FreeWire Technologies Mobi EV Charger: FreeWire Technologies Headquarters

San Leandro, California

Property Profile

FreeWire Technologies' (FreeWire) Mobi EV Charger (Mobi) mobile dual-port Alternating Current (AC) Level 2 charging station customer base to date has been primarily workplaces (Figure 1). multi-unit dwelling (MUD) properties are another potential application, but FreeWire does not yet have MUD customers. Since an MUD demo site could not be located, the Mobi located at FreeWire's corporate headquarters (a workplace) was used as a MUD proxy. MUD and workplace have similar usages, with long-dwell time parking (8-12+ hours), just shifted between evening/nighttime and daytime. FreeWire's headquarters parking garage was the specific demo site. Several FreeWire employee owned electric vehicles (EVs) as well as EVs used for testing FreeWire's products regularly used the garage, even during the COVID pandemic. Prior to the demonstration employees primarily charged at home, but FreeWire asked employees to charge primarily at work during the demonstration period to maximize usage of the Mobi.

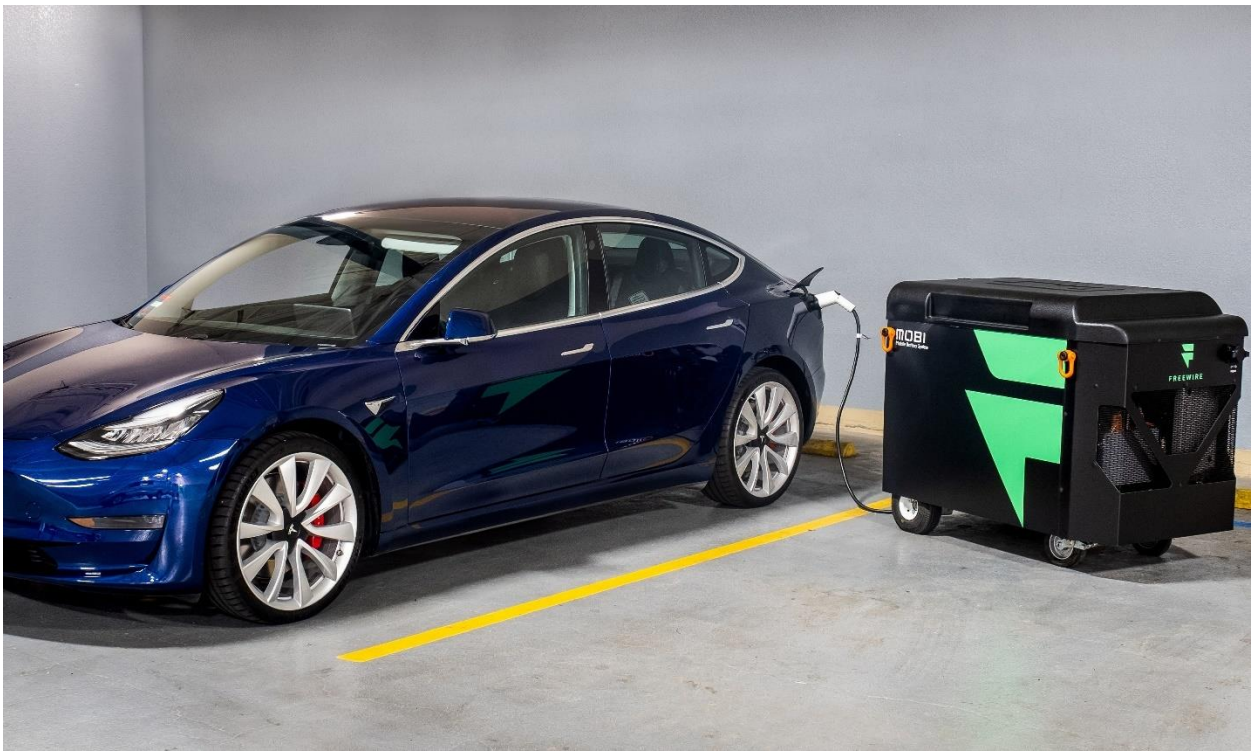

Figure 1: Mobi EV Charger plugged into a vehicle (Source: FreeWire Technologies)

Charging Barriers

The Mobi can address multiple common charging barriers. Most notably it removes all the expenses and complications with running electrical connections across a parking garage or parking lot. Instead of bringing in additional service and running electrical service to individual parking spaces, the Mobi can be wheeled to any parking space with a vehicle in need of charging. The Mobi requires periodic charging. The Mobi can be charged at an outlet close to the electrical panel, which should have minimal installation costs. It can also be charged during off-peak times, such as the middle of the day when MUD residents may be at work and more renewables are available on the grid.

