City of San Diego Serra Mesa-Kearny Mesa Branch Library

ASHRAE Level II Audit Report

August 2017

Prepared for

California Energy Commission

Prepared by

Center for Sustainable Energy

Center for Sustainable Energy®

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Abbreviations and Acronyms

ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
Btu	British thermal unit
Btu/hr	Btu per hour
CBECS	Commercial Buildings Energy Consumption Survey
CEC	California Energy Commission
CFL	Compact Flourescent Lamp
CFM	Cubic Feet per Minute
CSE	Center for Sustainable Energy
EER	Energy Efficiency Ratio
EUI	Energy Use Intensity
EUL	Effective Useful Life
HPS	High Pressure Sodium
HVAC	Heating Ventilation and Air Conditioning
IDSM	Integrated Demand-Side Management
kBtu	Thousand British Thermal Units
kWh	Kilowatt-Hour
LED	Light Emitting Diode
MMBtu	Million British Thermal Units
NBI	New Buildings Institute
SDG&E	San Diego Gas and Electric
SEER	Seasonal Energy Efficiency Ratio
SML	Serra Mesa Library
TE	Thermal Efficiency
ZNE	Zero Net Energy

Acknowledgements

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I. Executive Summary

Introduction

The Center for Sustainable Energy (CSE) conducted an American Society of Heating and Air-Conditioning Engineers (ASHRAE) Level II audit for the City of San Diego's Serra Mesa/Kearny Mesa Branch Library (SML or SML facility). CSE conducted this audit as part of an Electric Program Investment Charge (EPIC) demonstration agreement (EPC-15-085[1]) 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 SML facility. To help achieve the ZNE goal, CSE is identifying relevant ECMs to deploy at the facility then installing a number of energy efficiency measures (EEM) 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 streams. 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:

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[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 implementation 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

On January 11, 2017, CSE conducted a comprehensive walk-through of the SML facility to document existing appliances, equipment, fixtures, energy efficiency features and overall building characteristics to assess the site's existing energy conditions.

Following the on-site assessment, CSE developed a preliminary energy consumption profile including 12-months of the SML facility's electric and natural gas utility data, accessing the facility's ENERGY STAR Portfolio Manager profile and energy use intensity (EUI) score. This consumption analysis reveals that the SML facility consumes approximately 1,052,000 kBtu of energy annually consisting of over 273,000 kWh/yr. in electricity and 120 MMBtu/yr. in natural gas.

Figure 1 (right) shows that electricity accounts for approximately 90% of SML's overall energy consumption. Electricity is consumed primarily for lighting and HVAC, peaking during the summer months to meet an increased air conditioning demand. The SML 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.

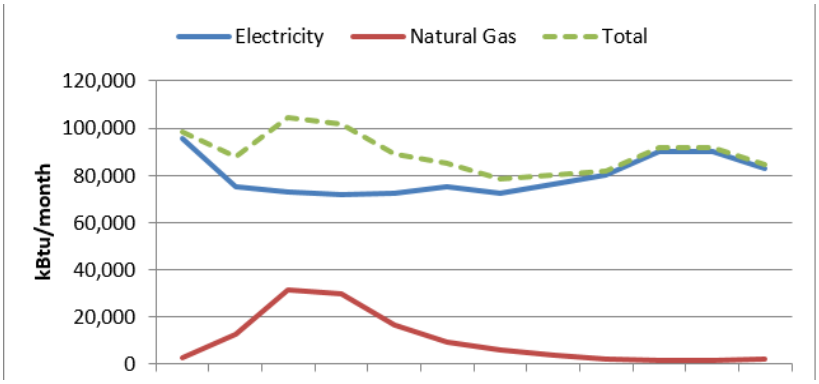

Figure 1: Serra Mesa/Kearny Mesa 2015-2016 Energy Consumption

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 SML facility's equipment, building/equipment operation systems and the overall comfort of occupants. After analyzing these opportunities in more detail, CSE recommends the following targeted EEMs based on potential energy savings for the SML facility equipment and fixtures.

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
EEM-1	Install Occupancy Sensors	0	5,065	0
EEM-2	Replace Indoor Lighting Fixtures with LED Equivalents	13.8	45,559	0
TOTAL		**13.8**	**50,624**	**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	Internal Rate of Return	Net Present Value	Simple Payback (yr.)
EEM-1	$1,418	$5,700	$0	8	$5,700	18%	$3,848	4.0
EEM-2	$12,755	$57,334	$6,187	15	$51,147	24%	$90,664	4.0
TOTAL	**$14,173**	**$63,034**	**$6,187**	•	**$56,847**	**24%**	**$94,511**	**4.0**

Table 2: Potential Cost Savings from Recommended Energy Efficiency Measures (EEMs)

When combined, these measures would reduce the library's electricity consumption by about 18.5% and bring SML's EUI down from 65.3 to approximately 56.3 kBtu/ft^2.

II. Existing Site Conditions

The Serra Mesa Library (SML or SML facility), located at 9005 Aero Drive, is a branch of the San Diego Public Library system serving the Serra Mesa and Kearny Mesa neighborhoods and surrounding communities. The library is located west of the I-15 (see Figures 2 and 3) and is in California's Climate Zone 7. The facility receives both electricity and gas service from San Diego Gas and Electric (SDG&E) with one meter for each utility service.

