Los Angeles Bureau of Street Lighting: Curbside Charging Analysis

Introduction

By late 2022, the Los Angeles Bureau of Street Lighting (LABSL) had installed more than 500 public-access electric vehicle (EV) charging stations across the city for general use and for multiple user types (residents, workplace, and retail). The data received for this analysis is from LABSL's four electric vehicle service providers (EVSPs): ChargePoint, FLO, GreenLots/Shell ReCharge, and Tellus. LABSL has been installing curbside charging stations in each of the City's 15 Council Districts since 2016. The installation sites have been throughout each Council District and equity has been one of the site selection criteria. The earliest installations were ChargePoint, GreenLots (now Shell ReCharge), and Tellus. More recent installations have been FLO units. Most of the FLOs are overhead mounted units. No curbside chargers were installed in FY 2020-21 due to Covid-19. Installations resumed in FY 2021-22. LABSL is supporting the Vehicle Charging Innovations for Multi-Unit Dwellings (VCI-MUD) project, and has provided a large, anonymized dataset of charging session summary data covering the period from January 1, 2020, through September 2022. LABSL provided raw tabular data for all charging stations and charging sessions that consists of charging session data summaries from all four EVSPs. A one-line summary was provided for each charging session with parameters including: EVSP vendor, station ID, station address/location, station type/level, station maximum power level (kW), anonymized user ID, charging session connection start/end times, charging session power delivery start/end times, and other parameters.

An aggregated table of the station information was also provided and included an attribute to identify if LABSL felt each station could support multi-unit dwelling (MUD), e.g., apartments and condominiums, users. The EVSPs' data do not indicate if users live near the charging stations they used. LABSL and the VCI-MUD team agreed that a simple, and likely relevant, criteria for "MUD-supporting" was if stations were located within a 0.25-mile radius from at least one MUD building. LABSL tagged stations that met these criteria were tagged as "MUD". Even so, there was no guarantee of the number of MUD resident sessions that occurred at these "MUD" stations.

The analysis presented here attempted to pull insights regarding usage of all of the charging stations, with particular interest in the MUD-supporting stations and how multiple user groups may use charging stations (e.g., MUD residents, workplace, and retail).

Data Cleaning

The first step in the analysis process was to aggregate and clean the charging session data from each of the networks. This involved identifying and remapping the relevant data fields from each charging network so all of the session data could be aggregated into a single charging session table. The aggregated session data was then checked for missing or erroneous values. A summary of the issues discovered is provided below .

Error Description	Rows with Error
Sessions with 0 energy transfer	6361
Duplicated rows in session data	47
Sessions with negative energy transfer	44
Sessions with more than 200 kWh of energy transfer	133
Sessions with durations > 100 hours	108

Figure 1. Observed errors in the session data

In addition to the errors listed, there were 46 station IDs that appeared in the session data but did not appear in the station table. These station IDs did not have a MUD designation so the charging sessions from these stations was excluded from the analysis. There were also 20 station IDs that appeared in the station data without any sessions.

Dataset Profile

The LABSL-provided dataset contained 213,269 sessions from 533 stations distributed between the four (4) EVSPs. FLO and Greenlots accounted for 95% of the stations in the dataset. Figure 2 provides additional summary statistics for the dataset.

EVSP	Count of Stations	Total Count of Sessions	Average Sessions Per Station	Average Sessions per Day	Average Energy (kWh) Transferred per Session	Average Cost ($) per Session	Average Session Duration (Hours)	Average Cost per kWh ($/kWh)
Greenlots	190	68632	361.22	69.19	12.90	4.37	3.04	0.34
Chargepoint	19	20212	1,063.79	20.33	11.32	3.22	2.33	0.28
FLO	316	124126	392.80	124.88	14.00	3.94	2.99	0.28
Tellus	8	299	37.38	1.50	14.16	6.72	2.74	0.23

Figure 2. Summary statistics for charging session data

Charging sessions at FLO and Greenlots stations accounted for 88% of the charging stations in the dataset. Interestingly, ChargePoint stations had the highest average sessions per stations with usage more than three (3) times higher than FLO or Greenlots charging stations. The FLO stations had the highest average number of sessions per day as a group, due to the large number of FLO stations. ***All EVSPs in the dataset had similar averages for session energy transferred, duration, and cost per kWh***.

