Plug-in, Charge Up, Peel Out: Electric Vehicle Supply Equipment Development Guidebook for Pennsylvania Local Governments

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Executive Summary

The accelerating adoption of electric vehicles (EVs) in Pennsylvania is putting pressure on local governments to embrace best practices to encourage the development of EV infrastructure, particularly electric vehicle supply equipment (EVSE), also known as charging locations. New federal funding and planning by Pennsylvania agencies reflect the importance of EVs to the Biden and Wolf administrations. This report, and the supplemental materials in the appendix, provide valuable information regarding EVs, EV infrastructure, best practices, and resources for EVSE development. Also provided is a model ordinance which seeks to protect consumers and residents, reduce costs, and provide responsible planning and development. In preparing these documents, our team conducted a literature review, data analysis, and interviewed over 20 stakeholders including policy experts, developers, EV infrastructure firms, representatives of planning authorities, state government departments, local government managers, and planners.

In Q4 of 2021, EVs accounted for 4.5 percent of the vehicles sold in the United States (*Strong Finish: EV Sales Mark New Record in Fourth Quarter of 2021,* 2022). There is a growing consensus among industry leaders that EVs will represent 25 percent to 40 percent of sales by 2030 and will comprise half of all cars on the road by 2050 (Adler, 2021). EV ownership today is concentrated in PA's larger urban areas and their suburban counties among white, middle aged, higher-income men (*Pennsylvania Registered Vehicles by Fuel Type and Zip Code,* n.d.; Fuels Institute, 2021). As EVs become cheaper, begin to directly compete with gas-powered vehicles, and as EV battery range increases, EV ownership is expected to both deepen and widen in the Commonwealth. Currently, EVs generally have a higher sale price but cost roughly two-thirds as much to maintain and half as much to 'fill up' (Baldin, 2020).

The projected mass adoption of EVs presents equity issues that local governments will face. As rural areas are seeing slower EV adoption, the related lack of EV infrastructure in rural areas threatens to leave local consumers behind and keep away tourists with EVs. Since most charging happens at home in the evenings and overnight, Pennsylvanians without personal parking garages can struggle to charge and may be forced to rely on sporadically available public chargers. Without unique equipment standards, EV drivers with disabilities may struggle to find accessible EVSE-equipped parking and charging equipment. Pennsylvanians without smartphones, credit cards, and debit cards or other traditional financial products (the unbanked) often struggle to utilize EVSE that often require payment via card or mobile app.

One essential tool for local governments to support electric vehicle adoption and EVSE infrastructure installation is the attached model ordinance. Ordinances have been introduced and passed into law in hundreds of communities, large and small, and across entire states, such as California and New Jersey. EV ordinances usually require EVSE equipment and design standards as well as EVSE and make-ready (MR) parking minimums for new developments. This report includes a review of ordinance issues and best practices as well as a model ordinance. In addition to the model ordinance, this report includes other recommendations and best practices for municipalities to manage the rising growth of EVs, facilitate EVSE deployment, and mitigate the growing equity issues related to EVs.

Introduction

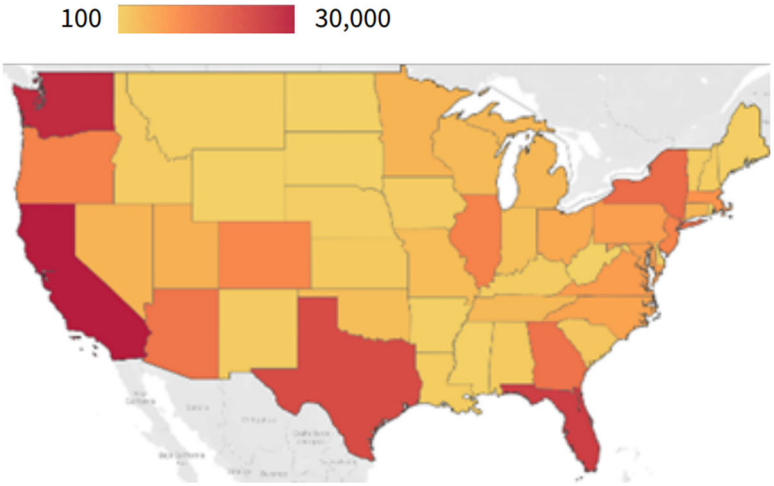
Problem Statement

"As electric vehicles rapidly increase in popularity, local governments will be tasked with the challenge of meeting their residents' need for accessible electric vehicle charging stations within their municipalities. In Pennsylvania, local municipalities are responsible for the development of code language and the implementation of equitable and sustainable EVSE standards. If local governments do not engage with EVs and EV infrastructure, they are at risk of prohibiting access to EVs for certain residents and losing out on revenues from EV owners looking to patronize local businesses. Many local governments do not have the resources to internally develop plans to implement or regulate electric vehicle infrastructure within their jurisdictions. This guidebook provides clear and detailed guidance regarding the installation and maintenance of electric vehicle infrastructure."

Current and Projected EV Sales

EVs are becoming rapidly adopted in the United States and Pennsylvania despite the economic slowdown induced by the COVID-19 pandemic. In Q4 of 2021, EVs accounted for 4.5 percent of the vehicles sold in the United States (*Strong Finish: EV Sales Mark New Record in Fourth Quarter of 2021,* 2022). While EV growth in the US has so far been outpaced by China and Europe, the US has experienced a 200 percent increase in EV ownership since 2010 (Walton et al., 2020).

Figure 1: Heatmap of BEV Population Based on Number of Registrations by State (2018)

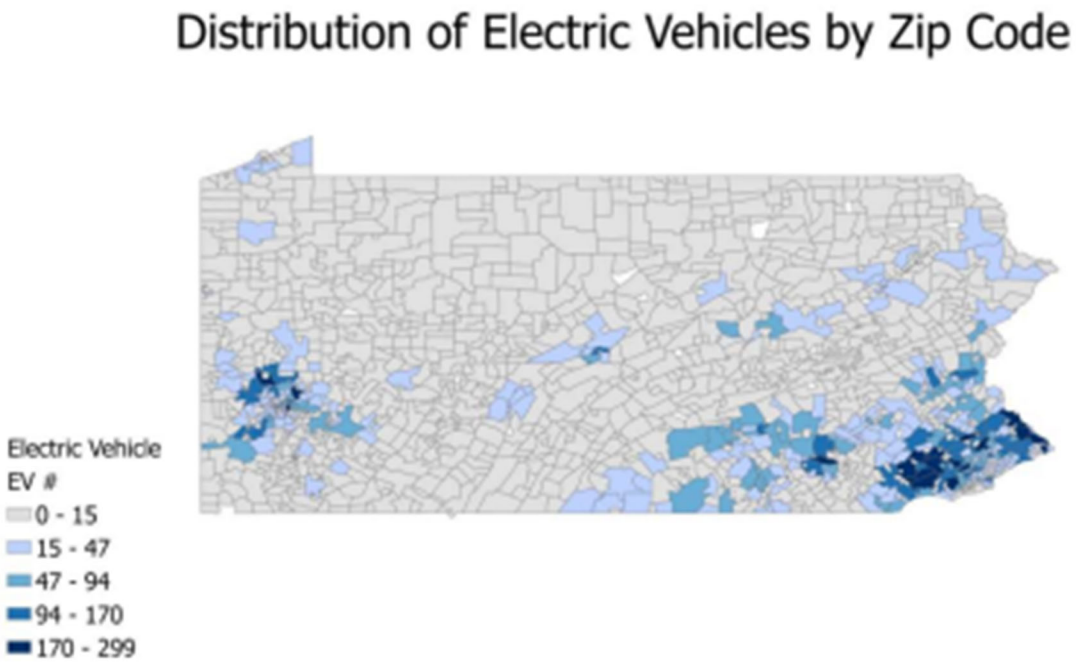


Note: Total registrations in California is 256,000 but the legend ends at 30,000 to highlight the variation in other states.

Source: "Electric Vehicle Registrations by State," National Renewable Energy Laboratory

Adapted from: Fuels Institute. (2021). EV Consumer Behavior. https://www.fuelsinstitute.org/Research/Reports/EV-Consumer-Behavior/EV-Consumer-Behavior-Report.pdf

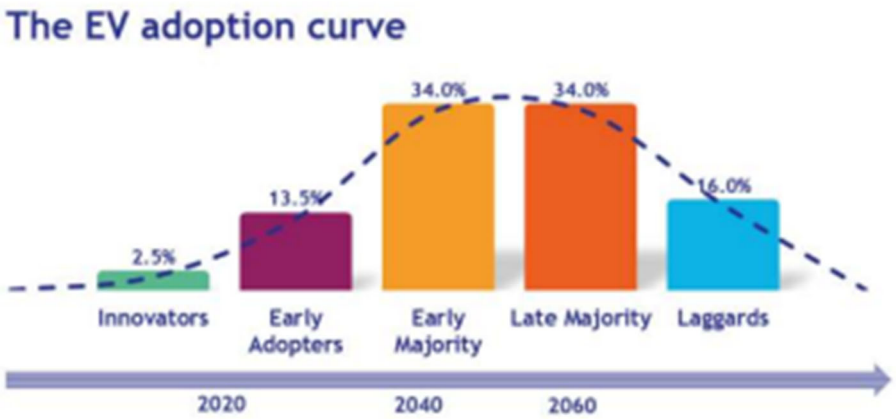
Figure 2:



Data from: Pennsylvania Registered Vehicles by Fuel Type and Zip Code. (n.d.). Retrieved April 11, 2022, from https://s3.amazonaws.com/tmp-map/dot/vpic/pa-registered-vehicles-by-fuel-type-and-zip-code.html.

PA is solidly in the middle of the pack among US states regarding EV adoption. PennDOT and PADEP developed the 2021 PA EV Road Map to identify barriers to EV use in the Commonwealth and provide corrective strategies. According to the PA EV Roadmap, in 2021, there were 23,689 registered electric vehicles and 1,469 public EV charging stations in Pennsylvania with most zip codes reporting fewer than 15 electric vehicles. As of now, EVs are heavily concentrated in urban and suburban southeastern and southwestern Pennsylvania (*Pennsylvania Registered Vehicles by Fuel Type and Zip Code,* n.d.). Deloitte estimates the most prevalent reason that consumers are hesitant to purchase EV's is the lack of EV infrastructure (Deloitte, 2020). The current number of public chargers in Pennsylvania will need to increase over time to accommodate growing EV ownership. Squarely behind the concern about EVSE is the concern about range anxiety (Deloitte, 2020). Consumers worry about longer road trips and that their EV's will not sustain a long enough charge to hold up to the rigors of cross-country travel. Both of these concerns can be alleviated by providing ample charging stations both at retail locations and along highway corridors.