Technology Solution

The FreeWire Technologies Mobi EV Charger (https://freewiretech.com/products/mobi-ev/) is a mobile dual-port AC Level 2 charging station (also referred to as electric vehicle charging equipment [EVSE]). The system is unique because the Mobi moves to where EVs are parked, rather than having to install charging stations where vehicles are parked. It can also be positioned in shared space or spaces. The unit has an internal 80 kilowatt-hours (kWh) lithium-ion battery pack and has two AC Level 2 charging cords. It can charge two vehicles at the same time, each at up to 6.6 kWh. The Mobi is charged via an AC Level 2 charging station. This greatly simplifies the installation requirements. The Mobi's battery requires approximately 12 hours for a full charge. The Mobi is self-powered. The drive system is controlled with a joystick to drive the Mobi to the vehicle. The Mobi can handle inclines up to 9 degrees and is designed to handle ramped parking garages.

During the demonstration period, FreeWire was developing software, and a user app, to provide access control, differentiate by user, data collection, and charging management. The Mobi sends users a text message when their car is fully charged to improve its utilization.

In a MUD setting, FreeWire has considered training residents to operate the Mobi. But concerns about vandalism, users leave Mobi somewhere where it should not be after their charge is complete, and other reasons have led FreeWire to determine that the best use case is for a trained/attendant (i.e., a building employee[s]) to manage moving the Mobi.

The Mobi can be used as a long-term charging infrastructure solution or be used as an initial step to gauge and understand the MUD property's EV charging needs. It can also be used to expand the amount of charging available when shared used stations are reaching capacity or are frequently crowded during peak periods.

Charging Analysis

During the demonstration period, many FreeWire employees were working from home, so there was less demand for charging than there would have been otherwise. However, as noted earlier, prior to the demonstration employees primarily charged at home, but FreeWire asked employees to charge primarily at work during the demonstration period to maximize usage of the Mobi. The Mobi was only available to FreeWire employees, so served the same role as a resident-only solution.

Figure 2 displays energy provided from shows charging for a 45-day period from mid-January to the end of March. Days with no charging were omitted from the visual. Since MUD resident sessions in shared use situations average 10-12 kWh per session, this figure shows that the Mobi could easily serve 4-5 charging sessions per day. The Mobi dispensed nearly 50 kWh on its highest usage days, well below the unit's 80 kWh capacity. FreeWire employees were responsible for moving the unit themselves. In a MUD application, residents could be trained to move the unit themselves. Other workplace installations have used a parking attendant to move the unit between vehicles.

