each utility service.

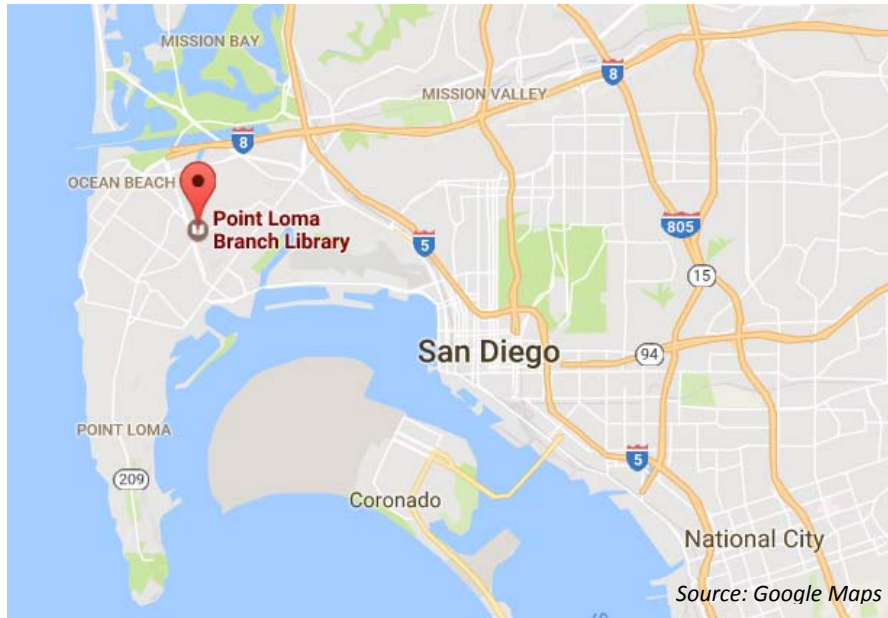


Figure 2: Point Loma-Hervey Library – Google Maps Regional View

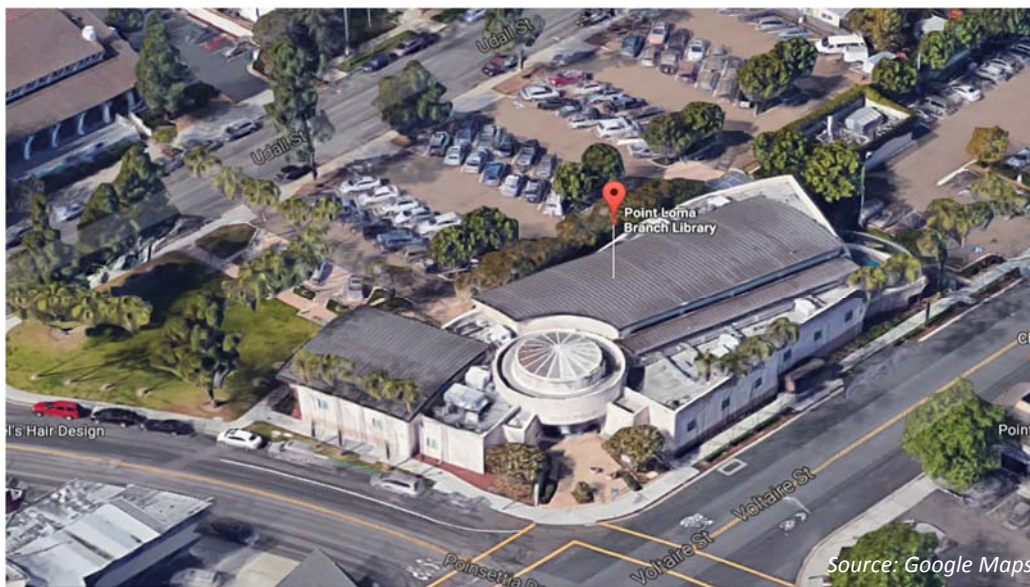


Figure 3: Point Loma-Hervey Library Site Map – Google Maps Satellite View

The 2,480-square-foot facility was constructed in 2003 and serves some 19,000-22,000 visitors each month. The library staff includes up to 10 to 15 employees on any given shift and occupies study and seminar rooms, a staff workroom, computer labs and a community room for hosting large groups and community events. The building is open to the public during the following hours.

- Monday, Thursday-Saturday: 9:30 a.m.–6 p.m.
- Tuesday & Wednesday: 11:30 a.m.–8 p.m.
- Sunday: 12:30–5 p.m.

Description of Existing Building Systems

Building and Equipment Schedules

- Occupancy Schedule – Eight to ten full-time employees (up to 15 during summer) arrive 30 minutes prior to library opening and closing with approximately 19,000-22,000+ visitors per month occupying PLH for varying lengths of time.
- Lighting Schedule – Same as Occupancy Schedule; minimal lighting during unoccupied hours for security.
- Outdoor Lighting Schedule – Operated by a timer scheduled for roughly 5:30 p.m.–7 a.m.; timer accounts for daylight saving time and leap year settings.
- HVAC Schedule – Coincides with library open hours. Thermostat temperature settings can only be adjusted locally by two degrees Fahrenheit; master temperature settings are controlled remotely by the City Facilities Division.

Building Envelope

- Roof – White roofing over built-up 4-ply, Class A fire retardant roof with mineral surfaced cap sheet. Standing seam copper Class A fire retardant roof. Built-up roof to have rigid R-19 insulation, metal roof to have batt R-19 insulation.
- Wall – Stone veneer over ¾" stucco base; ½" plywood over 6" x 20 GA. metal stud with R-11 batt insulation (typical).
- Windows – Dual pane 1" total thickness, U-factor of 0.29 and solar heat gain coefficient of 0.37 in metal frame, KalWall-type translucent clerestory windows and skylights with metal frame and typical glass block windows.

Indoor Lighting

- Upper and Lower Level Stacks – Interior lighting for the adult stacks and the central portion of the upper level utilizes a suspended two-bulb, caterpillar style fluorescent fixture with F28T5 lamps. The elevated ceiling above this section is illuminated using a series of 150-watt flood lamps and a large section of clerestory windows surrounding the space allows for a considerable amount of natural daylight to infiltrate. The lower level stacks in the children and young adult sections use a common fixture found throughout the library, a 2'x2' recessed U-bulb ceiling light that has a single 40-watt

lamp. A main light switch controls the fixtures for most the public space which is manually operated by PLH staff upon entering and exiting the premises each day.

