Cyber Switching Electric Vehicle Master Controller: The Henry Condominiums

Portland, Oregon

Property Profile

Figure 1. The Henry's main entrance

The Henry Condominiums (The Henry) is a luxury mixed-use condominium building in Portland, OR (Figure 1). The Henry was the first LEED gold condominium in U.S. The 15-story building has commercial spaces on the ground floor, floors 2-4 are parking, and floors 5-15 are for the residences. Built in 2005 with 123 residential units and 140 parking spaces (some units have two spaces). There are no guest parking spaces. As of 2021 there were 12 plug-in electric vehicles (PEVs) registered at The Henry, but only 7-8 charged at the building. Others charge elsewhere (work, public, etc.). The garage has separate electrical service from the residential building. The original installation included a 200 A panel with eight (8) circuit breakers. This was designed to be sufficient to power eight (8) charging stations (also referred to as electric vehicle charging equipment [EVSE]). The Henry sees EV charging as a top tier amenity and requirement to retain residents/attract residents, to show its commitment to sustainability.

Parking spaces are deeded/assigned to residents. Since there are no guest parking spaces, locating charging stations in a common area was not feasible. Instead, permission to install and power for charging stations is granted to residents on an as-requested basis. The Henry's board reviews/approves applications, and the resident pays for the installation costs up to the electrical panel, assuming there is sufficient electrical capacity. The Henry requires provides residents with a 240 VAC NEMA 14-50 electrical outlet located 1 meter above the floor with white conduit centered on the parking spot. Residents must provide their own plug-in type (i.e., not hardwired) charging station and mount it in their parking space. The first resident charging station was installed in 2015. As of January 2021, there were eight residents with EV charging stations with one additional planned charging station.

The Henry decided early-on that it would not pay for energy meters to monitor individual charging station energy use. At the time the decision was made, electricity meters cost about $600 and with an expected $15/month energy use, the meter cost and staff time to read the meter, bill and collect the money did

not make economic sense. Instead, The Henry decided to charge residents a flat monthly fee ($15) to charge their vehicles.

Charging Barriers

The Henry's Charging Committee realized early on that it needed to find a way to share the high capital costs of adding charging stations and the electrical capacity at the building. The committee understood that charging infrastructure would be used for a small percentage of the time over a full day. Even for vehicles that are used/charged daily, the charging station circuit may only be in use 5% of the time. Drivers who are away may not use their charging stations for months at a time (vacation, summer home, etc.). The property felt that installing more charging infrastructure was not necessarily the best solution.

With 123 units, 8 charging stations, and more frequent resident charging station applications (currently two per year) which will likely accelerate, The Henry knew it needed to be proactive to determine a solution to minimize cost and impact to the building while meeting residents' EV charging needs.

In the recent past, The Henry thought it would be logical to build out the system incrementally, based on demand. But it is now clear to the building operators that it needs to have a master plan to build out in a systematic way. Continuing with the incremental approach would have resulted in a very disorganized and more expensive system.

Early build-out planning – The Henry has just recently started to plan a major build-out of EV charging stations for the building. The condo board is coordinating with an electrical contractor who has experience designing/installing EV charging infrastructure in multi-unit dwelling (MUD) properties. The Henry has a rough plan, but the cost of installing individual uncontrolled electric circuits to each parking space/charging station would be too expensive to be feasible. A load management system reduces the upgrades needed to serve more spaces.

How to pay for a build-out – The Henry's approach was that residents who want to charge their cars in their parking space were to bear all the costs; the homeowners' association (HOA) will pay none of the costs. The HOA has discussed considering making the initial capital investments with the stipulation that they would be repaid by residents over time. There is a growing recognition that The Henry will need to offer charging services to remain competitive with other condominiums in their area. So, these investments are valuable to the HOA in general.

The approach used by two other buildings in the Portland area was to raise the capital from owners to fund the required electrical infrastructure upgrades. In these cases, the expectation was that the building would install charging stations at participating residents' parking spots. The buildings would also be partially repaid for the infrastructure upgrade as other owners connect their cars to the installed infrastructure. At another building the cost was $5,000 per participating owner. The Henry sought out the lowest cost solution that met its residents' needs.