Charging Station Usage Analysis

Figure 3 provides an overview of charging behavior throughout the dataset. The first interesting trend to note is the small dip in daily session counts in March 2020. This dip probably reflects the initial COVID-19 travel restrictions. Charging activity began to recover in May 2020 and experienced a steep and expected growth between June 2020 and December 2020. This timeframe corresponds with when COVID-19 restrictions were being relaxed and people began traveling more. The legend indicates MUD charging stations as “True” (in dark green) and non-MUD charging stations as “False” (in orange).

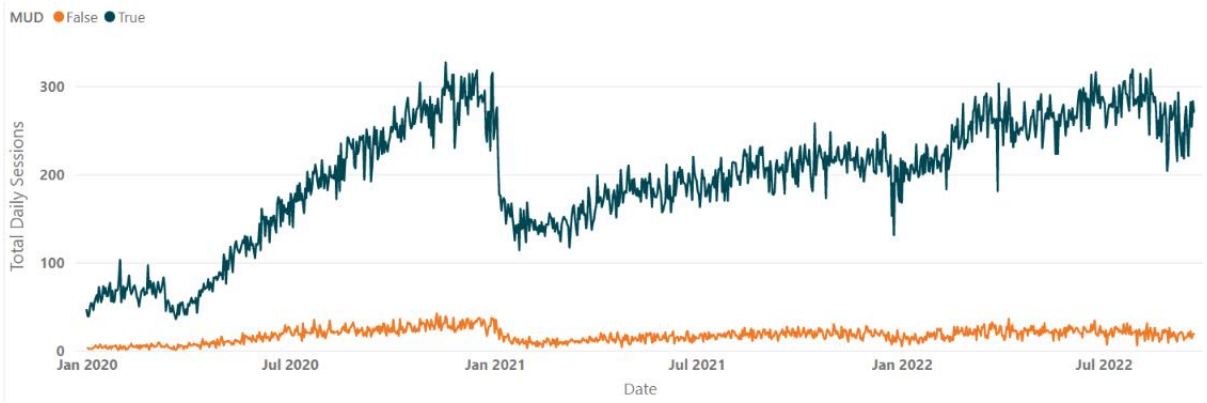

Figure 3. Total daily sessions by date and site type.

The largest drop is daily charging sessions occurred between January 3-6, 2021. This drop was seen in the data for all EVSPs. The daily charging station usage activity increased gradually after this drop but did not recover to the levels seen in December 2020 until much later in July 2022.

Figure 4 shows that the number of available curbside charging stations also increased during the time frame covered by the dataset. Most of the FLO and Greenlots charging stations in this dataset came online between January 2020 and July of 2020. There was almost no change in the number of ChargePoint of Tellus charging stations between 2020 and 2022 FLO was the only EVSP to add a significant number of new curbside stations after 2021 (Figure 6).