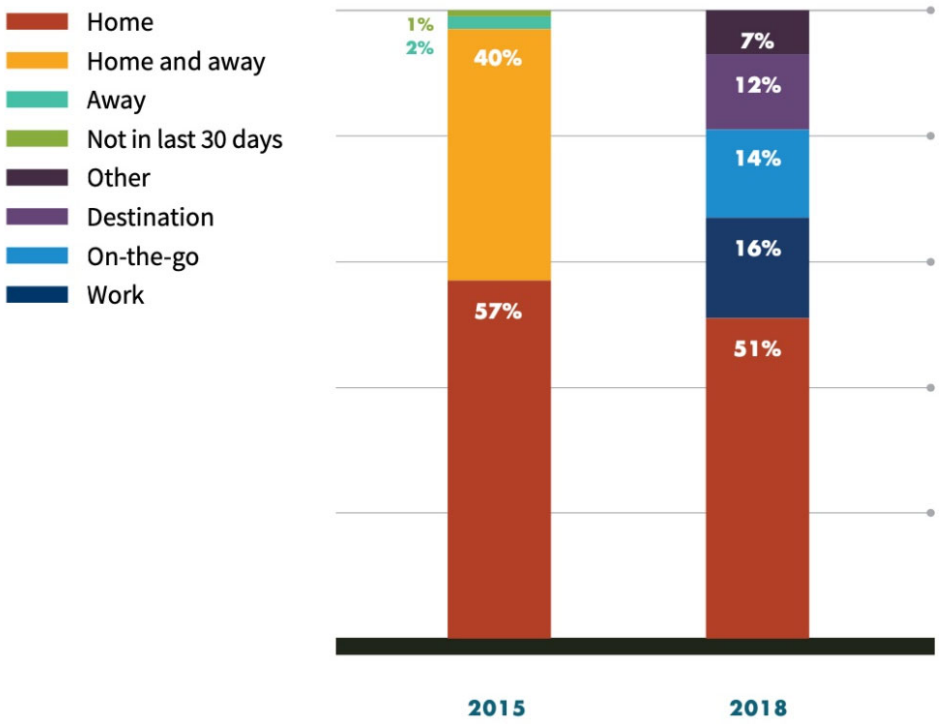
Figure 3:



From: Kalibrate. (2021, July 30). *EV customer segmentation: The early EV driver*. Kalibrate Global. Retrieved April 11, 2022, from https://kalibrate.com/insights/blog/electric-vehicles/the-early-ev-driver/

As of 2022, the typical EV purchasers are current vehicle owners who are middle aged, white males earning more than $100,000 a year with at least a college degree. While sales have grown exponentially, this profile has not significantly altered (Fuels Institute, 2021). The first wave of EV consumers can be characterized by technology enthusiasts who are often the first to adopt to new consumer technology products. Reports suggest they tend to be affluent, brand conscious, travel often, express interest in environmental causes, and they express interest in healthy living (Kalibrate, 2021).

Figure 4: Average PEV Charging Frequency by Location



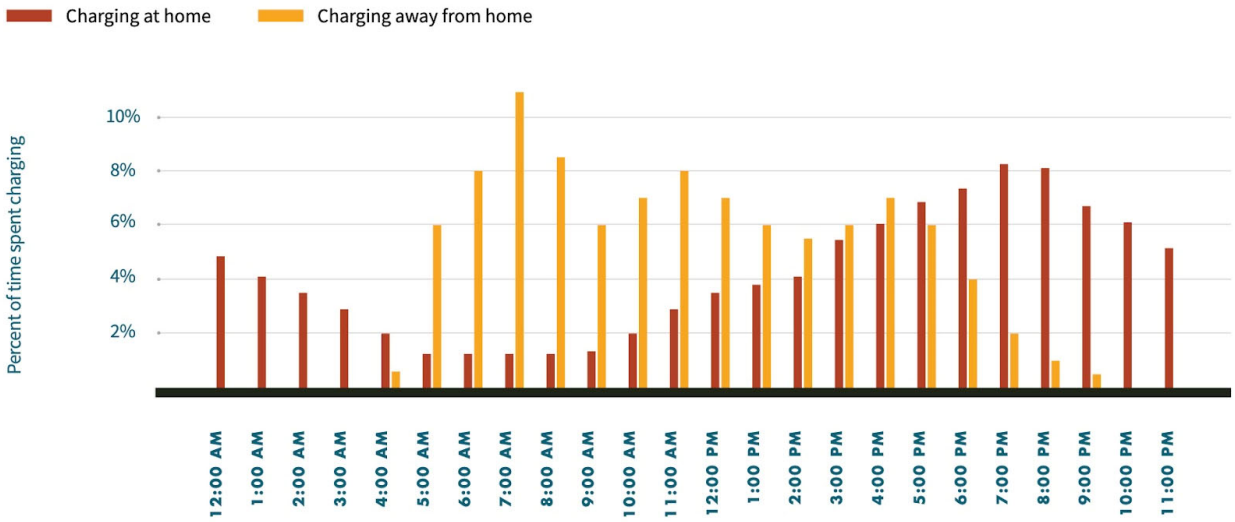
Source: John Smart, "EV Charging Infrastructure Usage in Large-scale Charging Infrastructure Demonstrations: Public Charging Station Case Studies for ARB"

Adapted From: Fuels Institute. (2021). EV Consumer Behavior. https://www.fuelsinstitute.org/Research/Reports/EV-Consumer-Behavior/EV-Consumer-Behavior-Report.pdf

EV drivers usually recharge daily or every other day and most do so overnight at home. Many charge vehicles at a workplace parking lot and about 70 percent to 80 percent of charging occurs at home or at work. Most EV consumers drive within their battery range and use a publicly accessible charger when making longer trips or when they have difficulty charging overnight at home. The most popular publicly accessible chargers are in locations where drivers park for longer

periods (e.g., airport parking lots, grocery stores, dining establishments and general retail shopping) (Fuels Institute, 2021).

Figure 5: Estimate: Percentage Time Spent Charging at a Given Point in Time During the Day (2017)

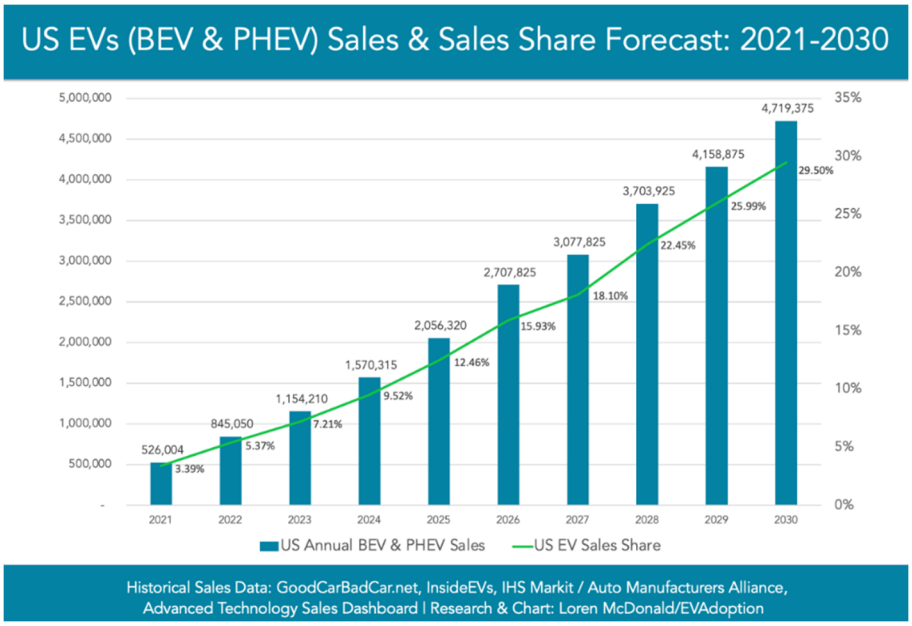


Note: Away includes charging at work and at public charging stations
Source: American Public Power Association, A Public Power Guide to Understanding the U.S. Plug-in Electric Vehicle Market

Adapted From: Fuels Institute. (2021). EV Consumer Behavior. https://www.fuelsinstitute.org/Research/Reports/EV-Consumer-Behavior/EV-Consumer-Behavior-Report.pdf

EV drivers tend to base their choice of public chargers mostly on dependability, convenience, cost of use, and need to travel beyond the EV's range. EV drivers expect to spend 30 to 60 minutes at a charger, although some studies show consumers would prefer to spend 15 minutes or less. Evidence suggests grocery store visits, dining, and shopping are preferred activities while charging (Fuels Institute, 2021).

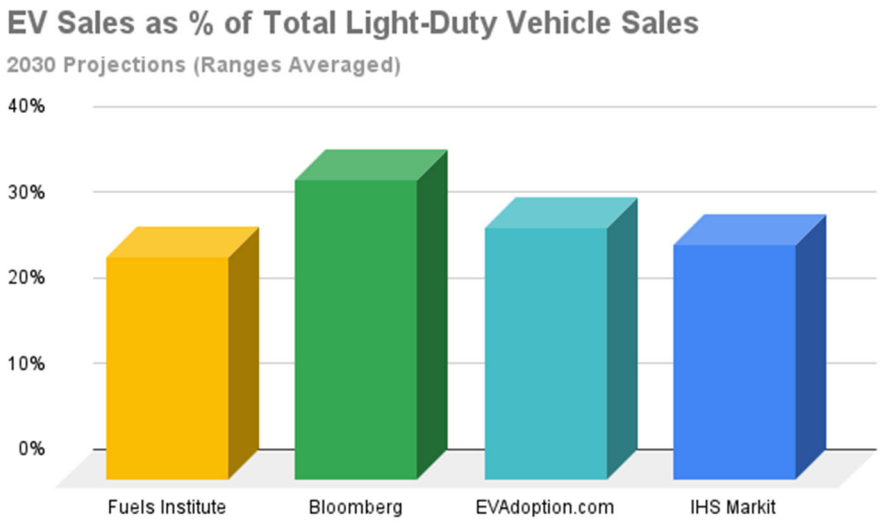
Figure 6:



From: EVAdoption. (n.d.). *EV Sales Forecast*. EVAdoption. Retrieved March 17, 2022, from https://evadoption.com/ev-sales/ev-sales-forecasts/#:~:text=Below%20is%20our%20latest%20long,more%20than%20500%2C000%20in%202021.

Industry experts agree that EVs will rocket in popularity and prevalence in the US and Pennsylvania. IHS Markit projects that 45 percent of new car sales in the US will be electric vehicles by 2035, and half of all cars on the road will be electric by 2050. According to Bloomberg Research, the US EV market is poised to reach 70 percent of light-duty vehicle sales by 2035. (Adler, 2021). The Biden administration has set a goal of EVs comprising 60 percent to 70 percent of total vehicles by 2050 (Cage, 2022). The potential ceiling for EV market share is extremely high, as EVs are 85 percent of new vehicle sales in Norway as of 2021 (Kalibrate, 2021).

Figure 7:



Sources: Fuels Institute. (2021). EV Consumer Behavior. https://www.fuelsinstitute.org/Research/Reports/EV-Consumer-Behavior/EV-Consumer-Behavior-Report.pdf

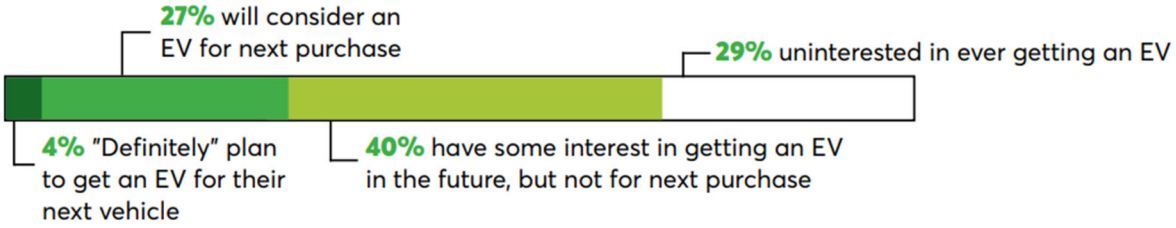
(2021). *Electric Vehicle Outlook 202*1. Bloomberg NEF. Retrieved from https://bnef.turtl.co/story/evo-2021/page/1?teaser=yes

EVAdoption. (n.d.). *EV Sales Forecast*. EVAdoption. Retrieved March 17, 2022, from https://evadoption.com/ev-sales/ev-sales-forecasts/#:~:text=Below%20is%20our%20latest%20long,more%20than%20500%2C000%20in%202021.

