Berkeley Mental Health Services Facility

MEASUREMENT & VERIFICATION REPORT

ZERO NET ENERGY SMALL COMMERCIAL RETROFITS (CEC EPIC 15-308)

March 2023

Photo courtesy of Lawrence Berkeley National Laboratory

Introba

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1 Introduction

The Berkeley Mental Health Services building, located at 2640 Martin Luther King Jr Way, Berkeley, CA 94704, is an existing office building that underwent a zero net energy retrofit. The building is one story and approximately 8,800 square feet.

The retrofit was designed to serve as a demonstration project under the Zero Net Energy Small Commercial Retrofits EPIC grant (CEC EPIC 15-308) in collaboration with Lawrence Berkeley National Lab (LBNL), Integral Group, and 2030 Districts.

Measurement and Verification (M&V) planning and implementation can assist in optimizing energy performance over the lifetime of a building or project space by comparing the monitored performance of its systems to calculated and historical values. The goals of the M&V process were to verify zero net energy performance, validate simulation results by end-use, assess occupant thermal/visual comfort and operational best practices, and validate tubular daylighting device (TDD) visual performance and impact on lighting energy.

The approximate project schedule was completion of design documents in July 2018, construction from September 2018 to July 2019, and undertaking the M&V process from February 2022 – January 2023, after HVAC system issues were resolved. At the end of the M&V period, the PV system had not yet been energized.

Prior to the retrofit work, building use varied significantly due to long periods of vacancy and mold issues due to poor building construction and lack of dehumidification. The building is located over an underground stream that had been covered over, resulting in high humidity in the crawl space under the building, and resulting in mold over time. Dehumidifiers were brought in as part of the space remediation process. Therefore, comparison to recent historical energy data may not be accurate. Older historic data has been employed to ensure the comparison is valid.

The retrofit of the building upgraded several systems to reduce energy consumption, electrify HVAC and DHW systems, provide on-site energy through rooftop solar panels, and improve indoor environmental quality for occupants. The net result is an energy efficient, all electric building, with a further goal of zero net energy using on-site solar energy production.

The following is a list of the major Energy Efficiency Measures (EEMs) included in the retrofit of the building:

- (2) packaged heat pump variable air volume air handling units (AHUs) with energy recovery ventilators (ERVs), demand-controlled ventilation, and Therma-Fusers.
- LED lighting with occupancy and daylighting controls, (35) tubular skylights, and (5) existing skylights
- (6) instantaneous electric water heaters
- R-19 roof and R-19 cavity insulation added
- Reduced plug loads to 0.49 W/sf connected load
- Rooftop solar photovoltaic (PV) system

In addition, mold remediation and structural improvements, including vapor barriers, were incorporated into the building.

2 Methodology

In order to monitor the energy performance of the building, post-occupancy energy trend data was captured over the 12-month observation period (February 2022 – January 2023) and compared to energy model predictions per the protocols of the International Performance Measurement and Verification Protocol (IPMVP) - Option C, Whole Facility.

2.1 Historical Data

Historical utility data (from 2003 – 2017) for both the electricity and natural gas consumption was used to calculate the average monthly consumption (Figure 1). This data was used to calibrate the pre-retrofit baseline model. Based on the design decisions a 64% reduction in total energy, 43.9 kBtu/sf/yr to 15.7 kBtu/sf/yr, was anticipated during the design phase. This predicted EUI was updated to 17.5 kBtu/sf/yr based on changes made in the construction phase. Note that the building retrofit included the removal of all natural gas based HVAC and DHW, with an aim for a net zero carbon annual operation, offsetting electricity use through onsite PV generation.

During the historical period, there were variations in occupancy and performance that are reflected in the utility data. The building had been vacant for some years before the retrofit work was conducted and there were mold issues due to issues with the dehumidifiers. The use of the average energy data over this period is considered to be a good approximation of typical energy use.

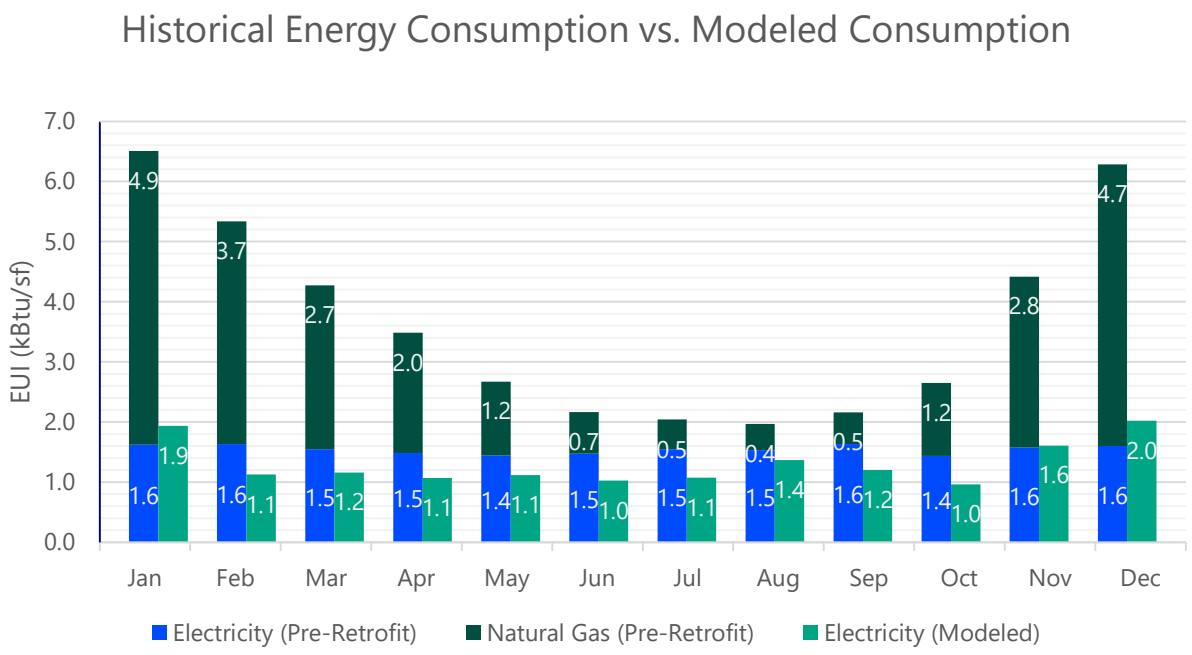


Figure 1 - Historical Energy Consumption vs Modeled Consumption

2.2 Data Collection

Specifically, the following data was collected:

- Electrical panel-level energy use. Electrical panels disaggregated end use power consumption as follows: AHUs; lighting, in total and by amperage in select rooms; plug loads, in total and by amperage in select rooms; and domestic hot water (DHW) generation. A submeter for the PV generation was also installed, though no data has been collected on this meter to date due to delay with the utility approving the

interconnection. EV charger data was included in the main building utility metering, but not submetered through the electrical panel. EV charger data instead was collected separately through the charger management system, to be subtracted from the building meter.

- Electrical measurements (current draw in amps) for targeted loads representative of key conditions (e.g., energy per air handler, lighting energy in rooms with TDDs, and plug load energy in high load spaces). For a full-list of metering points see Appendix B – Monitoring Points.
- Quarterly measurements of occupant thermal and visual comfort-related parameters and quarterly high dynamic range (HDR) photographs were taken over weekends using stand-alone instrumentation and data logging.
- Surveys/interviews with full-time occupants (staff) to assess if sensors are providing a realistic assessment of building comfort and to evaluate how occupants are interfacing with building systems.
- Monthly utility bills, including total energy use and energy costs

Detailed data on the information collected can be found in Appendix A – Detailed Energy Data.

A detailed list of the systems, equipment, and points monitored is included in Appendix B – Monitoring Points.

2.3 Measured Data

This section describes how the measured data was used to compare against the baseline and proposed energy models, track building zero net energy performance, and validate energy simulation results by end use.

During the most recent year of the building's operation (February 2022 – January 2023), weather conditions and metered performance of energy-using systems were collected and analyzed, as described below, to determine post-construction conditions and operation.

To perform a more detailed analysis, the energy usage data was broken-down into end-use groups. The facility is equipped with meters that measure power usage at the electrical panel level and electrical current on targeted equipment (AHU-1; AHU-2; plug loads in the IT Closet (131), Staff room (136), Copy Area (126), and Admin Offices (103); and lighting in the COT Office (132), FSP Office (135), Staff room (136), MHSA Office (130), Admin Offices (103), and FIT Office (112)). Energy is separated by mechanical, lighting, domestic hot water, and plugs on the electrical panels and in the energy model.

Trend data was reviewed and compared monthly to modeled predictions. Large discrepancies in predicted and actual energy use were identified for the owner to address. An electrical single line diagram indicating the metering locations is in Figure 2.

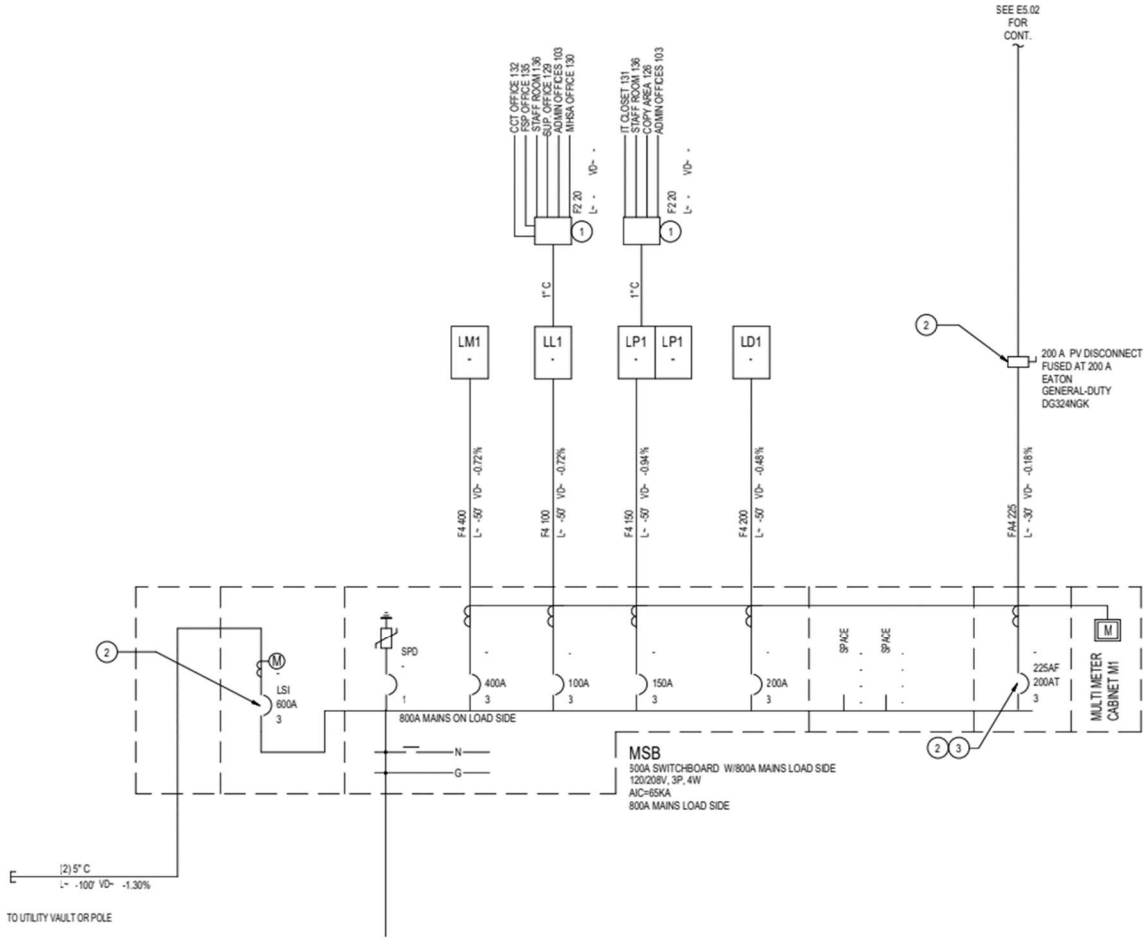


Figure 2 Electrical Single Line Diagram

2.3.1.1 Occupancy Profile

The occupancy profile of the building has a significant impact on the annual energy consumption. In the pre-construction energy model, reasonable estimates were made for the occupancy based on the City's anticipated use of the building, which included long occupied periods during weekdays, and also included weekend occupancy to serve their clients. During the M&V period, surveys of permanent staff and visitor occupancy information were conducted and logged to develop a more accurate occupancy use.

2.3.1.2 Mechanical System

To verify HVAC energy use, monitoring consisted of the energy use from the (2) heat pump ERV air handlers and the metered data for each individual air handler was analyzed to determine the energy consumption. The measured data was used to establish a typical heating and cooling profile and was compared to the profiles in the proposed model. Changes to the set points, hours of operation, and internal loads were analyzed in the trended data.

2.3.1.3 Lighting System

To verify lighting energy use, the metered data for the lighting electrical panel (LL1), and specific rooms with tubular daylighting devices, were analyzed to determine the energy consumption. The measured data was used to establish a typical daily weekday and weekend lighting profile (kWh vs. hour), which could be compared to the energy model. Peak lighting demand was used to determine and verify total installed lighting wattage and total lighting power density.

2.3.1.4 Plug Loads

To verify plug load energy use, the metered data for the receptacles electrical panel (LP1) and specific high load rooms was analyzed to determine the energy consumption. The measured data was used to establish a typical daily weekday and weekend plug load profile (kWh vs. hour), which could be compared to the energy model. Peak plug load demand was used to determine and verify the total installed plug load density.

2.3.1.5 Domestic Hot Water System

To verify plumbing equipment energy use, which consists of the energy use from the (6) instantaneous water heaters, the metered data for the plumbing panel (LD1) was analyzed to determine the energy consumption. The measured data was used to establish a typical water heater profile (kWh vs. hour). While DHW data was collected throughout the M&V period, it was much lower than anticipated, and it may be that the DHW meter may have failed in early 2022. This issue was reported, however was not resolved during the M&V reporting timeframe. It is possible that the data collected was correct, and that hot water use really was this low, however we suspect that some measurement error might be involved.

2.3.1.6 Solar Photovoltaic (PV) System

At the time of writing, the PV system was yet to be energized due to ongoing conversations regarding the interconnection agreement with the utility provider Pacific Gas & Electric (PG&E). Due to this, the PV system is currently not producing electricity. Therefore, modeled PV generation values have been used to show that the building has the potential to be zero net energy, and is anticipated to be, once the logistical barriers have been cleared.

2.3.1.7 EV Charging

EV charging was not part of the building design or energy budget during the retrofit's design process. However, during the construction project a separate EV charging project was added to the retrofit. It was determined at that time that the building design did have some additional PV generation capacity to support some degree of EV charging, however it was noted that this was not part of the Zero Net Energy goals for the research project. The EV chargers were not separately submetered, however their energy consumption data would be available through the charging vendor platform. The whole building utility meter would include both the building and PV net consumption, as well as the contributions from the EV charging, so any ZNE analysis would need to separate out the EV charging component.

2.3.2 Occupant Survey Description

The Occupant Survey, which is an anonymous web-based tool, was deployed to the Berkeley Mental Health staff to assess indoor environmental quality of the space. The survey helps to determine satisfaction and productivity based on 7 categories namely:

- Personal Workspace
- Layout
- Visual Privacy
- Furniture
- Air (both Temperature and Air Quality)
- Lighting
- Acoustics
- Cleanliness and Maintenance

The occupant survey was conducted twice, in April and September of 2022. In April 6 occupants completed the survey, and in September 16 occupants completed the survey.

In both surveys around half of the respondents were satisfied with the workspace and storage they were provided, while the other half desired more work surface area, storage, and space for meeting with others. Generally, the furniture was considered satisfactory, with the only dissatisfaction relating to training on the ergonomics of their workstation, or the accessibility of whiteboards.

Visual privacy was a point of complaint, with two thirds of people not believing that they had enough separation between desks, and concern over the number of people walking through their work area. Conversely many didn't feel they had enough area to gather and mix with co-workers.

Occupants reported feeling both hot and cold in the spaces, some saying it interfered with their work. More control over their temperature was requested, as well as higher air movement rates. Odors were a minimal problem, but some reported stuffy or stale air.

It seemed that most respondents considered the electric lighting levels to be acceptable but almost all desired more daylight at their workstations.

Acoustics were challenging to occupants, with the acoustic privacy of treatment rooms being brought up by several people, as well as echoing, and the challenges this created for hearing impaired people.

Cleanliness of the building was satisfactory, but there were a few maintenance issues reported.

2.4 Spot Measurements

Spot measurements of visual and thermal comfort variables were conducted in order to provide a quantitative assessment of occupant experience in the space after the retrofit was completed with an additional level of sensor data beyond that implemented in the retrofit. Visual comfort was assessed using the Daylight Glare Probability (DGP) metric [Wienold, 2006], based on measurements using high-dynamic-range (HDR) luminance mapping. It is generally considered desirable for DGP to remain below 0.3. HDR images were captured and processed by several custom apparatuses that were placed where occupants would normally face, with the camera lens at seated eye height (48 inches, also see Figure 3). Measurement locations are shown in Figure 4 - Locations for visual and thermal comfort spot measurements.

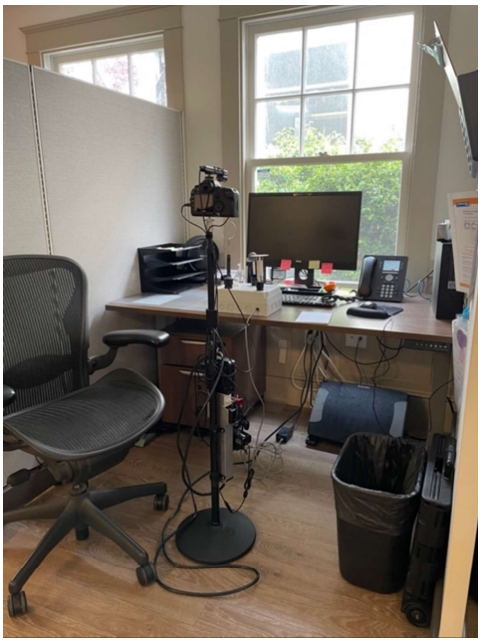


Figure 3 - Visual and thermal comfort measurement apparatuses deployed on site.

The visual comfort apparatus is mounted on a floor stand. The gray box visible on the desk is the thermal comfort apparatus.

Apparatuses for measuring variables relevant to thermal comfort – dry bulb temperature, mean radiant temperature, relative humidity, and air velocity – were also deployed at similar locations. These measurements were used for calculating the Predicted Mean Vote/Percentage of People Dissatisfied (PMV/PPD) metric [ANSI/ASHRAE, 2013]. PMV provides a measure of how occupants are expected to perceive the space: values of -3, -2, -1, 0, 1, 2, 3 correspond to "cold", "cool", "slightly cool", "neutral", "slightly warm", "warm", and "hot" sensations, respectively. PPD is an indication of the percentage of people who would not be satisfied with the thermal environment. ASHRAE recommends that PPD be maintained under 20% and PMV between -0.5 and 0.5. Calculations were performed assuming an occupant metabolic rate of 1.3 met was assumed. This value can be considered an average level for work performed in an office [Akimoto, 2010]. Clothing insulation was assumed to be 0.61 clo – trousers and long-sleeved shirt (CBE ASHRAE-55 Thermal Comfort Tool [University of California, Berkeley, 2021]).

It was not possible to do spot measurements of the PV system because it had not been energized when work was completed.

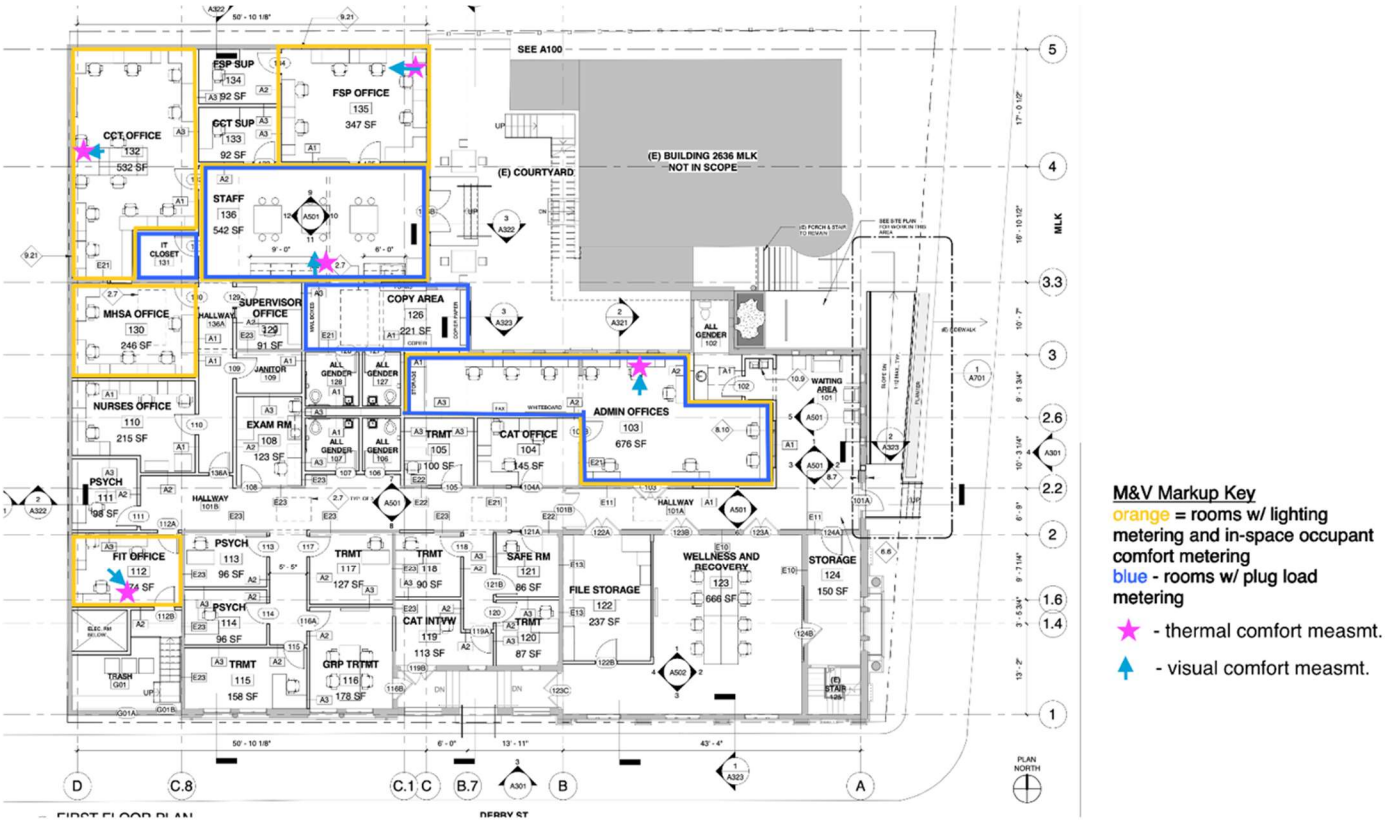


Figure 4 - Locations for visual and thermal comfort spot measurements.

The measurements took place at two different times of the year, in April and October 2022, in order to cover a variety of environmental conditions (weather, position of the sun). On each of these occasions, instruments were deployed on a Friday afternoon, collecting data over the weekend (i.e., while the space was unoccupied) until they were retrieved on the first workday following the weekend. Due to unforeseen equipment issues, thermal comfort data for the April site visit was unfortunately not available for analysis.

3 Results

3.1 Measured Savings Achieved

The reduction in energy consumption between the historical building averages and the submetered energy consumption for the building (without EV charging) is 79% (43.9 kBtu/sf/yr to 9.0 kBtu/sf/yr), exceeding the 64% savings previously predicted.

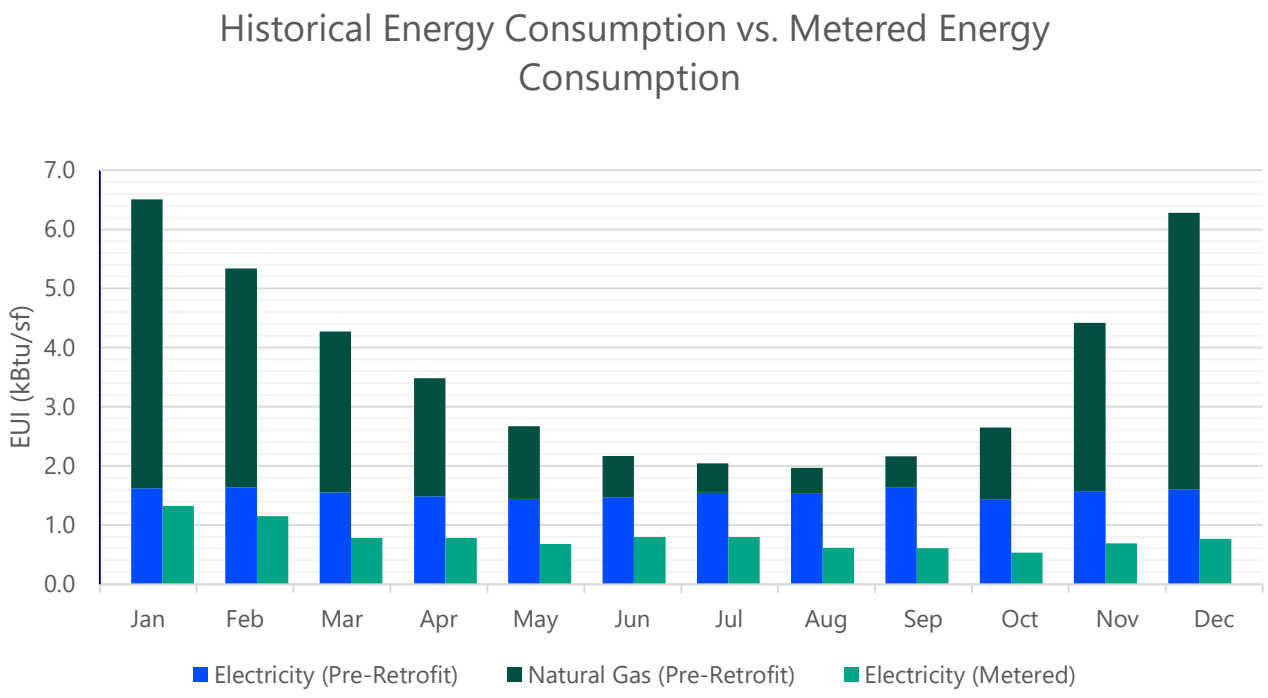


Figure 5 – Historical Energy Consumption vs. Metered Energy Consumption

The reduction in annual energy costs over the same period is 35% from an average of approximate $11,114/yr to $7,273/yr. While the reduction in energy costs is less than the reduction in energy consumption, due to the difference in pricing between natural gas and electricity, it is expected that once the PV system is enabled, the reduction in annual energy cost will increase, as it is predicted that zero net energy will be achieved.

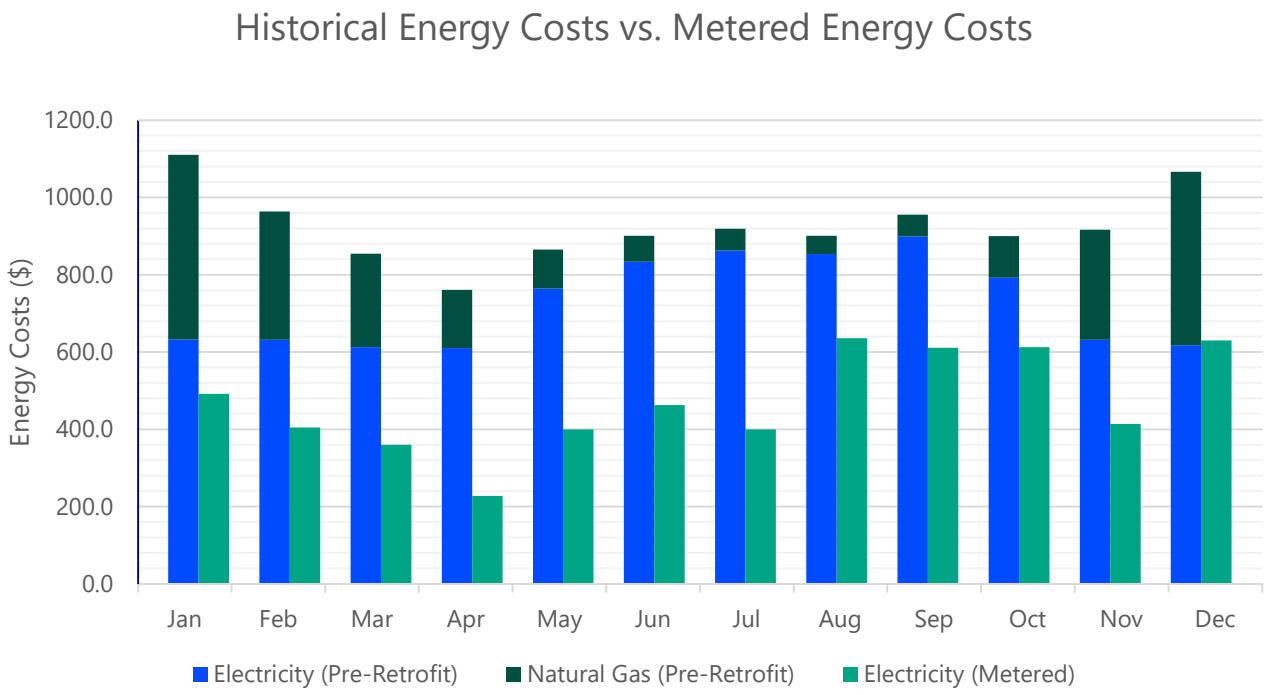


Figure 6 – Historical Energy Costs vs. Metered Energy Costs

3.2 Actual Savings vs Predicted

The total energy consumption for the building post-retrofit (without EV charging) was less than the predicted modeled data (79,130 kBtu/yr vs 137,439 kBtu/yr). For each end use, the metered energy use was less than the predicted modeled data, with a large variation in the amount of difference.

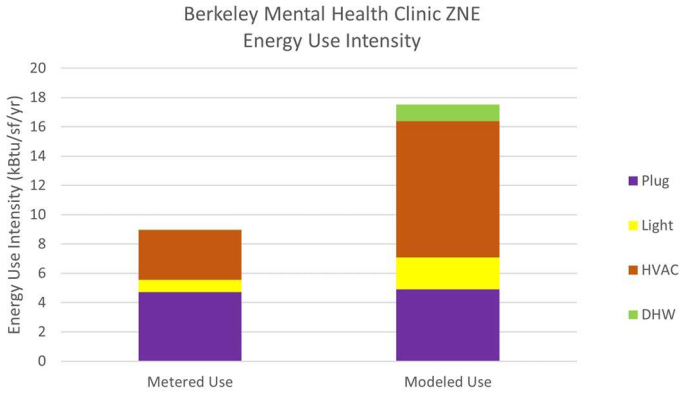


Figure 7 – Modeled vs Metered EUI

The following sections compare the measured submeter data to the modeled data lighting, plug loads, and lighting, using the average of data from March 2022. Similar comparisons graphs for each month can be found in Appendix A – Detailed Energy Data.

3.2.1 Lighting Electricity

The modeled lighting energy is more than twice the metered data (9,117 kBtu/yr metered vs 18,417 kBtu/yr modeled). When comparing the measured data against the modeled lighting energy it can be seen in Figure 8 that the peak lighting consumption is roughly the same as the modeled value, as expected. However, on weekdays, it should be noted that the peak energy consumption is happening much earlier in the day than anticipated.

This could be due to a number of factors. For example, the location of the daylighting sensors may be different than the modeled location, causing the dimming of the lights to occur at different times than predicted. It is also likely that the "typical meteorological year" weather data that was used in the modelling will not exactly line up with the degree of sun or cloud on any specific day. The only weather data that was tracked was dry-bulb temperature, so the weather file was unable to be compared for solar conditions.

Additionally, the building occupancy schedule likely differs from the modeled occupancy with higher occupancy in the morning than the evening, resulting in the lights turning on due to the occupancy sensors in the spaces. The modelled occupancy schedule assumed people left their offices over the lunch hour, which does not seem to be happening based on the measured data, and it assumed less lights were on over the weekend. Higher than predicted weekend use could be a function of more people stopping into the office on the weekend to do work, or the schedule of the cleaners, who would also trigger the occupancy sensors. The weekday overnight usage is also higher than anticipated, likely due to the same factors.

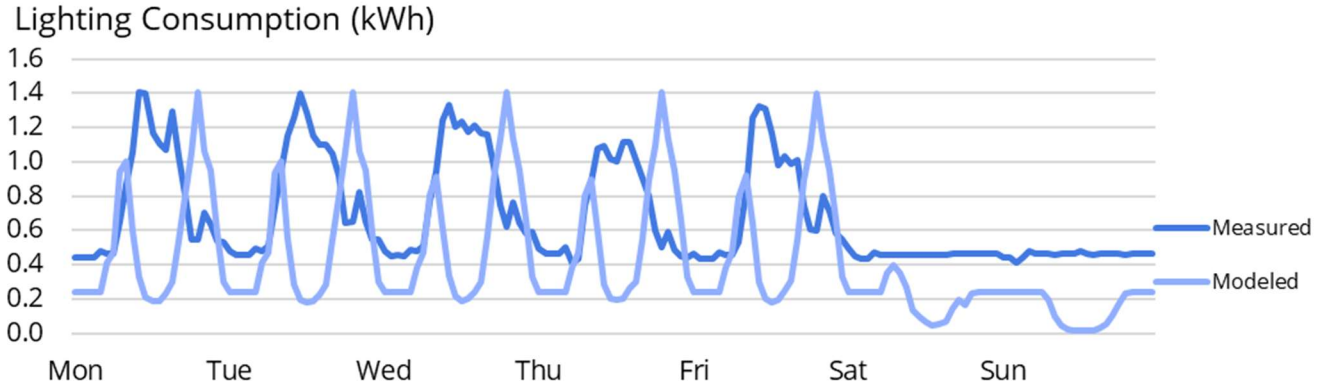


Figure 8 – Average Hourly Lighting Electricity Consumption – Measured (March 2022) vs Modeled (March)

3.2.2 Plug Load Electricity

The metered plug load energy consumption (41,1474 kBtu/yr) is lower than the modeled plug load consumption (43,115 kBtu/yr), but not by a significant amount. When comparing the measured plug load consumption against the modeled data the first thing that is noted is that there is much less variation between the lows and the highs. When looking at the measured high-end hourly plug loads for Monday for example (2.7 kWh), it is noted that these are averages for all Mondays in the month of March which may help smooth peak consumption values. Additionally, it appears that the diversity in the utilization of the installed plug load equipment is lower than anticipated in the energy model, further reducing the daily plug load peak consumption.

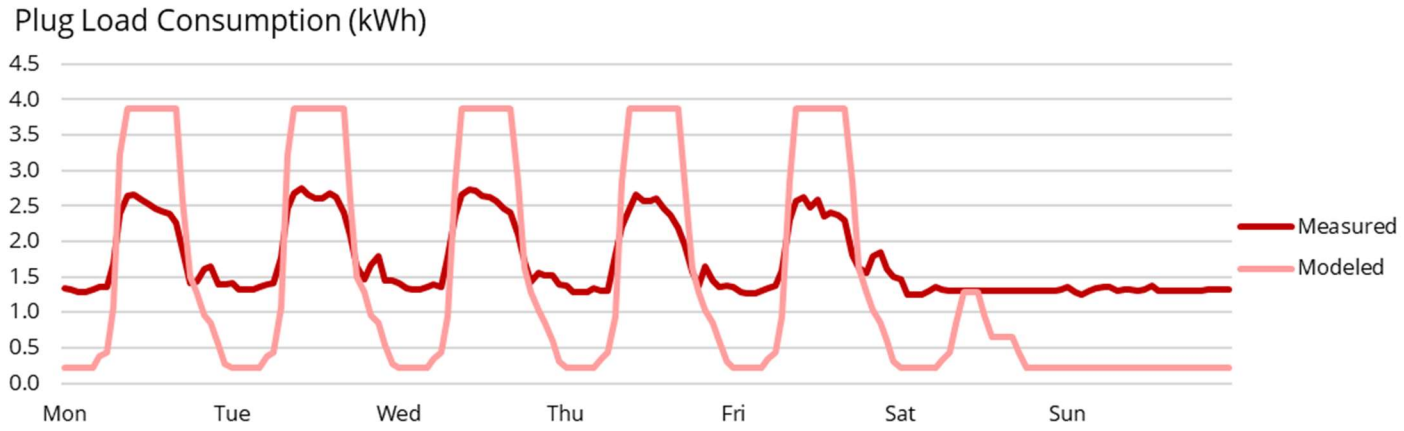


Figure 9 – Hourly Plug Load Electricity Consumption – Measured (March 2022) vs Modeled (March)

When examining the daily minimum plug load consumption in the modeled data, it appears that some of the plug load reduction strategies are not delivering the expected results. Specifically, looking at the unoccupied period over the weekend, the measured plug load consumption is approximately six times higher than the modeled consumption. Additionally, during the overnight periods when the loads are expected to be minimal, the measured plug loads are similarly higher than the modeled values. This could be due to the occupancy-controlled outlets not being well utilized or possibly the isolated branch panel set-aside for printers, fax machines, and similar devices is not being powered off by the system when the building is unoccupied. Site visits did show that additional plug strips had been put in place to avoid the use of the controlled outlets in some locations, which would have the effect of increasing the minimum power draw.

3.2.3 HVAC Electricity

HVAC energy comparisons are presented in Figure 10, below. When comparing HVAC measured data versus modeled data, care must be taken as the largest variations are likely to occur due to the differences between the real-world weather and the typical meteorological year data used for the simulation. Nevertheless, a couple of trends can be seen from these results.