- Seminar, Computer and Other Rooms – Many of the rooms that make up the outer perimeter of interior space for both the upper and lower levels do not contain windows and utilize three main lighting fixture types. The most common lighting found in the computer and multimedia rooms use a 2'x2' recessed U-bulb fixture with a 40-watt fluorescent lamp. Certain rooms also will use a recessed 6" downlight with a 26-watt bulb in conjunction with the 2'x2' U-bulb fixtures. Some spaces, such as the staff workroom contain 2'x4' parabolic fixtures that use three 32-watt fluorescent bulbs. A few of these rooms have working occupancy sensors that control the lights and the rest of the fixtures are manually controlled by staff.
- Community Room – The Community Room, which is said to be used often, is a large space with high ceilings and large window sections that allow for daylight to infiltrate. Blinds often are left down when unoccupied and raised during certain events. The current configuration for lighting is the use of 10" recessed downlighting with a single 100-watt bulb and perimeter lighting from smaller, 6" downlights that are using 26-watt bulbs. All fixtures are controlled by a master dimmer switch and are adjusted by staff to accommodate guests. However, a strip of 100-watt track lights as well as the 6" perimeter downlights are typically kept on low to highlight the art that is displayed for the public.
- Entrances and Rotunda – The main entrance and rotunda are illuminated only with a series of 13-watt surface strip lights that supplement the daylight that infiltrates the translucent dome above the rotunda. Large glass doors and floor-to-ceiling windows at the main entrance and side entrances allow for an abundance of light into the immediate area and some hallways. There are typically 26-watt, 6" downlights within these areas. Lights in these spaces are manually operated by library staff upon entering and exiting the premises each day.

Outdoor Lighting

- Parking Pole Lights – (20) 180-watt high pressure sodium (HPS), (8) single branch 250-watt HPS downlights, (2) double branch 250-watt HPS downlights
- Landscape/Building Accent Lighting – (10) 250-watt HPS flood, (2) 120-watt decorative navigation lights, (3) 175-watt in-ground floodlights
- Building Exterior Entry – (2) 35-watt HPS wall packs entries, (8) 13-watt wall sconces, (6) 100-watt 6" recessed downlights
- Building Exterior Walkway – (2) 70-watt ground flush-mounted hydrargyrum quartz iodide (HQI) metal halide lights, (7) 70-watt bollards

Mechanical Systems

- Heating, Ventilation & Air Conditioning (HVAC) System – The PLH facility HVAC equipment includes a central 100-ton Evapco Model LSCB-135 chiller and 10 packaged units that serve the heating

(natural gas) and cooling (electric) needs of the entire facility. The chiller is in a gated area adjacent to the parking lot and all packaged units are located on the roof in different sections, local to the corresponding space they serve with a total of five units dedicated to each level. Petra Models PAHHC-24, -30 and -40 (tag: AH-1 thru 5) provide the children’s areas, computer and seminar rooms in the lower level with both heating and cooling needs through a typical duct system controlled by five local thermostats. Both the upper and lower levels use locked local thermostats controlled by a central monitoring device that can only be adjusted by a phone call that must be made to building services to request a temperature change of only 1-2°F up or down from 72°F. The five units that serve the upper level are Petra Models PAHHC-40 and -80 (tag: AH-6 thru 10). A dedicated unit (tag: AH-10) serves the Community Room and like all HVAC packaged units mentioned, it is original to the building and installed circa 2002.

A smaller, stand-alone, split Trane unit serves the cooling requirements of the telecom/data room with a 450 CFM indoor fan section. This operates separately from other HVAC building from an unlocked thermostat installed inside the room. Other HVAC equipment includes five centrifugal roof exhausters that range from 230 CFM to 790 CFM to provide ventilation to the restroom as well as other areas of the facility.

- Hot Water System – A single A.O. Smith Model BTR-180-110 natural gas water heater, located in a storage closet near the workroom, provides hot water needs to the library’s restroom facilities and kitchen areas. This 180 MBH, 81-gallon unit is 2002 vintage and appears to be in good working order. This single unit serves all the hot water needs for the building.

Energy Profile

Electricity accounts for about 87% of PLH’s energy consumption with the annual peak in the summer months to meet an increased air conditioning load. Conversely, the PLH facility consumes natural gas for both space and hot water heating, with the annual peak occurring in the winter months when the demand for space heating is greatest (Figure 4).

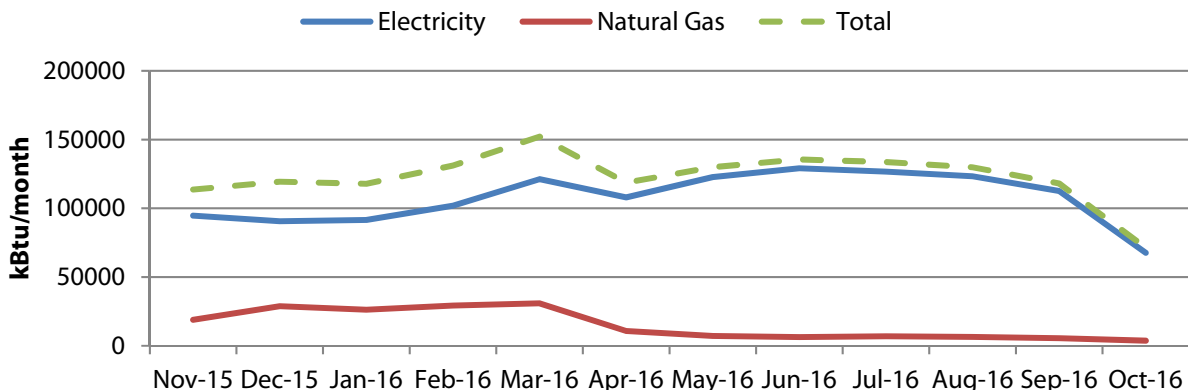


Figure 4: Point Loma-Hervey Library Energy Consumption Profile (kBtu/month)

Using 15-minute interval utility data over the course of a year, Figure 4 illustrates how the PLH facility’s electricity and natural gas use varies by season, weekday versus weekend and by time of day. For electricity, the weekday load profiles take an average of all weekday profiles separated into summer months (May-October) and winter months (November-April). The weekend load profiles take the average of all weekend days throughout the year separated into summer and winter categories.

In Figure 5, the average electric load appears slightly greater (approximately 20%) in the summer months compared to the winter months (~10%) primarily due to increased space cooling demands.

