Pioneer Valley
Electric Vehicle (EV)
Charging Station Plan/Guide

A 'smart guide' to develop and expand EV Charging Stations in the Pioneer Valley region.

Catalyst for Regional Progress
pvpc

Prepared & Presented by
Pioneer Valley Planning Commission
EV Charging Station Plan Working Group

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Acknowledgments & Overview

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This plan/guide began as an effort to identify and prioritize locations for new Electric Vehicle (EV) charging stations in the Pioneer Valley. As our work advanced, however, we learned that this moment in time is of significant importance in the development, expansion and transition to Electric Vehicles in the United States, and as a result, this plan evolved into a plan/guide to advance two key recommendations:

1) Each municipality in the region should host at least one dual-head level 2 EV charging station available to the public.
2) All businesses in the region that have customers who park for more than 30 minutes should consider hosting at least one dual-head level 2 EV charging station available to their customers and employees.

The purpose of this plan/guide remains the same. We have identified and prioritized locations for new EV charging stations and in so doing we are signaling to residents, developers, municipal officials and our state and federal partners that this region, the Pioneer Valley region of western Massachusetts, is ready, willing, and able to do our part on behalf of the Commonwealth and the country, to locate EV charging stations here to overcome the #1 barrier identified in the country's transition to EVs, which is "fear of not having a location at which to charge one's EV".[1]

[1] Electrify America research@www.electrifyamerica.org

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Executive Summary

This EV Charging Station Plan/Guide is designed to facilitate and advance the installation of EV charging stations throughout our region in an effective and informed way. In 2008 the Pioneer Valley was one of the first regions in Massachusetts to design a plan for a clean energy future and the transition to electric vehicles in 2018 and beyond is an important piece of this evolving work. This Plan/Guide summarizes the state of practice with respect to EV work in the United States and more specifically in Massachusetts, and provides recommendations to create a more comprehensive charging network here in the Pioneer Valley to support Massachusetts goal of 300,000 EVs by 2025 and to aid EV drivers by addressing implementation barriers.

EVs can save money and reduce air pollution in the Pioneer Valley. Compared to gasoline-powered cars, EVs are more energy efficient and cost 50- 70% less to operate per mile. A substantial and ever increasing portion of Massachusetts electricity grid is powered by clean low-carbon energy sources (not oil or coal), allowing EVs to reduce greenhouse gas emissions and pollutants that cause smog and acid rain. Massachusetts has prioritized EV market development support through its Massachusetts Zero Emission Vehicle Commission and the Mass Drive Clean campaign.

This plan/guide includes:

1) Definitions and Acronyms explained
2) Context/overview of status of EV & EV Charging Infrastructure in region in December 2017
3) Priorities for the Pioneer Valley & Guidance for Municipal Officials and Business Owners in siting EV charging stations
4) Appendices—full of useful resources and websites as this technology is evolving very rapidly

Electrify America has spent several years understanding the state of the art of ZEV/EV use in the United States and has determined that the number one barrier to the advancement of ZEVs/EVs is "location and availability of charging stations".

Several municipalities in the Pioneer Valley, including Amherst, Granby, Northampton, Palmer, Springfield, West Springfield and Westfield have already taken advantage of the incentives, grants and assistance available from the Commonwealth of Massachusetts to purchase EVs and install EV charging stations. Many more are currently working on this, including Agawam, Belchertown, Holyoke, Longmeadow, Monson and Pelham.

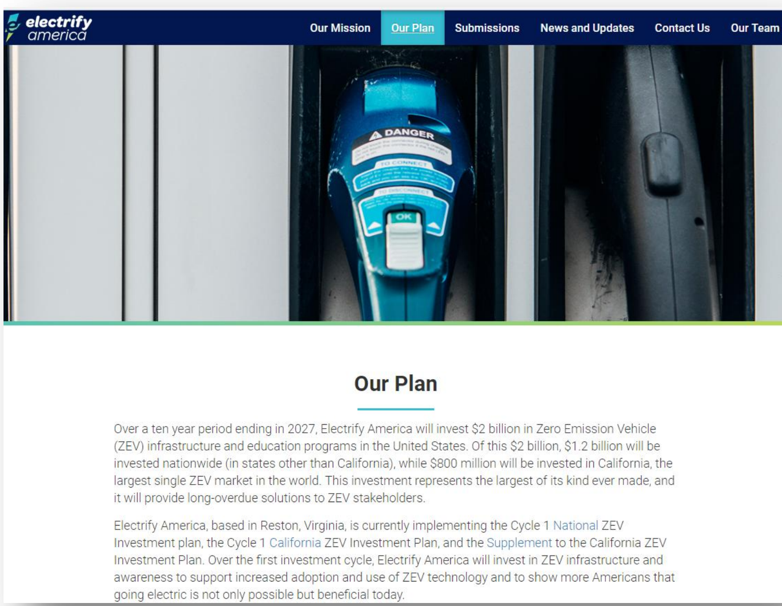
Most plug-in hybrid electric vehicle (PHEV) and electric vehicle (EV) models are available in Massachusetts due to our participation in California's zero emission vehicle (ZEV) mandate that requires all major car manufacturers to sell increasing percentages of ZEVs. Both PHEVs and EVs displace petroleum fuel by charging their batteries from the electrical grid. EVs typically have a larger battery pack for more electric miles (~up to 238 at last check), but have no option when the battery is depleted. PHEVs have a shorter electric range (~10-50), but also have a small gasoline engine that can power the vehicle if needed.

EVs replenish their batteries by connecting to charging stations at home, work, or at public locations. Various “charging level” stations provide different rates of charge from 30 minutes to 12+ hours, with faster chargers being more expensive to install and operate. The station installation costs can also vary from site to site. Ideal locations are where the parking space is close to the electrical panel and the existing service is sufficient to sustain the additional electrical load.

At the last count, 463 EVs were purchased or leased in the Pioneer Valley since June, 2014, as reflected in the number of rebates issued during that period through the Massachusetts Offers Rebates for Electric Vehicles (MOR-EV) program. 165 were EVs and 379 were PHEVs and PHEV+s combined (214 PHEV, 82 PHEV+). Northampton has the most EVs in the Pioneer Valley, reflected in the 66 rebates given since June 2014. Currently there are approximately 40 publicly available charging stations in the region, four of which are Level 3 or "fast charging" stations. All EVs and PHEVS come with a plug in so that owners can charge them at home if they have access to an electrical outlet in their garage or near where they park their car. The recently updated Massachusetts State Building Code, approved by the Board of Building Regulations and Standards requires all new construction to be built with the conduit ready for an EV charging station.

EV charging stations are getting a huge boost with the assignment of two billion dollars of the Volkswagen (VW) emission scandal settlement money going exclusively to ZEV infrastructure and awareness. VW has created a subsidiary, Electrify America, (www.pvpc.org/website https://www.electrifyamerica.com/), charged with investing the $2 billion in a nationwide network of workplace, community, and highway chargers that are convenient and reliable with a goal of enabling millions of Americans to discover the benefits of electric driving.

In addition to this massive investment in charging infrastructure, announcements from car manufacturers of their intentions to manufacture EV only vehicles going forward (Volvo in 2019, Jaguar Land Rover in 2020), and with others promising to dramatically increase the share of EVs sold (Volkswagen AG by 2030, Mercedes-Benz by 2022, BMW by 2025, Ford by 2023, GM by 2023), it is clear that now is the time for all municipalities in the Pioneer Valley and for PVPC to do our part to facilitate this transition.



Electrify America has spent several years understanding the state of the art of ZEV/EV use in the United States and has determined that the number one barrier to the advancement of ZEVs/EVs is "location and availability of charging stations". Unfortunately for our region, we are not in the target area for the first round of $500,000 million investments from Electrify America, but we certainly can advocate for Massachusetts investments here and also for the private sector to collaborate. Because the Boston metropolitan statistical area is being invested in by Electrify America, our region can make a case for greater investments here in western Massachusetts.

Given all that we have learned, the Pioneer Valley EV charging station plan work group targeted this plan for two primary audiences:

- Municipal governments in the region, and
- Businesses that should/could host EV charging stations on their property.

In addition, there are steps the Pioneer Valley Planning Commission and other regional and state entities could take to facilitate EV charging station implementation in the region. Supplementing the following detailed action strategies to advance EV charging stations at Pioneer Valley municipalities and target businesses, four additional focus areas were identified to support the expanded use of EVs in the Pioneer Valley.

1. *Zoning Rules* that are amenable to the installation of public EV charging stations are important and municipal planners and planning boards should work with PVPC as needed to assess local land use regulations to assure they facilitate and do not hinder installation of EV charging stations. Members of the PVEV work group are particularly concerned about business parking requirements and the effect of EV only parking spots on parking requirements in 'built-out' communities and also believe in an incentive-based approach, using local land use regulations to incentivize EV charging station installation. At a minimum, zoning laws should permit the installation of each charging station type in an appropriate setting. The Massachusetts Department of Housing and Community Development (DHCD) District Local Technical Assistance (DLTA) funds could be used by communities to amend their zoning, permitting, and parking ordinances to assure that they are EV-friendly.

2. *Educating potential EV owners* through large scale awareness efforts that are coordinated with EV manufacturers and local dealerships. These efforts should be directed towards key demographics of potential EV buyers and draw a connection to renewable electricity generation initiatives such as municipal Green Communities work and local Solarize campaigns.

