Direct Current Fast Charger Usage in the Pacific Northwest During 2014

January 2016

Key Conclusions

- Data from direct current fast chargers (DCFC) installed in Washington and Oregon by the West Coast Electric Highway Project and The EV Project were analyzed to determine how often the chargers in these networks were used. In a previous study of the same chargers from September 2012 through December 2013, it was found that the most highly used chargers were located in the urban areas of Seattle and Portland. In 2014, the chargers in less populated areas had increased usage, especially along Interstate 5 north of Seattle and between Seattle and Portland.
- Throughout 2013 and 2014, usage of Blink and AeroVironment DCFC networks in Washington and Oregon generally increased. All AeroVironment DCFCs had a higher average weekly usage in 2014 than in 2013. Excluding a period of very high use of the Blink network in 2013, Blink chargers were used more, on average, in 2014 than in 2013.
- When looking at geographical locations of electric vehicle (EV) registration, along with the frequency of DCFC usage, many highly used DCFCs were shown in areas with few EVs registered. This suggests that these chargers were used primarily by drivers that had to travel in order to reach them, as opposed to local drivers.

Introduction

The deployment of DCFCs is a major topic of discussion within the EV community. DCFCs are a type of electric vehicle supply equipment (EVSE) that charge EVs by providing DC power directly to the EV's battery pack. Generally, DCFCs can charge vehicles at 50 kW or higher (compared to charge rates of 1 to 7 kW when vehicles charge using alternating current Level 1 and Level 2 EVSE), allowing vehicles to be charged quickly. For example, under the right conditions, the Nissan Leaf can charge its battery pack from near complete depletion to around 80% state of charge in 30 minutes or less using a DCFC [1]. For this reason, many believe that DCFCs should have a major role in public EV charging infrastructure.

Most EV models currently on the market typically require recharging after driving less than 100 miles. This offers a driving range sufficient to meet the needs of most drivers most of the time. However, if drivers of these EVs want to take long trips, even infrequently, they need a convenient way to charge during the trip. One concept for overcoming EV range limitation is to install DCFCs along transportation corridors to provide EV drivers opportunities to recharge quickly along their journey. This paper describes the use of DCFCs that have been installed for this purpose along major highways in the Pacific Northwest of the United States.

What was Studied?

The West Coast Electric Highway Project was launched in 2011 to provide a widespread charging network of AeroVironment brand DCFCs to enable EV travel along the western coast of the United States. The network is designed to allow EV drivers to travel between major metropolitan areas and to reach other popular destinations in the region using fast chargers spaced at 25 to 50 mile intervals [2]. West Coast Electric Highway chargers were only located outside of larger cities because The EV Project, also launched in 2011, installed a network of Blink brand EVSE in metropolitan areas of the Pacific Northwest, among other regions. In the states of Washington and Oregon, a total of 56 AeroVironment and 12 Blink DCFCs were installed within 1 mile of interstates and highways as a result of these two projects.

Idaho National Laboratory received charging data from 45 AeroVironment brand DCFCs and 12 Blink brand DCFCs along highways in Oregon and Washington. Analysis of these data determined how often each DCFC was used. The period of study for this paper was January 1, 2014, through December 31, 2014. All DCFCs in the study had CHAdeMO connectors and could be used by any CHAdeMO-compatible EV.

Weekly Direct Current Fast Charger Usage on the West Coast Electric Highway

DCFC usage on the West Coast Electric Highway was studied to determine the average number of charges per week performed at each charger. These results are shown for the year 2014 in Figure 1. It is important to note that frequency of use was not considered when selecting locations for West Coast Electric Highway DCFCs. The

network was designed solely to allow EV drivers to take long distance trips.

