EPC-15-085: Behavior Analysis Summary Report

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. Executive Summary

This report was prepared by the Center for Sustainable Energy (CSE) as a component of demonstration project EPC-15-085, funded by a California Energy Commission EPIC grant. The project retrofit three City of San Diego public libraries, i.e., Valencia Park/Malcolm X Library, Serra Mesa-Kearny Mesa Library, and Point Loma/Hervey Library to become zero net energy buildings. To measure the qualitative retrofit effects on employees and volunteers, the Center for Sustainable Energy conducted two surveys, one before the retrofits and the second after the retrofits. This report presents results of both surveys: the pre-retrofit survey conducted in April-May 2018 before the libraries were upgraded with energy conservation measures (ECMS) and the post-retrofit survey conducted in October-November 2020 following completed retrofits in May 2020, thereby allowing time for building occupants to experience any differences.

Decisive conclusions from this study are difficult to draw for the many reasons. Data relied entirely on respondents' self-report and are not triangulated with actual temperature and lighting measurements. The pre-retrofit sample population was not identical to the post-retrofit sample population, possibly a result of the approximate two-year lag for construction to be completed, compounded by a further delay as a consequence of the State of California public health orders for COVID-19 closures. While library staff were able to return to the library after six months and were then able to complete the post-retrofit survey, the sizable volunteer cohort was not permitted to return and were therefore excluded from the post-retrofit survey. Despite limitations in this survey design, there are several promising findings that show occupant behavior changes, building improvement and point to further refinements in the three demonstration libraries that could boost comfort, increase behavior changes and provide a basis for further education and demonstration of the potential benefits of ZNE libraries to a broader audience.

Key findings include:

Awareness of energy conservation measures: There was an increase in the percent, but not total number of library staff, aware of energy conservation measures after retrofits were complete.

Thermal Comfort: After retrofits, most respondents reported an increase in thermal comfort at the front desk and workroom areas, which staff reported spending a lot of time in, but they also still reported comfort levels varied between specific spaces at the three libraries, with some reporting discomfort.

Daytime temperatures: Although Serra Mesa-Kearny Mesa and Valencia Park/Malcolm X Libraries mostly reported comfortable temperatures, daytime temperature imbalances are still identified as

problems in all three libraries in various work areas. Point Loma/Hervey Library reported the most uncomfortable areas.

Temperature controls: Respondents at all three libraries reported an increase of temperature controls at front desk areas but there were still many areas that lacked temperature controls.

Lighting brightness: Respondents at Point Loma/Hervey and Valencia Park/Malcolm X staff seem satisfied with lighting brightness after the retrofits, but it was noted that lights should be replaced quickly if they burn out. Serra Mesa-Kearney Mesa reported the dimmest or too bright areas.

Lighting sufficiency: Lighting sufficiency varied in different workspaces at the libraries, but overall, respondents from all three libraries responded more positively about daylight and lighting sufficiency. Brighter lights were still desired in some areas, while excessive direct sunlight was still reported in others.

Lighting controls: Most respondents still do not know, or were not familiar with, lighting controls at their libraries.

Plug load management: Responses were mixed on if the smart plugs were working properly and some respondents noted they removed them. More education is needed on how to operate the installed smart plugs.

Environmental policies: There does not seem to be consistent environmental policies at the libraries, but the most enacted are for indoor lighting and recycling.

Behavior: Half of all library respondents agreed their behaviors helped conserve energy after retrofits were complete. This was an increase from the pre-retrofit surveys, where more than half of respondents at all three libraries felt neutral.

Maintenance: Pre-retrofit survey respondents at all libraries indicated they rarely or never contacted their library's maintenance department. Post-retrofit responses were similar. But in the cases in which they did call upon maintenance, post-retrofit response times, (while diverse across the three libraries), trended toward increased frequency of responses at all three libraries, i.e.,

- There was an increase in same-day response times for lighting, heating & cooling issues at Point Loma/Hervey and Serra Mesa–Kearny Mesa Libraries, compared to zero same-day responses pre-retrofit.
- While there were no same-day responses indicated for lighting, heating & cooling issues at Valencia Park/Malcolm X Library, there was an increase in the frequency of one to three-day responses compared to pre-retrofit. Plumbing also saw these same increased response times at this location.

The rest of this report details these key findings more fully, and points to potential improvements to comfort and behavior change and other enhancements. This would involve a coordinated effort of stakeholders, including the City of San Diego and a range of library stakeholders. Through targeted follow-up, diagnoses, and education, this demonstration project could further be used to showcase the viability and benefits of transforming important public resources, like libraries, into ZNE buildings.

II. Introduction

A zero-net energy (ZNE) building is one where the actual annual consumed energy is less than or equal to the on-site renewable generated energy., California has ambitious goals for the development of ZNE buildings, as outlined in its Energy Efficiency Strategic Plan. These goals include 50% of new major renovations of state buildings will be ZNE by 2025 and 50% of existing commercial buildings will be retrofit to ZNE by 2030.

In recognition of these goals, the California Energy Commission (CEC) funded a demonstration project – EPC-15-085– which focuses on converting three public libraries in the City of San Diego to ZNE through retrofits. The three libraries benefitting from retrofits include the Point Loma/Hervey Library, Valencia Park/Malcolm X Library, and Serra Mesa-Kearny Mesa Library. The libraries received energy efficiency technologies combined with on-site solar photovoltaic (PV) generation to achieve ZNE or near-ZNE.

The project team was led by CSE and included the City of San Diego Sustainability office staff. To assess how the retrofits affected building occupants, CSE and City sustainability staff conducted two surveys of library staff: a pre-retrofit survey in April-May 2018 and post-retrofit survey in October-November 2020. This report summarizes the findings of the surveys which focused on understanding the occupants' comfort expectations and energy saving behaviors at the libraries before and after ZNE retrofits. Earlier research conducted for the project – including ASHRAE level II audits, baseline energy consumption measurement and modeling, and baseline energy modeling – informed this survey effort. Findings for the previous research activities are published at https://energycenter.org/sdzn3.

Libraries

The three surveyed libraries (Figure 1) are different in many ways, including their square footage, functions, interior space layout, organizational culture, and the design of energy systems.

Point Loma/Hervey

Point Loma/Hervey Library opened in 2003 with an area of 22,480 square feet. It is the only library in this study with two floors. The rotunda's sky dome and windows filter sunlight to prevent it from deteriorating the books. The library consumes about 1,400 MMBtu of energy annually with an intensity of 70.4 kBtu/sq.ft. Electricity accounts for 87% of the library's annual energy consumption with the annual peak in the summer months to meet the increased demand of air conditioning.

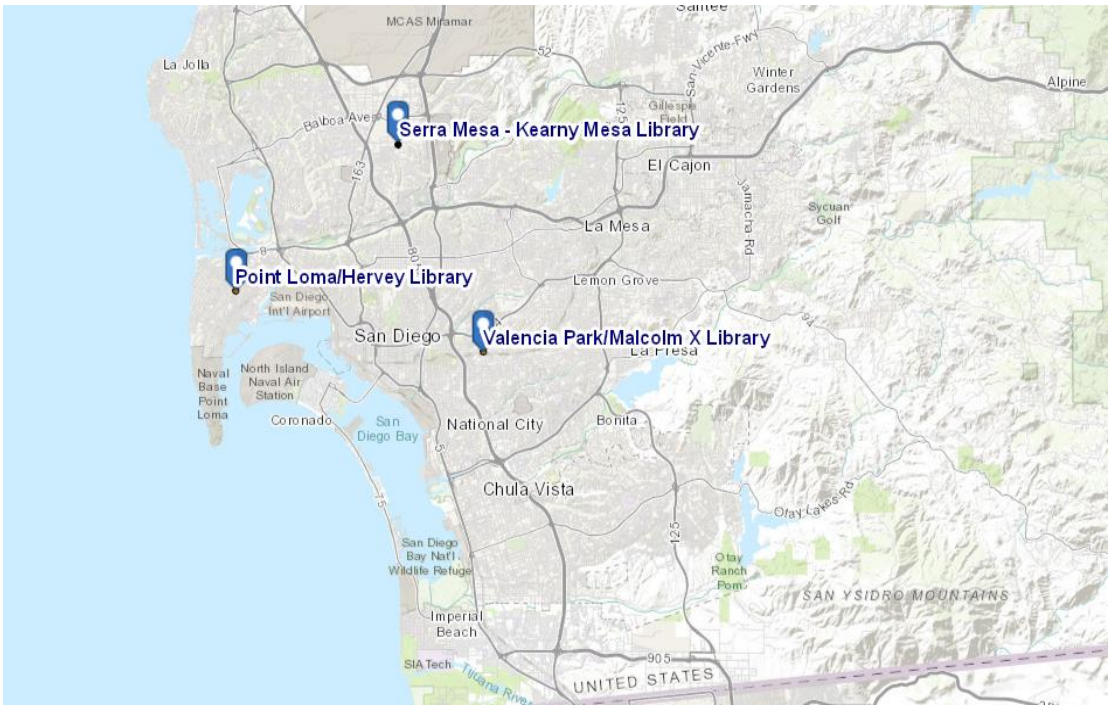

Figure 1: Site map of the Three Libraries

Valencia Park/Malcolm X

Valencia Park/Malcolm X Library was built in 1996 and remodeled in 2016 with the addition of the IDEA lab, a technology lab offering advanced technology and training programs for teenagers. The library has an area of 26,000 square feet and consumes approximately 1,200 MMBtu of energy annually. The library has the lowest energy intensity of all, at 41.1 kBtu/sq. ft – about 40% lower than the other two libraries. Electricity accounts for about 90% of the library's annual energy consumption, peaking in the summer months when the air conditioning load is high.