3. *Fast charging stations will be needed* to facilitate longer EV travel distances, including inter-regional trips. These should be placed in strategic locations that are convenient for drivers traveling on Interstate highways and in larger cities where there is a concentrated population of EV drivers so the stations meet the needs of drivers passing through the region as well as people living here.

   More EVs will be utilized by Pioneer Valley residents in the near future because they provide benefits for the entire community. While current EV adoption rates are too low to pursue any charging station requirements or regulations, gradually expanding the charging network in the region and supporting the recommended strategies to help our communities become more EV-ready will prepare us for the future. Even today, attracting EV drivers from other areas of the state can complement the efforts to promote tourism in the Pioneer Valley. EVs also attract highly educated and technology savvy individuals who can help drive our emerging technology industries.

4. *Entrepreneurial Opportunity* ZEV/EV owners think differently about charging their vehicles than do internal combustion engine (ICE) vehicle owners. Whereas ICE vehicle owners are used to going to gas stations for 5-10 minutes to fill their tank, ZEV/EV owners think of their car more like a smart phone; they are always aware of percentage of charge and eager to 'top off' a charge whenever they can because they know it can take 5 hours to fully charge (depending on level of charger--explained later). As a result, the PVEV charging station plan work group anticipates a potentially lucrative business opportunity for entrepreneurial thinkers who could open a chain of ZEV/EV charging stations with no cost wifi, coffee, snacks etc.

High Priority Recommendations

To help create a more comprehensive charging network that supports current and future EV drivers, this Plan/Guide recommends:

- Each municipality in the region take on the responsibility of installing at least one dual-head charger available for public use.
- All businesses whose customers spend at least one hour at their business should consider installing at least one dual-head level 2 charging station.
- The State of Massachusetts should adopt legislation comparable to California Assembly Bill No. 2565 which would require a lessor of a dwelling to approve a written request of a lessee to install en EV charging station at a parking space allotted for the lessee in accordance with specified requirements and that complies with the lessor's approval process for modification to the property.
- Each municipality should consider local regulations comparable to the Atlanta ordinance that requires EV parking spaces in new developments of a certain agreed upon and locally appropriate size.
- The Commonwealth should continue to move forward aggressively with existing plans for the placement of fast chargers at highway rest stops on I-91 and I-90.

The key next steps to implementing this EV Charging Station Plan/Guide are:

1) Meeting with our legislative delegation to determine best legislative strategy to achieve our goals.

2) Aggressively educating member municipalities about the EV charging station incentives available from the Commonwealth and facilitating applications from member municipalities for funds to offset the costs, such that every municipality in the region would host at least one dual-head municipally owned EV charging station available to the public.

3) Aggressively educating target businesses (those where customers stay for 30 minutes to 2 hours or more) about the EV charging station incentives available from the Commonwealth, such that every target business (i.e. restaurant, movie theater, doctor's office...) in the region would host at least one EV charging station available to the public.

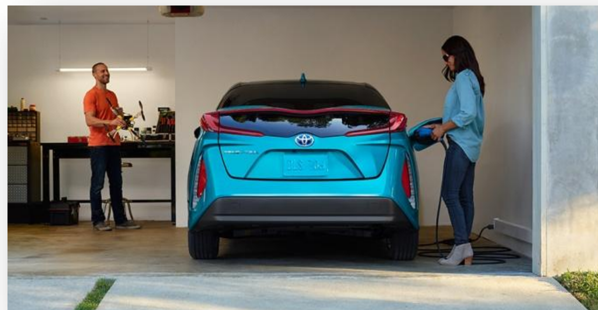
4) Supporting, and participating in as appropriate, any efforts to plan or deploy level 3 chargers (aka DC fast chargers) in the region.

Technology Context/Background

ELECTRIC VEHICLES

Hybrid electric vehicles (HEVs) supplement the internal combustion engine with electrical power produced by an on-board electric motor. The electrical system acts as a generator when a driver applies the brakes, converting kinetic energy into electrical energy that is stored in a small battery pack. Gasoline or diesel is still the primary fuel. Electric vehicles (EVs) take the HEV concept further, using a larger on-board battery for extended electric-only range. The driver charges the battery by plugging the vehicle into a charging outlet. When running on electricity, EVs are able to completely offset the use of gasoline, eliminating all tailpipe emissions.

Two different types of EVs are available: plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV), what we will be referring to as EVs. A PHEV is an HEV with a larger battery that plugs in to charge, but it keeps a gasoline or diesel engine as a backup. Some variations are called extended range EVs, or EREVs. After the battery energy is exhausted, the engine starts and the vehicle acts like a normal HEV until it is charged again from the grid.



The Toyota Prius Prime is a popular plug-in hybrid electric vehicle choice.

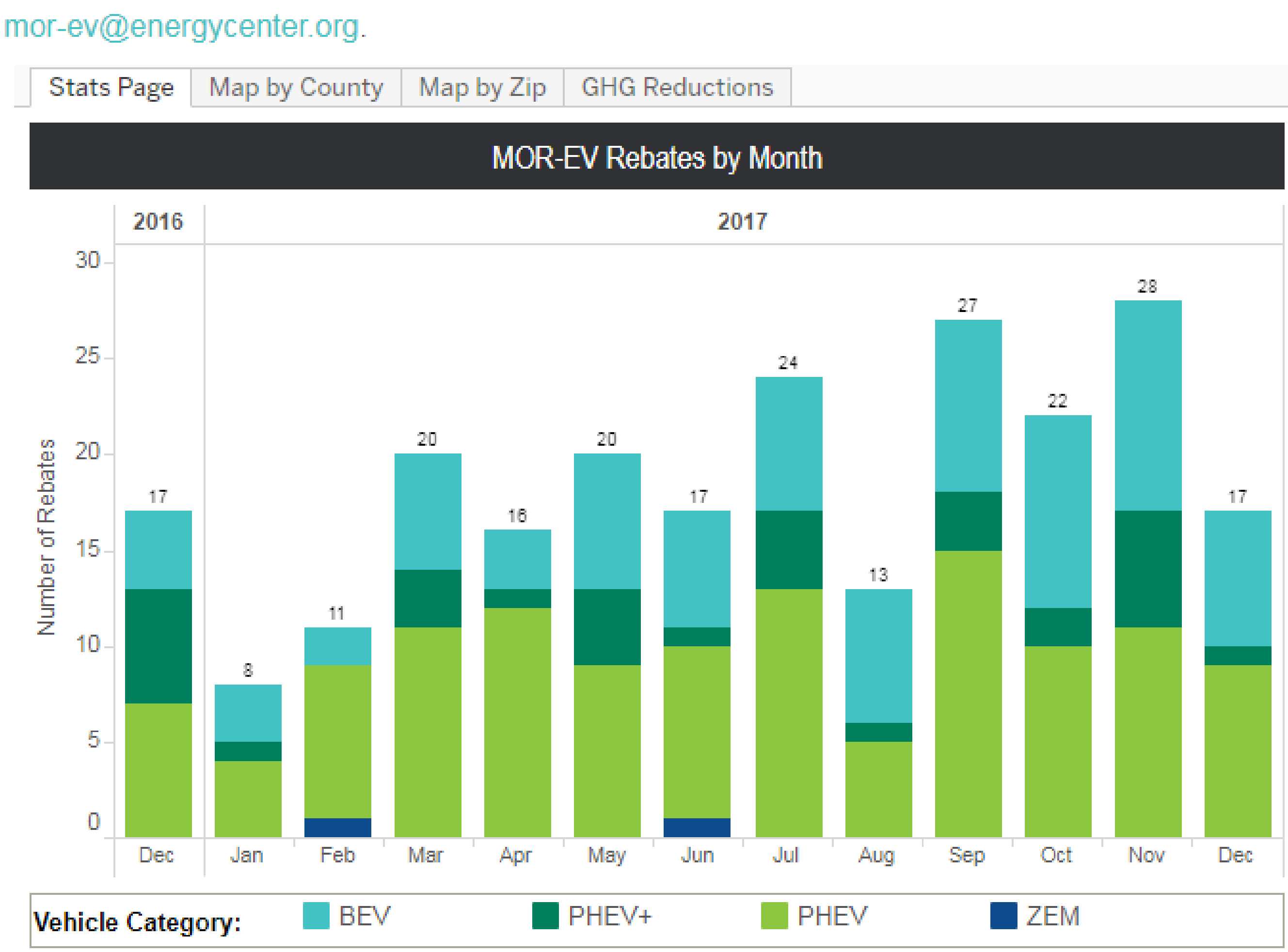
EVs fully remove the gasoline or diesel powertrain and replace it with an electric powertrain consisting of an electric motor, power electronics, and a battery pack. EVs have a longer all-electric range than PHEVs, but do not have a fuel backup when the battery is depleted. Using electricity as a vehicle fuel is currently less expensive per mile than gasoline, and can be even more cost effective if the EV driver can take advantage of off-peak electricity rates.

Current EVs can travel between 60 and 265 miles on a single charge and take at least 30 minutes to recharge the battery. A gasoline vehicle will be able to travel 300-500 miles on a single tank and can fuel in less than five minutes.