Figure 2: Serra Mesa-Kearny Mesa Library – Google Maps Regional View

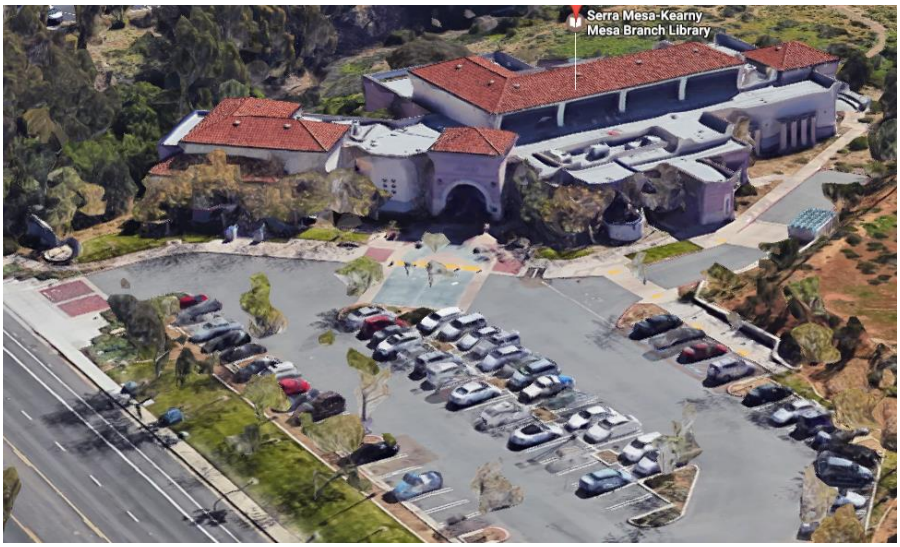

Figure 3: Serra Mesa-Kearny Mesa Library Site Map – Google Maps Satellite View

The 15,626-square-foot library was constructed in 2006 and currently serves 5,000-10,000 visitors each month. The library staff includes up to seven employees on any given shift and occupy study and seminar

rooms, a staff workroom and a community room for hosting large groups and community events. The building is open to the public during the posted 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 – Seven full-time employees arrive 30 minutes prior to library opening and leave at closing with approximately 5,000-10,000 visitors per month occupying SMLfor varying lengths of time. Custodial staff performed janitorial duties five days per week and typically leaves within one hour of library closure.

- Lighting Schedule – Same as Occupancy Schedule; minimal lighting during unoccupied hours for security purposes.

- Outdoor Lighting Schedule – Determined from 15-min Interval data to be roughly 5:30 p.m. to 7:00 a.m. and is on a timer.

- HVAC Schedule – Coincides with library operating hours, locked thermostats, controlled remotely, and on a timer. Thermostat temperature settings can only be adjusted locally by two-degree Fahrenheit; master temperature settings are controlled remotely by the City Facilities Division.

Building Envelope

- Roof – SML's sloped roof is comprised of clay roof tile on 2'x12' wood framing. Flat roofing consists of four-ply built-up roofing with skid-resistant asphalt plank walkways installed for areas requiring maintenance access All roofing includes R30 insulation.

- Walls – Exterior walls are of 2'x6' construction featuring R19 insulation, completed with cement plaster and a painted finish.

- Windows – Fixed double pane tinted windows in metal frames.

Indoor Lighting

- Stacks, Seminar and Staff Rooms – Interior lighting in the book stack areas and seminar rooms consists of suspended 1'x4' two-lamp and three-lamp F28T5 fluorescent uplight fixtures and about 20 of a 6" diameter recessed can lights with twin-tube fluorescent bulbs. Most suspended fixtures consist of perforated metal diffusers that directly the majority of light upwards. A main light switch controls most of the public space fixtures and is manually operated by library staff upon entering and exiting the premises each day. The seminar rooms include occupancy controls.

- Community Room – Interior lighting in the multipurpose room includes an array of 6" diameter recessed fluorescent can lighting for general space lighting, along with four suspended uplight lamps and stage track lighting. All the lighting in the room is controlled by a single wall-mounted manual light switch and provides five different levels of lighting options. While the space does include occupancy sensors, employees and visitors are encouraged to manually turn off lights in unoccupied spaces.

- Entrances and Atrium – The lobby space is illuminated with a variety of track lighting, recessed can lighting and hanging lamp fixtures featuring U-bulb fluorescent fixtures. A manually operated main lighting switch is turned on and off by library staff upon entering and exiting the premises each day.

Outdoor Lighting

- Parking – pole lights – (13) 250W HPS down lights.

- Landscape/Building Accent Lighting – (10) 250W HPS flood lights.

- Building Exterior Entry: (4) 100W top post-mounted high pressure sodium lamps.

- Building Exterior Walkway: (10) 70W metal halide outdoor accent lights.

Mechanical Systems

- Heating, Ventilation & Air Conditioning (HVAC) System – The library is heated (natural gas) and cooled (electricity) throughout the year via ten packaged AC units located on the roof of the library. Overall, these units appeared to be of 2005 vintage and in good condition. These units have 3-5 years of useful life remaining at the time of the audit (2017), according to equipment life expectancies[4]. These units are controlled by a central building management interface located in the Telecom room, which gives staff the ability to adjust temperatures of each zone throughout the library by a 4-degree band. Digital thermostats are located throughout the library but remain locked and are seldom touched except for the computer lab thermostat.

- The HVAC system also includes a series of exhaust fans located in restrooms and janitorial closets and barometric relief fans that operate in conjunction with the rooftop package units.

  Hot Water System – A single A.O. Smith Model GPDH-40-100 natural gas water heater, located in a janitorial closet near the entrance to the community room, provides hot water to SML's public restroom facilities and community room kitchen. This 40MBH, 40-gallon unit is 2005 vintage and appears to be in good working order.

[4] Database for Energy-Efficient Resources, Update for 2014 Codes, California Public Utilities Commission, http://www.deeresources.com/index.php/deer-versions/deer2013-update-for-2014-codes.

Energy Profile

SML consumes about 1,052,000 kBtu of energy annually consisting of over 273,000 kWh/yr. in electricity and 120 MMBtu/yr. in natural gas. Figure 4 shows that electricity accounts for about 90% of the library's overall energy consumption, peaking in the summer months. Electricity is consumed primarily for lighting and HVAC, with the peak generally occurring in the summer months to meet an increased air conditioning load. The library consumes natural gas for both space and hot water heating, with the annual peak generally occurring in the winter months when the demand for space heating is greatest.