Serra Mesa-Kearny Mesa

Serra Mesa-Kearny Mesa Library is the newest of the three libraries and opened in 2016. The 15,626-square foot library includes a large children's area, meeting and conference rooms, and a computer lab. It also includes green building technology and recycled materials. Windows are plentiful in the Serra Mesa-Kearny Mesa Library, providing significant daytime lighting. In addition, windows are set deeply into thick walls and covered archways shading them from the hot environment, which enhances comfort while lowering energy bills. The library consumes about 1,100 MMBtu of energy annually with an intensity of 67.3 kBtu/sq. ft. Electricity accounts for 90% of the energy consumption in the library, peaking in the summer months to meet the increased demand of air conditioning.

III. Survey Objectives

The objectives of the surveys:

Pre-retrofit

- To explore occupants' understanding of how their behaviors impact the building's energy performance.
- To understand occupants' comfort expectations and if these expectations are being met.
    - If not, understand how their comfort can be improved.
- To understand what motivates occupants to change energy saving behaviors.

Post-retrofit

- To understand how occupants interact with new energy conservation measures (ECMs) in their buildings, and if they are more aware of how their behaviors impact building performance than prior to the retrofit.
- To understand occupants' comfort expectations and if these expectations are affected by the retrofit.
    - If not, understand how their comfort can be improved
- To understand if the retrofit motivated occupants to change energy saving behaviors.

IV. Survey Methods

CSE developed the pre- and post-retrofit surveys with input from the City of San Diego and the CEC. The surveys were tested internally before they were launched. The pre-and post-retrofit surveys were administered via Alchemer (formerly Survey Gizmo), an online survey management platform. Respondents were invited to participate in the survey via custom e-mails with follow-up reminders. Responses were submitted directly through the link provided in the email. Data was collected automatically and electronically stored in a secure database maintained by CSE. The survey questionnaires included both closed and open-ended questions, allowing respondents to write in their own comments and suggestions. CSE administered the pre-retrofit survey between April 30, 2018 and May 25, 2018, and the post-retrofit survey between October 14, 2020 and November 13, 2020.

The pre-retrofit survey included 28 questions and the post-retrofit survey included 32 questions. Both pre- and post-retrofit survey instruments are available in Appendix A and B. The pre-retrofit survey was distributed to all library staff and volunteer populations at the three libraries (n=65). The post-retrofit survey was distributed to library staff, but not volunteers at the same three libraries (n= 37). A total of 34 respondents participated in the pre-retrofit survey and a total of 20 respondents participated in the post-retrofit survey. This equates to a 52% response rate for the pre-retrofit survey and a 54% response rate for the post-retrofit survey. A detailed breakdown of total samples and response rates is illustrated in Tables 1 and 2 in section VI below.

Limitations

Limitations to this research design include the relatively small population and sample size comprised of staff and volunteers from the three libraries. Not all the same individuals responded to both the pre- and post-retrofit surveys; nearly half the number of possible respondents was lost by the time of the post-retrofit survey. More than two years passed between the two surveys due to construction schedules and another six months after construction to allow enough time for occupants to experience possible differences between pre-and post-retrofit. This timeline was further delayed due to library closures resulting from the State of California public health orders for COVID-19. The volunteer population that participated in the pre-retrofit survey was excluded from the post-retrofit survey, as they were prohibited from working at the libraries as part of transmission-reduction measures. This limited sample means that no statistical significance can be drawn, and results may not be generalizable across and even within the three libraries. It may also be worth noting that between the two surveys, some staff had been reassigned to different work areas of the library.

Nonetheless, this report presents interesting findings which are worthy of further exploration and could enhance this demonstration effort, benefit other ZNE library retrofit initiatives and inform further research.

V. Survey Results

Respondent Characteristics

Survey Respondents

Pre-retrofit surveys were distributed to a total population of 65 staff and volunteers across the three libraries. A total of 34 staff and volunteers participated, amounting to a 52% total response rate. The response rate did not vary significantly between libraries: Point Loma/Hervey had the highest response rate (57%), followed by Valencia Park/Malcom X (50%), followed by Serra-Mesa-Kearny Mesa (47%). See Table 1.

Table 1: Survey Respondents (Pre-Retrofit)

	Point Loma/Hervey			Valencia Park/Malcolm X			Serra Mesa – Kearny Mesa			All		
	Staff	Volunteer	Staff + Volunteer	Staff	Volunteer	Staff+ Volunteer	Staff	Volunteer	Staff+ Volunteer	Staff	Volunteer	Staff+ Volunteer
Responses	9	8	17	9	1	10	7	0	7	25	9	34
Population	16	14	30	18	2	20	12	3	15	46	19	65
%	56%	57%	57%	50%	50%	50%	58%	0%	47%	54%	47%	52%

Post-retrofit surveys were distributed to a total population of 37 staff across all three libraries, of which 20 responded amounting to a 54% response rate. Volunteers were not included in the post-retrofit

survey. The response rate at Serra Mesa-Kearny Mesa was the highest by far (80%), followed by Valencia Park/Malcom X (46%), followed by Point Loma/Hervey (43%). See Table 2.

Table 2: Survey Respondents (Post-Retrofit)

	Point Loma/Hervey			Valencia Park/Malcolm X			Serra Mesa–Kearny Mesa			All		
	Staff	Volunteer	Staff + Volunteer	Staff	Volunteer	Staff+ Volunteer	Staff	Volunteer	Staff+ Volunteer	Staff	Volunteer	Staff+ Volunteer
Responses	6	0	6	6	0	6	8	0	8	20	0	20
Population	14	0	14	13	0	13	10	0	10	37	0	37
%	43%	0%	43%	46%	0%	46%	80%	0%	80%	54%	0%	54%

Respondent Demographics

While respondents' demographic information was collected as part of both the pre- and post-retrofit surveys, it is difficult to make demographic-specific conclusions based on different pre- and post-survey individual respondents:

- Point Loma/Hervey pre-retrofit survey n=17 / post-retrofit n=6
- Valencia Park/Malcolm X pre-retrofit survey n=10 / post-retrofit n=6
- Serra Mesa- Kearney Mesa pre-retrofit survey n=7 / post-retrofit n=8

Appendix C contains two tables with the full demographic breakdown of respondents from each library in both pre- and post- surveys.

Respondent Roles and Work Areas

In both pre-and post- surveys, respondents were asked to report what role they played at the libraries. In the pre-retrofit survey, most respondents were library assistants, aids and volunteers. In the post-retrofit survey, most respondents were library assistants, aids and librarians. Since no volunteers were included in the post-retrofit survey it is not possible to draw conclusions about comfort and behavior change by role.

Respondents were asked in which areas of the library they spent most of their time. Tables 3 and 4 below show numbers as percentages of total survey respondents pre- and post- retrofit. Across all three libraries, the front desks and workrooms were the two most used areas in both pre- and post-retrofit surveys.

Table 3: Respondents Work Areas (Pre-Retrofit)

	Point Loma/Hervey	Valencia Park/Malcolm X	Serra Mesa – Kearny Mesa
Book Return Area	6%		14%
Book Stacks 1st	24%	30%	43%
Book Stacks 2nd	18%		
Children's Area	29%	10%	14%
Conference/Meeting Rooms	18%		
Front Desk	29%	70%	43%
Staff Break Room	6%		
Workroom	18%		71%
Performing Arts Center		10%	
Teen IDEA Lab		30%	
Youth Service Desk/Office			14%
Other	29%	10%	

Table 4: Respondents Work Areas (Post-Retrofit)

	Point Loma/Hervey	Valencia Park/Malcolm X	Serra Mesa Kearny Mesa
Book stacks (1st Floor)	9%	9%	13%
Book stacks (2nd Floor)	9%		
Children's area	9%		6%
Front desk	36%	27%	31%
Workroom	18%	18%	25%
Other	18%	18%	
Youth service desk/office			25%
Book return area		9%	
Computer lab		9%	
Outdoor areas		9%	

Respondent Energy Conservation Awareness

Respondents were asked if they were aware of any ECMS at their libraries. In the pre-retrofit responses, 74% (25 of 34) of all respondents reported they were aware of ECMs (Figure 2). In the post-retrofit survey, 95% (19 of 20) of respondents said they were aware of ECMs (Figure 3). There was an increase in the total percent on those that "yes" they were aware, even when removing volunteer respondents. In the pre-retrofit responses, 76% (19 of 25) of staff respondents reported they were aware of ECMS. However, there was not an increase in total number of staff reporting they were aware of ECMS (19).

