

PowerFlex: The Madrone



San Francisco, California

Property Profile

The Madrone is a large mixed-use residential complex in San Francisco's Mission Bay neighborhood that covers the entire city block. The complex is comprised of a nine-story mid-rise building base in a U-shape with two 16-story towers connected (Figure 1). There is limited commercial space on west side of building with four retail spaces. The 2-story parking garage is located in the middle of the U, starting on ground level. Other property features (pool, etc.) are on top of garage. The building began operation in 2012. There are 329 residential units and 329 parking spaces in the garage (one per unit). All parking is for residents, there is no guest parking. The Madrone is high-end Class A property and providing electric vehicle (EV) charging is a needed amenity/service for current and future residents. EV charging was originally included during design because of expected resident requirements. But The Madrone sees EV charging as a top tier amenity and requirement to retain residents/attract residents, to show its commitment to sustainability. In the long-term, approximately 90% of parking stalls are eligible for charging stations (adequate space, etc.). Parking is not deeded to residential units, so is assigned by the homeowners' association (HOA).

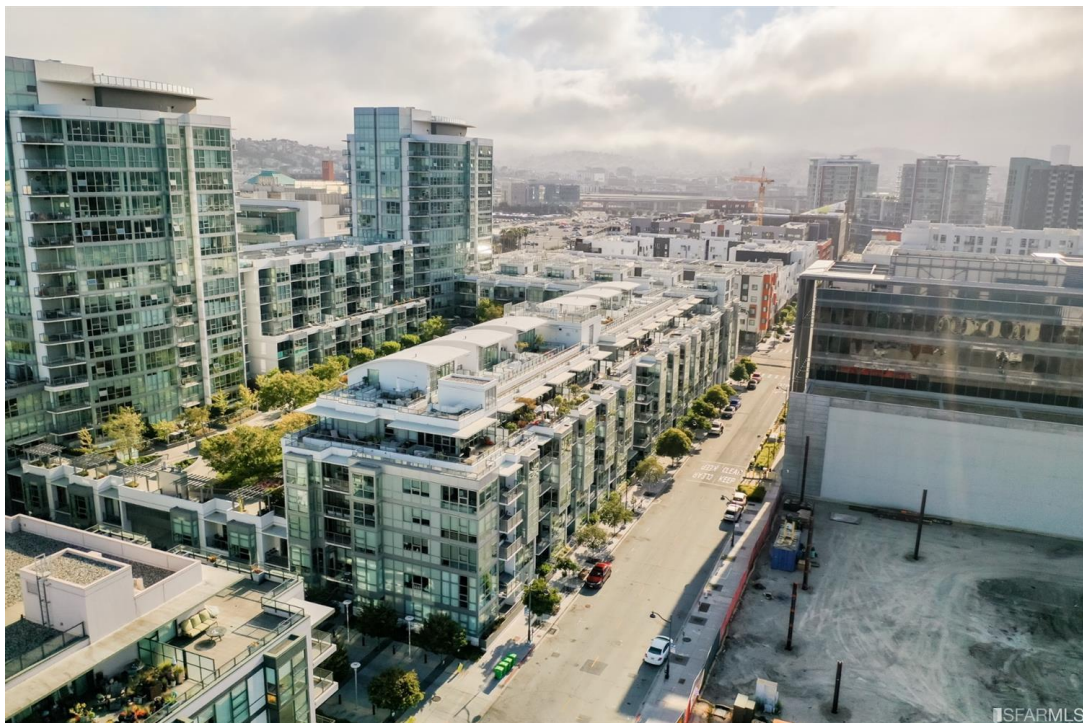


Figure 1: The Madrone (Source: San Francisco Association of Realtors MLS)

Charging Barriers

Initial costs have been a leading barrier to The Madrone's installing EV charging stations. The Madrone opened before EV readiness requirements were in place for new construction (e.g., specifying a percentage of charging stations). However, EV charging stations were planned for during the development (2009+) and one (1) charging station installed and electrical infrastructure to expand to 10 (~3% of the vehicle population). When the building opened in 2012, EV charging station demand was higher than expected at approximately 6%. (In June 2022, approximately 20-30% of vehicles at The Madrone are plug-in electric vehicle [PEV].) The Madrone's initial EV charging solution's pricing was too expensive (\$0.65 per kilowatt-hours [kWh]) to be a long-term solution, so a scalable and less expensive solution was needed.

