Process For Identifying Public Electric Vehicle Charging Stations In The Columbus Region

Columbus Prioritizes 925 Locations for Chargers
Background and Introduction

In 2016, Columbus was named the winner of the U.S. Department of Transportation’s Smart Cities Challenge and awarded a $10 million grant from the Paul G. Allen Philanthropies. Grant efforts underway target decarbonization, charging infrastructure and fleet and consumer adoption of electric vehicles.

The work is being completed in cooperation with several private, public and academic partners. This paper focuses on the process the City of Columbus’s Smart Columbus team established for siting public charging stations.

Through this process, there were many takeaways that the city would like to share with others in hope that it will simplify their path to deployment of PEV (Plug-In Electric Vehicle) chargers and greater adoption of PEVs.

See Figure 1 for a roadmap that provides a logical methodology for determining public charging locations. Smart Columbus followed this process to identify the most ideal locations for public Level 2 and DC Fast Chargers. The column on the left side of the roadmap orients the user to what information or decisions are being made in the corresponding activities identified in the flow chart on the right. This paper uses these same sections, on the left of Figure 1, as headings for more detailed descriptions of the work undertaken during the siting process.

Key learnings from this project are captured here for companies, municipalities and regions wanting to understand or influence the
**FIGURE 1:** Process for Identifying Public Charging Locations
Analysis was conducted across a seven-county area that includes Franklin County, where the City of Columbus resides, and the six contiguous counties, as shown in Figure 2. The six contiguous counties are Delaware, Licking, Fairfield, Pickaway, Madison and Union counties. Urban areas, interstates and major highways are shown for reference.

**FIGURE 2:** Seven-County Charging Siting
Grant Commitments

The objective of installing charging infrastructure, under the Paul G. Allen Philanthropies grant agreement, is to:

Support the acceleration of electric vehicle adoption through installation of charging infrastructure, with the goal of 925 new charging ports by the end of the three-year grant period, including up to 75 fast charging stations and 850 Level 2 ports. See Figure 3.

The charging commitment is comprised of several efforts:

• Multi-Unit Dwelling (MUD) Charging
• Workplace Charging
• Fleet Charging
• Public Access Charging

This paper focuses on Public Access Charging. The commitments under the

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<th>Organization</th>
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<tr>
<td>AEP</td>
<td>Level 2</td>
<td>90</td>
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<td>DC Fast</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
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Both the City of Columbus and AEP are committed to installations of Level 2 and DC Fast Charging (DCFC) stations under the Paul G. Allen Philanthropies grant agreement. In addition, the State of Ohio, other cities and counties in the region, and private entities have been installing charging stations. The AEP commitment was contingent on approval by the Public Utilities Commission of Ohio (PUCO) and will include charging stations both internal to the seven-county region as well as other locations external to the seven-county region but within the AEP service territory. The final numbers of chargers installed by AEP and the City of Columbus may be modified again based on future learning, opportunities or other factors.
Grant Commitments

The process of selecting priority public charging locations begins by mapping the home locations of consumer-owned PEVs in the region. Home locations are obtained by analysis of registration data obtained from sources such as IHS Polk, an artificial intelligence-assisted database of automotive audiences, or directly from the Bureau of Motor Vehicles. These locations can be mapped to identify concentrations of PEV ownership, referred to as hotspots. Since ownership information is not provided by the Bureau of Motor Vehicles (or IHS Polk), there are invariably some company-owned vehicles included in the population.

Figure 5 shows the concentrations of plug-in vehicles in their home zip codes at the end of 2016. This set of registration data was obtained by NREL from IHS Polk [1]. The registration data shows that a total of 2,104 PEVs were registered in the 7-county region at the end of 2016. In examining the data, we noted that 475 PEVs were registered in one zip code, 43026. This number of vehicles is inconsistent with the remainder of the data and the demographics of the region. Further examination showed that BMW Financial is located in zip code 43026 and is the registrant of 429 company-owned BMWs. Company ownership was verified by contact with BMW Financial. These company-owned vehicles were subtracted from the total in zip code 43026 since their actual locations are not in our region. This adjustment also reduced the estimated total PEVs in the seven-county region to 1,675 PEVs at the end of 2016.