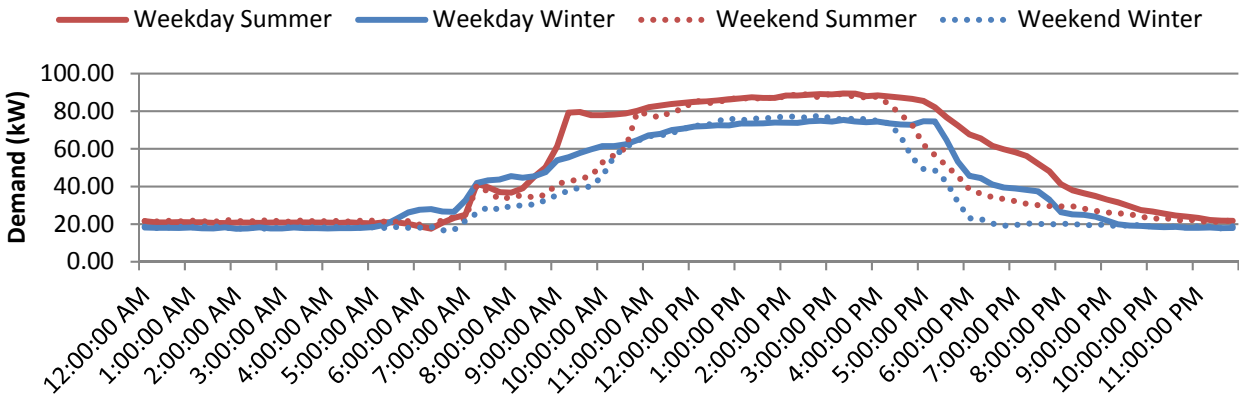


Figure 5: Point Loma-Hervey Library Seasonal Electric Demand Consumption Profile

The overnight 20 kW baseload (unoccupied) is mainly attributed to security and parking lot lighting. The morning load spikes between 7:00–9:00 a.m. coincide with library staff arriving and the HVAC schedule. Opportunities to reduce the unoccupied electricity load include upgrading emergency lighting and exterior lighting fixtures with lower wattage lamps. Additionally, proper building management software, along with on-site renewable energy generation and energy storage, can smooth these spikes and reduce peak periods of consumption.

The PLH facility is enrolled in SDG&E’s AL-TOU commercial tariff that charges customers for electric and natural gas consumed, as well as transmission and distribution costs. Table 3 outlines 12 months of the PLH facility’s electricity and natural gas usage (November 2015–October 2016). The City paid an average annual blended rate of electricity of \$0.239/kWh and \$9.25/MMBtu (\$0.925/therm) at PLH.

Utility	Meter #	Tariff	Energy Consumption	Annual Energy Costs	Avg. Cost per Unit
Natural Gas	1403761	GN-3	1,857 therms/yr.	\$1,636	\$0.88/therm
Electricity	6691684	AL-TOU	409,469 kWh/yr.	\$99,392	\$0.239/kWh
Totals				\$100,370	

Table 3: Point Loma-Hervey Library Utility Service Data and Historical Energy Consumption

Table 4 represents monthly electricity consumption using 15-minute interval data and the time-of-use (TOU) tariff through which PLH receives service. The consumption and coincident demand that occurs during each

TOU period as well as the noncoincident (max, during any TOU) monthly demand. The purpose of analyzing when energy is used is to assess the value of energy saved through various EEM recommendations. A unit of energy saved during on-peak periods is worth more than a unit saved during semi- or off-peak periods. CSE's recommended lighting and HVAC EEMs account for TOU pricing when calculating anticipated savings.

Month	Total On-Peak (kWh)	Total Semi-Peak (kWh)	Total Off-Peak (kWh)	Max of On-Peak Demand (kW)	Max of Semi-Peak Demand (kW)	Max of Off-Peak Demand (kW)
Jan	2,326	8,653	6,927	99.2	99.8	106.2
Feb	5,679	22,023	19,123	135	145.3	104.3
Mar	2,540	10,944	6,636	135	145.3	104.3
Apr	3,823	24,178	15,367	89.6	104.3	105.6
May	11,583	9,363	15,099	131.8	103	114.6
Jun	7,028	6,415	11,220	120.3	103	114.6
Jul	18,807	13,570	18,385	113.9	142.1	128
Aug	8,461	5,776	5,894	113.9	142.1	128
Sep	13,090	9,026	13,072	109.4	133.8	117.1
Oct	18,512	12,937	16,395	156.2	141.4	117.1
Nov	4,103	15,997	13,129	99.2	148.5	100.5
Dec	4,152	15,895	13,212	99.2	148.5	106.2
Total	100,104	154,777	154,459	156.2	148.5	128.0

Table 4: Point Loma-Hervey Library Annual Electricity Consumption

Table 5 displays the monthly billing components based on the applicable TOU tariff and electricity usage in Table 4. Certain monthly charges are fixed and not based on electricity use and are typically not factored into energy savings from conservation measures.

Month	Consumption Total Amount (\$)	Demand Total Amount (\$)	Tax Total Amount (\$)	Other Total Amount (\$)	Bill Total Amount (\$)	Average \$/kWh
Jan	\$1,506.95	\$2,222.09	\$232.34	\$172.67	\$4,134.05	\$0.231
Feb	\$3,913.62	\$5,517.39	\$588.07	\$434.86	\$10,453.94	\$0.244
Mar	\$1,801.51	\$3,168.08	\$305.93	\$190.83	\$5,466.35	\$0.272
Apr	\$3,712.12	\$4,488.69	\$510.19	\$400.71	\$9,111.71	\$0.219
May	\$3,510.59	\$4,620.80	\$499.25	\$319.13	\$8,949.77	\$0.247
Jun	\$2,370.65	\$2,539.93	\$303.12	\$205.68	\$5,419.38	\$0.220
Jul	\$5,042.04	\$6,393.28	\$701.95	\$445.66	\$12,582.93	\$0.248
Aug	\$2,050.73	\$2,797.56	\$296.66	\$179.71	\$5,324.66	\$0.265
Sep	\$3,495.60	\$4,539.96	\$493.00	\$311.25	\$8,839.81	\$0.251
Oct	\$4,961.52	\$7,202.63	\$742.57	\$434.23	\$13,340.95	\$0.281
Nov	\$2,838.72	\$4,573.44	\$455.68	\$299.14	\$8,166.98	\$0.245
Dec	\$2,839.94	\$4,037.82	\$424.76	\$298.46	\$7,600.98	\$0.227
Total	\$38,043.99	\$52,101.67	\$5,553.52	\$3,692.33	\$99,391.51	\$0.245

Table 5: Point Loma-Hervey Library Annual Electricity Billing Summary

Benchmarking

Benchmarking offers a quick way to compare buildings of similar types and function. Buildings are normalized by comparing the annual energy use (electricity and gas or other fuel) on a per-square-foot basis as energy use intensity (EUI). EUI information enables the development of a square footage index, which is then compared to similar buildings to identify the potential for greater energy and operational savings. CSE’s calculated benchmarking results of the PLH facility are shown in Table 6, which account for 12 months of utility consumption data.