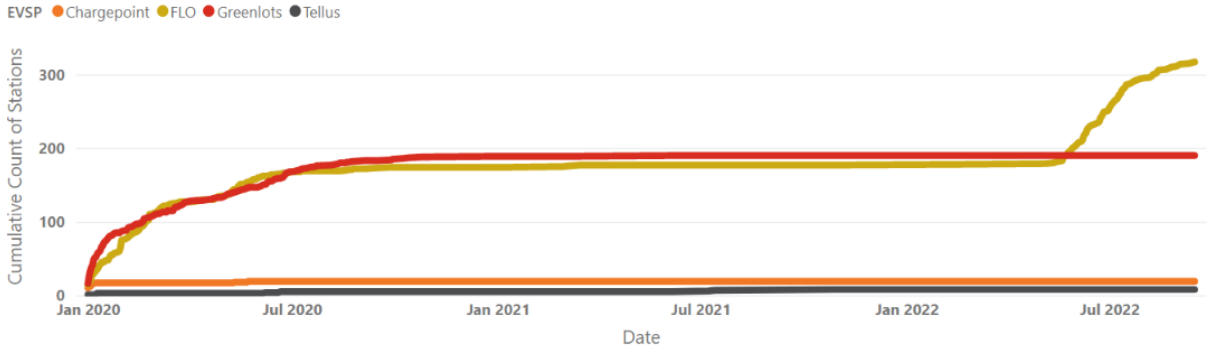

Figure 4. Cumulative count of available charging stations by date and EVSP

Figure 5 shows a similar metric to Figure 3 but the values are normalized by the number of stations. The normalization reduces the impact of the increasing charging station count on the data trends to show more of an average station's usage. This plot shows that MUD ("True", dark green) and non-MUD ("False",

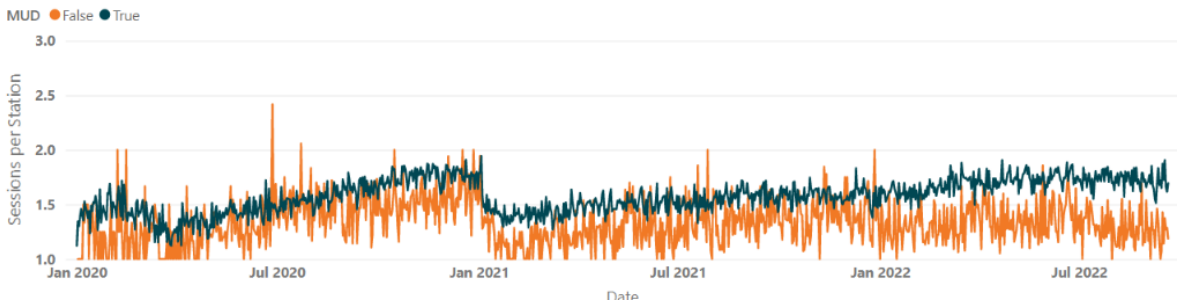

Figure 5. Count of daily sessions normalized by number of stations

orange) stations have similar levels of charging activity and follow similar trends. The non-MUD stations showed more variability on a day-to-day basis, but this is likely due to the smaller sample size of stations. Non-MUD stations only made up 12% of all the stations in this dataset.

The two EVSPs with the most stations, FLO and Greenlots, also accumulated charging sessions at the highest rates. The effect of the dip in daily session counts for FLO stations can be seen in as well. The slope of the cumulative session counts became shallower in January 2021 when the second round of travel restrictions went into effect.