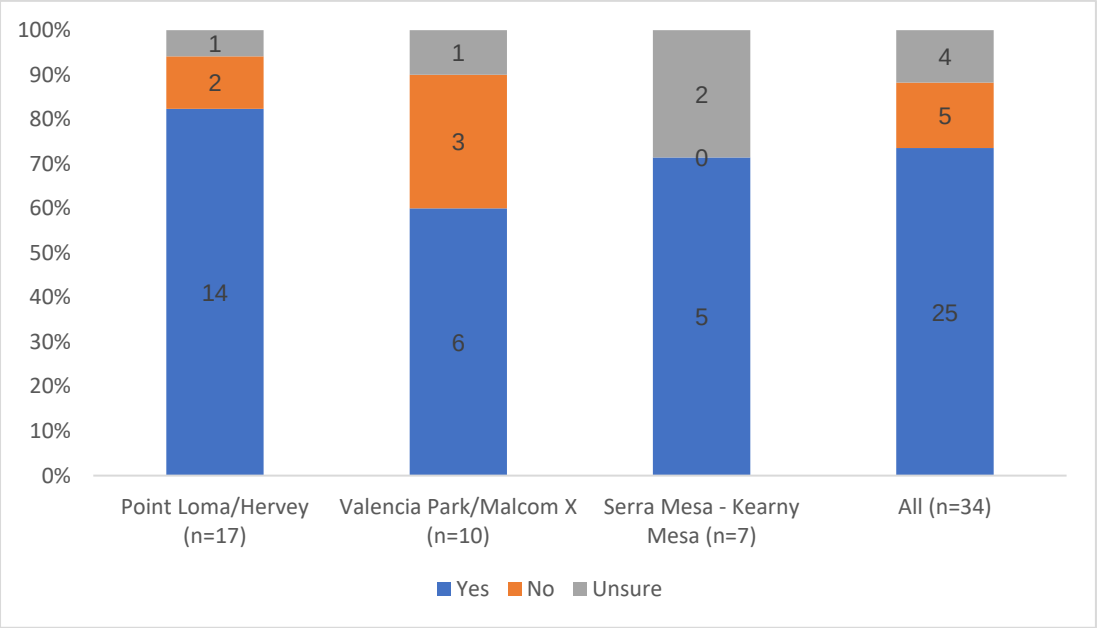

Figure 2: Pre-Retrofit Respondent Energy Conservation Awareness (# of respondents)

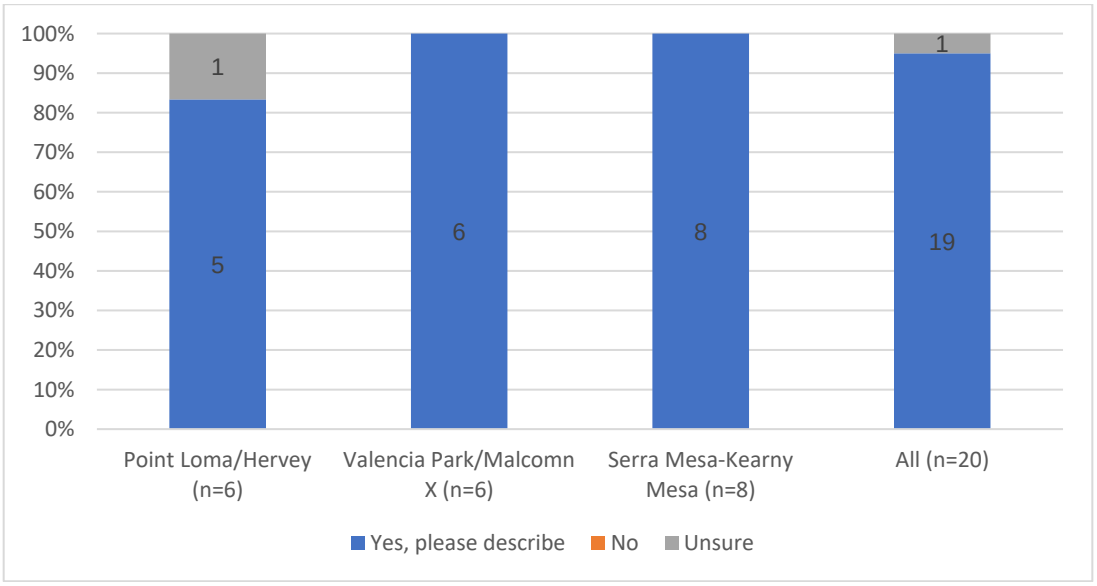

Figure 3: Post-Retrofit Respondent Energy Conservation Awareness (# of respondents)

Thermal Comfort

Overall Thermal Comforts

Respondents were asked to rate their overall level of thermal comfort in their most-common work areas from very uncomfortable to very comfortable. Based on pre-and post-retrofit survey responses, there was a noticeable improvement in thermal comfort at all three libraries after retrofits were completed. After the retrofits were installed, six respondents reported increases in thermal comfort and 11 respondents reported a neutral impact. Serra Mesa–Kearny Mesa library had the most notable satisfaction increase with three participants reporting positive increases in thermal comfort.

Point Loma/Hervey Library had the most negative ratings (four negative) for their comfort by working area, while Serra Mesa-Kearny Mesa had the best ratings (14 positives and one negative). Valencia Park/Malcolm X also had a majority of positive ratings (nine positive) and only one negative rating. Overall, everyone reported positive comfort levels at the front desk areas. There were no responses on conference room comfort and the workroom at Serra Mesa-Kearny Mesa library was rated somewhat uncomfortable.

These results can be compared to the pre-retrofit results, where employees and volunteers at Valencia Park/Malcolm X Library reported the highest satisfaction, with all its respondents rating their level of thermal comfort as somewhat comfortable to comfortable for all their working areas. By contrast, respondents from the other two libraries gave negative ratings for almost all their working areas. The very uncomfortable rated areas for these two libraries were the front desk and conference/meeting room at Point Loma/Hervey, and front desk and workroom at Serra Mesa–Kearny Mesa.

Daytime Temperature

After the retrofits, respondents were asked to rate the daytime temperature in their working areas from hot to cold during the summer season. The summer season was the first full season after retrofits were installed. For Serra Mesa-Kearny Mesa and Valencia Park/Malcolm X libraries, most respondents said they were comfortable in most areas in the library. In Serra Mesa, only four reported it been cool or cold: in the workroom (cold), book stacks (cool), youth center (cool), and San Diego Workforce Partnership Center (cold). Only one warm response for the workroom. There were 12 responses for being comfortable at the library (this was a “select all that apply” question). Valencia Park/Malcolm X had seven comfortable replies. Only one hot response in the outdoor area, one cool response for work room and one cold response for the book stacks.

However at Point Loma/Hervey, many said it was warm throughout the library. There were eight uncomfortable responses, and only three comfortable responses for front desk, children’s area and youth service office desk. Three respondents reported the front desk being warm. There was also some additional feedback on daytime temperature of libraries, one respondent at Serra Mesa-Kearny Mesa noting that COVID-19 may have an impact on comfort, the respondent said, “***We are currently closed due to COVID, which I think makes it feel colder in the large areas, like the children's area. Once***

people are back in the building, it should be comfortable. The [youth service desk] is locate[d] right under an AC vent, so it will always be cold." Another respondent at Point Loma/Hervey noted the libraries "***Need to figure out a way to balance the temperature in the building***" suggesting that thermal comfort may have not improved.

Prior to the retrofits, respondents were also asked to rate the daytime temperature in their working areas from hot to cold during each season, not just summer. At the Serra Mesa-Kearny Mesa Library there were 17 uncomfortable responses, including three for the summer season: in the bookstacks (hot), in the workroom (hot), and at the youth service desk (cool). At Valencia Park/Malcolm X , there were 17 uncomfortable responses, including six for the summer season: in the bookstacks (cool), in the children's area (warm), at the front desk (two warm responses and one cold response), and in the workroom (warm). A Point Loma/Hervey, there were 47 uncomfortable responses, including 12 for the summer season: in the book return area (hot), in the first floor book stacks(one hot response and two warm responses, in the second floor book stacks (one hot response and one warm response), in the children's area (cold), at the front desk (warm), in the workroom (cool), and in other areas (one warm response, one cool response and one cold response).