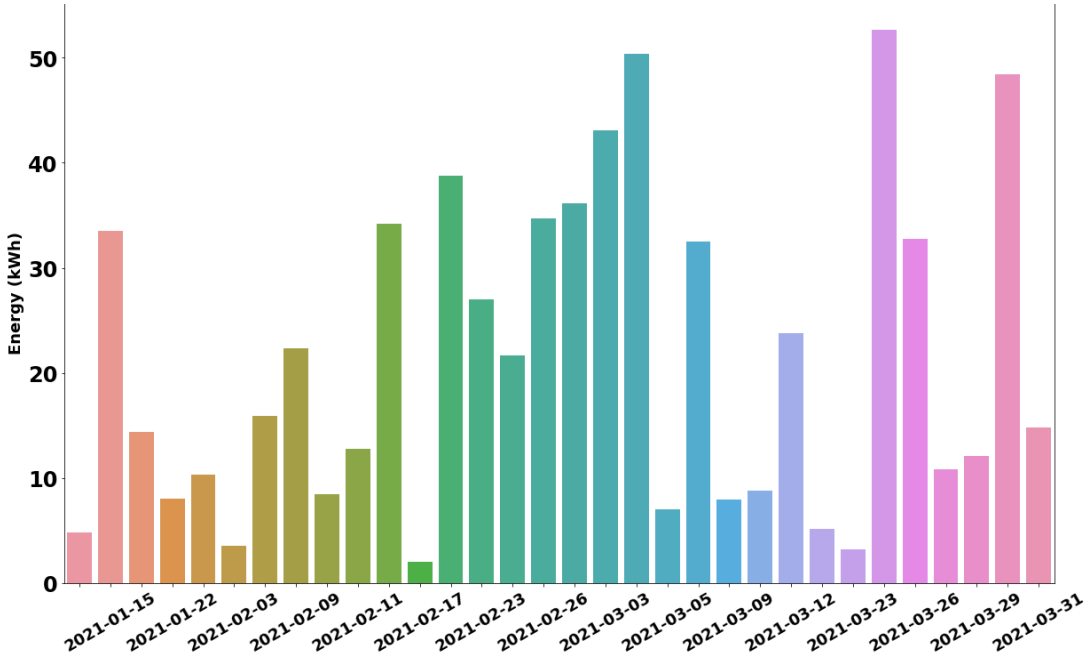

Figure 2. Freewire Technologies Mobi energy use over a three-month period

Figure 3 shows the energy provided over time for different users. There were a range of session lengths and energy consumption. In a MUD application, one might expect a few shorter sessions in the evening with one overnight charging session. After a morning session, the last user would need to plug the unit in to charge throughout the middle of the day.

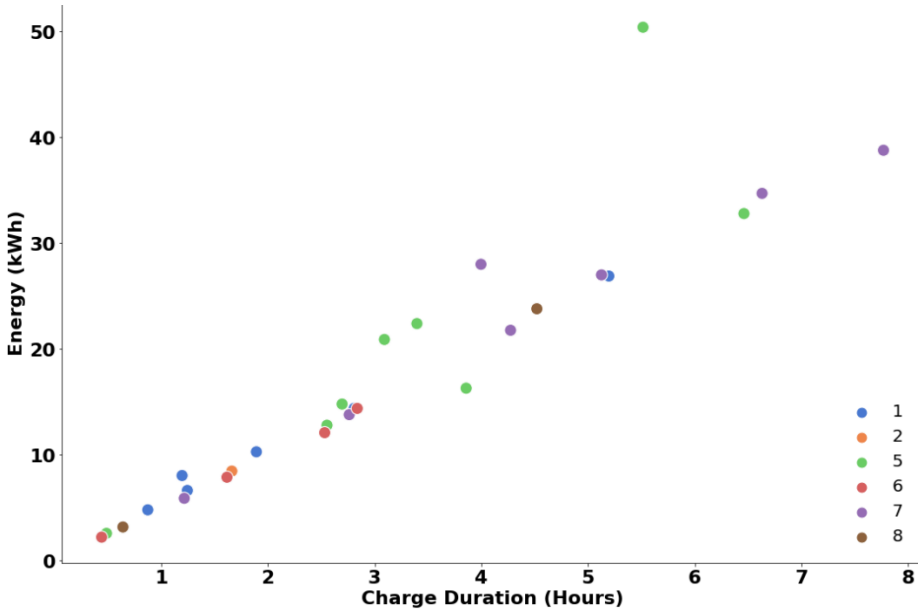

Figure 3: Energy provided by charge duration and user ID (each color represents a unique user)

Business Case Analysis

The capital costs of a single Mobi can be close to the capital cost of installing 4-5 dedicated charging stations. FreeWire claims that, with average daily charging needs, the Mobi can support up to eight (8) EVs per day. In the case in the case of very expense installations, it could offer a less expensive alternative. However, in high usage situations, the Mobi's capacity to charge could be limited. Vehicles with large energy capacity (75-100+ kWh) battery packs which a full vehicle charge would deplete the Mobi's battery. Since a Mobi can deployed quickly, it can be used to serve immediate charging needs and establish demand prior to a permanent charging installation.

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 the FreeWire Technologies Mobi EV charger with an integrated dual-port charging station to those of other standard high- non-networked charging stations.

At the time of the demonstration at FreeWire's headquarters had multiple employees and company vehicles using the Mobi. The Mobi's internal battery pack needs to be charged with a standard AC Level 2 charging station. The business case analysis uses the same installation configuration as at FreeWire's headquarters 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. Four options are shown: 1) the Vehicle Charging Innovations for Multi-Unit Dwellings (VCI-MUD) project innovative charging hardware option; one FreeWire Mobi EV Charger with integrated dual-port networked charging station, 2) a typical standard high-feature public-access type charging station; the dual-port ChargePoint CT-4000, 3) two typical standard single-port medium-feature MUD-property type charging stations; the ChargePoint CPF-50, and 4) two typical standard non-networked charging stations; the Clipper Creek HCS-40. All technology options require the same electrical power, so the electrical infrastructure costs were assumed to be the same.