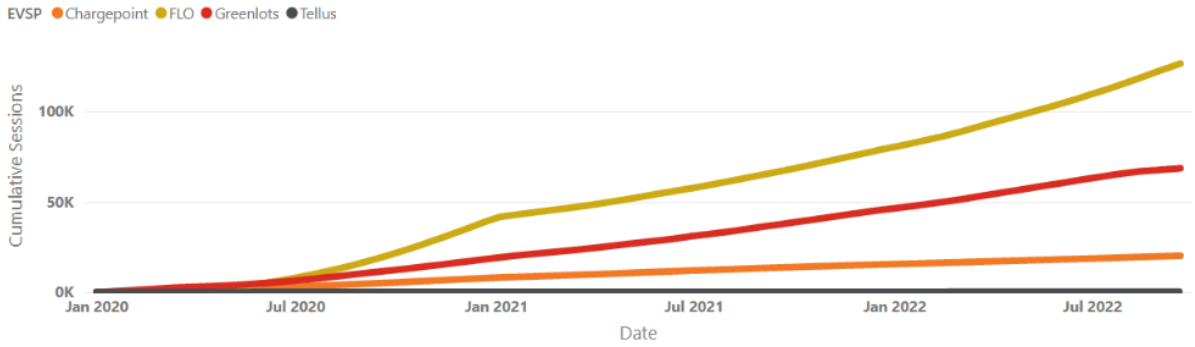

Figure 6. Cumulative count of charging sessions by EVSP

There was not much variation in charging behavior based on days of the week for any of the EVSPs (Figure 7). For non-MUD sites there was a slight drop in average session counts for Saturday and Sunday. This could indicate that at least some of these charging stations are used for workplace charging. For MUD sites, Fridays seemed to have increased demand for charging at ChargePoint stations, but other EVSPs had consistent demand throughout the week.

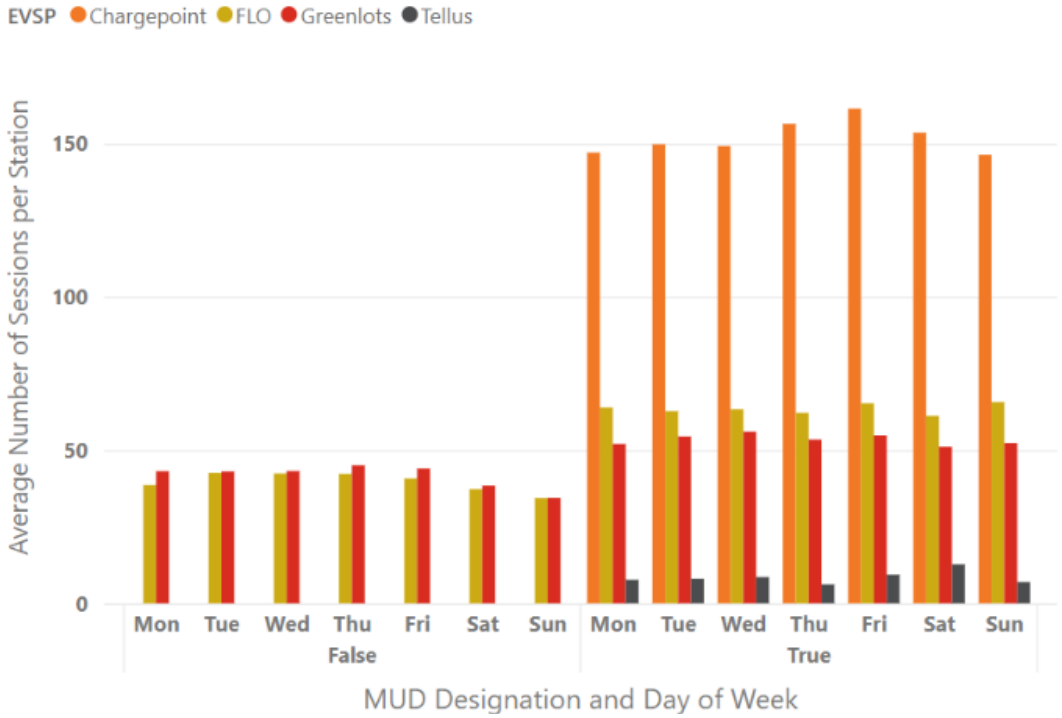

Figure 7. Average number of charging sessions per station by day of week and site type.

Most of the sessions in this dataset were between 1-4 hours and occurred during the daytime. This implies that the majority of charging sessions were not typical nighttime MUD resident usage. The blue line in Figure 8 shows that most of the charging sessions that lasted between 1-4 hours were initiated between 8 AM and 6 PM, implying workplace or retail customer usage. In contrast, most of the sessions that lasted more than 8-hours (the red and grey lines), were initiated between 6 PM and midnight (typical nighttime MUD usage). The sessions that fell in the 8-12 hour and >12-hour charging duration bins only made up 6% of the charging session dataset. So, although most of the charging stations in this dataset were identified as MUD-supporting, the charging behavior seen at these stations suggests that they are not being heavily utilized by MUD residents for overnight charging.