This “range anxiety” can often be solved with careful planning (including being sure to plug in every night and knowing where charging stations are along your route), or through the purchase of a PHEV to have a gasoline engine in reserve. PHEVs have ranges similar to gasoline vehicles, but typically only run on electricity for the first 10 to 50 miles.

Ambient temperature conditions will impact the realized driving range due to added power requirements to heat or cool the interior. There is also a decrease in performance of the EV batteries. While manufacturers continue to improve the vehicle's performance for adverse climates, a decrease in electric mileage by up to 50% on the coldest days and 20% on the hottest may occur. Pre-conditioning the EV while it is still plugged-in is a good strategy for minimizing the decline in range.

In January 2017, Governor Baker of Massachusetts signed the Electric Vehicle bill and the Commonwealth has a robust offering of incentives, rebates and programs to support the adoption of EVs in MA. They are summarized at the website: www.mor-ev.org. The Commonwealth also incentivizes the installation of EV charging stations, with information available at: https://www.mass.gov/how-to/massevip-workplace-charging. According to the Massachusetts Rebate website, 240 rebates were processed for EV owners in Hampden and Hampshire counties in 2017. Since the program was launched in 2014, 491 rebates have been processed for EV owners in our region.



EV CHARGING INFRASTRUCTURE

EV drivers have various options available to plug in and charge their batteries at charging stations, which are also referred to as electric vehicle supply equipment (EVSE). For the majority of users, a home charger can fulfill almost all of their charging needs. Public charging stations are used to recharge EVs while drivers are at work, shopping, or at other destinations, and help expand the functionality of electrification technology for many owners. *Note: EVSE technology is developing rapidly so charging times etc. may vary.*

LEVELS OF CHARGE: DIAGRAMS AND ATTRIBUTES

LEVEL 1

ATTRIBUTES:

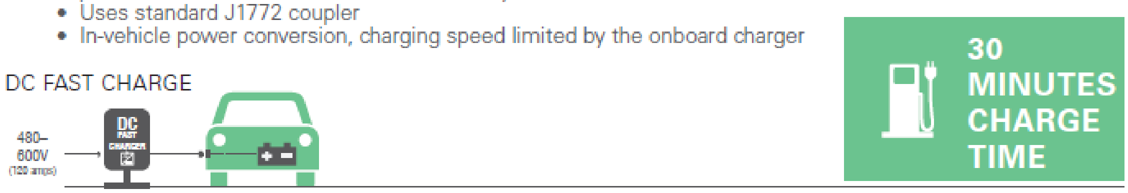
- A standard outlet can potentially fully recharge an EV battery in 8–12 hours, though larger batteries, such as on the Tesla Model S, would require between 1 and 2 days
- This level is often sufficient for overnight, home charging
- Standard outlets can also provide an option for "peace of mind" charging using onboard equipment on the go
- Uses standard J1772 coupler
- In-vehicle power conversion

LEVEL 2

ATTRIBUTES:

- Free-standing or hanging charging station units mediate the connection between power outlets and vehicles
- Requires installation of charging equipment and often a dedicated 20–80 amp circuit, and may require utility upgrades
- Well-suited for inside and outside locations, where cars park for only several hours at a time, or when homeowners seek added flexibility of use and a faster recharge
- The public charging network will comprise primarily level 2 charging stations
- Public context requires additional design features, such as payment and provider network interfaces or reservation systems
- Uses standard J1772 coupler
- In-vehicle power conversion, charging speed limited by the onboard charger

DC FAST CHARGE



ATTRIBUTES

- Free-standing units, often higher profile
- Enable rapid charging of EV battery to 80% capacity in as little as 30 minutes
- Electrical conversion occurs in EVSE unit itself
- Relatively high cost compared to level 2 chargers, but new units on the market are more competitively priced
- Draws large amounts of electrical current, requires utility upgrades and dedicated circuits
- Beneficial in heavy-use transit corridors or public fueling stations
- Standard J1772 "combo" coupler approved in October 2012

image from the excellent resource **Siting & Design Guidelines for Electric Vehicle Supply Equipment** Transportation & Climate Initiative http://www.transportationandclimate.org/sites/default/files/EV_Siting_and_Design_Guidelines.pdf

For many EV owners, the vehicle they select will accommodate their normal daily driving needs without needing to charge during the day. However, if that owner needs to run extensive errands one day, wants to take their EV to a recreational destination in the evening or on weekends, or is pushing the limits of their EV's battery range in the winter when it operates less efficiently, they will want to find an opportunity to get an additional charge during the day.

For some EV owners, installing a charger at their primary residence may be challenging (e.g. if they are renting or have an older house with insufficient electrical capacity to add more load) and will need charging infrastructure at their workplace or a public venue for an EV to be a feasible choice.

Charging stations are classified by their approximate charge rates and the form of power delivered (alternating current [AC] or direct current [DC]). Charging times for specific vehicles vary depending on power electronics, state of charge, battery capacity, and level of charging station used.

AC Level 1 Charging is limited to 120 volts of alternating current (VAC) and uses a typical household three-prong plug. All current EVs are sold with AC Level 1 capabilities and only need a dedicated 20 amp outlet to charge. AC Level 1 stations charge slowly, and are generally used in home or workplace charging applications where EVs will be parked for long periods of time. AC Level 1 charging adds 2 to 5 miles of electric range per hour of charging time. Usually, a portable AC Level 1 charger is included in the initial vehicle purchase price. As noted previously, the new Massachusetts state Building Code now requires newly constructed homes provide a dedicated conduit in the garage for an EV charging station. Hardware cost: Up to $1,000.


AC Level 1 Charging Station

AC Level 2 Charging

AC Level 2 Charging provides electrical energy at either 240 VAC (typical for residential applications) or 208 VAC (typical in commercial and industrial applications). This level of charging is viable for both residential and public charging locations. Unlike AC Level 1 charging, AC Level 2 charging requires additional hardware that can be mounted on the wall, to a pole, or as a stand-alone pedestal. It must be hard-wired to the electrical source. The increased charging rate and affordability of AC Level 2 charging stations make them the most popular choice for the majority of EV charging applications. It provides up to 7.2 kilowatts (kW) for residential and up to 19.2 kW for commercial, which typically results in 10 to 20 miles of range added per hour of charging time.
Hardware cost: $450-$5,000.

DC Fast Charging- also sometimes referred to as Level 3 utilizes direct-current (DC) energy transfer and a 480 VAC input to provide extremely rapid recharges at heavily used public charging locations. The type of station is generally cost prohibitive for home applications. However, depending on the EV, DC fast charge stations can provide an 80% recharge in as little as 20 minutes. This option is not available on all EVs and frequent or repeated use may decrease battery life.
Hardware cost: $7,000-$40,000.

Tesla's Supercharger Network offers DC fast charge for free, but is only available for Tesla owners. The network currently covers many major travel corridors across North America. Each Supercharger offers 120 kW charging (about 140 miles of range in 20 minutes).

Connectors, or plugs, for AC Level 1 and Level 2 charging stations have been standardized to allow owners of all EV models to utilize the same charging infrastructure. The industry standard for AC Level 1 and AC Level 2 charging is the Society of Automotive Engineers (SAE) J1772 connector, which provides significant safety and shock-proof design elements.

Up until 2013, the Japanese CHAdeMO connector was the only DC fast charge standard connector, available on both the Nissan Leaf and Mitsubishi i-Miev. In early 2013, the SAE J1772 connector standard was expanded to include DC fast charge with the SAE J1772 Combo connector, which is available on the Chevrolet Spark, Volkswagon e-Golf, and BMW i3.
Tesla uses a different proprietary connector, but includes a SAE J1772 compliant adapter cable with each vehicle sold and offers adapters for CHAdeMO and SAE J1772 Combo connections for an additional price.

SAE J1772 Combo connector

(AC Level 1 and Level 2 connector would include the top circular plug components)

Tesla DC Fast Charge

Which Charging Infrastructure Where?

AC Level 1 charging stations are most suitable for residential overnight charging. However, because of their low cost and lower power draw from the grid, AC Level 1 can also be an effective option for locations where EVs are parked all day long, especially PHEVs that have smaller battery packs. This includes workplaces, commuter lots, or long term parking at airports.

Many AC Level 2 charging stations are designed to be more durable for an outdoor setting and work well for public venues where an EV may be parked for 2-6 hours.

DC Fast Chargers require a significant investment and draw considerable power, but they are necessary for inter-regional travel by EVs that wish to use major highways and go farther than the distance available from one battery charge. DC Fast Chargers may also be effective in urban areas with a high population of EVs because they provide convenience over AC Level 2 charging (much shorter time) and they don't require a large number of parking spaces that would be needed to charge a lot of EVs using AC Level 2 chargers.

Higher charging station power draw can lead to increased electrical costs for the facility, but some applications may be able to take advantage of lower off-peak electrical rates with a time-of-use schedule if the EV charging will occur during off- peak times (night).

New charging technologies are progressing rapidly. BMW has developed its Light & Charge system, which converts existing street and parking lot light poles into connected nodes on a smart city network. Each pole includes high-efficiency LED lighting, EV chargers, and a sophisticated Sensor Bus that connects the site to the cloud. Each Light & Charge location will include one ChargePoint DC Fast Charger and up to four AC Level II chargers. All of the chargers are available to the public and compatible with any EV equipped with a standard SAE J1772 charging port.