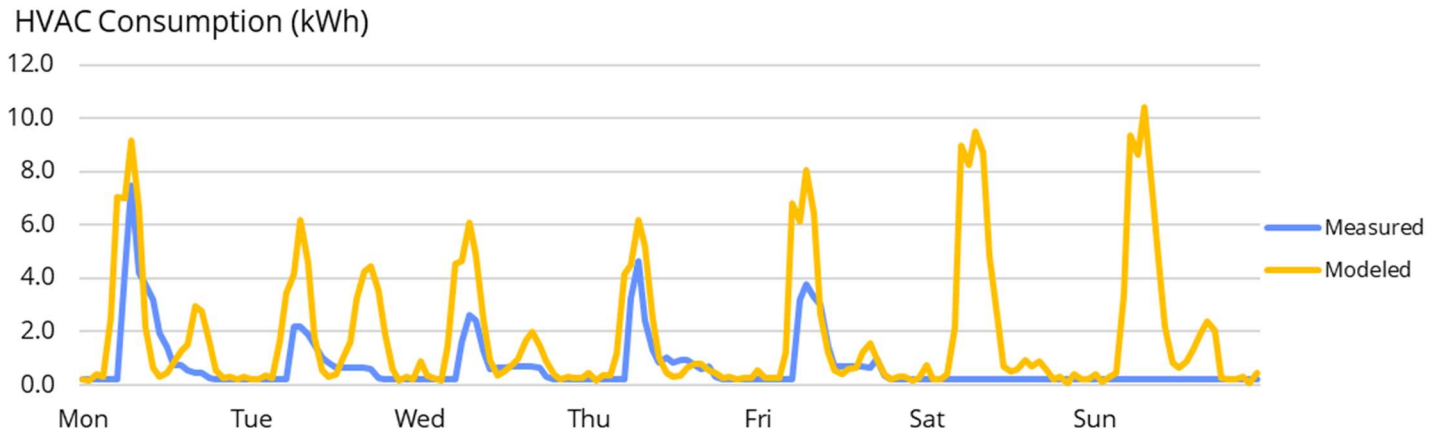


Figure 10 – Hourly HVAC Electricity Consumption – Measured (March 2022) vs Modeled (March)

There is a spike in both the measured and modeled data on Monday mornings. This appears to be due to the morning warm-up cycle to heat the building back up after being empty on the weekends. For the rest of the

weekdays, while the consumption varies a bit between the measured data and the modeled values, the overall shape of the energy consumption is similar which indicates that there is not a significant disconnect between the modeled hours of operation and the actual operation of the HVAC system in the building.

Of note, based on the measured data it appears that the HVAC system is turned off entirely on the weekends, which differs from the modeled schedule of operations. Upon discussion with the City, it does appear that the operating schedule assumptions in the energy model were no longer valid given the post-pandemic related use of the building. Previous understanding of the operation of the facility was that there would be open operating hours over the weekends, however it appears that the facility has reduced operating hours, or relies on remote work instead on weekends. If interior space conditions on the weekends are within the building's operating requirements (for both temperature and relative humidity), and if the building can meet the desired setpoint when occupied conditions resume, this operating strategy may help reduce the annual building energy consumption. The thermal conditions of the space should be monitored to verify that they are maintained within the operating requirements of the space.

3.2.4 Metered vs Utility Data

The whole building metered data included in this report is obtained from summing the individual HVAC, lighting, plug load, and DHW submeters. The utility meter is the only whole building meter, and also includes the PV generation contribution as well as the EV charging energy.

When the sum of the meters is compared to the utility data some discrepancies are seen. Prior to this comparison the EV energy was removed from the utility total based on data from the ChargePoint system, as it was outside the scope of the project.

Some discrepancy is expected as the domestic hot water meter likely failed early in 2022, so this energy will be seen in the utility data, but not in the metering sum, until the meter is fixed.

Based on the results of the comparison it appears that part of the PV system may have been energized, but not all of it, and this is impacting what is seen in the submetered data vs the utility data. The meter for the PV system is not reporting generation, but the utility interval exports cannot be explained otherwise.

From	Thru	Billed Electrical Usage (kWh)	Billed Electrical Minus EV Usage (kWh)	Sum of Submeter Data (kWh)	Sum of Utility Interval - Total (kWh)	Sum of Utility Interval - Imports (kWh)	Sum of Utility Interval - Exports (kWh)
12/26/2022	1/25/2023	3,986	3,932	2,185	3,890	3,921	(31)
11/27/2022	12/26/2022	3,712	3,587	1,958	3,600	3,637	(38)
10/25/2022	11/27/2022	3,196	3,128	1,764	3,075	3,210	(134)
9/26/2022	10/25/2022	2,042	1,987	1,363	971	2,012	(1,041)
8/26/2022	9/26/2022	1,769	1,706	1,554	(906)	1,691	(2,596)
7/26/2022	8/26/2022	1,557	1,546	1,570	(1,571)	1,670	(3,240)
5/25/2022	7/26/2022	4,158	4,123	4,093	2,832	5,989	(3,157)
4/26/2022	5/25/2022	1,515	1,483	1,741	(2,302)	1,498	(3,800)
2/24/2022	4/26/2022	1,747	1,627	4,009	(1,866)	3,838	(5,704)
1/25/2022	2/24/2022	2,763	2,748	2,948	225	390	(166)
	Total	26,445	25,868	23,185	7,949	27,856	(19,907)

Overall however, despite these discrepancies the submetered data is generally validated in the sense that it is seen as being a subset of the overall utility meter data (23,185 kWh vs 25,868 kWh), with the difference viably being the missing amount of domestic hot water load.

3.2.5 PV generation results (Modeled)

The PV system consists of 118 panels with a rated capacity of 340 W each for a total 40.12 kW DC capacity. The panels are installed at a 10-degree tilt in alternating directions, with 39 of the panels oriented north, 53 to the south, 12 to the east and 14 to the west. Note that Plan north is 30 degrees east of true north. There is minimal shading on the site from adjacent structures, however some shading from adjacent trees occurs.

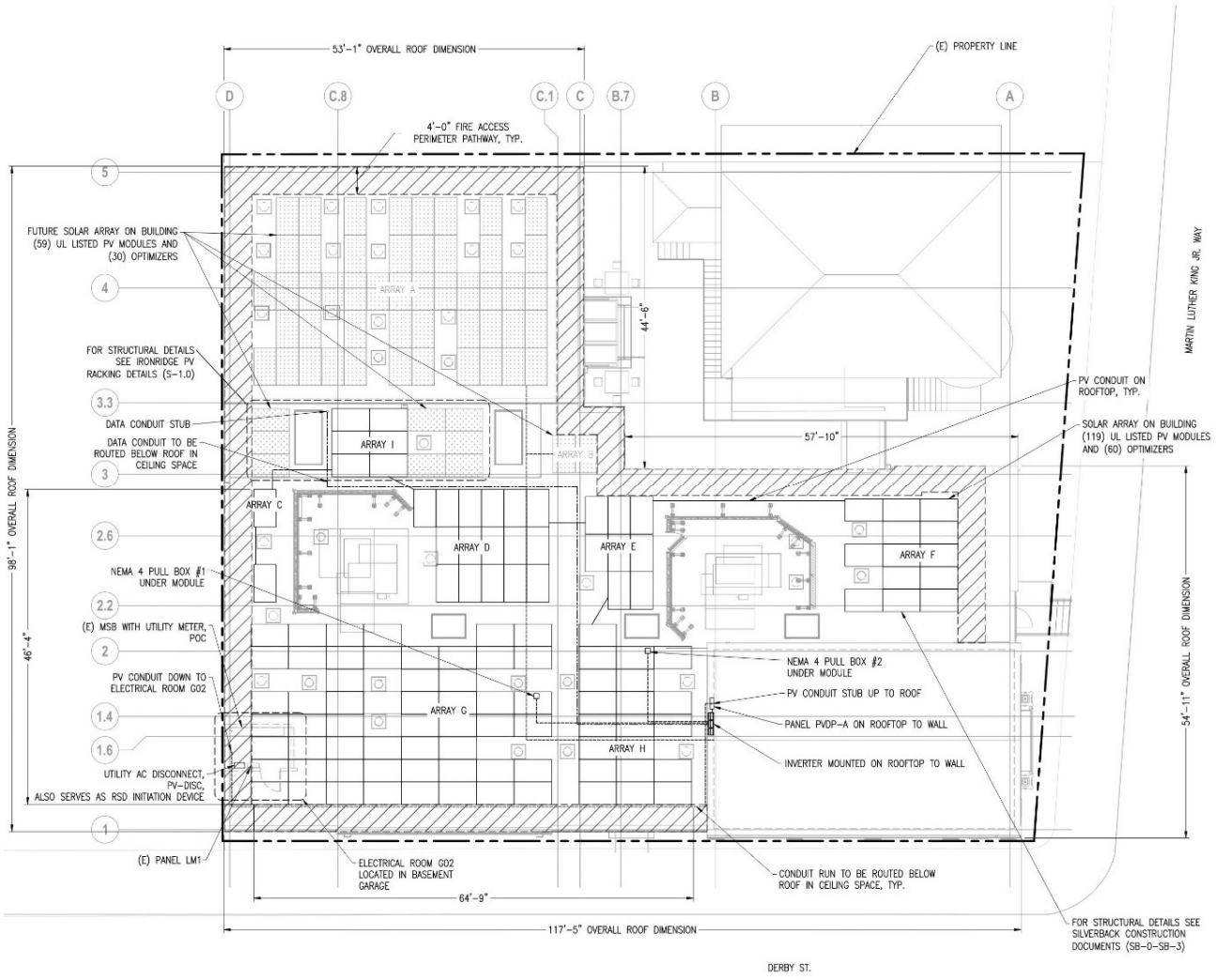


Figure 11 - PV System Layout

While the PV system has been installed, it has not been formally initialized and therefore is not producing all of the expected electricity. There is also no usage appearing on the PV submeter at all as of the time of this writing. Information from the SolarEdge monitoring system has been requested, but not yet received. Based on the modeling of the system, it is expected that the system will produce approximately 54,675 kWh of electricity per

year. This production would significantly exceed the metered energy consumption of 23,125 over the monitoring period so it is expected that this project will be zero net energy once the PV system is activated.

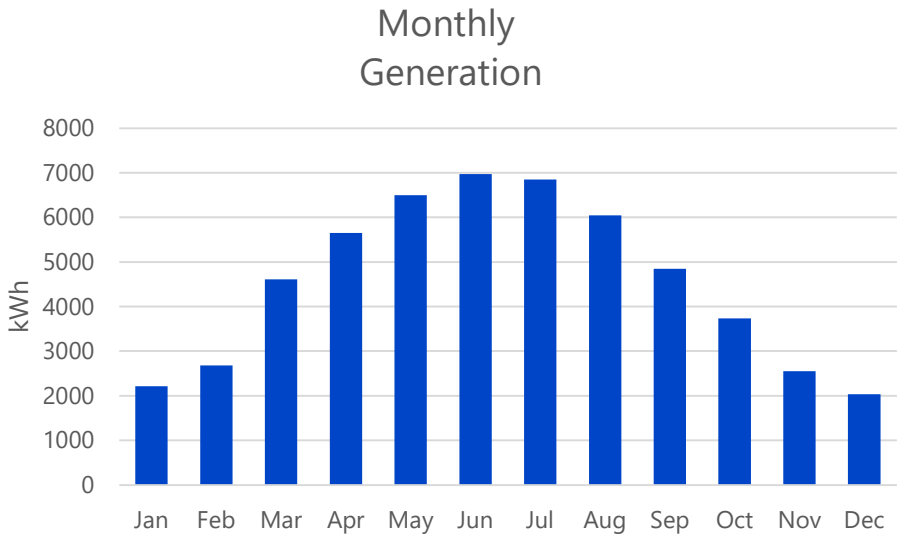


Figure 12 - Monthly Modeled PV Generation

It is also useful to note that even with the amount of EV charging that has been reported to date (577kWh) that the site would still easily achieve ZNE performance annually.

3.3 Comfort

3.3.1 Visual comfort

Measured visual comfort conditions were generally under the 0.3 Daylight Glare Perception (DGP) threshold for visual comfort. The highest DGP values were consistently measured in the kitchen (with several TDDs in the field of view; this measurement location is shown in Figure 13) and the reception (facing a window; this measurement location is shown in Figure 3) areas (see Figure 14 and Figure 15). In both locations DGP was kept under 0.3 during both site visits.

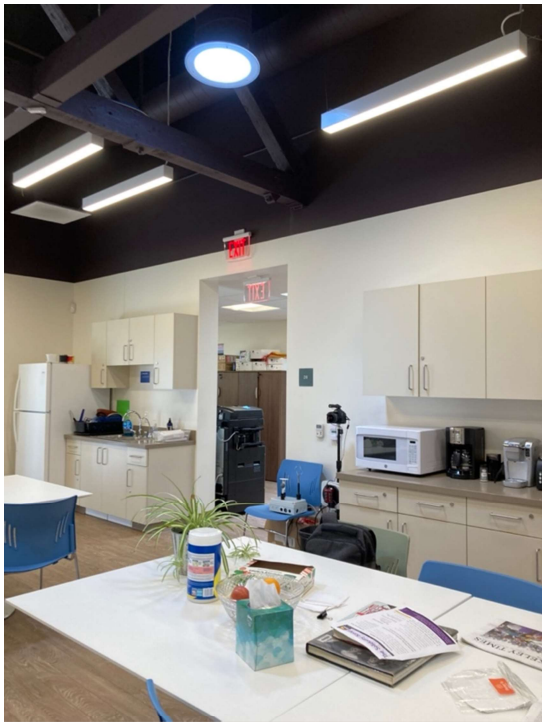


Figure 13 –View of the kitchen area showing visual and thermal comfort measurement apparatuses and one of the TDDs that was in the field of view of the visual comfort measurement.

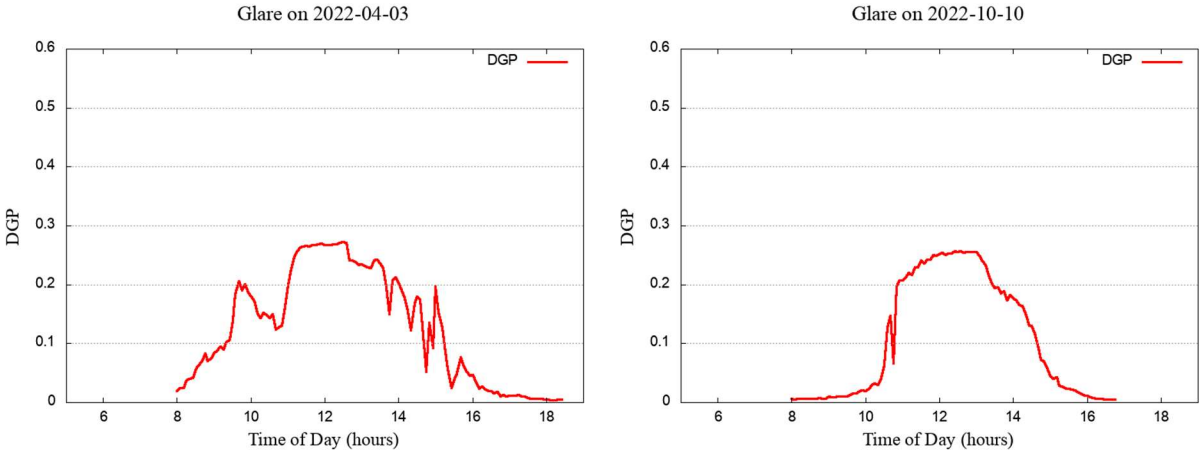


Figure 14 –DGP in the kitchen area in April (left) and October (right).

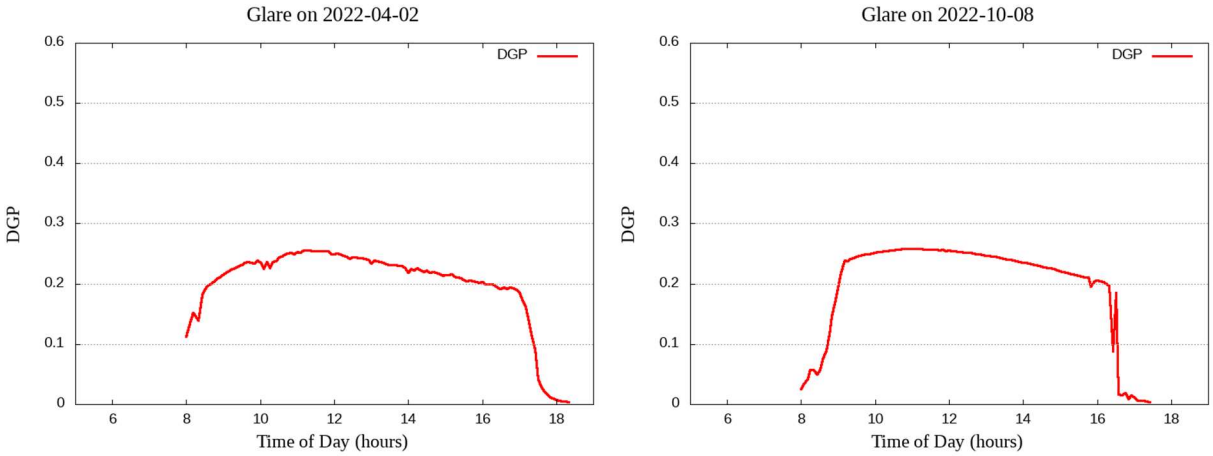
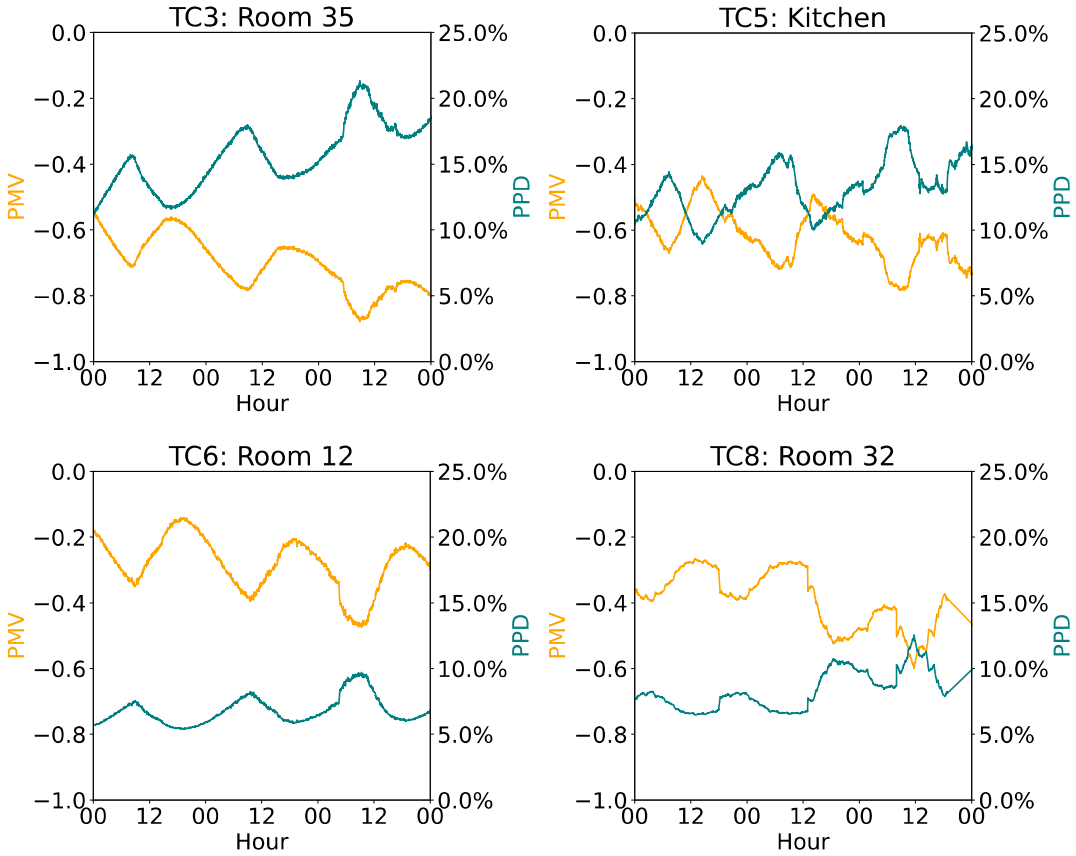


Figure 15 – DGP in the reception area in April (left) and October (right).

3.3.2 Thermal comfort

Results from thermal comfort measurements generally show comfortable conditions (Figure 16). Larger spaces (Room 32, kitchen, reception) approached the "slightly cool" rating of -1 PMV, with PMV reaching around -0.8 on two occasions. It should be noted that this happened on the third day of a long weekend, when the space had been unoccupied, and therefore devoid of the heat provided by occupants and other internal loads (e.g., office and kitchen equipment) for more than 48 hours; accordingly, the space would be expected to be warmer during normal operation of the building.



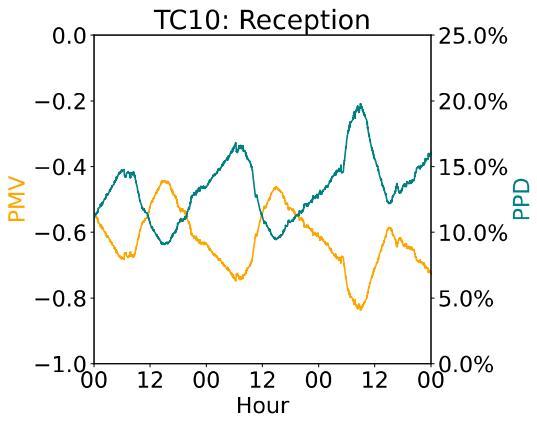


Figure 16 –PMV and PPD levels measured in the five measurement locations for three days in October.

3.3.3 Occupant Survey Findings

The survey was first conducted in April 2022. In total, 12 occupants responded to the survey, five occupants completed the survey, and one respondent participated partly in the survey.

The survey was conducted again in September of 2022. In total, 26 occupants responded to the survey, and 16 occupants completed the survey.

The building was initially designed for 59 occupants, but anticipated a maximum of 29 post-COVID.

Figure 17 and the text that follows summarize the occupant survey responses regarding their satisfaction with the spaces. The full results are available in Appendices C and D.

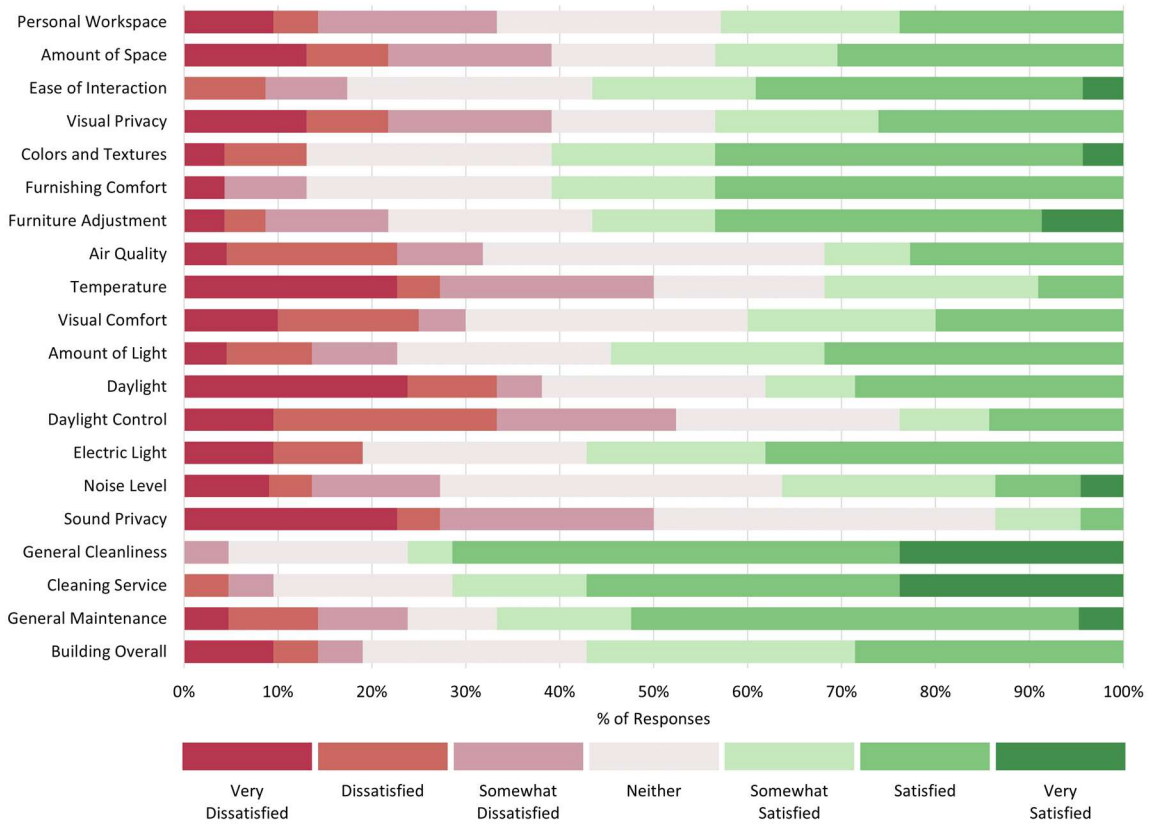


Figure 17 –Occupancy Survey Snapshot.

- ## Personal Workspace and Layout

  April: Five of the 6 respondents mentioned that they sit near an exterior wall and 2 occupants said that they sit near a window. Occupants sitting near the window can control the window blinds or shades. Two of 6 respondents were satisfied with the amount of space available for individual work and storage. The remaining 3 occupants mentioned that they are dissatisfied with the amount of work surface area, available filing and storage space and space for meeting other people and interacting with coworkers.

  September: Eleven of the 16 respondents mentioned that they sit near an exterior wall, and 5 occupants said that they sit near a window. Seven of 16 respondents were satisfied or somewhat satisfied with the amount of space available for individual work and storage. Six occupants mentioned that they were dissatisfied with the amount of work surface area, available filing and storage space, or space for meeting other people and interacting, while the remaining 3 occupants had neutral feelings.

- ## Visual Privacy

  April: Fourpeople were satisfied or somewhat satisfied with the level of visual privacy. 4 people were satisfied or somewhat satisfied with the ease of interaction with co-workers. 2 occupants mentioned that there is very little space separating people which affects visual privacy. One occupant mentioned having to leave the door open as a constraint for visual privacy. Two respondents said that their workstations are difficult to find or out of the way and there are few organized opportunities to interact with co-workers. Reduction in access to natural light due to locked doors was cited as an issuerelated to visual privacy.

  September: Five people were satisfied or somewhat satisfied with the level of visual privacy. Eight people were satisfied or somewhat satisfied with the ease of interaction with co-workers. Four occupants mentioned that there is very little space separating people which affects visual privacy, and that too many people walk through their workspaces, while 2 occupants stated that people can easily see in from outdoors. One respondent said that their workstation was difficult to find or out of the way, that there are few organized opportunities to interact with co-workers, and conversation with coworkers is discouraged due to noise concerns.

- ## Furniture

  April: Three occupants were satisfied with the office furnishings provided to them. Three occupants were satisfied or very satisfied with the office furnishings, ability to adjust furniture to meet their needs, colors and textures of the flooring, furniture, and surface finishes. Two occupants had a neutral opinion and only one person was dissatisfied. Dissatisfaction was related to ergonomic issues and controls in shared spaces. A minor comment was made about location and accessibility of whiteboards.

  September: Ten occupants were satisfied with the office furnishings provided to them, the ability to adjust furniture to meet their needs, the colors and textures of the flooring, furniture, and surface finishes. Four occupants had a neutral opinion and 3 people were somewhat dissatisfied. One person was very dissatisfied, relating to lack of knowledge of the ergonomic features of the furniture, and the lack of décor.

- ## Air (both Temperature and Air Quality)

  April: Five occupants responded to the questions related to Air. Two occupants were somewhat satisfied, 2 were somewhat dissatisfied and 1 was very dissatisfied with the temperature in the workspace. Four occupants mentioned that the temperature interferes or significantly interferes with productivity. Two people mentioned that it gets too hot. The single male occupant who responded to the survey mentioned that it is too hot in cold weather and 1 female occupant said it is too cold, leading to low productivity. Draft from windows or vents has been cited as a possibility for feeling cold. In regard to air quality, 2 occupants were satisfied, 2 occupants had a neutral reaction, and 1 person was somewhat dissatisfied with tobacco smoke and patient odors, but it is a minor problem. Four occupants said that the air quality neither enhances nor interferes with their ability to get work done and 1 occupant says that it enhances productivity. Printers, outdoor smells (car exhaust and smog), patient related odors, tobacco smoke, and others were cited by the occupants as problematic odors in the space. One occupant would like to have more air purifiers in the space. Front desk staff often prop open the front windows in an attempt to increase air circulation, even during hot summer days.

  September: Four occupants were satisfied or somewhat satisfied, 4 were dissatisfied or somewhat dissatisfied, and 4 were very dissatisfied with the temperature in the workspace. 6 occupants mention that the temperature interferes or significantly interferes with productivity. Six people mentioned that it gets too hot, including one who feels it is too hot in cool weather as well as warm. Five people mentioned that it gets too cold, including 2 who feel it is too cold in warm weather as well as cold. In total 8 people said that their thermal comfort somewhat interferes, interferes, or significantly interferes with their productivity. Air movement being too low was cited as a possibility for thermal comfort issues. In regard to air quality, 4 occupants were satisfied, 6 occupants had a neutral reaction, and 6 were dissatisfied or somewhat dissatisfied, with the most common complaint being air that was stuffy or stale. Patient odors were also mentioned but considered a minor problem. Air purifiers in the space were appreciated but noted as noisy. Access to temperature controls was desired, but where it was available it was noticed as being adjusted by others.

- ## Lighting

  April: Five occupants responded to the questions related to Lighting. Occupants were aware that they have control of light switches, dimmers or window blinds and shades. One occupant was satisfied, 2 had a neutral reaction and 2 were dissatisfied with the amount of overall light and electric light in the workspace. One occupant sitting near the window was satisfied with the daylight, one occupant was dissatisfied due to glare issues and the other 3 occupants dissatisfied due to being far away from the windows and not getting enough daylight. Three people were dissatisfied with the inability to control daylight in their space and 2 people were neither satisfied nor dissatisfied with the inability to control daylight in their space. Two occupants had neutral reactions, 1 person was somewhat satisfied and 2 people were dissatisfied with the visual comfort of lighting, feeling that it interfered with their ability to work. General reasons for dissatisfaction were not enough daylight, electric lighting is an undesirable color, or reflections on the computer screen. Timing of occupancy sensors and dimmer settings on lights have been mentioned as an issue. Glare from windows or electric lights, inadequate blinds or shades have been cited as sources of visual discomfort.

September: Occupants were aware that they have control of light switches, dimmers or window blinds and shades. Ten occupants were satisfied or somewhat satisfied, 3 had a neutral reaction and 3 were dissatisfied or somewhat dissatisfied with the amount of overall light and electric light in the workspace. Six occupants were satisfied with the daylight, but a further 6 were dissatisfied, and 3 were neutral. Eight people were dissatisfied with the inability to control daylight in their space and 3 people were neither satisfied nor dissatisfied with their ability to control daylight in their space. The visual comfort of the lighting caused 4 occupants to have neutral reactions, 6 to be satisfied or somewhat satisfied, and 3 people to be dissatisfied or very dissatisfied. General reasons for dissatisfaction were not enough daylight, having no windows, or missing task lights, while 1 person did mention the electric lighting is an undesirable color. Timing of occupancy sensors was an issue for at least 2 occupants.

- ## Acoustics

April: Two occupants had a neutral reaction, 2 others were somewhat dissatisfied, and 1 person was neither satisfied not dissatisfied with the overall sound privacy in the space. People talking on the phone, telephones ringing, excessive echoing of voices or other sounds, people talking in neighboring areas, people able to hear conversations happening in other rooms, outdoor traffic noise and other outdoor noise were all cited as reasons for dissatisfaction.

September: Six occupants had a neutral reaction, 2 others were somewhat satisfied, and 8 people were somewhat dissatisfied, dissatisfied, or very dissatisfied with the overall sound privacy in the space. People talking on the phone, telephones ringing, excessive echoing of voices or other sounds, people talking in neighboring areas, people able to hear conversations happening in other rooms, and people overhearing private conversations were all cited as reasons for dissatisfaction. The treatment rooms were noted as not acoustically private, echoey, and one respondent noted two of the rooms as especially difficult for people with hearing impairments.

- ## Cleanliness and Maintenance

April: Two occupants were very satisfied, 1 occupant was satisfied, 1 occupant had a neutral reaction, and 1 person was dissatisfied with the overall cleanliness of the building. Two people were very satisfied, 1 person was dissatisfied, 1 person was somewhat dissatisfied, and 1 person was neither satisfied nor dissatisfied with the cleaning service provided for their workspace. The only reason cited for dissatisfaction by one person was that locked offices are not cleaned as frequently as required.

September: Three occupants were very satisfied, 9 occupants were satisfied, and 3 occupants had a neutral opinion of the overall cleanliness of the building. Three people were very satisfied, 7 occupants were satisfied, 3 occupants were somewhat satisfied, and 3 had a neutral opinion of the cleaning service provided for their workspace. 1 person was very satisfied, 8 occupants were satisfied, 3 occupants were somewhat satisfied, and 1 had a neutral opinion of the general maintenance of the building. One person was somewhat dissatisfied, and 1 person was very dissatisfied with the maintenance, and the reasons cited were that the front of the building is barren with no trees, and that despite only recent occupancy of the building there have been a couple of incidents of major damage, and general wear and tear not expected to be seen after only a year e.g. painting chipping, finish coming off handles.

4 Conclusion

The reduction in energy consumption between the historical building averages and the metered energy consumption for the building is 79% (43.9 kBtu/sf/yr to 9.0 kBtu/sf/yr), exceeding the 64% savings predicted in the models.

The reduction in annual energy costs over the same period is 35% from an average of approximate $11,114/yr to $7,273/yr, a 35% reduction.

It is expected that once the PV system is fully and correctly enabled net zero operation will be achieved, as the normalized modeled generation of 21 kBtu/sf/yr is significantly larger than the metered use of 9 kBtu/sf/yr. However this will not be confirmed until actual measurements of the system can be seen. If this does hold true, then there may be a significant opportunity for a large portion of the building stock to operate as net positive to compensate for building typologies (taller buildings and those with more intense loads) that are more challenging to retrofit to achieve net zero energy.

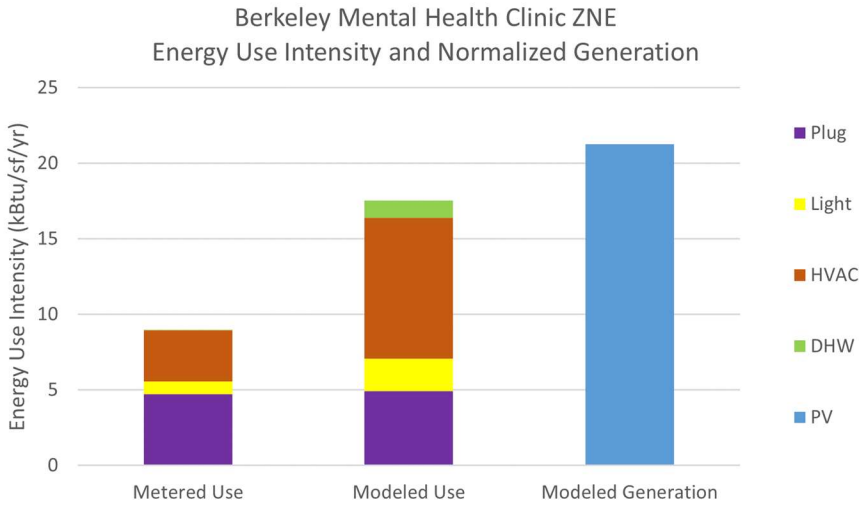


Figure 18 – Modeled vs Metered EUI vs Normalized Generation

Reviewing end uses individually from the initial models showed differentials at the hourly data level, however the annual usage was close in some cases. These differentials can be significantly attributed to variations in occupant behavior and building operation from initial predictions, which is always a challenge with modelling. Variations in actual weather conditions may also have had some impact on building performance.

The visual comfort measurements undertaken in the building indicate that tubular daylight devices can provide useful daylight without causing uncomfortable conditions.

Thermal comfort measurements when the building was empty indicated neutral to slightly cool conditions in the space, suggesting comfortable thermal conditions when the space is occupied.

The data reviewed herein has been limited by some challenges. An initial period of HVAC operation was incorrect as the unit was not providing full heating until January 2021. The domestic hot water meter was functioning initially, but likely failed in April 2022 after which no energy has been recorded for this system. The PV system has not been energized, or not fully energized, which is causing conflict between the submetering and utility metering, so some

assumptions have been made. Nevertheless, despite these variances it is clear that the building systems are performing well and that Zero Net Energy conditions will be achieved.

This project has demonstrated that retrofit projects can achieve net zero at various scales without hugely complex systems. Not every project has to be the stereotypical net zero new build; this performance is accessible to many buildings.

This has demonstrated that 100% OSA units can viably provide comfortable, ZNE retrofits in climate zones such as this. The system has the added benefit of improving indoor air quality, when paired with regular filter replacements.

Tubular daylighting devices can provide good supplemental daylighting for spaces where other access to windows is not available. However, these do not provide access to views, and the accompanying health benefits, and as such should be used selectively.

Plug load occupancy controlled outlets were not well accepted by the building occupants, although the energy impacts of not having full use of these was still within the ZNE condition for the building. Further education and operational practices are needed to achieve the fully intended performance. This will be critical going forth, as improved system performance leaves a larger and larger fraction of the energy use in the plug load category.

PV interconnection issues have taken a very long time and are still not resolved. Early engagement with the utility is recommended, by maintaining one point of contact there as much as possible. It is also likely there are further backlog and resource issues at the utility contributing to this issue.

Regular data review is recommended to ensure persistence of performance over time, using the tool developed in the ZNE Best Practices report. It is important to track usage, identify outliers, and to compare meters regularly with utility bills. This review will also show schedules of actual operation and see how those are impacting goals.

