

EPC-15-085:
Report of Installation Activities

*City of San Diego Public Library ZNE
Demonstration Project*

Prepared for
California Energy Commission

Prepared by
Center for Sustainable Energy

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I. Introduction

The Center for Sustainable Energy (CSE) developed this *Report of Installation Activities* with contributions from Mazzetti Inc. (Mazzetti), M+NLB Construction Services (M+NLB), San Diego Green Building Council (SDGBC), City of San Diego (City) and San Diego Gas & Electric (SDG&E). It documents installation activities completed at three City of San Diego public libraries (Serra Mesa-Kearny Mesa, Valencia Park/Malcolm X and Point Loma/Hervey) as part of the California Energy Commission (Energy Commission) Electric Program Investment Charge¹ demonstration project EPC-15-085. This project is a demonstration of cost-effective zero net energy (ZNE) and integrated demand-side management strategies that are referred to throughout this report as energy conservation measures (ECMs). ECMs were installed in all three existing libraries with the goal of achieving ZNE or near-ZNE when coupled with existing photovoltaic (PV) systems.

II. Installation Planning

A design evaluation of each library was conducted from December 2018 to February 2019 by Mazzetti. At each library, significant opportunities reached from a baseline analysis² were found to reduce energy consumption, improve occupant comfort, reduce building maintenance and extend equipment life. The following ECMs were initially identified.³

- Retrofitting lighting systems and adding controls
- Replacing existing HVAC equipment with new high-efficiency units and adding controls
- Upgrading building management systems (BMS) to enable smart building control strategies
- Optimizing plug loads
- Securing the building envelope with window film and weatherstripping

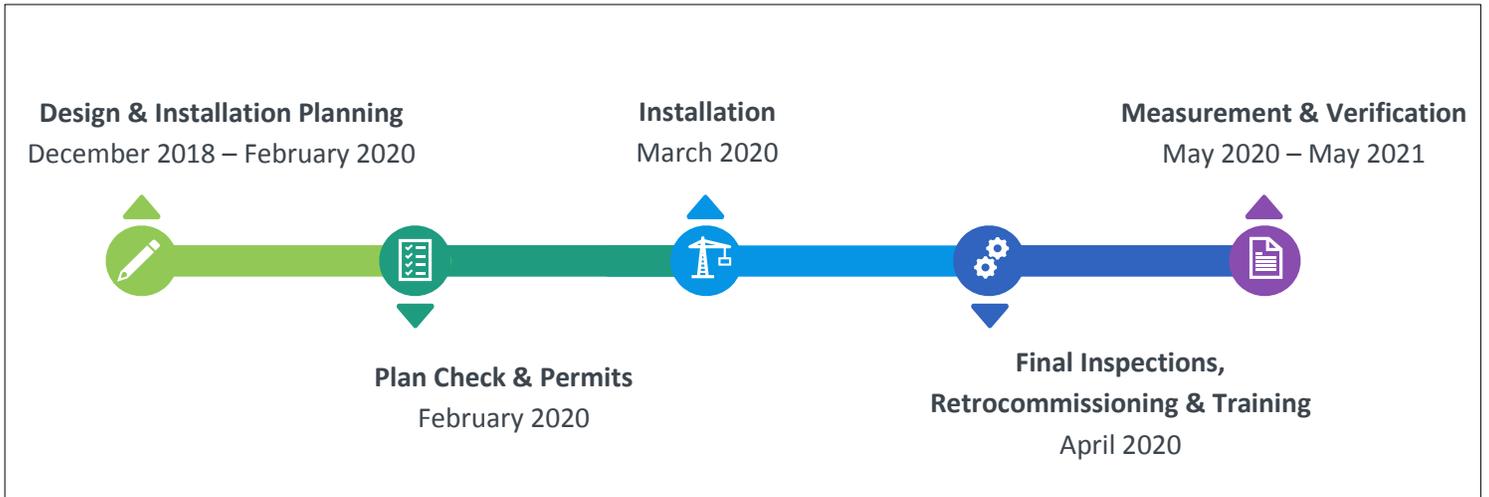
From March 2019 into early 2020, design documents were created, refined and approved to fit additional project requirements. In addition, utility programs were evaluated, subcontractors selected, a pre-installation meeting held and public notification for work was given in order to initiate ECM installations. These installation planning activities are described in more detail and a project timeline is provided in Figure 1.

¹ *Electric Program Investment Charge*. California Energy Commission. <https://www.energy.ca.gov/research/epic/>

² *EPC-15-085: Building Energy Baseline & Modeling Report for City of San Diego Public Library ZNE Demonstration Project*. October 2018. Center for Sustainable Energy.