Wireless Charging

Industry and consumers agree that the hassle of cords is one of the barriers slowing EV adoption, but recent advancements in Wireless Electric Vehicle Charging (WEVC) technology may provide the needed boost for more widespread EV adoption by helping electric vehicles surpass the convenience of gas cars. Wireless inductive charging is already a routine feature in smartphones, electric toothbrushes and other household electronics. Wireless EV charge pads and accompanying adapters for select plug-in models have been available for several years. Installation can be more complicated than a standard wall charger, but overall cost is comparable. Since 2014, Plugless Power has offered wireless charge kits for the Chevy Volt, Nissan LEAF and Cadillac ELR starting at under $1300—roughly $800 – $1,000 more than a typical Level 2 charging station – and kits for luxury EV's like the BMW i3 and Tesla Model S for more than $3,000.

While the third-party conversion retailer has run the market so far, auto-manufacturers are poised to make the switch in newer models. Mercedes-Benz will begin selling built-in wireless charge capability as an add-on for its S-Class S550e plug-in in 2018. Luxury competitors Audi and BMW are both rumored to be considering integrating wireless systems soon as well.

Until wireless charging capability becomes a universal option or standard feature for EVs, the prevalence of public wireless charge infrastructure will likely remain scarce. In order for that to happen, the industry will first have to finalize a charging standard.

In 2016, the standards organization Society of Automotive Engineers (SAE) released a draft wireless charging standard (J2954) which should help pave the way for broader interoperability. Standardizing wireless charging protocols is critical to making WEVC a convenient way to charge any electric vehicle, just as standardized home outlets can power any consumer appliance. [2]

Who Pays?

Workplace and public chargers usually offer free electricity paid for by the organization that installed them. Metered public charging stations are also common, with pay-for-service electricity as you would pay at a parking meter. If you charge at home, the electricity usage is added to your electric bill.

Most AC Level 2 and DC Fast Chargers come with an option to purchase a *subscription to a charging network* that can collect payments from users and limits use of the station to charging network members. EV drivers who are part of the network can access any charging station located within the network. There is often no fee for EV drivers to become members, and non-members may be able to activate the station using a toll-free number. In addition to listing the stations on its network maps for EV drivers, the network will track station usage so you know when and how long it is being used. Station owners are responsible for maintaining network subscriptions, which can cost $20 to $30 per month per charging outlet. In Massachusetts, municipalities using funds from the Commonwealth to offset the costs of EV charging stations are required to track and report on station use, so joining an established network may be a useful way to accomplish this requirement.

Different *ownership options* exist for charging stations, most commonly, owned by the host. However, third-party charging station service providers may pay for the installation, operate the station, and share some of the profits with the host site. Some charging station manufacturers, third-party charging station service providers, or charging station network providers are considering offering the option to lease charging stations as well. Massachusetts still has rebates up to $25,000 available in western MA to offset the cost of workplaces (with over 15 employees) installing charging stations. MA DEP now requires that anyone using DEP or other state funds have a 'networked' charging station for usage reporting purposes.

For a *cost-effective and successful charging station installation*, one must factor in how much use can be expected and how much benefit EV drivers can get from charging while parked at that location. Offering charging can help businesses increase visits, keep customers for longer durations, and serve as a valuable perk for employees or residents. EV drivers often seek out charging locations as they go about their everyday routines, for example, at restaurants, stores, and entertainment venues.

For public installations, consider the time an EV driver would typically spend parked at that location, because short durations may offer fewer benefits to EV drivers. Other important factors include, but are not limited to: patterns of travel in an area; the area's demographics, which may be correlated with characteristics typical of EV owners; and the nature of a potential EV charging station location, whether it is public property, private businesses such as retail companies, multifamily housing or other institutions. Building leases or third-party

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[2] https://www.fleetcarma.com/when-can-we-expect-wireless-charging-for-electric-vehicles/

operated parking can complicate charging station installations and all parties should work out arrangements to clarify ownership, operation, and revenue in advance.

Installing EV charging stations at workplaces can be very successful at the right business and have benefits for employers and their employees alike. EV charging stations can help to attract and retain desirable employees. EV drivers are typically tech- savvy and highly educated, qualities many employers seek in prospective employees.

Charging stations visibly demonstrate an organization's commitment to sustainable energy consumption and complement other environmentally friendly initiatives. Some workplace charging locations are able to serve employees and visitors, as well as the general public. Two key examples are:

- Colleges or Universities
- Medical Campuses

Other examples of public venues that have successful charging station installations include:

- Regional transit (commuter lots)
- Downtown multi-purpose parking lots or garages
- Retail destinations (malls or outlets with multiple stores)
- Popular year-round leisure destinations

In addition to the EV charging station's location, *the specifics of placement and installation will impact ease of use for EV drivers and station cost effectiveness*. Charging station installation costs can exceed the cost of the hardware itself and are influenced by a number of factors that should be considered when determining if a site and specific location are desirable.

The currently available electrical service can be a key factor in siting. All new charging station installations should have a load analysis performed on the facility's electrical demand to determine if there is capacity to add EV charging stations.

Upgrading electrical service would add significant cost to the installation. A longer distance between the electrical panel and the EV charging station means increased installation costs because it increases the amount of necessary trenching (and repair), conduit, and wire.

Although it is desirable to minimize the distance between the electrical panel and EV charging station as much as possible, you also need to consider the impact of placing the station at that location on the property. For example, placing charging station parking spaces in the back of a building might discourage their use, but other customers may be upset if a charging station is installed in prime parking spaces that often remain vacant because there are few EV drivers.

Other considerations have less impact on installation costs, but can impact how effective the station is at benefiting EV drivers and other clients. Be sure to think about the path of the charging cord when in use (so it is not a tripping hazard), parking lot management practices (will the charging station get in the way of pavement cleaning or snow plowing, or is it a space where snow is piled in the winter or where equipment might be stored), and signage (for EV drivers to easily find the station).

Siting and Design Guidelines for Charging Stations identify and diagram key siting and design issues that are relevant to local governments as well as developers, homeowners, businesses, utility providers, and other organizations interested in best practices for EV charging infrastructure implementation.

Site Design for Electric Vehicle Charging Stations highlights best practices for designing EV parking spaces, and provides several illustrated design scenarios.

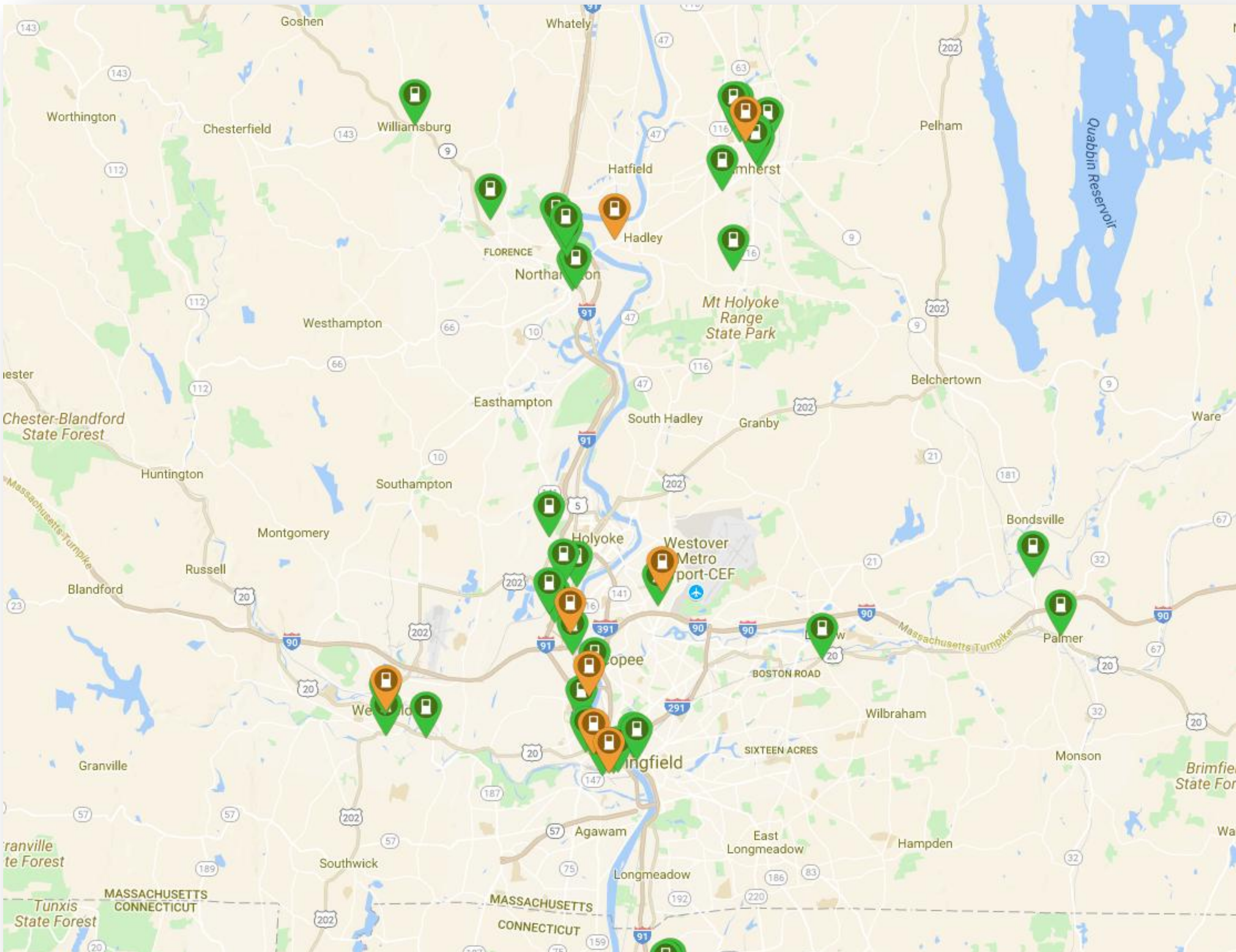
Effective signage helps EV drivers navigate to charging station spaces and helps to prevent those spaces from being occupied by a non-EV.