Pivoting to an Electrified Future. IHS Markit. Retrieved 4/1/22 from https://cdn.ihsmarkit.com/www/pdf/0421/675485260-0421-CU-AUT-ZEV-Whitepaper.pdf

Market and consumer analysis shows movement towards mass EV adoption. Between three to four-in-ten Americans state they are at least somewhat likely to buy an EV as their next vehicle. A total of 71 percent said they had interest in purchasing an EV at some point. Three-in-ten Americans say they know a lot about EVs, and this group is more likely to consider an EV as their next vehicle. Millennials are particularly open to considering the purchase of an EV (Consumer Reports, 2020; Preston, 2020a).

Figure 8: Portion of American Adults Interested in Purchasing EVs



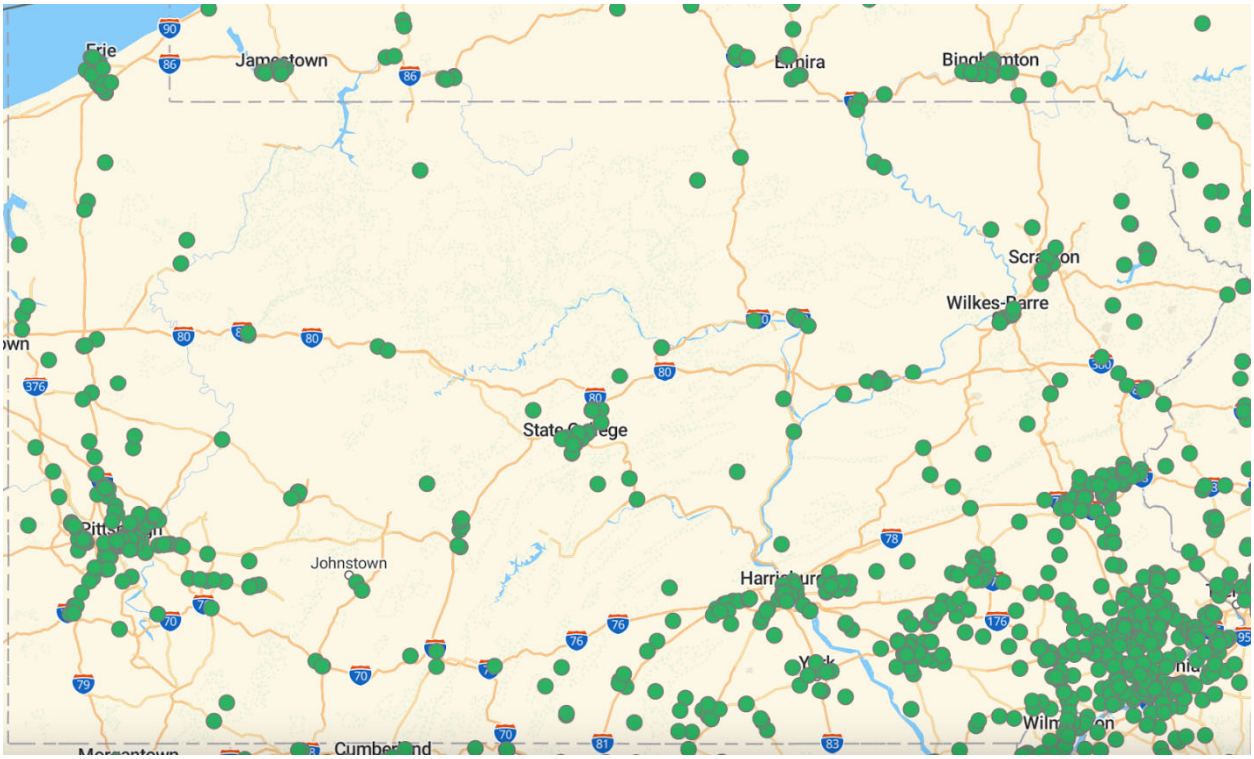
Adapted from: Consumer Reports. (December, 2020). *New CR survey finds the majority of consumers are interested in getting an electric vehicle*. https://advocacy.consumerreports.org/wp-content/uploads/2020/12/EV-Survey-2020-Fact-Sheet-12.16.20-3.pdf

Many Pennsylvanians are eagerly adopting EVs for several reasons. First, EVs are widely seen as key to reaching key environmental goals, such as reducing air pollution and combating climate change. Second, EVs have a growing reputation for reliability and longer-term cost benefits, including maintenance and fueling costs. While EVs generally have a higher purchase price, they can be two-thirds the cost to maintain and half as much to fuel as gas-powered vehicles (Baldin, 2020; Fuels Institute, 2021). Purchase prices of EVs have historically been significantly higher than gas-powered vehicles, however they have been steadily dropping over the last few years. Some industry experts project that EVs will be purchase price-competitive with fossil fuel vehicles as soon as 2024 and will be cheaper in 2030 (Gearino, 2021). However, until EV purchase prices equal or undercut the purchase price of fossil-fuel vehicles, price-sensitive middle- and low-income consumers will be hindered from purchasing EVs, threatening mass and equitable adoption.

EVs' prevalence may not spread as widely, or as quickly, if other serious challenges to ownership are not addressed. About half of surveyed drivers want an EV that can drive more than 300 miles on a single charge and slightly less than half of those who do not "definitely" plan to buy an EV as their next vehicle cite inadequate EVSE infrastructure as what is holding them back. Other items individuals stated were purchase price, 43 percent; insufficient knowledge, 30 percent; and a lack of a place to charge at home, 28 percent (Consumer Reports, 2020).

Local governments can join the fight to reduce these threats to mass EV adoption by supporting local EVSE infrastructure development and charging at home. Municipalities can facilitate publicly accessible EVSE development in high use areas, such as grocery stores and retail locations. This report, and the attached Annotated PA EV Ordinance in the appendix, provide best practices and examples of how local governments can encourage EVSE development in high use public areas and in Pennsylvania homes.

Figure 9: Pennsylvania EVSE Locations



Source: US Department of Energy. Electric Vehicle Charging Station Locations. Retrieved on 4/25/22 from https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC)

Local governments will not be alone in this endeavor. Pennsylvania is addressing this issue by creating highway charging stations or AFC. PennDOT and other key stakeholders have begun establishing AFC routes and are currently expanding its corridor system. Charging infrastructure is seeing robust growth in the 50 largest metropolitan areas. U.S. public DC fast chargers, Level 2, and workplace charging increased 36 percent, 28 percent, and 19 percent, respectively from 2019 to 2020. DC fast chargers comprise 16 percent of public chargers in the 50 examined metropolitan areas, the remainder are Level 2. These metropolitan areas accounted for 77 percent

of new EV registrations, 61 percent of the total light-duty market, and 55 percent of the U.S. population. Their EV vehicle uptake was 3.2 percent, more than five times the uptake in the rest of the country (Bui et al., 2021; Preston, 2020b). While this development is encouraging, the disparity between metropolitan and rural EVSE raises serious equity and logistical concerns.

EV Implementation and Best Practices

Ensuring Equity in EV Charging Access

To further alleviate consumer concerns and promote EV adoption, ensuring equity in EV charging access should be a serious consideration for your municipality. While the majority of EVSE infrastructure is installed and managed by private organizations, local governments may install or manage EVSE as a means of increasing equity in EV charging access. As of now, EV ownership demographics have not been representative of the general population. Despite rising rates of EV ownership, the average EV owner is a male in their 40s or 50s, is a homeowner, and has a higher-than-average household income of over $100,000 (Fuels Institute, 2021).

However, these demographics are destined to change as EVs take over the automotive industry. As EVs are projected to become the "standard" vehicle, your municipality can help spur a higher and broader rate of adoption by ensuring this technology and EVSE will be accessible to all their constituents, regardless of housing status, disability, or access to credit, debit cards, or mobile apps.

Range Anxiety and Rural Access

Up to this point, electric vehicle adoption has been most robust in suburban areas. According to current Pennsylvania vehicle registration data, every county in the bottom half of electric vehicle prevalence as a percentage of total vehicles is a rural county. Rural counties are as defined by the Center for Rural Pennsylvania (Pennsylvania Registered Vehicles by Fuel Type and Zip Code, n.d.; Center for Rural PA, n.d.). Range anxiety is a major obstacle to individual consumer choices on EV purchasing, and public EV charger density is overwhelmingly lopsided toward urban and rural areas, with many rural areas having no public chargers at all (Bonges & Lusk, 2016; Tolbert, 2021).

As EV adoption continues to grow and vehicle manufacturers adjust their production away from gasoline-powered vehicles, a lack of charging infrastructure will become an increasing problem for rural residents and early adopters of this technology in those areas. Even now, rural communities without EVs can encounter issues with business and tourism. Areas without public EV charging stations may find themselves increasingly avoided by EV drivers from urban and suburban areas, resulting in a loss of tourism and retail income for communities (EV Connect, 2021).

Alternatively, if your municipality takes action to ensure the availability of public EV charging infrastructure, while reducing barriers to EVSE installation, it can stand out as an EV-friendly destination for EV drivers. Given that it takes longer to charge an electric vehicle than to fuel a gasoline-powered car, EV drivers are more likely to engage in other activities while fueling, such as visiting stores, restaurants, parks, and other attractions, which would deliver benefits to

your businesses if your community can accommodate EV drivers (U.S. Department of Transportation, n.d.).

Residents of Dwellings Without Private Parking Garages

At-home charging is the primary method of charging electric vehicles, but due to limited access to this type of charging, there are more barriers to overcome when trying to increase electric vehicle ownership. As electric vehicles become increasingly popular, you should keep in mind people without private parking garages – the easiest way for someone to get their own EV charger – both as a crucial equity consideration and as an amenity potentially demanded by your residents in the future.

In 2020, it was estimated that 81 percent of EV owners lived in single-family detached homes, despite only 68 percent of the population living in single-family detached homes (Bauer et al., 2021). Residents of multifamily dwellings, or those who rely on on-street parking, are usually unable to install EV chargers on their own. This may lead them to look to their municipality for solutions. In addition, lower-income communities have a higher percentage of drivers living in apartments and attached homes, types of homes less likely to have individual garages, and have fewer publicly available charging stations at places such as gas stations or shopping centers (Fleming, 2018). With proper planning early in implementation, your municipality can address this growing issue and meet this future demand.

A growing number of municipalities are encouraging or requiring EVSE installation in new residential construction or parking facilities in new residential developments that can accommodate EVSE in the future ("make-ready" or "MR"). At-home charging is "almost always the cheapest, most convenient, most reliable, and grid-friendly option," and municipalities have the tools to promote it. By using development requirements, building codes, incentives, and partnerships for the installation of EVSE in parking facilities for multi-family dwellings, your municipality can also ensure that all your residents, of diverse income and housing categories, can share in the rise of electric vehicle ownership (Descant, 2021).

Requirements for new development will make it much easier for your residents in those houses and communities to get access to EV charging, however, it does little to help residents in already-built housing units. Fortunately for them, trends so far reflect a shifting pattern of charging, potentially offering opportunities for EV ownership to more categories of people and creating other opportunities for municipal action. Home charging is expected to decrease from 78 percent to 50 percent of EV electricity consumption between 2020 and 2030, with increasing usage of public and workplace charging; more accessible to those without at-home charging capabilities (Bauer et al., 2021).

Your municipality, either on its own or in partnership with local businesses, can drive the installation of public EV charging stations throughout your community. Doing so offers a place for charging to those residents unable to do it at home. To improve access to "home" charging, your municipality can consider arrangements to allow overnight parking and EV charging in locations, possibly using municipal parking lots or private partnerships if feasible, near multi-

family developments, apartment buildings, or neighborhoods generally lacking separate garages. For both residents and visitors of your municipality, having publicly accessible charging stations where people spend time offers convenience, provides an important service, as well as boosts nearby businesses and attractions. ***Appendix 8: EV Charging Station Siting Guide*** offers some guidelines on what chargers to use and potential locations to consider placing public EV charging stations.