Additionally, the parking garage did not have Wi-Fi or reliable cellular signal to fully-enable the charging station network. So, adding reliable network access had to be included regardless of the charging solution selected. As noted above, parking is not deeded to residential units, so is assigned by the HOA. The HOA is able to re-assign residents' parking spaces, but also works to install new charging stations in residents' current parking spaces to minimize disruptions.

Technology Solution Summary

PowerFlex (<https://www.powerflex.com/>) is a turnkey electric charging station hardware/network provider that provides the charging stations, a cloud-based software platform that provides data collection, access-control, data analytics, payment processing, and customer support. Each charging station is connected to PowerFlex's data service through a smart gateway via an internet connection (ethernet, Wi-Fi, cellular, etc.).

PowerFlex staff worked closely with the property management to set the pricing policies to meet their needs (e.g., cover costs, generate revenue). PowerFlex's cloud-based software platform portal is used to implement the access-control and pricing with flexible controls that allow for setting different profiles based on time of day, weekday/weekend. PowerFlex's system can be used for both shared-access charging stations (e.g., common parking areas) and for dedicated use (e.g., in residents' parking spaces). Access can be granted to different groups (e.g., residents and public) at different times, and with different pricing.

PowerFlex integrates their hardware and software into select non-networked EV charging stations from leading manufacturers to provide MUD properties/users flexibility to select the charging station that meets their requirements (cost, design, etc.). Each station is electrically wired directly to the electrical distribution panel so, if enough power is available, each can provide full power. A separate PowerFlex system controller is installed on each of the two garage floors to address low signal strength through concrete floors/walls. Controllers need internet access. The PowerFlex system uses The Madrone's network. Each charging station (within 150' of the PowerFlex system controller) communicates via Zigbee.

PowerFlex noted that it is one of the few service providers to directly support Tesla's proprietary high-powered wall connectors. The PowerFlex system includes a utility grade electric meter to collect usage

data on each charging station. The result is the leveraging of quality, low-cost, non-networked charging stations into fully featured “smart” charging stations.

Users interact with the charging stations via PowerFlex’s mobile app. So, the garage needs to have adequate cellular or open Wi-Fi signal. The app is used to view real-time charging station status, start a charging session, tell the system how much charge is needed by when, view the charging session status, receive messages from the system (e.g., charge complete or charging station available). The PowerFlex system directs power so that the vehicles with the earliest departure times or greatest energy needs receive priority in charging.

PowerFlex’s Adaptive Load Management software algorithms optimizes power consumption across a small to large network of charging stations to manage the load from all of the charging stations at the panel and/or transformer level to maintain a safe power output. Load balancing and load management are key features. The load management approach determines the best charging schedule based on need and timing. Figure 2 provides an example of how the Adaptive Load Management works. The benefits are