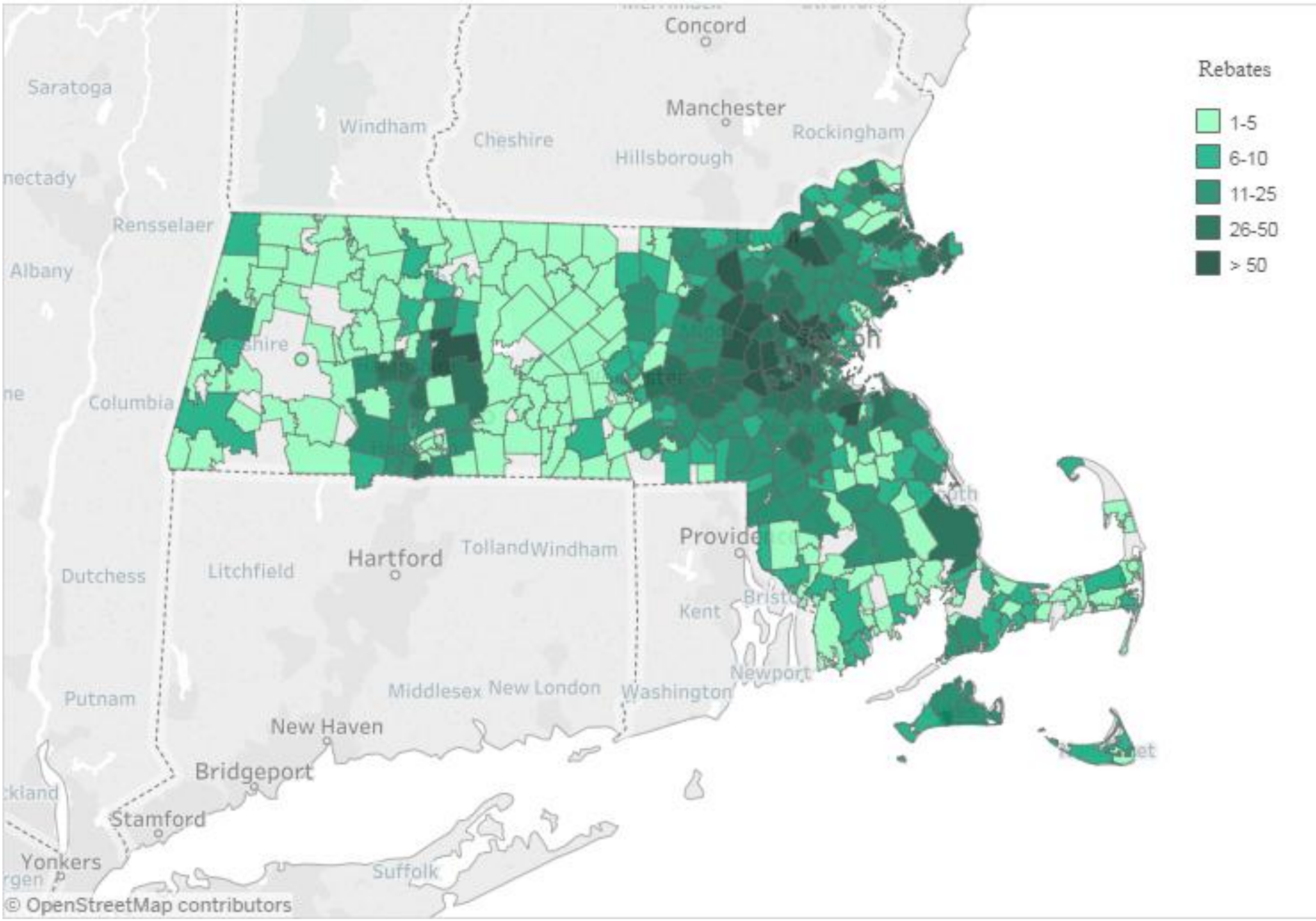
The **Charging Station Signage Overview** covers general service (guidance), regulatory (enforceable), and special

(information/trailblazer) signage. Another effective strategy for distinguishing the EV charging space is to paint the entire space green or mark the pavement with an EV charging symbol.

Current EV Landscape

Currently, there are 48 public Level 2 or fast- charging station locations in the Pioneer Valley, representing an estimated 96 charging ports as most have at least 2 charging ports per location. As can be seen from the map below, (available on-line and updated regularly at: www.plugshare.com), EV charging stations in the region are concentrated along the I-91 corridor, with some of the region's Green communities also hosting EV charging stations, including those in Palmer, Amherst, Williamsburg and Ware.





The map of Massachusetts shows EV ownership (both PHEVs and EVs) by zip code as of December, 2017. The zip code with the most EV owners is Northampton.


Granby MA

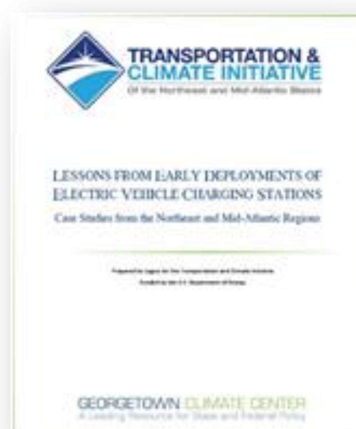
Community EV & EV Charging Infrastructure Readiness

Although gasoline-powered vehicles will be around for many years, a shift in the transportation industry toward electrification will change how people drive and fuel their vehicles. EVs can be very beneficial to communities and their residents. Unlike gasoline-powered vehicles, EVs are quiet, emit no direct air pollution, and do not require imported fuel that must be transported with the risk of spills or leaks. To enjoy these benefits and support residents who make the investment in cleaner cars, communities can promote the use of EVs by becoming EV- ready. Municipalities can prepare for EVs and the infrastructure that is used to charge them with the following best practices guides for amending local rules and regulations to be EV-friendly.

Understanding which level and how many charging stations are feasible for different settings based on expected EV use is critical. The type and number of EVs in a community will help shape how many and what kind of charging station an EV owner might need. The different types of charging stations will charge EV batteries at different rates. The type of EV charging infrastructure at each site should correspond with the amount of time a vehicle might be parked there while the driver is shopping, working, or enjoying entertainment. As a municipality, zoning laws must permit the installation of each charging station type in an appropriate setting.

Lessons from Early Installations of Charging Equipment https://www.nyserda.ny.gov/-/.../ChargeNY/Lessons-Early-Deployments-of-EVSE.pdf documents EV charging infrastructure installations in the Northeast and Mid-Atlantic, and uncovers some of the related challenges and opportunities.

- In general, preparing the charging sites as part of a new development is more cost effective than incorporating EV charging infrastructure into an existing structure. The cost of electric system upgrades also tends to increase with the age of the building.
- Installations in public spaces, such as sidewalk right of way, can be administratively burdensome and formalizing clear procedures for permitting and approval will help expedite installations.
- Standardization of signs, both regulatory (on- site) and directional (wayfinding) will not only improve communication to drivers but also reduce the burden on site owners and designers.
- Site owners, current and prospective, often struggle with the question of return on investment on EV charging equipment.
- Cords without a management system are often left spread about on the ground and may potentially become a hazard for users or the equipment.
- The Northeast and Mid-Atlantic regions have not yet formally adopted guidelines or recommendations on the definition of ADA- accessible charging space and the minimum number of charging stations that need to meet that definition.
- A careful evaluation of the possible spaces where the EV charging equipment could be located and their impact on the economics of the installation should be part of the planning process before a commitment to installing the equipment is made.


TRANSPORTATION & CLIMATE INITIATIVE

LESSONS FROM EARLY DEPLOYMENTS OF ELECTRIC VEHICLE CHARGING STATIONS

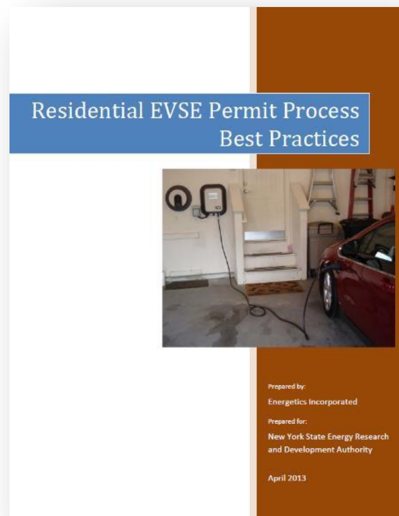
GEORGETOWN CLIMATE CENTER

- Public-private partnerships to fund the installation of charging stations help the host construct a more attractive economic case to install the equipment, while enabling government to pursue their community goals.