Public Charging Access for Americans with Disabilities

As electric vehicle charging infrastructure becomes more common, equity considerations demand that accessibility be included in EV charging infrastructure planning; this is especially important for the 12 percent of Pennsylvanians with mobility-related disabilities (CDC's National Center on Birth Defects and Developmental Disabilities). The Americans with Disabilities Act generally requires that new construction be "readily accessible to and usable by individuals with disabilities," creating an important municipal consideration for the design and placement of EVSE (Center for Disease Control and Prevention, 2021).

To ensure that accessibility is a principle respected in efforts to expand EV charging infrastructure, your municipal ordinances can require that EV charging stations include accessibility-related factors. These could include specific requirements for accessible parking spaces in new development, EV charging parking space dimensions, and accessible design elements for charging equipment (ECOtality North America, 2011; NCPEV Taskforce, 2014; Wendler, 2018). By considering these factors, your municipality can guide the development of EV infrastructure to be accessible to those with disabilities, ensuring that spaces of sufficient size and access are available to meet the needs of their population.

The Unbanked - Ability to Pay for Charging

According to a 2019 study by the Federal Reserve, 5 percent of the population do not have a bank account ("unbanked") and 17 percent do not have a credit card. These rates are significantly higher among lower-income households, individuals without a college or high school education, and racial minorities (*Economic Well-Being of U.S. Households in 2020*, 2021). A similar amount, 15 percent, do not own a smartphone, again, higher for lower-income individuals (Pew Research Center, 2021). Since an important objective of public EV charging stations is to provide access to those without access to at-home charging, the overlap between the unbanked or underbanked and needing accessible public charging stations in the future as EVs become more common. This makes it prudent for you to consider payment methods for charging stations in your municipality.

An EV charging station that only offers the ability to pay with a single method, such as by credit card or mobile app, will limit access for this group, without a clear consensus around any singular solution. You may prefer free charging stations in some cases if the goal is to provide an attraction for another purpose, such as a store or restaurant. Charging stations that require pre-registration or membership have been found to create confusion for charging customers, and your municipality should work with EV charging companies and businesses looking to install charging stations to ensure access to multiple payment types (California Air Resources Board, 2022).

Cash payments, although rare, have been utilized successfully in some cases as an alternative alongside pay-by-app to avoid high credit card fees and ensure access (Teplyakov et al.). Other payment arrangements, such as payment through a 1-800 toll free number or prepaid debit cards, can also facilitate access to these underserved groups. Regardless of which payment types are used, you should take care to ensure signage is clearly visible and outline procedures to avoid confusion and frustration for EV drivers. Through our interviews with local municipalities and research, we have not uncovered a silver bullet to allowing someone without access to a bank account or mobile phone to operate public EVSE requiring payment. However, increasing payment accessibility is still an effective tool in lowering the overall barrier to EV ownership. To see a guide focused on equity in EVSE implementation, visit **Appendix 9**, there is also an explanation of equity provisions in the PA EV Model Ordinance.

Stakeholder Engagement

Each locality will have their own unique pathway toward further building out EVSE in their community. Some localities will be able to rely on adopting a comprehensive ordinance while others will find creating goals and a roadmap through thorough community engagement more fruitful. If you, a local policymaker, are unsure of where your community lies in its attitude towards or desire for more EVSE development, it may be necessary for you and your locality to begin engaging with community stakeholders regarding this topic. Advice within this section is outlined in greater detail in NJTPA's *Alternative Fuel Vehicle Readiness: A Guidebook for Municipalities;* while this may be advice most important for localities who are looking to spur EVSE development outside instituting an ordinance, we certainly believe that localities interested in using an ordinance would still find a stakeholder engagement process valuable.

Engaging with your community stakeholders is crucial in identifying common goals and the actions needed to reach them. This may seem like common practice for several policy issues you may seek to solve within your community, however, it is more important than ever in this case. Advanced Energy, an energy consulting firm, explains that good planning is crucial in EVSE development as its planning is complex and customer interaction with EVSE is a brand-new experience if you compare it to its most direct relative, gas stations (2014). Refueling a conventional fossil fueled vehicle takes a handful of minutes using a nozzle that is compatible with all conventional fossil fueled vehicles. EVs do not have universal compatibility with their refueling equipment, take at least a half-hour to charge, and even have equipment which provides different refueling speeds. These added factors require greater coordination within your community and more intentional action.

You can begin this process by identifying individuals from your local government, civic community, and business community who are diverse in background and may be interested in helping your locality create a comprehensive EVSE plan (North Jersey Transportation Planning Authority [NJTPA], 2017).[1] These individuals may include municipal managers, public utility

[1] Local government stakeholders for example can be legislative body members, transportation department staff, or borough managers; civic community examples can be faith leaders, nonprofit leaders, neighborhood group leaders; business community examples can be chambers of commerce, utilities, or labor leaders.

staff, and EV owners, to name a few. Ideally, these individuals will agree to commit to serving on a stakeholder group that will gather facts surrounding the EVSE development issue and provide a comprehensive plan for your locality to address your community's current and future EV support needs.

Once you have identified and gathered a group of stakeholders, begin holding regularly scheduled meetings at a frequency that best fits your needs. These meetings can cover any range of topics that are most needed. You should not shy away from beginning these meetings with informational sessions where you hear from experts. This issue is ever developing with advances in technology, and centers around a still burgeoning technology. Eventually, you should work towards using these meetings to discuss goals, challenges, and next steps to an eventual EV readiness plan (NJTPA, 2017).

To start the process of creating comprehensive goals and a roadmap, begin by reviewing sample plans or ordinances from other localities. While this guidebook and appendices are a valuable start, your locality will have unique needs that will need to be considered. Reviewing these plans can give a rough outline for your stakeholders of what issues or barriers that are unique to your locality and may need addressing as well as the strategies that will help you overcome them. Next, you should have the group discuss the goals that they believe are crucial to success in achieving greater EVSE buildout in your community (NJTPA, 2017). NJTPA in their guidebook states, "When obstacles arise, having a well-defined goal in mind allows for effective problem solving," (p. 31). Identifying, sharing, and narrowing down on commonly agreed goals will help the stakeholder group work collaboratively to establish a comprehensive plan to further develop EVSE within your community. Establishing this foundation may spur other opportunities to encourage EVSE in your community that previously may have been untenable.

Once common goals have been decided, have the group work together to identify existing regulatory hurdles to EVSE development within your community. These hurdles can often include zoning and parking codes, permitting and inspection, or current building codes (NJTPA, 2017). Also, work to examine hurdles that might exist within your community pertaining to charging availability. These items could include lack of consumer awareness, or general ambivalence or hesitant attitudes towards EVs from members in your community. These items can even be key topics your roadmap can seek to address (NJTPA, 2017). Use these identified hurdles to help inform the steps that you will include within your roadmap.

Your roadmap and the findings that your stakeholder group uncovers in its work will be unique to your locality. You may want to move forward with adopting new ordinances that address the regulatory barriers that you identified earlier, or you may find that your locality can achieve its EVSE development goals via a comprehensive program that focuses on reaching out to and supporting potential businesses or other non-residential sites that may be interested in hosting EVSE on their property. This guidebook, its model ordinance, associated educational materials, and the additional resources they point you to will sufficiently provide you with strategies to achieve your EVSE development goals.

Model Ordinance Considerations

Futureproofing EVSE

As electric vehicle adoption is in its initial stages within the Commonwealth, it is important for decision makers, like yourself, to use infrastructure standards that promote safe, equitable, efficient, and environmentally conscious use. A key decision in EV charging station installation is the charging standard, categorized into Level 1 (120V), Level 2 (240V), and Level 3/DC Fast/Rapid/Superchargers. When measured in time to charge to a range of 100 miles, it would generally take 20 to 33 hours using a Level 1 charger, 3 to 4 hours using a Level 2 charger, or 20 to 30 minutes using a DC Fast/Rapid charger (Low Power EV Charging, n.d.). Level 1 charging does have benefits, as it can use a standard household electric outlet, is usually the standard charging cord that comes with a new electric vehicle, and can accommodate most commutes with overnight charging, made even more reliable when workplace charging is also available (Smith, 2016).

While accessible, the slow rate of Level 1 charging makes it unsuitable for public charging stations. It is also not ideal from a future-proofing perspective. Level 2 charging stations offer a much faster charging rate, usually accommodating a full EV battery charge overnight while also charging fast enough to add substantial range in a public setting, such as a downtown, shopping mall, grocery store, or other facility. This charging level is ideal for municipalities or businesses looking to put in a standard EV charging station and is also worth encouraging for new residential construction to avoid high retrofitting costs in the future (Meffert, 2021).

A DC Fast/Rapid charger provides the fastest charging speeds; however, it is also significantly more expensive and requires far more extensive electrical infrastructure (400-900V) support. The average DC Fast/Rapid charger installation costs $21,000, far exceeding the $3,000 for a Level 2 charging station, and $10,000 to $40,000 for the unit compared to $400 to $6,500 for a Level 2 unit (Castellano & Smith, 2015). DC Fast/Rapid chargers offer the greatest value along travel corridors such as major highways but may be suitable in other public areas with access to the required electrical infrastructure, where people are likely to spend less than 30 minutes in a visit, and where user turnover can be enforced. Considering the significant cost difference, Level 2 chargers should be seen as standard and are sufficient for most public and residential uses.

Along with each charging level you, or one designing an EVSE site, must consider the different connectors used to charge an EV. Unfortunately, there is not a universal adapter that can be used by all vehicle manufacturers. This highlights why having consistent connectors across public station locations is essential to building out AFCs and creates equity gaps in the type of vehicles that can be serviced and used. Should you play a role in installing public EVSE, you should seek consistent use of standards that reach the most EV users. It is important for decision makers, like yourself, to be aware of different charging speeds and connectors when considering public EVSE so that charging stations can keep up increased demand as EVs grow in popularity. Having a charging standard eases EV travel and potentially increases the number of EV models available for purchase by addressing consumer concerns (USAID, n.d.).

As for the type of connectors available, Level 1 and 2 have a standard SAE J1772 connector that can be used by all EVs in the United States whereas DCFC has three standards: CCS, CHAdeMO, and Tesla. Of the DCFC connectors, the CCS connector services the most manufacturers whereas Tesla is only usable on Tesla vehicles. Meanwhile, CHAdeMO services a limited number of manufacturers compared to the overall EV market. The leading EV charging networks in Pennsylvania for Level 2 chargers currently are Blink, ChargePoint and Tesla. For DCFC, ChargePoint, EVgo and Electrify America are the predominant networks. As per the Alternative Fuels Data Center, there are only 67 public station locations and 150 EVSE ports that have CCS connectors available, emphasizing the need for more DCFC build out with CCS connector access (Alternative Fuels Data Center, 2022).

Preventing Stranded Assets

Installation of EVSE includes other important choices for your municipality and other entities looking to have EV charging stations including location, charging company, charger compatibility, among others. When your municipality engages in the design of EV charging stations, it is important that they seek to create accessible and reliable stations for all who need it in the future. Therefore, in addition to charging standards, potential site hosts must protect themselves against potentially stranded assets, which is an installed EVSE that can no longer be supported. One notable instance was the 2013 bankruptcy of ECOtality, a charging company with over 12,500 charging stations nationwide, leaving its network in the lurch until it was purchased by CarCharging Group (Ottaway, 2014). Some charging companies also have limitations in the vehicles they can service because of EV manufacture model specifications of the vehicles charging access point. Despite these limitations, there are still ways to provide equitable access by establishing EVSE standards that ensure it may serve as many EV owners as possible.