Appendix A – Detailed Energy Data

Monthly Electrical Submetering Data (kWh)

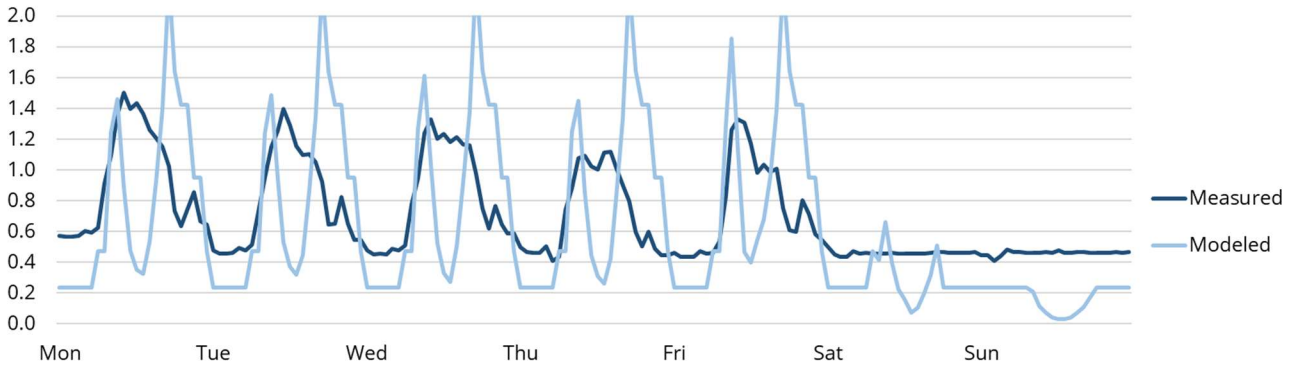
	Plug	Lighting	DHW*	HVAC
2022				
Jan	1329.9	638.7	9.3	1261.9
Feb	1197.1	566.8	9.1	922.7
Mar	1284.1	514.8	9.3	525.7
Apr	912.6	106.0	*9.2*	404.6
May	966.2	111.0	*9.2*	863.5
Jun	989.5	108.5	*9.2*	999.4
Jul	1039.1	121.5	*9.2*	679.2
Aug	1025.1	124.8	*9.2*	450.1
Sep	928.0	93.4	*9.2*	509.0
Oct	943.7	96.1	*9.2*	359.1
Nov	936.9	94.2	*9.2*	662.5
Dec	979.2	95.4	*9.2*	1048.5
2023				
Jan	950.6	93.9	*9.2*	1309.8

*Note that DHW use after March 2022 is estimated, due to failure of the DHW meter

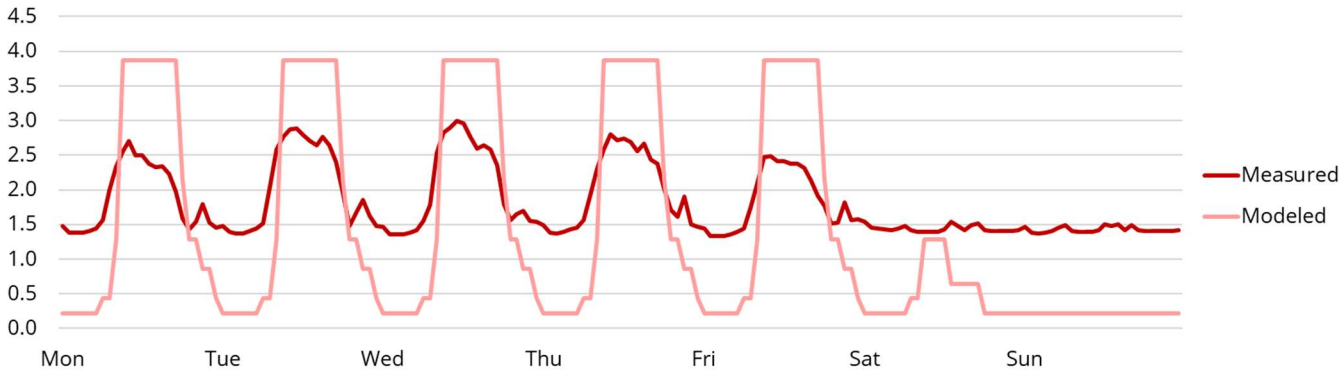
Monthly Comparisons (Measured vs Modeled)

January 2022

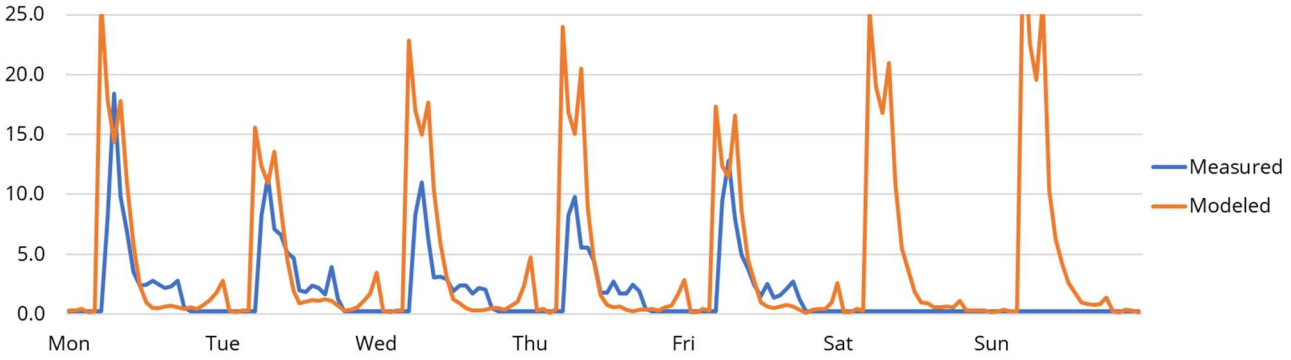
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

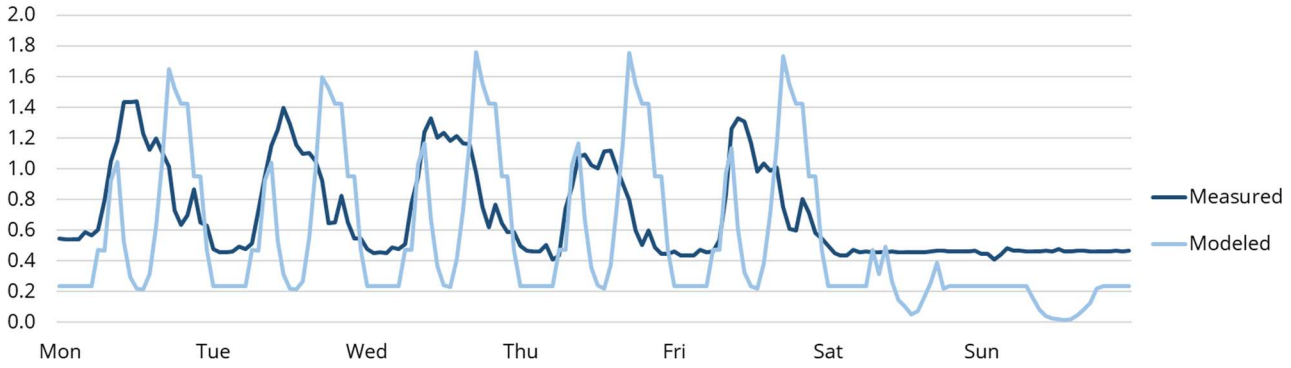


HVAC Consumption (kWh)

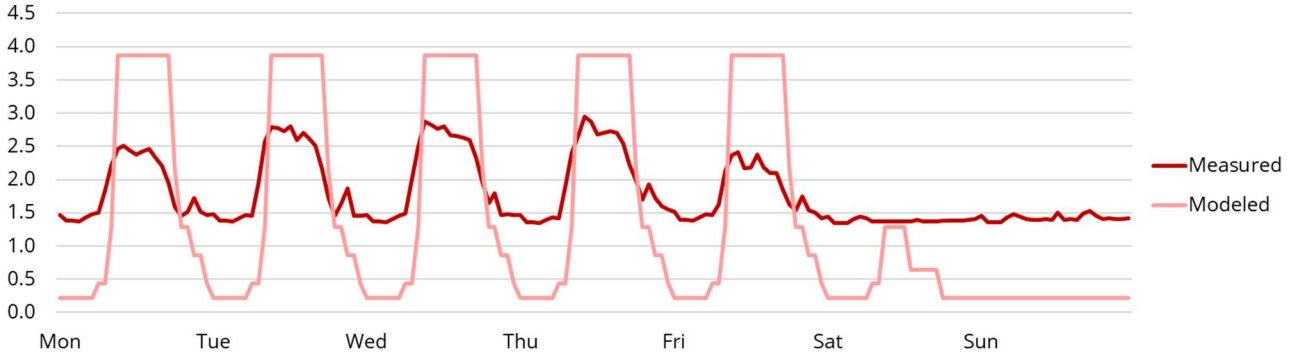


February 2022

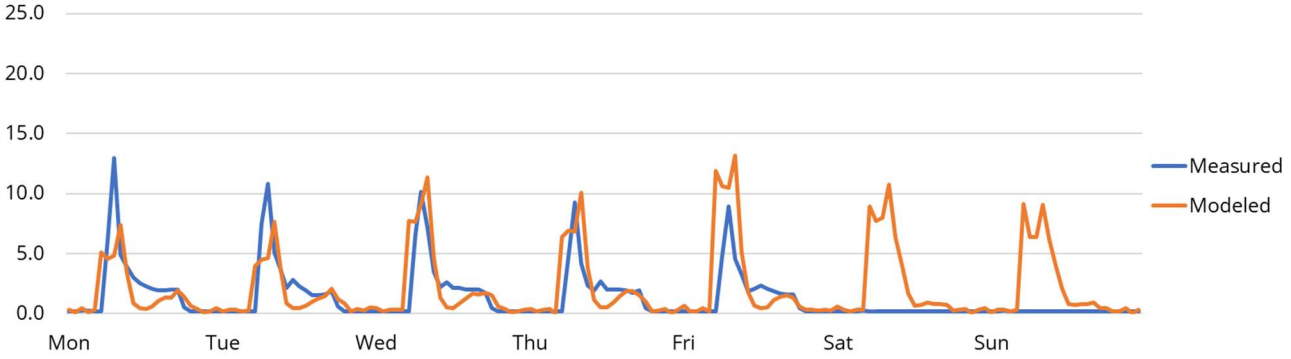
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

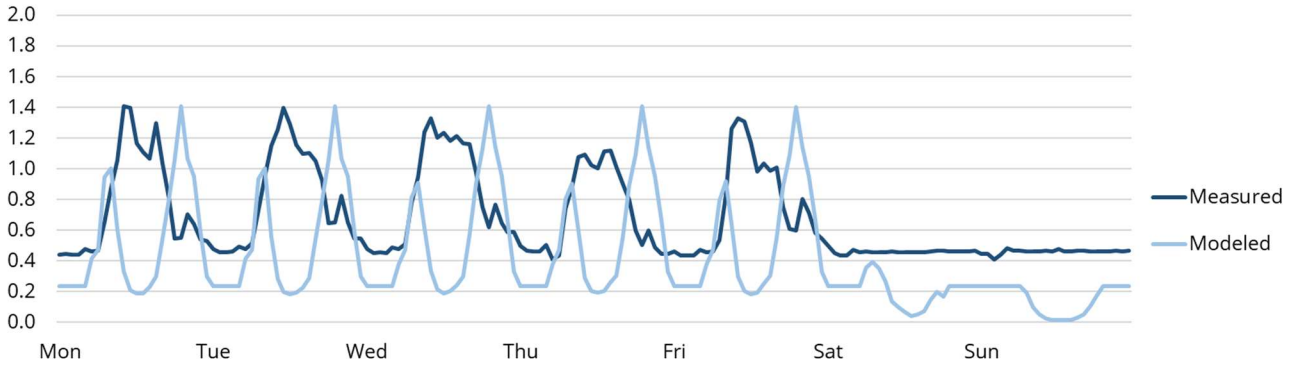


HVAC Consumption (kWh)

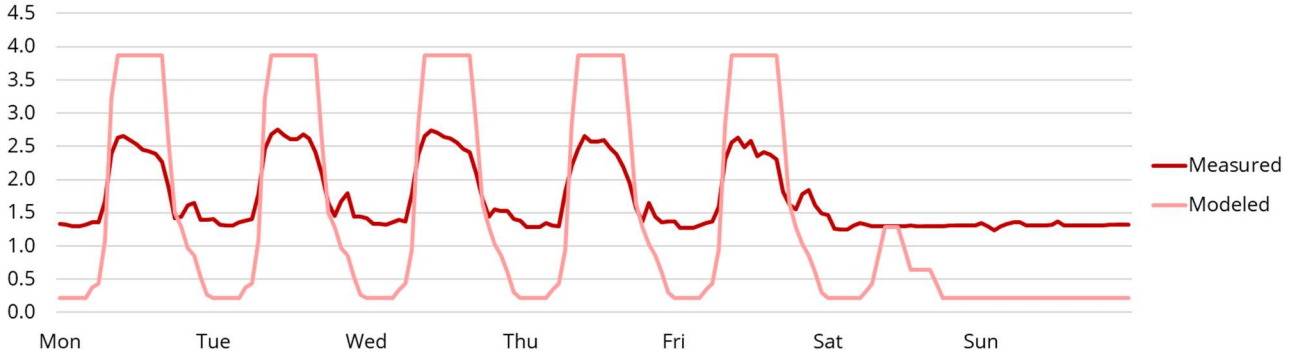


March 2022

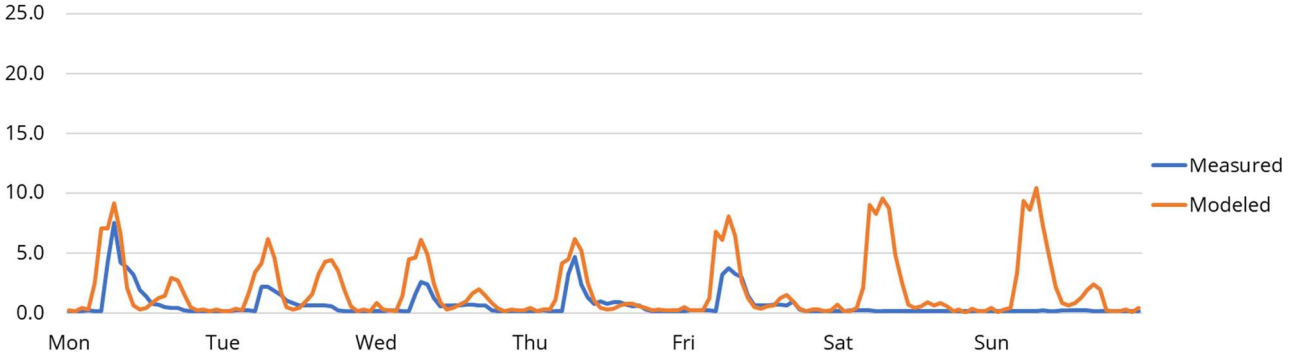
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

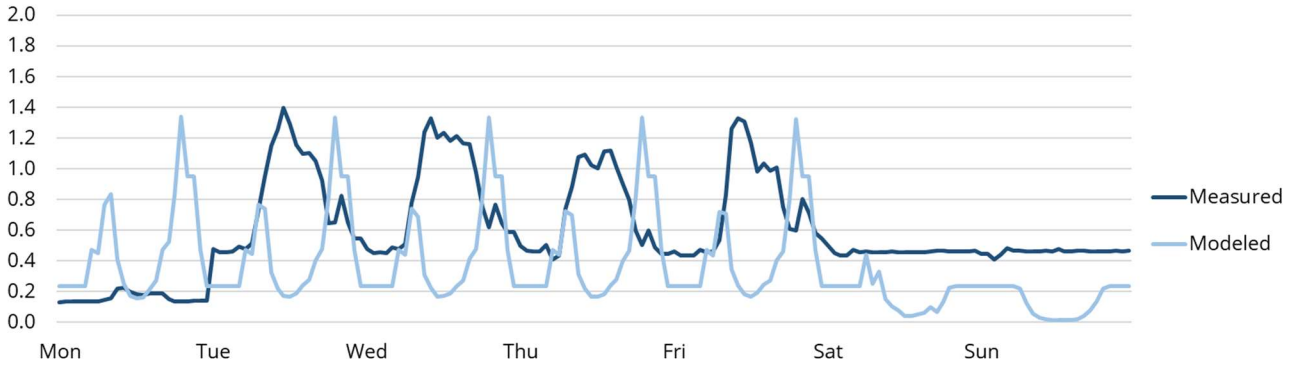


HVAC Consumption (kWh)

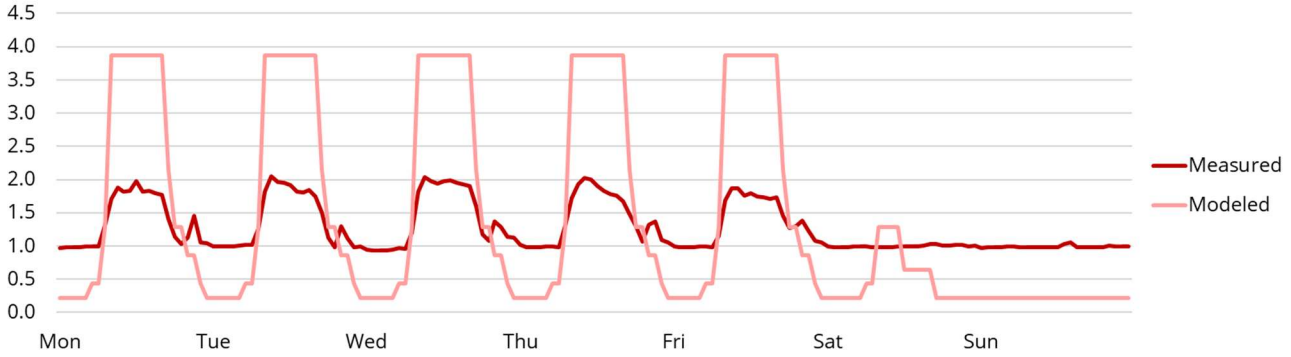


April 2022

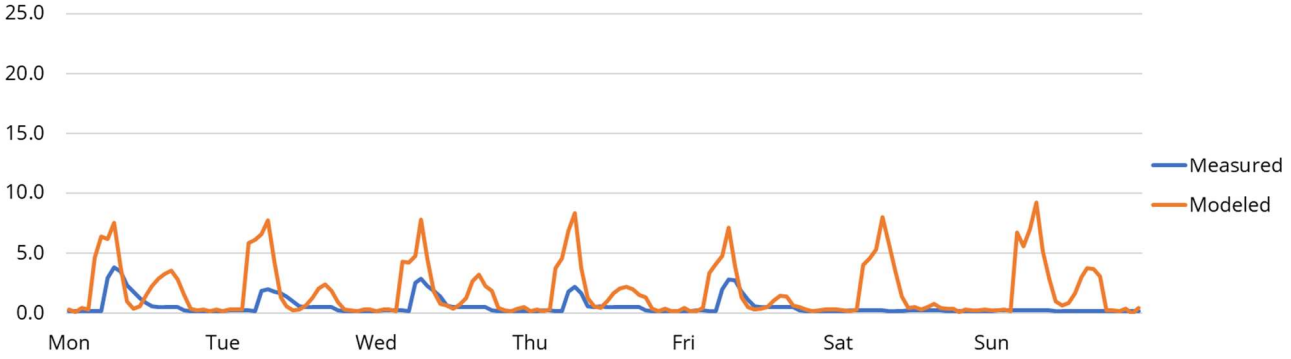
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

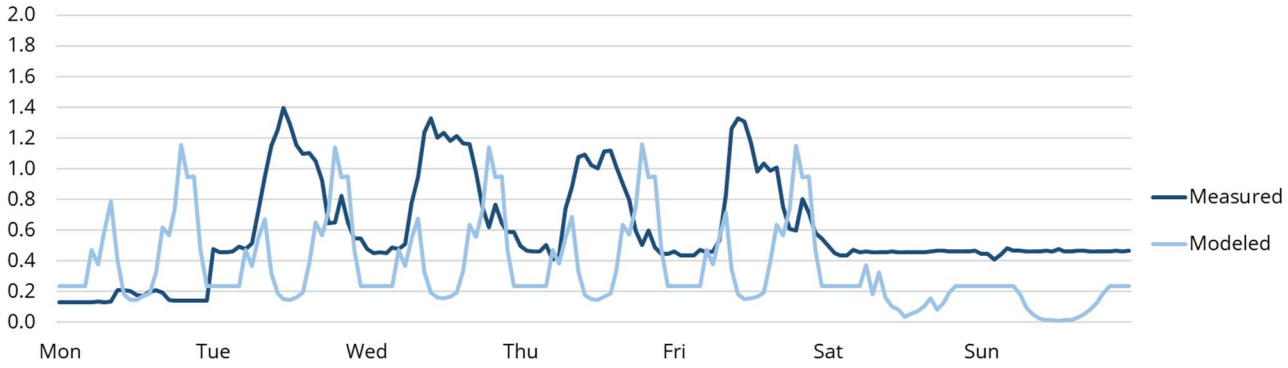


HVAC Consumption (kWh)

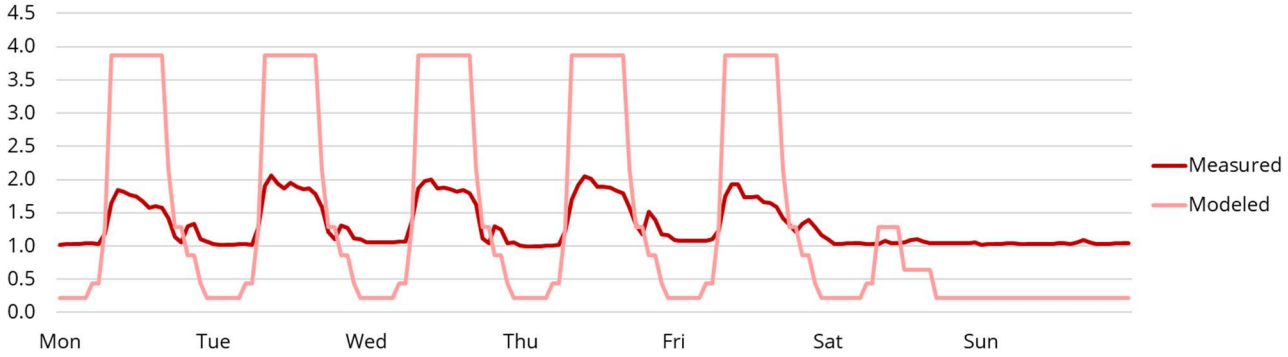


May 2022

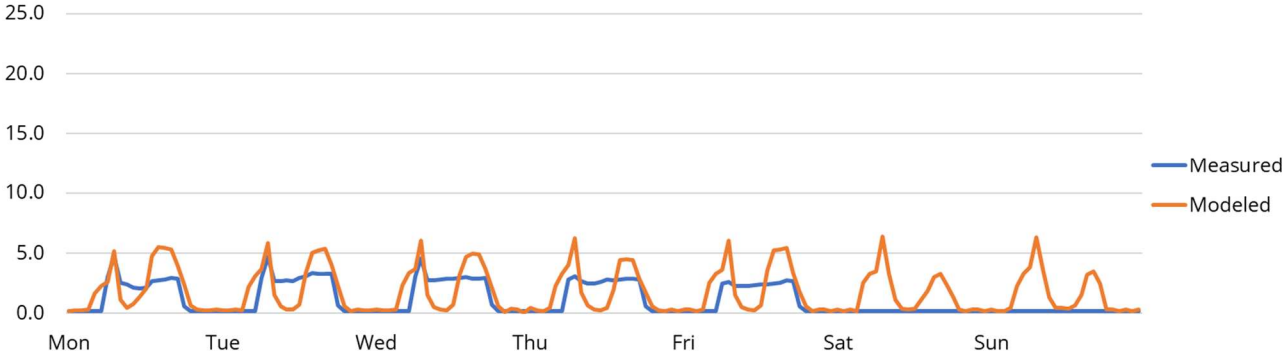
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

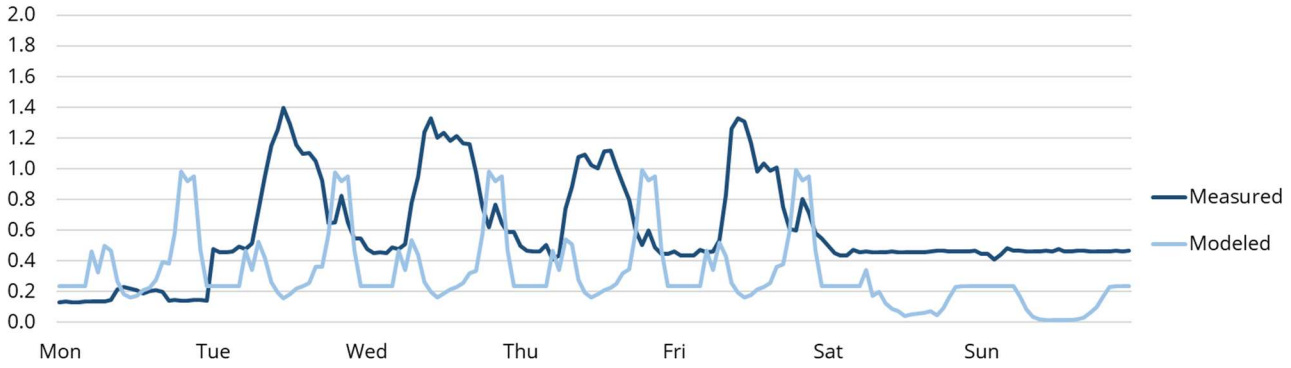


HVAC Consumption (kWh)

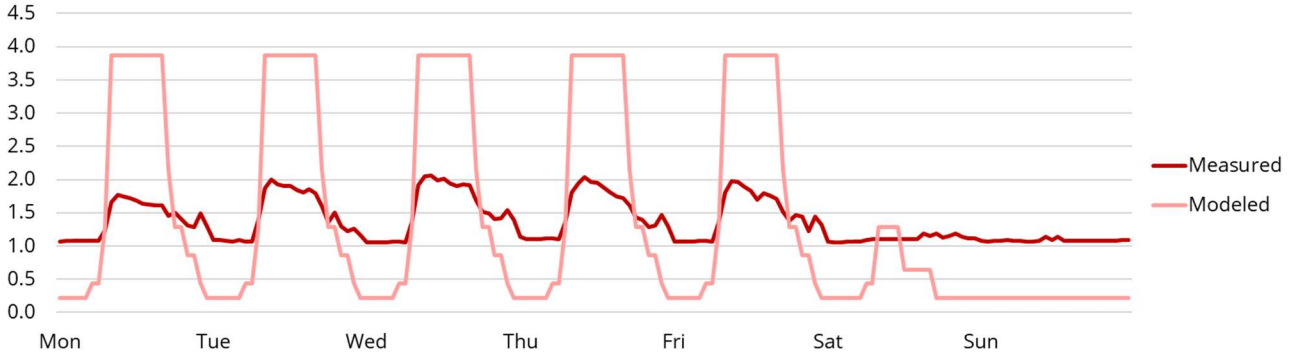


June 2022

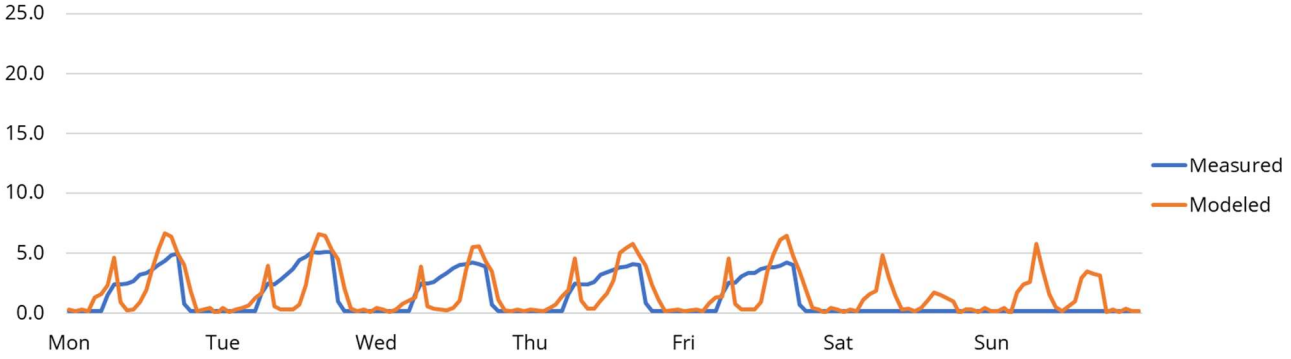
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

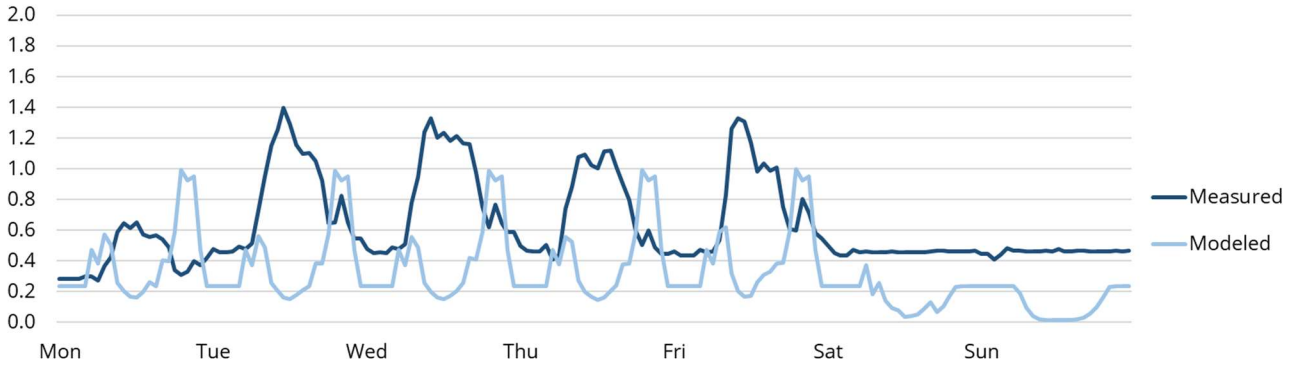


HVAC Consumption (kWh)

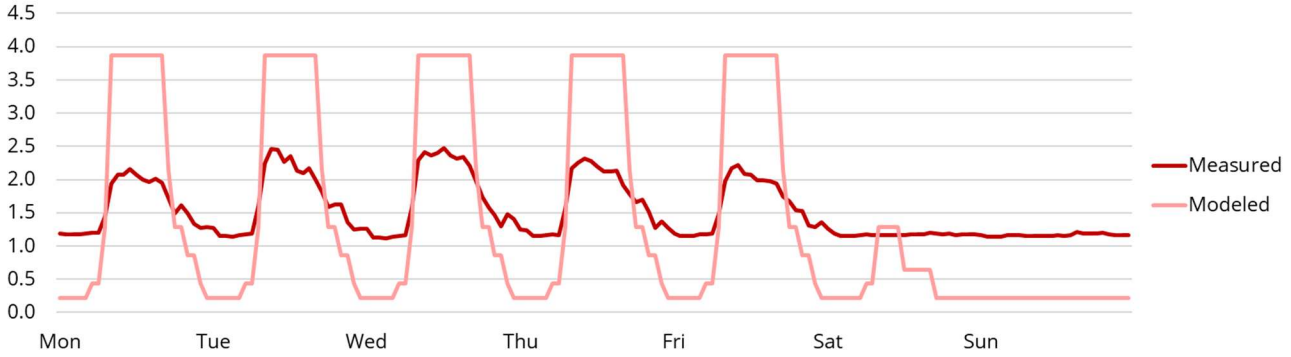


July 2022

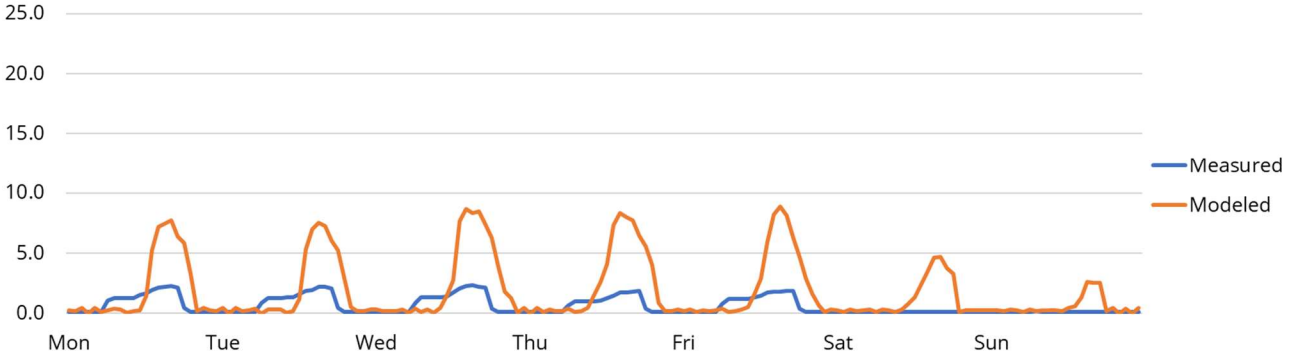
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

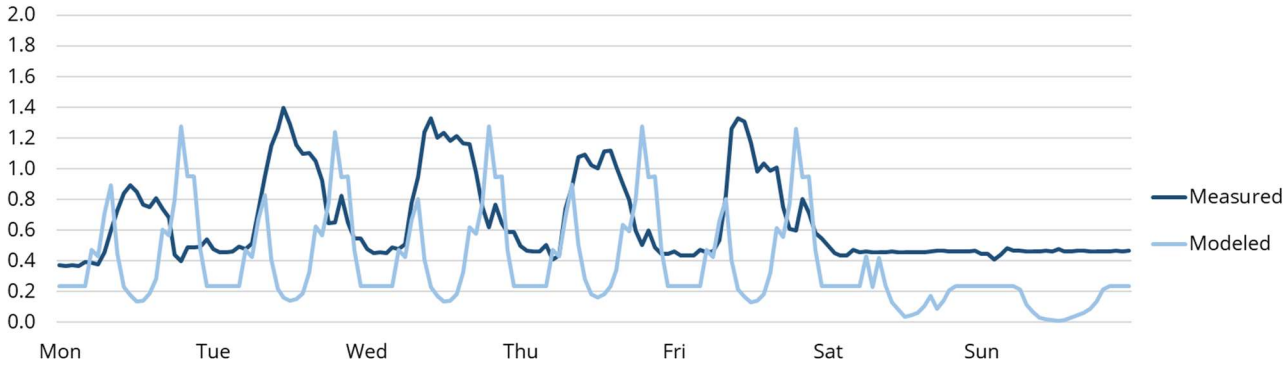


HVAC Consumption (kWh)

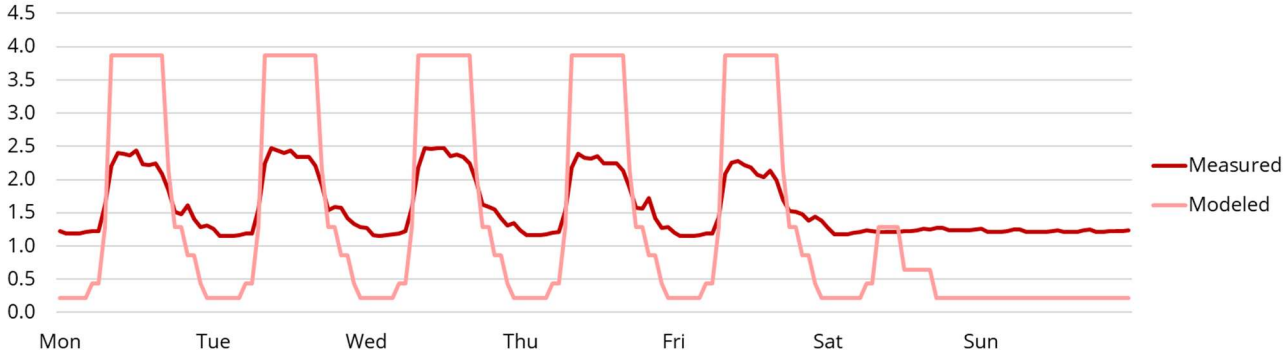


August 2022

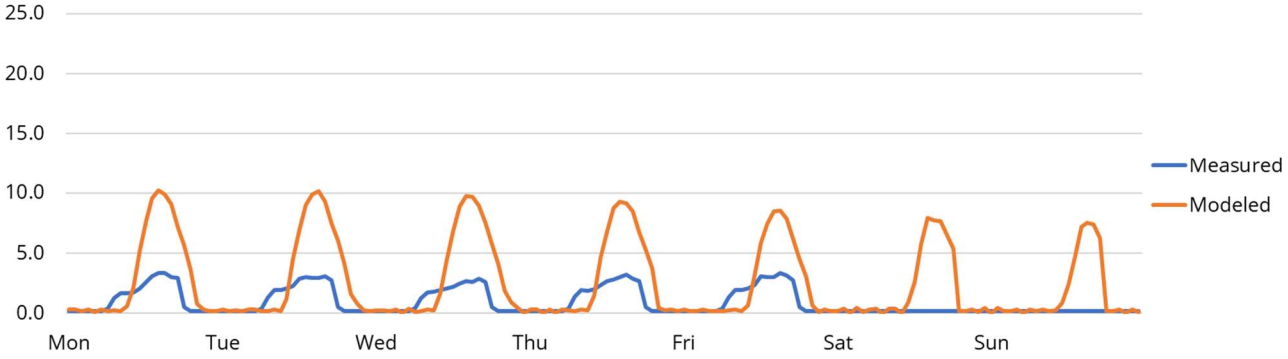
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