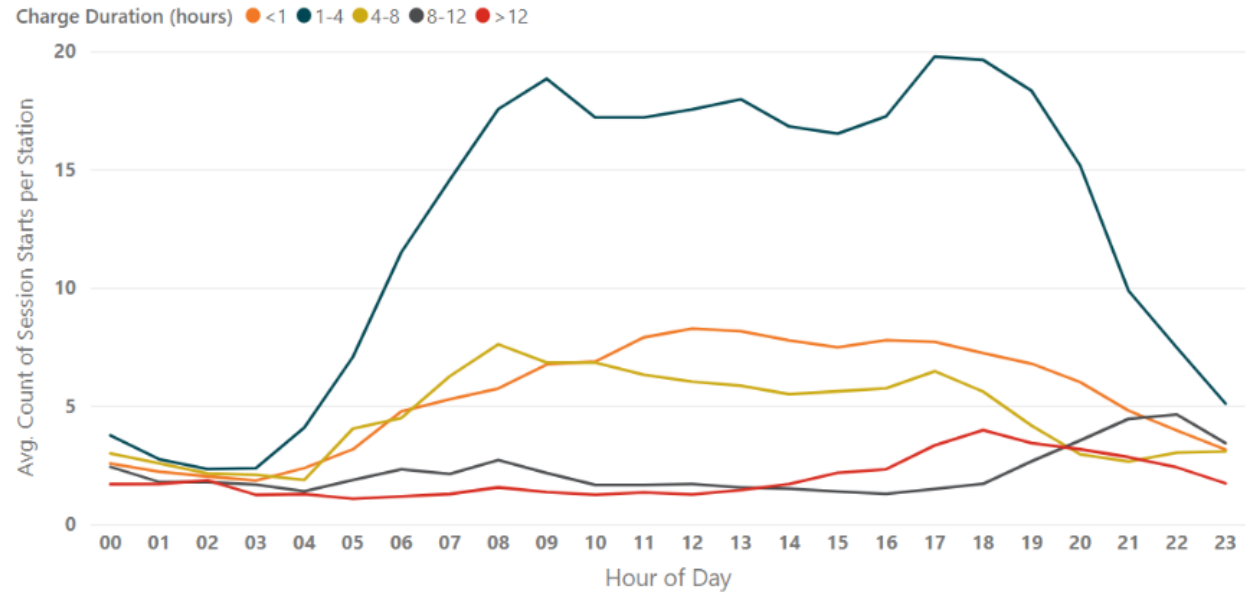

Figure 8. Distribution of average charge session start times by hour of day and session duration

Figure 9 and Figure 10 provide additional context to the trends shown in Figure 8. The patterns seen in Figure 9 and Figure 10 are almost perfect opposites of each other. For charging sessions lasting less than