Also, temperature imbalances were reported to be major problems in open-ended responses. For example, the Point Loma/Hervey book return area was reported as hot during the spring and summer, while its children's area was reported as cold during the same seasons. As one respondent stated, "***I do know that most times I am there it is quite cold in lower level, children's area.***" And another person said, "***All staff at our library are used to using small fans to cool off at the front desk, but it doesn't help enough. The front desk is always usually warm and stuffy.***"

As for the Serra Mesa–Kearny Mesa Library, respondents reported its book stacks and workroom areas as generally warm to hot over the year, and its youth service desk as generally cool to cold. As one respondent stated, ***"When the air conditioning is cooling that area [youth service desk], the person at the desk takes the brunt of the cold. I have to wear gloves at the desk."***

Temperature Controls

Based on pre-and post-retrofit responses, temperature control seems to have increased in many areas of the Serra-Mesa-Kearny Mesa Library except for the youth service desk/office area (Tables 5-6). The increased temperature control could have led to the increase thermal comfort mentioned above. Prior to the retrofits, the above-mentioned temperature imbalances could be explained by poor temperature controls. When asked about the availability of temperature controls in the library, answers were generally negative. None of the working areas at the Serra Mesa–Kearny Mesa Library were reported to have effective temperature controls, except for the book return area; one respondent stated he was able to control its temperature slightly (Table 5).

Table 5: Pre-retrofit Temperature Control Availability at Serra Mesa – Kearny Mesa Library (# of respondents)

	Front desk	Children's area	Book stacks	Book return area	Youth service desk/office	Workroom
Not at all	3 (100%)	1 (100%)	3 (100%)	-	1 (100%)	5 (100%)
Slightly	-	-	-	1 (100%)	-	-
Somewhat	-	-	-	-	-	-
Fairly well	-	-	-	-	-	-
Very well	-	-	-	-	-	-

Table 6: Post-Retrofit Temperature Control Availability at Serra Mesa – Kearny Mesa Library (# of respondents)

	Front desk	Children's area	Book stacks	Youth service desk/office	Workroom	Front desk
Not at all	1 (20%)	-	-	2 (50%)	1 (25%)	1 (20%)
Slightly	-	-	-	-	-	-
Somewhat	3 (60%)	-	1 (50%)	2 (50%)	2 (50%)	3 (60%)
Fairly well	-	-	-	-	-	-
Very well	1 (20%)	1 (100%)	1 (50%)	-	1 (25%)	1 (20%)

At the Point Loma/Hervey Library, temperature control seems to have increased at the front desk area of the library but not in other areas of the library based on pre-and post-retrofit responses (Tables 7-8). Overall, respondents did not report an increase in thermal comfort in the Point Loma/Hervey library which could be attributed to their limited control of temperature and the installation of a temporary chiller in August 2020. One respondent noted, "***Need to figure out a way to balance the temperature in the building***." Another mentioned the need to, "***Have a consistent comfortable, workable temperature***."

Prior to the retrofits, for the Point Loma/Hervey Library, all but one respondent stated they had little or no control over the temperature in their working areas (Table 7). One said, "***temperature at front desk is controlled outside the building. We need to control inside of the building.***" Another indicated that, "***we have no control of the temperature. Being able to adjust the temperature in various zones is something our patrons have requested for years.***"

Table 7: Pre-Retrofit Temperature Control Availability at Point Loma/Hervey Library (# of respondents)

	Front desk	Conference/meeting room	Children's area	Book stacks	Book return area	Staff break-room	Workroom
Not at all	5 (100%)	1 (50%)	4 (80%)	6 (100%)	1 (100%)	1 (100%)	2(67%)
Slightly	-	-	1 (20%)	-	-	-	1 (33%)
Somewhat	-	-	-	-	-	-	-
Fairly well	-	-	-	-	-	-	-
Very well	-	1 (50%)	-	-	-	-	-

Table 8: Post-Retrofit Temperature Control Availability at Point Loma/Hervey Library (# of respondents)

	Front desk	Children's area	Book stacks (1st Floor)	Book stacks (2nd Floor)	Other	Workroom
Not at all	2 (50%)	-	1 (100%)	1 (100%)	2 (100%)	1 (50%)
Slightly	1 (25%)	1 (100%)	--	-	-	-
Somewhat	1 (25%)	-	-	-	-	1 (50%)
Fairly well	-	-	-	-	-	-
Very well	-	-	-	-	-	-

Based on pre-and post-retrofit responses, the temperature control at Valencia Park/Malcolm X Library seems to have increased in the front desk area but decreased in the workroom (Tables 9-10). Also, some workers were not aware of the temperature control system as one respondent said, "***How does it work? I don't think we were ever shown***."

Prior to retrofit, answers from Valencia Park/Malcolm X were comparatively positive: two people stated they could control the temperature of the Teen IDEA lab and one stated they could control the workroom very well. However, there were still areas where respondents reported they could not control the temperature at all, including the front desk, children's area, Teen IDEA lab, and workroom (Table 9).

Table 9: Pre-Retrofit Temperature Control Availability at Valencia Park/Malcolm X Library

	Front desk	Children's area	Teen IDEA lab	Book stacks	Performing arts center	Workroom
Not at all	5 (71%)	1 (100%)	1 (33%)	2 (67%)	-	1 (33%)
Slightly	-	-	-	1 (33%)	-	-
Somewhat	2 (29%)	-	-	-	1 (100%)	1 (33%)
Fairly well	-	-	-	-	-	
Very well	-	-	2 (67%)	-	-	1 (34%)

Table 10: Post-Retrofit Temperature Control Availability at Valencia Park/Malcolm X Library

	Front desk	Computer lab	Book stacks	Book return area	Outdoor areas	Other	Workroom
Not at all	1 (33%)	1 (100%)	1 (100%)		1 (100%)	1 (50%)	2 (100%)
Slightly	1 (33%)	-	-	1 (100%)	-	-	-
Somewhat	-	-	-	-	-	-	-
Fairly well	1 (33%)	-	-	-	-	1 (50%)	-
Very well	-	-	-	-	-	-	-

After the retrofit, there was a mix of other thermal comfort open-ended responses. Respondents suggested better temperature controls and better access to change the temperature. One respondent mentioned COVID-19 as a reason they are not at the library much. There were some respondents that said “no” or “n/a” meaning they had no suggestions for improvement. There were no comments on malfunctioning air conditioners but there was again a comment about a vent blowing directly on the youth service desk that should be adjusted at Serra Mesa-Kearny Mesa Library.

Prior to the retrofit, when respondents were asked to suggest ways to improve thermal comfort, the overall message was a need for an effective temperature control system inside the libraries. In addition, a few people reported their air conditioners were not working properly, or vents were not placed properly. For example, one Serra Mesa–Kearny Mesa respondent requested that an air conditioning vent blowing directly on the youth service desk should be adjusted. And another Point Loma/Hervey respondent suggested avoiding installing vents over marble counters or directly over staff areas.

Lighting

Lighting Brightness

Respondents were asked to rate the lighting in their working areas from very dim to very bright. For post-retrofit surveys, most responses were either neutral or bright (31 of 38 responses across libraries and work areas). Respondents at Point Loma/Hervey Library noted, “***I am very satisfied with the new LED lights***” and “***Everything is working well, at the moment would change anything***.” Also, one respondent at Valencia Park/Malcolm X noted that, “***The lighting is good*.**”

However, five respondents at Serra Mesa-Kearny Mesa Library reported dim or too bright areas at the front desk and in the workroom, and at Valencia Park/Malcolm X Library, one person reported the outdoor area as dim and one person reported the computer room being very dim. One respondent from Serra Mesa-Kearny Mesa noted, “***After the retrofit, there are a lot of areas that are dimmer since the previous lighting would cast light up that was reflected off the ceiling, while the retrofit lighting only casts down. Allowing light to shine towards the ceiling again might help.”*** Another noted, ***“they could be brighter***.”

There were also a few comments from Valencia Park/Malcolm X respondents about fixing lights in a timely manner and planning for lights when they need to be replaced. These comments are likely attributed to lighting fixtures that burned out months after they were installed due to a defective batch of lights. These light fixtures had to be ordered under warranty and shipping lead time was about four-six weeks.

These responses can be comparted to pre-retrofit response where across all three libraries, almost no respondents gave extreme answers like too bright or too dim, except one from Serra Mesa-Kearny Mesa who indicated the lighting at their workroom was very bright. However, many people rated the lighting at their working areas dim, indicating upgrades and adjustments are needed to improve the

situation. Reported dim areas included book stacks at the Point Loma/Hervey Library and the front desk, children's area, Teen IDEA lab and Performing Arts Center at Valencia Park/Malcolm X Library.