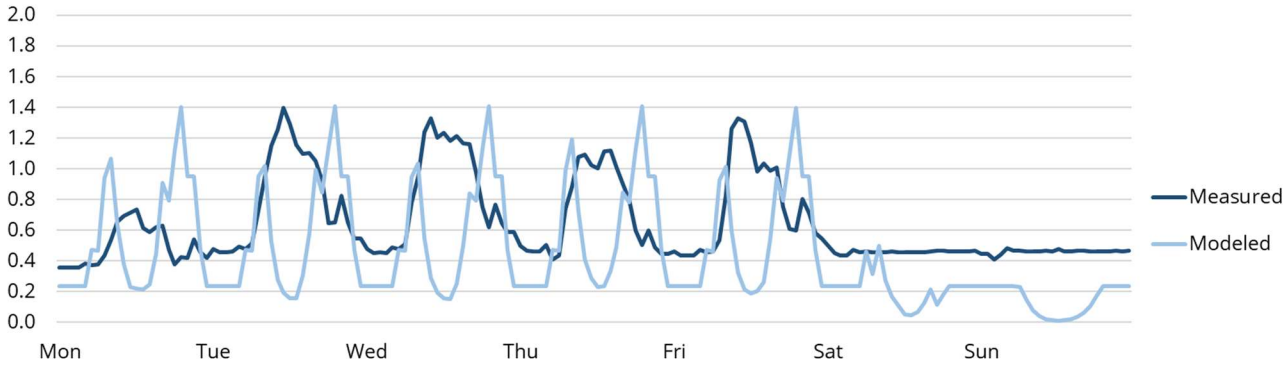


HVAC Consumption (kWh)

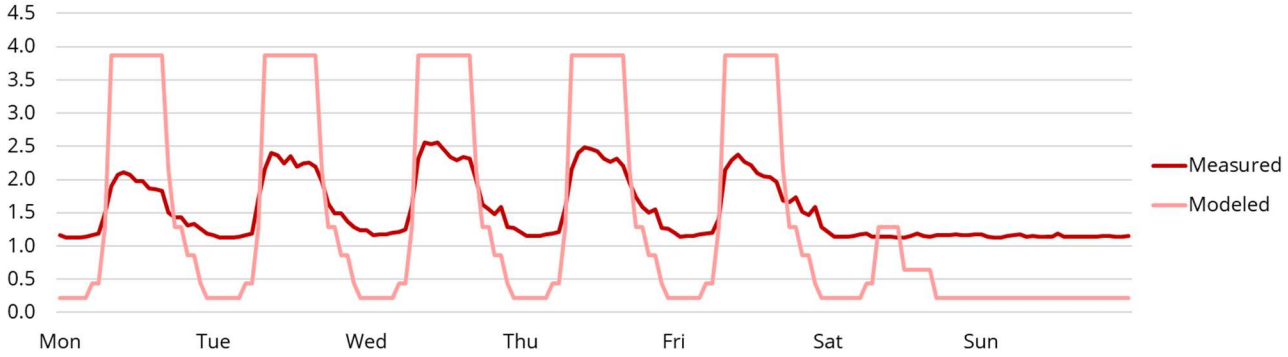


September 2022

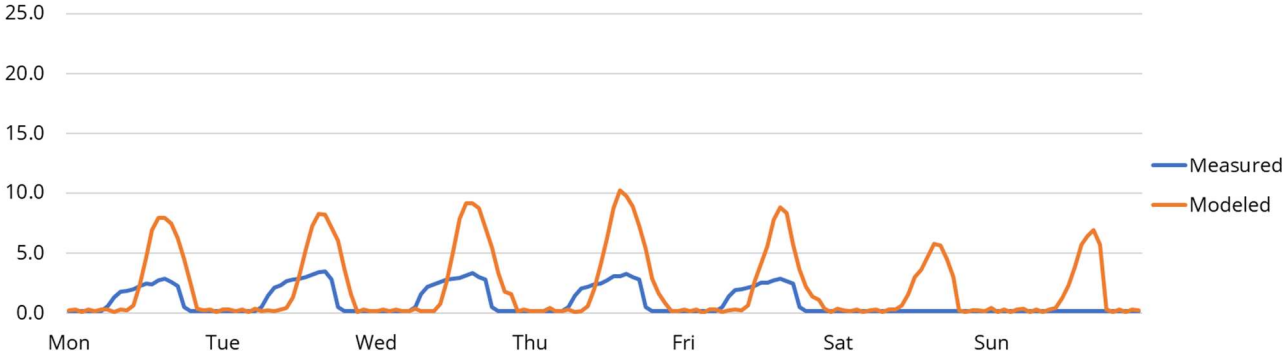
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

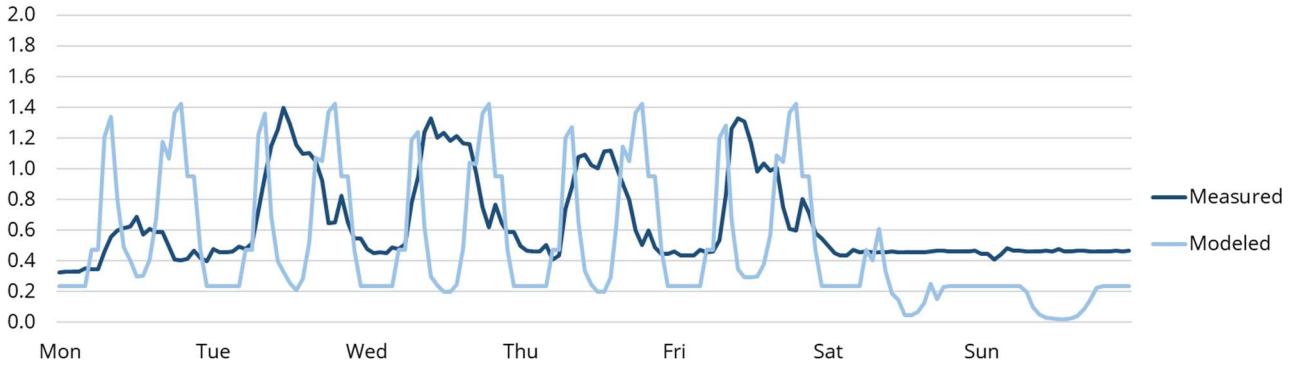


HVAC Consumption (kWh)

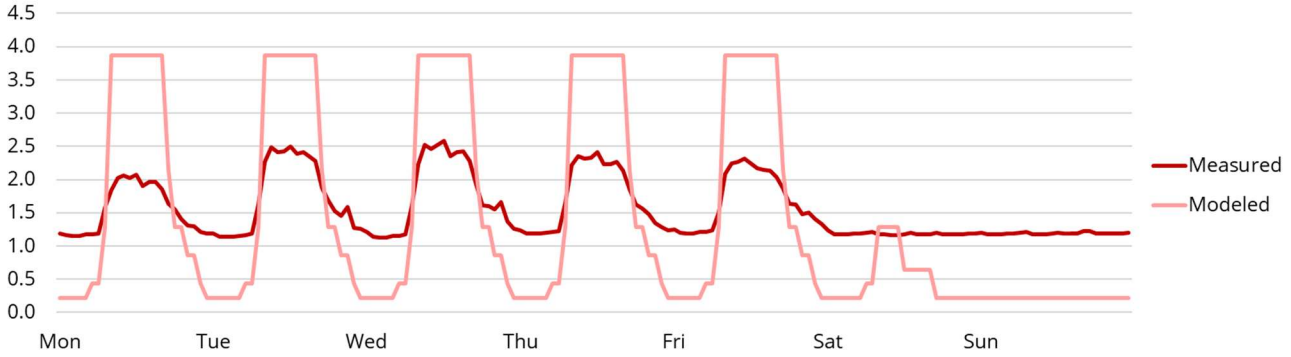


October 2022

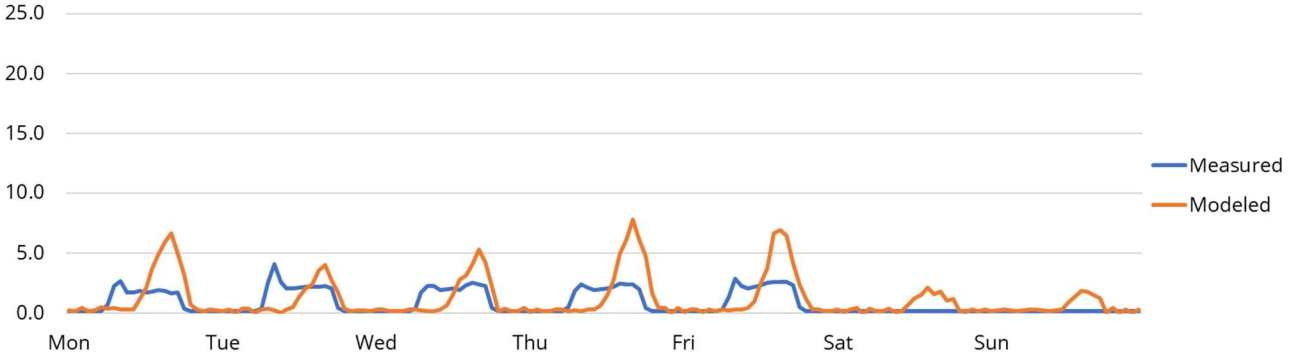
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

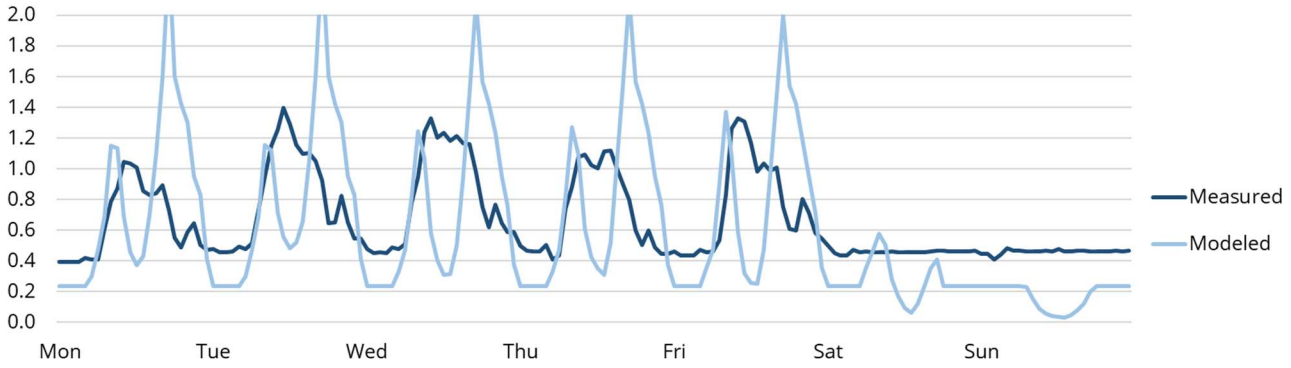


HVAC Consumption (kWh)

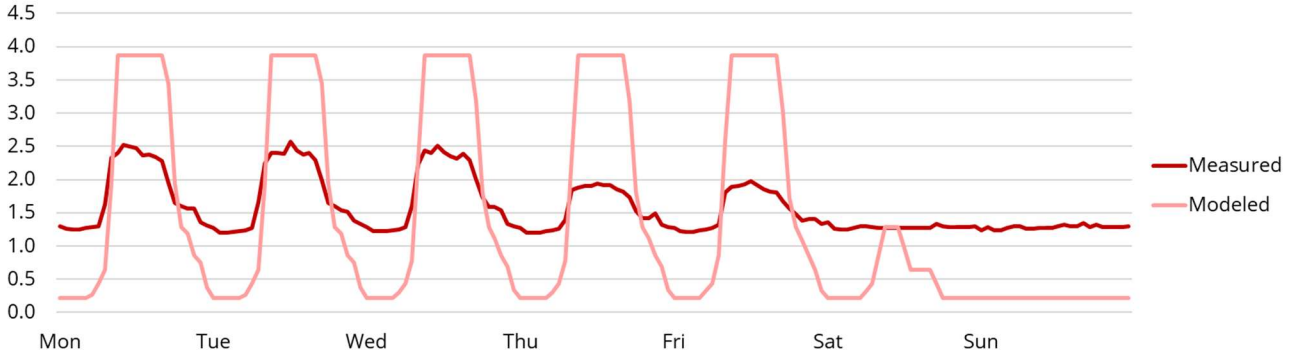


November 2022

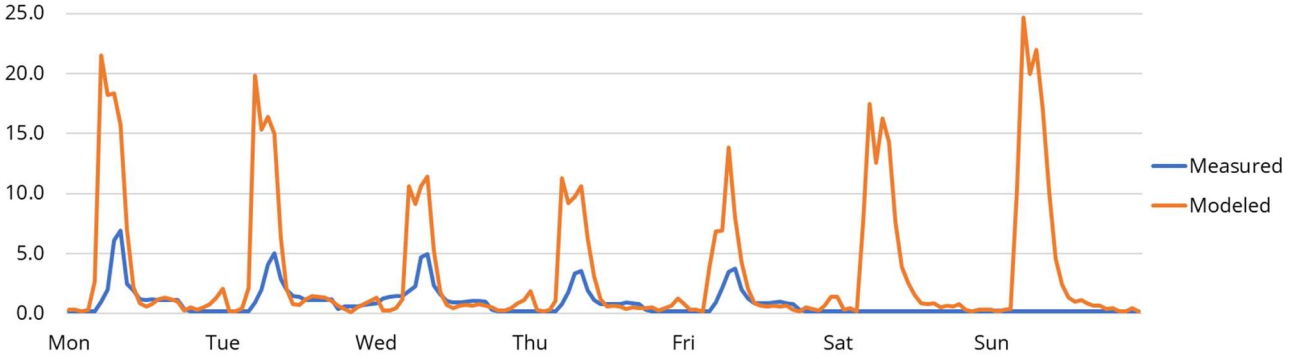
Lighting Consumption (kWh)



Plug Load Consumption (kWh)

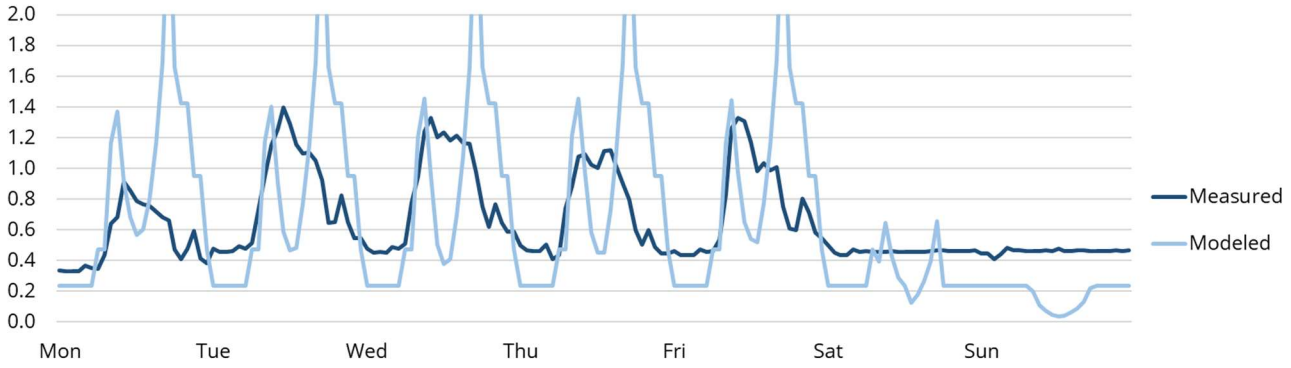


HVAC Consumption (kWh)

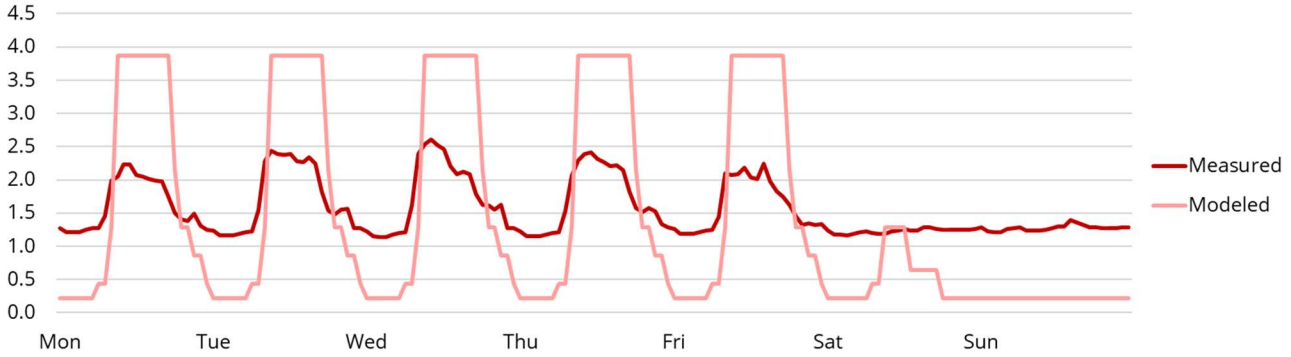


December 2022

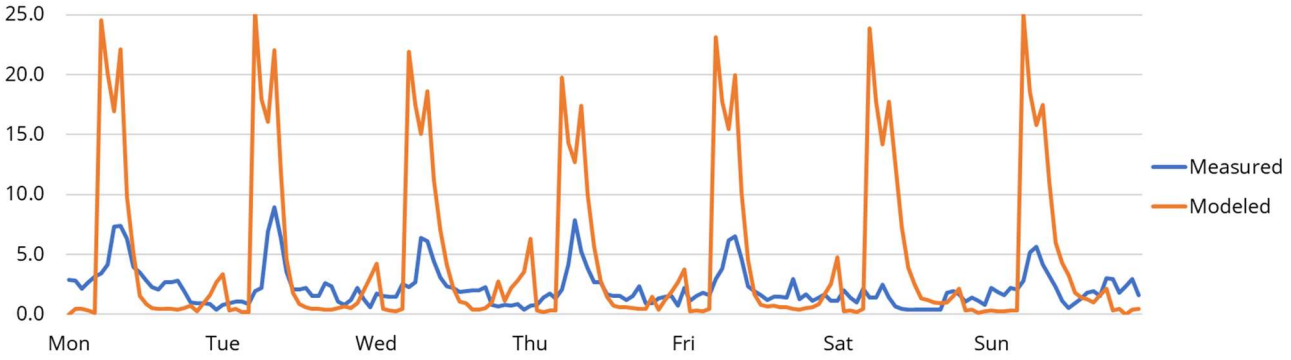
Lighting Consumption (kWh)



Plug Load Consumption (kWh)



HVAC Consumption (kWh)



Appendix B – Monitoring Points

The following is a detailed list of the systems, equipment, and points that were monitored.

Point	Sensor Location	Units	Required for Design?	Additional Point?	Trend Interval	Temporary or Permanent Point
Total Interior Lighting Power	Electrical Panel LL1	kW, kWh		✓	5 min	Permanent
Total Instantaneous Water Heater Power	Electrical Panel LD1	kW, kWh		✓	5 min	Permanent
Total Plug Load Power	Electrical Panel LP1	kW, kWh		✓	5 min	Permanent
Total Solar PV Power	Main Switchboard	kW, kWh		✓	5 min	Permanent
AHU-1 Total Power	Electrical Panel LM1	kW, kWh		✓	5 min	Permanent
AHU-2 Total Power	Electrical Panel LM1	kW, kWh		✓	5 min	Permanent
Plug Load Amperage: ● IT Closet (131) ● Staff room (136) ● Copy Area (126) ● Admin Offices (103)	Electrical Panel LP1 Circuits	Amps		✓	5 min	Permanent
Room Lighting Amperage: ● COT Office (132) ● FSP Office (135) ● Staff room (136) ● MHSA Office (130) ● Admin Offices (103) ● FIT Office (112)	Electrical Panel LL1 Circuits	Amps		✓	5 min	Permanent
AHU-1 Supply Air Temperature (after coil)	AHU-1 Unit	degF	✓		5 min	Permanent
AHU-1 Supply Air Temperature (before coil)	AHU-1 Unit	degF	✓		5 min	Permanent
AHU-1 Return Air Temperature	AHU-1 Unit	degF	✓		5 min	Permanent
AHU-1 Outside Air Temperature	AHU-1 Unit	degF	✓		5 min	Permanent
AHU-2 Supply Air Temperature (after coil)	AHU-2 Unit	degF	✓		5 min	Permanent
AHU-2 Supply Air Temperature (before coil)	AHU-2 Unit	degF	✓		5 min	Permanent
AHU-2 Return Air Temperature	AHU-2 Unit	degF	✓		5 min	Permanent
AHU-2 Outside Air Temperature	AHU-2 Unit	degF	✓		5 min	Permanent

Point	Sensor Location	Units	Required for Design?	Additional Point?	Trend Interval	Temporary or Permanent Point
Indoor Air Quality: CO2 (2) return air ducts at AHUs	Interior wall-mounted	ppm	(2) spaces w/ DCV		5 min	Permanent
Thermal Comfort: Room Temperature	Interior wall-mounted	degF	(2) points for AHU control	✓ (all other rooms)	5 min	Permanent
Thermal Comfort: Room Relative Humidity: ● File Storage room (122) ● Treatment Room (118) ● Psych Room (113) ● Treatment Room (105) ● Exam Room (108)	Interior wall-mounted	%RH		✓	5 min	Permanent
Work Surface Light Levels: ● COT Office (132) ● FSP Office (135) ● Staff room (136) ● MHSA Office (130) ● Admin Offices (103) ● FIT Offie (112)	In room (work surface)	lux		✓	5 min	Temporary (data logger for 6-12 months); provided by LBNL
Thermal Comfort: Mean Radiant Temperature, Air Velocity, Drybulb Temperature: ● COT Office (132) ● FSP Office (135) ● Staff room (136) ● MHSA Office (130) ● Admin Offices (103) ● FIT Offie (112)	In room	degF, m/s, degF		✓	spot measurement	Temporary (quarterly for 9-12 months), provided by LBNL
Thermal Comfort: Temperature Stratification: ● COT Office (132) ● FSP Office (135) ● Staff room (136) ● MHSA Office (130) ● Admin Offices (103) ● FIT Offie (112)	In room	degF		✓	spot measurement	Temporary (quarterly for 9-12 months), provided by LBNL
High-Dynamic-Range (HDR) Photographs	In room (unoccupied)	(photograph)		✓	spot measurement	Temporary (quarterly for 9-12 months), provided by LBNL
Spectrometer	In room (unoccupied)	various		✓	spot measurement	Temporary (quarterly for 9-12 months), provided by LBNL

Appendix C – Occupant Survey Results: April 2022

Attached herein is the Occupant Survey report that was conducted for the Berkeley Mental Health facility during April 2022

Occupant Survey Report

Berkeley Mental Health Center

Center for the Built Environment

June 2022

CBE
CENTER FOR THE BUILT ENVIRONMENT

Table of Contents

CBE Occupant Survey

Originally developed in 2000 as a research tool at the Center for the Built Environment at the University of California, Berkeley, the CBE Occupant Survey has become widely used as a way to receive feedback from occupants. This anonymous, web-based tool assesses indoor environmental quality from the perspective of occupants residing in the space. Specifically, occupants provide self-reports of satisfaction and productivity on a number categories including: ***Personal Workspace, Layout, Visual Privacy, Furniture, Air (both Temperature and Air Quality), Lighting, Acoustics, and Cleanliness & Maintenance***.

These surveys are deployed in various building types including offices, K-12 education spaces, higher
education buildings, laboratories, health care spaces, residence halls, and multi-unit housing.

How to use this report
You can use this report in multiple ways depending on the level of detail you are seeking. The first section is a high-level overview of the basic demographics and experiences of your space's occupants. By understanding who you have surveyed, you gain useful context about those generating your data. Through understanding your occupants, you can more deeply and accurately interpret your results.

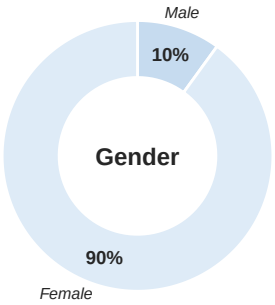
Next, you will be shown three high-level visualizations of your occupants' perceptions of their space. First, you will see how your particular building compares to the broader CBE database. By having this comparison point, you can better determine just how well or how poorly different aspects of your space are performing. Second, you will see a quick snapshot of all of the ways in which your occupants and satisfied and dissatisfied within the space. You can quickly see which areas of your space are preforming well according to occupants, and which areas have room for improvement. Third, you will be shown a graphic that depicts occupant satisfaction again, but you will be able to see the distribution of individual votes for each category (in addition to the percentages you see in the graphic just before this).

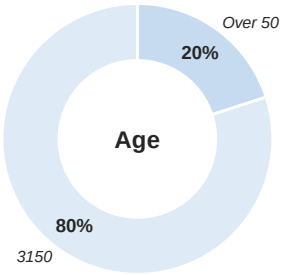
Following this broad overview of both occupants and the space, you are then able to explore the 10 categories our survey covers in more detail. Within each section you will first see how satisfied your occupants are with that particular aspect of the space. Further, you will be able to explore more deeply where challenges may be present. Whenever dissatisfaction of any kind is detected, dissatisfied occupants are asked a series of questions aimed at drilling down into the sources of that particular challenge.

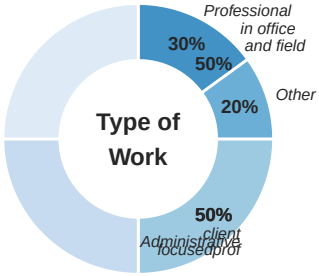
Finally, if you have included any additional modules or custom questions intended to target aspects of your space beyond the Core Occupant Survey, you will see those results presented.

Occupant Demographics and History With Space

Below you can view basic information about the 12 occupants who completed this survey. This information provides broader context for your results and can be used to guide you as you dive more deeply into your data. For example, if you notice that only a certain subset of your population (e.g. staff who have worked in the building less than one year) are your primary respondents, then that tells you how generalizable your results may be to your broader space.

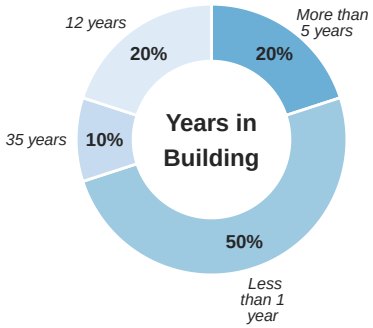


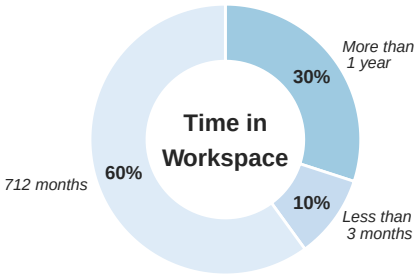


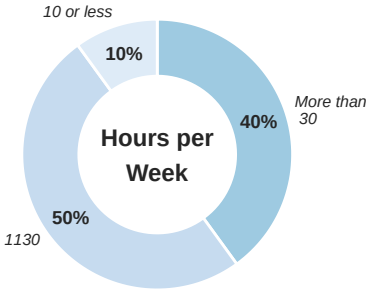


Percentage labels under 5% are not shown on the plot

The following information provides an overview of occupants' broad experiences with the current workspace. Again, this can help you better understand your results. For instance, do individuals who have worked in this building for a longer period of time have different perceptions than those who have not?



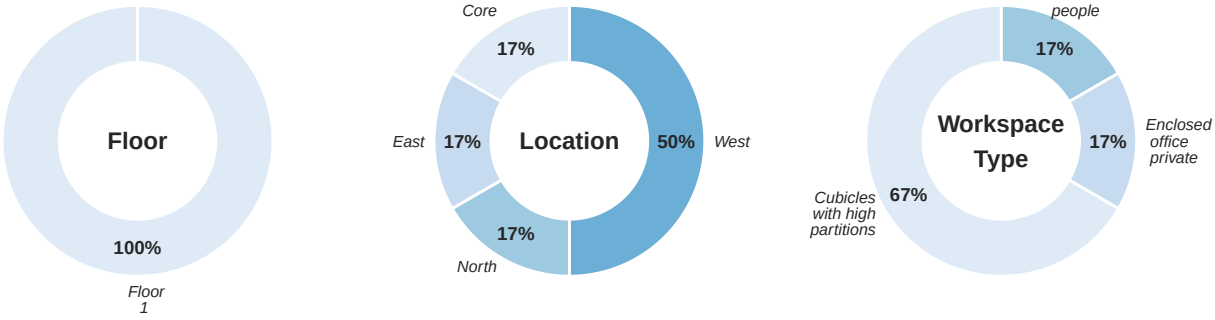




Percentage labels under 5% are not shown on the plot

Occupant Location

The next set of plots show the breakdown of survey responses by floor, location, and workspace type. **Of the 12 occupants who responded to the survey, 33% report that they are near a window and report being near an exterior wall. Most survey responses were from Floor Floor 1, and the most common area was .**



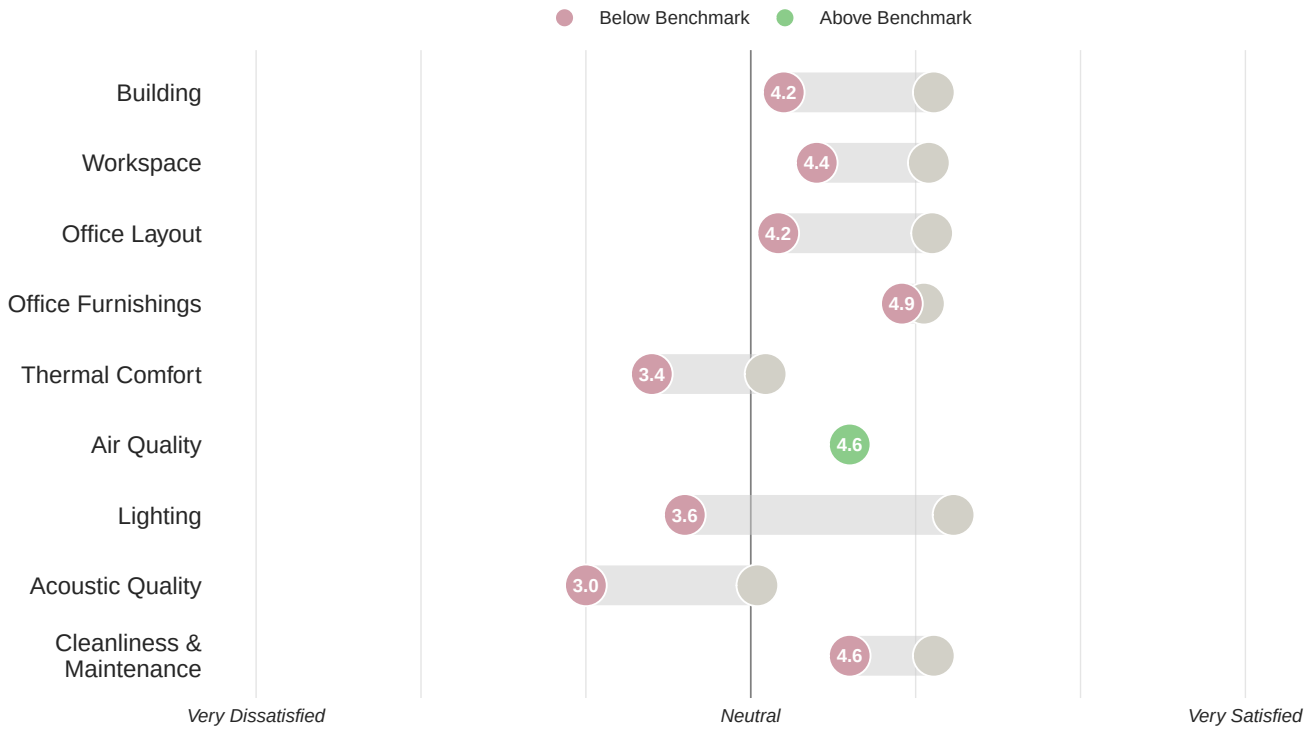
Percentage labels under 5% are not shown on the plot

Benchmarking Your Building

Office spaces typically struggle when it comes to acoustical satisfaction. However, if you do not understand to what degree the average building struggles, you cannot know how large of an issue it is in your particular space.

Below you will see a comparison of your building to the broader, globally sampled, CBE database. By comparing to our database, you can anchor your result to get a clearer picture of how well your building is actually preforming.

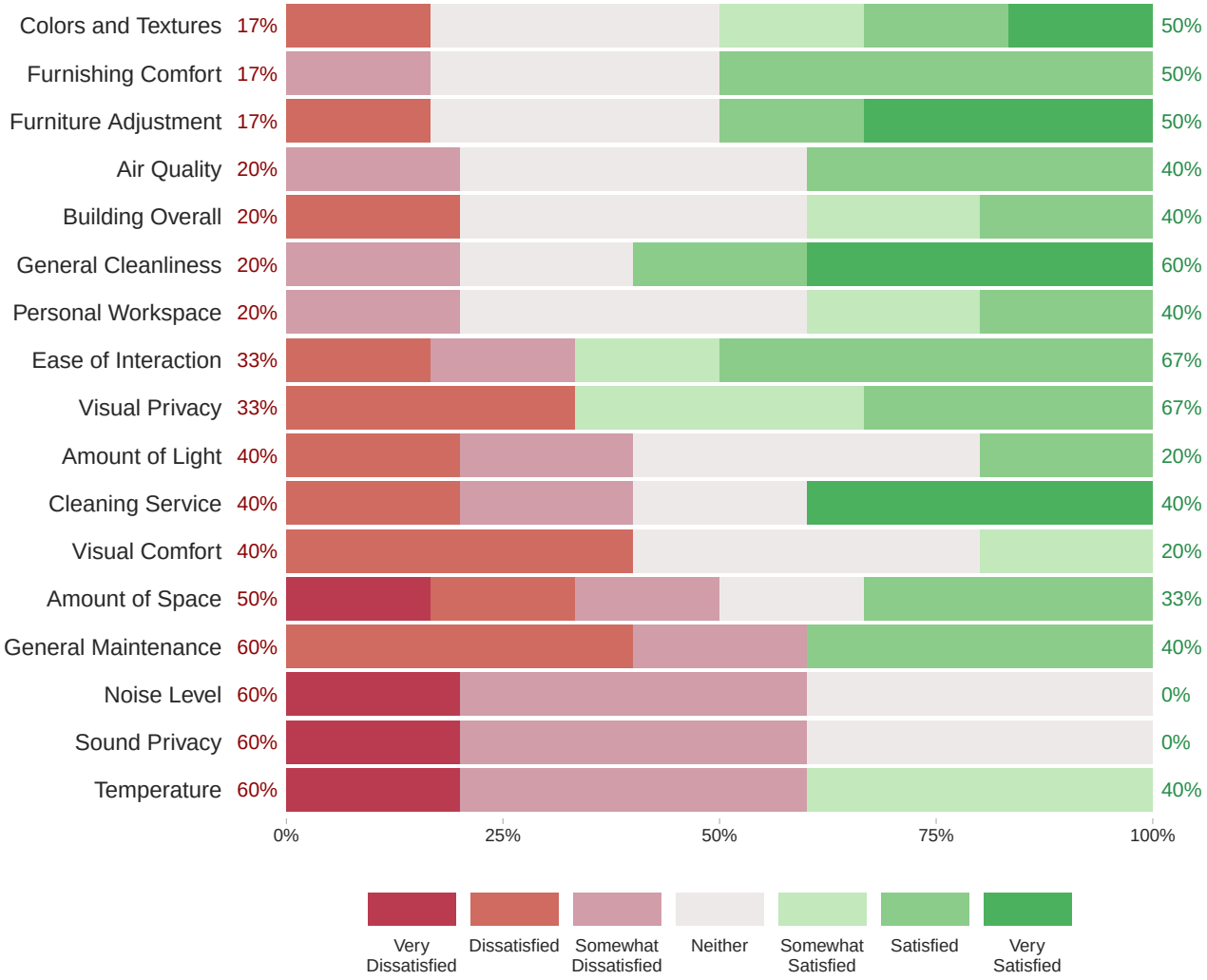
Use this information to pinpoint your space's strengths and weaknesses, and make more informed decisions on where to invest to improve or maintain the quality of your environment.



Satisfaction with the Workspace

Before you begin assessing the specifics of how well a building is performing, it is useful to look at a snapshot of the overall ways occupants are viewing the space.

Below, you can see occupant satisfaction across each area that the survey measures. The numbers in red, to the left of the bars, show the percentage of dissatisfied occupants (somewhat dissatisfied to very dissatisfied), and the numbers in green, to the right of the bars, show the percentage of satisfied occupants (somewhat satisfied to very satisfied). These results are arranged in descending order, with the best performing category at the top and the worst performing at the bottom.



This graph shows all individual satisfaction votes for every occupant who completed the survey.

Each column represents an occupant, and the rows represent the satisfaction question they responded to. They are arranged so that occupants with lower satisfaction overall are towards the left, and occupants with higher satisfaction overall are towards the right. By looking across the rows you can quickly determine environmental quality problem areas, and by reading the columns you can see how each occupant expressed satisfaction.

We also asked participants to write in any additional comments they may have for the building overall. We encourage you to explore the raw data for these specific insights.

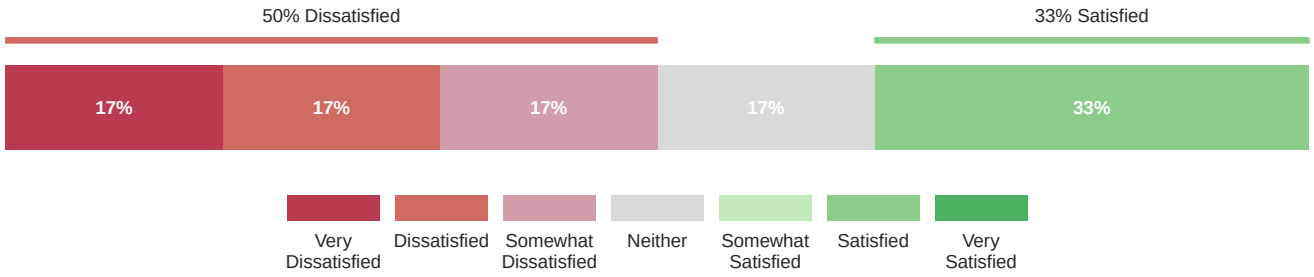
Office Layout

This section explores the ways in which occupants perceive the layout; specifically, how satisfied they are with the amount of space provided and their ability to easily interact with others.