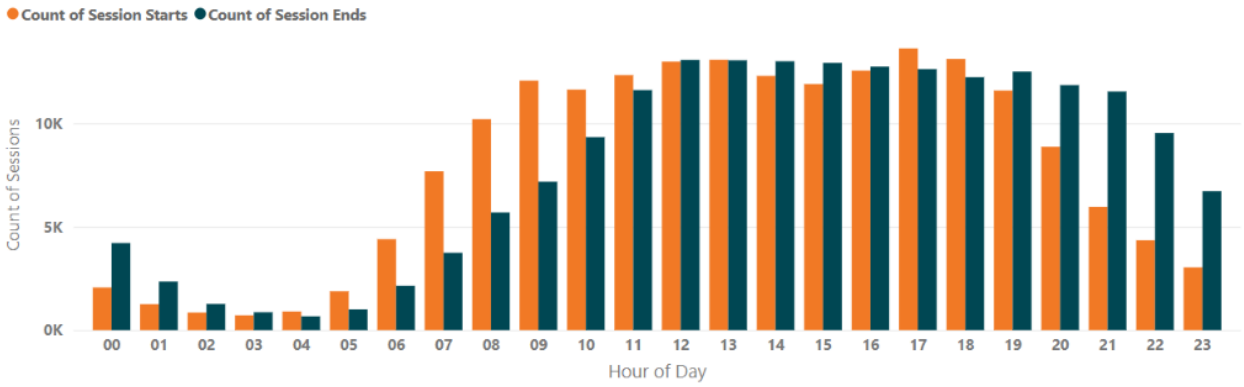

Figure 9. Distribution of session starts and ends by hour of day for charging sessions lasting less than 8 hours

8-hours, the ratio of session starts to session ends was highest between the hours of 5 AM and 11 AM. For sessions lasting more than 8-hours, this same ratio was highest between 6 PM and 12 PM (midnight).

This contrasting behavior implies that a charging station that is used for retail or workplace charging in the daytime can also be used for MUD charging at night.

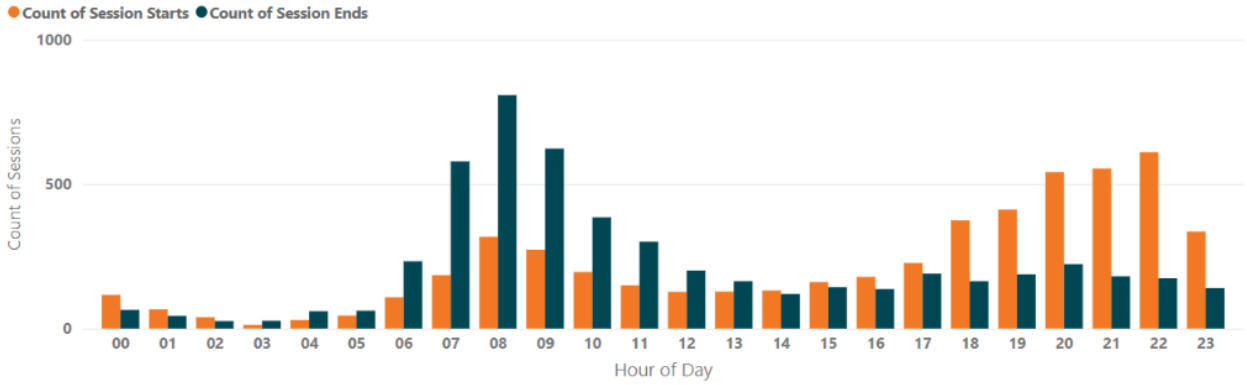

Figure 10. Distribution of session starts and ends by hour of day for charging sessions lasting more than 8 hours

The shorter charging session duration categories saw a higher percentage of unique users (Figure 11). This is to be expected because charging sessions initiated by visitors, retail shoppers, or people charging mid-trip usually have shorter sessions. The users in the 8-12 hours and >12 hours duration categories are more likely to be MUD residents, but they only made up 15% of all unique users. The number of repeat users at a given station is another indicator of MUD charging. Only 15% of the users in this dataset used a station more than once.