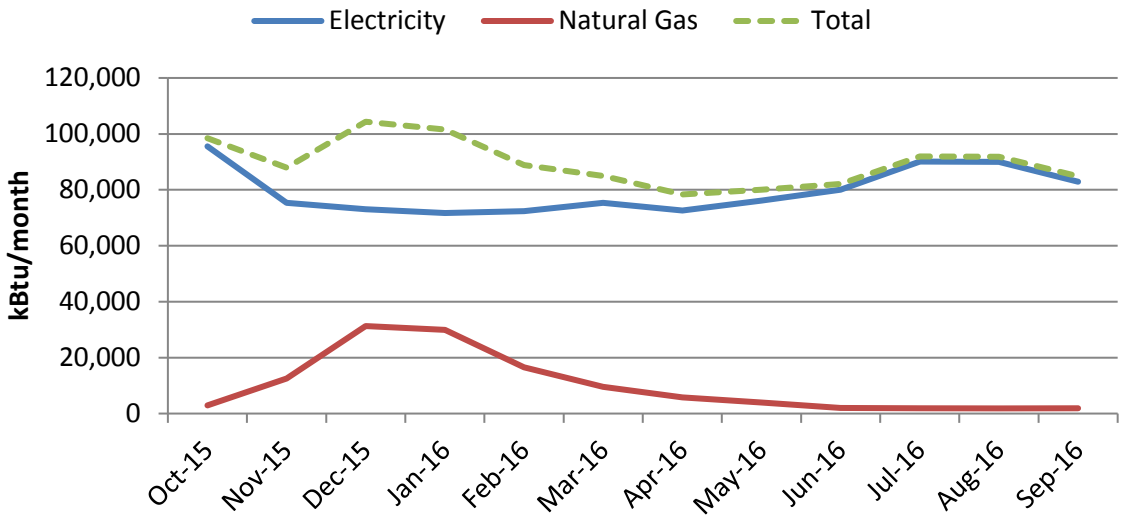

Figure 4: Serra Mesa-Kearny Mesa Library Energy Consumption Profile (kBtu/month)

Using 15-minute interval utility data over the course of a year, Figure 5 illustrates how the SML 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 the all weekend days throughout the year separated into summer and winter categories.

As illustrated in Figure 5, the average electric load is significantly greater (approximately 25%) in the summer months compared to the winter months. This variance is primarily due to increased space cooling demands during the warm summer months. The overnight 12 kW baseload (unoccupied) of is mainly attributed to security and parking lot lighting. The morning load spikes around 8-9 a.m., which coincides with library staff arriving to the facility and the heating, ventilation and air conditioning (HVAC) schedules. Opportunities to reduce the unoccupied electric 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.

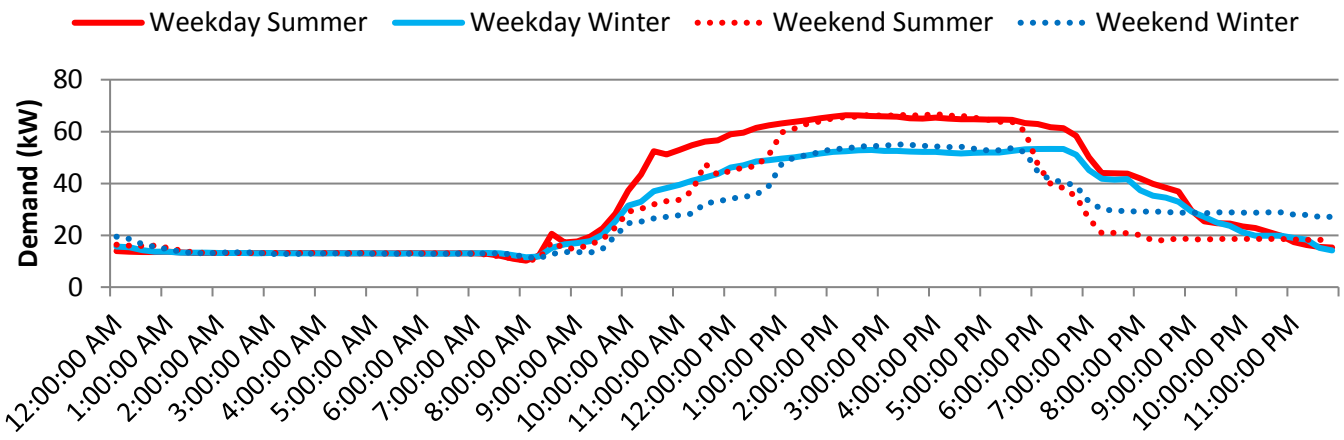

Figure 5: Serra Mesa-Kearny Mesa Library Seasonal Electric Demand Profile

SDG&E provides SML with both electric and natural gas service. Table 3 outlines 12 months (November 2015 – October 2016) of utility service data. The City pays an average blended electric rate of $0.239/kWh and gas rate of $9.10/MMBtu ($0.91/therm) for SML.

Utility	SDG&E Meter	Tariff	Energy Consumption	Annual Energy Costs	Avg. Cost per Unit
Natural Gas	1300058	GN-3	1201 therms/yr.	$1,098	$0.91/therm
Electricity	6693453	AL-TOU	273259 kWh/yr.	$65,473	$0.240/kWh
Totals				$66,571	

Table 3: Serra Mesa-Kearny Mesa Library Utility Service Data and Historical Energy Consumption

Table 4 is representative of the monthly electric consumption using 15 minute interval data and the Time of Use (TOU) tariff through which SML receives service. The table displays the consumption and coincident demand during each TOU period as well as the non-coincident (Max, during any TOU) monthly demand. The purpose of analyzing *when* energy is being used is to assess the value of energy saved through different proposed measures. A unit of energy saved during On-Peak periods is worth more than a unit saved during Semi- or Off-Peak periods. Proposed lighting and HVAC measures accounted for TOU pricing when calculating anticipated savings.