When respondents were asked for comments on improving lighting comfort in their libraries, one from Valencia Park/Malcolm X library suggested, "***Installing brighter lights at its front desk area.***" Another from Point Loma/Hervey suggested installing motion sensitive lighting, possibly floor lamps to offer better lighting near the front desk, "***where patrons have complained that the lighting is insufficient.***"

Lighting Sufficiency

After the retrofits, respondents at all libraries mostly said light fixtures provided enough light by themselves (36 of 38 responses were positive ratings). The exceptions were at Valencia Park/Malcolm X Library in the computer room and outdoor area, respondents said they strongly disagreed and disagreed respectively. For the most part, all library work areas were a 3 (neutral), 4 (agree), and 5 (strongly agree). Especially at the front desk, which is an improvement. Furthermore, all libraries reported sufficient lighting in the front desk, except one respondent out of 12 said they disagreed from Serra Mesa-Kearney Mesa. One respondent from Point Loma/Hervey Library, four respondents from Serra Mesa-Kearny Mesa and one person from Valencia Park/Malcolm X said it was sufficient. Responses were mixed on if there is enough natural light to work effectively, 50% (19 of 38) disagreed or strongly disagreed.

During the pre-retrofit surveys, answers were somewhat diverse regarding lighting sufficiency at the three libraries. The majority from Point Loma/Hervey and Serra Mesa-Kearny Mesa felt positive or neutral about light fixtures at their libraries. They agreed or neither agreed nor disagreed that the light fixtures could provide enough light by themselves in their working areas. By comparison, at Valencia/Malcolm areas including front desk, Teen IDEA lab and Performing Arts Center were reported not having enough light from light fixtures at the Valencia Park/Malcolm X Library. Also, respondents felt quite negative for daylight sufficiency at all three libraries. The majority stated they disagreed or strongly disagreed that daylight only could provide enough natural light to work effectively. Most of all, six areas were reported without effective daylight at the Point Loma/Hervey Library, and daylight was found to be not effective for front desk and book stacks areas in all three libraries.

In addition to the areas that were reported without effective daylight, there were also areas reported with excessive direct sunlight. For the post-retrofit survey, only very few staff reported at Serra Mesa-Kearny Mesa that had to close blinds due to excessive sunlight. This can be compared to the pre-retrofit responses, where respondents thought there was a need to close blinds or screens to reduce heat or glare. Those areas included Valencia Park/Malcolm X's front desk and work room; Point Loma/Hervey's conference/meeting room and book stacks; and Serra Mesa-Kearny Mesa's book stacks, youth service desk, and workroom. As one from Serra Mesa library stated, "***The youth service desk is positioned so that every evening as the sunsets, the sun shines directly into the person who is sitting there's face. There are no shades for us to close, we either have to be blinded or leave that area.***" That respondent also requested automatic shades to help with this situation.

Lighting Controls

Respondents were asked to rate seven types of lighting controls at their working areas, ranging from very poor to very good. For pre-retrofit surveys at all libraries, the majority stated they did not know or were not familiar with those controls but for those that did respond, there was a mix of ratings. This generally remained the same for post-retrofit responses except now most were familiar with manual switches (11 out of 17 responses were good or very good across all libraries) and central building lighting controls (11 out of 16 responses were good or very good across all libraries). This is likely attributed to a lighting control training conducted with library staff after the retrofits were complete.

These responses can be compared to the pre-retrofit survey. For those who gave ratings, results from Valencia Park/Malcolm X and Serra Mesa-Kearny Mesa libraries were generally positive. At the Serra Mesa-Kearny Mesa library, all but one respondent rated the manually controlled blinds/shades/curtains at their working areas between fair to very good. By comparison, comments about lighting controls in Point Loma/Hervey library were mixed. It was reported that controls at both the front desk and children's area worked poorly/very poorly, but controls at the meeting room, book stacks, workroom, and book return areas worked fair/good/very good.

Plug Load Management & Environmental Policies

There were a few questions that were only asked on the post-retrofit survey regarding installed plug load management devices (smart plugs) and if there are environmental policies enacted at the libraries. Smart plugs were installed on copiers and printers at all three libraries as part of retrofits but were not identified as part of the design when the pre-retrofit survey was created. Also, one question asking about environmental policies at the libraries was added only to the post-retrofit survey to gauge what environmental policies would be valuable to the libraries moving forward.

It was found across all libraries, only nine staff were aware of smart plugs being installed while 3 said no and 8 said they were unsure. Out of those nine, only three reported noticing changes when they used a copier or printer connected to a smart plug (one from each library) while four did not notice changes when using the device and 2 were unsure. However, there were several responses that note issues with the devices. One respondent at Valencia Park/Malcolm X stated that, "***Smart plugs took a short time to "learn" to come on, but now seem fine***" and another at that library reported removing the devices, "***It's a hassle to always turn on the machines. So I took them off.***" At Serra Mesa-Kearny Mesa, one respondent also said, "***We have one smart plug for staff color printer. However, it's turned off when we need to use the printer, so it's turned off currently.***"

In terms of environmental policies implemented related to building equipment or systems, most (55%) of all respondents said there was an indoor lighting and recycling policy. The least number of respondents said there was shade/blind controls (10%) and operable windows and doors policy (25%) with most respondents were unsure on those policies.

Behaviors & Actions

Perceived Impact of Behaviors on Energy Use

Respondents were asked to what extent they felt their interactions with their library's lighting controls, thermostats, appliances, fans, and other equipment helped the building conserve energy. For the post-retrofit, across all three libraries, 50% (10 of 20) slightly agreed to strongly agreed that their behaviors helped conserve energy (Figure 4). This was an increase from the pre-retrofit surveys, where respondents at all three libraries, 61% (14 of 23) felt neutral – neither agreeing nor disagreeing that their behaviors helped conserve energy (Figure 5). A minority believed their behaviors helped conserve energy and none believed their behaviors did not help conserve energy.

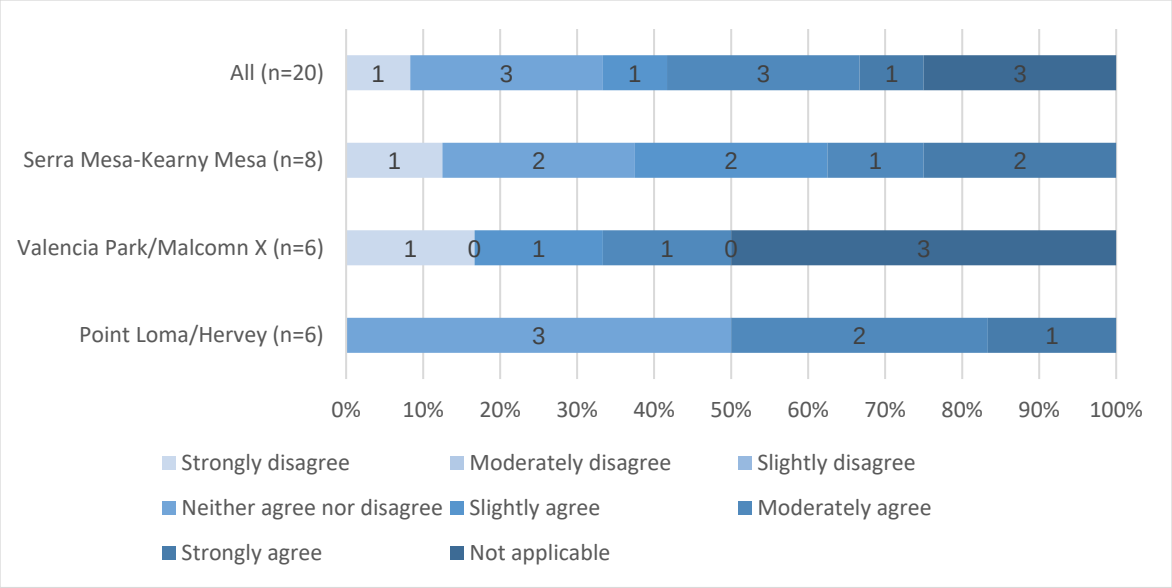

Figure 4: Post-retrofit Perceived Effect of Behaviors on Energy Use

Energy Conservation Actions

Respondents were also asked to rate their engagement in the six types of energy conservation behaviors from never to always/almost always. For the post-retrofit survey, results varied between negative and positive depending on the types of behaviors. Across all three libraries for both pre- and post-retrofit surveys, the majority indicated they never or rarely use ceiling fans to cool rooms, turn ceiling fans off in rooms that are not being used, or unplug kitchen appliances not in use. However, respondents were more likely to report turning off their work computer (70% compared to 47%), closing exterior doors (90% compared to 71%) and turning off lights (75% compared to 56%) than compared to the pre-retrofit survey. For both pre-and post-retrofit responses, the most common reason to engage in any of the above-mentioned energy conservation behaviors was to save energy. Point Loma/Hervey had the most save energy responses in the post-retrofit survey.