The zip codes with the heaviest concentrations of PEVs in Figure 5 are those that contain communities with high household income. The PEV zip code concentrations are consistent with expectations.

**FIGURE 5:** PEV Ownership Concentrations by ZIP code adjusted for company-owned BMWs in ZIP code 43026.
Upfront costs aside, range anxiety and a lack of charging infrastructure were also identified as major barriers to EV fleet adoption by the City of Columbus. City fleet drivers had concerns about being able to complete their daily work on a single charge, and where and when they could recharge, if needed. Range anxiety is partially a function of vehicle capability, and partially a driver education issue and charging infrastructure issue. Throughout the country, the availability of suitable charging infrastructure remains a challenge.

When the Smart Columbus grant period began in 2016, there were 12 DC fast charging stations (not including Tesla Superchargers) along with some public Level 2 charging and charging at regional workplaces [2]. As of November 2017, 43 DC fast charging ports (all public) and 100 Level 2 ports (85 are public) were in operation in Franklin County, a significant increase from a few years ago [3]. Although EV charging is more accessible today, the City of Columbus only expected to use public charging occasionally and aimed to deploy dedicated overnight charging stations for each new EV within the fleet. This expected charging behavior using a “home base” for fleet drivers is similar to personal EV use, where 80 percent of charging occurs at home [4].

City vehicles are either left in City parking facilities overnight or are taken home by the primary driver. For fleets, prioritizing the deployment of EVs for vehicles that are parked overnight at City facilities have two advantages. First, there is no easy way to reimburse employees for the cost of charging at home. Deploying appropriate charging at City facilities can also ease the management of EVs that are used by more than one employee throughout the day. The City of Columbus evaluated its facilities in order to provide adequate charging for the new fleet vehicles concurrently as it determined which vehicles to replace. In addition to siting the charging stations, Columbus had to determine the type of charging it would provide (see Box 2 for a description of the charging level options); the type determines how quickly EVs can be recharged and the cost of the infrastructure installation.

To further address range anxiety issues, the fleet management division knew they would need to prove to the fleet drivers that the EVs could meet their needs. One approach was to look at the travel distances of each fleet vehicle to assess if the EVs would be compatible. Then, going beyond the vehicle’s electric range, the Fleet Management office, in coordination with Clean Fuels Ohio and local auto dealers, provided EV driving demonstrations, showcasing with a Nissan LEAF and a Chevrolet Bolt models.

**FIGURE 6:** Aggregate light-duty trip counts by TAZ from the MORPC 2015 traffic demand model of Columbus (using a percentile color scale).

Satellite imagery credit: © 2009 Google, Map Data © 2009 Tele Atlas
Figures 7 and 8 show INRIX data. These GPS data compilations were obtained by NREL from INRIX, a data analytic service. Of particular interest are the traffic flows that start or end at the communities with high densities of PEVs. NREL compared MORPC 2015 light-duty trip count estimates (Figure 6) to NREL’s processed version of INRIX data from 2016. Both the MORPC and INRIX data sets confirmed PEV travel and traffic flows.

**FIGURE 7:** Full geographic extent of the INRIX travel data set for Columbus in 2016
Source: NREL [1]

**FIGURE 8:** Trip destination map derived from INRIX travel data set for Columbus in 2016.
Source: NREL [1]
Figure 9 shows vehicle dwell times derived by NREL from the INRIX data. Regions with long vehicle dwell times are characteristic of residences, intermediate dwell times are typically workplaces, and shorter though significant dwell times are shopping centers, entertainment centers, etc. The land-use at the vehicle dwell locations can be confirmed using land-use data provided by regional economic development entities, such as MORPC in the Columbus region as well as from local knowledge (see Table 1).

FIGURE 9: Vehicle Dwell Times derived from INRIX data. Source: NREL.
**TABLE 1:** Candidate destinations for Level 2 and/or DCFC Public Charging

<table>
<thead>
<tr>
<th>Destinations</th>
<th>Details</th>
<th>Level 1</th>
<th>Level 2</th>
<th>DCFC</th>
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<td>Office Buildings</td>
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<tr>
<td></td>
<td>Restaurants</td>
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<td>X</td>
<td></td>
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<td></td>
<td>Theaters</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Concert Venues</td>
<td>X</td>
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<tr>
<td></td>
<td>Riverfront Garages</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aterial Roadways in conjunction with city improvement projects</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Shopping Centers</td>
<td>Easton, Polaris are the 2 largest shopping complexes in the Columbus region</td>
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<td>X</td>
<td></td>
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<tr>
<td></td>
<td>Strip malls</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airport</td>
<td>Long-term parking</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Top Destinations*</td>
<td>Dublin, Worthington, New Albany, Delaware, Newark/Granville, Grove City</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Short Stops</td>
<td>Coffee shops, grocery stores, etc.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*Hot spots identified from INRIX and MORPC data through the region, especially in major suburbs.