Month	On-Peak (kWh)	Semi-Peak (kWh)	Off-Peak (kWh)	On-Peak Demand (kW)	Semi-Peak Demand (kW)	Off-Peak Demand (kW)	Max Demand (kW)
Jan	2315	7926	6435	56.6	61.4	58.9	61.4
Feb	2981	10259	8924	66.6	75.8	70.4	75.8
Mar	2716	10034	7382	66.6	75.8	70.4	75.8
Apr	3142	11695	8497	73	73.6	73	73.6
May	8210	5368	7982	90.9	90.6	89.6	90.9
Jun	8529	5325	7863	90.9	90.6	89.6	90.9
Jul	11564	7159	10203	93.4	84.8	87	93.4
Aug	9502	5724	6325	93.4	84.8	87	93.4
Sep	9558	6140	9880	94.7	85.1	82.9	94.7
Oct	11289	7178	10353	89.9	81.9	80	89.9
Nov	2886	10696	8329	74.2	84.8	73.9	84.8
Dec	2809	10043	8038	65.9	63.4	58.9	65.9
Total	**75501**	**97547**	**100211**	**94.7**	**90.6**	**89.6**	**94.7**

Table 4: Serra Mesa-Kearny Mesa 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 conservations measures.

Month	Consumption Total Amount ($)	Demand Total Amount ($)	Other Total Amount ($)	Tax Total Amount ($)	Bill Total Amount ($)
Jan	$1,406.01	$1,939.39	$198.76	$211.21	$3,755.37
Feb	$1,859.55	$2,363.73	$250.51	$267.03	$4,740.82
Mar	$1,789.40	$2,582.32	$230.54	$273.68	$4,875.94
Apr	$2,008.33	$2,388.35	$257.68	$276.02	$4,930.38
May	$2,138.87	$2,718.93	$241.94	$301.24	$5,400.98
Jun	$2,161.40	$2,685.75	$218.48	$299.31	$5,364.94
Jul	$2,887.79	$3,684.23	$292.64	$405.46	$7,270.12
Aug	$2,198.91	$2,851.25	$219.69	$311.06	$5,580.91
Sep	$2,830.26	$3,349.53	$259.34	$379.93	$6,819.06
Oct	$2,877.47	$3,647.55	$294.19	$402.80	$7,222.01
Nov	$1,880.96	$2,537.22	$231.20	$275.31	$4,924.69
Dec	$1,791.87	$2,303.48	$235.98	$256.62	$4,587.95
Total	**$25,830.82**	**$33,051.73**	**$2,930.95**	**$3,659.67**	**$65,473.17**

Table 5: Serra Mesa-Kearny Mesa 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. The City of San Diego uses ENERGY STAR Portfolio Manager to conduct ongoing benchmarking of SML. CSE accessed the SML Portfolio Manager profile and observed that the current site EUI is 67.3 as shown in Table 6.

Electric (kBtu)	932,398
Natural Gas (kBtu)	120,071
Total (kBtu)	1,052,469
Site Area (ft^2)	15,626
Site EUI (kBtu/ ft^2)	**67.3**

Table 6: Serra Mesa-Kearny Mesa 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).[5]

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 Institue (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 a similar building uses and climate zones.

When using the 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.

[5] CBECS data, https://www.eia.gov/consumption/commercial/data/2012/c&e/pdf/c11.pdf.

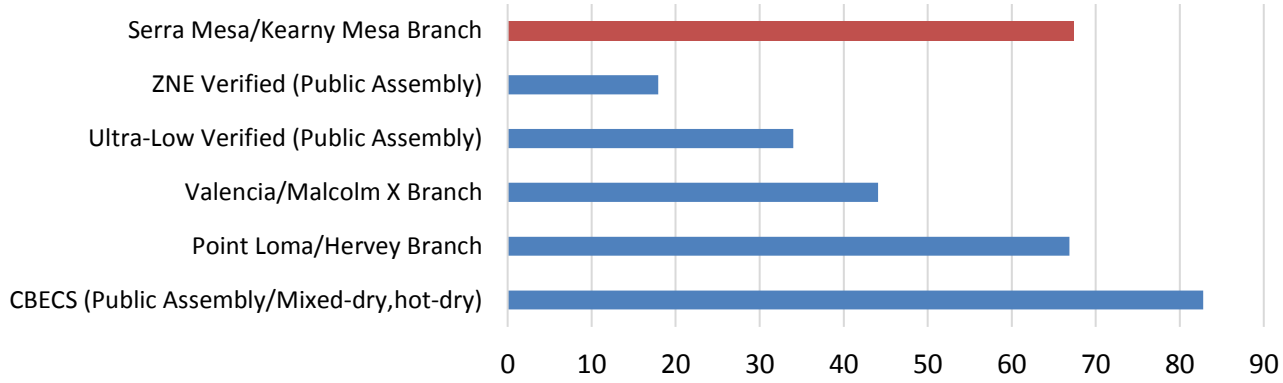

Figure 6: Serra Mesa-Kearny Mesa Branch Library EUI Compared to Various Averages (kBtu/ft²)

SML currently uses about 17% less energy on a square-foot basis compared to similar facilities in the nation according to CBECS property type and climate zone data. Contrastly, SML uses the most energy on a square-foot basis than the other two libraries chosen for this study. It can also be seen that when comparing SML to ZNE or ultra-low verified buildings that many energy efficiency opportunities need to be deployed in order to reach ZNE or near-ZNE thresholds.

End-use Breakdown

The following end-use breakdown was generated using electric and gas utility monthly data and CBECS building energy modeling data. These end-use consumption estimates utilize engineering models to account for energy consumed by heating and cooling equipment, ventilation, lighting, office equipment and other uses. These estimates are for a *Public Assembly* building within the range of 10,001 – 25,000 square feet in the U.S. Pacific Census Region.

Figure 7 shows most SML's energy consumption is assumed to be attributed to plug loads*[6] (46%), with HVAC as the next greatest energy consuming end use. 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.