Electric (kBtu)	1,397,166
Natural Gas (kBtu)	185,700
Total (kBtu)	1,582,866
Site Area (ft²)	22,480
Site EUI (kBtu/ ft²)	70.4

Table 6: Point Loma-Hervey Library Current Site Energy Consumption and EUI

Table 6 represents a traditional way to perform energy benchmarking, however, advanced tools, such as the Environmental Protection Agency’s ENERGY STAR Portfolio Manager, simplify analysis for energy consumers and give them the ability to connect directly to their utility to track building performance and make comparisons to similar buildings of similar use, characteristics and climate zones nationwide. This data is provided by the Commercial Buildings Energy Consumption Survey (CBECS).⁴

Comparative Energy Use Intensity

Figure 6 compares the existing site EUI to the other two libraries being evaluated by this project, similar building types that have achieved a ZNE or ultra-low verified designation, and applicable CBECS data for similar building use types. The New Building Institute (NBI) maintains a list of *Public Assembly* buildings that have achieved ZNE and ultra-low buildings including their energy consumption and EUI values. The nationwide averages for *Public Assembly* buildings use 2012 CBECS data to establish a typical EUI for similar building uses and climate zones.

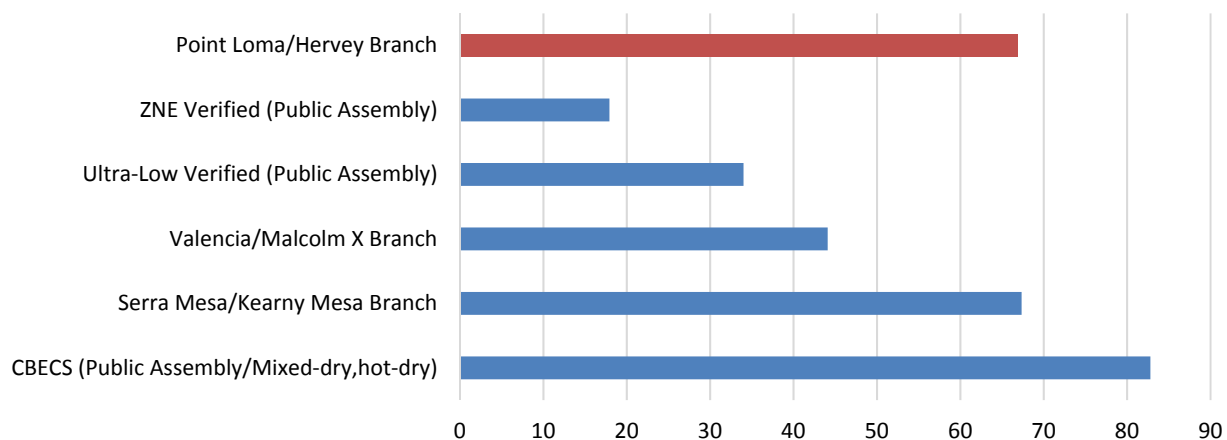


Figure 6: Point Loma-Hervey Library Existing EUI Compared to Various Averages (kBtu/ft²)

⁴ CBECS data, <https://www.eia.gov/consumption/commercial/data/2012/c&e/pdf/c11.pdf>.

When using NBI data, it is important to compare to the *base (gross) energy use* value that accounts only for the building's consumption and not any additional energy offset provided by on-site renewable energy production. Base energy use displays the building's performance with existing equipment and controls. The base energy use output ignores the variability of how much of an effect something like solar PV could have on a property's net consumption from the grid over the course of a year.

PLH currently uses about 15% less energy on a square-foot basis compared to similar facilities in the nation based on CBECS property type and climate zone data. It also uses the second most energy on a square-foot basis compared to the other two libraries chosen for this study. It also can be seen that when comparing PLH to ZNE or ultra-low verified buildings that there is great opportunity for energy savings.

End-use Breakdown

Figure 6 was generated using electric and gas utility monthly data and CBECS building energy modeling data. These end-use consumption estimates utilize engineering models that account for energy being used by HVAC equipment, lighting, office equipment and other uses. These estimates are for a *Public Assembly* building within the range of 10,001–25,001 square feet in the U.S. Pacific Census Division.

PLH facility's energy consumption is assumed to be attributed to plug loads⁵ (46%), with HVAC as the next greatest energy consuming end use (38%). It should be noted that this breakdown only shows past building consumption and could vary from how this site is operating in real time. Future planned modeling and monitoring of the site will reveal the actual end-use breakout for comparison to CBECS national average estimation.

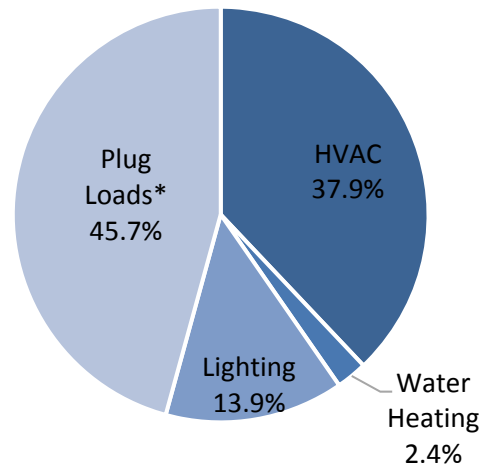


Figure 7: Point Loma-Hervey Total Energy Consumption (kBtu) by End Use

⁵ Plug loads include printers, desktops, laptops, monitors, refrigerators, TVs, etc.

III. Energy Efficiency Measures

As a result of this audit and analysis of PLH’s energy consumption trends, CSE identified several energy efficiency measures (EEMs) to help reduce energy consumption. By addressing each measure, the City creates an opportunity to increase energy efficiency by reducing both operating costs and PLH’s carbon footprint. EEMs are determined using ASHRAE Level II procedures for commercial building energy audits. The following section describes the details of each EEM recommended for consideration. A full equipment inventory for PLH is in Appendix A.