Those traffic flows that initiate in the PEV residential hotspots are of primary interest in the identification of charging destination hotspots.

Other data sources, such as parking meter collection data, can confirm local knowledge of areas in the downtown as well as the Short North and Grandview (see Figure 10). Parking meters are part of both public and private agencies’ parking management solutions. Public infrastructure such as libraries, stadiums, tourist attractions, civic buildings, universities, restaurants, bars and hospitals generate high parking demand, which is a major driver for parking meter use. An area in Columbus that has many of these attributes is the Short North, located between downtown and The Ohio State University (one of the largest universities in the United States) along High Street, a major arterial roadway through Columbus. The Short North and Grandview neighborhoods are both popular restaurant and entertainment destinations that experience congestion during much of the day and into the evening. Heavily used metered parking spots in these areas are potentially prime areas for charger locations. Parking meters are generally installed in high traffic areas.
**FIGURE 10:** Parking meter collection for Downtown, Short North and Grandview
Source: City of Columbus
Suitability analysis results for an example City of Columbus vehicle provided by the Electrification Coalition. The results show that the vehicle is a good candidate for EV replacement based on daily usage.

Source: [9]

Best Locations for Charging

Since charging stations at popular shopping, entertainment and dining areas can have high traffic and also provide businesses with a convenient way to attract traffic from PEV drivers, these businesses are ideal partners for charger ownership. The locations shown in Table 1 are prime examples in the Columbus region.

In summary, ideal charger locations are close to popular destinations or have proximity to PEV hotspots. This latter choice is particularly useful for residences of multi-unit dwellings that do not provide on-site charging. For long commutes within the Columbus region (for example, Newark or Delaware to downtown Columbus), mid-trip charging with DCFC can be useful.

There is a portion of the traffic flows that connect with other cities in the state and region (see Figure 7). These traffic flows typically follow the interstate highways (I-70 and I-71). These routes might be best served by a network of mid-trip DCFCs to provide in-route charging access for battery electric vehicles (BEVs).
Legacy Chargers

There are numerous locations where chargers have been installed prior to the Smart Columbus project. According to the U.S. Department of Energy data, as of May 2018, there are approximately 84 public charging locations in the seven-county Columbus region [3]. About 92% of the charging locations are in Franklin County and 65% in Columbus’ city limits. These stations provide about 140 Level 2 plugs and about 52 fast charging plugs at 22 stations. Fast charger plugs are a mixture of CHAdeMO, SAE CCS and Tesla plugs. Both ChAdeMO and CCS plugs are typically available at a DCFC charging location. Teslas that are equipped with a connector can typically charge at all DCFC chargers. However, as of June 2018, only Teslas can charge at a Tesla station.

Based on data obtained from the Ohio Bureau of Motor Vehicles, Plug-in Electric Vehicles (PHEVs) that cannot use fast chargers currently represent about 60% of the Columbus market, but less than 50% of the national market [4]. Vehicle registration data obtained from the Ohio Bureau of Motor Vehicles indicates that during 2015, 2016 and 2017, the Tesla Model S (658, 842, and 1,421 vehicles registered, respectively) dominated the Columbus region’s BEV market followed by the Nissan Leaf (472, 419 and 647 vehicles registered). This will likely change as more long-range BEVs become available in Columbus.

Many of the legacy chargers, though not all, are connected by networks. Networks include Blink, eVgo, ChargePoint, Greenlots and Tesla.