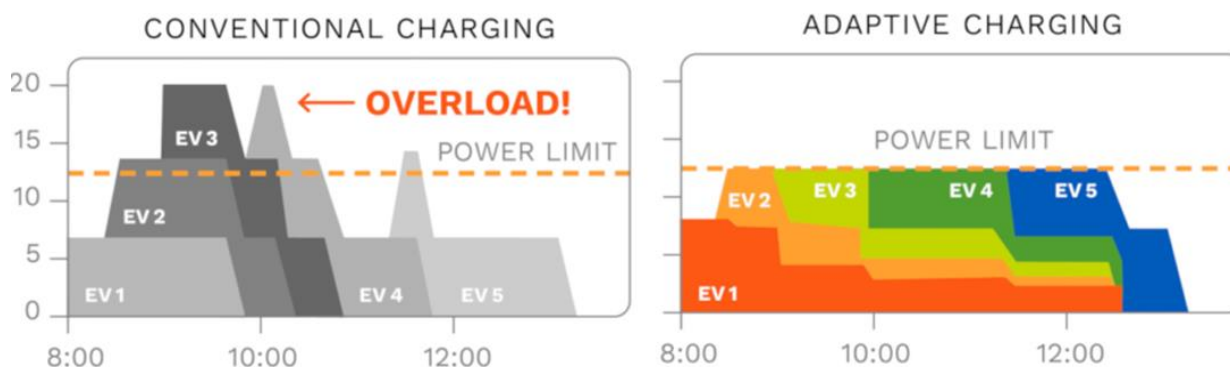


Figure 2. Visualization of PowerFlex ADR load management

especially true for installations with large numbers of charging stations. Reducing the maximum power threshold has three key benefits over an unmanaged system: 1) maintaining peak power at safe levels within the available electrical capacity, 2) reduces the peak power (important for reducing demand charges, and 3) enables operating “3-4 times the number of charging stations while avoiding expensive infrastructure upgrades”. The PowerFlex system can participate in utility programs and rate structures such as time-of-use rates, or more complicated real-time rates, and can respond to demand response/OpenADR commands.

The transformer installed during the original installation was sized to support between 200-250 charging stations, so The Madrone has lots of growth potential. The PowerFlex system allows for economical system expansions. Adding a new single station costs approximately \$3,000 (charging station, electrical supplies, and labor). The installation of new incremental charging station additions takes approximately 4-hours with minimal effort/drilling. Very easy; not the typical months-long project.

Charging Analysis

From January-May 2021, the PowerFlex system at The Madrone delivered 67,440 kWh of electrical energy (equivalent to approximately 211,000 miles of electric vehicle miles). Although the installation included 60 charging ports, in most cases, less than half of the ports had vehicles connected, and an even lower number were actively charging. Figure 3 shows that over a week in April 2021, a maximum of 11 of the 60 stations were plugged in during the early evening hours, with six ports actively charging.