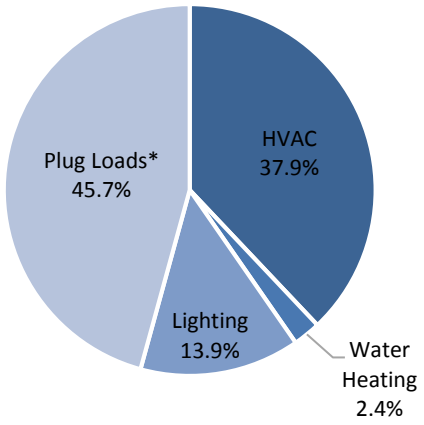

Figure 7: Valencia Park/Malcolm X Library Total Energy Consumption (kBtu) by End-Use

[6] Plug loads include printers, desktops, laptops, monitors, refrigerators, TVs, etc.

III. Energy Efficiency Measures

Resulting from this audit and analysis of SML's energy consumption trends, CSE identified several energy efficiency measures (EEMs) to help reduce energy consumption in SML. By addressing each measure, the City creates an opportunity to increase energy efficiency by reducing both operating costs and SML'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 SML is located in Appendix A.

Low-Cost/No-Cost Measures

Replace HVAC Thermostat Controls

HVAC units are currently controlled via locally-controlled wall-mounted thermostats, most of which are original to the building and are more than 12 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.[7]

Adjust Heating/Cooling Setpoints

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

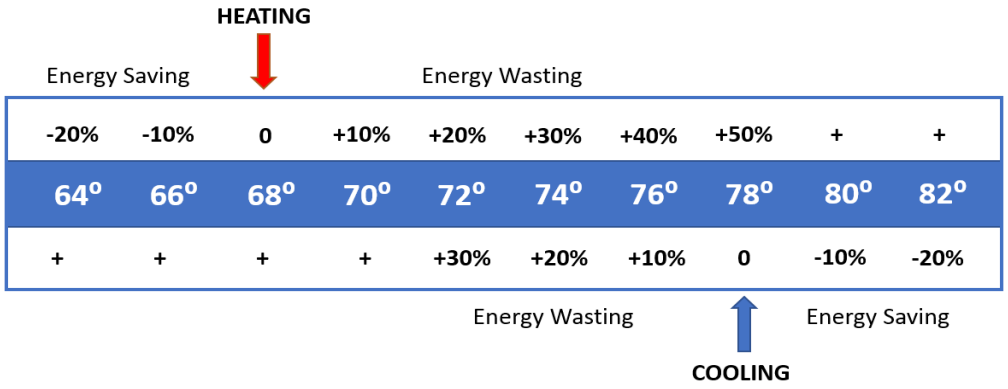

Figure 8: Energy Penalties and Benefits Resulting from Changes in Cooling and Heating Set points[8]

Repair Economizers

Four of the 10 rooftop air conditioning units serving the SML include nonintegrated economizer units. As often is the case, economizers in aging rooftop packaged units fail within 5-7 years[8] if proper maintenance schedules are not upheld, but generally 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 and secure energy savings from free cooling. SDG&E currently offers incentives for commercial HVAC tune-ups and discounted maintenance packages through the Premium Efficiency Cooling

[7] Business Energy Solutions Program, https://www.sdge.com/business/sdges-business-energy-solutions-program.
[8] Database for Energy-Efficient Resources, Update for 2014 Codes, California Public Utilities Commission, http://www.deeresources.com/index.php/deer-versions/deer2013-update-for-2014-codes.

program.[9] Incentive amounts are based on the size of the systems and economizer options, however, the program expires on December 31, 2017.

Automated Demand Response
SDG&E's Summer Saver Program[10] is a no-cost, energy-saving demand response program where customers enroll to have their HVAC units cycled during peak periods throughout summer (up to 60 hours during May through October). In return, SDG&E provides an annual credit on customers SDG&E bill.

The air conditioning units run times are reduced by the selected 30% or 50% cycling, compared to the hour before the conservation period. For 50% cycling this is half the run time. A 50% cycling enrollment would earn $7.50/ton and 30% cycling would earn $4.50/ton. **If SML were to enroll all their units, this would amount to approximately $286 per year for 30% cycling and $476 per year for 50% cycling.**

Capital Investment Measures

This section identifies measures requiring a moderate to significant upfront investment for the SML faciltiy. These measures can provide significant energy savings and attractive net-present values. CSE evaluated the following capital investment measures and plan to implement many them during the project's construction phase.

Occupancy Sensors
Lighting is currently controlled via manual switches at SML. 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 by Title 24, Part 6. Table 7 below shows SDG&E's[11] estimated energy savings (5) from installing occupancy sensors for different space types. **SML classifies as a Public Assemble space type.**

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: Valencia Park/Malcolm X Branch Library Potential Energy Savings from Occupancy Sensors by Space Type

[9] SDG&E Premium Efficiency Cooling program, https://www.sdge.com/premium-efficiency-cooling.
[10] SDG&E's Summer Saver Program, https://www.sdge.com/business/demand-response/summer-saver-program.
[11] SDG&E Estimated Occupancy Sensor Energy Savings, https://www.sdge.com/sites/default/files/regulatory/SDG&E%202.0%20Energy%20Savings.pdf

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

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
LTNG-1	Install Occupancy Sensors	-	5,065	-

Table 8: Potential Energy Savings by Occupancy Sensors

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	$1,418	$5,700	$0	8	$5,700	18%	$3,848	4.0

Table 9: Potential Cost Savings by Occupancy Sensors

Replace Existing Fixtures with LED Equivalents

SML currently has an indoor lighting power density of 1.33 watts per square foot and presents an opportunity for energy efficiency improvement. The most common lighting fixtures throughout SML consist of 4-ft 28-watt linear fluorescent 2- or 3-lamp fixtures. There are 81 T5 fixtures across the entire branch, which is equivalent to about 162 individual lamps. CSE recommends replacing existing 28-watt and 32-watt fluorescent fixtures to continuous dimming linear LEDs. While LED technologies generally have a greater upfront 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 (~3,300 hours/year), this means that T8 lamps would start failing after 6-7 years. In contrast, linear LED fixtures have estimated useful lives of about 35,000-50,000 hours, or about 11-15 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 foot than fluorescent equivalents. Given SML's electric profile, reducing lamp wattage also should translate to peak demand and energy reductions. CSE analyzed replacing the various interior and exterior lighting fixtures to LED equivalent fixtures.[12] The results are in the Tables 10 and 11.