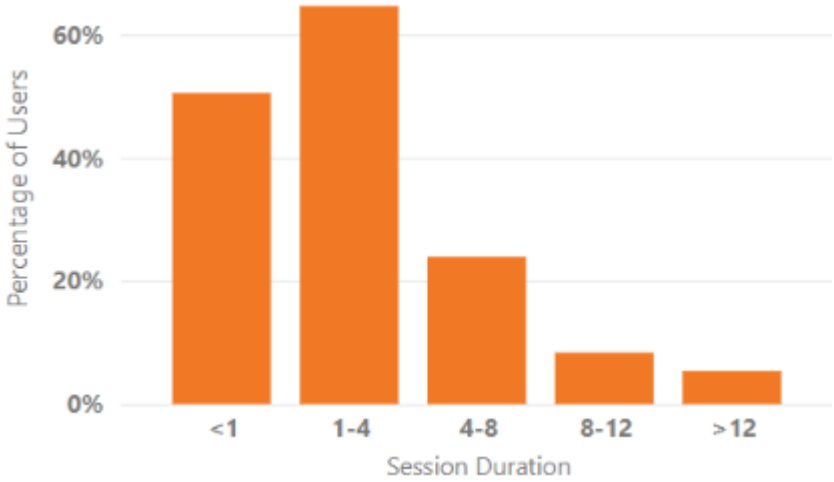

Figure 11. Percentage of unique users that had at least one charging session in a session duration category.

The utilization metrics shown in Figure 12 shows the percentage of days, from first session date to last date in the dataset, that a station was occupied at any given hour of day. For example, if a station was active for a total of seven (7) days and there were only two sessions that spanned across 8 AM then this station would have an occupancy of 28.5% at 8 AM.

The overall utilization of these curbside charging stations was low, ranging between 3% and 14%. The charging stations at MUD sites had higher average occupancy values for all hours of the day. The occupancy at non-MUD sites peaked around 10 AM, but the charging station occupancy at MUD sites stayed at, or near, its peak value from 11 AM to 9 PM. This could imply that the MUD stations are being used by both MUD and other user groups.

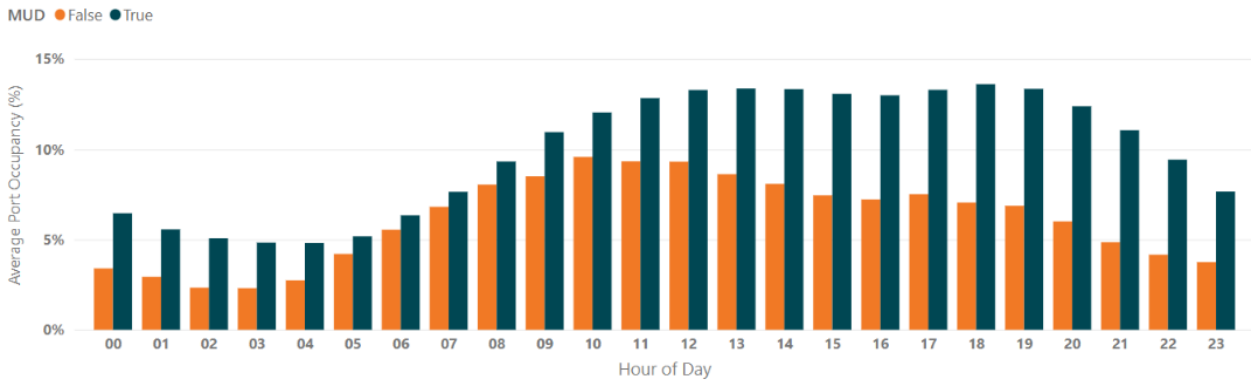

Figure 12. Average station occupancy by hour of day for MUD and non-MUD stations.

Summary

This analysis revealed that there are a significant number of MUD-supporting curbside charging stations, but it is likely that only a small percentage of the sessions at these charging stations were created by MUD residents. Charging session duration and session start/end times were used to distinguish between MUD and non-MUD charging behaviors in this analysis. Sessions that started late in the day and lasted more than 8-hours were treated as indicators of MUD charging, but most of the charging sessions in the dataset spanned between 1- and 4-hours and were initiated during daytime hours. These sessions were assumed to be non-MUD charging. There were also very few overnight sessions compared to daytime sessions. It is possible that MUD residents without charging near the MUD they live at could be using the LADWP charging stations to charge while at work, or other activities. However, the dataset is not detailed enough to confirm/refute this. It is possible that the COVID-19 restrictions and the prevalence of work from home arrangements led to deviations from expected MUD charging behavior. Additional data and analysis are required to determine the underlying reasons for low levels of MUD charging behavior seen in this dataset.