Before entering into agreements to install charging stations, prospective hosts should make sure they understand who will pay for maintenance, electricity, and other ongoing costs after installation.

Every EV charging station installation context is unique, but all should use certified equipment and a licensed electrician. Complying with industry best practices for siting, design, and installation will help lower costs and increase value to EV drivers.

Site elements to consider:
- Location: visibility/preferred parking, parking lot management, station mounting, wire run
- Wire run: distance and obstructions between panel and station, need for boring/trenching
- Electrical Supply: power capacity, panel up to code, potential to use an existing subpanel
- EVSE: mounting type (wall or pedestal), cord management, networking, certification, make
- Permitting: process, cost, local experience
- Other: protection, signs, maintenance



Zoning and parking ordinances have a wide impact on how and where public charging stations are installed and used. Zoning rules can help determine what types of land uses are appropriate for AC Level 1, AC Level 2, and DC fast charging stations and how they should be sited. Parking rules dictate who is allowed to park in parking spaces adjacent to charging stations, and whether cars parked there illegally can be fined or towed. One of the most frustrating situations for an EV driver in need of a charge is to pull up to a charging station, only to find it is occupied by a conventional vehicle.

Examples of zoning and parking policies from across the country can be found in the **Planning Policy Tool Guide**, which also addresses local permitting practices and building codes. This guide highlights best practices and introduces policy options for public officials and private-sector leaders to prepare their communities, jurisdictions, states, or organizations for EVs.

Simple and consistent EV charging station *permitting processes* can make installing EV infrastructure much easier. Current national building and electrical codes neither inhibit nor facilitate the implementation of EV charging stations. But at a municipal level, the adoption of certain provisions in local codes has successfully encouraged EV-readiness in some municipalities.

EV Ready Codes for the Built Environment provides current codes for charging stations and identifies code provisions that could be incorporated into local code to encourage a basic or advanced level of EV-readiness. It highlights best practices from around the world to make recommendations for jurisdictions in the Northeast and mid-Atlantic.

Classification of charging station installation work within a jurisdiction can impact the time and cost of the permitting process. An overview on **Permit Process Streamlining** reviews best practices for charging station permitting and presents sample application forms.

In early 2017, Massachusetts lawmakers passed Senate Bill S.2505, "An Act promoting zero emission vehicle adoption," which explicitly authorized the Board of Building Regulations and Standards (BBRS) to set new "EV Ready" requirements in the state building code to make it easier, safer, and cheaper for families and businesses to install their own charging stations. As noted previously, EV readiness is now required in new construction.

DHCD has funding available for communities to amend their permitting, zoning, and parking ordinances so they are more EV-friendly, along with other opportunities available to support EV and charging station use through the District Local Technical Assistance Program (DLTA).

For businesses and other employers thinking about installing EV charging stations on site, it is important to not get stuck thinking about the present. Do not make decisions based on how many customers or employees currently have EVs. Think instead about the future and survey employees and customers asking if/when they intend to purchase an EV and why they are waiting. It may be because they are concerned about access to charging stations.

Resources

Both Chris Mason, Sustainability Officer for the City of Northampton and Jay Joyce, Chair Town of Granby Energy Committee and Planning Board Member have successfully used state funds to purchase both EV charging infrastructure and EVs. They have both volunteered to be available for follow-up questions.

You can contact them at:

- Jay Joyce-Town of Granby: Jay-Joyce@comcast.net
- Chris Mason-City of Northampton: cmason@northamptonma.gov

As of December 2017, the Commonwealth of Massachusetts offered rebates to individuals who purchase or lease eligible EVs. More information is available on the Massachusetts Offers Rebates for Electric Vehicles site: https://mor-ev.org/

In addition, the Massachusetts Department of Environmental Protection (MassDEP) offers incentives for employers to install Level 1 and Level 2 EV charging stations. For more information, see: https://www.mass.gov/how-to/massevip-workplace-charging

The following site provides information on tax credits and rebates offered at both the federal and state level for purchasing and leasing EVs: https://www.massenergy.org/drivegreen/incentives

For information on installing a home charger, see: http://www.plugincars.com/quick-guide-buying-your-first-home-ev-charger-126875.html

Plug My Ride contains a wealth of information on purchasing EVs, installing EV charging stations, and addition resources for learning about EVs. Information is geared to individuals, businesses, dealers, cities, and installers: http://plugmyride.org/

The Northeast Electric Vehicle Network contains information on the network of charging stations, EV policies, and much more geared to individuals, businesses, local governments, multi-unit housing owners, and utilities: http://www.transportationandclimate.org/northeast-electric-vehicle-network-documents

The US Department of Energy Alternative Fuels Data Center provides a variety of information on installing EV charging stations:

At home: https://www.afdc.energy.gov/fuels/electricity_charging_home.html
In multi-unit dwellings: https://www.afdc.energy.gov/fuels/electricity_charging_multi.html
In cities and towns: https://www.afdc.energy.gov/fuels/electricity_charging_public.html
And at workplaces: https://www.afdc.energy.gov/fuels/electricity_charging_workplace.html

FAQ **From Chevy Bolt web page https://www.chevyevlife.com/bolt-ev-questions-and-answers/#ev-glossary**

How much will it cost me to charge an EV?

We estimate that it will cost an average of $50 a month1 to charge the Bolt EV. According to the EPA label, the average vehicle costs an average of $7,000 over 5 years to fuel, which is $116.67 a month. That means just by driving electric, you could save over $65 a month – or about $800 a year. In some states and regions (NOT in Massachusetts) utility rates vary by time of day and demand on the grid, so ZEV/EV owners can charge at night, when utility rates are at their lowest off-peak price, and could save even more. Based on EPA-estimated 119 MPGe, $0.13 per kWh national average electricity cost, $2.45 per gallon gas, and 15,000 miles per year.

Do I need any special equipment to charge at home?

A 120-volt charge cord comes standard with the Bolt EV. The 240-volt (32-amp) charging is the fastest and most convenient way to charge at home – however, it does require a separate charging unit (also called an EVSE) and professional installation. With the 240-volt charging unit, there is the benefit of up to 25 miles of range per hour of charge. So, if you drive an average of 40–50 miles a day, like most U.S. commuters, you could replenish your battery in about two hours. You can find the available 240-volt charging unit at Bolt EV certified dealers and online at GM Accessories. Aerovironment, provides a convenient, easy-to-use solution for home installation. Otherwise, be sure to talk to a certified electrician about installation costs and incentives in your area.

Acronyms

AC	Alternating Current
BEV	Battery Electric Vehicle
DC	Direct Current
EREV	Extended Range Electric Vehicle
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
kW	KiloWatts
kWh	KiloWatt Hours
MPG	Miles Per Gallon
MPO	Metropolitan Planning Organization
MSRP	Manufacturer Suggested Retail Price
PHEV	Plug-in Hybrid Electric Vehicle
PVPC	Pioneer Valley Planning Commission
SAE	Society of Automotive Engineers
VAC	Volts of Alternating Current
ZEV	Zero Emission Vehicle

Definitions

Electrified Vehicle
This widely used term represents anything with an electric propulsion system, but most commonly refers to vehicles that are either plug-in hybrids, all-electric vehicles or even conventional non-plug-in hybrids.

EV - Electric Vehicle
A vehicle that is propelled by a motor powered by electrical energy from rechargeable batteries or another power source on board the vehicle.1

BEV - Battery Electric Vehicle
An electric vehicle that depends on a battery system and has to be plugged into a charging source to replenish the charge. It does not have a traditional combustion engine as seen in gas vehicles. Can also be called identified as “pure electric” or “EV.”

PEV - Plug-In Electric Vehicle
Any motor vehicle that can be recharged from an external source of electricity. The electricity is stored in rechargeable battery packs and either drives or contributes to driving the wheels.1

HEV - Hybrid Electric Vehicle
A vehicle that combines an internal combustion engine with an electric propulsion system. The charge on the batteries is maintained from regenerative braking and from other onboard power sources (such as an internal combustion engine).1

PHEV - Plug-In Hybrid Electric Vehicle
A hybrid electric vehicle that incorporates a separate battery system where the charge is restored by plugging into an external power source.1

EREV - Extended Range Electric Vehicle
A vehicle with a plug-in battery pack, electric motor and an onboard gas-powered generator. The difference between this and a plug-in hybrid is that the electric motor always drives the wheels, while the gas-powered generator recharges the battery pack to restore energy.