³ *EPC-15-085: Report of Installation Activities and Financial Considerations for City of San Diego Public Library ZNE Demonstration Project*. February 2019. Center for Sustainable Energy.

Figure 1: Project Timeline



Design Changes

Initial design documents needed to be refined to fit additional project requirements, mainly an updated budget and schedule once all installation contracts would be in place. Due to cost constraints and younger age of equipment, HVAC was not replaced with new high-efficiency units as part of the demonstration project as doing so would have resulted in an undesirably high payback in terms of cost savings. At Serra Mesa-Kearny Mesa and Valencia Park/Malcolm X, a select rooftop unit (RTU) was not replaced, and at Point Loma/Hervey, an air handler unit (AHU) was not replaced. Also, carbon dioxide-based demand-controlled ventilation systems were not implemented on the planned units. Additionally, at Valencia Park/Malcolm X, an ultraefficient Ventacity VS100RT Smart Ventilation™ Management System heat recovery ventilator and dedicated outdoor air system was unable to be installed as an emerging technology solution.

Due to schedule constraints and the long lead time to acquire battery systems, energy storage was not installed at any of the sites by the end of the project. This was known when initial designs were prepared by Mazzetti. However, to provide support for energy storage planning at the libraries, CSE conducted an energy storage analysis for each library in Energy Toolbase™ for the City. The preliminary analysis results recommended a potential battery storage system at Serra Mesa-Kearny Mesa (90 kW/360 kWh) and Valencia Park/Malcolm X (116 kW/464 kWh) to utilize excess PV production throughout the year and discharge during peak times when energy is typically consumed from the utility grid. Considering the smaller PV system at Point Loma/Hervey, there is not enough excess PV production to justify the cost of installing battery storage.

Updated ECM costs and energy savings estimates that removed HVAC replacements (Appendix A) and updated designs were provided to the Energy Commission and the City for approval.

Utility Program Participation

The libraries are serviced by SDG&E, which offers several commercial demand response and distributed energy resource programs, the most applicable being the Technology Incentives (TI) Program that incentivizes the purchase and installation of certain automated demand response measures.⁴ Program participants receive 60% incentive payment upfront and then the 40% remainder payment after the demand response savings are verified. Participation would require the libraries to sign up for one of the three available commercial demand response programs for at least three calendar years. Unfortunately, since the libraries are designated as “Cool Zones,” they were unable to enroll. Cool Zones are public places for senior citizens, people with special needs and the public to escape midday summer heat from about May to October each year. Thus, each library’s electricity load may not be able to be reduced enough during peak grid days due to their requirement of maintaining a cool building.

Furthermore, the libraries were evaluated for eligibility in additional SDG&E energy efficiency incentive programs, and SDG&E was able to provide cost-savings estimates. Unfortunately, in this case, the ECMs planned at the libraries were not eligible or the savings from the program were not great enough to exceed the cost of time to complete the application and verification required.

Subcontractor Selection and Work Schedule

The construction manager of the project, M+NLB, developed a bidding package, identified installation subcontractors, planned subcontractor budgets and project schedules and finalized their construction agreement with the City and CSE by winter 2019, at the same time designs were being adjusted and utility programs evaluated. Additionally, since the subcontractor lighting bids were originally higher than the project budget would allow, M+NLB worked with the selected subcontractor to develop a value engineering lighting package to bring the project within budget. M+NLB then organized on-site activities, which lasted three months from January to March 2020.

As the libraries have many visitors each day and offer popular public services, it was very important for the project team to work to avoid any library closures and to inform visitors about any disruption. A pre-installation meeting was held on January 6, 2020, with City sustainability, library and facility staff, and the project team including the installation subcontractors to discuss the plan to minimize disruptions. It was decided that no libraries would need to be fully closed, but that areas of work would be sectioned off. Additionally, M+NLB would keep City sustainability, library and facility staff apprised of changes to areas that were sectioned off each week. Furthermore, work would occur at all three libraries at once and different crews would be assigned to each library.

⁴ *Save on Upgrades with the Technology Incentives Program.* San Diego Gas and Electric.

<https://www.sdge.com/businesses/savings-center/energy-management-programs/demand-response/technology-incentives>

Visitor Notification

Visitors were notified of ongoing work starting in January 2020 by City public information office-approved door signs, social media posts and press releases. Also, library managers alerted those with conference room reservations of possible schedule changes, and the presence of dust/debris as well as noise during the installation period.