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

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
LTNG-2	Replace T5/T5HO Fixtures with LED Equivalents	10.3	33,904	-
LTNG-3	Replace T8 Fixtures with LED Equivalents	0.3	1,038	-
LTNG-4	Replace Indoor Compact Fluorescent Fixtures with LED Equivalents	2.4	8,005	-
LTNG-5	Replace Halogen Incandescent Fixtures with LED Equivalents	0.8	2,613	-
LTNG-6	Replace Outdoor Compact Fluorescent Fixtures with LED Equivalents	0.7	2,957	-
LTNG-7	Replace HID Parking Lot Fixtures with LED Equivalents	1.0	4,171	-
LTNG-8	Replace Outdoor Metal Halide Fixtures with LED Equivalents	0.4	1,905	-

Table 10: Potential Energy Savings by Installing LED Equivalent Fixtures

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.)
LTNG-2	$9,492	$23,490	$2,025	15	$21,465	44%	$84,066	2.3
LTNG-3	$291	$8,880	$850	15	$8,030	-7%	-$4,800	>EUL
LTNG-4	$2,241	$22,170	$2,790	15	$19,380	8%	$5,537	8.6
LTNG-5	$731	$2,794	$522	15	$2,272	32%	$5,860	3.1
LTNG-6	$828	$9,735	$1,770	10	$7,965	1%	-$1,251	9.6
LTNG-7	$1,168	$15,000	$0	10	$15,000	-4%	-$5,528	>EUL
LTNG-8	$533	$2,800	$300	10	$2,500	17%	$1,825	4.7

Table 11: Potential Cost Savings by Installing LED Equivalent Fixtures

Based on the above results, SML should look to replace interior lighting with LED equivalents. Combined, all indoor lighting measures (LTNG-2 through LTNG-5) would provide about $90,600 in net present value and a four-year simple payback.

HVAC Equipment Upgrade

The air conditioning equipment serving the library appears to be original to the building, vintage 2005, and will be reaching the end of its useful life within the next 3-5 years per ASHRAE equipment life expectancies. However, as can be seen in the following tables, early retirement of the existing units does not make economic sense. As the equipment listed in Table 3 is more than 12 years old at the time of this assessment, replacing the existing units with high-efficiency models when they burnout will provide significant energy savings compared to the minimum efficiency standard and help to move the site closer to its ZNE goals. SML also may wish to compare switching some of the gas-fueled package units to electric heat pumps when the units need replacement.

Measure Number	Measure Description	Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)
HVAC-1	Replace AC-1 unit with 13 EER or greater	0.2	38	0
HVAC-2	Replace AC-2 unit with 13 EER or greater and add economizer	0.2	715	0
HVAC-3	Replace AC-3 unit with 12.5 EER or greater and add economizer	0.6	1,772	0
HVAC-4	Replace AC-3 unit with 12.5 EER or greater and add economizer	0.6	1,804	0
HVAC-5	Replace AC-5 unit with 13 EER or greater	0.2	29	0
HVAC-6	Replace AC-6 unit with 18 SEER or greater and add economizer	1.1	899	0
HVAC-7	Replace AC-7 unit with 18 SEER or greater and add economizer	2.0	356	0
HVAC-8	Replace AC-8 unit with 18 SEER or greater and add economizer	1.7	476	0
HVAC-9	Replace AC-9 unit with 13 EER or greater	0.2	36	0
HVAC-10	Replace AC-10 unit with 18 SEER or greater	1.7	142	0

Table 12: Potential Energy Savings from HVAC Equipment Upgrades

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive[13]	Measure Life (years)	Net Measure Cost	IRR (over Life of Measure)	NPV	Simple Payback (yr.)
HVAC-1	$8	$12,727	$32	15	$12,695	N/A	-$12,606	>EUL
HVAC-2	$154	$12,727	$134	15	$12,593	-16%	-$10,881	>EUL

[13] SDG&E 2017 Energy Efficiency Business Incentives, https://www.sdge.com/rebates-finder/save-energy-earn-incentives.

HVAC-3	$382	$18,814	$358	15	$18,456	-12%	-$14,209	>EUL
HVAC-4	$388	$18,814	$362	15	$18,452	-12%	-$14,138	>EUL
HVAC-5	$6	$12,727	$31	15	$12,696	N/A	-$12,630	>EUL
HVAC-6	$194	$5,567	$295	15	$5,272	-7%	-$3,115	>EUL
HVAC-7	$77	$4,403	$353	15	$4,050	-13%	-$3,193	>EUL
HVAC-8	$102	$4,791	$322	15	$4,469	-11%	-$3,335	>EUL
HVAC-9	$8	$14,452	$32	15	$14,420	N/A	-$14,331	>EUL
HVAC-10	$31	$4,791	$272	15	$4,519	-20%	-$4,175	>EUL

Table 13: Potential Cost Savings from HVAC Equipment Upgrades

IV. Conclusion

CSE recommends that the SML facility upgrade all indoor lighting to LED equivalent fixtures and install occupancy control sensors. Both of these 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 18.5% and reduce the EUI from 67.3 to approximately 56.3 kBtu/sq.ft.** as 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	0	5,065	0
EEM-2	Replace Indoor Lighting Fixtures with LED Equivalents	13.8	45,559	0
TOTAL		13.8	50,624	0

Table 14: Potential Energy Savings from Recommended Energy Efficiency Measures

Measure Number	Total Cost Savings	Measure Cost	Potential Utility Incentive[14]	Measure Life (years)	Net Measure Cost	IRR (over Life of Measure)	NPV	Simple Payback (yr.)
EEM-1	$1,418	$5,700	$0	8	$5,700	18%	$3,848	4.0

[14] 2017 Energy Efficiency Business Incentives. SDG&E, https://www.sdge.com/rebates-finder/save-energy-earn-incentives.