ZEV – Zero-Emission Vehicle
The term ZEV is both an emissions standard and a program of sales requirements in California. A standard ZEV vehicle produces no emissions from its onboard source of power. Battery electric cars such as the Chevrolet Bolt EV qualify as zero-emission vehicles. Hydrogen fuel-cell vehicles also qualify as a ZEV.2

Electric Driving Vocabulary

MPGe - Miles Per Gallon Gasoline Equivalent
MPGe is the EPA's standard to rate the efficiency of a non-gas-powered car in terms familiar to gasoline drivers. It is the distance in miles that an electric or fuel-cell vehicle can cover on the same amount of energy – 33.7 kilowatt-hours – that's the equivalent energy contained in 1 gallon of gasoline. Electric vehicles tend to use energy more efficiently than combustion-engine cars, and as a result, the MPGe rating for these vehicles tends to be higher.3

Regenerative Braking
To capture energy generated when applying the brakes by using the traction motor as a generator to convert to electric energy and recharge the battery. In other words, regenerative braking captures otherwise lost kinetic energy and transfers that energy back to the battery pack.1

kW – Kilowatt
One thousand watts.4

kWh – Kilowatthour
A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu.4

Types of Charge Stations

Level 1 Charging
Level 1 equipment provides charging through a 120-volt, alternating current plug and requires a dedicated circuit. Generally speaking, L1 charging refers to the use of a standard household outlet. L1 charging equipment is standard on plug-in vehicles and therefore is portable and does not require the installation of charging equipment.1

Level 2 Charging
Level 2 equipment offers charging through a 240-volt, AC plug and requires installation of home charging or public charging equipment. These units require a dedicated 40-amp circuit. Level 2 charging equipment is compatible with all electric vehicles and plug-in electric hybrid vehicles. Level 2 chargers have a cord that plugs directly into the vehicle in the same connector location used for Level 1 equipment.1

DC Fast Charging/Level 3

DC Fast Charging provides accelerated charging times for battery electric vehicles. DC Fast Charging for Bolt EV requires the available DC Fast Charge port, and can provide up to 90 miles of range in about 30 minutes of charge depending on outside temperature. Public DC Fast Charging locations are becoming increasingly available throughout the United States.

Charge System Parts

SAE J1772™

The North American (and Japanese) standard adopted by the Society of Automotive Engineers (SAE) for the design of the charge coupler (a pin and sleeve device). The Chevrolet Volt and Bolt EV adhere to the SAE J1772 standard.

Combined Charging System (CCS)

CCS is a quick charging method for battery electric vehicles that delivers high-voltage direct current (DC) via a special electrical connector derived from the SAE J1772 (IEC Type 1) or IEC Type 2 connector. As the plug is a combination of an alternating current (AC) connector with a DC option, the resulting connector is called a Combo Coupler. Chevrolet vehicles equipped with DC Fast Charging provisions adhere to the CCS standard.

Charge Coupler

The connecter (or handle) and vehicle receptacle that connects the electric charging source to the electric vehicle.

EVSE - Electric Vehicle Supply Equipment

The “charging” equipment used to maintain a charge on EV battery systems.

Types of Battery Chemistries

Lead-acid (or PbA) batteries

This is the chemistry used for traditional 12-volt car batteries, first invented way back in 1859. Lead-acid batteries aren't suitable for modern electric cars due to their low energy density.

Nickel-Metal Hydride (NiMH) batteries

NiMH batteries offer roughly twice the energy capacity of lead-acid batteries for the same weight. They are not used in plug-in electric cars, but they're still fitted to the majority of hybrid cars – which are only slowly switching to lighter lithium-ion batteries.

Lithium-ion battery (Li-ion or LIB)

Virtually all plug-in hybrids and battery electric vehicles use lithium-ion batteries. They offer roughly double the power-to-weight ratio of NiMH, or four times that of old-style lead-acid batteries.

National Interest Groups

NEMA - National Electrical Manufacturers Association

This is the association of choice for the electrical manufacturing industry. Established in 1926 and headquartered near Washington, D.C., its approximately 450 member companies manufacture products used in the generation, transmission and distribution, control and end use of electricity.

SAE International - Society of Automotive Engineers
A nonprofit educational and scientific association dedicated to evolving mobility technology.

The above definitions come from various sources:

U.S. Department of Energy at www.afdc.energy.gov.
California Environmental Protection Agency at www.arb.ca.gov/html/gloss.htm#P.
U.S. Department of Energy at www.fueleconomy.gov/feg/label/learn-more-electric-label.shtml#comparing-fuel-economy-to-other-vehicles.
U.S. Energy Information Administration www.eia.gov/tools/glossary/index.php.

Appendix A: Myths & Facts about Electric Vehicles

http://zeroenergyproject.org/2017/11/10/10-myths-electric-cars-true/
This piece by Steve Hanley originally appeared in GAS2, and is based on research reported by Norwegian news outlet TU. Please follow this link to find the charts and graphs that support the findings reported here. Hat Tip to Leif Hansen.

New ideas always make us nervous at first. Airplanes and automobiles were once considered dangerous but are now part of everyday life. Electric cars are a relatively new idea. Some early adopters can't wait to own one but the majority of people are skeptical.

If electric cars suddenly went mainstream, traditional automakers and fossil fuel companies could lose a lot of business. Some of those companies are actively spreading misinformation in an attempt to slow the transition away from conventional cars. That wrong information becomes the basis of myths that can make people decide to delay buying an electric car.

Often, those myths contain a kernel of truth that has been distorted. Let's take look at the most frequent myths and try to figure out which are true and which are not.

Myth #1: More CO2 is emitted during production of electric cars than regular cars.

Conclusion: True, but, that extra energy to manufacture is quickly 'paid back' in the much more energy efficient operation of the vehicle.

Studies show that manufacturing an electric car uses significantly more energy than manufacturing a conventional car. Much of the difference is attributable to manufacturing the battery. Mercedes makes the B Class and the B Class Electric. About 45% of the emissions from the B Class Electric occur during manufacturing. For the conventional B Class, the number is only 18%. So it is fair to say an electric car has higher emissions right up until it rolls off a dealer's lot. But after that, the conventional car rapidly catches up and eventually passes the electric car in total lifetime emissions. How much of a difference there is depends on the source of the electricity used to recharge the electric car. Using electricity from fossil fuel plants, the electric car will emit 25% fewer emissions during its lifetime. But if the electricity comes from hydro or renewables, its will emit 64% fewer emissions while it is in active service. And, better still, if the electricity that powers the car comes from a rooftop solar array, emissions will be zero.

Myth #2: Electric car batteries are a ticking environmental bomb.

Conclusion: False

Electric car batteries are largely recyclable and there is little chance they will simply be discarded in landfills at the end of their useful life as some fossil fuel advocates like to suggest. There aren't enough used electric car batteries for economies of scale to kick in yet, but many companies are experimenting with reusing the ones that are available for residential and commercial electrical storage. When a lithium ion battery is no longer able to power a vehicle, it still has about 80% of its power remaining. It just can't charge and discharge as rapidly as it needs to for transportation use.

Myth #3: Electric cars create more particulates than conventional cars

Conclusion: False

The theory is that electric cars have heavy batteries and all that weight wears roadways faster, which puts more particulates into the atmosphere. The first thing you need to know is that there are two kinds of particulates — those less than 2.5 microns in size and those up to 10 microns. The small particulates can get into the lungs and actually cross into the bloodstream. The larger ones cannot. Virtually all particulates 2.5 microns and smaller come from internal combustion engines. None come from electric cars. Studies showing heavy vehicles cause more wear and tear to roads involve heavy trucks. The extra weight of a Volkswagen e-Golf (about 500 pounds) compared to a conventional Golf is too small to make any significant difference. In addition, brake dust is the primary source of larger particulates. Electric cars use mechanical brakes far less frequently than conventional cars because they make use of regenerative braking, which recharges the battery when they slow down. That means they create far less brake dust. In fact, brake pads in electric cars may last 100,000 miles or more.

Myth #4 Electric cars cause people to stop using public transportation

Conclusion: False

This one is rather Euro-specific, as more Europeans commute using public transportation than do Americans do. The analysis, by Norwegian news site TU, shows that the number of people who buy an electric car and stop using public transit systems is quite small — on the order of 5%. In most of those cases, purchasing an electric car goes along with moving to a new home further from the city.

Myth #5: Electric cars increase the total number of cars on the road.

Conclusion: False

The data shows that most electric cars replace an existing conventional car. In about a third of cases, the electric car is the sole means of private transportation in the household. There may be some cases in which a single- car family adds an electric car, but the vast majority of the time, the total number of cars in the household remains the same.

Myth #6: Making electric car batteries harms the environment.

Conclusion: Partly True And Partly False

Making lithium ion batteries does require mining operations to acquire the raw materials. Mining operations of any type are not usually environmentally friendly. On the other hand, internal combustion engines run on fossil fuels. Extracting oil from the earth introduces enormous amounts of carbon dioxide and methane into the atmosphere.

Myth #7: Electric car batteries have a short life span and are expensive to replace.

Conclusion: False

Real world data shows that there are Nissan LEAF automobiles being used as taxis that still have 75% of their battery capacity after 120,000 miles of service. Statistics for Tesla indicate about a 5% loss of battery capacity during the first 50,000 miles but only a further 5% loss over the next 150,000 miles. In sum, a Tesla owner can expect to have 90% battery life remaining after 200,000 miles of driving.
It is possible to replace portions of a battery without replacing the entire battery pack. And Nissan has just announced that the price of a standard 24 kWh battery for the LEAF is $5,499 — about the same as replacing an internal combustion engine.

Myth #8: Electric Cars Will Put Excessive Strain On The Electrical Grid

Conclusion: False

Most electric car charging is done at home using 3.2 kW of power. That translates to about 16 amps on single phase household current — less than an electric dryer or stove. A study in Norway finds that nation will have approximately 1.5 million electric cars on the road by 2030 and that the electricity needed to charge them will increase demand for electricity by only 3%.
Some remote sections of the grid may need updating, but the overall effect on the entire grid will be minimal.