Technology Solution Summary

In typical charging station installations, each charging station requires a dedicated power line from the distribution panel to each charging station (Figure 2). Limited usage per charging station and conduit installation costs in addition to electrical capacity upgrades are all very costly. Unmanaged charging can lead to high demand charges when many vehicles charge at the same time (e.g., when returning home after work). Both of these can lead to high capital and operating costs.

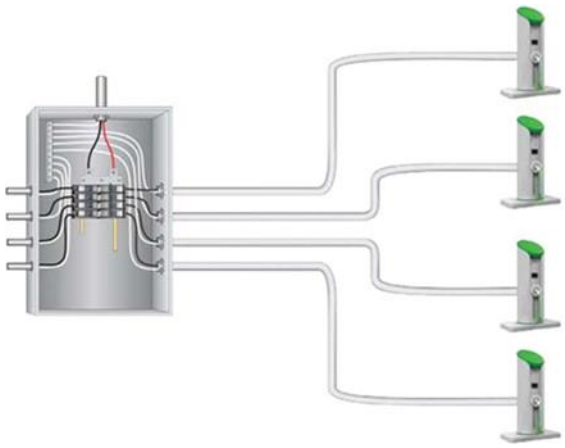

Figure 2. Typical charging station power wiring schematic

The Cyber Switching Electric Vehicle Master Controller (EVMC) (https://www.cyberswitching.com/evmc/) system solution electrically connects/multiplexes up to four (4) charging stations to share a single electric circuit/power line (Figure 3). The EVMC switches power to the multiple connected charging stations in a "round-robin" scenario, turning the charging stations on/off rotating on various configurations of a programmable timed basis to each connected EV. As described earlier, The Henry's system provides an electric outlet for residents, who purchase their own charging stations. So, in this situation, the EVMC controls the electric outlet power on/off with the remaining functions being identical. Multiple EVMCs can be installed at a single property (adjacent to each other or at different locations) as more charging stations are needed/installed.

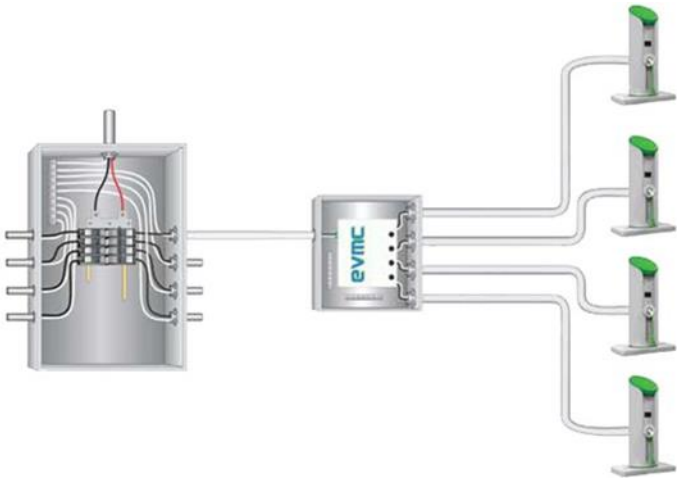

Figure 3. Cyber Switching EVMC charging station power wiring schematic

The EVMC does not communicate with the charging stations. Rather, the EVMC checks the charging status prior to charging a vehicle and, if charged, moves on to the next vehicle in line. When a charge is needed it turns the charging station on/off based on the scheduled order. This simple approach enables the system to control any charging station. This allows MUD properties/users flexibility to select the charging station that meets their requirements (cost, design, etc.). This includes low-cost non-networked charging stations. The EVMC's utility grade electric meter enables determining/collecting usage data on each charging station. The result is the EVMC upgrades the functionality of quality, low-cost, non-networked charging stations into fully featured "smart" charging stations.