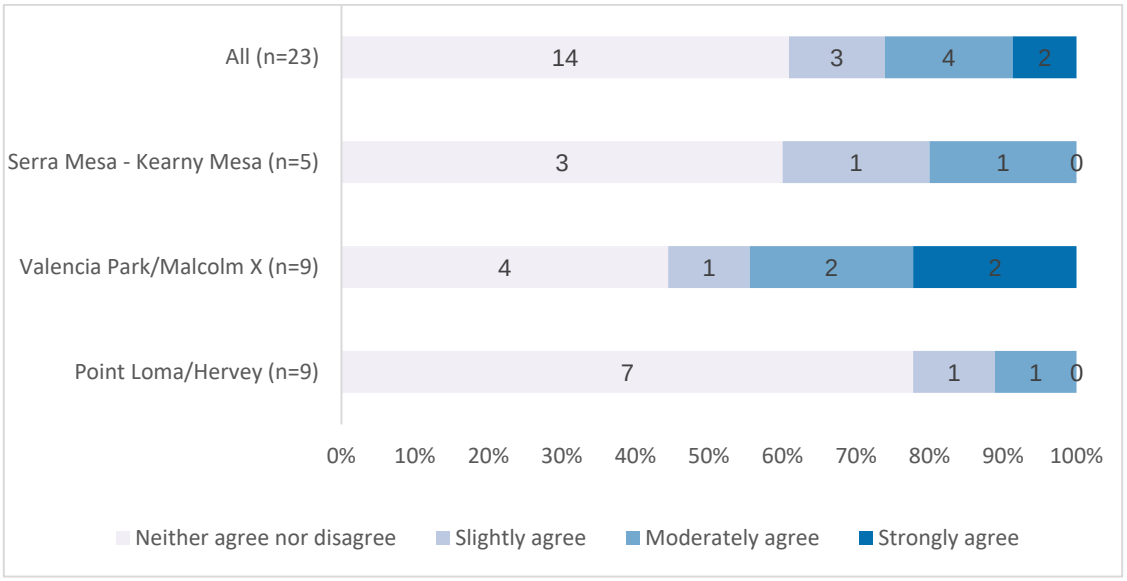

Figure 5: Pre-Retrofit Perceived Effect of Behaviors on Energy Use

Table 11: Pre-Retrofit Respondent Frequency of Engaging in Energy Conservation Behaviors

	Point Loma/Hervey (n=17)		Valencia Park/Malcolm X (n=10)		Serra Mesa – Kearny Mesa (n=7)		All (n=34)	
	Never-Rarely	Sometimes-Often-Always/almost always	Never-Rarely	Sometimes-Often-Always/almost always	Never-Rarely	Sometimes-Often-Always/almost always	Never-Rarely	Sometimes-Often-Always/almost always
Turn off work computer or monitor(s) when not in use	53%	47%	50%	50%	57%	43%	53%	47%
Close exterior doors left open or popped open unnecessarily	41%	59%	10%	90%	29%	71%	29%	71%
Turn off lights in rooms that are not being used	47%	53%	40%	60%	43%	57%	44%	56%
Use ceiling fans to cool rooms	94%	6%	80%	20%	100%	0%	91%	9%
Turn ceiling fans off in rooms that are not being used	94%	6%	80%	20%	100%	0%	91%	9%
Unplug kitchen appliances not in use	65%	35%	80%	20%	86%	14%	74%	26%

Table 12: Post-Retrofit Respondent Frequency of Engaging in Energy Conservation Behaviors

	Point Loma/Hervey (n=17)		Valencia Park/Malcolm X (n=10)		Serra Mesa – Kearny Mesa (n=7)		All (n=34)	
	Never-Rarely	Sometimes-Often-Always/almost always	Never-Rarely	Sometimes-Often-Always/almost always	Never-Rarely	Sometimes-Often-Always/almost always	Never-Rarely	Sometimes-Often-Always/almost always
Turn off work computer or monitor(s) when not in use	0%	100%	33%	67%	50%	50%	30%	70%
Close exterior doors left open or popped open unnecessarily	17%	83%	17%	83%	0%	100%	10%	90%
Turn off lights in rooms that are not being used	0%	100%	33%	67%	38%	63%	25%	75%
Use ceiling fans to cool rooms	67%	33%	100%	0%	88%	13%	85%	15%
Turn ceiling fans off in rooms that are not being used	83%	17%	100%	0%	88%	13%	90%	10%
Unplug kitchen appliances not in use	83%	17%	83%	17%	50%	50%	70%	30%

Interactions with Maintenance Department

Post-retrofit survey results seem to indicate the frequency of contacting the maintenance department has increased since retrofits were completed. For the post-retrofit survey, when asked about the frequencies of contacting their library's maintenance department, 0% (0 of 20) stated they very rarely or never contacted compared to 53% (18 of 34) on the pre-retrofit survey. (Figure 6 and 7). For those who contacted maintenance, only two people from Point Loma/Hervey Library stated they contacted the maintenance once a week or more, while all others contacted once or twice a month to a few times a year. This could be due to several factors as the Point Loma/Hervey Library chiller stopped working and was replaced with a temporary chiller and there were some control adjustments and lighting replacements required after the retrofits were completed.

Answers to how quickly building maintenance staff resolve issues or complaints about heating/cooling, plumbing, lighting and building maintenance were diverse across three libraries. There was an increase in post-retrofit responses for same-day response times for lighting and heating & cooling issues at Point Loma/Hervey Library, up compared to zero same-day pre-retrofit responses. There was also an increase in same-day response times for lighting and heating & cooling issues at Serra Mesa – Kearny Mesa Library, up compared to zero same-day pre-retrofit responses.