Low-cost/No-cost Measures

Replace HVAC Thermostat Controls

HVAC and lighting controls are currently controlled via local wall-mounted thermostats and manual control switches, most of which are original to the building and are more than 20 years old. This type of equipment has a useful life of 11 years, so may need replacement or upgrade. Further, building management technologies have improved significantly since the construction of this facility, and optimizing facility HVAC controls may provide additional energy savings. Currently SDG&E offers rebates that cover the full cost of programmable thermostats through their Business Energy Solutions Program.⁶

Repair Economizers

Eight of the 10 rooftop air handling units serving PLH include economizer packages. As is often the case, economizers in aging rooftop packaged units often fail within 5–7 years if proper maintenance schedules are not upheld, but have a useful life up to 10 years. CSE was unable to verify proper economizer operation during the inspection. An economizer maintenance check is recommended to ensure proper operation to secure energy savings from free cooling.

Adjust Heating/Cooling Setpoints

Additional savings might be possible through the simple adjustment and standardization of heating and cooling setpoints. Figure 8 shows energy penalties or benefits for every degree changed in cooling and heating setpoints.

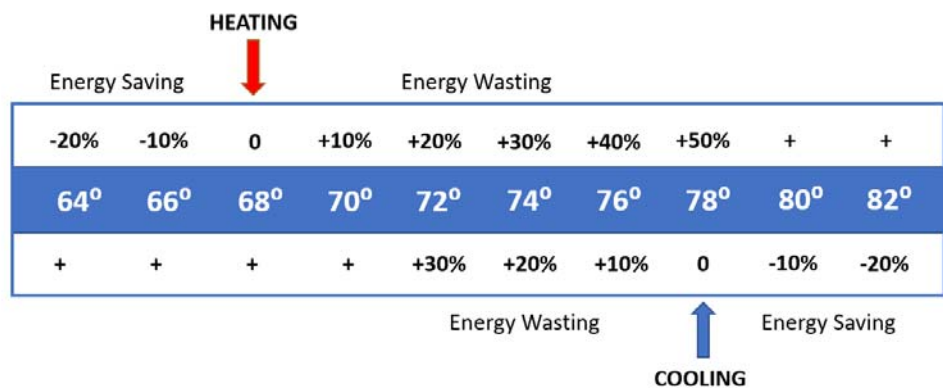


Figure 8: Energy Penalties and Benefits Resulting from Changes in Cooling and Heating Set points⁷

⁶ SDG&E Summer Saver Program, <https://www.sdge.com/business/demand-response/summer-saver-program>

⁷ National Energy Education Development Project (NEED). *Saving Energy at Home and School*. <http://www.need.org/Files/curriculum/guides/BuildingScience.pdf>, 2016-2017

Capital Investment Measures

The following section identifies measures that often provide significant energy savings and attractive net present values, but require a moderate to significant upfront capital investment. CSE evaluated the following capital investment measures at PLH.

Install Occupancy Sensors

Lighting is currently controlled via manual switches at PLH. Installing controls, such as occupancy sensors and/or daylight photosensors, can curtail energy consumption by ensuring lights are dimmed or turned off in areas with adequate sunlight infiltration or during unoccupied periods. Further, occupancy sensors and other lighting controls may be required under Title 24. Table 7 shows SDG&E's⁸ estimated energy savings by space type from the installation of occupancy sensors. These savings estimates do not pertain to whole building energy reductions, instead they are associated with the percent of lighting hours that could be reduced in a particular building space by occupancy sensors. For example, if PLH's breakroom has lighting controls up to 25% of lighting hours could be reduced.

Space Type	% Savings	Space Type	% Savings	Space Type	% Savings
Assembly	45	Industrial	45	Restroom	45
Break Room	25	Kitchen	30	Retail	15
Classroom	30	Library	15	Stair	25
Computer Room	35	Lobby	25	Storage	45
Conference	35	Lodging (Guest Rooms)	45	Technical Area	35
Dining	35	Open Office	15	Warehouses	45
Gymnasium	35	Private Office	30	Other	15
Hallway	25	Process	45	Parking Garage	15
Hospital Room	45	Public Assembly	35		

Table 7: Potential Energy Savings by Space Type from Occupancy Sensors

Tables 8 and 9 include CSE's calculated energy and costs savings that could be gained with the installation of occupancy sensors at PLH.

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
LTNG-1	Install Occupancy Sensors	0	4,383	0

Table 8: Potential Energy Savings from Occupancy Sensors

⁸ SDG&E Estimated Occupancy Sensor Energy Savings,
<https://www.sdge.com/sites/default/files/regulatory/SDG&E%202.0%20Energy%20Savings.pdf>

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive	Measure Life (yr.)	Net Measure Cost	Investment Rate of Return	Net Present Value	Simple Payback (yr.)
LTNG-1	\$1,311	\$5,700	\$0	8	\$5,700	16%	\$3,128	4.3

Table 9: Potential Cost Savings from Occupancy Sensors

Replace Existing Fixtures with LED Equivalents

Currently, PLH has a lighting density factor of 1.14 watts per square foot (including only indoor lighting), which proves to be an area of significant opportunity. The most common lighting fixtures throughout PLH are 2'x2', 40-watt U-bulb fluorescent fixtures. There are 173 4-pin compact fluorescent fixtures across the entire branch, which is equivalent to about 8 kW worth of electric energy. CSE recommends replacing existing fluorescent fixtures to continuous dimming linear LEDs. While LED technologies generally have a greater initial cost and longer payback, they offer a greater net present value because of their longer effective useful life (EUL) and annual savings.

The life expectancy of a T8 lamp is 20,000–24,000 hours. Given the lighting hours of the facility (~3,070 hours per year), this means that T8 lamps would start failing after 6.5–7.5 years. In contrast, linear LED fixtures have estimated useful lives of about 35,000–50,000 hours, or about 11–16 years, when operating at current lighting hours. Given current Title 24, Part 6 lighting requirements, LEDs have an advantage in achieving significantly lower wattage per square feet than fluorescent equivalents. Given the electric profile of PLH, reducing lamp wattage should translate to peak and maximum demand reductions. CSE analyzed replacing the various interior and exterior lighting fixtures to LED equivalent fixtures.⁹ The results are in the Tables 10 and 11.