The Henry's application with dedicated parking spaces/charging stations, controlling electric outlets, and flat fee billing did not require a mobile app/internet method for reservation, billing, etc. But should one of more of these features is needed, Cyber Switching can provide these functionalities through software partners.

An important differentiator with Cyber Switching's system is that it does not need an internet connection to function. If system management, data reporting, or other advanced features are needed, each EVMC needs to be connected to Cyber Switching's data service via an internet connection (ethernet, Wi-Fi, cellular, etc.). The advanced features require a small monthly subscription fee.

Cyber Switching's data visualization dashboard displays the system status, usage, totals, etc. (Figure 4). Data can also be downloaded for analysis by the property. The data portal provides access to and combines all EVMCs for a property for easy MUD property operator usage visualization, oversight, and management.

Figure 4. Cyber Switching EVMC data portal

Cyber Switching does not have an ongoing subscription fee for use of the EVMC and use of the data portal. This is a good and unique feature of Cyber Switching.

Charging Analysis

One benefit of the Cyber Switching system is that it collects and records detailed meter data for each charging station. The Henry will analyze the collected data to determine if/when it needs to adjust the flat monthly fee plan.

Currently monthly energy usage is approximately 500 kilowatt-hours (kWh) for all stations combined. There has been some variation among the energy consumption among current users. A few residents use slightly more than $15 worth of electricity. Other residents may go for a week or months (e.g., residents with second homes) between charging sessions.

Figure 5 shows the charging of a typical user over the course of a month, totaling 138 kWh with an average charging session of approximately 12 kWh.

Day Type	Total Power Used
Weekday	88.0000
Weekend/Holiday	50.8800
Total	138.8800 kWh

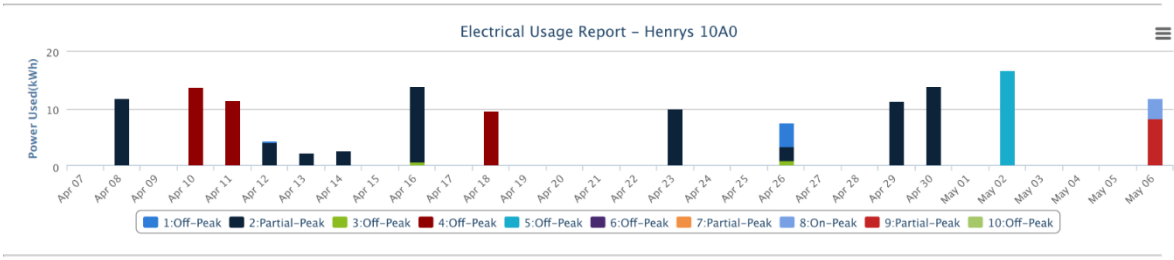

Figure 5: The Henry monthly charging session data

Because of the pandemic, some residents lived in their second homes for large portions of 2020 and early 2021. Some charging stations were not used at all during this time. In one case, one resident had installed a charging station, because they were planning to buy an electric vehicle in the future.

Two residents have an informal charging station sharing agreement where two EVs share the use of the same charging station. There are currently three unused charging station circuits on the EVMC, with the ability to install addition EVMCs and charging station in the future.

Business Case Analysis

To date The Henry's installation costs are as follows: 1) infrastructure addition (200-amp panel and buss providing eight additional 40-amp circuits at a cost of $1,000 per charging station circuit. (The cost of this installation was just under $12,000.) The $1,000 also covers the cost of installing the Cyber Switching units - Approximately $1,500 per unit. Currently, The Henry currently has the electrical capacity to charge 14 cars. The total infrastructure cost was $15,000 + $7,000 for the two Cyber Switching units, or $1,475 per circuit.

The Henry has found the average cost of running conduit from the electrical distributional panel to residents' parking spaces is approximately $2,500. A charging station costs approximately $500, which totals about $3,000 per charging station.

The total gross cost averaged $4,475 per charging station assuming the baseline case where each station is independently powered. There was a 30% tax credit available to The Henry, so the net cost would be approximately $3,135 per charging station. If more EVMCs are installed closer to where the charging stations are needs and multiple stations can be installed at once, this can lower the per station costs.