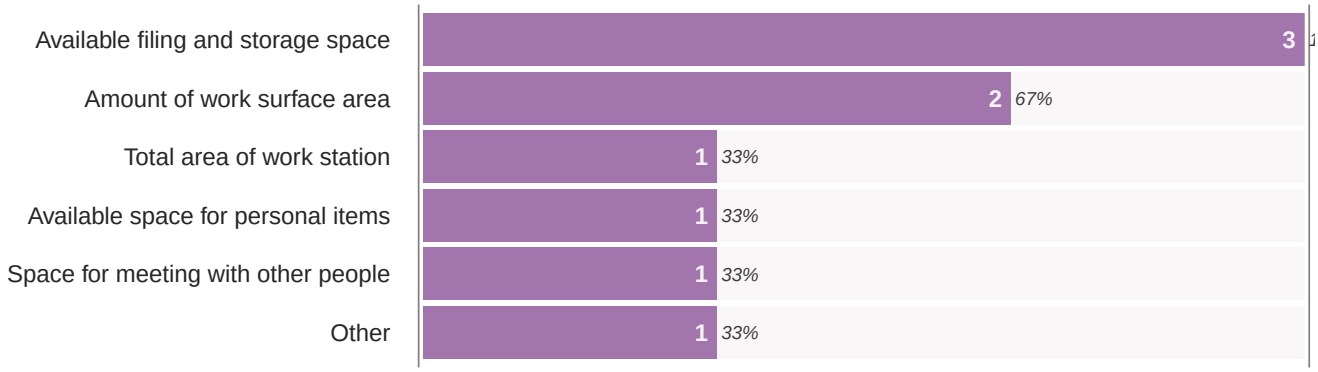
Further, whenever an occupant is dissatisfied with one of these aspects, they were prompted to identify why they are dissatisfied. These drill down questions will help you identify sources of dissatisfaction you may be able to address in the future.

Amount of Space

How satisfied are you with the amount of space available for individual work and storage?



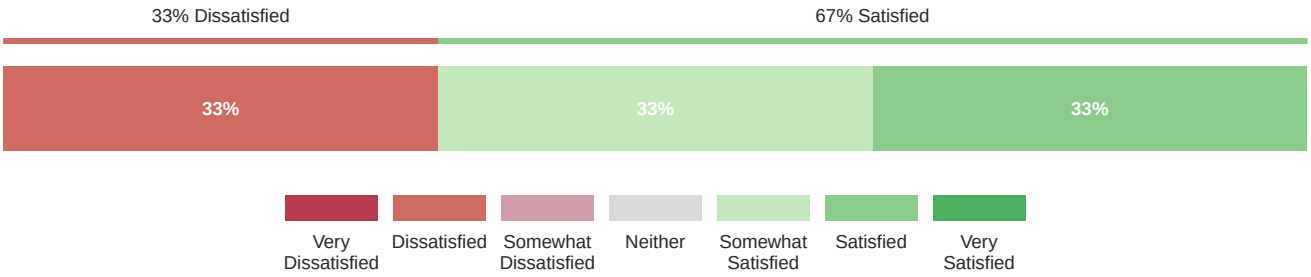
There were 3 participants who indicated that they have some level of dissatisfaction with the amount of space available; below you will see the reasons for their dissatisfaction. Participants were allowed to select as many sources as they like, therefore counts may vary.



Visual Privacy

Though certainly related to the way one experiences the layout of a space, the CBE Survey benchmarks "visual privacy" as its own characteristic. Our research has shown that this aspect of environmental quality is important, unique, and should be evaluated on its own. Here, you can see how occupants perceive this aspect within the space.

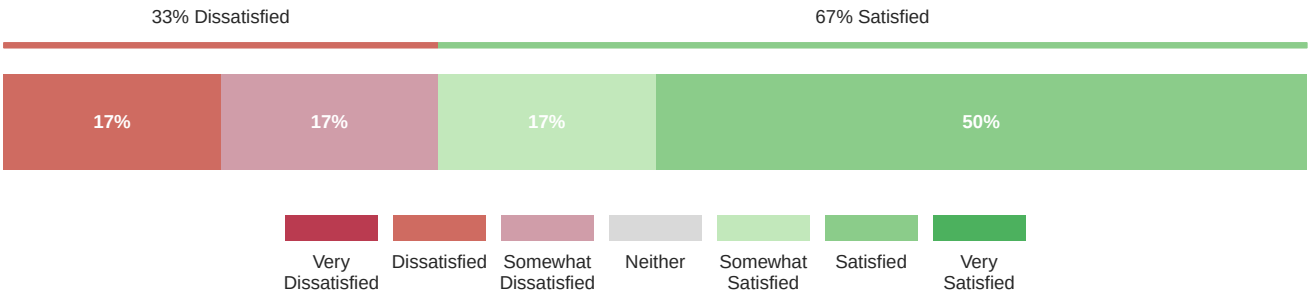
How satisfied are you with the level of visual privacy?



There were 2 participants who indicated that they have some level of dissatisfaction with the visual privacy of the space; below you will see the reasons for their dissatisfaction. Participants were allowed to select as many sources as they like, therefore counts may vary.

Ease of Interaction

How satisfied are you with the easy of interaction with co-workers?



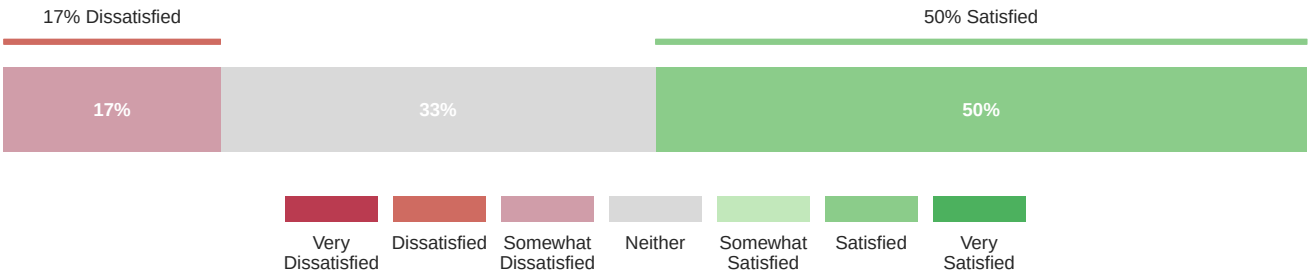
There were 2 participants who indicated that they have some level of dissatisfaction with the ease of interaction in the space; below you will see the reasons for their dissatisfaction. Participants were allowed to select as many sources as they like, therefore counts may vary.

Participants were also asked to describe any specific issues related to layout that they feel are important to them. Please look to the raw data for these detailed text responses.

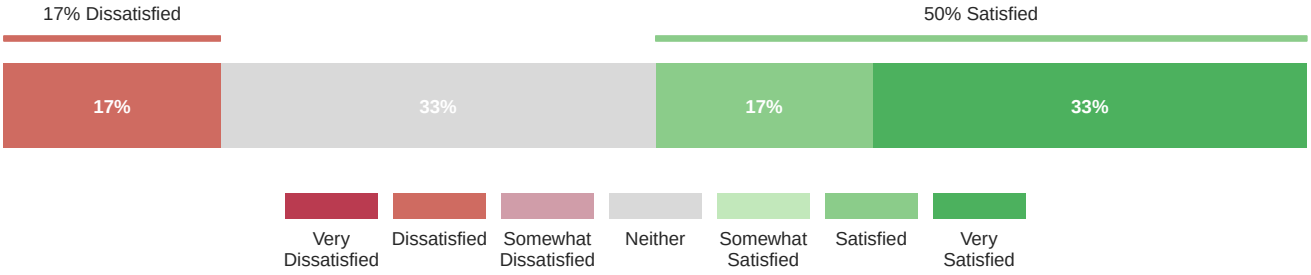
Office Furnishings

Here you can examine the ways in which occupants perceive the comfort and adjustability of the furnishings, and the overall design features (color, finishes) of the space.

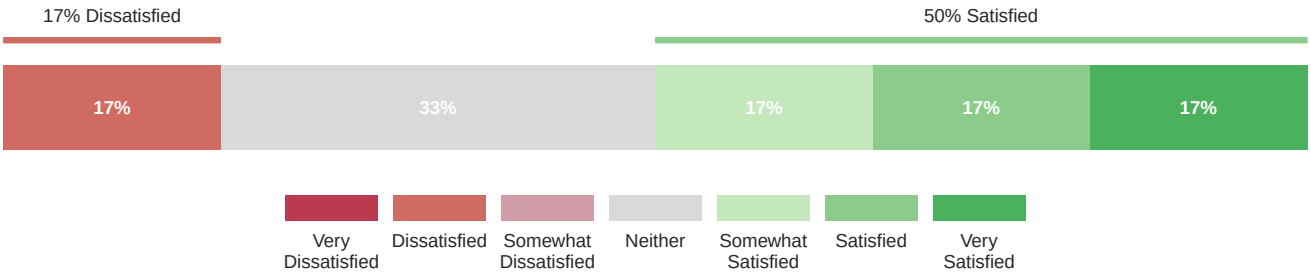
How satisfied are you with the comfort of your office furnishings?



How satisfied are you with your ability to adjust your furniture to meet your needs?



How satisfied are you with the colors and textures of flooring, furniture, and surface furnishes?



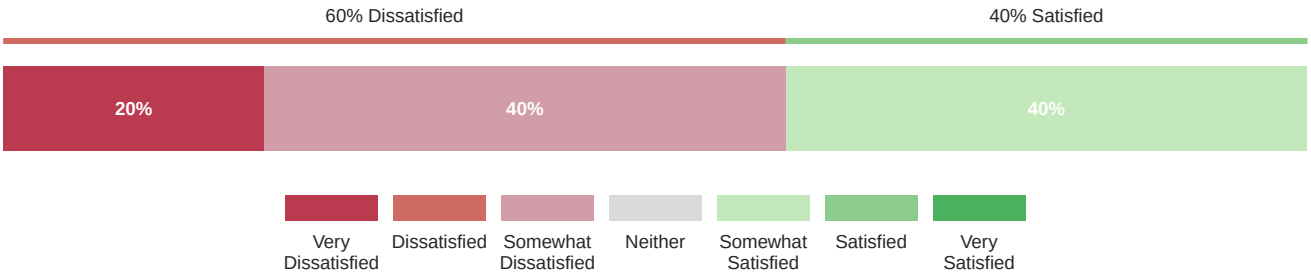
Participants were also asked to describe any specific issues related to furnishings that they feel are important to them. Please look to the raw data for these detailed text responses.

Thermal Comfort

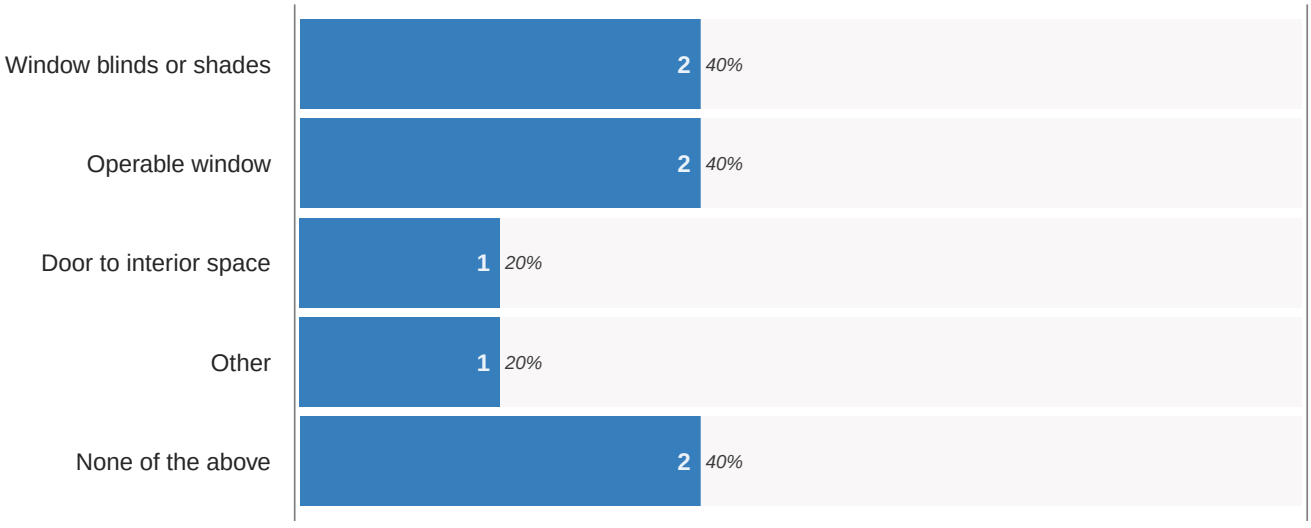
Next, this report highlights occupants' thermal experiences within the workplace. First, examine how satisfied the occupants are with their thermal comfort. Next, see which aspects of the environment that can influence thermal comfort are those occupants feel they have control over.

Whenever an occupant indicates dissatisfaction, they were prompted to identify why they are dissatisfied with the thermal environment. They were also shown a series of drill down questions aimed at identifying the time of day and season in which these issues arise. The questions examine exactly which building features influence this thermal discomfort.

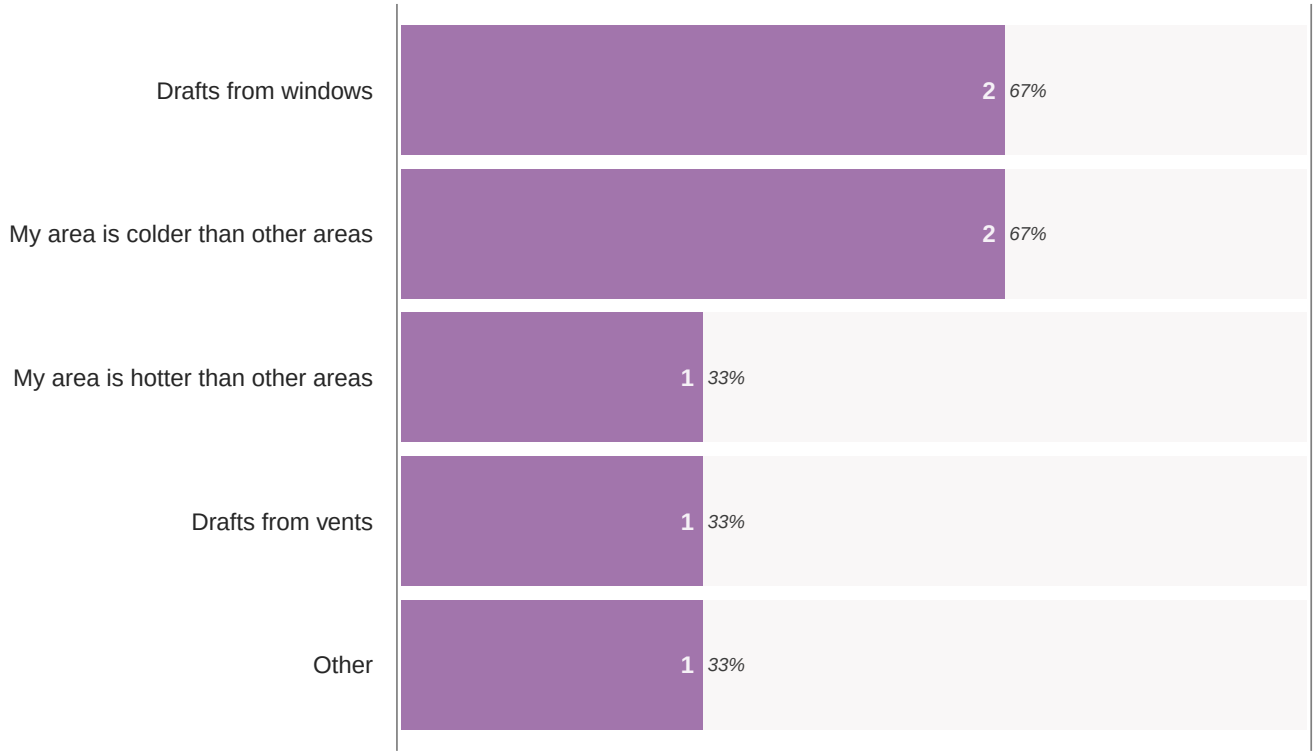
How satisfied are you with the temperature of your workspace?



Which of the following do you personally adjust or control in your workspace?

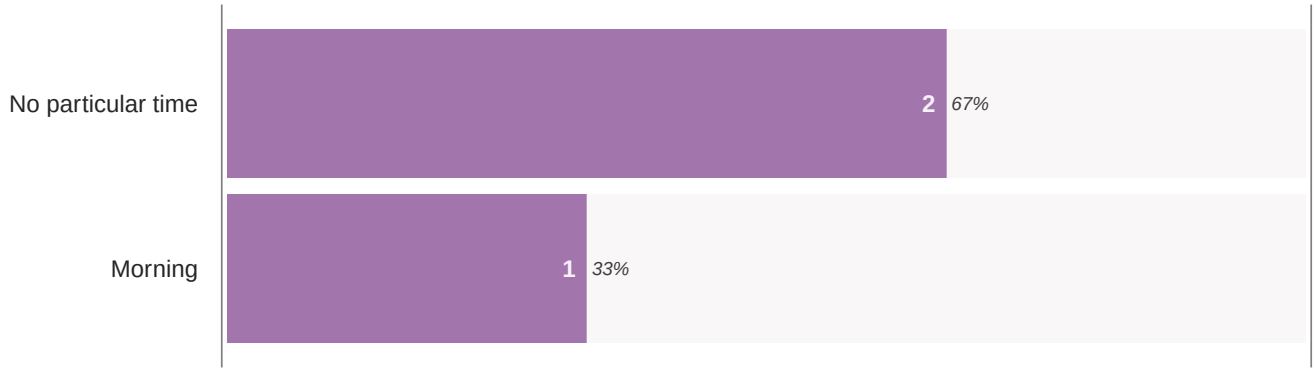


There were 3 participants who indicated that they have some level of dissatisfaction with the temperature of the space; below you will see the reasons for their dissatisfaction. Participants were allowed to select as many sources as they like, therefore counts may vary.



If participants have indicated there they have some level of dissatisfaction with the temperature of the space, below you will see details as to why they feel this is unsatisfactory. **Of the 12 respondents of this survey, feel it is too cold and 12% feel it is too hot in summer. In the winter, 8% feel it is too cold and 4% feel it is too hot.**

When is temperature most often a problem?

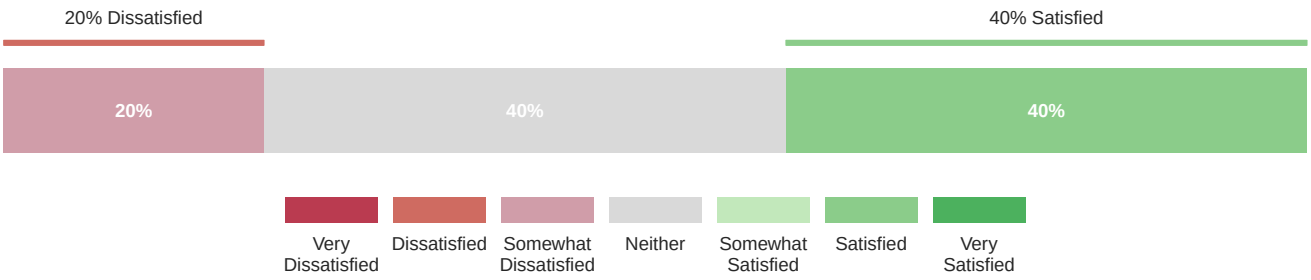


Participants were also asked to describe any specific issues related to thermal comfort that they feel are important to them. Please look to the raw data for these detailed text responses.

Air Quality

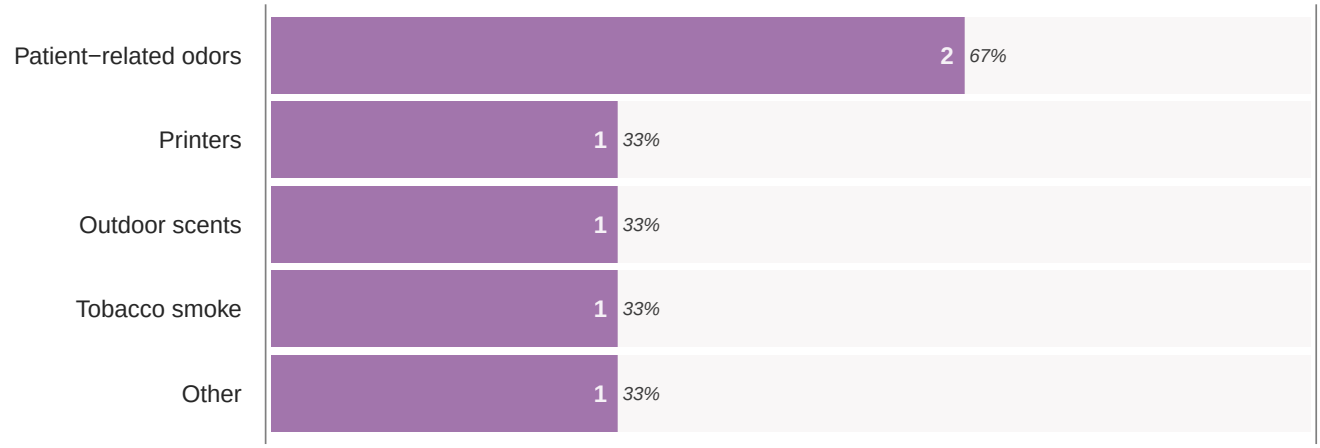
This section explores the ways in which occupants perceive the air quality of the space. Dissatisfied occupants are asked to identify the magnitude of the issue and the odor sources within the space (if there are any). These drill down questions will help you identify sources of dissatisfaction that you may be able to address.

How satisfied are you with the air quality of your workspace?



There were 1 participants who indicated that they experience some level of dissatisfaction with the air quality of the space. Here you can see the magnitude of each issue (i.e. whether or not a space is too stuffy, unclean, or smelly).

The following are sources that contribute to odor issues within this space. Participants were allowed to select as many sources as they like, therefore counts may vary.



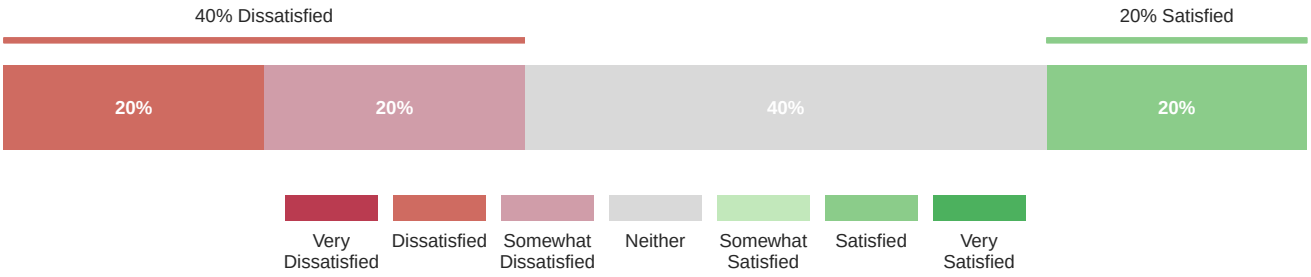
Participants were also asked to describe any specific issues related to air quality that they feel are important to them. Please look to the raw data for these detailed text responses.

Lighting

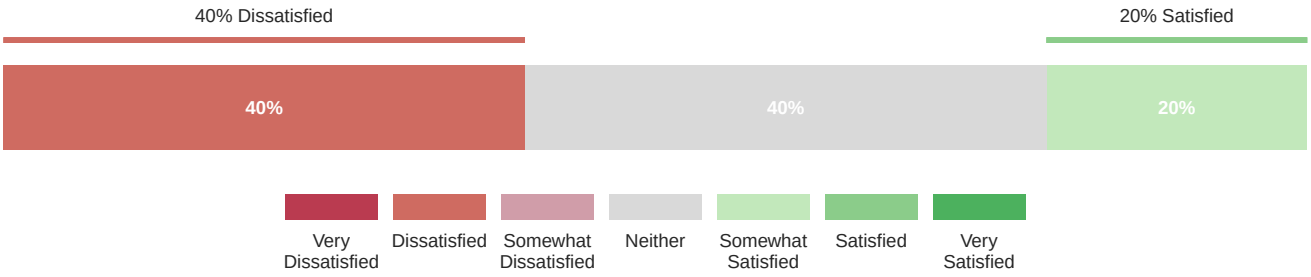
The next section examines the ways in which occupants perceive the lighting within the space. Here you can occupants' perceptions of the amount of light available to them and their satisfaction with their own visual comfort. Next, see which aspects of the environment that influence lighting are those that occupants feel they have control over.

Again, whenever an occupant is dissatisfied they were asked to identify why they are dissatisfied with the lighting. These drill down questions will help you identify sources of dissatisfaction you may be able to address in the future to improve visual comfort and reduce environmental challenges like glare.

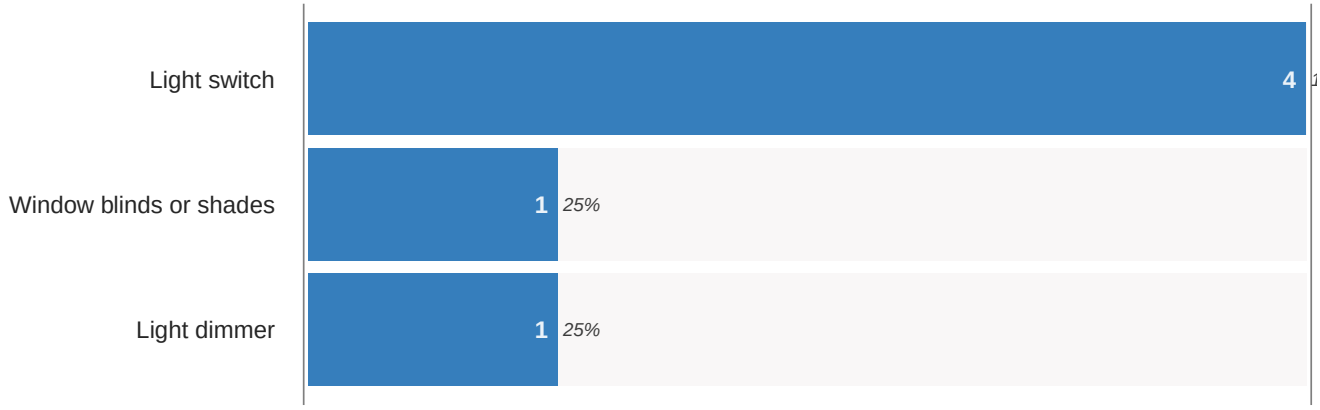
How satisfied are you with the amount of light in your workplace?



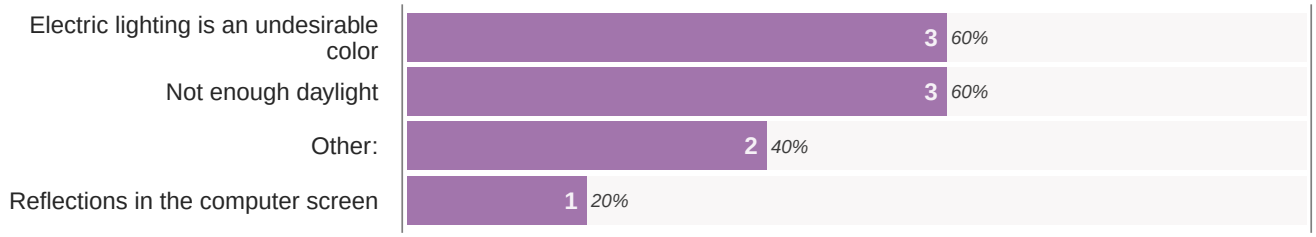
How satisfied are you with the visual comfort of the lighting?



Which of the following controls do you have over the lighting in your workspace?



There were 5 participants who indicated that they experience some level of dissatisfaction with the lighting in the space. The following contribute to lighting issues. Participants were allowed to select as many sources as they like, therefore counts may vary.

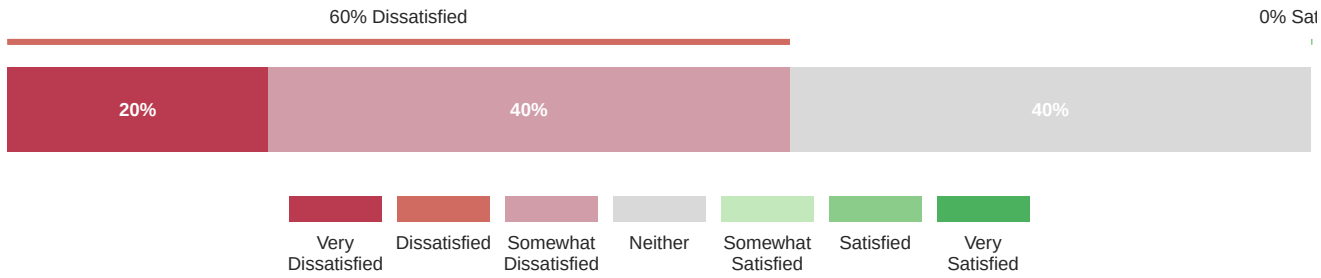


Participants were also asked to describe any specific issues related to lighting that they feel are important to them. Please look to the raw data for these detailed text responses.

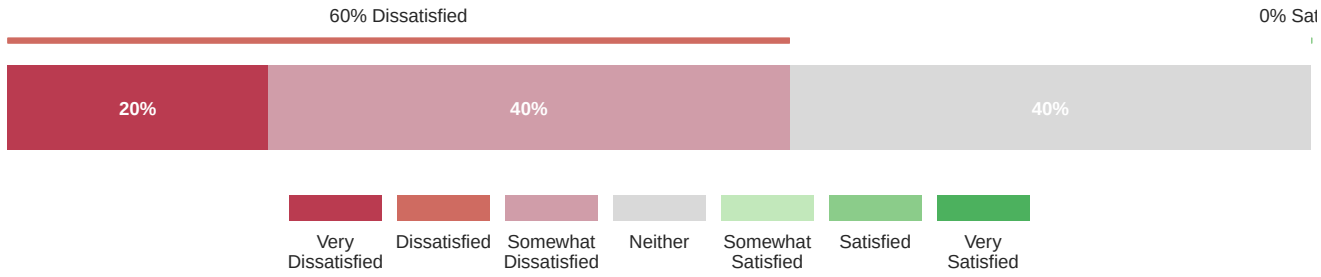
Acoustic Quality

This section explores the ways in which occupants experience acoustics in the space. Specifically, occupants report their satisfaction with overall noise level and sound privacy. Further, whenever an occupant is dissatisfied they were asked to identify the sources of sound disturbances in the space. These drill down questions will help you identify sources of dissatisfaction you may be able to address in the future either with design or workplace policy intervention.

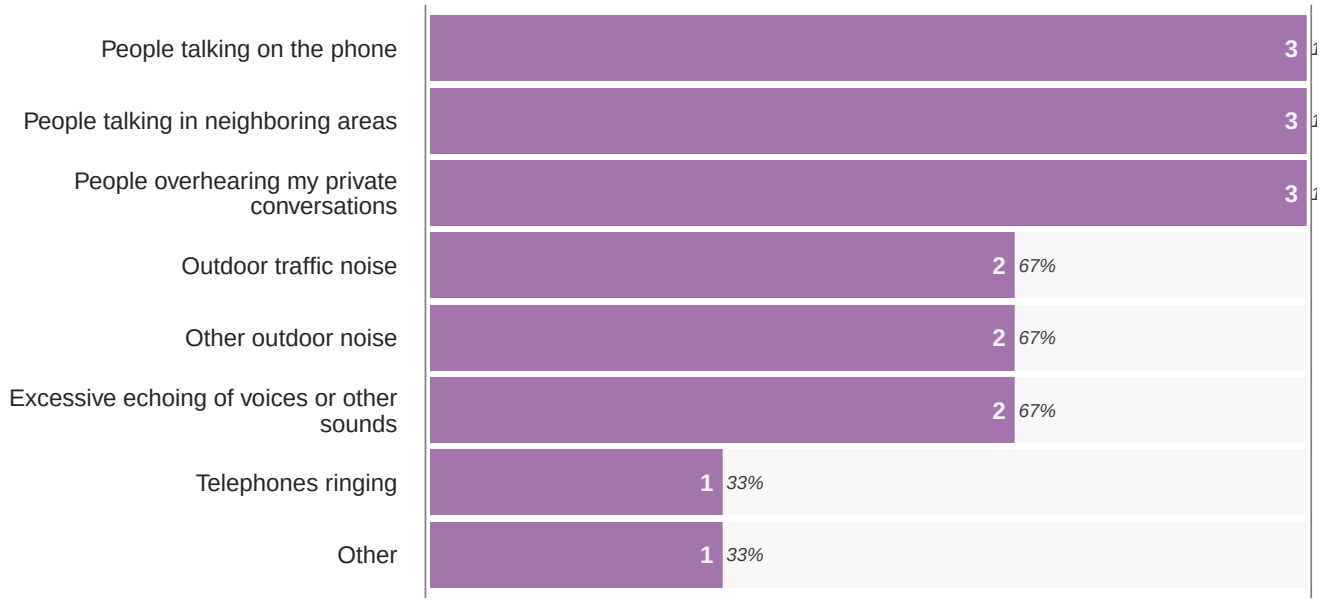
How satisfied are you with the noise level of your workspace?



How satisfied are you with the sound privacy of your workspace?



There were 3 participants who indicated that they experience some level of dissatisfaction with the acoustics in the space. The following contribute to lighting issues. Participants were allowed to select as many sources as they like, therefore counts may vary.

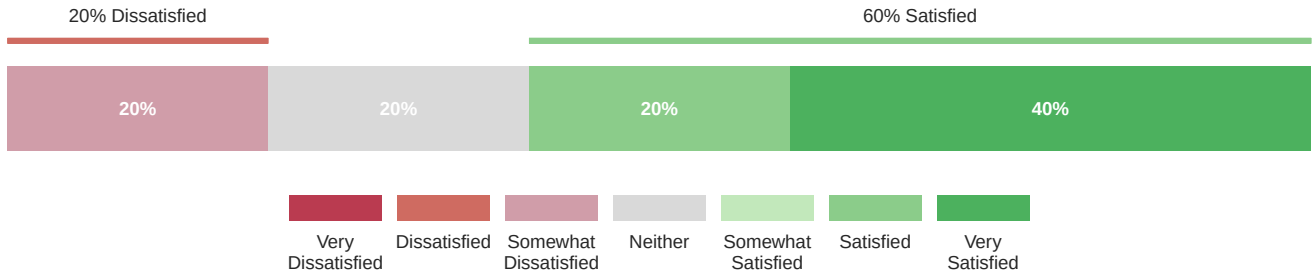


Participants were also asked to describe any specific issues related to acoustics that they feel are important to them. Please look to the raw data for these detailed text responses.

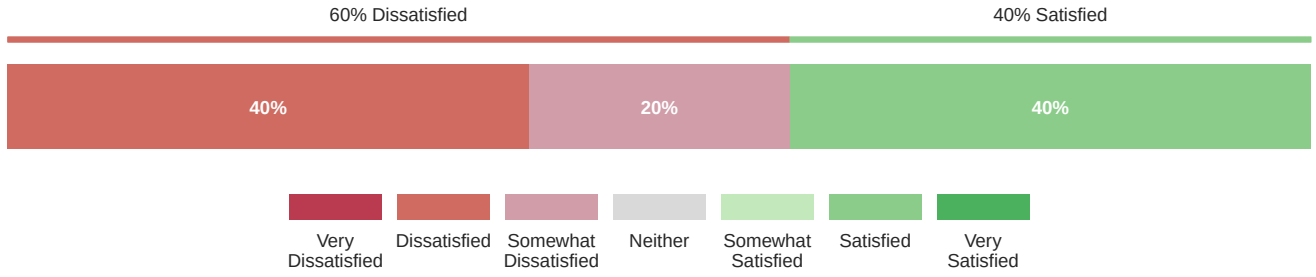
Cleanliness and Maintenance

Here occupants report their satisfaction with the cleanliness and maintenance of the space. Whenever an occupant is dissatisfied with the cleanliness of space, they were prompted to identify the sources of that dissatisfaction so you can more effectively address what may need to be adjusted with the building's cleaning services.

How satisfied are you with the general cleanliness of your workspace?

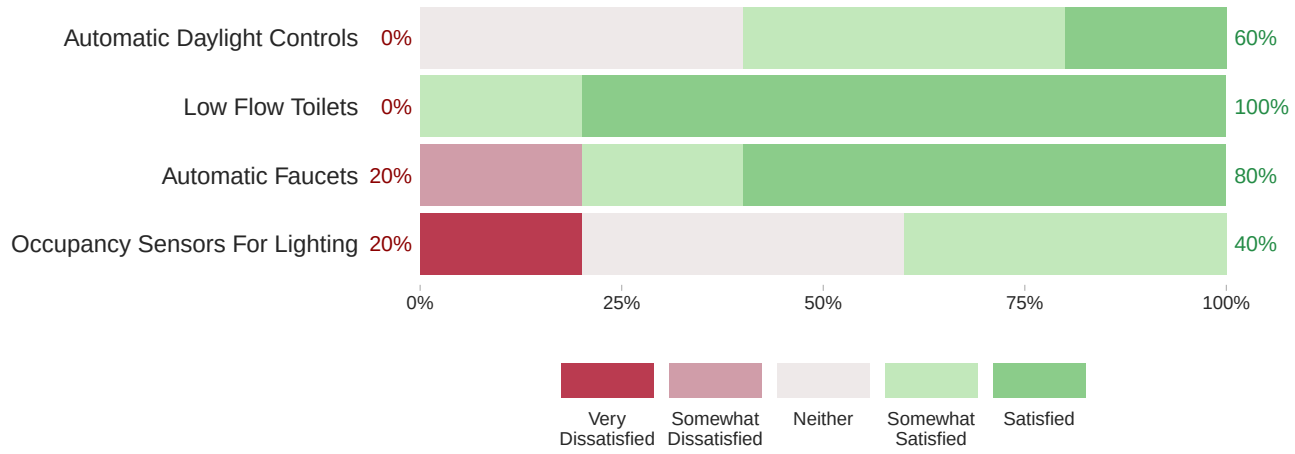


How satisfied are you with the general maintenance of your workspace?