The presence of legacy Level 2 and/or DCFC chargers at a location identified in this selection process raise the question of whether additional charging is necessary. If available, legacy charger usage data can be used to

Charging Location Amenities/ Cost and Availability of Power/ Type of Charger

If charging at a destination where the vehicle might remain parked for one to two hours or longer, access to a Level 2 charger is desired. The charger location should have easy access to power. It should be close to the driver’s final destination (<0.2 miles). If there is easy access to a sufficient power supply, then consideration should be given to both Level 2 and DCFC.

If charging mid-trip with a DCFC, then the vehicle operator will remain at or close to the charger while the vehicle is charging. To be used, the location must be safe for the person responsible for charging while outside the vehicle. It should also have easy access to amenities, such as a coffee shop, sandwich shop and/or restrooms, since the charging operation might last 20 to 30 minutes.

The cost to install the DCFC charger will be highly dependent on the cost of connecting with a transformer with sufficient energy. The dwell time at the charger will depend on the power level of the charging event and the number of miles-range that will normally be needed by the vehicle. Of course, only EVs and not PHEVs will be serviced at the DCFC. It will be important to minimize power costs and avoid utility demand charges.

For both Level 2 and DCFC, proximate businesses should be approached to create possible partnerships. If the partner is normally a significant power consumer, the partner may be able to avoid demand charges for DCFC by placing the charger behind his/her electric meter.

If the location has no access to power without significant construction and added expense, the location is not suitable for charger installation. For those locations that are suitable, both Level 2 and DCFC should be considered—keeping in mind the benefits and limitations of both types of chargers.
Level 2

Level 2 chargers will require access to a 240 volt, 15 to 40 amp AC circuit (typically 30 amps to provide 7 kW of charging power). Access to this type of circuit is generally available within a business or multi-unit apartment community. The connection cost will depend largely on the type of construction adjacent to the charger. Best candidates are locations where infrastructure new construction or upgrades are in progress.

Another approach that is being piloted in Columbus is the use of solar photovoltaic power with some storage capacity that can be easily installed and moved about. The limitation of the units that are produced by a partner, DC Solar, is that the charging power is limited to about 3 kW.

DCFC

DCFC installations are at higher power levels; typically 50 to 150 kW. Although chargers with higher power levels (250kW to 300kW) are now being developed, not all EVs can accept the higher power levels. Nevertheless, the higher power DCFC units will have substantially higher installation costs than Level 2 chargers. In addition, the charger itself may require cooled cables and is built to higher electrical standards than Level 2 chargers—resulting in charger costs that are typically 10 times higher than Level 2 chargers.

In support of the City of Columbus Electrification Program, ms consultants, a local engineering and architecture firm, conducted a detailed cost study for up to 12 DCFCs on adjacent streets (initial plans are one charger on one street and two on the other) that will provide easy access to and from downtown Columbus [5]. There is an existing utility vault between the two parallel streets and both streets are being upgraded at this time. Additional construction costs to provide a cabinet at each street to include metering and switching, conduits and foundations for the chargers are estimated to cost about $95,000 to the City of Columbus. The utility added cost for a transformer upgrade and cabling is estimated to be about $96,000. This total of about $191,000 does not include the DCFCs, which will be installed after construction is completed.

To minimize DCFC costs, desirable locations should be adjacent to transformers with sufficient power ratings to operate the chargers and minimize cabling costs.

Ranking

If the charging stations and charging plugs exceed the number and/or cost that can be installed within the project budget, then the chargers should be ranked in importance. Major items that ranking should be based on include:

- **Expected usage/revenue**: Driven mostly by traffic density, parking density and strategic mid-trip location (such as on freeways or major highways between frequently traveled destinations).
- **Cost**: Cost differentials are driven by infrastructure needs—primarily for DCFC.
- **Critical need**: Location enables EVs to travel to a destination that otherwise would be unreachable due to EV range limitations. The metric is EV drivers reaching a destination beyond their typical range.
- **Expected partners**: Businesses and public entities that benefit by the proximity of charging stations. Businesses that need to attract the public may offer convenient and/or free charging. Public entities such as bus park-and-ride parking lots and the airport may also benefit from access to charging. Additional business partners may be taxi or car services.
- **Shopping centers and restaurants**: Can be excellent partners and benefit economically from charger installations. In Columbus, Easton Town Center has beneficially provided both Level 2 and DCFC for the convenience of its customers.
If charging at a destination where the vehicle might remain parked for one to two hours or longer, access to a Level 2 charger is desired. The charger location should have easy access to power. It should be close to the driver’s final destination (<0.2 miles). If there is easy access to a sufficient power supply, then consideration should be given to both Level 2 and DCFC.