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
LTNG-2	Replace Indoor T5 Fixtures with LED Equivalents	1.1	3,333	0
LTNG-3	Replace Indoor T8 Fixtures with LED Equivalents	0.7	2,144	0
LTNG-4	Replace Indoor Compact Fluorescent Fixtures with LED Equivalents	3.9	11,890	0
LTNG-5	Replace Indoor Halogen, Incandescent and Metal Halide Fixtures with LED Equivalents	11.8	36,154	0
LTNG-6	Replace Outdoor Compact Fluorescent and Metal Halide Fixtures with LED Equivalents	0.5	2,242	0
LTNG-7	Replace HID Parking Lot Fixtures with LED Equivalents	0.9	4,009	0

Table 10: Potential Energy Savings by Installing LED Equivalent Fixtures

⁹ Design Lighting Consortium Premium technical requirements for LED luminaires, <https://www.designlights.org/solid-state-lighting/qualification-requirements/dlc-premium-requirements/>.

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive	Measure Life (yr.)	Net Measure Cost	Investment Rate of Return	Net Present Value	Simple Payback (yr.)
LTNG-2	\$997	\$16,240	\$1,400	16	\$14,840	1%	-\$3,223	14.9
LTNG-3	\$641	\$13,285	\$1,275	16	\$12,010	-2%	-\$4,536	>EUL
LTNG-4	\$3,557	\$28,080	\$2,340	16	\$25,740	11%	\$15,707	7.2
LTNG-5	\$10,816	\$15,550	\$1,465	16	\$14,085	77%	\$111,943	1.3
LTNG-6	\$671	\$3,885	\$470	11	\$3,415	16%	\$2,461	5.1
LTNG-7	\$1,199	\$14,200	\$0	11	\$14,200	-1%	-\$3,694	>EUL

Table 11: Potential Cost Savings by Installing LED Equivalent Fixtures

Based on the above results, PLH should look to replace compact florescent, incandescent, metal halide and halogen lighting (indoor and outdoor) with LED equivalents. Combined, these lighting measures (LTNG-4 through LTNG-6) would provide about \$130,100 in net present value and a 2.9-year simple payback. Should the City wish to implement all measures, the additional lighting upgrades would erode project economics, but still produce a simple payback in less than 5 years.

HVAC Equipment Upgrade

The air conditioning and ventilation equipment serving PLH appears to be original to the building, circa 2003, and reaching its end of useful life (EUL), which is approximately 20 years. Conversations with PLH staff and visual inspections of the equipment and associated ductwork reveal no critical need to replace existing equipment other than to increase energy efficiency. While these units may operate up to or past their EUL, they may begin to incur increased operations and maintenance issues. Tables 12 and 13 show that early retirement of the existing equipment does not yet make economic sense. However, when that time does come, replacing the existing units with high-efficiency models will provide significant energy savings compared to the minimum efficiency standard and help to move the PLH facility closer toward ZNE.

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
HVAC-1	Replace Existing Heating Hot Water Boiler with 90% Efficiency or Greater	0	0	240
HVAC-2	Replace Existing Evaporative Condensing Chiller with 16 EER (0.75 kW/ton) Efficiency or Greater	10.7	14,830	0

Table 12: Potential Energy Savings from HVAC Equipment Upgrades

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive	Measure Life (years)	Net Measure Cost	IRR (over Life of Measure)	NPV	Simple Payback (yr.)
HVAC-1	\$204	\$68,400	\$360	20	\$68,040	-19%	-\$65,270	>EUL
HVAC-2	\$3,193	\$95,000	\$3,832	20	\$91,168	-3%	-\$47,776	>EUL

Table 13: Potential Cost Savings from HVAC Equipment Upgrades

IV. Conclusion

CSE recommends that the PLH facility upgrade all indoor and outdoor lighting to LED equivalent fixtures and install occupancy control sensors. Both measures can be explored within the funding and scope of this project. **When combined, these measures would reduce the library's electricity consumption by about 13.4% and bring the EUI to around 62.1 kBtu/sq.ft.** (shown in Tables 14 and 15).

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
EEM-1	Install Occupancy Sensors (LTNG-1)	0	4,383	0
EEM-2	Replace Existing Fixtures with LED Equivalents (LTNG-4,5,6)	16.1	50,286	0
TOTAL		16.1	54,669	0

Table 14: Potential Energy Savings from Recommended Energy Efficiency Measures

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive	Measure Life (yr.)	Net Measure Cost	Investment Rate of Return	Net Present Value	Simple Payback (yr.)
EEM-1	\$1,311	\$5,700	\$0	8	\$5,700	16%	\$3,128	4.3
EEM-2	\$15,043	\$47,515	\$4,275	11-16	\$43,240	34%	\$130,111	2.9
TOTAL	\$16,355	\$53,215	\$4,275	8-16	\$48,940	33%	\$133,238	3.0

Table 15: Potential Cost Savings from Recommended Energy Efficiency Measures

CSE recommends the City pursue these additional no- or low-cost energy conservation measures that further increased energy savings.

- Replace aged thermostats with new programmable thermostats
- Adjust cooling and heating setpoints to find the most energy-efficient balance to maintain occupant comfort
- Investigate current economizer functionality and repair any broken equipment
- Enroll in an HVAC cycling demand response program

Finally, CSE recommends that the City evaluate the following larger capital investment measures as part of PLH's long-term maintenance or upgrade cycles to advance the library toward ZNE.

- Replace HVAC units that have reached the end of their useful life with high-efficiency units
- Install renewable generation technologies, such as solar and storage
- Replace gas-fired package units with all-electric, high-efficiency heat pumps