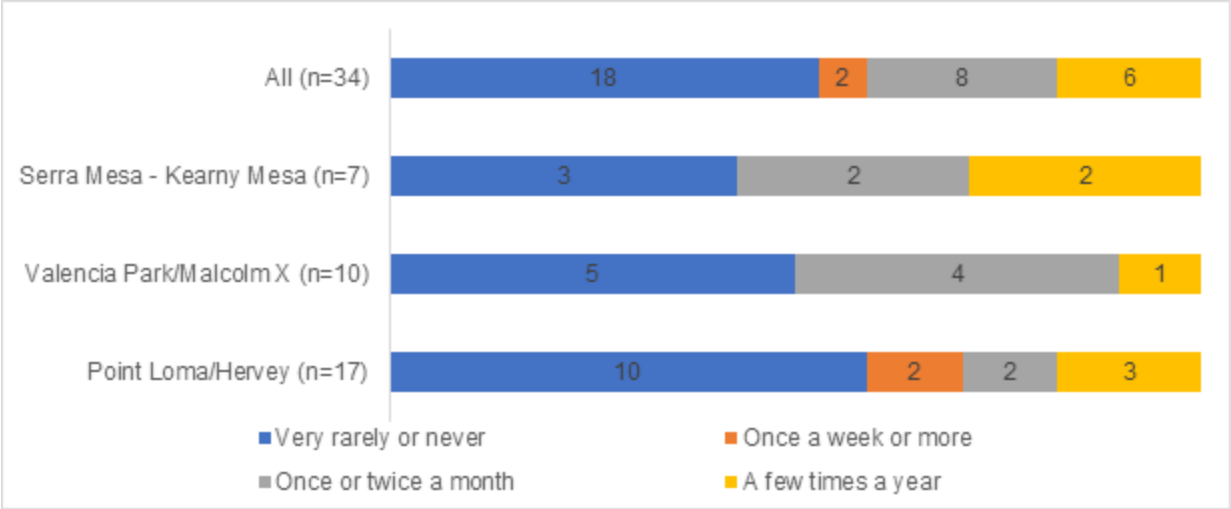

Figure 6: Pre-Retrofit Frequencies of Contacting Maintenance Department

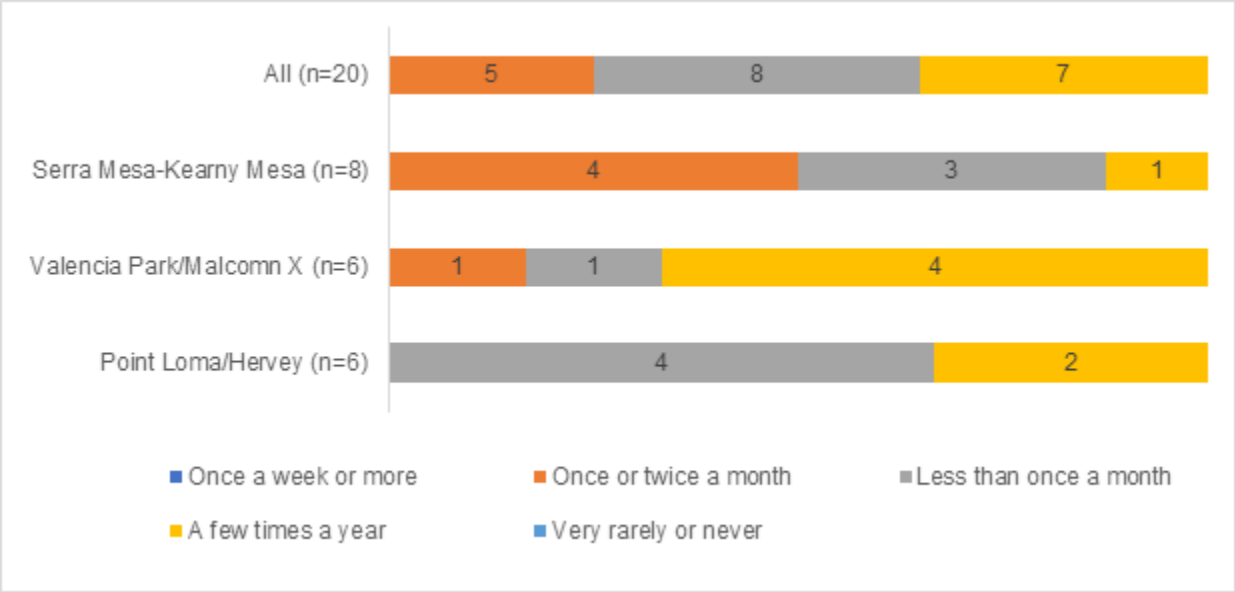

Figure 7: Post-Retrofit Frequencies of Contacting Maintenance Department

While there were no same-day responses indicated for lighting and heating & cooling issues at Valencia Park/Malcolm X Library, there was an increase in the frequency of one to three- day responses compared to pre-retrofit. Plumbing also saw these same increased response times at this location. However, at Point Loma/Hervey Library there still seems to be at least one-two+ weeks for maintenance responses. For lighting repairs, 75% (3 out of 4) of respondents reported waiting 1 or 2+ weeks for fixes (Figure 8) and all respondents (7 of 7) reported waiting one-two+ weeks for repairs (Figure 9).

These responses can be compared to those who responded on the pre-retrofit surveys. It was expected that issues would usually be resolved within two weeks at Valencia Park/Malcolm X Library. A clear message from Point Loma/Hervey respondents is that it usually took a longer time to resolve its lighting issues. As respondents commented, "***Expired ceiling lights take a while to be replaced"*** and "***It takes forever to get a light replaced in our community room."*** For the Serra Mesa-Kearny Mesa Library, plumbing issues were reported be resolved usually within three days; heating/cooling issues were usually resolved within two weeks, and lighting issues sometimes could take up to more than two weeks to be resolved.

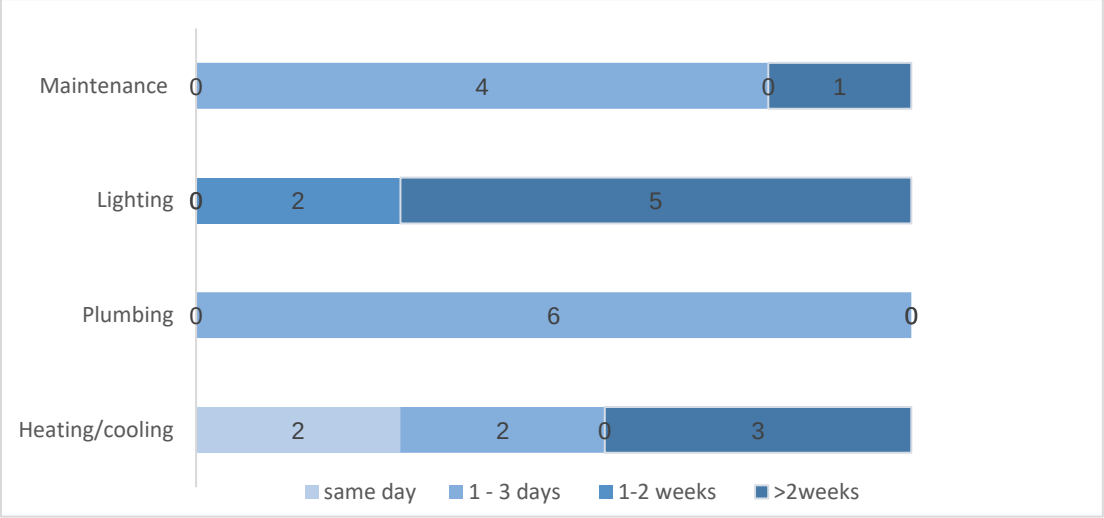

Figure 8: Pre-Retrofit Maintenance Responses at Point Loma/Hervey Library (# of respondents, not applicable answers were excluded)

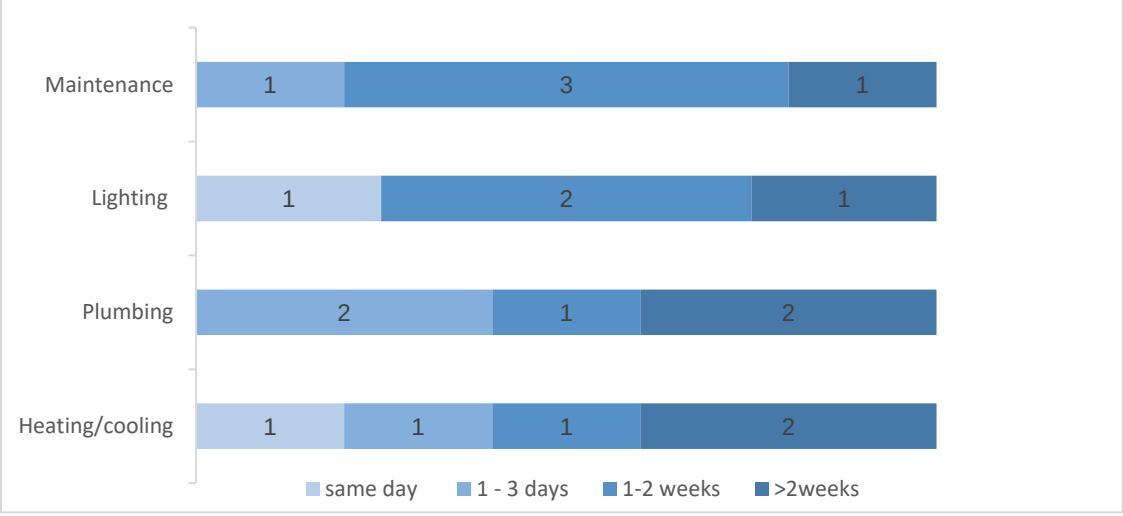

Figure 9: Post-Retrofit Maintenance Responses at Point Loma/Hervey Library

Serra Mesa–Kearny Mesa Library seemed to have improved their maintenance responses. In the pre-retrofit survey, four respondents across all areas responded waiting more than two weeks waiting for maintenance (Figure 11) while in the post-retrofit survey no one responded waiting more than two weeks waiting for a maintenance response (Figure 10). However, more respondents still reported waiting 1-2 weeks in the post-retrofit than in the pre-retrofit despite fewer respondents overall. There were also more "same day" responses in the post-retrofit survey.

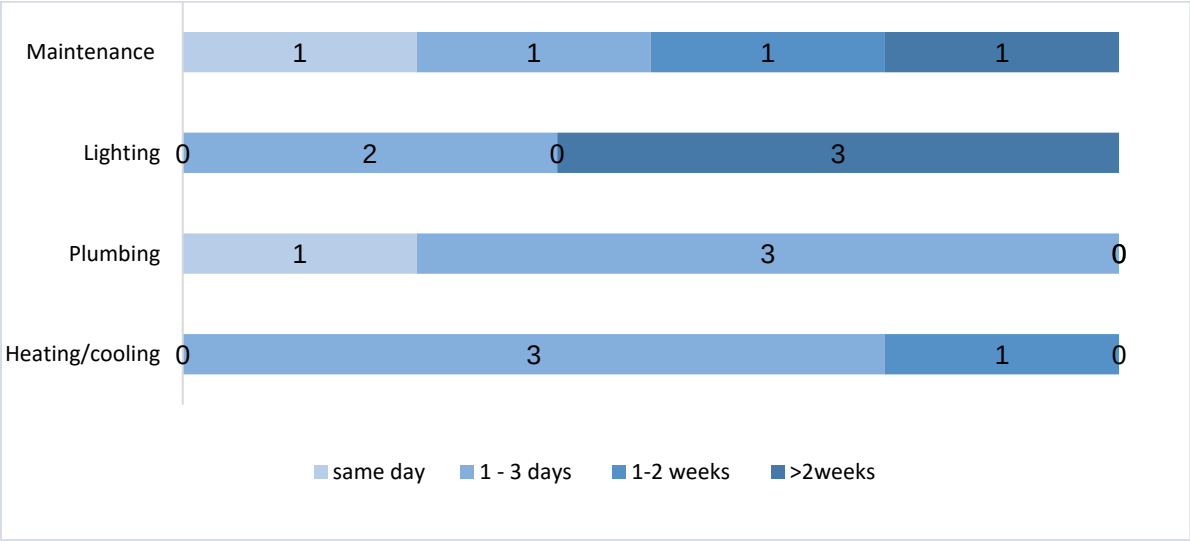

Figure 10: Pre-Retrofit Maintenance Responses at Serra Mesa – Kearny Mesa Library (# of respondents, not applicable answers were excluded