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Authors

Bud Braughton, City of Columbus, NLBraughton@columbus.gov
Edward Ungar, PhD, HNTB Corporation, eungar@hntb.com
Katie Zehnder, HNTB Corporation, kzehnder@hntb.com

Contributors

Mandy Bishop, PE, City of Columbus, MKBishop@columbus.gov
Kevin McSweeney, City of Columbus, KMMcSweeney@columbus.gov
Kayla Stucke, GPD Group, kstucke@gpdgroup.com
Tom Flask, PE, HNTB, tflask@hntb.com
Scott Jaffee, PE, GPD Group, sjaffee@gpdgroup.com
References


Infrastructure Deployment

Given that charging infrastructure is a major barrier to fleet EV adoption, the City of Columbus prioritized charging access as part of its EV procurement decision. Data such as that shown in Figure 7 helped to identify daily parking locations (including overnight), which allowed the City to narrow potential charging station locations to nine common parking areas to serve the six divisions deploying EVs. Of the nine common parking areas, Columbus identified three charging primary sites that could best accommodate the 93 EVs in the first phase: 50 Level 2 charging stations in a garage downtown, 16 for the Facilities Management Division, 20 for the Division of Fire. The 10 PHEVs for the Division of Police will not have Level 2 charging during this first phase, but will instead rely on Level 1 charging. According to the City, accommodating charging for the first phase of EV procurement was relatively straightforward, but the remaining charging stations may be more difficult to site.

A mix of gasoline-powered passenger cars are being replaced with EVs for several divisions within the City of Columbus.
Source: City of Columbus
Lessons Learned and Guidance for Other Cities

The Smart Columbus initiative gave the City of Columbus an incentive to execute an innovative hybrid lease-purchase contract for EV procurement. The procurement process followed by the City can serve as a model for other jurisdictions looking to acquire EVs. The RFP designed by the City was intentionally flexible, allowing for both purchase and lease options, the capturing of all or a part of the federal EV tax credit, and a discount for the purchase of an EV by City employees. The combination of an innovative contract and persistence from the City and partner organizations resulted in the procurement of the first 93 of 200 EVs for the City.

The success of the City of Columbus’ fleet electrification program thus far can be attributed to the collaboration of the many organizations involved in the procurement. Throughout the process, the City identified lessons learned that could be useful to other public agencies beginning their own EV procurement process.

First, the team found that persistence is important to get buy-in from the drivers with range anxiety and to achieve unconventional contracts for public agencies, such as leasing. Not only was the City persistent, but the team practiced a commitment to internal communication that made working toward a shared goal easier to achieve.

Second, allowing for flexibility in the invitation to bid was critical to selecting the final hybrid lease-purchase contract. The project-funded incentives helped the City to overcome the cost barriers for vehicles and charging infrastructure that all public agencies face.

Third, non-profits, including Clean Fuels Ohio and the Electrification Coalitions, were an important part of the team that helped provide education, outreach, and analytical services. The non-profits offered free analytical services to the City and other entities that eased the decision-making process; they recruited fleets to participate in the program; and they offered training and demos to educate fleets throughout the procurement process and beyond.

Finally, the City found the rapidly advancing EV technology was a benefit to the fleet, as they were able to take advantage of the longer-range Nissan LEAF. Keeping apprised of these changes in vehicle offerings from auto manufacturers allowed to City to cost-effectively address range concerns raised by their drivers.

The City of Columbus will continue to work toward the procurement of 200 EVs by the end of the Smart Columbus grant term. These findings and early lessons learned can ensure that they will continue to successfully meet the project goals and serve as a valuable example for other public agencies to follow.
APPENDIX A: ASSUMPTIONS FOR FLEET PROCUREMENT ANALYSIS

Below is a table of assumptions for the procurement analysis presented in Evaluating the Bids for a Universal Term Contract. The analysis was completed using version 1.10 of the Fleet Procurement Analysis Tool, available for free from Atlas Public Policy at www.atlaspolicy.com/rand/fleet-procurement-analysis-tool.

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<tr>
<th>Factor</th>
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