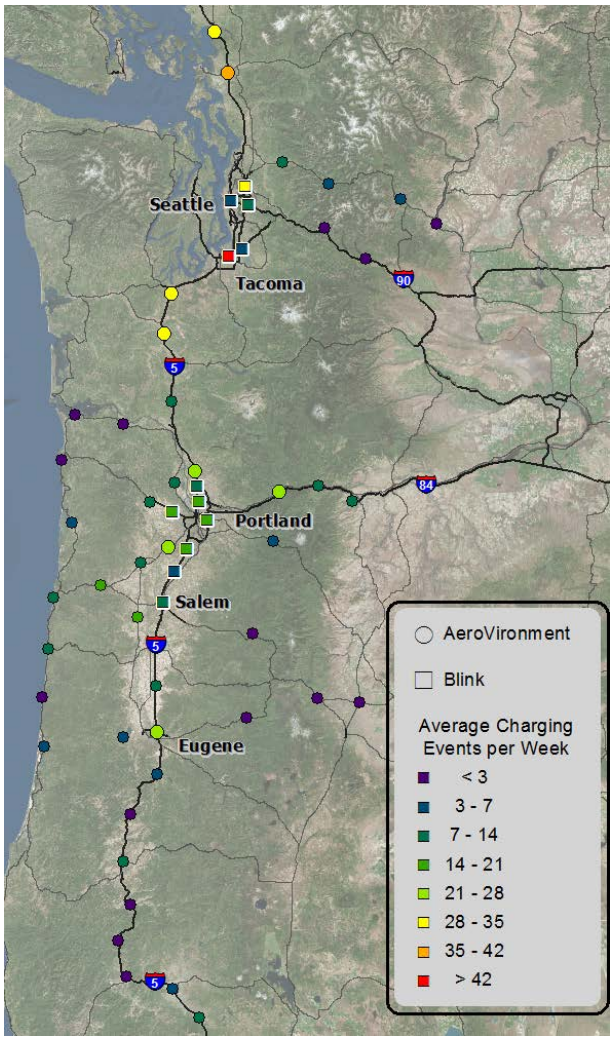

Figure 1. Frequency of DCFC usage on the West Coast Electric Highway in 2014. Symbol colors represent frequency of use and symbol shapes signify DCFC brand.

The DCFCs that were used the most were those along major highways and travel corridors, with especially high use occurring along Interstate 5. DCFCs in more remote locations tended to be used less frequently than those in more populated areas.

In a previous study, a similar figure was shown to describe DCFC use from September 2012 through December 2013 [3]. This same figure is included in this document as Figure 2 for comparison. Figure 2 shows that the most frequently used DCFCs in that time period were in the Seattle and Portland areas. This is not necessarily the case in 2014, where many of the chargers in surrounding areas were used more than those in cities. Many of the chargers along Interstate 5 were used significantly more in 2014 than during the previous study, especially those between Portland and Seattle and those north of Seattle.

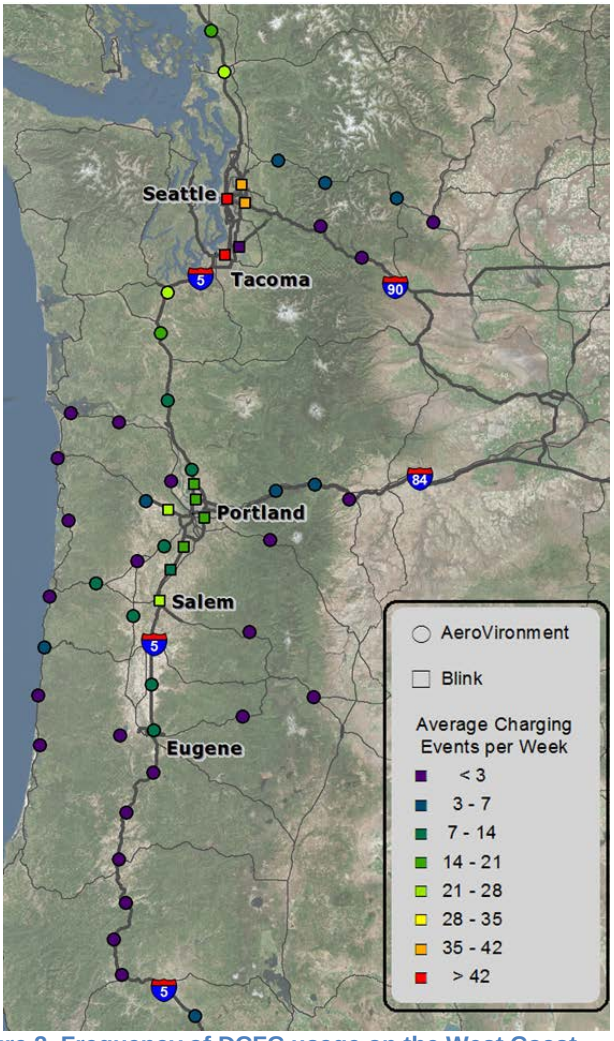

Figure 2. Frequency of DCFC usage on the West Coast Electric Highway in 2013. Symbol colors represent frequency of use and symbol shapes signify DCFC brand.