This business case analysis summary using the available provided data includes the following components:

1) Initial costs: charging station capital cost, charging station installation cost, electrical infrastructure work cost, and commissioning/activation costs

2) Monthly costs: electric costs, charging station service provider fees, charging station usage fees, and MUD property revenue

Here we compare the initial costs, operating costs, and revenue generation of non-networked stations paired with the Cyber Switching EVMC to those of networked and non-networked plug-in charging stations.

At the time of the demonstration The Henry had eight residents with their own charging station installed in their deeded/assigned parking spots. Each charging station was connected directly to the distribution panel. Cyber Switching's EVMC controller unit can control any charging station, though controlling low-cost non-networked charging stations is more economical since advanced charging station control features are not used/bypassed. The business case analysis uses the same installation configuration as at The Henry (charging station at each parking spot) and the same standard alternative technology options other innovative charging technology business case analyses for all technology examples for consistency.

Initial Costs

Table 1 shows a breakdown of the initial one-time costs to purchase and install each charging station option. Three options are shown: 1) the Vehicle Charging Innovations for Multi-Unit Dwellings (VCI-MUD) project innovative charging hardware option; two Cyber Switching EVMC units, each controlling four (4) non-networked charging stations [total of 8 charge ports], 2) a typical standard single-port networked residential charging station; the ChargePoint Home Flex, and 3) a typical standard non-networked charging station; the Clipper Creek HCS-40. The *Low-Cost/Feature* and *Non-Networked* technology options require the same electrical power, so the electrical infrastructure costs were assumed to be the same.

Table 1. The Henry charging station options initial cost comparison

INITIAL COSTS			
EVSE Type	**VCI-MUD Innovative Charging Technology**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	Cyber Switching EVMC	ChargePoint Home Flex	Clipper Creek HCS-40
Charging Station	$5,500	$0	$0
EVSE Installation	$4,712	$5,592	$4,712
Electrical Infrastructure	$32,000	$32,000	$32,000
TOTAL INITIAL COST	**$42,212**	**$37,592**	**$36,712**

Monthly Costs and Revenue

Prior to the technology demonstration, The Henry was not able to meter/determine usage for the EV charging stations as a group, or individually. To help support the electrical costs The Henry charged residents a conservative flat rate of $15/month during the demonstration period to use a (resident-provided) charging station. The Cyber Switching allows the MUD property to track energy usage by charging station. This enables The Henry to develop/set its own charging session pricing structure. The

same session pricing scheme was assumed for the other charging station types, except for the non-networked unit where billing residents is not an option.

Table 2 shows a breakdown of the monthly costs involved with each charging station option and monthly revenue generated from charging session fees. Net revenue was calculated as the monthly session revenue less service provider fees, and monthly electricity costs. Energy costs were calculated based on the assumption that electrical rates remain constant.

Table 2. The Henry charging station options monthly cost comparison

AVERAGE MONTHLY FEES and Revenue			
EVSE Type	**VCI-MUD Innovative Charging Technology**	**Low-Cost/Feature**	**Non-Networked**
Example Model	Cyber Switching EVMC	ChargePoint Home Flex	Clipper Creek HCS-40
Energy Cost (kWh)	$338	$338	$338
Session Usage Fee	$15/month per charging station	$15/month per charging station	$15/month per charging station
TOTAL SESSION REVENUE	$120	$120	$120
NET REVENUE	**-$218**	**-$218**	**-$218**

Estimated 10-Year Costs Summary

The total estimated costs for each EVSE type over 10 years are summarized in Table 3 and Figure 6. Costs were calculated under the assumption of double the current monthly usage for the entire 10-year period (anticipating increased demand in the future).