EEM-2	$12,755	$57,334	$6,187	15	$51,147	24%	$90,664	4.0
TOTAL	$14,173	$63,034	$6,187		$56,847	24%	$94,511	4.0

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.

- Replacing aged thermostats with new programable thermostats.
- Adjusting cooling and heating setpoints to find the most energy efficient balance to maintain occupant comfort.
- Investigating current economizer functionality and repairing any broken equipment.
- Enroll in an HVAC cycling demand response program.

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

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

APPENDIX A: Serra Mesa/Kearny Mesa Library Branch Equipment Inventory

Indoor and Outdoor Lighting

Area	Space ID	Fixture Description	kW per Fixture	Fixture Qty.	Total Wattage
Interior	Lobby/Main Entrance	X1: Spotlight	0.050	8	400
Interior	Lobby/Main Entrance	F: 6" Can Downlight	0.032	6	192
Interior	Lobby/Main Entrance	P1: Hanging lamp	0.026	1	26
Interior	Lobby/Main Entrance	S1: Wall Sconce	0.027	2	54
Interior	Men's Public RR (lobby)	F: 6" Can Downlight	0.032	3	96
Interior	Men's Public RR (lobby)	D: Wall slot light	0.056	1	56
Interior	Women's Public RR (lobby)	F: 6" Can Downlight	0.032	3	96
Interior	Women's Public RR (lobby)	D: Wall slot light	0.056	1	56
Interior	Seminar Rm 2/B	B: Suspended 4' linear indirect fluorescent	0.108	2	216
Interior	Seminar Rm 1/A	B: Suspended 4' linear indirect fluorescent	0.108	1	108
Interior	Community Room	F1: 6" Can Downlight (slanted)	0.032	10	320
Interior	Community Room	P1: Hanging lamp	0.026	4	104
Interior	Community Room	X1: Spotlight	0.050	8	400
Interior	Community Room	Q: 4" Accent Luminary	0.075	2	150
Interior	Community Room Janitorial Room	F: 6" Can Downlight	0.032	1	32
Interior	Community Room Elec Room	F: 6" Can Downlight	0.032	1	32
Interior	Community Room: Storage Room	M: 1x4' Recessed Ceiling Light	0.064	1	64
Interior	Community Room: Kitchen Room	K: Task Lighting	0.025	1	25
Interior	Juvenile Stacks	P3: Hanging Fixture	0.078	9	702
Interior	Juvenile Stacks	P4: Hanging Fixture	0.078	6	468
Interior	Juvenile Stacks	P5: Hanging Fixture	0.052	5	260
Interior	Juvenile Stacks	A: Suspended 4' lamp	0.056	2	112
Interior	Juvenile Stacks	A1: Suspended 4' lamp	0.056	1	56
Interior	Children's Area	S: Wall Fixture	0.013	4	52
Interior	Children's Area	T: Recessed 7" Can Downlight	0.032	19	608

Interior	Children's Area	W: Outdoor Recessed LED Luminaire	0.025	8	200
Interior	Young Adult Area	A: Suspended 4' lamp	0.056	10	560
Interior	Young Adult Area	A1: Suspended 4' lamp	0.056	3	168
Interior	Young Adult Area	S: Wall Fixture	0.013	3	39
Interior	Adult Stacks	A: Suspended 4' lamp	0.056	47	2632
Interior	Adult Stacks	F: 6" Can Downlight	0.032	2	64
Interior	Adult Stacks	S: Wall Fixture	0.013	10	130
Interior	Gallery	P: Suspended lamp	0.104	3	312
Interior	Gallery - Book Shelves	Book Shelf Downlights	0.032	28	896
Interior	Research Area	C: 2x2' Recessed Skylight	0.040	12	480
Interior	Research Area	S: Wall Fixture	0.013	3	39
Interior	Reference	C: 2x2' Recessed Skylight	0.040	12	480
Interior	Reference	S: Wall Fixture	0.013	3	39
Interior	Reading Room	R: Recessed Display Wall Washer	0.040	4	160
Interior	Reading Room	H: Linear uplighting	0.018	10	180
Interior	Computer Lab	B: Suspended 4' linear indirect fluorescent	0.108	4	432
Interior	Circulation Desk	R: Recessed Display Wall Washer	0.040	3	120
Interior	Circulation Desk	P2: Suspended Lamp	0.052	4	208
Interior	Circulation Desk	F: 6" Can Downlight	0.032	8	256
Interior	Circulation Desk	K: Task Lighting	0.025	2	50
Interior	Manager's Office	B: Suspended 4' linear indirect fluorescent	0.108	2	216
Interior	Staff Backroom	B: Suspended 4' linear indirect fluorescent	0.108	8	864
Interior	Staff Kitchen	C: 2x2' Recessed Skylight	0.040	4	160
Interior	Book Drop Room	B: Suspended 4' linear indirect fluorescent	0.108	1	108
Interior	Staff Restroom	F: 6" Can Downlight	0.032	2	64
Interior	Telecom Room	N: 1x4' Industrial Turret	0.064	3	192
Interior	Main Entrance	SK: Outdoor Wall-Mount Lamp	0.032	2	64
Interior	Main Entrance	F1: 6" Can Downlight (slanted)	0.032	1	32
Exterior	Outdoor: SE of Bldg	SK: Outdoor Wall-Mount Lamp	0.032	2	64