Some notable differences are evident in the usage of each brand of charger. Many of the AeroVironment chargers had usage increases sufficient to change their symbol color. Further inspection of the data behind the map shows that every AeroVironment DCFC was used more frequently in 2014 than during the previous period. This includes seven DCFCs that realized increases of more than 10 charges per week, on average. On the other hand, many Blink units saw decreases in average weekly usage, including one in downtown Seattle that decreased from more than 40 charges per week in the earlier study period to less than 4 per week in 2014. This sharp of a decrease in use was most likely due to the charging equipment not working rather than EV drivers not wanting to charge in that location. Inspection of the Seattle charger on PlugShare.com (i.e., an online tool for finding EV charging

locations) shows that users frequently commented that the charger was not operational throughout 2014.

Direct Current Fast Charger Usage Over Time

To understand how the charging network was used overall and to provide insights into why differences were seen in usage between DCFC manufacturers, Figure 3 was created. Figure 3 shows average usage per DCFC over time for the Blink and AeroVironment chargers.

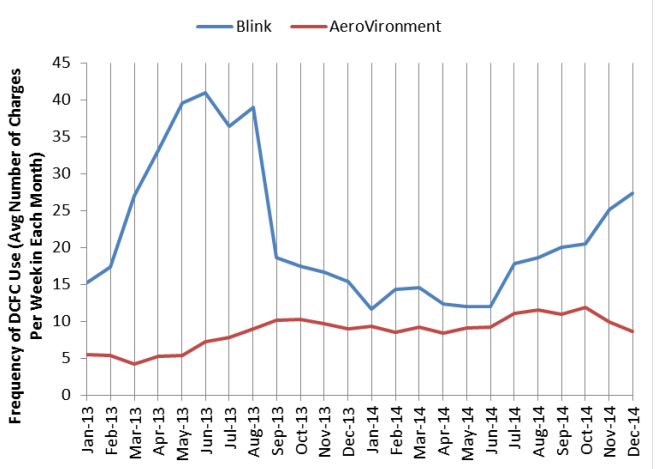

Figure 3. Average usage of Blink and AeroVironment DCFCs through 2013 and 2014. Frequency is calculated on a per-unit basis.

The trend in DCFC usage throughout 2013 and 2014 is generally positive for both Blink and AeroVironment chargers. The Blink chargers saw a spike in usage during 2013, which fell off quickly in September. It is likely that the inclusion of this spike in the previous study period led to averages that were higher than those from 2014 for many of the Blink DCFCs. The rapid decrease in September 2013 coincides with the period of time when usage fees were implemented for the Blink DCFC network. Prior to this period of time, charging at any of the Blink DCFCs was free. It is speculated that the addition of fees contributed to the decrease in usage, but the exact reasons for the decline are unknown. It should be noted that AeroVironment DCFCs were free to use prior to April 1, 2014, and no noticeable differences in monthly usage were seen after fees were introduced.

The general positive trends in monthly usage may be attributed to several factors. These trends could have been related to drivers having increased awareness of the DCFC network. Drivers had more time to learn about the network and may have used it more as a result. These effects are difficult to quantify. Another possible factor is that throughout the study period, the number of EVs in the region was increasing; therefore, there were more vehicles around to use the chargers.

Density of Registered CHAdeMO-Compatible Vehicles

To further understand the geographical context of fast charger use, the map from Figure 1 was updated to show the number of CHAdeMO-compatible EVs registered in zip codes across Washington and Oregon at the end of 2014. This map is shown in Figure 4. The CHAdeMO-compatible EVs included in the registration numbers are the Nissan Leaf and Mitsubishi i-MiEV, because they were the only such vehicles available in the area during, or prior to, the study period.