Table 1. FreeWire charging station options initial cost comparison

INITIAL COSTS				
EVSE Type	**VCI-MUD Innovative Charging Technology**	**High-Cost/ Feature**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	FreeWire Mobi EV Charger	ChargePoint CT-4000	ChargePoint CPF-50	Clipper Creek HCS-40
Demo Technology Capital	$65,000[1]	$0	$0	$0
Charging Station	$565[2]	$7,210	$3,775	$1,130
EVSE Installation	$200[2]	$1,200	$1,200	$400
Electrical Infrastructure	$2,800[2]	$2,800	$2,800	$5,600
Commissioning	$0	$349	$0	$0
TOTAL INITIAL COST	**$68,565**	**$11,559**	**$7,775**	**$7,130**

[1] Three-year warranty ($16,900) included

[2] The initial costs associated with one Clipper Creek HCS-40 are included because the FreeWire Mobi requires charging from an AC Level 2 EVSE

Monthly Costs and Revenue

Prior to the technology demonstration, FreeWire had the ability to monitor the use (charging/discharging) of the Mobi but did not have a method for tracking charging station usage by end-users. (This functionality was developed during the demonstration period.) As a result, FreeWire did not have the ability to bill end-users for usage. FreeWire's mostly workplace customers provided the Mobi's use as an amenity, so usage tracking/billing was not a need. Since there was no fee to use the Mobi all other charging station types were assumed to use the same approach. 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 is 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. FreeWire charging station options monthly cost comparison

AVERAGE MONTHLY FEES				
EVSE Type	**VCI-MUD Innovative Charging Technology**	**High-Cost/ Feature**	**Low-Cost/Feature**	**Non-Networked**
Example Model	FreeWire Mobi EV Charger	ChargePoint CT-4000	ChargePoint Home Flex	Clipper Creek HCS-40
Subscription and Data	$600	$55	$37	$0
Maintenance	$0	$62	$33	$0
Warranty	$0[1]	$0[2]	$0[2]	$0
Energy Cost (kWh)	$85	$85	$85	$85
Demand Cost (kW)	n/a	n/a	n/a	n/a
TOTAL AVERAGE MONTHLY FEES	**$685**	**$201**	**$154**	**$85**
AVERAGE MONTHLY REVENUE				
Session Usage Fee	None	None	None	None
TOTAL SESSION REVENUE	**$0**	**$0**	**$0**	**$0**
NET REVENUE	**-$685**	**-201**	**-$154**	**-$85**

[1] Three-year ($16,900) warranty included in capital costs.
[2] Included in charging station maintenance fee

Estimated 10-Year Costs Summary

The total estimated costs for each EVSE type over 10 years are summarized in Table 3 and Figure 4. 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. FreeWire estimated 10-year cost summary

EVSE Type	**VCI-MUD Innovative Charging Technology**	**High-Cost/ Feature**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	FreeWire Mobi EV Charger	ChargePoint CT-4000	ChargePoint Home Flex	Clipper Creek HCS-40
Capital Costs	$68,565	$11,559	$7,775	$7,130
Electricity Costs	$20,298	$20,298	$20,298	$20,298
Service Provider Fees	$72,000	$13,980	$8,380	$0
TOTAL COST	**$160,863**	**$45,837**	**$36,453**	**$27,428**
PAYBACK PERIOD	**n/a**	**n/a**	**n/a**	**n/a**