Working with a Charging Network

If your locality is looking to installing EVSE on public property or has locations in your community looking to host a charging station, they should consider working with an EV charging network to install, maintain, and run the site. EV charging networks are businesses that install and/or maintain a system of EVSE. These businesses can generate revenue in a variety of ways: by collecting usage surcharge fees, charging a site host a subscription to maintain the system, or by providing advertisement opportunities. Networked EVSE also allows hosts to offer non-cash payment options, remotely monitor use, and provide better informed customer service.

Ownership and operation of EVSE installations can take a few different forms. EVSEs are usually either host-owned or owned by the EV charging network. (U.S. Department of Energy, n.d.) If the host owns the EVSE they are responsible for purchasing, installation, and maintenance of the equipment at the tradeoff of having control over the fees and revenue raised. Alternatively, the EV charging network can maintain ownership of the equipment and be responsible for the afore-mentioned costs. Even in this case, the host may be able to arrange an agreement to collect revenue from the equipment. There are other variations of these agreements that can have blended elements. (U.S. Department of Energy, n.d.) Being aware of these possibilities is a strong first step to creating a host-network agreement that meets your goals.

Before working with potential EV charging networks on installing EVSE, it is important to ask questions of the service provider to ensure that their standards meet the needs of the site you wish to host. Consider the following questions:

1. How fast do you want vehicles to charge?
2. How large is the site's electrical panel?
3. Where will the charger be installed?
4. How many charging stations are needed?
5. Is the infrastructure Energy Star Safety Certified?
6. Does the network offer cost savings or a warranty for large installation projects?
7. What are the smart technology features offered?

Without network access for public or private use, localities would have limited ability to gather data on their region's electricity capacity relative to increased consumption of electricity. Non-networked charging stations subject consumers to more expensive repairs and limit their ability to track utility costs and opt into incentives and/or revenue opportunities.

Get to Know Prominent Charging Networks

If you work to install charging infrastructure on public property or with a private site host, it is important that you become familiar with charging networks that are prominent throughout the state and within your community. The Alternative Fuel Data Center (AFDC), a hub of alternative fuel related data organized under the U.S. Department of Energy, can help you and other potential site hosts become more with the type of EVSE and charging station networks as well as their prevalence within the state. This information allows for thoughtful considerations when determining what stations to install as well as how they will be monitored. As per the AFDC, Pennsylvania's predominant charging networks are: Blink, ChargePoint, Tesla Destination, EVgo, and Electrify America. Of these five networks, Blink, ChargePoint, and Electrify America are the most prevalent Level 2 and DCFC providers in PA (*Electric Vehicle Charging Station Locations,* 2022).

Of the current charging network companies available, the most versatile are Blink, ChargePoint, Electrify America, and EVgo, which all differ in pricing and the products and services they offer customers. For instance, the Blink network utilizes its software to connect chargers to the cloud so that hosts across several industries have remote management capabilities and remote access to essential charging station information. The network also provides flexible business models for their host locations alongside a variety of charging stations for Level 2, DCFC, and mobile charging.[4] Such company business models can either be hybrid owned, only requiring the hosts to make the site EV ready; host owned, ideal for sole ownership and operation; Blink owned, which shares revenues with a host, but with Blink as the main operator; or Blink serviced, which gives the owner full control of ownership using Blink's subscription program (*The Power of Blink Network,* 2021). The cost to use Blink EVSE varies from member to guest in each state. In PA, members pay a rate of $0.39 per kWh and guests pay $0.49 per kWh for level 2 charging

[4] Mobile charging uses a portable charging station that operates off of a batter provides power to EVs

(*EV Charging Rates* 2021). DC fast charging customers pay per session, $6.99 for members and $9.99 for guests (*EV Charging Rates* 2021).

Along with a range of business models, Blink also offers a variety of charging stations that abide by the OCPP 1.6J interface to support non-Blink equipment. Hosts can choose from a variety of deployment configurations such as, single and multiple cord pedestals, individual and paired wall-mount chargers, and single-family residential charging stations (*The Power of Blink Network,* 2021). Furthermore, there are three pedestal specifications: the rectangle, triangle, and triangle dual port pedestals (*IQ 200 Charging Stations Specifications,* n.d.). Depending on charging needs, these options range in the number of amps, connectors, and kW of output. Level 2 stations range from 50 to 80 amps, DCFC stations range from 50 to 175 kW, and mobile emergency chargers are limited to 9.6 kW output for the mobile emergency charger, or one mile of charge per minute (*IQ 200 Charging Stations Specifications,* n.d.). When considering the type of pedestal to install hosts must consider the future use of that station and whether a dual port option would be most useful to avoid unnecessary costs in the future.

ChargePoint is the most common network found in PA offering a wide variety of Level 2 and DCFC stations. They design, build, and support software in several languages and to multi-family, fleet, commercial, and industrial settings through a mobile app (*EV Driver Support,* n.d.). The public charging stations provided through this company are independently owned meaning that consumers pay the price determined by the site host. Other stations are free with a subscription to a Charge Point account which provides customers with a card linked to that account. The first time a customer uses a charging station found through the app, they will be charged $10 to keep the account active (E*V Driver Support,* n.d.).

ChargePoint offers Level 2 charging stations are offered in either a single or dual port option with power sharing capabilities. This allows them to share one 20 to 40 amp circuit between two parking spaces (*Smart Charging Stations,* n.d.). These Level 2 chargers include the CT4000, an all-purpose charging station and the CPF50, a fleet and multi-family charging station (*CT4000 family,* n.d.). The CPF50 is specifically designed with a panel sharing and scheduled charging energy management system to conserve grid power and manage charging during peak times (*CPF50 Charging Station,* n.d.). To scale their efforts, ChargePoint created the Express 250 DCFC station that has a maximum output of 62.5 kW and 125 kW when paired. In a paired configuration, two vehicles can be charged at the same time, sharing power based on allocation policies of a given site (*Chargepoint Express 250,* n.d.). The Express Plus (EXPP) software was designed to grow with charging demand, being able to add ports to existing stations to provide more charging access within one station and accommodate with EXPP Power Links (*Chargepoint Express Plus,* n.d.). This expands the charging capacity for that site without having to further invest in infrastructure.

Electrify America is another dominant network in Pennsylvania. They own a significant amount of 150 kW to 350 kW chargers compared to other networks. Electrify America prioritizes incorporating zero-emission design into their EV infrastructure by providing solar EV charging stations that have a sun-tracking solar array. These charging stations can charge two vehicles at once offering the ability to charge vehicles at a rate of 3.3 kW (*Renewable Energy & Sustainability,* n.d.). To make a profit, this network bases consumer prices on location and the amount of kW

needed. In Pennsylvania, Electrify America stations charge Pass+ members a $4.00 monthly fee along with $0.12/min for a 1-90 kW output and $0.24/min for a 1-350 kW output. As for guests, a 1-90 kW output is $0.16 and $0.32 for a 1-350 kW output (*Pricing and Plans for EV Charging,* n.d.). Level 2 charging is also offered, charging consumers a rate of $0.03/min or the same pricing as DCFC stations if charged per kW (*Pricing and Plans for EV Charging,* n.d.). As of 2021, Electrify America is the only network to be Plug & Charge (ISO 15118) enabled, which allows vehicles to connect to a charging station without the need for an app or Radio-frequency identification (RFID) card.

Electrify America is also building out their network with load management in mind, incorporating over 100 energy storage systems on sites nationwide. Solar canopy technology has also been incorporated to power DCFC stations and deliver energy back to the grid (*Renewable Energy & Sustainability,* n.d.). Since charging multiple vehicles at a time requires a lot of power, such systems store electricity from renewable energy sources and the grids using batteries to bypass charging from the grid during peak charging times. This sustainable strategy reduces stress on the electrical grid, mitigates demand surges, maintains consistent pricing, and provides a more reliable customer experience (*What is Battery Energy Storage?,* n.d.). Without such systems in place, energy costs may fluctuate, and costs can be passed down to the consumer.

EVgo is another dominant EVSE network company prevalent throughout PA who helps hosts manage permitting, installation, maintenance and more with a high-level quality customer care team. Since 2019 EVgo has led sustainability efforts by powering its stations strictly with renewable energy (*Sustainability*, n.d.). Every kilowatt-hour consumed on the EVgo network results in the purchase of a kwh Renewable Energy Credit (REC) from an accredited supplier (*Sustainability*, n.d.). EVgo holds a focus to enhance the sustainability of its EVSE operations while also helping government stakeholders meet their environmental, social and corporate goals (*Host EV Fast Charging Stations for Your Customers,* n.d..).

To meet the needs of consumers, EVgo stations are compatible with all battery electric vehicles including Tesla. The company provides both level 2 and DC fast charging stations with business, commercial, and fleet options. EVgo partners with a wide variety of businesses like grocery stores, retail and shopping centers, gas stations, convenience stores, hotels, parking lots and fleets (*Host EV Fast Charging Stations for Your Customers,* n.d.). To expand its outreach EVgo also provides automakers like Nissan and BMW with services like prepaid charging credits, infrastructure deployment, marketing, data reporting and integrated technology (*Partner with the EV Fast Charging Leader,* n.d.). For its charging services, EVgo's charging rates have three different structures, pay as you go, EVgo member, or EVgo plus. All pricing varies by state and its time of use charging rates. For reference, the company's website provides charging rates for Pennsylvania customers which start at $0.30 per minute plus a free session fee (this sometimes can cost a fee) and $3.00 reservation fee for the "Pay as You Go" charging plan. The EVgo "member pricing" starts at $0.27 per minute with a $4.99 prepaid charging credit and $3.00 reservation fee. Finally, "EVgo Plus" members have a monthly subscription fee of $6.99 along with a $0.24 per minute charging fee (*EVgo Fast Charging Pricing,* n.d.).

Sticking to charging station networks that are interchangeable and share EVSE management data across their networks will help local municipalities optimize their charging station locations and provide transparency.

Protocol Standards for Networked EVSE

Once adequate infrastructure is constructed, it is important for each networked station to follow a basic protocol within the EVSE software to help site hosts manage use of their EVSE. Some networked stations operate from proprietary software while others operate using a platform called Open Charge Point Protocol (OCPP). EVSE that operate off OCPP can be operated by multiple companies and will better allow you to switch between charging networks. Relying on EVSE with proprietary software may make you dependent on that specific charging network. These issues should be kept in mind when planning EVSE development. (U.S. Department of Energy, n.d.)

Site hosts can improve their services by implementing additional protocol that supports longer term use of charging station locations. One example is OCPP. Another is the Open Charge Point Interface (OCPI) which exchanges information about the charge points and enables roaming so that EVs can easily find and use compatible EVSE outside of their standard network (Bopp et al., 2020). To accomplish this, OCPI provides session and location information, sends remote commands, provides detailed billing records, and provides energy tariff information (Driivz Team, 2022). Other types of protocol include Open Automated Demand Response (OpenADR) which is typically used to send information signals between distribution system operators (DSOs), utilities, energy management, and control systems to balance demand during peak charging times as well as simplifying customer energy management (Driivz Team, 2022).

Open Smart Charging Protocol (OSCP) facilitates capacity-based smart charging and provides open communication between a charge point management system and an energy management or system to predict electricity grid capacity (Driivz Team, 2022). Subject to future application, the eMobility Interoperation Protocol (eMIP) provides authorization and a data clearinghouse application programming interface (API) as well as smart charging features like the ISO 15118. ISO 15118 is an international standard for bi-directional digital communication between EVs and charging stations that allows for bidirectional charging and discharging of EVs (Driivz Team, 2022).[5] ISO 15118 enables plug and charge capabilities that limit the hassle with charging for EV drivers by including automatic authentication and billing which avoids the need for RFID cards, apps, or memorizing PIN numbers to pay for vehicle charging (Driivz Team, 2022). Aside from considering standard protocol, site hosts should ensure that the infrastructure they are installing is Energy Star Safety certified; this certification helps EVSE purchasers identify models that save money and energy while also ensuring safe EVSE use during poor weather conditions.