APPENDIX A: Point Loma-Hervey Branch Library Equipment Inventory

Indoor and Outdoor Lighting

Area	Space ID	Fixture Description	kW per Fixture	Fixture Qty	Total Wattage
Upper Level	Rotunda	F: 6" Recessed Round Downlight	0.026	1	52
Upper Level	Rotunda	G: Continuous Surface Strip Lighting	0.013	1	13
Upper Level	South Entry (Voltaire)	F: 6" Recessed Round Downlight	0.026	1	182
Upper Level	Friends of the Library Room	A: 2'x2' Recessed U-bulb	0.040	1	240
Upper Level	Friends of the Library Room	T: Under-cabinet Task Light	0.032	1	32
Upper Level	Community Room	U: 10" Recessed Downlight	0.100	1	900
Upper Level	Community Room	F: 6" Recessed Round Downlight	0.026	1	312
Upper Level	Community Room	B: Track Lights	0.100	1	1000
Upper Level	AV/Storage Room	A: 2'x2' Recessed U-bulb	0.040	1	160
Upper Level	Kitchen	A: 2'x2' Recessed U-bulb	0.040	1	80
Upper Level	Janitor Closet	V: 1'x4' Surface Ceiling Light	0.064	2	64
Upper Level	Men's RR	C: Recessed Perimeter Lighting	0.032	1	256
Upper Level	Men's RR	F: 6" Recessed Round Downlight	0.026	1	26
Upper Level	Women's RR	C: Recessed Perimeter Lighting	0.032	1	256
Upper Level	Women's RR	F: 6" Recessed Round Downlight	0.026	1	26
Upper Level	Copy Room	A: 2'x2' Recessed U-bulb	0.040	1	80
Upper Level	Storage	A: 2'x2' Recessed U-bulb	0.040	1	80
Upper Level	Book Drop South	V: 1'x4' Surface Ceiling Light	0.064	2	64
Upper Level	Workroom	R: 2'x4' Recessed Parabolic	0.096	3	864
Upper Level	Workroom	R: 2'x4' Recessed Parabolic	0.096	3	96
Upper Level	Branch Manager Office	A: 2'x2' Recessed U-bulb	0.040	1	120
Upper Level	Circulation Desk	A: 2'x2' Recessed U-bulb	0.040	1	200
Upper Level	Circulation Desk	F: 6" Recessed Round Downlight	0.026	1	130
Upper Level	Staff Break Room	R: 2'x4' Recessed Parabolic	0.096	3	96
Upper Level	Staff Break Room Restroom	C: Recessed Perimeter Lighting	0.032	1	64
Upper Level	Seminar Room 1	A: 2'x2' Recessed U-bulb	0.040	1	80

Upper Level	Seminar Room 2	F: 6" Recessed Round Downlight	0.026	1	52
Upper Level	Janitor Room (North)	V: 1'x4' Surface Ceiling Light	0.064	2	64
Upper Level	Reading Room (North)	A: 2'x2' Recessed U-bulb	0.040	1	720
Upper Level	Alcove (West)	A: 2'x2' Recessed U-bulb	0.040	1	80
Upper Level	Seminar Room (NW)	A: 2'x2' Recessed U-bulb	0.040	1	80
Upper Level	Seminar Room (NW)	F: 6" Recessed Round Downlight	0.026	1	52
Upper Level	Reading Area (West)	A: 2'x2' Recessed U-bulb	0.040	1	600
Upper Level	Reading Area (West)	W: Wall Sconce (Indoor)	0.026	1	104
Upper Level	Reference Stacks	CC: Trough Uplights	0.150	1	1200
Upper Level	Reference Stacks	W: Wall Sconce (Indoor)	0.026	1	26
Upper Level	Reference Stacks	A: 2'x2' Recessed U-bulb	0.040	1	80
Upper Level	Reference Stacks	F: 6" Recessed Round Downlight	0.026	1	156
Upper Level	Adult Stacks	CC: Trough Uplights	0.150	1	900
Upper Level	Adult Stacks	M: Flood Light (Uplight)	0.150	1	1800
Upper Level	Adult Stacks	S: Suspended Surface Downlight (Stacks)	0.056	2	3136
Lower Level	Children's Story Area	H: Recessed 1" Pin Hole Lighting	0.050	1	400
Lower Level	Children's Story Area	K: Recessed Fiber Optic Ceiling Light	0.071	1	71
Lower Level	Children's Story Area	G: Continuous Surface strip lighting	0.013	1	13
Lower Level	Storage Room	AA: 2'x4' Recessed	0.032	1	32
Lower Level	Video/Audio Room	A: 2'x2' Recessed U-bulb	0.040	1	400
Lower Level	Multimedia Room	A: 2'x2' Recessed U-bulb	0.040	1	240
Lower Level	Telecom/Data Room	V: 1'x4' Surface Ceiling Light	0.064	2	128
Lower Level	Classroom	A: 2'x2' Recessed U-bulb	0.040	1	400
Lower Level	Seminar 3 Room	A: 2'x2' Recessed U-bulb	0.040	1	80
Lower Level	Seminar 3 Room	F: 6" Recessed Round Downlight	0.026	1	104
Lower Level	Seminar 4 Room	A: 2'x2' Recessed U-bulb	0.040	1	80
Lower Level	Seminar 4 Room	F: 6" Recessed Round Downlight	0.026	1	104
Lower Level	Seminar 5 Room	A: 2'x2' Recessed U-bulb	0.040	1	80
Lower Level	Young Adult Stacks	A: 2'x2' Recessed U-bulb	0.040	1	640
Lower Level	Men's RR (North)	C: Recessed Perimeter Lighting	0.032	1	96
Lower Level	Women's RR (North)	C: Recessed Perimeter Lighting	0.032	1	96
Lower Level	Music Room	A: 2'x2' Recessed U-bulb	0.040	1	200
Lower Level	Children's Stacks	A: 2'x2' Recessed U-bulb	0.040	1	240

Lower Level	Art Area	A: 2'x2' Recessed U-bulb	0.040	1	320
Lower Level	Children's Reading Area	A: 2'x2' Recessed U-bulb	0.040	1	160
Lower Level	Outdoor Patio	BB: Outdoor Wall Lighthouse Light	0.060	1	180
Lower Level	Janitor Closet	V: 1'x4' Surface Ceiling Light	0.064	2	128
Lower Level	Hall/Lobby	C: Recessed Perimeter Lighting	0.032	1	64
Lower Level	Men's RR	C: Recessed Perimeter Lighting	0.032	1	64
Lower Level	Women's RR	C: Recessed Perimeter Lighting	0.032	1	64
Lower Level	Elevator Equipment Room	V: 1'x4' Surface Ceiling Light	0.064	2	64
Lower Level	Ship Theme Area	B: Track Lights	0.100	1	2200
Lower Level	Ship Theme Area	N: Recessed 8" Parabolic Downlight	0.250	1	2000
Lower Level	Ship Theme Area	Z: Marine Wall Light	0.100	1	700
Lower Level	Children's Stacks (East)	A: 2'x2' Recessed U-bulb	0.040	1	1440
Lower Level	Librarian Vestibule	F: 6" Recessed Round Downlight	0.026	1	208
Lower Level	Librarian Vestibule	A: 2'x2' Recessed U-bulb	0.040	1	40
Outdoor	Main Entrance	EE: Wall Mount Lipped Sconce	0.013	1	39
Outdoor	Main Entrance	U: 10" Recessed Downlight	0.100	1	200
Outdoor	South of Bldg. (Poinsettia Dr.)	EE: Wall Mount Lipped Sconce	0.013	1	26
Outdoor	West Entrance	EE: Wall Mount Lipped Sconce	0.013	1	39
Outdoor	West Entrance	U: 10" Recessed Downlight	0.100	1	100
Outdoor	West Entrance	DD: Bollards	0.070	1	490
Outdoor	West Entrance	FF: In-ground Floodlight	0.175	1	525
Outdoor	N. of Building	U: 10" Recessed Downlight	0.100	1	300
Outdoor	N. of Building	GG: Recessed Navigation Light	0.120	1	240
Outdoor	Parking Lot	SA: Arm Mounted Pole Light (1 branch)	0.250	1	2000
Outdoor	Parking Lot	SB: Arm Mounted Pole Light (2 branch)	0.500	2	1000
Whole	Emergency Lights	Emergency Lights	0.002	1	40