Myth #9: Electric cars don't lower pollution, they move it from one place to another.

Conclusion: Partly true, partly false

The biggest knock on electric cars is that if they use electricity generated from burning coal, they are just taking pollution out of the cities and moving it to the suburbs where the generating stations are. Renewable energy, however, is rapidly claiming an ever increasing portion of the energy pie. In addition, an electric car is significantly more efficient than a car powered by an internal combustion engine, which means fewer carbon emissions in total regardless of where the electric generating plants are located.
So yes, electric cars do shift some emissions from one place — usually a congested city with a smog problem — to another. But overall, total electric car emissions for an electric car are between 25% and 65% lower than a those from a conventional car.

Myth #10: Electric Car Owners Don't Pay Their Fair Share To Maintain Roads

Conclusion: True
Maintaining roads, bridges and tunnels costs a lot of money. Congress has not raised the federal gasoline tax, which is supposed to pay for such maintenance, in more than 30 years. It is obvious a car that uses no gasoline pays no gas taxes and therefore does not contribute to the highway trust fund.
But the issue is more a political one than the fault of electric cars. Politicians need to devise new methods of paying to maintain the transportation infrastructure. Fees based on overall weight are one possible way of doing this. In fact, Norway is considering a form of taxation based on weight at this very moment.
Another method is billing drivers for each mile driven. Combining the two may offer the fairest way to adequately fund road maintenance but raises questions about privacy and government tracking of citizens. We need to find a way to pay for our roads, without penalizing electric car owners.

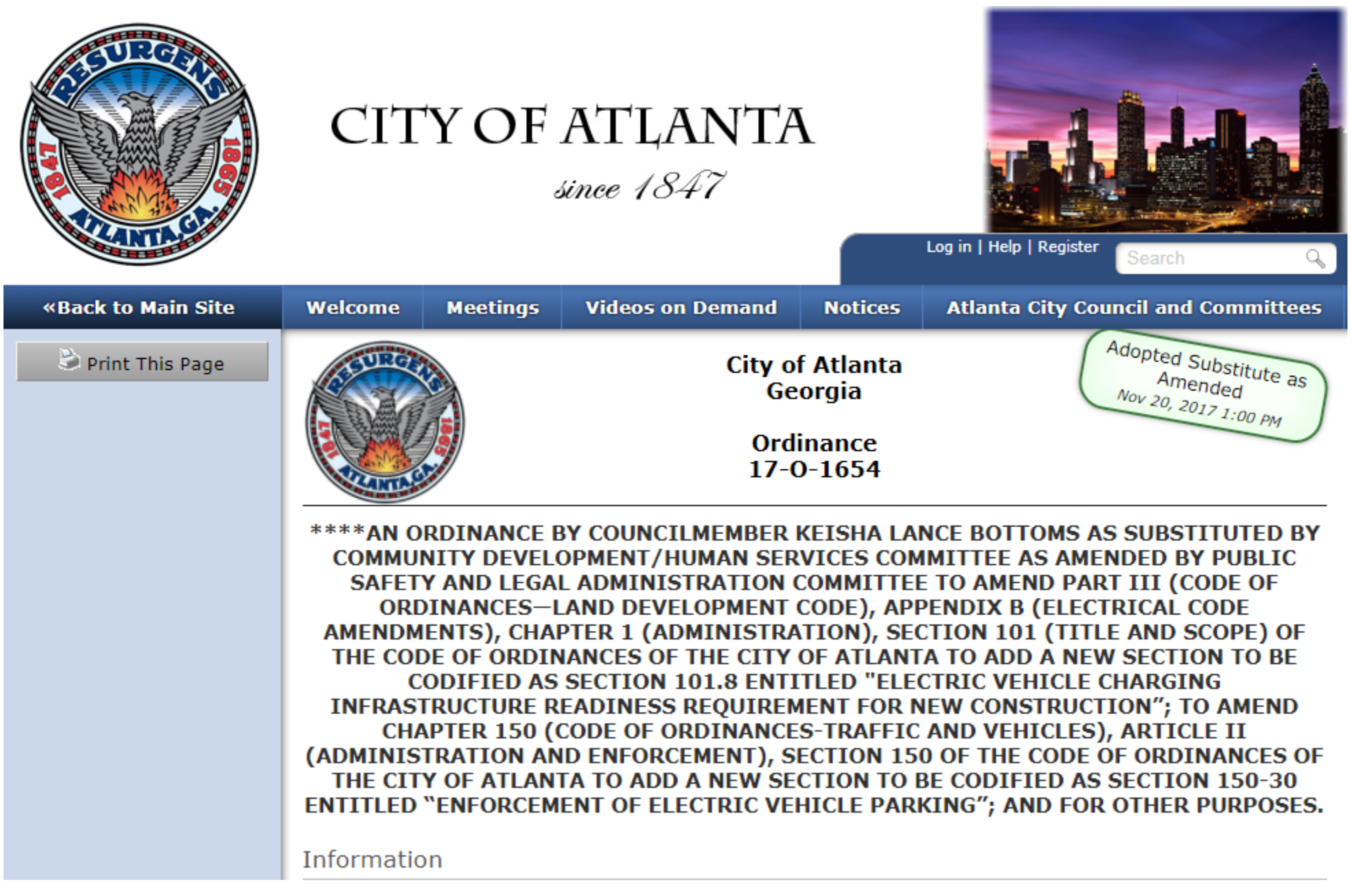
The Take Away

So there you have it. Everything you ever wanted to know about electric cars but were afraid to ask. Is it true that electric cars contribute to global carbon emissions? Of course it is. Virtually every human activity does. But as the energy grid continues to get greener, manufacturing procedures get cleaner and battery recycling programs ramp up, the impact of electric cars will become less disadvantageous and increasingly net positive.

Appendix B--Model Legislation

example from CA
http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB2565&search_keywords=

example from Atlanta
http://atlantacityga.iqm2.com/Citizens/Detail_LegiFile.aspx?MeetingID=2068&ID=13626



Appendix C--Descriptions of the related best practice areas for the Massachusetts Community Compact Best Practice Program

https://www.mass.gov/service-details/best-practice-areas

Energy Efficiency and Renewable Energy

Best Practice: Purchase Fuel-Efficient or Electric Vehicles to increase vehicle efficiency and reduce GHG emissions and fuel costs

Best Practice: Provide Electric Vehicle Infrastructure to facilitate the purchase & use of electric vehicles

Climate Change Mitigation

Best Practice: Promote Fuel Efficient Transportation to reduce municipal transportation emissions & those from people living/working in the community

Appendix D Bibliography/Webliography

List of Reports and Websites Referenced in preparing this Plan/Guide

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Ewing, J. (2017, December 18). What Needs to Happen Before Electric Cars Take Over the World. Retrieved from https://www.nytimes.com/2017/12/18/business/electric-car-adoption.html

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additional websites of interest

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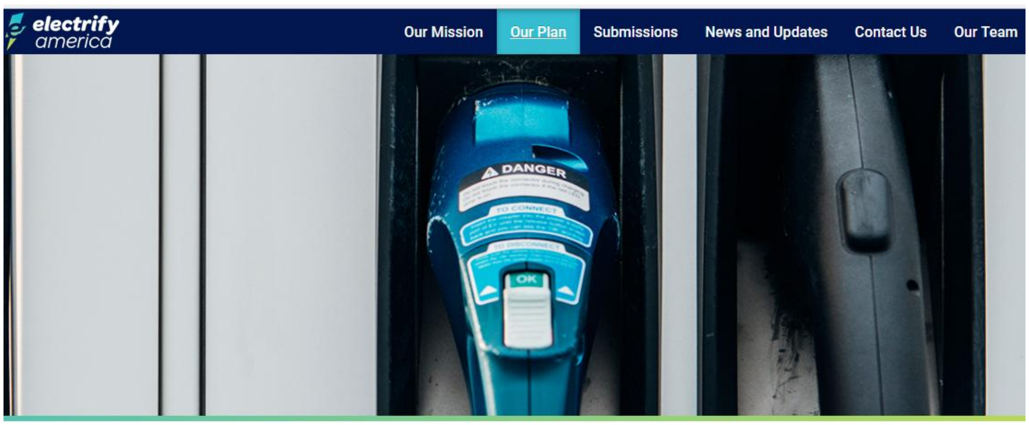
www.pvpc.org

https://www.electrifyamerica.com/our-plan



Our Plan

Over a ten year period ending in 2027, Electrify America will invest $2 billion in Zero Emission Vehicle (ZEV) infrastructure and education programs in the United States. Of this $2 billion, $1.2 billion will be invested nationwide (in states other than California), while $800 million will be invested in California, the largest single ZEV market in the world. This investment represents the largest of its kind ever made, and it will provide long-overdue solutions to ZEV stakeholders.

Electrify America, based in Reston, Virginia, is currently implementing the Cycle 1 National ZEV Investment plan, the Cycle 1 California ZEV Investment Plan, and the Supplement to the California ZEV Investment Plan. Over the first investment cycle, Electrify America will invest in ZEV infrastructure and awareness to support increased adoption and use of ZEV technology and to show more Americans that going electric is not only possible but beneficial today.