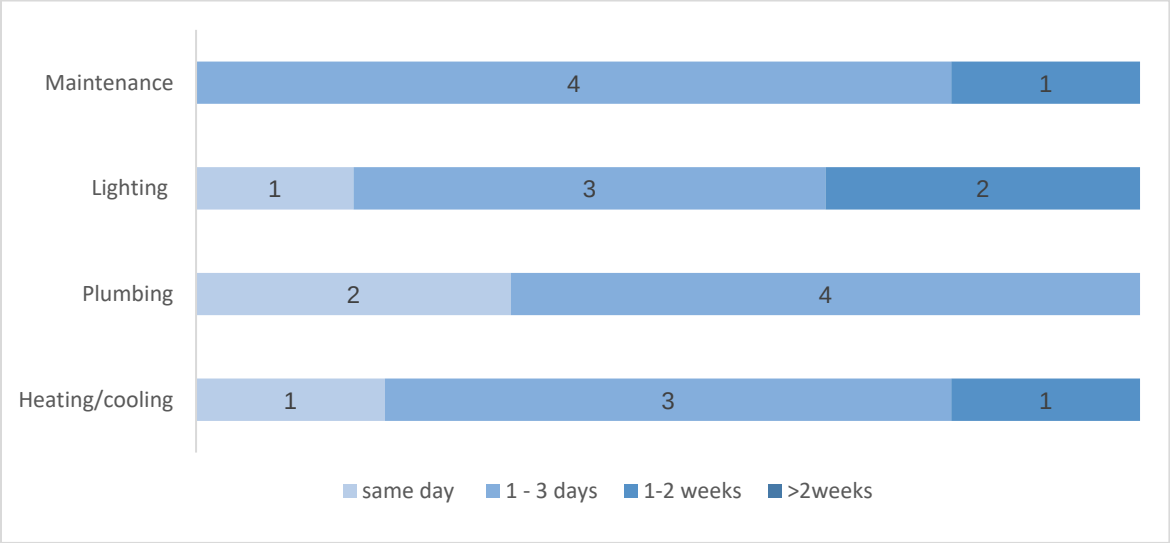

Figure 11: Post-Retrofit Maintenance Responses at Serra Mesa – Kearny Mesa Library (# of respondents, not applicable answers were excluded

For Valencia Park/Malcolm X, there also seemed to be some small improvements. In the post-retrofit survey, one respondent reported waiting one day for plumbing issues (Figure 12) while there were none in the pre-retrofit (Figure 13). Further, there were 11 responses in the post-retrofit that waited one-three days and only five that waited one-two weeks while there were only nine in the pre-retrofit that waited one-three days and 11 that waited one-two weeks. Waiting times seemed to improve for this library across all maintenance issue areas. A respondent from this library commented "***ASAP REPLACEMENT OF LIGHT FIXTURES WHEN REQUIRED"*** which reflects on the figure below (Figure 12) that lighting replacements usually take a few days instead of being on the same day.

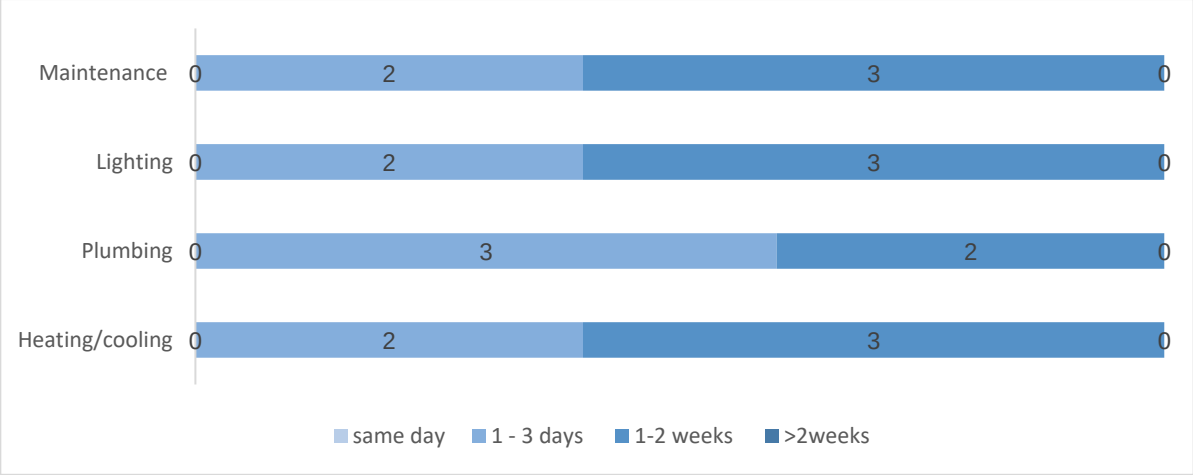

Figure 12: Pre-Retrofit Maintenance Responses at Valencia Park/Malcolm X Library (# of respondents, not applicable answers were excluded)

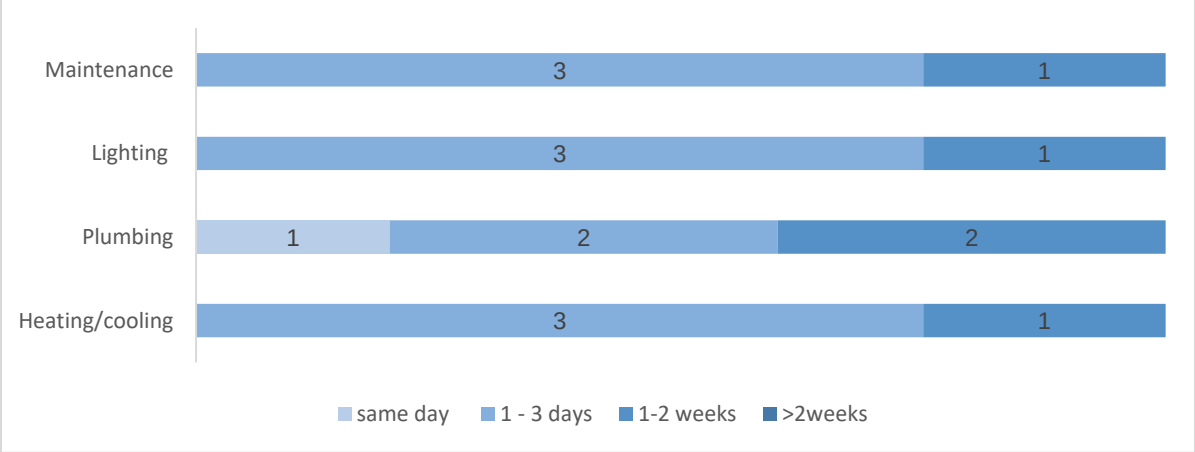

Figure 13: Post-Retrofit Maintenance Responses at Valencia Park/Malcolm X Library (# of respondents, not applicable answers were excluded)

VI. Recommendations

The survey results in this report will be shared with City of San Diego Sustainability staff along with energy usage information received from the nine-month measured measurement and verification (M&V) period. The M&V period is where modeled energy savings are being verified against actual utility energy data in order to determine if the libraries have achieved ZNE and near-ZNE. CSE and the City will then determine if any additional operation, maintenance or other changes are needed at the libraries and document recommendations in the project's Ongoing Maintenance and Retrocommissioning Plan, to be developed in early 2021.

It is also important for respondents to be included in the study's feedback. Key findings from this report point to potential improvements to comfort, behavior change and other benefits that could be boosted by the involvement of all library stakeholders, through follow-up diagnoses and education.

Awareness of energy conservation measures could be further increased among library staff, maintenance workers and library patrons by consolidating and extending the lessons learned through the retrofit experience to a broader audience. Some respondents are already engaged in energy-saving practices which can be built on for further awareness, education and championing the cause. These three libraries have a right to be proud of their buildings and should be encouraged to leverage their ZNE status to distinguish themselves as leaders in sustainability. This could in turn motivate new staff, visitors and community members.

Various thermal comfort, daytime temperatures, lighting and controls were identified as issues at all libraries to some extent and in different spaces. While these issues vary from building to building, this study identified issues in a sufficiently granular way that can be targeted, diagnosed, and remedied through tweaks and education to ensure maximum comfort and satisfaction at each library, allowing them to fully demonstrate the possibilities and benefits of ZNE libraries. Some recommendations include:

- Extend ZNE education to new employees and volunteers when they return, as well as library customers.
- Follow up with library managers on thermal and lighting sufficiency concerns in work areas that were reported with the most issues.
- Further educate library staff on existing lighting and temperature controls.
- Follow up with library managers on which smart plug devices have been removed and see if the devices needed more time to learn on-off patterns.
- Work with library managers to investigate, develop and enact environmental policies.
- Work with library facility staff to develop a maintenance and Retrocommissioning Plan.

Appendix A: Pre-retrofit Survey Instrument

Appendix B: Post-retrofit Survey Instrument

Appendix C: Pre-and Post-retrofit survey demographics