Moreover, the project team wanted to engage and educate library communities about the ZNE aspect of the project. The SDGBC held presentations and tabling events at each library leading up to on-site installation activities. They held 12 separate tabling events, spoke with 253 visitors and handed out marketing collateral. The public response was mostly positive about the project. They expressed approval that the libraries were going to have better lighting and be more energy efficient. The most common response was appreciation that the library would save money on utility costs. Visitors also said that they felt the project was good for the environment and that they were happy the library could produce all or most of its own energy. The public was also appreciative that the library would remain open during installation.

Further, the project installed kiosks at each library that display project information, real-time energy use and PV generation to educate visitors (Figure 2).



Figure 2: Energy Kiosk and Dashboard
Source: SDGBC

Permit Applications and Procurement

From January to February 2020, materials were procured and permits secured. As material lead time ranged from about two to eight weeks and a month was estimated for installation, material storage was needed in the parking lot for lighting retrofit and control work at two library sites. One library was close enough to the lighting installation subcontractor office that on-site storage was not needed. Permits were only required for lighting retrofits and controls with fees at all three libraries totaling about \$2,200. The work areas and schedules at each library were dictated by material procurement and availability.

III. ECM Installation

ECM installation began in February 2020 and was completed in April 2020 when final inspections were passed. All three libraries received lighting retrofits and controls, plug load management devices and the Tridium building automation system (BAS) with BACnet to integrate HVAC controls, lighting controls,

plug load devices and energy monitoring equipment. Valencia Park/Malcolm X also received HVAC controls that were BACnet-capable unlike the other two libraries that already had BACnet HVAC controls.

Lighting Retrofits and Controls

LED lighting fixtures and/or lighting retrofit kits/lamps were installed per Mazzetti's final designs. The libraries also had lighting control panels replaced with systems capable of BACnet communication for integration to the BAS and with additional local programming capabilities. The lighting controls integration allows for remote control of the lighting with on/off function of various zones preprogrammed and aligned for each library's operating hours. The local scheduling can be overridden after hours for a two-hour duration for the custodial staff.

Overall lighting levels at all three libraries have significantly increased (Figure 3). Further, the new central lighting control systems and programmed lighting schedules ensure lights shut off to conserve energy; whereas before the retrofit, lights were left on after hours.



Figure 3: Before (left) and After (right) Book Stack Lighting Retrofit at Serra Mesa-Kearny Mesa
Source: CSE and City

Plug Load Management

The recommended emerging technology solution from SDG&E's Emerging Technologies Program was Bert smart plugs to manage and control the energy consumption of plug load devices at all libraries. The plugs were installed between the power cables for various devices (copiers, printers, etc.) and the wall receptacle. They were also connected to the facility Wi-Fi network to integrate with the Tridium BAS and enable a programmable daily schedule aligned with staff arrival. Two smart plugs were installed at Serra Mesa-Kearny Mesa, eight at Valencia Park/Malcolm X and four at Point Loma/Hervey.

Tridium Building Automation and HVAC Controls



Figure 4: Tridium Building Automation System JACE

Source: City

A Tridium Niagara N4 BAS was installed at each library and Viconics HVAC controllers were installed at Valencia Park/Malcolm X. The Tridium control system includes a supervisory-level control front-end system installed on a centralized City server along with a JACE (Figure 4) with BACnet drivers and additional LON drivers to communicate to the existing Trane controls. The system manages all HVAC controls (existing Trane and new Viconics), on/off lighting controls and the Bert smart plugs. It also reports real-time energy data from the Autani energy monitoring devices installed at the

libraries. Moving forward, the BAS upgrade will reveal additional control strategy opportunities for each building once energy trends are evaluated and control sequences are optimized.

Challenges Encountered

During installation, several challenges were encountered regarding a change to a planned chiller replacement outside the project, Title 24 energy efficiency requirements, completing building envelope improvements, connecting Bert devices, needing overnight work and planning for COVID-19 impacts.

Point Loma/Hervey Chiller Replacement

The City initially planned to replace the chiller at Point Loma/Hervey library during the installation of the project's ECMs, but it was unable to be replaced at the same time. The City is working on a revised schedule to complete the installation, likely within the next year.

Title 24 Requirements

The Energy Commission updates state Building Energy Efficiency Standards (Title 24, Parts 6 and 11) every three years, and the timing was such that the project's permitting applications were unable to be submitted prior to the most recent 2019 code change effective on January 1, 2020.⁵ As a result, lighting designs needed to be updated to include lower-wattage lighting in order to meet the new code to obtain building permits, which delayed installation work by about three weeks. Lighting retrofits were

⁵Building Energy Efficiency Standards-Title 24. California Energy Commission. <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards>

installed at 80% of the 2019 Title 24 baseline requirements (the greater savings allowed the project to forego the daylight harvesting requirement).