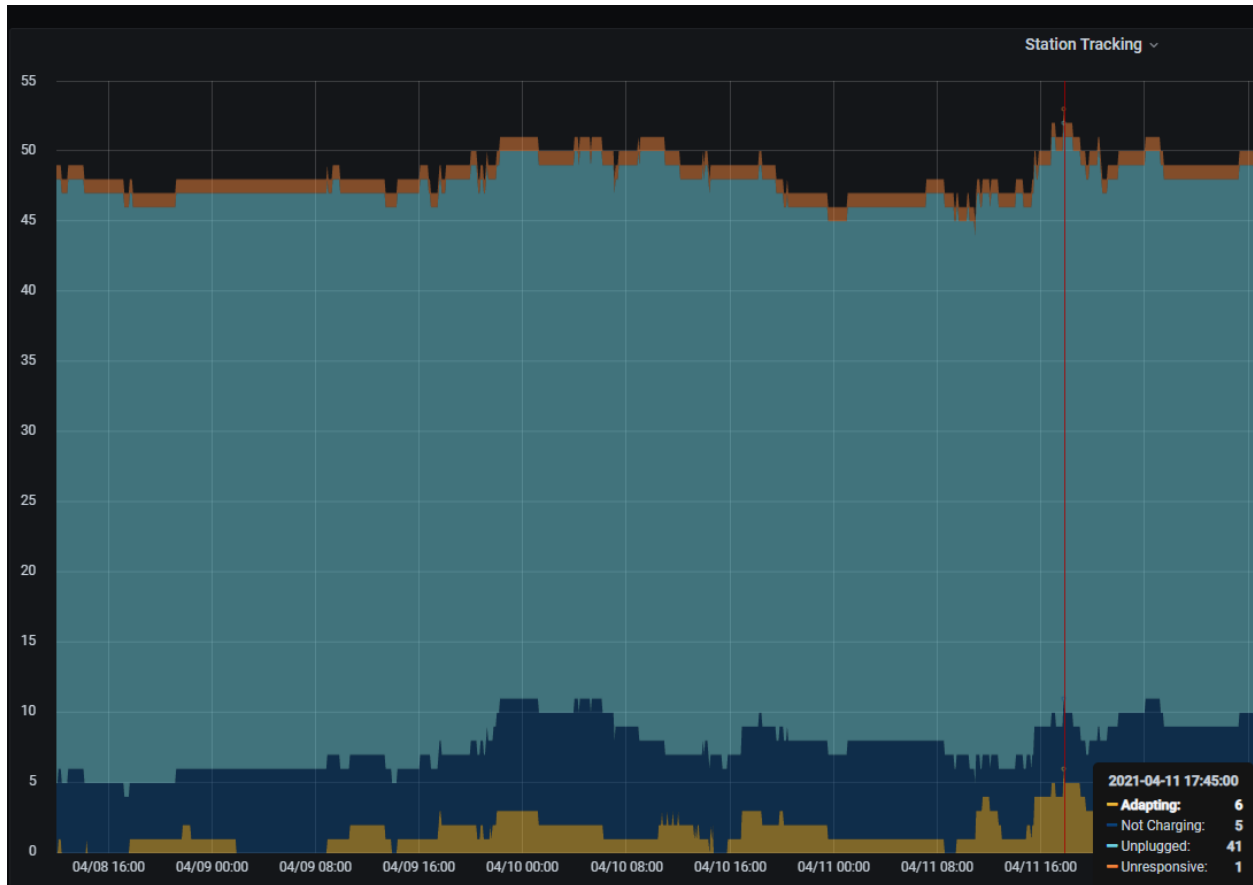


Figure 3: PowerFlex charge port utilization status at The Madrone over a representative week

In most cases, real-time (power) demand could be held relatively low, peaking around midnight when the lowest cost electricity is available (Figure 4). Daily demand was held to 20 kW in many cases, equivalent to only three (3) out of 60 stations charging at full power.

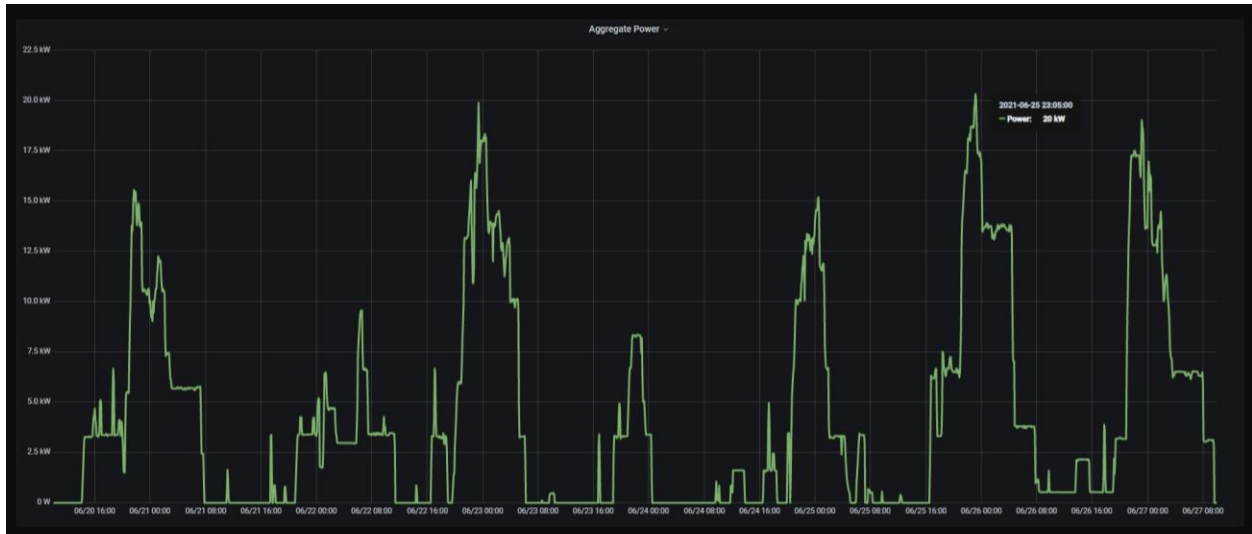


Figure 4: Charging station demand curves at The Madrone over an example week

The average session is between 18-24 kWh (Figure 5). This is in line with other shared-use situations. Because of The Madrone’s urban location many residents do not need to use their vehicles every day. The highest energy use is on the weekends, potentially from residents’ longer weekend recreational trips.