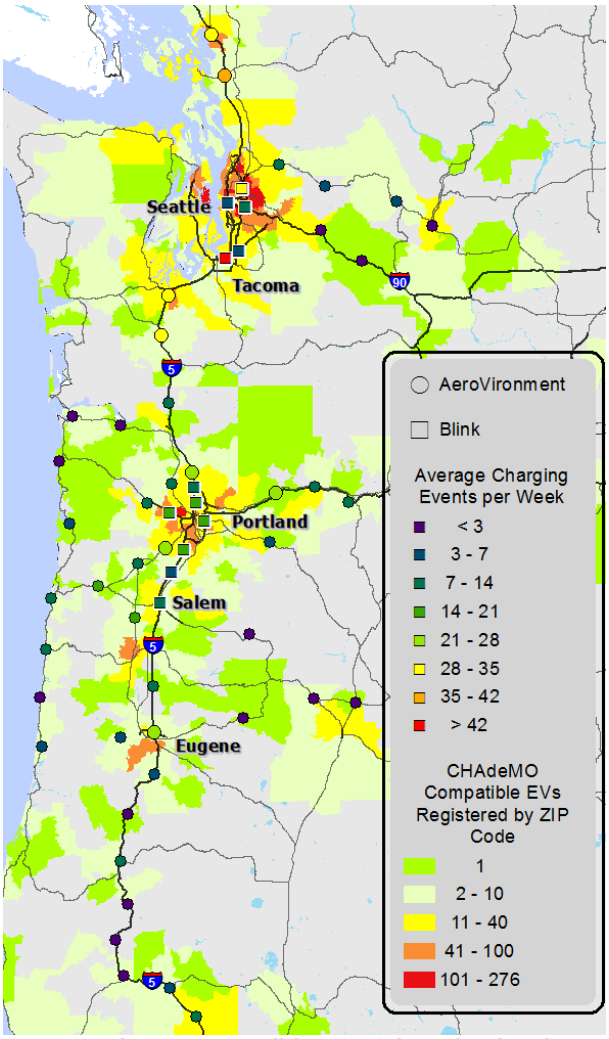

Figure 4. CHAdeMO-compatible EV registration by zip code is shown with the DCFC usage frequency from Figure 1. Gray areas are those with no such vehicles registered.

As expected, the locations in the region with the most CHAdeMO-compatible EVs are the Seattle and Portland

areas, where the population is the largest and the EV charging infrastructure is the most developed. One may think that more vehicles in an area would correlate to more DCFC use; however, this was not always the case. Several highly used DCFCs are located where very few EVs are registered. This means that for most drivers, longer distance travel is necessary in order to use these chargers. These results fit with the findings from the previous study, which showed that when using DCFCs outside of larger cities, drivers drove farther than when using chargers within cities.

About The EV Project

The EV Project was the largest plug-in electric vehicle infrastructure demonstration project in the world, equally funded by the United States Department of Energy (DOE) through the American Recovery and Reinvestment Act and private sector partners. The EV Project deployed over 12,000 alternating current Level 2 charging stations for residential and commercial use and over 100 dual-port DCFCs in 17 U.S. regions. Approximately 8,300 Nissan Leafs™, Chevrolet Volts, and Smart ForTwo Electric Drive vehicles were enrolled in the project.

Project participants gave written consent for The EV Project researchers to collect and analyze data from their vehicles and/or charging units. Data collected from the vehicles and charging infrastructure represented almost 125 million miles of driving and 4 million charging events. The data collection phase of The EV Project ran from January 1, 2011, through December 31, 2013. Idaho National Laboratory is responsible for analyzing the data and publishing summary reports, technical papers, and lessons learned on vehicle and charging unit use.

For more information about The EV Project, visit avt.inl.gov/evproject.shtml.

About the West Coast Electric Highway

The West Coast Electric Highway is a network of 56 alternating current Level 2 EVSE and DCFC located every 25 to 50 miles along major roadways and at popular destinations in the Pacific Northwest (i.e., Washington and Oregon).

For more information about the West Coast Electric Highway, visit www.westcoastgreenhighway.com/electrichighway.htm and www.oregonelectrichighway.com.

About the AeroVironment Data

Idaho National Laboratory expresses thanks to AeroVironment for providing EVSE usage data and to the Washington and Oregon Departments of Transportation for providing the number of EVs registered across their states to Idaho National Laboratory, thereby making this study possible.

For more information about AeroVironment, visit evsolutions.avinc.com.

Company Profile

Idaho National Laboratory is one of DOE's 10 multi-program national laboratories. The laboratory performs work in each of DOE's strategic goal areas: energy, national security, science, and the environment. Idaho National Laboratory is the nation's leading center for nuclear energy research and development. Day-to-day management and operation of the laboratory is the responsibility of Battelle Energy Alliance.

For more information about Idaho National Laboratory, visit www.inl.gov.

References

1. See http://www.nissanusa.com/electric-cars/leaf/owner-questions.

2. Botsford, C., "The West Coast Electric Highway," www.energycentral.com/enduse/electricvehicles/articles/3017.

3. See "DC Fast Charger Usage in the Pacific Northwest" http://avt.inl.gov/pdf/evse/INL_WCEH_DCFCUsage.pdf.