Building Envelope

Valencia Park/Malcolm X features a large cylindrical glass window with two glass doors leading to an exterior space that contains a fountain within the building's footprint. This glass cylinder is responsible for a large solar heat gain during the day, and a half-inch gap was found along the perimeter of the doors resulting in air infiltration and heat loss. Window film and weatherstripping were planned to be installed to reduce solar heat load and improve occupant comfort. However, due to design changes to meet Title 24 requirements and additional design efforts, this improvement was deemed to have the least impact on savings and was not completed so that the project could remain within budget and on time.

Bert Wi-Fi Connectivity and Site Constraints

Low Wi-Fi connectivity and some site constraints were unobserved at an initial site assessment for the devices and only 14 of the originally planned 21 plugs were installed (Table 1). The City will determine if any other Bert plugs will be able to be installed with some fixes and/or if they can be installed at other plugs that previously were unidentified.

Overnight Work and COVID -19

In the planning stages, overnight work was not identified as a need but during installation, it became clear that it would be required to install lighting control panels at the libraries. There was not enough uninterrupted time to complete the install in the mornings before the libraries opened, and if work had to stop without completion, it would have impacted library operations. However, before overnight work was to begin, the libraries were closed to the public due to COVID-19 and work on the lighting control panel was complete during the day.

Following the library closure, a statewide shelter-in-place order was issued for California on March 19, 2020, which led to a temporary work stoppage as all partners needed to ensure compliance with the order. This delayed installation completion by about a week, but work was able to continue as it was deemed essential work. COVID-19 project impacts included some crew members being unable to continue working, lighting control panel shipments being delayed, masks and social distancing were required on site and an on-site training was conducted with a mix of in-person and virtual attendees.

Table 1: Bert Install Locations

Location	Device/Plug Load	Installed (Y/N)	If Applicable, Reason Not Installed
Valencia Park/Malcolm X			
Teen Center	Robo Printer	Y	Not Applicable
Teen Center	Robo Printer	Y	Not Applicable
Teen Center	Printer	Y	Not Applicable
Copy Room	Copier	Y	Not Applicable
Friends of Library Room	Printer	Y	Not Applicable
Back Librarian Area	Copier	Y	Not Applicable
Circulation Desk	Printer	Y	Not Applicable
Community Room	Projector	Y	Not Applicable
Serra Mesa–Kearny Mesa			
Circulation Desk	Printer	N	Low Wi-Fi
Circulation Desk	Copier	N	Device Removed
Circulation Desk	Copier	Y	Not Applicable
Staff Backroom	Printer	Y	Not Applicable
Staff Backroom	Printer	N	Device Removed
Community Room	Projector	N	Power Source High in Ceiling
Point Loma/Hervey			
Workroom	Printer	N	Device Removed
Workroom	Printer #2	N	Low Wi-Fi
Copy Room	Copier	N	Low Wi-Fi
Circulation Desk	Printer	Y	Not Applicable
Reference Stacks	Printer	N	Extension Cord Needed
Video/Audio Room	Copier	Y	Not Applicable
Librarian Vestibule	Printer	Y	Not Applicable
Computer Room	Projector	Y	Not Applicable

IV. Measurement and Verification Considerations

Some of the challenges encountered during construction and their impacts will need to be considered when comparing actual cost and energy savings to the project baseline during the one-year measurement and verification (M&V) period. Those considerations include the following.

- Window film and weatherstripping was not completed and will not provide any savings at Valencia Park/Malcolm X.
- Only 14 of the originally planned 21 Bert devices were able to connect to City Wi-Fi and less savings from the devices will occur at Serra Mesa-Kearny Mesa and Point Loma/Hervey.
- There will be less HVAC savings at Point Loma/Hervey library until the higher efficiency chiller is installed.
- Lower wattage lighting was installed at all libraries to meet 2019 Title 24 requirements, resulting in greater lighting savings at all libraries.
- Due to COVID-19, the libraries are currently closed to the public, so operating schedules will be different.

V. Report Summary and Next Steps

In summary, after ECM installation planning, all libraries received lighting retrofits and control systems, BAS and plug load management devices (an emerging technology). Valencia Park/Malcolm X also received new HVAC controls. Installation challenges were recorded and their impacts will be considered during the one-year M&V period. The next steps for the project are to complete commissioning and retrocommissioning of the ECMs and to document efforts in the *Retrocommissioning Reports* and *Ongoing Retrocommissioning Report*. Also, CSE and the City will monitor the newly installed ECMs and their impact on facility energy use over the next twelve months.

Appendix A

EPC-15-085: Updated City of San Diego Public Library ZNE ECMs and Modeled Savings



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