Table 3. The Henry estimated 10-year cost summary

EVSE Type	**VCI-MUD Innovative Charging Technology**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	Cyber Switching EVMC	ChargePoint Home Flex	Clipper Creek HCS-40
Capital Costs	$42,212	$37,592	$36,712
Electricity Costs	$81,103	$81,103	$81,103
TOTAL COST	**$123,315**	**$118,695**	**$117,815**
PAYBACK PERIOD	**n/a**	**n/a**	**n/a**

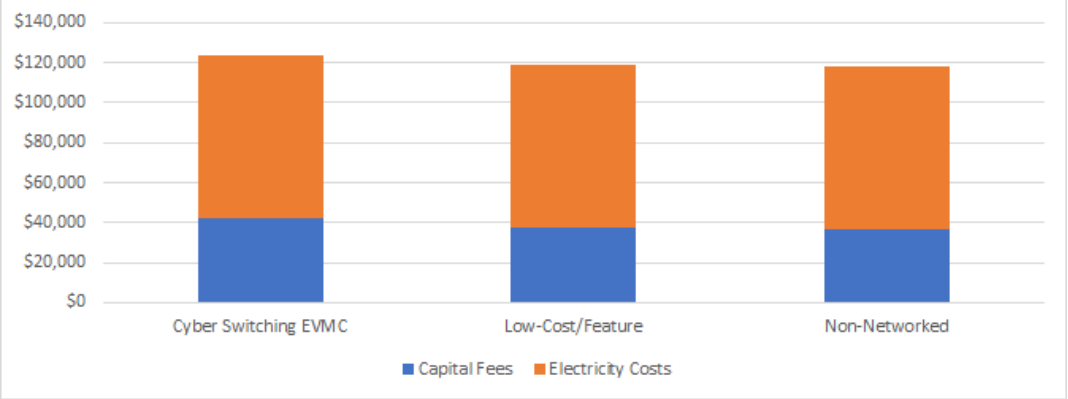

Figure 6. The Henry 10-year cost analysis summary plot

Cost Analysis without Location-Dependent

Some costs are installation-specific (region, state, building). These costs include permitting, electrical infrastructure upgrades/installation, charging station installation, and electricity. These costs vary by location but remain similar between EVSE type. Table 4 is a modification of Table 1 with the location dependent costs removed. The intent of this is to show a more equal comparison for VCI-MUD Toolkit users to build off of for their specific location conditions.

Table 4. The Henry charging station options initial cost comparison with location-dependent costs removed

INITIAL COSTS			
EVSE Type	**VCI-MUD Innovative Charging Technology**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	Cyber Switching EVMC	ChargePoint Home Flex	Clipper Creek HCS-40
EVMC Capital and Installation	$5,500	$0	$0
Charging Stations	$4,712	$5,592	$4,712
TOTAL INITIAL COSTS	**$10,212**	**$5,592**	**$4,712**

MUD Property Management Feedback

A member of The Henry's HOA board involved in the Cyber Switching 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 Henry noted that the business model of many charging station network companies getting into serving MUDs would increase the costs to MUDs by 2-3 times. This is why The Henry decided to use non-networked stations. The Henry is not aware of other MUD properties that have used the same approach of simply providing electrical outlets.

The Henry and Cyber Switching had to work out some initial issues. For example, Tesla cars draw 48 A which was above the EVMC's default 32A circuit breaker limit. Residents received 32 A initially, but Cyber Switching updated the EVMC units to allow 48 A charging.

As expected with the EVMC's charge management approach, charging takes up to four times longer than if on a dedicated circuit. Users needed to be educated on the system's functionality and what behavior changes were needed to maximize their experience. Primarily, leave the car connected to the charging station whenever parked, rather than only when needed. The EVMC collects usage data by port which The Henry can use to analyze to determine usage patterns. The Henry had initial issues receiving the data.

The EVMC is a cost-effective option for providing/expanding charging station access as long as residents/users are aware of the system's operation approach and how to adapt their charging behavior.

The Henry is active in the Portland, OR condominium network and was surprised how unique each condominium building, project, etc. are. Culture, physical infrastructure, and interest/ability of HOA boards varied widely which impacts how EV charging station installations are handled.