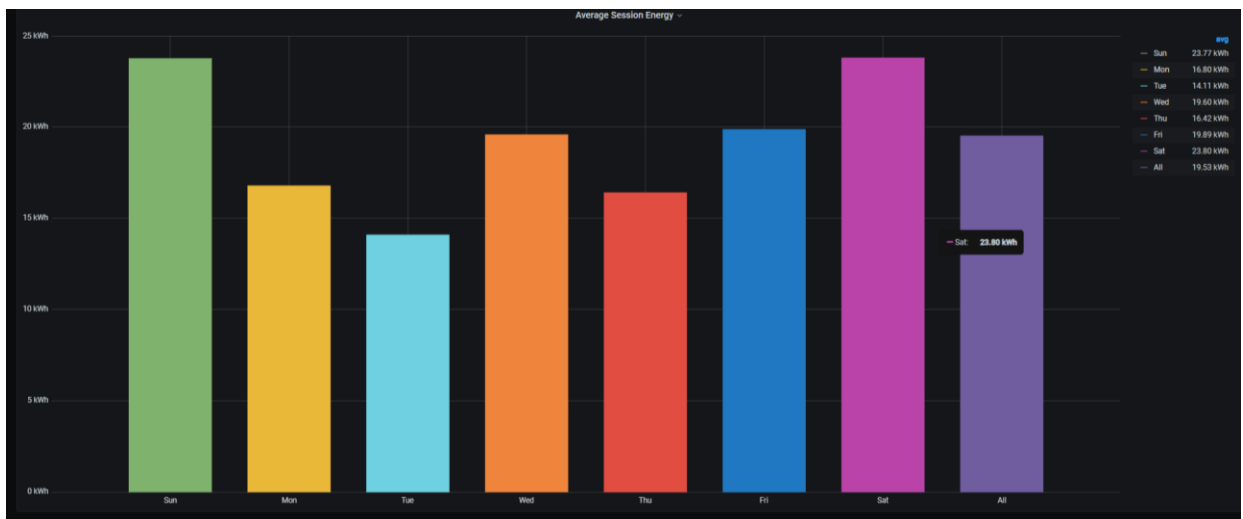


Figure 5 Average session energy consumption at The Madrone

The average session times (from connection to disconnection) were also quite long, between 12-24 hours (Figure 6). This shows users leave their vehicles plugged in overnight, or all day. This gives PowerFlex’s Adaptive Load Management software plenty of opportunity to charge every vehicle while minimizing the instantaneous total system power demand.