[5] Bidirectional charging is charging that can transfer energy two ways.

Grid Load Management & Energy Storage

Another method to future-proof EVSE is with the use of renewable energy, grid load management, and energy storage. With over 100 energy storage systems nationwide, solar canopy technology has also been incorporated to power DCFC stations and provide onsite energy storage to deliver energy back to the grid. Since charging multiple vehicles at a time requires a tremendous amount of power, such systems store electricity from renewable energy sources and electrical grids using rechargeable batteries to supplement grid power during peak charging times. The benefits to this sustainability strategy include reducing stress on the electrical grid, mitigating demand surges to maintain consistent pricing, providing a more reliable customer experience, and supporting renewable energy use. Without such systems in place the cost for power is likely to surge relative to high usage and the reliability of the grid would decline, highlighting the importance of sustainable infrastructure and grid load management.

Therefore, the larger concern is with energy distribution companies and managing grid load and though time of use rates to limit charging during the peak hours of 5pm - 9pm. To prevent grid reliability issues, the Pennsylvania PUC has prioritized forming policies regarding energy storage and time of use rates by forming an EV charge rate tariff and pilot programs that allow distribution companies to build energy storage projects that focus on improving grid reliability. With those projects, solar battery banks have been found to lower peak demand charge and help level out peak time usage by decreasing the dependency on the grid. Although it is still forming such policies, Pennsylvania PUC and other key stakeholders aim to focus on maintaining and regulating microgrids through rate structures and educational efforts focused on how to manage grid load to avoid potential overflow and price fluctuations as EV ownership grows.

Although the electric grid currently produces adequate electricity without interruption, there are steps municipalities and site hosts can take to prevent misuse and poor management of grid load. Networks like Electrify America have initiated efforts to create battery energy storage systems to stabilize charging costs and manage grid use. Other preventative measures, such as Power Sharing, allows charging station locations to maximize the number of vehicles that can be serviced while managing the available power at the site. Site sharing, another load management strategy sets a power ceiling to limit the aggregate instantaneous load for all charging stations if the overall power available at a site is limited by a transformer (Chargepoint) Power Sharing supports various approaches to delivering and managing increased charging capacity. For example, Circuit Sharing allows a circuit to support more than one charging spot, Panel Sharing enables a charging site to maximize the number of charging ports electricity can be distributed to support more charging spots than an area rated capacity and Site Sharing which sets a power ceiling to limit the load for all charging stations if the available power is limited.

Individuals hosting charging station locations must consider the site's energy consumption and its impact on our environment. Local governments should be aware of local energy demand and use of renewable energy, as well as charging during peak times. To this end, it is essential to consider energy capacity needs and grid load restrictions when developing EV infrastructure.

Funding Opportunities

In the Autumn of 2020, the Bipartisan Infrastructure Law (BIL) was passed, creating an unprecedented investment into America's roadways. Included in the BIL was a commitment to implementing green technology into infrastructure plans. In this spirit, $7.5 billion was allotted for electric vehicle infrastructure development. Of the $7.5 billion, $2.5 billion was allotted as discretionary funding to be put into a grant program. The other $5 billion is allocated through the National Electric Vehicle Infrastructure (NEVI) Funding Program. $1 billion will be made available every year from 2022 to 2026. To receive funding, states must submit a State EV Infrastructure Deployment Plan to the Joint Office of Energy and Transportation by August 1, 2022. These funds must be used to implement electric vehicle infrastructure strategically and along key highway corridors. Over the next several months more guidance will be released regarding NEVI funding, including charging requirements and exact money allocations. This money will be crucial to the buildout of electric vehicle infrastructure (Horan & Jensen, 2022). This federal money will provide an opportunity for states to build out EV infrastructure in a way that would not have been possible before.

There are also several other funding opportunities outside of federal money. Both state agencies and private companies offer some financial incentives for electric vehicles and electric vehicle infrastructure. The existing grant and rebate programs are outlined in the table below

Figure 11:

Government Funding	Private Funding
DEP: Small Business Grant Program: will provide up to $50 of a project up to $5,000 for an energy efficient project, get more information here	PECO Plug-In Electric Vehicle Rebate: PECO will provide $50 to residential customers who purchase a new plug in EV. Find more Information here
Alternative Fuels Incentive Grant (AFIG): offered by Pennsylvania Department of Energy. Access here	PECO Commercial Electric Vehicle Supply Equipment Rebate: $500-$1500 to install a level 2 EV charger. More information here
Driving PA Forward has a variety of grant and rebate options on their website, visit the website here	PECO Commercial Electric Vehicle Supply Equipment Rebate: $500-$1500 to install a level 2 EV charger. More information here

Local Government Resource is available in Appendix 5

The funding areas outlined above can be instrumental in helping to fund electric vehicle infrastructure in municipalities and to encourage EV adoption among residents. As EV's become more prevalent, more funding opportunities will emerge.

Conclusion

Incorporating equity principles into EVSE development is crucial to making sure that EVSE adoption motivates greater EV adoption among the general population. If equity challenges are not addressed, individuals who are disabled, are of low-income, or are underserved will

struggle to use EVs. With generous amounts of funding becoming available through ARPA, now is the perfect time for your locality to utilize these dollars and ensure that your town is one that enables all its residents and visitors to use EVs.

By using the model ordinance provided with this guidebook, you can ensure that your municipality is prepared to meet the upcoming demand for equitable EVSE development. The strategies outlined in this document describe the options that you have available to draft the right ordinance or programming to meet your EVSE development goals. The educational materials also provided alongside this guidebook will help provide background information for yourself and stakeholders as you tackle this challenge. Success in this manner is reliant on doing methodical legwork to understand the issue, how it impacts your residents, and how to address those needs.

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Appendix 1: Annotated Pennsylvania Model Ordinance

*Much of the structure and content of these notes are inspired by the Great Plains Institute's Summary of Best Practices in Electric Vehicle Ordinances by Claire Cooke and Brian Ross, 2019, and a literature review of over 20 ordinances and model ordinances (*Cook, C., Ross, B. 2019.)

1. Electric Vehicle Charging Station as Permitted Land Use
    a. Restrictions on charging stations in the right of way
    b. Levels 1-3 EVSE allowed in all zones when accessory to the primary permitted use
    c. EV Charging as primary use
        i. Considered a motor fuel station for zoning purpose
        ii. Permit EV charging stations as primary use in all zoning districts where motor fuel stations are permitted

This section details where EV charging infrastructure is permitted. Ordinances explain where these land uses are permitted to ease the installation of infrastructure that serves the public. While charging stations are mostly an accessory use, they (especially DC fast chargers) may be a primary use in some instances.

Some ordinances allow only levels 1-2 EVSE in all zones.

2. New Single and Two-Family Dwellings Parking Minimums
    a. Min Level 2 EVSE or make-ready spaces
    b. A minimum of 1 make-ready parking spot provided per single or two-family dwelling
    c. If a garage is constructed
        i. Make-ready spots must be in the garage
    d. If no garage is built
        i. Make-ready spot must be provided in a nearby parking spot
        ii. 5% of total parking spaces must be EVSE
        iii. 25% of total parking spaces must be Make-ready
        iv. 10% of EVSE and Make-ready spaces must be disability accessible
    e. EVSE spaces must include signage

According to Consumer Reports, 71% of consumers say they would do most of their charging at home and EV owners with 250 miles of range can do 92% of their charging at home if they have a garage or parking space with EVSE. As most Pennsylvanians live in single or two-family dwellings, this ordinance provides for EVSE and make-ready spaces in new construction of these dwellings to capture savings by avoiding future costly retrofits to install chargers (2020a) (Preston, 2020b)

Level 2 charging should be the minimum standard for all EVSE and MR spaces considering its superior charging speed over level 1.

Level 1 charges 3-5 miles per hour

Level 2 charges 12-80 miles per hour

Level 3 charges 3-20 miles per minute but can be cost prohibitive in all but commercial uses

For most 1-2 family dwellings without garages, these spaces will be driveways with adjacent outlets.

According to the International Council on Clean Transportation, 2.4% of US light-duty vehicle sales in 2020 were EVs. According to Ford, Bloomberg Research, and the Fuels Institute, by 2030 20-40% of light-duty vehicle sales will be EVs. After 2030 that percentage will continue to increase. While the lag effect of market sales to vehicles on the road is important to remember, these percentages recognize that as of 2022 EVs are not widespread but that their adoption is imminent and extremely aggressive. The reviewed ordinances that include EVSE/MR parking minimums usually provide for a single digit's percentage of initial EVSE with 20-15% of the remaining spaces MR.

According to the CDC, 12% of Pennsylvanians have mobility-related disabilities (CDC, 2022). As these spaces are not reserved for disabled individuals, it is highly recommended to maintain a relatively high percentage of EVSE spaces accessible.

3. New Multi-family dwellings Parking Minimums
    a. Min Level 2 EVSE or make-ready
    b. 5% of total spaces must be EVSE
    c. 25% of total spaces must be make-ready
    d. 10% of EVSE and make-ready spaces must be disability accessible
        i. If any EVSE are required, a minimum of one space must be accessible to individuals with disabilities
    e. EVSE spaces must include signage

Individuals living in multi-family dwellings face a unique charging challenge. It is significantly more difficult for residents of multi-family dwellings to install and access charging infrastructure unless it is installed at construction. According to Consumer Reports, residents of apartment buildings are more likely to say they would have to rely on public DC charging stations (2020a) (Preston, 2020b).

4. New Parking Lots and Garages, Commercial, Office, Industrial, Public, Parks and Recreation and other Parking Minimums
    a. Min Level 2 EVSE and make-ready
    b. EVSE spots must include signage
    c. Businesses with 25 or fewer spaces are not required to install Make-ready or EVSE
    d. 5% of total parking spaces must be EVSE
    e. 10% of total parking spaces must be made ready

According to the Fuels Institute, nonavailability of chargers at home and making trips longer than the battery range are the two main reasons why drivers use public EVSE. The most popular public chargers are those where vehicles are typically parked for longer periods, including airport parking, grocery stores, dining, and shopping. EV consumers expect to spend 60

or fewer minutes at public EVSE (Fuels Institute, 2021). Provisions that ease burdens on businesses with fewer than 25 spaces lessen the cost and logistical burden on smaller businesses.

The lower make-ready percentage reflects the stronger consumer preference for home charging.

5. New Development and Construction Minimum Parking Requirements
    a. EVSE and make-ready parking spaces are always counted towards any parking minimum requirements
        i. If a variance has been granted that impacts parking requirements, all requirements apply to the variance parking number
    b. Each EVSE and make-ready parking space of level 2 or greater count as 2 parking spaces for regular parking minimums, up to a 10% reduction in total parking
    c. EVSE and make-ready installation requirements are always rounded up to the next full number unless the required number is already a full number
    d. New mixed-use sites with off-street parking are required to install EVSE and MR at the rate required by their individual uses or portion of the total parking spaces
    e. Public entities are not exempt from EVSE and make-ready requirements

EVSE and MR parking requirements should be clear and specific to avoid confusion and delay.

Some ordinances include these provisions that maintain fairness in calculating parking minimums, ease cost burdens and include an incentive to create more EVSE and MR spaces.

Many ordinances do not include public entities install EVSE and MR. This eases burdens on public entities. However, consumers benefit from uniform and standardized access to EVSE as a public good.