Exterior	Outdoor: SE of Bldg	SL: Outdoor Ceiling Mount Lamp	0.032	4	128
Exterior	Outdoor: SW of Bldg	SL: Outdoor Ceiling Mount Lamp	0.032	4	128
Exterior	Outdoor: NE of Bldg	SL: Outdoor Ceiling Mount Lamp	0.000	3	0
Exterior	Outdoor: NE of Bldg	SK: Outdoor Wall-Mount Lamp	0.032	7	224
Exterior	Outdoor: W of Bldg	SL: Outdoor Ceiling Mount Lamp	0.032	7	224
Exterior	Outdoor: W of Bldg	SK: Outdoor Wall-Mount Lamp	0.032	7	224
Exterior	Outdoor: S of Bldg	SK: Outdoor Wall-Mount Lamp	0.032	4	128
Exterior	Outdoor: E of Bldg	SK: Outdoor Wall-Mount Lamp	0.032	10	320
Exterior	Outdoor: E of Bldg	SL: Outdoor Ceiling Mount Lamp	0.032	2	64
Exterior	Outdoor: E of Bldg	SM: Outdoor wall-mount Downlight	0.032	9	288
Exterior	Outdoor: E of Bldg	W: Outdoor Recessed LED Luminaire	0.025	35	875
Exterior	Outdoor: Parking Lot	SA: Arm Mounted Pole Light (1 branch)	0.250	9	2250
Exterior	Outdoor: Parking Lot	SB: Arm Mounted Pole Light (2 branch)	0.500	2	1000
Exterior	Outdoor: Parking Lot	SC: Post Top mounted lamp	0.100	4	400
Exterior	Outdoor: Parking Lot	SD: Outdoor accent downlight	0.070	10	700

Table 16: Serra Mesa/Kearny Mesa Branch 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
AC-1	Trane	YHC072	2005	72	64	12.6	-	80%	Community Rm 110
AC-2	Trane	YHC072	2005	72	64	12.6	-	80%	Seminar Rms
AC-3	Trane	YCD151	2005	150	184	11.3	-	81%	Children's Rm 131
AC-4	Trane	YCD151	2005	NA	NA	11.3	-	81%	Stacks
AC-5	Trane	YHC072	2005	72	64	12.6	-	80%	Circulation
AC-6	Trane	YHC060	2005	60	48	14.2	-	80%	Staff Work Rm

AC-7	Trane	YCP024	2005	24	30	-	12.0	80%	Tele. Rm 135
AC-8	Trane	YHC036	2005	36	40	12.7	15.0	78%	Comp. Rm 124
AC-9	Trane	YHC092	2005	90	96	12.6	-	80%	Reference Rm 126
AC-10	Trane	YHC036	2005	36	48	12.7	15.0	78%	Reading Rm 129

Table 17: Serra Mesa/Kearny Mesa Branch Existing Split and Packaged AC Units

Hot Water Heater

Unit ID	Manufacturer	Model	Vintage	Capacity (Gal)	EF	Notes
WH-1	A.O. Smith	GPDH-40-100	2005	40	0.59	-

Table 18: Serra Mesa/Kearny Mesa Branch Existing Hot Water Equipment

Other Mechanical

Unit ID	Description	Manufacturer	Model	Capacity	Unit	Voltage	HP	Efficiency	Vintage
EF-1	Janitors Rm 109	Greenheck	6-080-D-X	250	CFM	120	1/30	-	2005
EF-2	Electric Rm 112	Greenheck	6-085-D-X	400	CFM	120	1/30	-	2005
EF-3	Men's Restroom 104	Greenheck	6-90-D-X	450	CFM	120	1/15	-	2005
EF-4	Women's Restroom 105	Greenheck	6-90-D-X	450	CFM	120	1/15	-	2005
EF-5	Staff Restroom	Greenheck	6-080-D-X	250	CFM	120	1/30	-	2005

EF-6	Janitors Rm 121	Greenheck	6-080-D-X	250	CFM	120	1/30	-	2005
EF-7	Electric Rm 134	Greenheck	6-90-D-X	450	CFM	120	1/15	-	-
RV-8	Intake/Relief Hood	Greenheck	GRS-8	250	CFM	-	-	-	-
RV-10	Intake/Relief Hood	Greenheck	GRSR-10	400	CFM	-	-	-	2005
RV-12	Intake/Relief Hood	Greenheck	GRSR-12	600	CFM	-	-	-	2005
RV-14	Intake/Relief Hood	Greenheck	GRSR-14	1000	CFM	-	-	-	2005
RV-16	Intake/Relief Hood	Greenheck	GRS-16	1000	CFM	-	-	-	-
RH-1	Range Hood	Broan	894804	460	CFM	120	-	-	2005

Table 19: Serra Mesa/Kearny Mesa Branch Other Existing Mechanical Equipment

Plug Loads

Space ID	Qty	Appliance	Notes
Circulation Desk	1	HP LaserJet P3015	Printing = 780W; Ready = 14.5W; Sleep = 3.94W; Off = 0.6W
Circulation Desk	1	Xerox WorkCentre 5845	Running Avg = 1,150W; Standby = 290W; Low Power = 125W; Sleep (2 Min Idle) = 4W
Circulation Desk	1	Xerox WorkCentre 5845	Running Avg = 1,150W; Standby = 290W; Low Power = 125W; Sleep (2 Min Idle) = 4W
Staff Backroom	1	HP LaserJet Pro 400 M451dw	Printing = 425W; Ready = 15.2W; Sleep = 4W; Off = 0.5W
Staff Backroom	1	HP Officejet Pro L7680	Printing = 40W; Ready = 5.593W
Staff Kitchen	1	Electrolux Fridge	Model# FFTR1814LWA
Staff Kitchen	1	LG Microwave	1.5 cu.ft.
Serra Mesa Library	58	Desktop w/ Monitor	Desktop = 240W; LCD Display = 20W

Table 20: Serra Mesa/Kearny Mesa Branch Existing Plug Loads