Table 16: Point Loma-Hervey Branch Library Existing Indoor and Outdoor Lighting Equipment

Split and Packaged AC Units

Unit ID	Manufacturer	Model	Vintage	Cooling Capacity (MBH)	Heating Capacity (MBH)	EER	SEER	TE	Notes
AH-1	Petra	PAHHC40	2002	155.1	59.5	-	-	65%	Sensible Cap=109 MBH; VFD; Young Adults, Music
AH-2	Petra	PAHHC40	2002	92.2	81.6	-	-	65%	Sensible Cap=68.6 MBH; Children's Library Art Area
AH-3	Petra	PAHHC40	2002	102.3	90.7	-	-	65%	Sensible Cap=73 MBH; Children's Reading/Story Area
AH-4	Petra	PAHHC24	2002	45.3	35.3	-	-	65%	Sensible Cap=30.7 MBH; Seminar Room Classroom
AH-5	Petra	PAHHC32	2002	39.6	42.8	-	-	65%	Sensible Cap=28.8 MBH; Multimedia Tel/Data
AH-6	Petra	PAHHC80	2002	215	95.1	-	-	65%	Sensible Cap=147 MBH; Adult Stacks - South Reading
AH-7	Petra	PAHHC40	2002	109.6	53.5	-	-	65%	Sensible Cap=80.7 MBH; Adult Stacks - North Circulation
AH-8	Petra	PAHHC40	2002	96.5	81.8	-	-	65%	Sensible Cap=71.8 MBH; Seminar 220, Break Room Office, Workroom
AH-9	Petra	PAHHC40	2002	136.2	59.2	-	-	65%	Sensible Cap=97.6 MBH; Rotunda, South Entry, Restrooms 201/202
AH-10	Petra	PAHHC80	2002	207.8	89.1	-	-	65%	Sensible Cap=142 MBH; Community Room

Table 17: Point Loma-Hervey Branch Library Existing Split and Packaged AC Units¹⁰**Hot Water Heater**

Unit ID	Manufacturer	Model	Vintage	Capacity (Gal)	Efficiency	Notes
WH-1	A.O. Smith	BTR-180-110	2002	81	80%	-

¹⁰ EER, SEER and thermal efficiency values for the Petra units were not verified at the time of this report.

Table 18: Point Loma-Hervey Branch Library Existing Hot Water Equipment

Other Mechanical									
Unit ID	Description	Manufacturer	Model	Capacity	Unit	Voltage	HP	Efficiency	Vintage
EF-1	Centrifugal Roof Exhauster	Greenheck	GB-70	230	CFM	115	1/6	-	-
EF-2	Centrifugal Roof Exhauster	Penn	DX08B	410	CFM	115	1/4	-	-
EF-3	Centrifugal Roof Exhauster	Penn	DX08B	325	CFM	115	1/4	-	-
EF-4	Centrifugal Roof Exhauster	Penn	DX11B	790	CFM	115	1/4	-	-
EF-5	Centrifugal Roof Exhauster	Greenheck	GB-70	250	CFM	115	1/6	-	-
P-1	Pump Base Mount End Suction	Baldor	EM3710T	7.5	HP	208	7.5	92%	-
P-2	Pump Base Mount End Suction	Baldor	EM3710T	7.5	HP	208	7.5	92%	-
P-3	Pump Base Mount End Suction	Nidec	DE94	10	HP	208	10	92%	-
P-4	Pump Base Mount End Suction	Nidec	DE94	10	HP	208	10	92%	-
P-5	Pump In-line Close-coupled	Baldor	JMM3613T	5	HP	208	3	88%	-
P-6	Pump In-line Close-coupled	Weg	BE29855	5	HP	208	3	88%	-
FC-1	Indoor Fan Section	Trane	TWE018C1408	450	CFM	208	1/8	-	-
CU-1	Outdoor Section	Trane	TTB012C100A2	15.2	MBH	208	-	3.8 COP	-

Table 19: Point Loma-Hervey Branch Library Other Existing Mechanical Equipment

Plug Loads			
Space ID	Qty.	Appliance	Notes
Workroom	1	HP Laserjet 1536dnf MFP	Printing = 445W; Ready = 4.7W; Off = 0.2W
Workroom	1	HP Laserjet Enterprise M605	Printing = 840W; Sleep = 3.7W; Off = 0.1W
Copy Room	1	Xerox WorkCentre 5845	Running Avg = 1,150W; Standby = 290W; Low Power = 125W; Sleep (2 min. idle) = 4W
Circulation Desk	1	HP Laserjet P3015	Printing = 780W; Ready = 14.5W; Sleep = 3.94W; Off = 0.6W
Reference Stacks	1	HP Officejet Pro 8600 Plus	Printing = 34W; Ready = 6.6W; Sleep = 2.2W
Video/Audio Room	1	Xerox WorkCentre 5845	Running Avg = 1,150W; Standby = 290W; Low Power = 125W; Sleep (2 min. idle) = 4W
Librarian Vestibule	1	HP Color Laserjet Enterprise M553	Printing = 617W; Ready = 33.7W; Sleep = 3.94W; Off = 0.1W

Staff Break Room	1	Emerson Microwave	
Staff Break Room	1	Whirlpool Fridge	Model# ER2CHMXPQ06
Kitchen	1	GE Fridge	
Kitchen	1	GE Range/Oven	Used very infrequently; Amp Rating at 208V = 40; Bake = 2650W; Broiler = 3600W; Convection = 2500W; kW Rating at 208V = 9.5
Whole Library	24	Desktop w/ Monitor	Desktop = 240W; LCD Display = 20W

Table 20: Point Loma-Hervey Branch Library Existing Plug Loads