Building Features

The following section summarizes occupant responses to questions about specific building features you chose to measure. These features change from survey to survey, and below you'll see the satisfaction responses to the nominated building features in this survey. If this section is blank, this is because features were not selected for this survey.



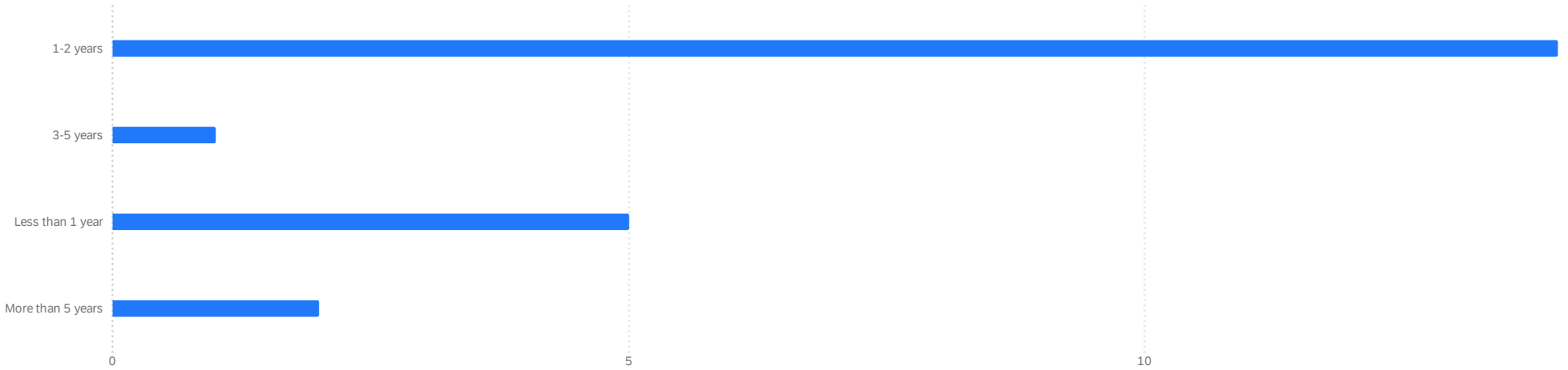
Participants were also asked to describe any specific issues related to these building features that they feel are important to them. Please look to the raw data for these detailed text responses.

Appendix D – Occupant Survey Results: September 2022

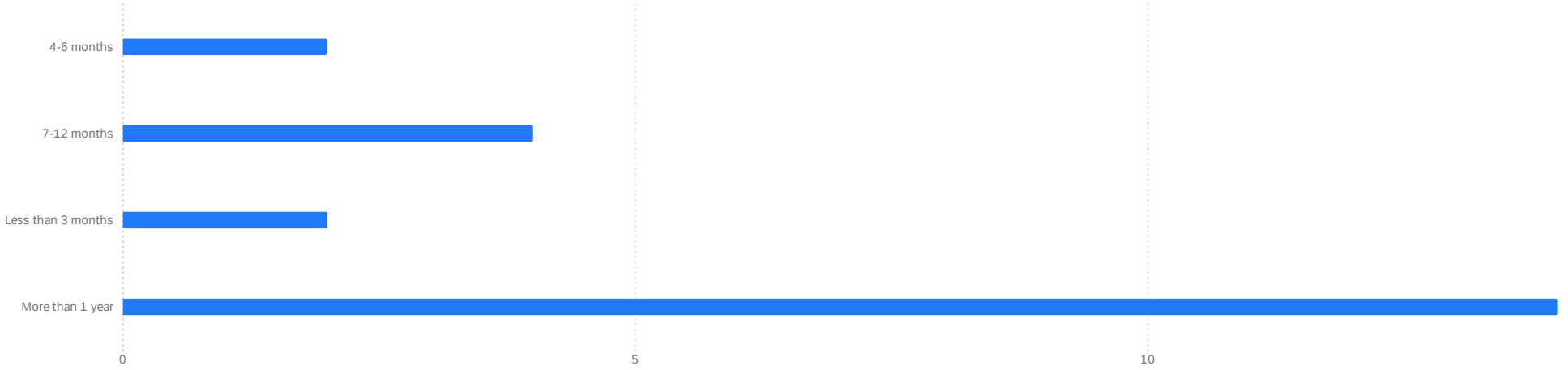
Attached herein is the Occupant Survey report that was conducted for the Berkeley Mental Health facility during September 2022

Responses: 26

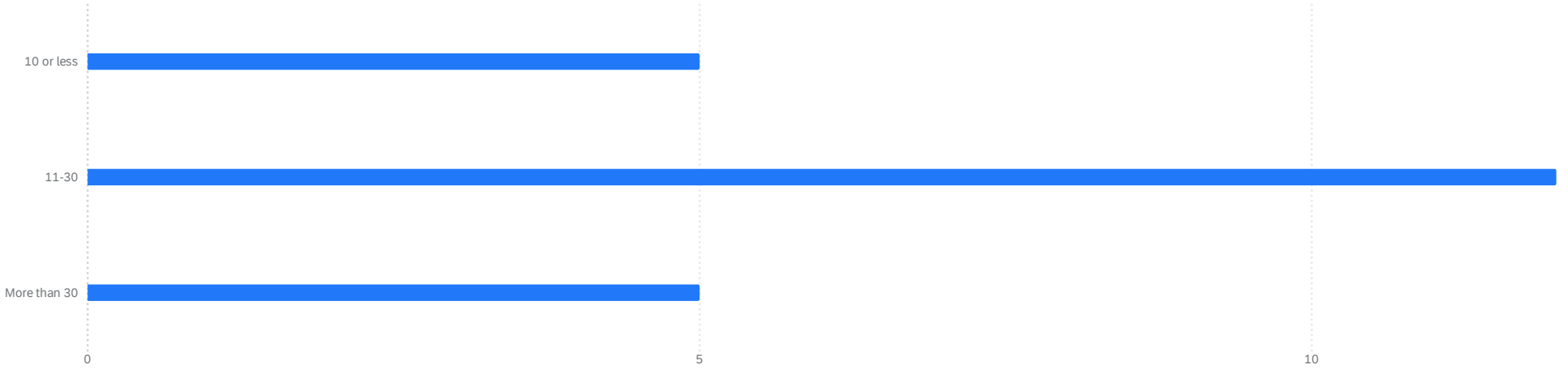
How many years have you worked in this building? 22



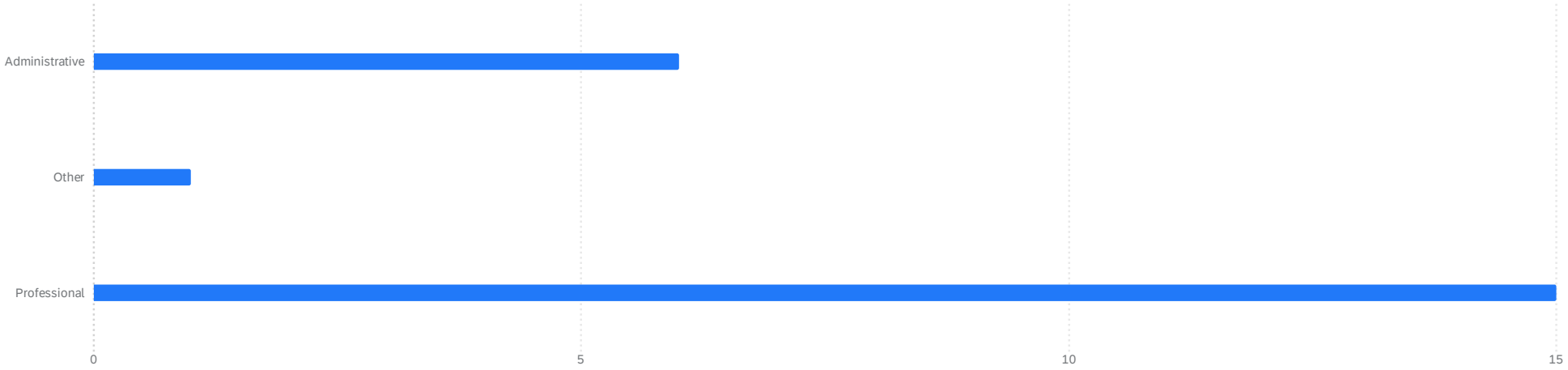
How long have you been working at your present workspace? 22



In a typical week, how many hours do you spend in your workspace? 22



How would you describe the work that you do? 22

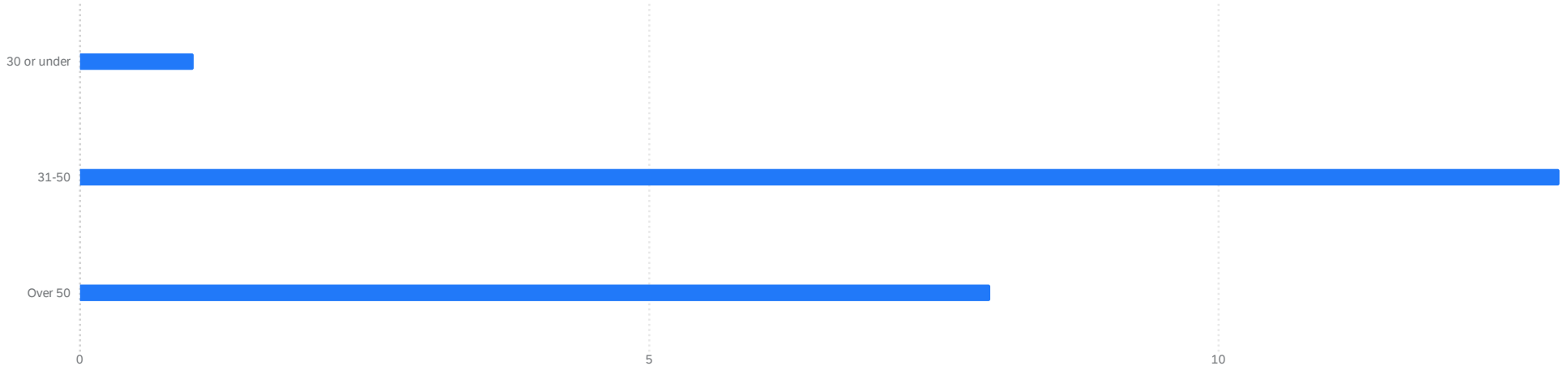


How would you describe the work that you do?: Other

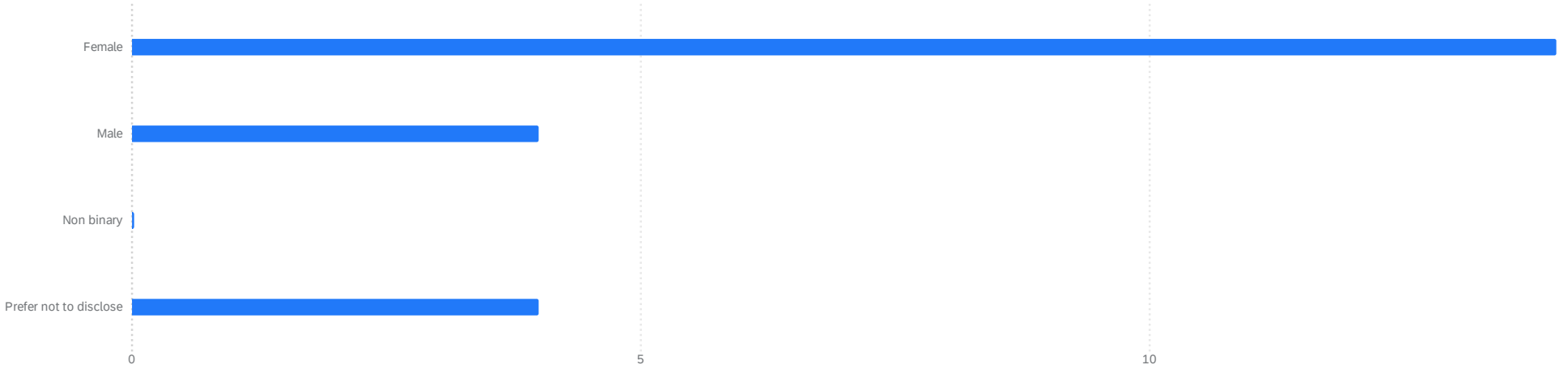
see clients and talk on phone/admin

No more results to show

What is your age? 22



What is your gender? 22



During a typical week, what percentage of your time do you spend working in the following locations? Please make sure all items together roughly total to 100%. 18

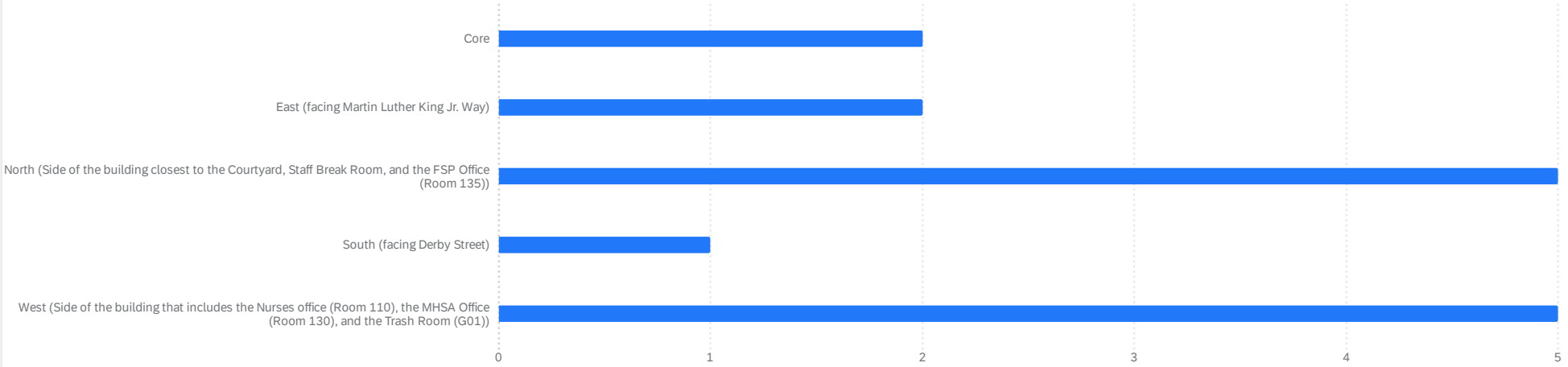
During a typical week, what percentage of your time do you spend working in...	Average	Minimum	Maximum	Count
In my own individual workspace	28.13	0.00	100.00	18
In a shared workspace	27.88	0.00	100.00	17
In a conference room	0.00	0.00	0.00	18
Working or meeting off-site	9.47	0.00	60.00	18
In patient rooms	2.57	0.00	20.00	18
In patient treatment areas	1.97	0.00	20.00	18
Q77_7 - Other: please specify	6.72	0.00	60.00	18

Considering only your working time in your building, please estimate the percentage of that time you spend on the following activities. Please make sure all items together roughly total 100%. 18

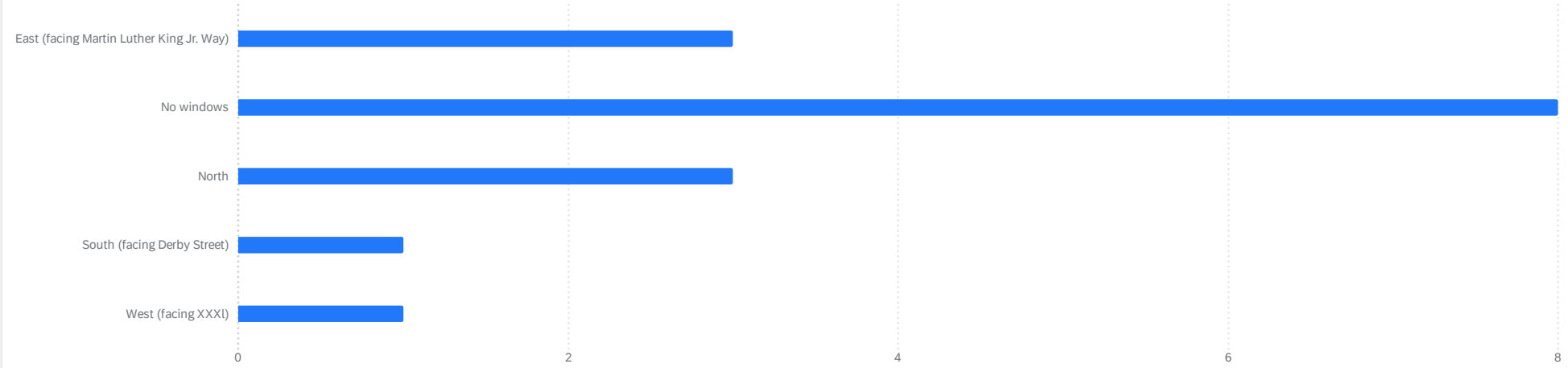
Considering only your working time in your building, please estimate the pe... ↑	Average	Minimum	Maximum	Count
In scheduled meetings	15.07	0.00	50.00	18
Q78_10 - Other: please specify	0.00	0.00	0.00	18
Talking face to face with colleagues outside of scheduled meetings	6.73	0.00	20.00	18
On the phone	13.56	0.00	50.00	17
Computer work at your own station	22.86	0.00	75.00	18
Computer work at a remote station	3.67	0.00	40.00	18
Reading print material	2.56	0.00	10.00	18

On which floor is your workspace located? 16

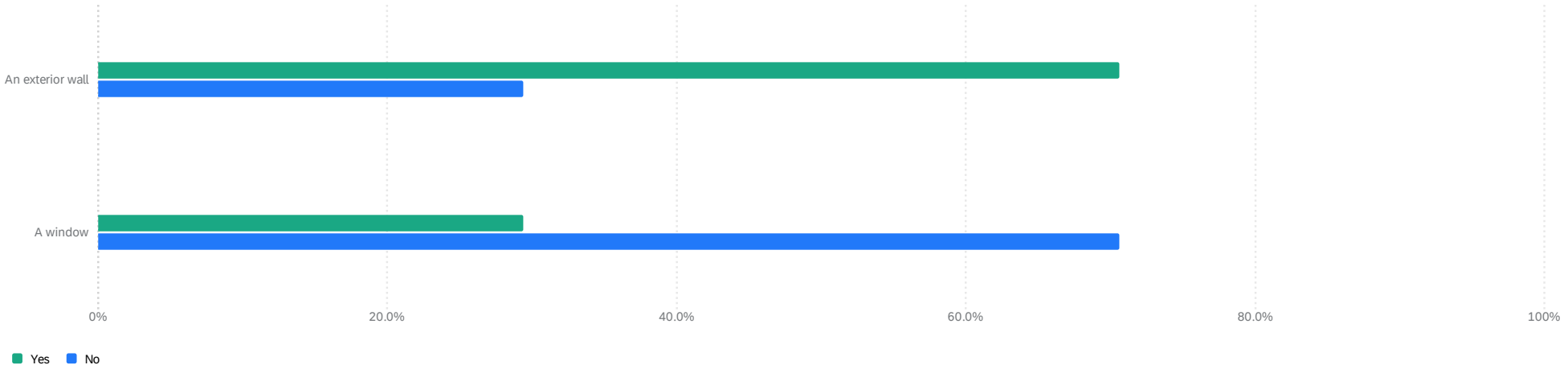
In which area of the building is your workspace located? 15



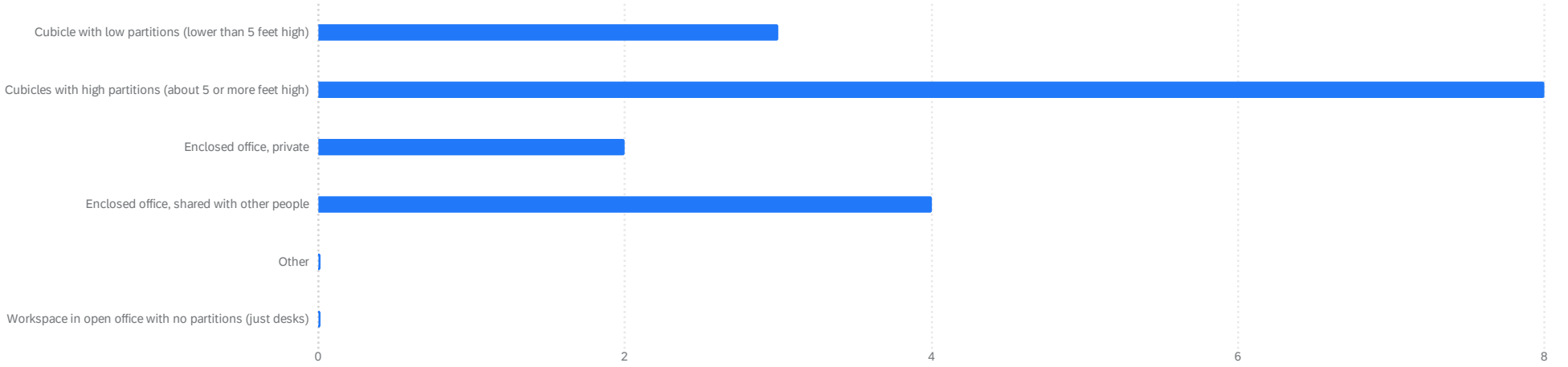
In which direction do the windows closest to your workspace face? 16



Are you near (i.e., within 15 feet)... 17



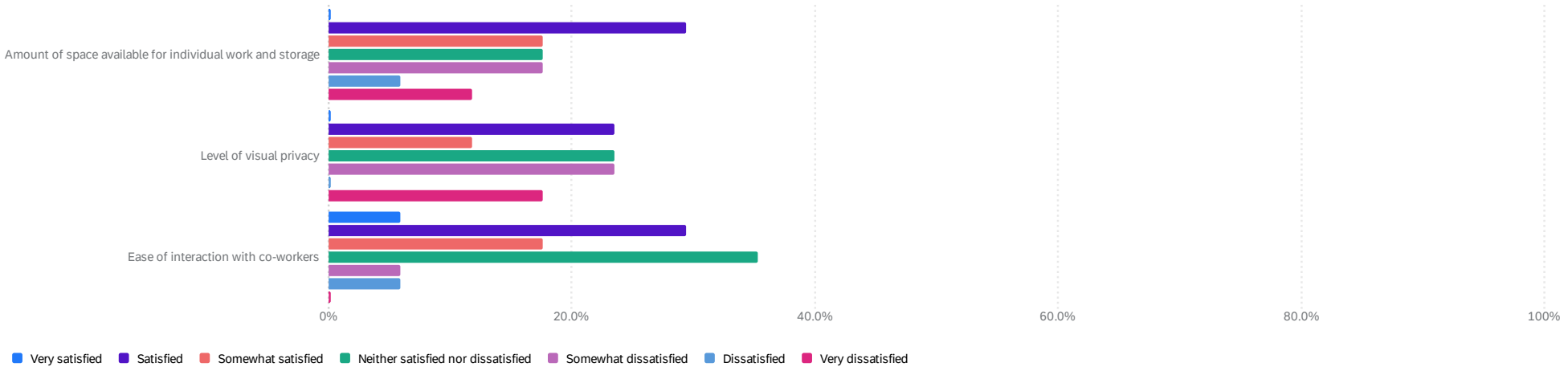
Which of the following best describes your personal workspace? 17



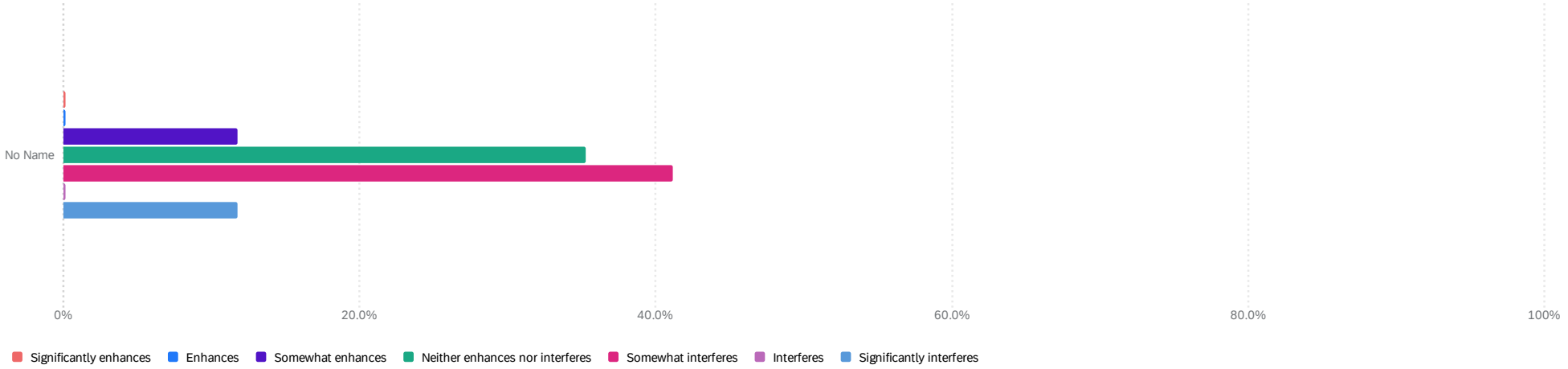
Which of the following best describes your personal workspace?: Other

No data found - your filters may be too exclusive!

How satisfied are you with the... 17



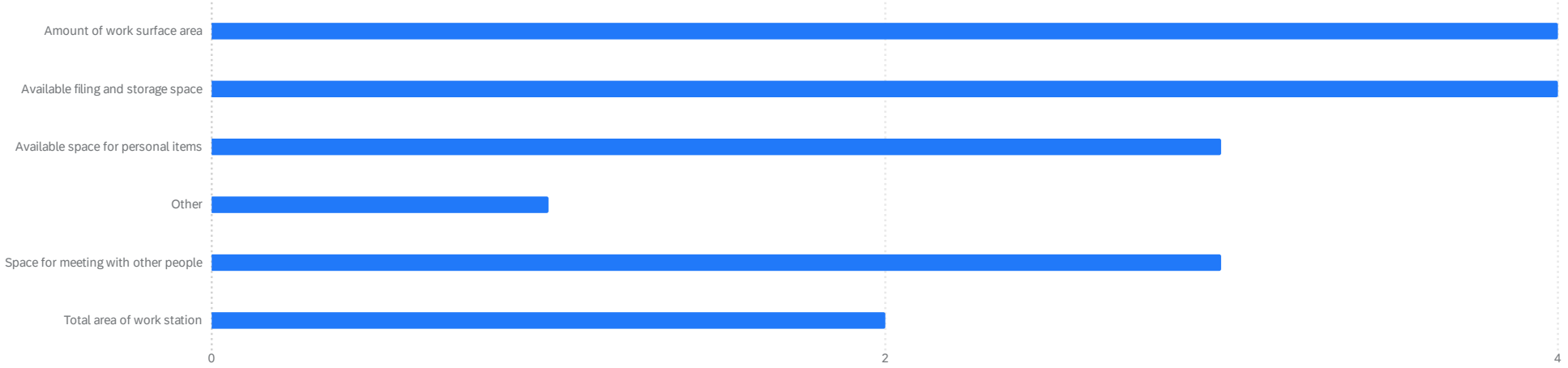
Overall, does the office layout enhance or interfere with your ability to get your job done? 17



Please describe any other issues related to the office layout that are important to you.

- none
- No window, was assigned a standing desk, vs regular desk with tray which would've been my preference. I am very dissatisfied with standing desk and the fact that I was never given the option to have a regular desk with tray which is more ergonomic for me.
- lack of windows is awful
- I rotated offices and have a station with m y belongings, it is hard to keep the 6 feet distance sometimes
- not enough privacy. Phone calls are loud. You can hear everyone talking outside in the kitchen, even with door lock.

You have said that you are dissatisfied with the amount of space available for individual work and storage. Which of the following contribute to your dissatisfaction? (Check all that apply.) 6

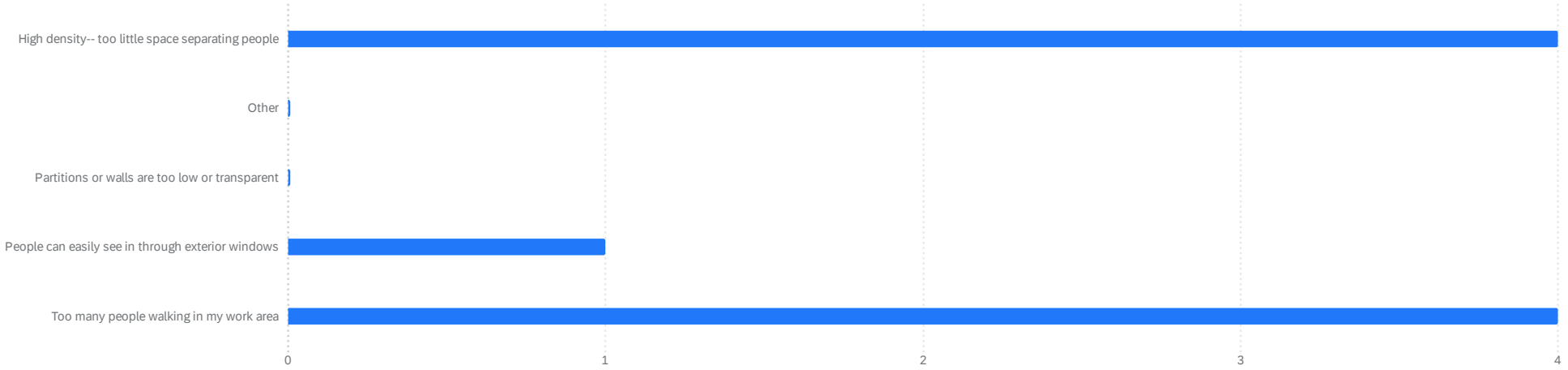


You have said that you are dissatisfied with the amount of space available for individual work and storage. Which of the following contribute to your dissatisfaction? (Check all that apply.): Other

standing desk

No more results to show

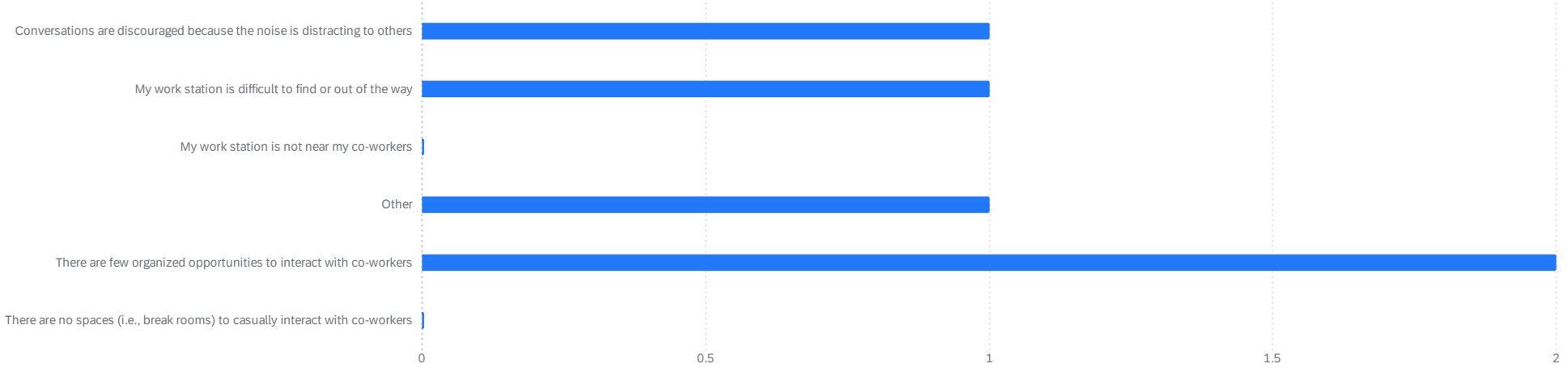
You have said that you are dissatisfied with the level of visual privacy. Which of the following contributes to your dissatisfaction? (Check all that apply) 7



You have said that you are dissatisfied with the level of visual privacy. Which of the following contributes to your dissatisfaction? (Check all that apply): Other

No data found - your filters may be too exclusive!

You have said that you are dissatisfied with the ease of interaction with co-workers. Which of the following contribute to your dissatisfaction? (Check all that apply). 2

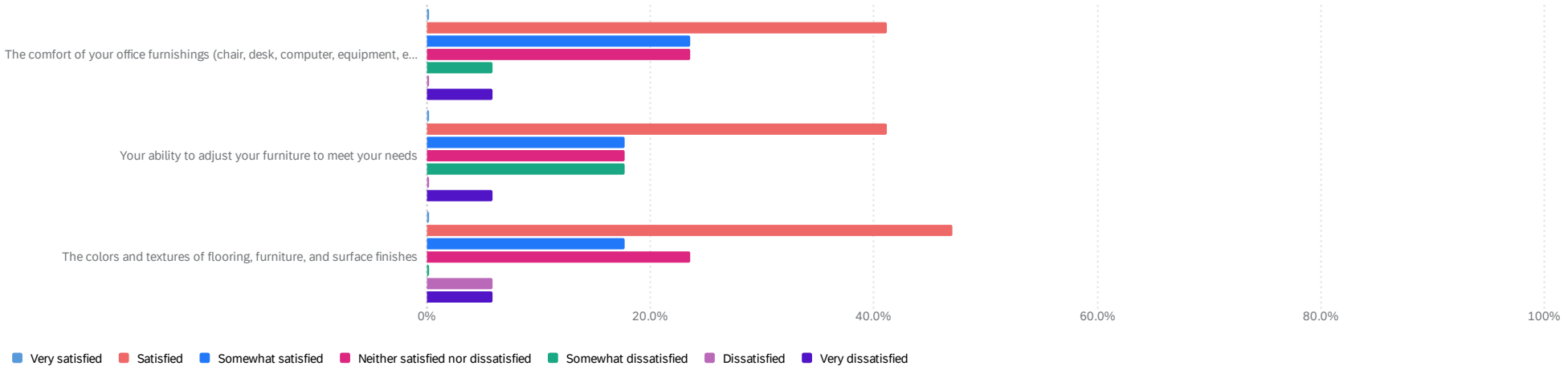


You have said that you are dissatisfied with the ease of interaction with co-workers. Which of the following contribute to your dissatisfaction? (Check all that apply).: Other

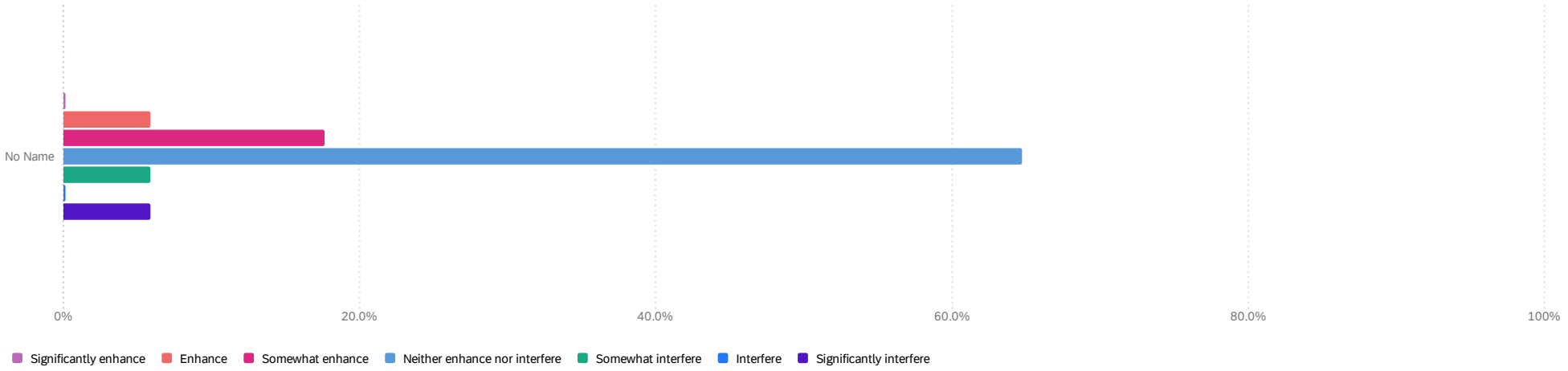
also, the culture does not lend to casual meetigs excpet in break room but due to open plan it fee0dl like everyone can hear your conversation.

No more results to show

How satisfied are you with... 17



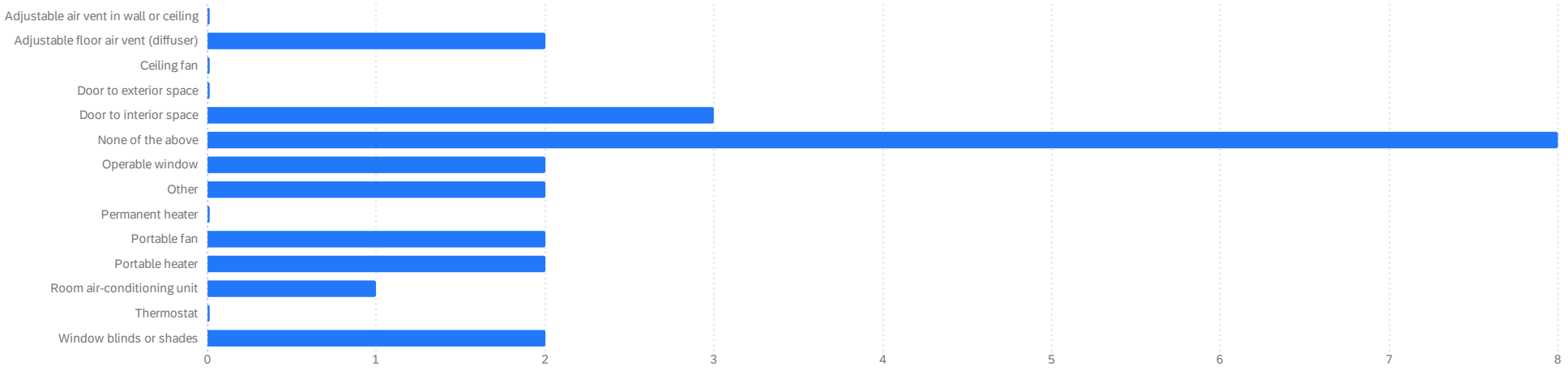
Do your office furnishings enhance or interfere with your ability to get your job done? 17



Please describe any other issues related to office furnishings that are important to you.