6. New and Existing EVSE Equipment Standards
    a. EVSE must be mounted
        i. Outlets and connector devices 36-48 inches from surface where mounted
        ii. Equipment mounted shall not impede pedestrian travel or create trip hazards within right of way
        iii. Retractable cords or place to hang above pedestrian surface, do not cross driveway, sidewalk, unloading area
    b. EVSE Protection: EVSE must either be:
        i. EVSE equipment minimum 24 inches from curb OR
        ii. EVSE must be protected by wheel stops or concrete filled bollards
    c. EVSE Parking space design
        i. Parking spaces size must not be different from normal parking space standards

The minimum standards and required design of EVSE encourages standardization and protects consumers from poorly designed and constructed infrastructure. These specific requirements are commonplace in ordinances.

Specific fines and provisions should be specified at the local level.

This maintenance provision protects the public and governments from private 'stranded assets' that are no longer functional and become blighted.

7. Signage and Road Marking Requirements
    a. Each EVSE space must include signage showing reserved for EV via usage of green paint for parking paint and/or signage
    b. Wayfinding signs effectively guide motorists. Regulatory signage must not interfere with parking spaces, drive lane or exit
    c. Required EVSE informational signage
        i. A contact number shall be provided on each EVSE signage space to report EVSE safety and equipment issues
        ii. Voltage and Amperage information
        iii. Charging and Parking fees
            1. This ordinance does not restrict fees collected for EVSE charging or parking
        iv. Hours of operation and time limits (if applicable)
        v. Safety information related to charging
        vi. Restrictions, fines, and towing provisions
    d. Lighting and Landscaping Requirements
        i. Lighting shall be provided in accordance with municipal parking rules unless charging is during daytime hours only
    e. EVSE functionality
        i. EVSE shall be maintained in all respects including the functioning of charging equipment and must be operational during business hours of use

Ordinances have considerable variation in the specific building and electrification requirements they impose. These requirements ensure that level 2 EVSE and MR spaces are properly electrified and ensure parking structures are properly designed for future EVSE conversions.

8. EVSE and MR Building Standards
    a. Require MR and EVSE have 208/240V and 40A per space with dedicated branch circuit and overcurrent protection device per space
    b. Require all parking spaces in a structure be made EV capable- i.e., conduit be installed throughout structure and subpanels sized to accommodate 60A or 40A breakers for each

Local governments are empowered to enforce publicly accessible EVSE parking restrictions. If these restrictions are not enforced, the public good will be reduced and these investments can be wasted.

9. New and Existing EVSE Parking restrictions and enforcement
    a. Local governments and their authorized authorities will enforce EVSE restrictions and are empowered to fine and towing violators

b. EVSE disability accessible spaces shall not be signed or enforced as disability access only
c. Parking Ordinance
    i. When a sign provides notice that a parking space is a publicly designated electric vehicle charging station, no person shall park or stand any non-electric vehicle in a designated electric vehicle charging station space.
    ii. Further, no person shall park or stand an electric vehicle in a publicly designated electric vehicle charging station space when not electrically charging or parked beyond the days and hours designated on the regulatory signs posted.
    iii. For purposes of this subsection, "charging," means an electric vehicle is parked at an electric vehicle charging station and is connected to the charging station equipment.
    iv. The parking enforcement officer or police department is authorized to cite and/or remove or cause the removal of vehicles parked in violation of this section.

10. Defining terms: at least these terms will need to be defined:
    a. Accessible electric vehicle charging station
    b. Battery charging station
    c. Battery Electric Vehicle
    d. Battery exchange station
    e. Charging Levels
        i. Level 1
        ii. Level 2
        iii. Level 3
    f. Electric Vehicle Charging Station
    g. Electric Vehicle
    h. Electric Vehicle, Plug-in Hybrid
    i. Electric vehicle charging station- private restricted use
    j. Electric vehicle charging station- public use
    k. Electric vehicle supply equipment
    l. Electric vehicle infrastructure
    m. Electric vehicle parking space
    n. Non-electric vehicle
    o. Rapid charging station
    p. Make-Ready Parking Space (MR)
    q. New Multi-family dwellings Parking Minimums
        i. 3 or more residential units

Appendix 2: Research Methods

To begin work on this project, all members of the consulting team performed extensive research into EV infrastructure and usage. While performing research, team members kept several key questions in mind:

1. What is electric vehicle infrastructure and what are the challenges to the adoption of electric vehicle infrastructure?
2. How prevalent are EV's currently and how common will they be in the future?
3. What tools and resources do municipalities need most to implement electric vehicle infrastructure?
4. Are there any incentives or funding opportunities for public charging station installation?
5. What is needed to manage the increase in electricity use?
6. What are the equity concerns with charging station implementation?

To get insight into such questions, the research team conducted in-depth literature review, data analyses, stakeholder interviews, and a comparative analysis of existing EV ordinances. Through these research methods, the consulting team has been able to produce initial policy research, an outline of a proposed model ordinance, and suggestions for educational materials to address concerns of local governments for EV implementation.

The literature review included several existing reports and analyses conducted by multiple agencies and organizations. The consultants relied heavily on the *Ready to Roll Volume I* report prepared by the DVRPC. This report served as a launching point for further research into EV deployment. The team also utilized a report by the Electrification Coalition, a non-profit organization which promotes policies that support plug-in EVs, entitled *Electrifying Transportation in Municipalities*. This report outlined several barriers local municipalities may experience when implementing EV infrastructure.

These reports also provided essential Pennsylvania specific information that has been a guide for further research. Though the team relied on these reports, the team also utilized over fifteen other reports to gather information regarding a model ordinance structure, standards, and best practices for EV implementation, along with both technological and energy resource ramifications. The team reviewed dozens of reports outlining sales projections for EV's to inform the need for an ordinance and guidebook. The insights provided by the literature review have been crucial to the success of assessing the scope of the problem as it pertains to PennDOT and the development of deliverable outlines.

With EVs' growth in popularity, several organizations have conducted research on EV infrastructure implementation. These stakeholders have been working in the Pennsylvania EV landscape and are able to provide insight into Pennsylvania's specific needs concerning EV deployment. To date, the consulting team has met with several stakeholders including the DVRPC, New Jersey DCA, Pennsylvania DEP, PUC, and several borough and township managers and elected officials. The DVRPC provided contextual information into the current state of EV affairs in Pennsylvania, particularly in Southeastern Pennsylvania. The New Jersey DCA was able to provide insight on the New Jersey EV Model Ordinance and explained the implementation efforts

that have been practiced since the adoption of the model ordinance by the NJ Legislature. The Pennsylvania DEP provided thoughts on the contents of a model ordinance from an energy perspective and gave information regarding sales projections for EVs over the next several years. With the prospect of EV sales increasing, the consulting team was provided with insight into the urgency of EVSE implementation. Other stakeholders such as the Pennsylvania PUC provided insight into the practicality of electric vehicle infrastructure as it relates to rate-setting, building, maintenance, installation, and regulation. Borough managers were also able to contextualize immediate needs of local municipalities in crafting a model ordinance around EVSE development.

Finally, the consulting team conducted a comparative analysis of many EV ordinances and model ordinances throughout the country. Using such a strategy helped the team understand key components of EV model ordinances and identifying points of contention between different model ordinances to inform the scope and contents of the Pennsylvania Model Ordinance. New Jersey's model ordinance includes valuable considerations including electrification standards and zoning and permitting issues. Furthermore, the ordinance from New Castle, Delaware provided a succinct model for single and two-family unit EV parking structures. Other ordinances consulted include Latrobe, Pennsylvania; model ordinance from Southern Georgia Regional Commission; Orlando, Florida; Southern Maine Planning & Development Commission; Atlanta, Georgia; and many others throughout the country. By comparing these model ordinances, the team has been able to identify necessary aspects of a model ordinance based on their feasibility in the Pennsylvania landscape.

Appendix 3: Stakeholders Consulted and Interviews Conducted

Name	Organization
Colton Brown, Energy Program Specialist	PA Department of Environmental Protection (DEP)
Jacob Newton, Exec. Energy Quadrant Coordinator	PA Department of Conservation and Natural Resources (DCNR)
Paula DeVore, Park Manager/Program Specialist	PA Department of Conservation and Natural Resources (DCNR)
Joseph Sherrick, Policy Manager	PA Public Utilities Commission (PUC)
Sean Greene, Manager, Air Quality Programs	Delaware Valley Regional Planning Commission (DVRPC)
Tom Bonner, Energy Policy Manager	PECO
Maria Connolly, Principal Planner	New Jersey Department of Community Affairs (DCA)
Gunnar Rhone, Engineering Specialist	PA Mobility Plan
Karen Atkinson, LTAP Program Manager	Pennsylvania State Association of Township Supervisors (PSATS)
Scott Coburn, Education Director/Counsel	Pennsylvania State Association of Township Supervisors (PSATS)
Ed Wagner, Township Manager	Lower Pottsgrove Township
Jean Krack, Borough Manager	Phoenixville Borough
Jennifer Logan, Administrative Assistant & Parking Manager	Phoenixville Borough
Andrew Hayman, Borough Manager	Folcroft Borough
Andrew Hayman, Councilman	Upper Darby Township
Sarah Miller, Director of Legislative & Regulatory Affairs	Pennsylvania Builders Association
Andrew Dick, State Government Affairs and Public Policy Manager	Electrify America
Will Agate, Founder & President	NetZero Microgrid Solutions
Emily Kelly, Public Policy Manager	ChargePoint

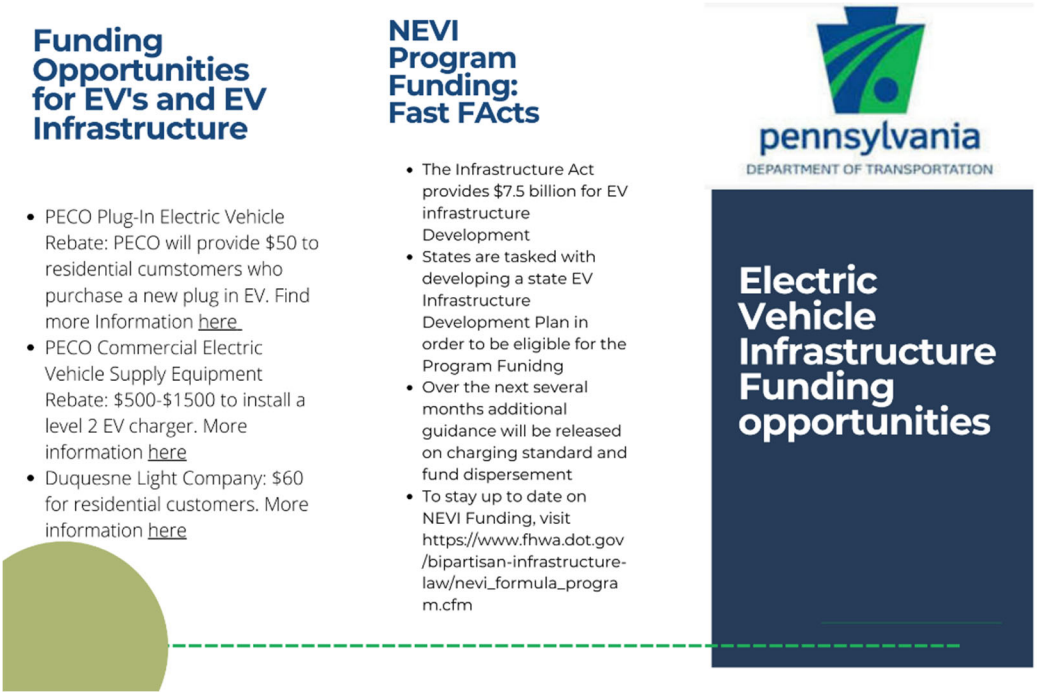
Appendix 4: Acronyms

AFC	Alternative Fuel Corridor
AFDC	Alternative Fuels Data Center
BEV	Battery Electric Vehicle
DSO	Distribution System Operator
eMIP	eMobility Interoperation Protocol
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
DCFC	Direct Current Fast Charging
DVRPC	Delaware Valley Regional Planning Commission
NJDCA	New Jersey Department of Community Affairs
NJTPA	North Jersey Transportation Planning Authority
MR	Make-ready
OCPI	Open Charge Point Interface
OCPP	Open Charge Point Protocol
OpenADR	Open Automated Demand Response
OSCP	Open Smart Charging Protocol
PADEP, DEP	Pennsylvania Department of Environmental Protection
PECO	Philadelphia Energy Company
PennDOT	Pennsylvania Department of Transportation
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PUC	Public Utilities Commission

Appendix 5: Local Government Resource – Funding Sources for EVs and EVSE

A PDF version of this brochure is available in the zip file

(Front)



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Appendix 6: Municipality Guide to Working with EV Charging Networks

A PDF version of this brochure is available in the zip file

(Front)

PennDOT: Electric Vehicle Charging Educational Materials **Date:** Spring 2022

Municipality Guide to Working with EV Charging Networks

WHAT IS THE ROLE OF AN EV CHARGING NETWORK?