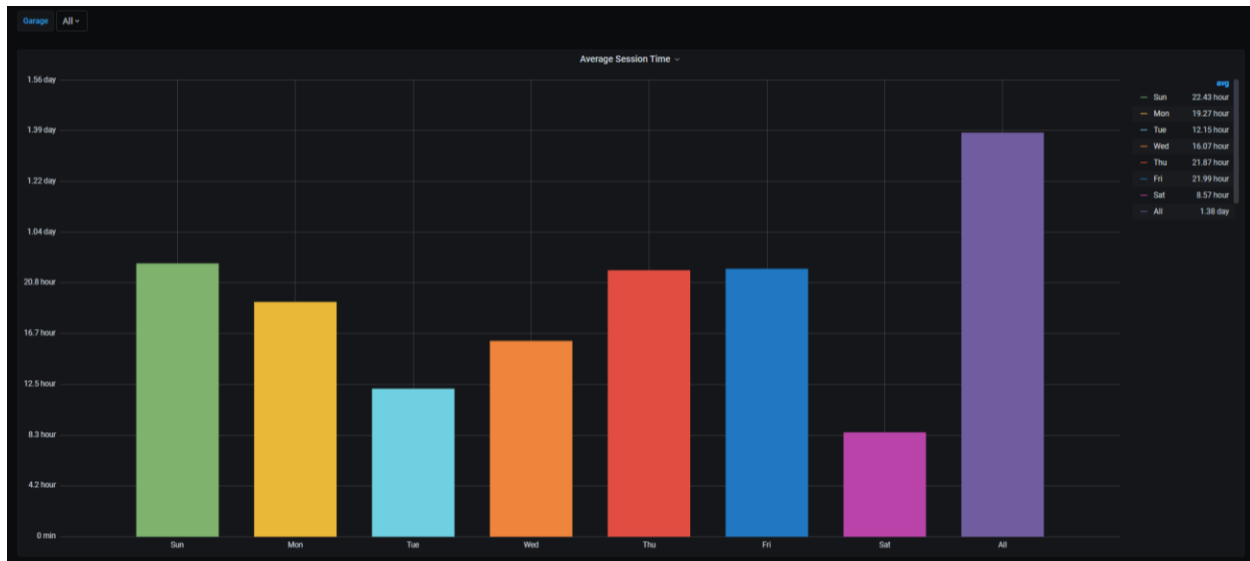


Figure 6: Average charging session time at The Madrone

Business Case Analysis

Leveraging grant incentive funding was critical to subsidize the charging station purchase and installation including initial installation and later expansions. PowerFlex managed identifying and securing the grant funds.

PowerFlex captures the Low Carbon Fuel Standard (LCFS) credits that are generated, where relevant, and uses them to reduce the MUD’s operating costs. In California, PowerFlex does not charge customers a monthly service fee in exchange for receiving the site’s LCFS credits.

The platform also collects usage data and provides data analytic services to allow MUD property owners to understand the charging station’s use and to determine optimal pricing structures for pay-for-use charging stations. PowerFlex also collects a percentage of the revenue collected by pay-for-use charging stations.

The Madrone showed how a large building could offer a large number of charging ports while keeping electric costs to a minimum. Although the system never reached its electrical limits during the observed period, it showed it could potentially serve all residents driving EVs.

The Madrone’s budget does not include EV charging (purchase, installation, and operation). So, the EV charging program is managed as a zero-budget amenity to cover the program’s costs. Actual electrical and Power Flex service costs and The Madrone’s charging session revenue is reconciled every month. The cost of charging is refined to ensure that operational costs and the initial investment payback are covered. As of June 2022, the nighttime (9 p.m. – 9 a.m.) charging rate was \$0.12/kWh and the daytime (9 a.m. – 9 p.m.) rate was \$0.20/kWh).

MUD Property Management Feedback

A member of The Madrone's management team involved in the PowerFlex charging station program was interviewed to get feedback on the system's performance and get the property management's and resident's feedback on the system usage, functionality, and benefits.

The Madrone noted that the PowerFlex charging stations do not have bi-directional communication. The result is that the charging station does not get data/info from vehicle (e.g., battery state-of-charge). This can limit the power output.

The Madrone noted that the PowerFlex system's operations approach goal is to meet providing the minimum required charge, targeting a full charge if time allows. So, given long-dwell parking/charging common for most charging needs at The Madrone, the PowerFlex system worked well.

The PowerFlex's mobile app user experience is good but has room for improvement. The system worked well for The Madrone's typical technically-minded residents, but The Madrone noted that improvements would help the ease of use for the average user.

As noted earlier, parking is not deeded to residential units, so is assigned by the HOA. The HOA is able to re-assign residents' parking spaces. It is often electrically and financially more efficient to install all charging stations together and reassign residents' parking spaces. But owners/residents prefer this to not happen, so, often The Madrone compromises and installs charging stations to the residents' parking stalls (instead of re-assigning the parking spot).