- none
- N/A
- n/a
- the cubical are too close
- They're fine
- need storage space

Which of the following do you personally adjust or control in your workspace? (Check all that apply) 16



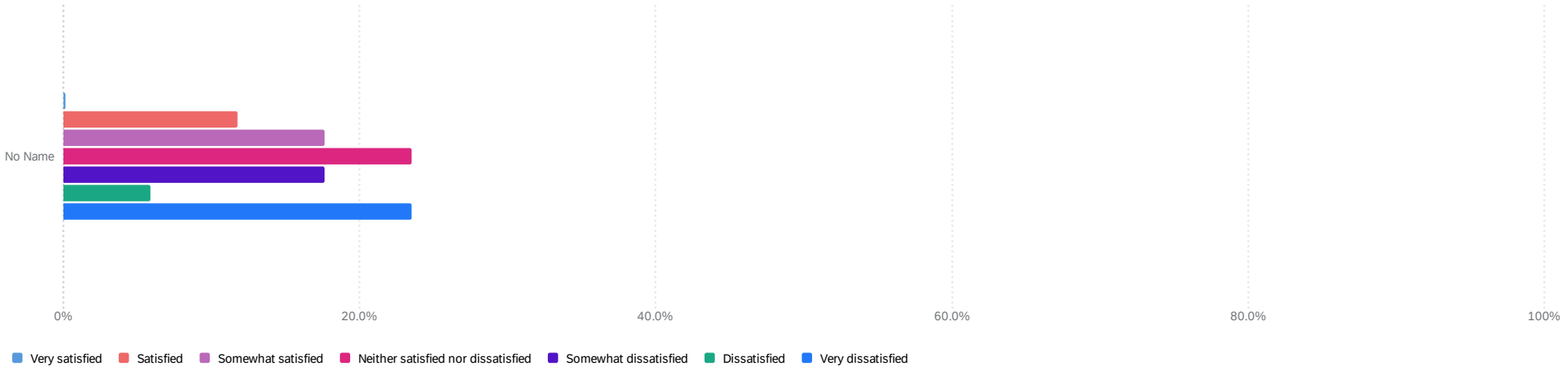
Which of the following do you personally adjust or control in your workspace? (Check all that apply): Other

Air purify

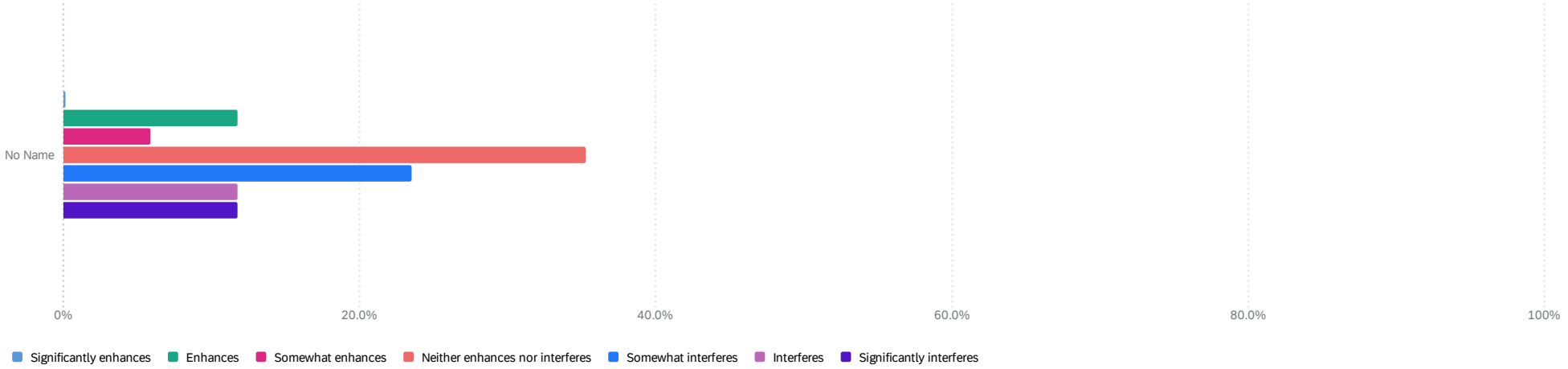
blinds only

No more results to show

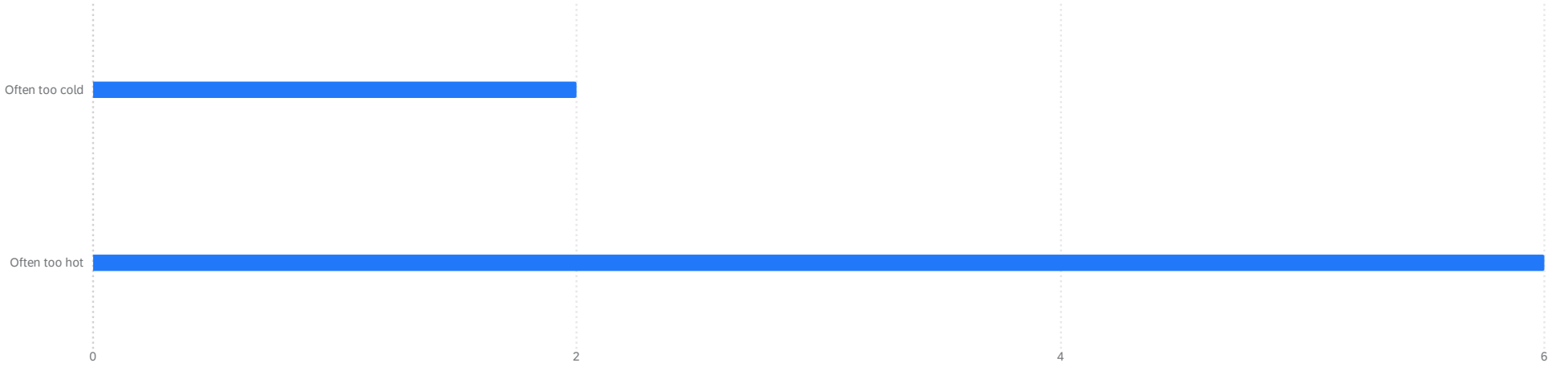
How satisfied are you with the temperature of your workspace? 17



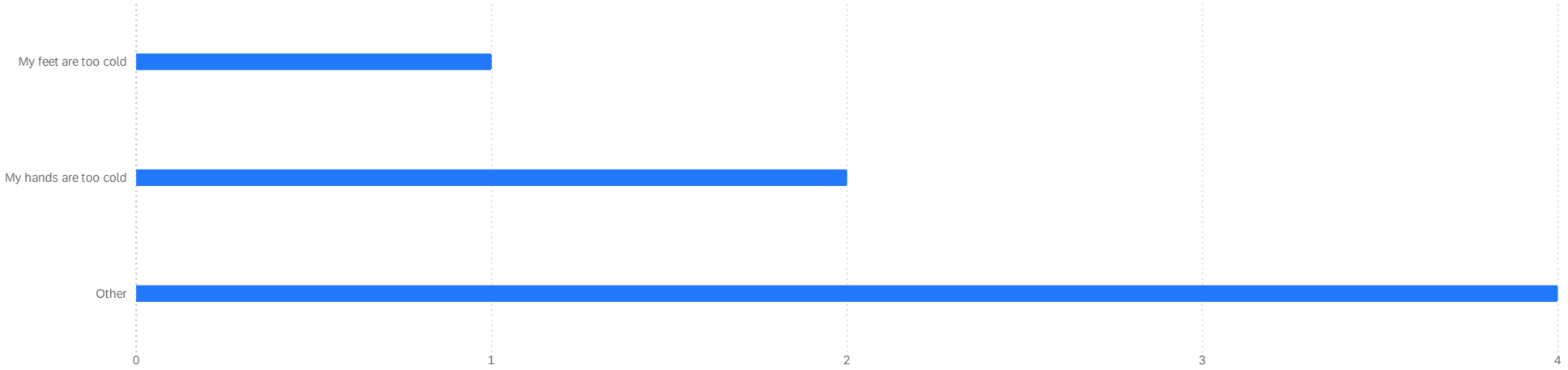
Overall, does your thermal comfort in your workspace enhance or interfere with your ability to get your job done? 17



In warm/hot weather, the temperature in my workspace is: (Check all that apply) 8



In warm/hot weather... (Check all that apply) 6

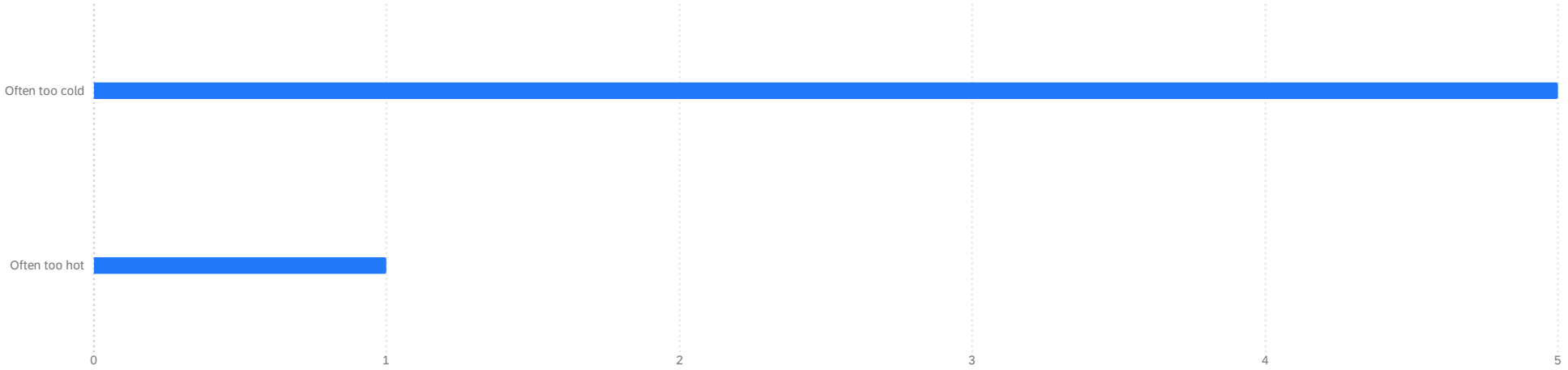


In warm/hot weather... (Check all that apply): Other

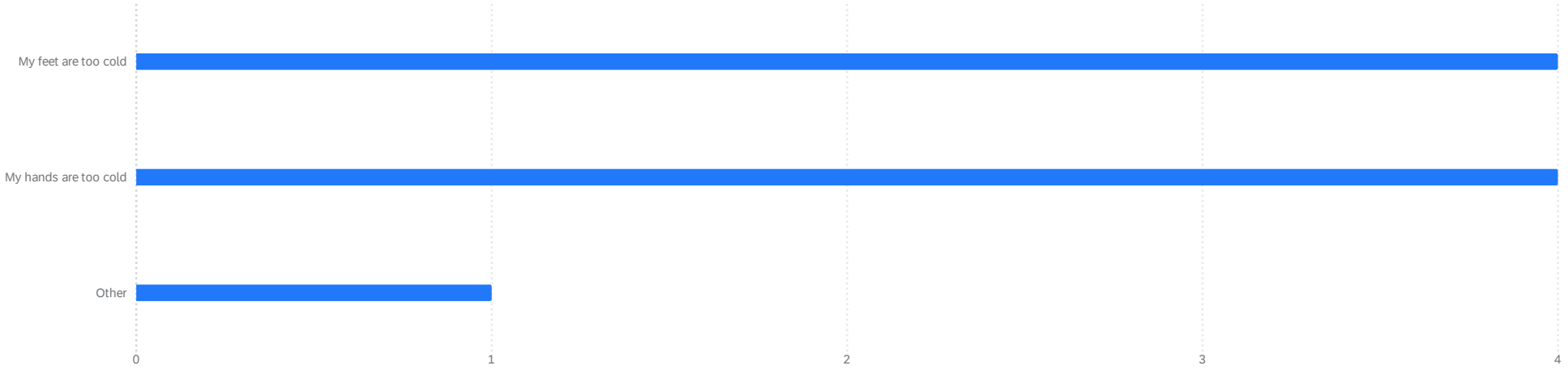
in warm weather too hot
N/A
stagnant air
im sweating

No more results to show

In cool/cold weather, the temperature in my workspace is: (Check all that apply) 6



In cool/cold weather... (Check all that apply) 5

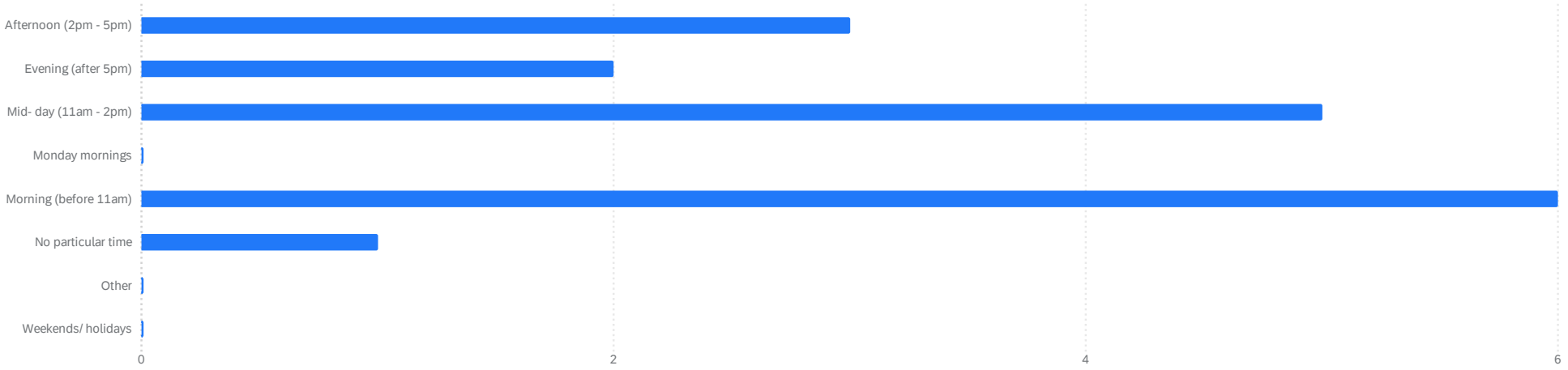


In cool/cold weather... (Check all that apply): Other

N/A

No more results to show

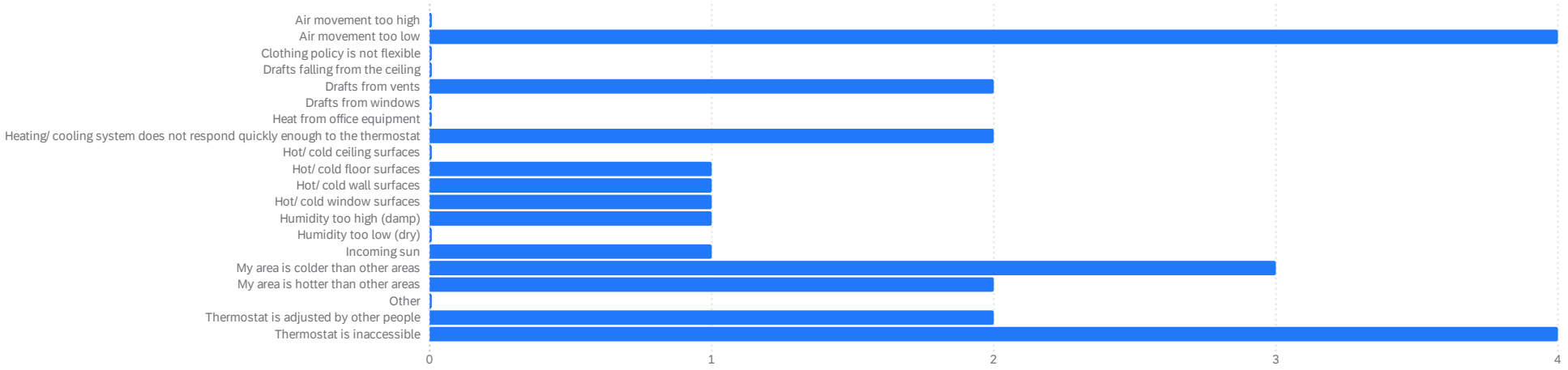
When is this most often a problem? (Check all that apply) 8



When is this most often a problem? (Check all that apply): Other

No data found - your filters may be too exclusive!

How would you best describe the source of this discomfort? (Check all that apply) 7



How would you best describe the source of this discomfort? (Check all that apply): Other

No data found - your filters may be too exclusive!

Please describe any other issues related to being too hot or too cold in your workspace.

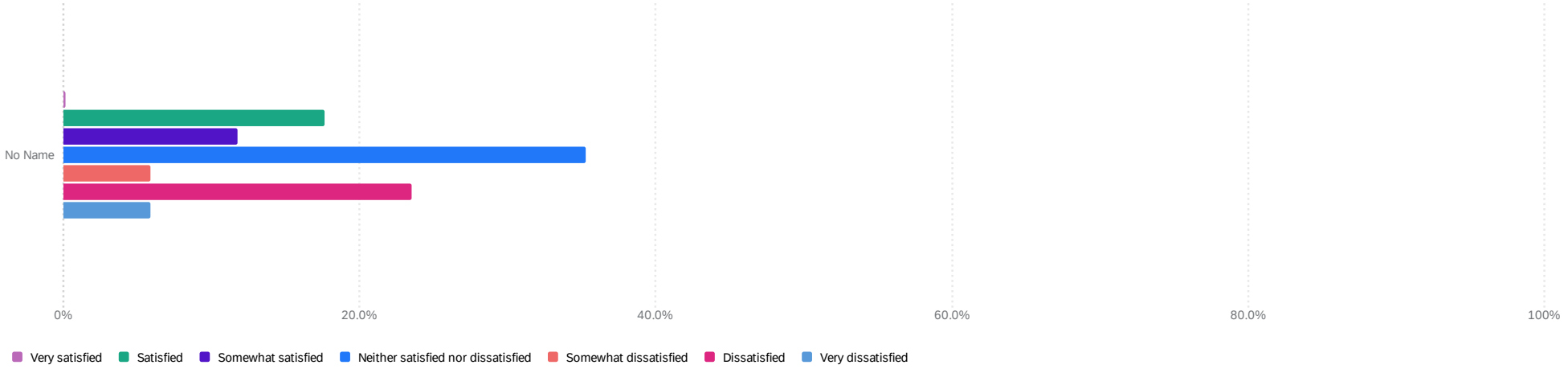
natural sun light on roof, when it is a hot weather makes the room too hot due to not window

It is just always cold.

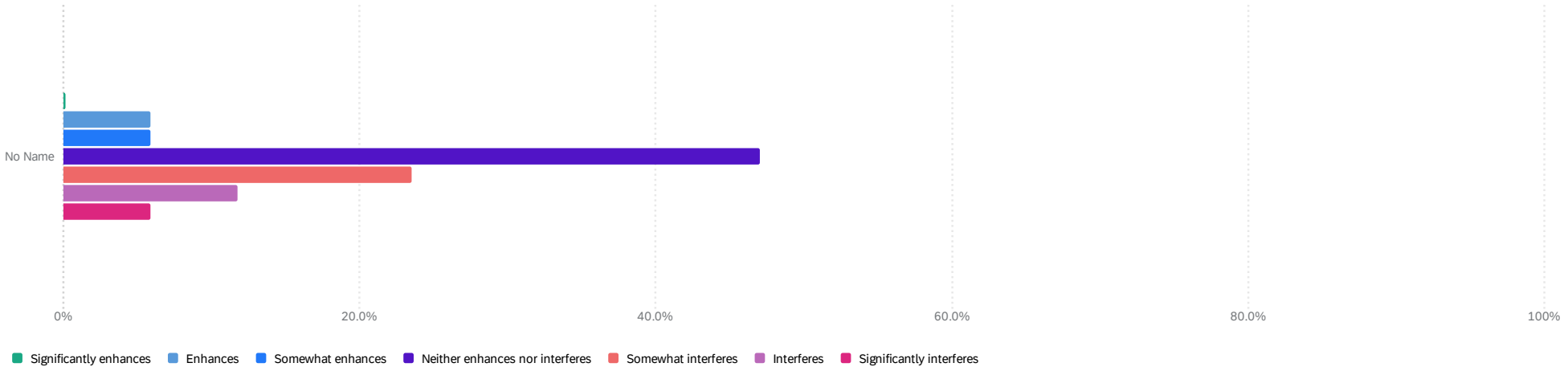
We've been told that the building is supposed to maintain an optimal temperature, but I don't know: a) what is considered optimal, b) "optimal" is a vague term and individual staff have different levels of a comfortable temperature, and c) what are the ways to modulate the temperature to allow for comfort to be able to do work? While I know that I am regularly hot and uncomfortable, other colleagues are complaining about the coldness. There is something wrong if no one is satisfied with the temperature.

No more results to show

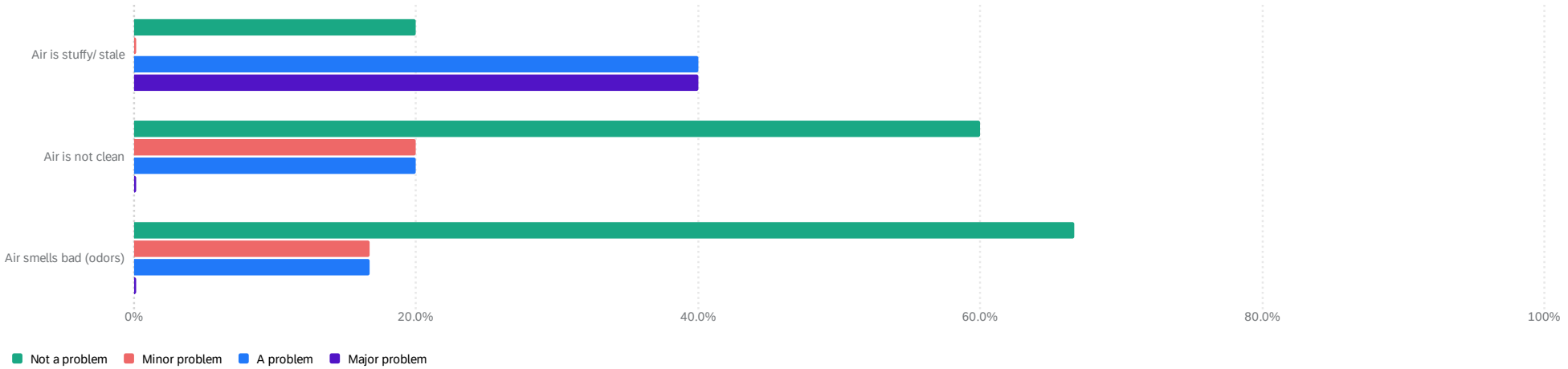
How satisfied are you with the air quality in your workspace? (i.e., stuffy/ stale air, cleanliness, odors) 17



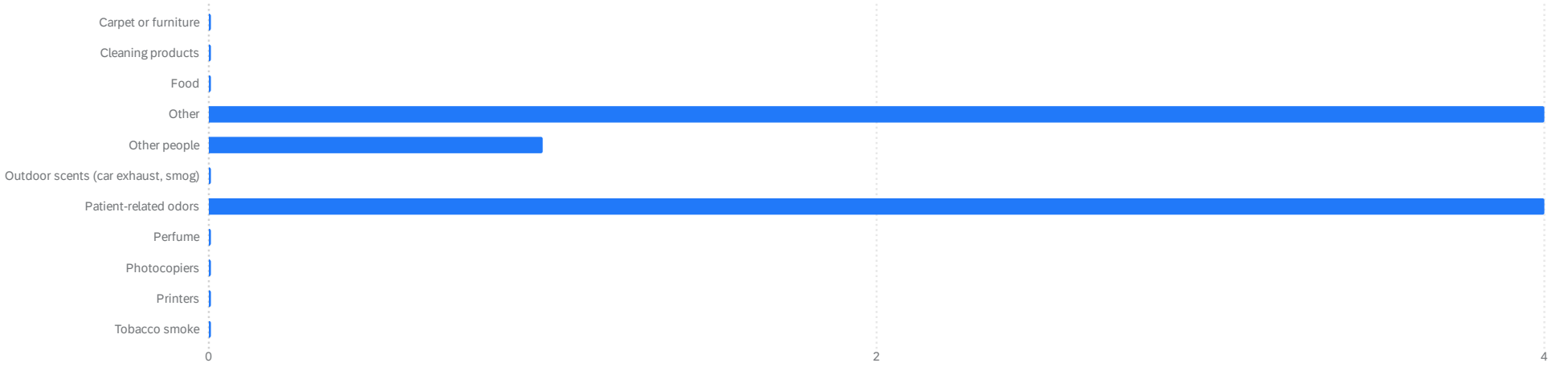
Overall, does the air quality in your workspace enhance or interfere with your ability to get your job done? 17



You have said that you are dissatisfied with the air quality in your workspace. Please rate the level of each of the following problems. 6



If there is an odor problem, which of the following contribute to the problem? (Check all that apply) 8



If there is an odor problem, which of the following contribute to the problem? (Check all that apply): Other

none

none

none

no odor just stale

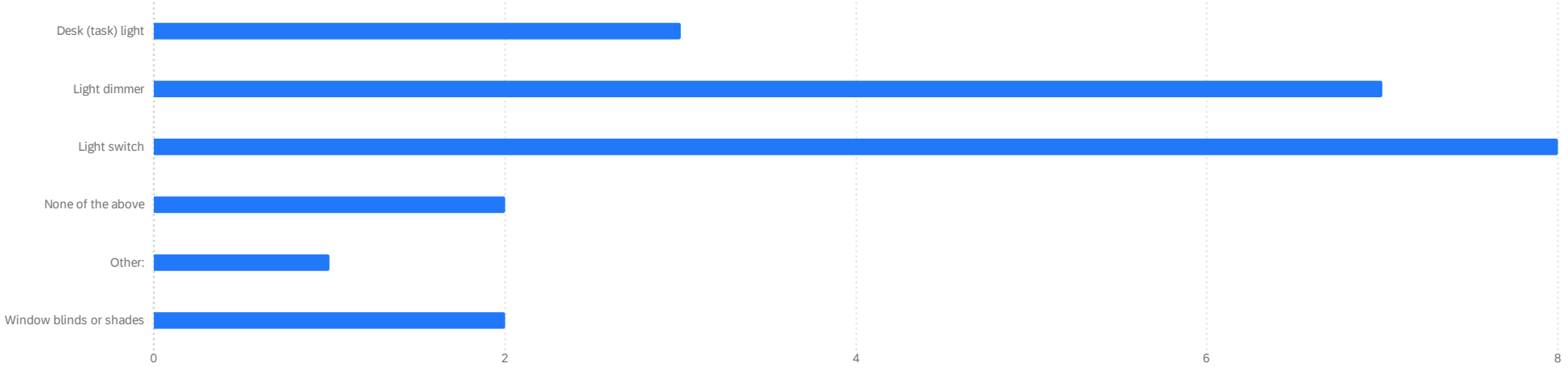
No more results to show

Please describe any other issues related to the air quality in your workspace that are important to you.

No Fresh air just circulated, the air purifiers are nice I guess but make a loud humming sound

No more results to show

Which of the following controls do you have over the lighting in your workspace? (Check all that apply) 17

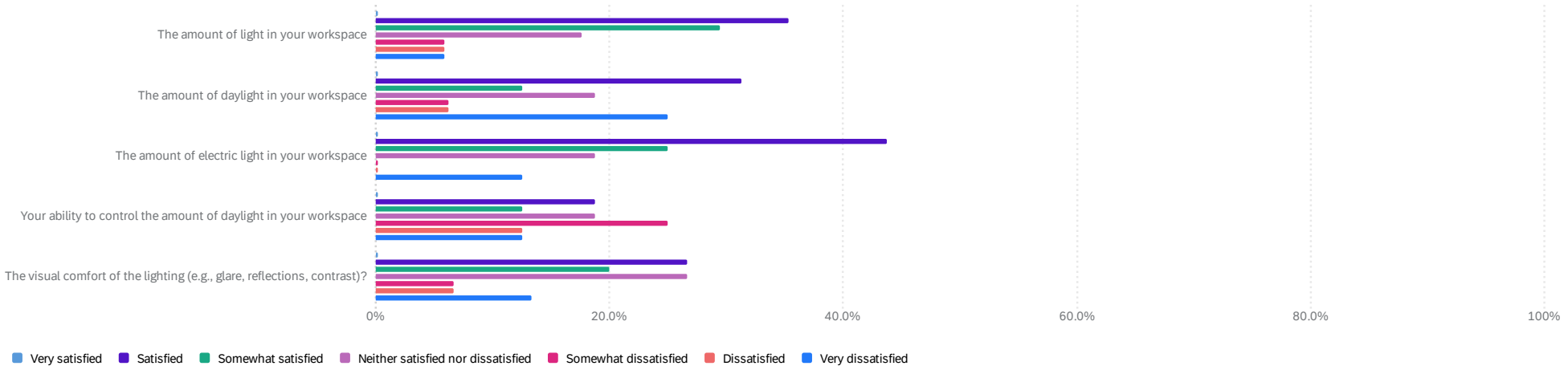


Which of the following controls do you have over the lighting in your workspace? (Check all that apply): Other:

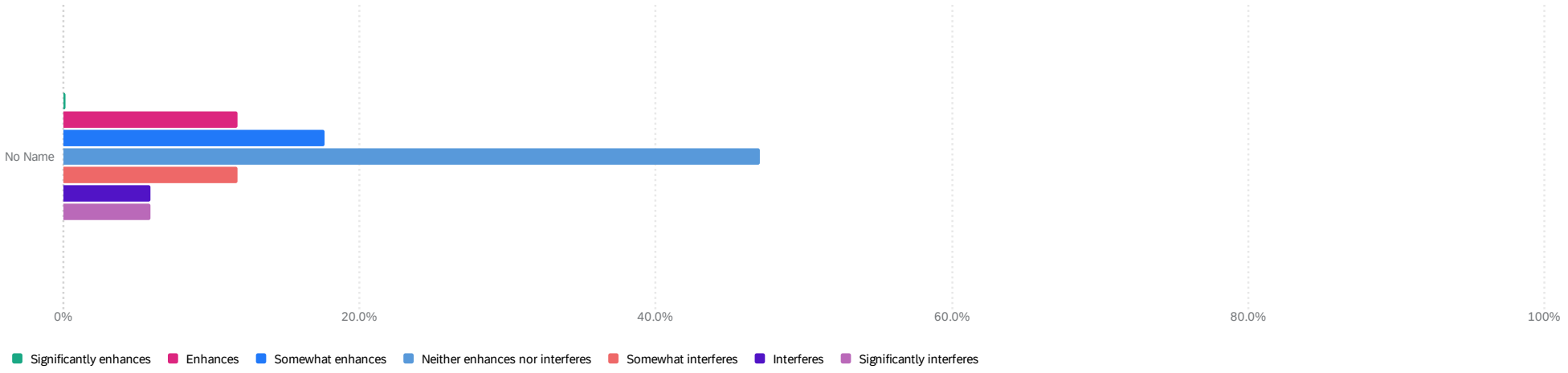
none

No more results to show

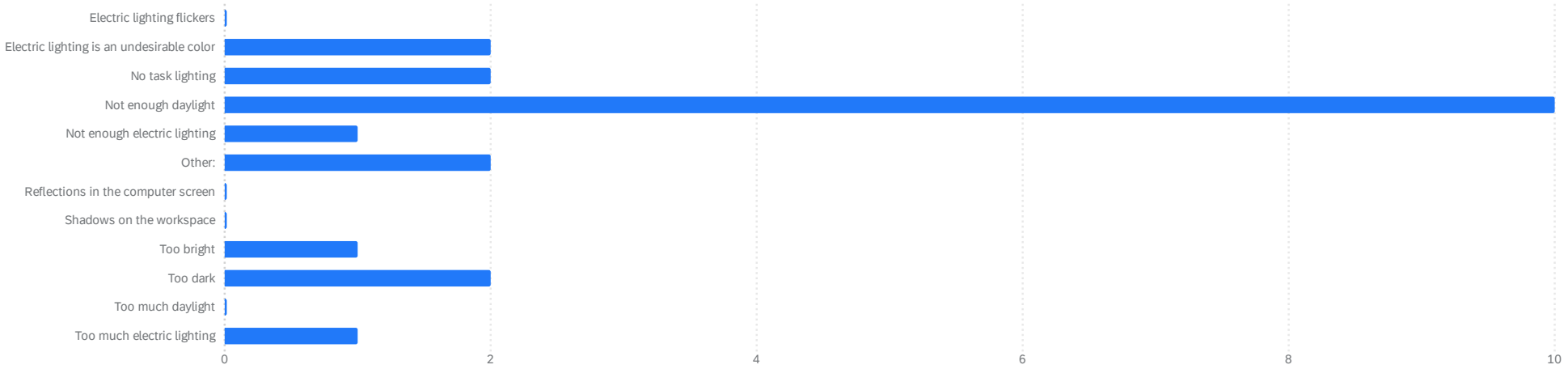
How satisfied are you with... 17



Overall, does the lighting quality enhance or interfere with your ability to get your job done? 17



You have said that you are dissatisfied with the lighting in your workspace. Which of the following contribute to your dissatisfaction (check all that apply) 13



You have said that you are dissatisfied with the lighting in your workspace. Which of the following contribute to your dissatisfaction (check all that apply): Other:

It goes off, often when working at the computer.

No more results to show

Please describe any other issues related to lighting that are important to you.