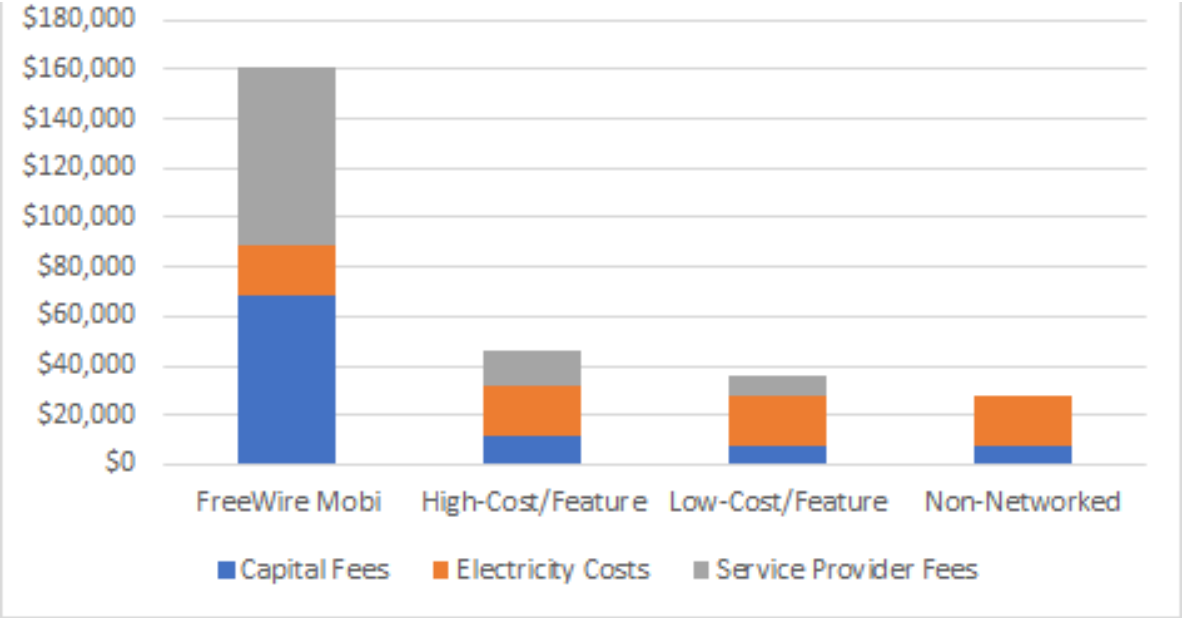

Figure 4. FreeWire 10-year cost analysis summary plot

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 and Table 5 are modifications of Table 1 and

Table 2 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. FreeWire charging station options initial cost comparison with location-dependent costs removed

INITIAL COSTS				
EVSE Type	**VCI-MUD Innovative Charging Technology**	**High-Cost/ Feature**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	FreeWire Mobi EV Charger	ChargePoint CT-4000	ChargePoint Home Flex	Clipper Creek HCS-40
Demo Technology Capital	$65,000	$0	$0	$0
Charging Stations	$565	$7,210	$3,775	$1,130
Site Validation	$0	$599	$599	$0
Commissioning/ Network Activation	$0	$349	$0	$0
TOTAL INITIAL COSTS	**$65,565**	**$8,158**	**$4,374**	**$1,130**

Table 5. FreeWire charging station options monthly cost comparison with location-dependent costs removed

AVERAGE MONTHLY FEES				
EVSE Type	**VCI-MUD Innovative Charging Technology**	**High-Cost/ Feature**	**Low-Cost/ Feature**	**Non-Networked**
Example Model	FreeWire Mobi EV Charger	ChargePoint CT-4000	ChargePoint Home Flex	Clipper Creek HCS-40
Subscription and Data	$600	$55	$37	$0
Maintenance	$0	$62	$33	$0
Warranty	$0[1]	$0[2]	$0[2]	$0
TOTAL AVERAGE MONTHLY FEES	**$600**	**$117**	**$70**	**$0**
AVERAGE MONTHLY REVENUE				
Session Usage Fee	None	None	None	None
TOTAL MONTHLY SESSION REVENUE	**$0**	**$0**	**$0**	**$0**
TOTAL NET MONTHLY REVENUE	**-$600**	**-$117**	**-$70**	**$0**

[1] Three-year ($16,900) warranty included in capital costs.
[2] Included in charging station maintenance fee

MUD Property Management Feedback

The lead member of FreeWire's team involved in the demonstration program was interviewed to get feedback on the system's performance and get the users' feedback on the system usage, functionality, and benefits.

Most users already knew how to use Mobi since they were employees, but the operation is basically the same as other AC Level 2 charging stations. The lead member of FreeWire's team also acted as the onsite attendant to move the Mobi between users. He coordinated the charging sessions with users manually since the mobile app was still under development. The app functionality would simplify the charger movement logistics. Users were able to charger their vehicles as they would have at home and no reports of charger unavailability or insufficient charge were noted during the interview.