EV Charging Networks are businesses that install and maintain a system of EV chargers for hosts. The services that they provide can range from simply installing charging stations to maintaining and managing an interconnected system through software. There are many payment structures between hosts and EV charging networks that can include surcharge fees, revenue generation through advertisement, or subscription fees.

WHAT FEATURES DO THEY OFER?

Networked chargers are chargers that are interconnected through software. They allow for monitoring, customer support, integrated payment, and energy supply management usually in return for some sort of cost.

WHO SHOULD I CONSULT?

Consult with your public works department if you are considering installing EV chargers on township property. Your electric service provider and PennDOT can also connect you with valuable resources.

WHAT RISKS SHOULD I BE AWARE OF?

Be mindful of different charging standards.

Consider the costs of installation and maintenance.

Technology changes quickly, consider ways you can future - proof your charging stations.

PROPRIETARY VS. OPEN SOURCE SOFTWARE?

Networked charging stations provide various "smart" features to users and operators. Some EV charging networks have a core product that is proprietary software which manages the chargers that they install.

Proprietary software can provide powerful features that are beneficial to hosts, however, hosts be aware of open source networking options.

Open Charge Point Protocol (OCPP) allows charging stations to use different networks when providing service to customers. This can make it easier for hosts to switch networks should they want to find a new provider. It can also protect a host against added costs of switching providers in the future.

(Back)

PENNDOT: ELECTRIC VEHICLE CHARGING EDUCATIONAL MATERIALS

RESOURCES FOR MORE INFORMATION

CA - Electric Vehicle Charger Selection Guide:
https://afdc.energy.gov/files/u/publication/EV_Charger_Selection_Guide_2018-01-112.pdf

Federal and State Laws and Incentives:
https://afdc.energy.gov/laws

North Jersey Transportation Planning Authority - Alternative Fuel Vehicle Readiness: A Guidebook for Municipalities:
https://nj.gov/dep/drivegreen/AlternativeFuelVehicle.pdf

U.S. Department of Energy - Costs Associated with Non-Residential Electric Vehicle Supply Equipment:
https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

U.S. Department of Energy - A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects:
https://afdc.energy.gov/files/u/publication/guide_ev_projects.pdf

ORGANIZATIONS THAT CAN BE OF HELP

U.S. Department of Energy Alternative Fuels Data Center:
https://afdc.energy.gov/fuels/electricity.html

Electrification Coalition: https://www.electrificationcoalition.org/work/state-ev-policy/pennsylvania-ev-policy/

Pittsburgh Region Clean Cities: Rick Price, Executive Director - rprice5705@aol.com

Eastern Pennsylvania Alliance for Clean Transportation:
Tony Bandiero, Executive Director, tfbandiero@ep-act.org

PADEP: https://www.dep.pa.gov/Pages/default.aspx

MPOs: https://www.penndot.pa.gov/ProjectAndPrograms/Planning/Pages/MPO-and-RPO-Contact-List.aspx

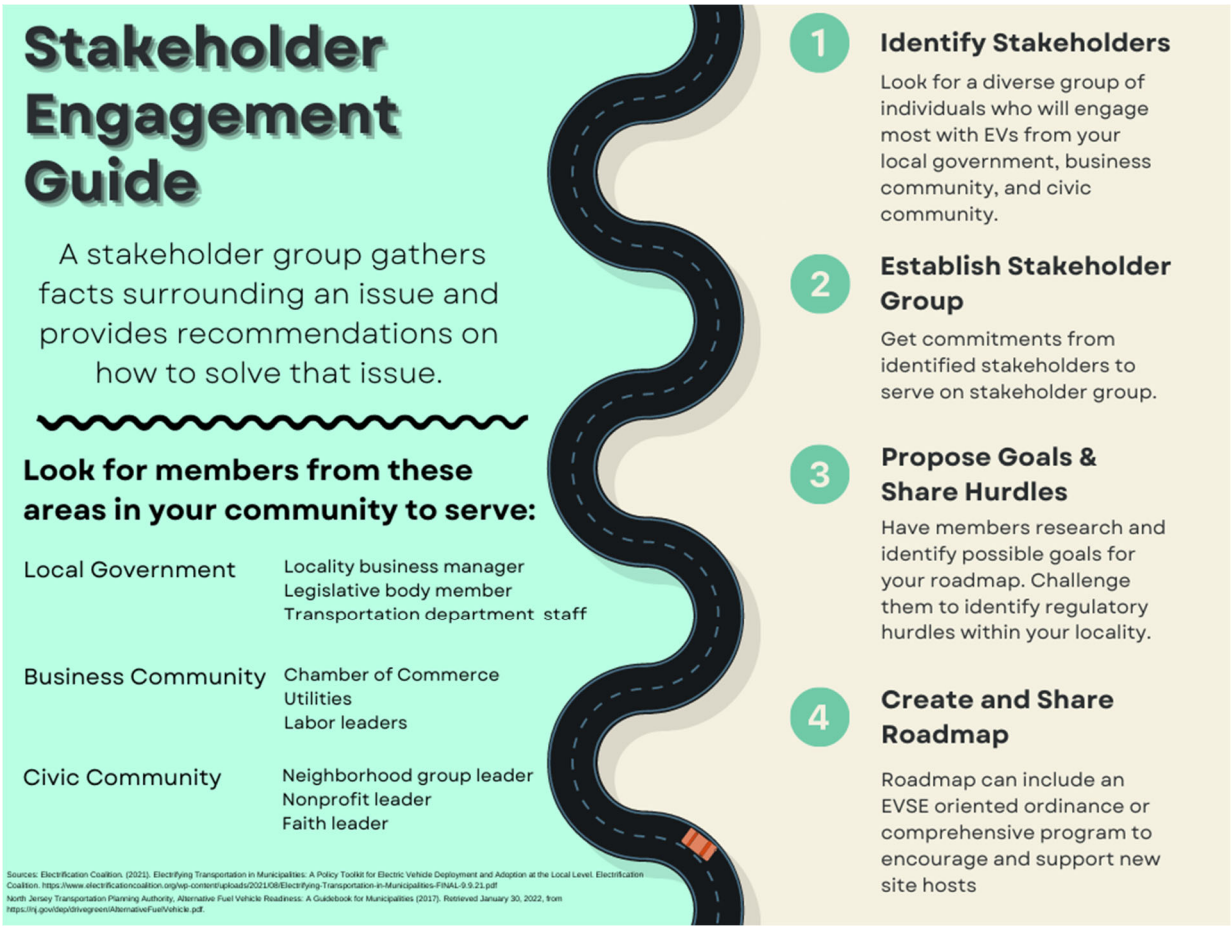
PSATS: https://www.psats.org/

Pennsylvania Municipal League: https://www.pml.org/

Pennsylvania Association of Boroughs: https://boroughs.org/

Appendix 7: Stakeholder Engagement Guide

A PDF version of this brochure is available in the zip file



Appendix 8: EV Charging Station Siting Guide

A PDF version of these flyers is available in the zip file

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RECOMMENDED PUBLIC EV CHARGER SITES

LEVEL 2

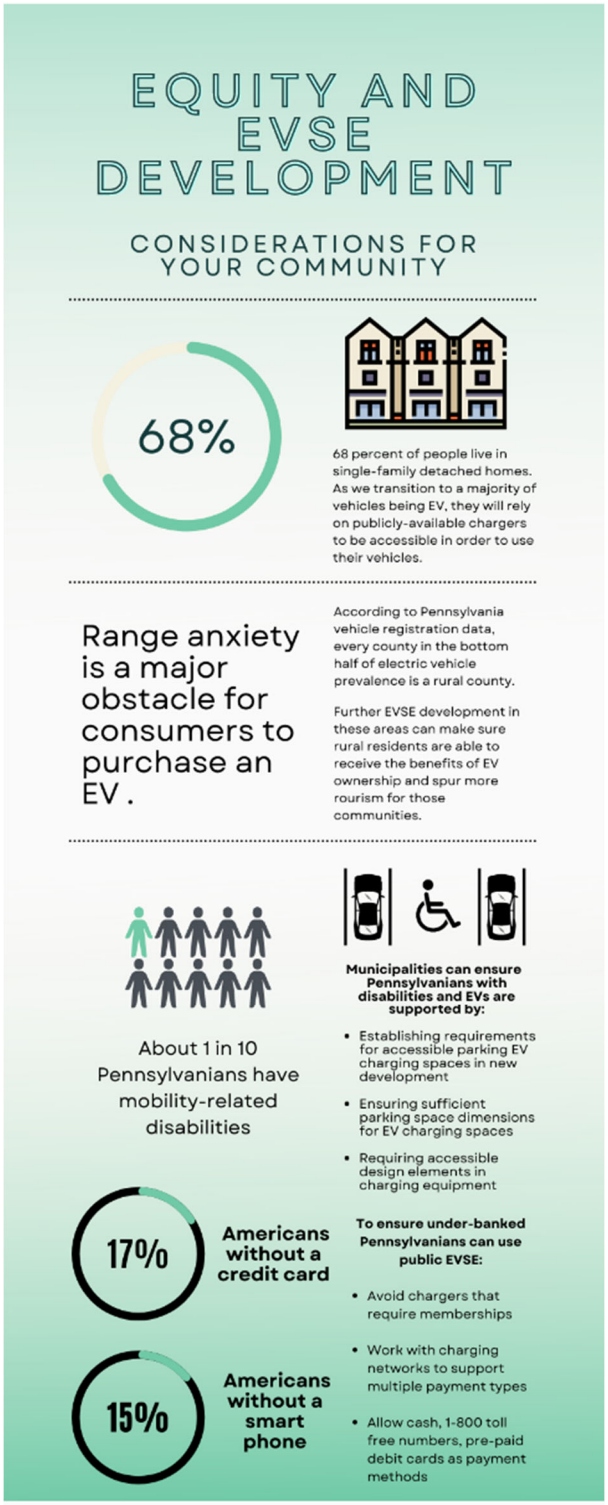
- PUBLIC GARAGES & DOWNTOWN LOTS
- COMMUNITY SITES: LIBRARIES, PARKS, POOLS, REC CENTERS
- TOURIST & LEISURE DESTINATIONS
- BUSINESS DISTRICTS
- SHOPPING CENTERS
- NEAR MULTIFAMILY HOUSING (ESP. OVERNIGHT)

DC/FAST

- REST STOPS
- DEDICATED FUELING STATIONS
- WAITING LOTS
- CAR DEALERSHIPS
- HIGH-TURNOVER RETAIL (GROCERY STORES, PHARMACIES, CONVENIENCE STORES)

Appendix 9: Equity and EVSE Development

A PDF version of this brochure is available in the zip file



Appendix 10: Futureproofing Electric Vehicle Infrastructure

A PDF version of these flyers is available in the zip file