Just the daylight

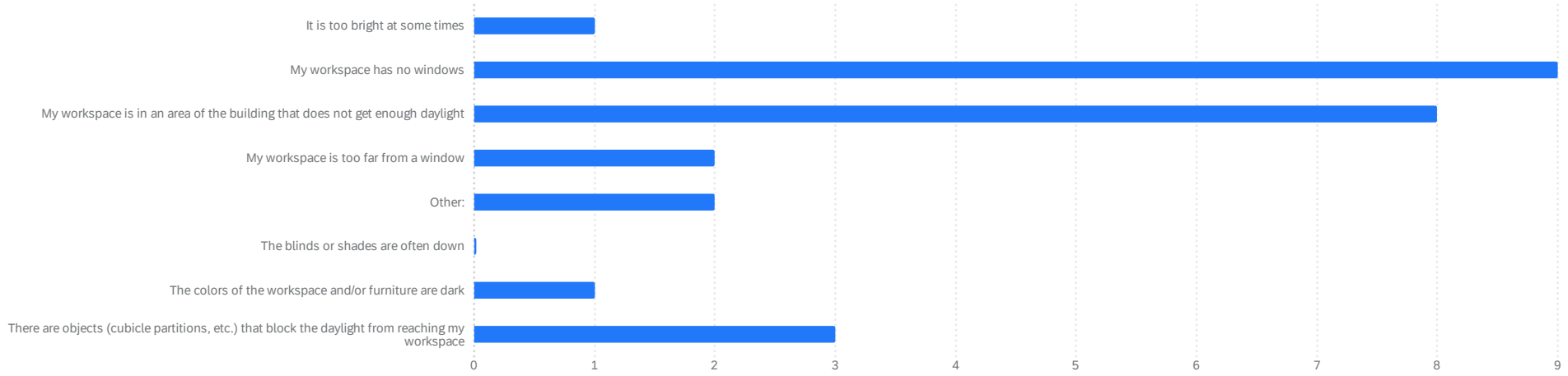
Lighting is on a sensor and will often go off even when I am still in the room working on my computer.

none

none at this time

No more results to show

You have said that you are dissatisfied with the amount of daylight in your workspace. Which of the following contribute to your dissatisfaction? (check all that apply) 16

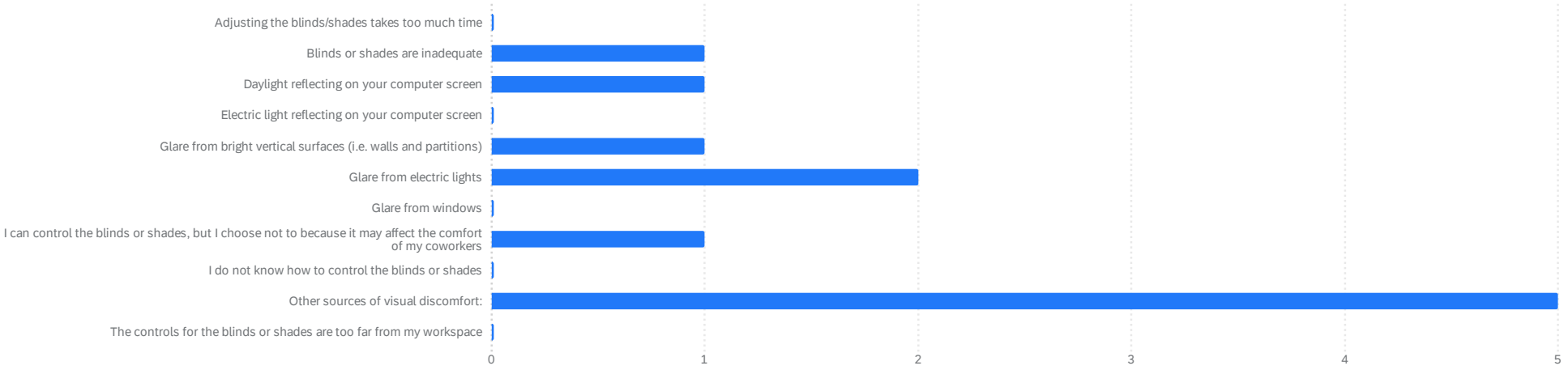


You have said that you are dissatisfied with the amount of daylight in your workspace. Which of the following contribute to your dissatisfaction? (check all that apply): Other:

none

No more results to show

You have said that you are dissatisfied with visual comfort in your workspace. Below is a list of factors that may contribute to your dissatisfaction. (check all that apply) 11



You have said that you are dissatisfied with visual comfort in your workspace. Below is a list of factors that may contribute to your dissatisfaction. (check all that apply): Other sources of visual discomfort:

There is not adequate lighting which causes strain on my eyes.

no daylight

N/A

the area is dark.

n/a

No more results to show

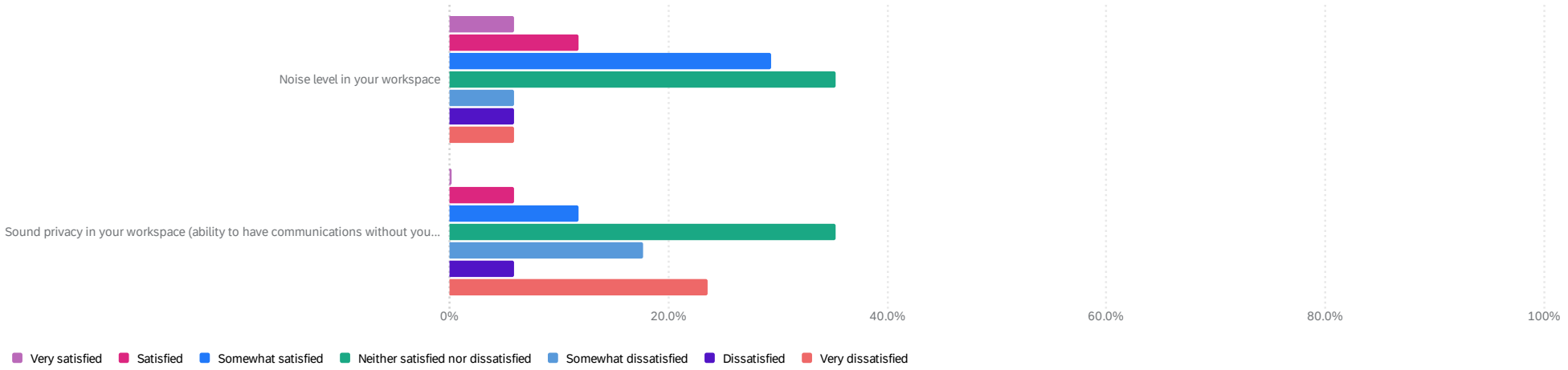
Please describe any other issues related to glare that are important to you.

none

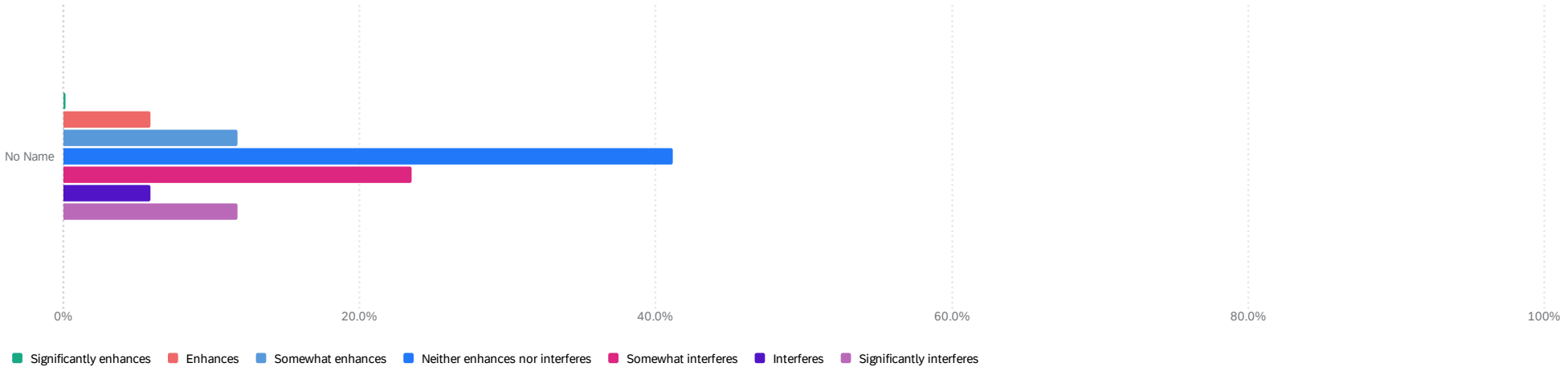
none

No more results to show

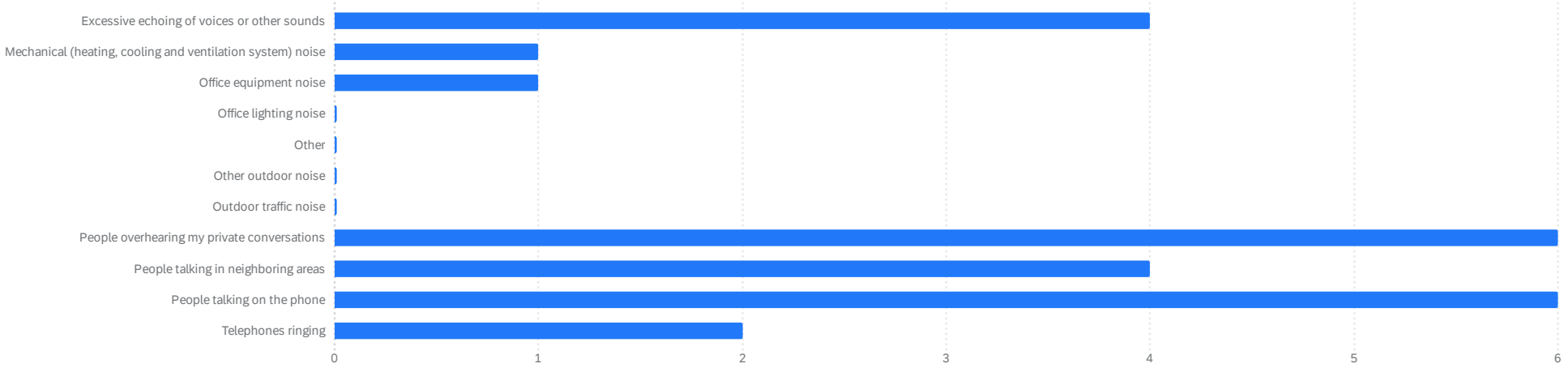
How satisfied are you with the... 17



Overall, does the acoustic quality in your workspace enhance or interfere with your ability to get your job done? 17



You have said you are dissatisfied with the acoustics your workspace. Which of the following contributes to this problem? (Check all that apply) 8



You have said you are dissatisfied with the acoustics your workspace. Which of the following contributes to this problem? (Check all that apply): Other

No data found - your filters may be too exclusive!

Please describe any other issues related to acoustics hat are important to you.

treatment rooms are not sound proof

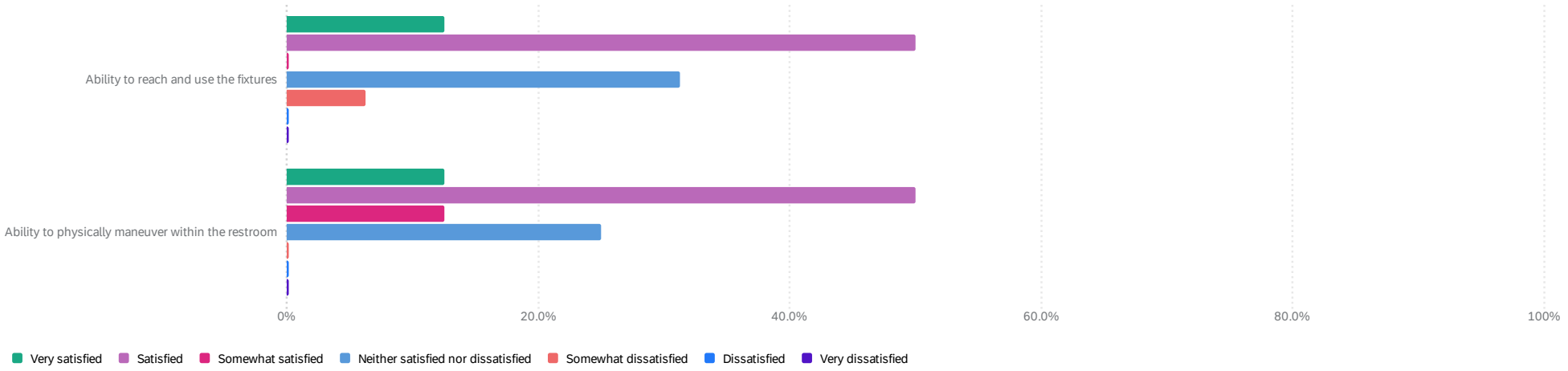
I can hear people in the next office talking

The therapy rooms 19 and 20 are a NIGHTMARE accoustically, for a person with a hearing impairment and hearing aids like me. Absolutely terrible. The fan is loud, especially in 20. The sound is so echoey that it seems like you're at the bottom of a well. Add the masks we need to wear and I hear about half of what a client is telling me, which is not good for a therapist.

All of the treatment rooms where we see clients are very echo-y and make it difficult to talk to people in person and over remote platforms (e.g. Zoom, Teams).

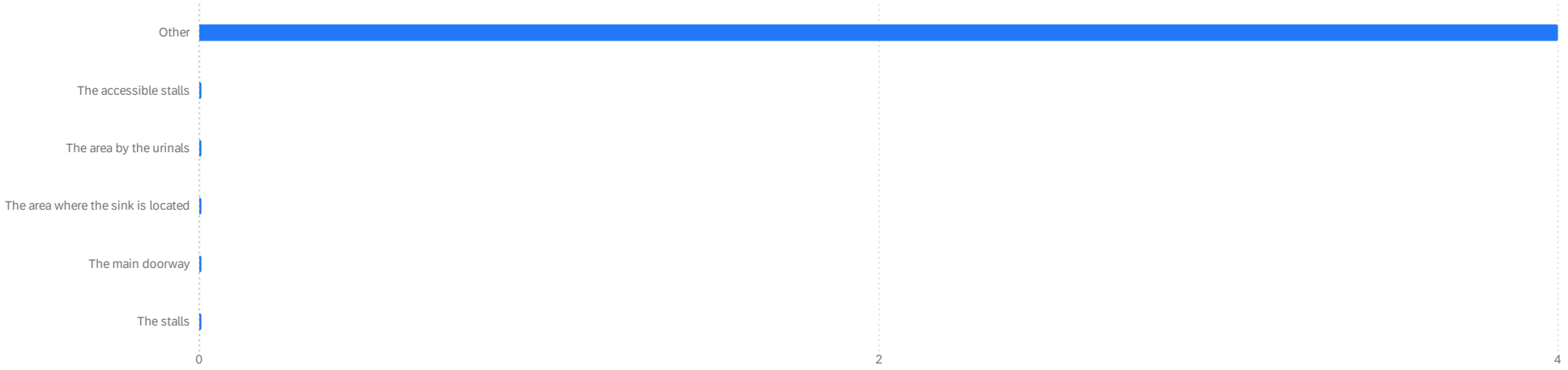
No more results to show

How satisfied are you with your... 16



You indicated you were dissatisfied with your ability to reach and use the fixtures in the restrooms in your building. Which issues in particular contribute to your dissatisfaction? (Check all that apply.) 1

You indicated you were dissatisfied with your ability to physically maneuver within the restrooms in your building. In what areas do you find it most difficult to maneuver? 4



You indicated you were dissatisfied with your ability to physically maneuver within the restrooms in your building. In what areas do you find it most difficult to maneuver?: Other

heavy door

none

none

No more results to show

Do you have any other comments or issues within the washroom you would like to mention?

didn't say i was dissatisfied

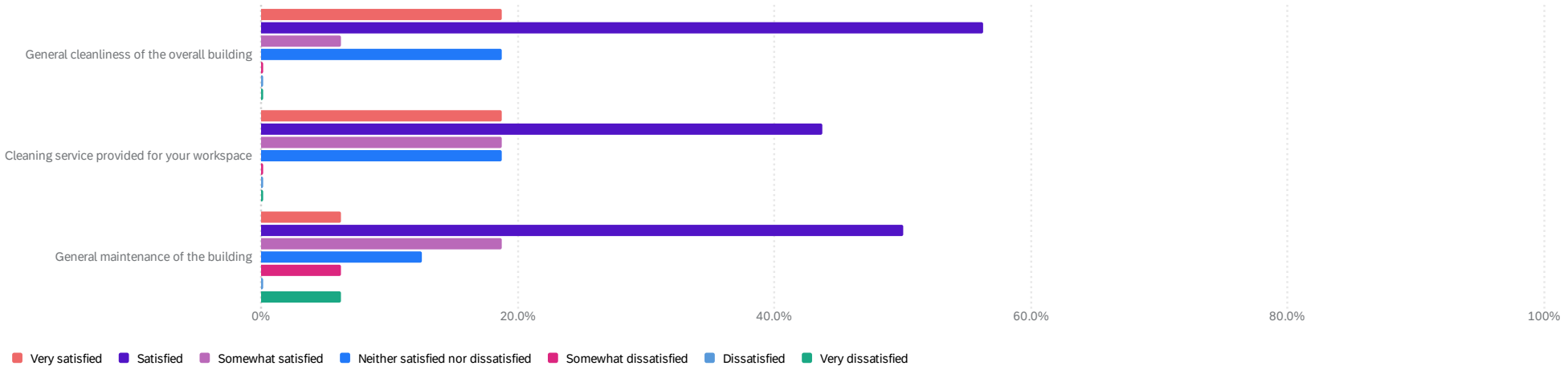
sorry n/a

the towels are not close to the sink and you drop water on the floor after you wash your hands

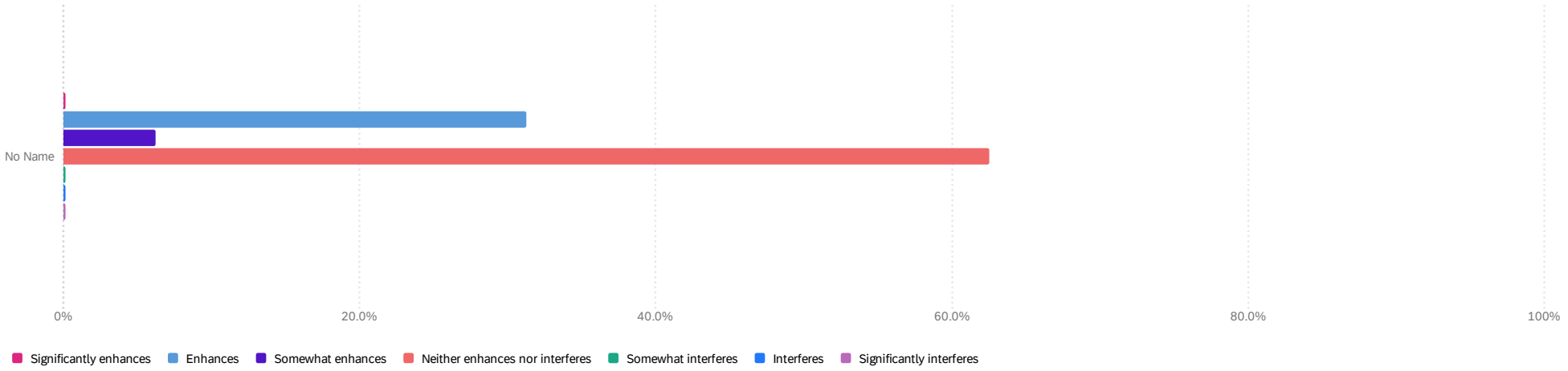
The automatic flushing on the toilet does not allow for sufficient time for people to complete their tasks (e.g. ensuring toilet paper or seat covering are fully in the bowl below flushing), necessitating the person to have to flush again and wasting water.

none

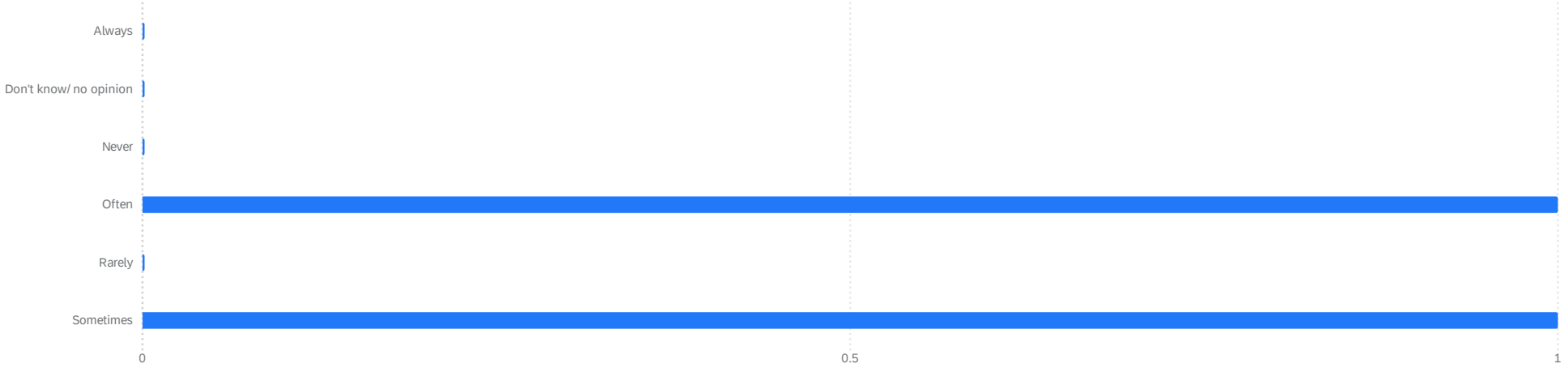
How satisfied are you with... 16



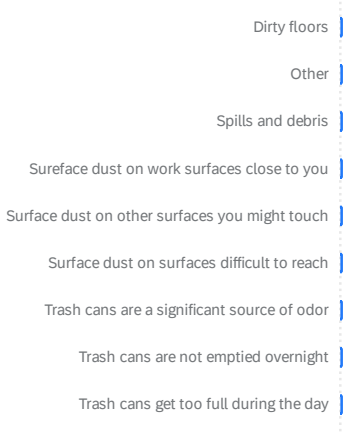
Does the cleanliness and maintenance of this building enhance or interfere with your ability to get your job done? 16



You have told us that you are dissatisfied with the cleaning service provided for your workspace. How often do you have significant problems? 2



Which of the following contribute to this dissatisfaction? (Check all that apply)



Which of the following contribute to this dissatisfaction? (Check all that apply): Other

No data found - your filters may be too exclusive!

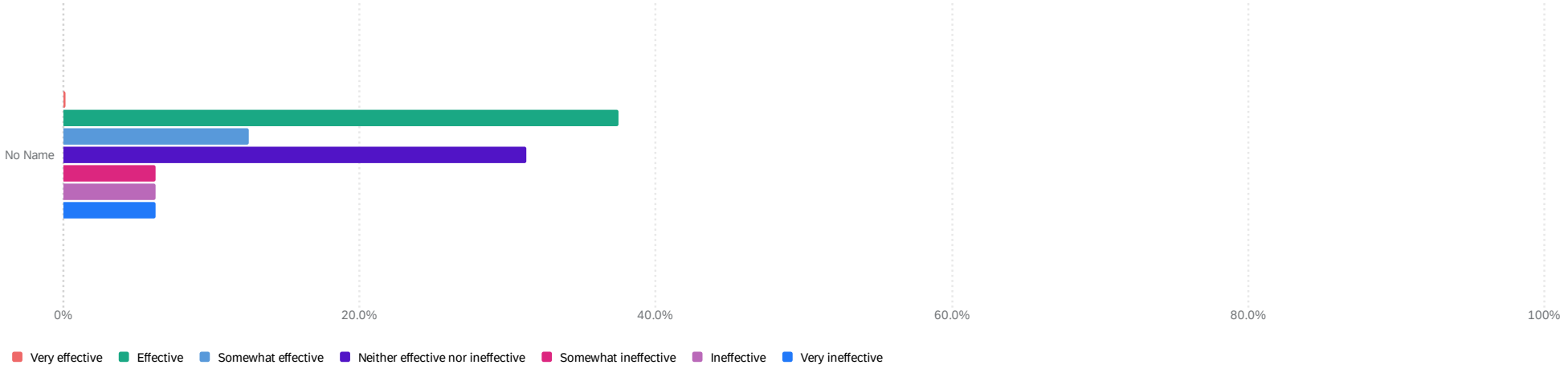
Please describe any other issues related to cleaning and maintenance that are important to you.

Even though we moved into the building in June 2022, we have already had significant damage (e.g. ceiling falling down after excessive rainfall caused water damage near the copy machines, door frame that leads from client to staff areas that fell off) and general wear and tear that I would not expect to see after only a year (e.g. painting chipping from doors, finishing coming off of door handles).

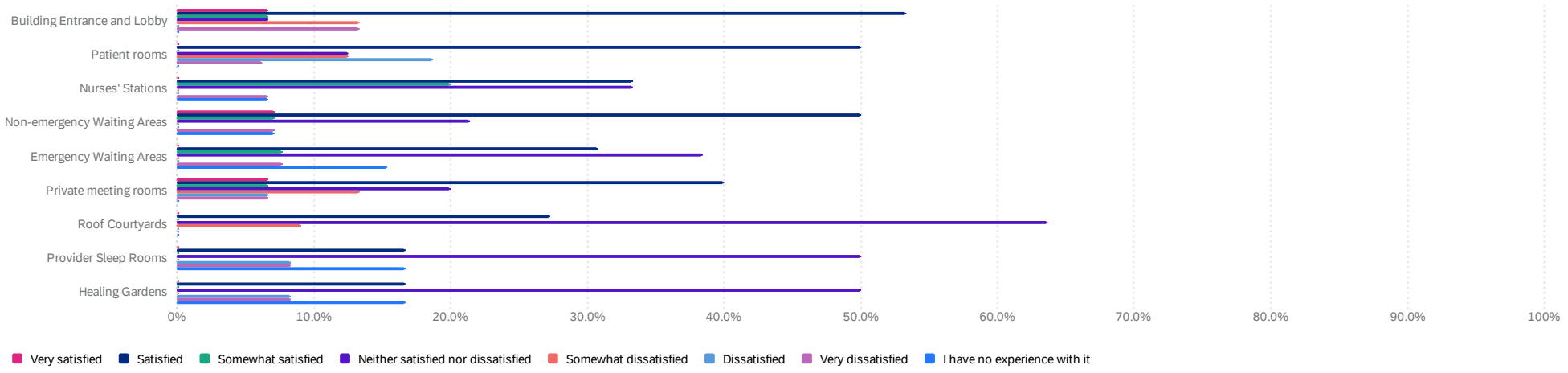
cleaning is fine, but the front of the building is barren with no trees

No more results to show

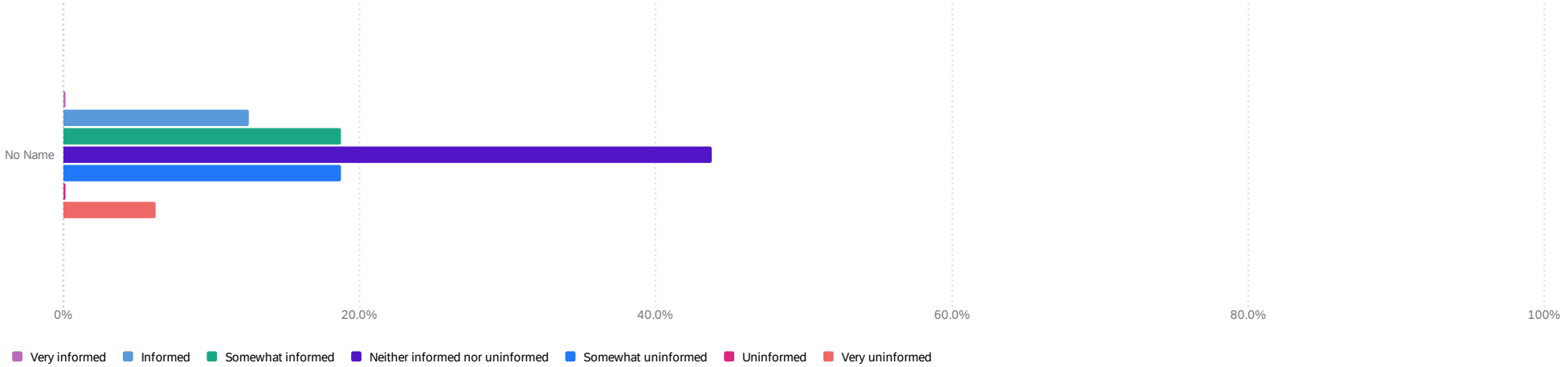
How effective is the building at providing quality healthcare? 16



For each of the clinical features listed below, please indicate how satisfied you are with the effectiveness of that feature: 16



How well informed do you feel about using the above mentioned features in this building? 16



Please describe any other issues related to the design and operation of the above mentioned features that are important to you.

Kitchen is too huge, small work spaces and treatment rooms, no artwork, building feels sterile.

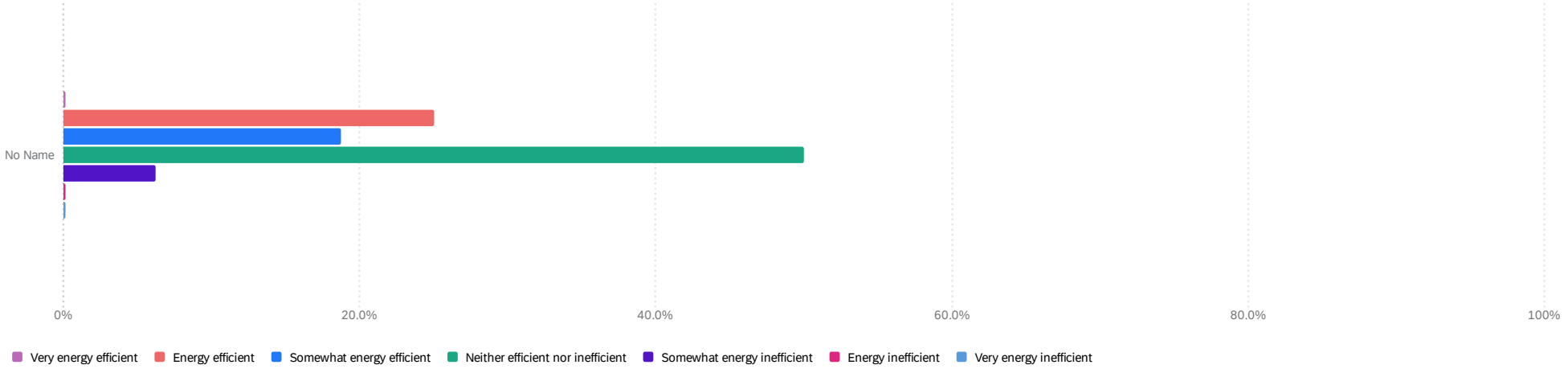
The lobby doesn't have any pictures or warm decoration the same with treatment rooms

The keys are very hard to use to enter the building. The doors inside takes too long to get thru them.

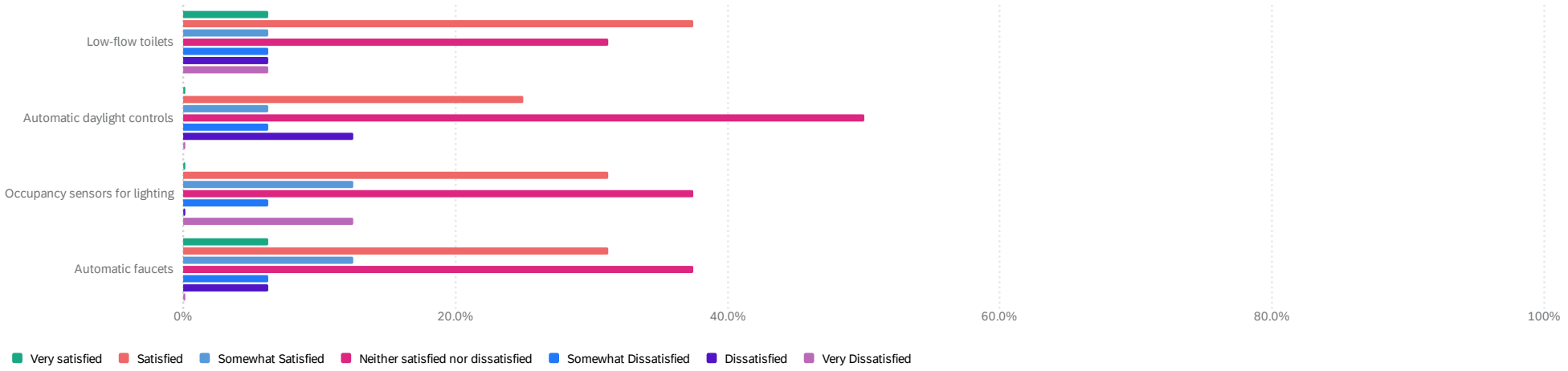
The patient treatment rooms were not set up to consider safety and to allow for staff to easily exit the room in case of emergency. In many of the rooms, the ways the desks and computers have to be positioned to be able to access the electrical outlets put barriers for staff to exit easily.

unable to adjust temperature of nurse room where medications are stored

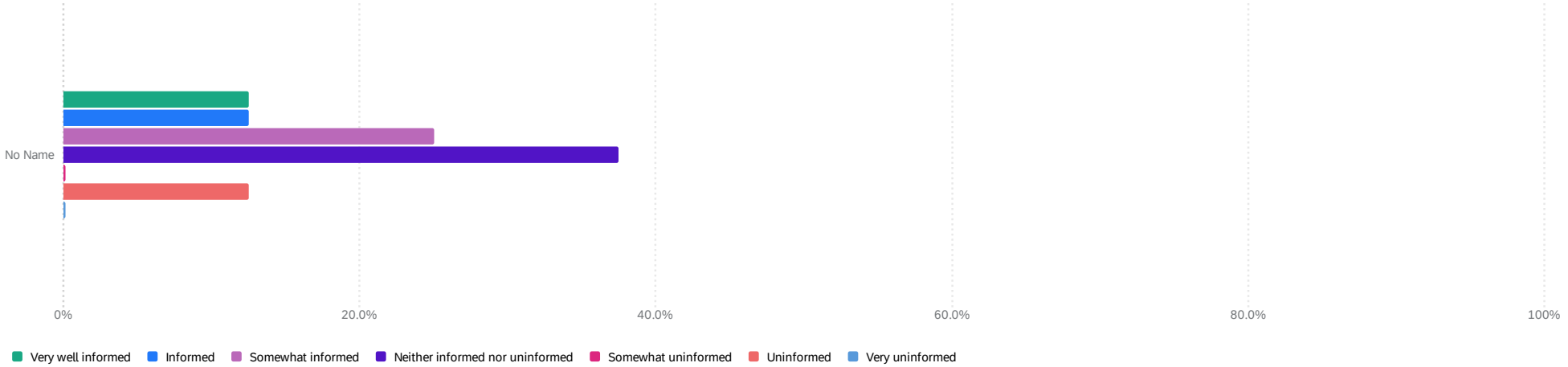
Considering energy use, how efficiently is this building performing in your opinion? 16



For each of the building features listed below, please indicate how satisfied you are with the effectiveness of that feature 16



How well informed do you feel about using the above mentioned features in this building? 16



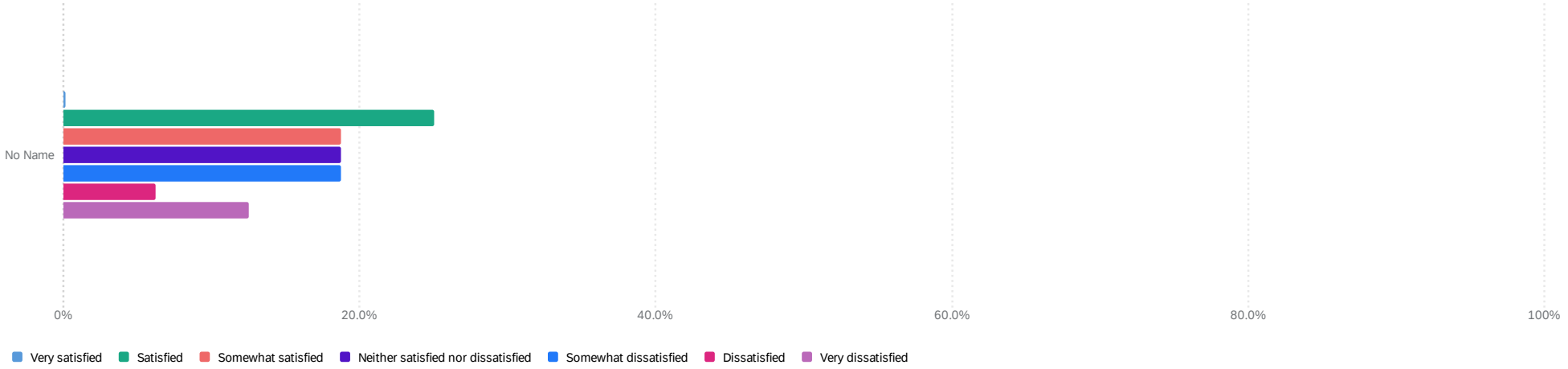
Please describe any other issues related to the design and operation of the above mentioned features that are important to you.

Please see previous comments about lightening and toilets.

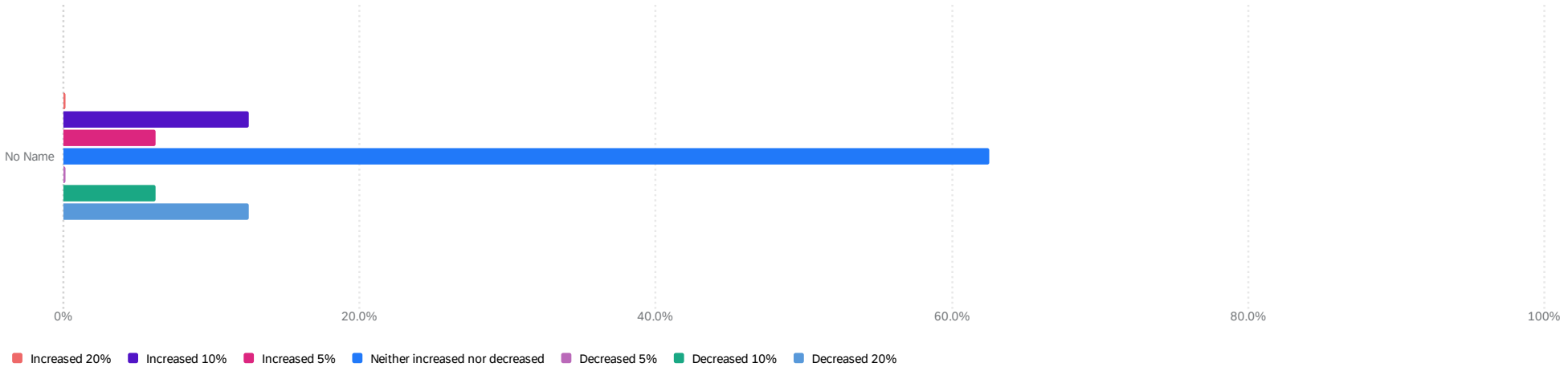
none

No more results to show

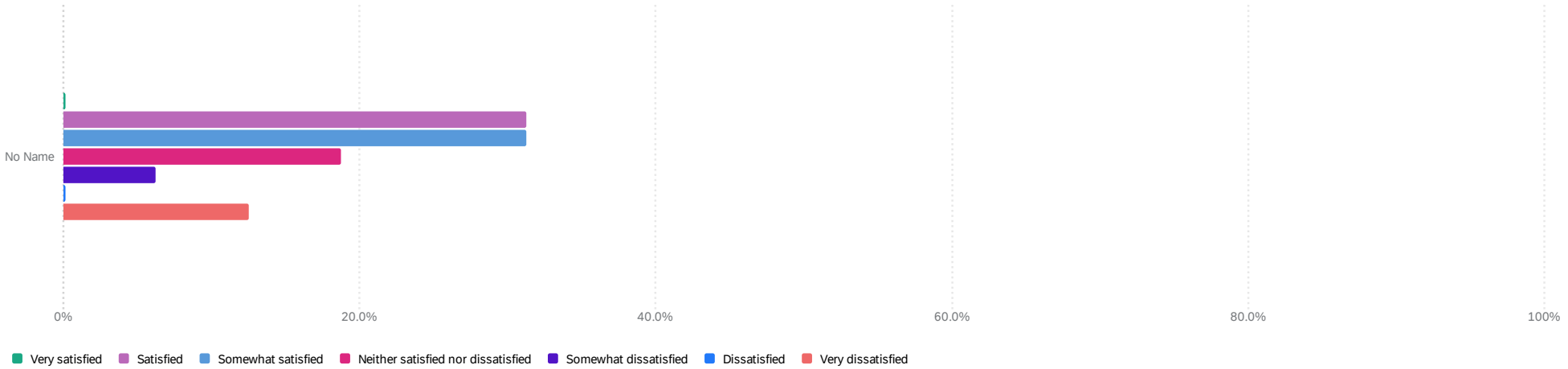
All things considered, how satisfied are you with your personal workspace? 16



Please estimate how your productivity is increased or decreased by the environmental conditions in the building (e.g., thermal, lighting, acoustics, cleanliness) 16



How satisfied are you with the building overall? 16



Any additional comments or recommendations about your personal workspace or building overall?

- Need more storage and space. Too many people in one room.
- Some of the doors take too long to open.
- I really like the building for the most part. The comments I made elsewhere cover my concerns.
- none
- building nice and new, pretty architecture, but feels sterile inside and too dark in my area. No personal touches or art

No more results to show

Appendix E – References

T. Akimoto, S. Tanabe, T. Yanai, M. Sasaki, Thermal comfort and productivity – Evaluation of workplace environment in a task conditioned office, Build. Environ. 45 (2010) 45–50, https://doi.org/10.1016/j.buildenv.2009.06.022.

ANSI/ASHRAE Standard 55-2013, Thermal Environmental Conditions for Human Occupancy, American Society of Heating, Refrigerating and Air-Conditioning Engineering, Atlanta, GA.

University of California, Berkeley. 2021. CBE Thermal Comfort Tool [WWW Document]. URL https://comfort.cbe.berkeley.edu/(accessed July 21, 2021)

Wienold J, Christoffersen J, 2006, Evaluation methods and development of a new glare prediction model for daylight environments with the use of CCD cameras, Energy and Buildings 38(2006):743-757.