Commonwealth of Massachusetts

Electric Vehicle Infrastructure Coordinating Council

Initial Assessment to the General Court
August 11, 2023

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A LETTER FROM THE UNDERSECRETARY

August 11, 2023

Massachusetts has long been, and continues to be, on the forefront of climate change mitigation within the United States. Through legislation, such as the Global Warming Solutions Act of 2008 and subsequent amendments, and the development of Clean Energy and Climate Plans for 2025/2030 and 2050, the Commonwealth has set ambitious limits for greenhouse gas emissions reduction statewide, requiring new and innovative approaches to transportation policy.

The Electric Vehicle Infrastructure Coordinating Council (EVICC) came together in May 2023 as a unique inter-agency group to examine how the state can support the projected growth of an electrified transportation sector. Through a series of public meetings, we heard perspectives from industry professionals, consumer advocacy groups, and state officials on topics ranging from the driver's experience to future impacts on the electric grid. Through public hearings, we heard directly from electric vehicle drivers on what challenges they face and their ideas for solutions.

This initial assessment represents a compilation of our findings to date, including recommendations and areas of further research. Our work does not end with this report; rather, it is just beginning. As directed by the statute, our task now is to continue fleshing out plans based on recommendations offered in this assessment.

Many thanks go to the Council members, meeting presenters, and constituents who have been involved in this process to date. This effort has been collaborative, informative, and comprehensive. I look forward to continuing this work in the years to come.

Michael Judge

Michael R. Judge
Undersecretary of Energy
Massachusetts Executive Office of Energy and Environmental Affairs

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1. EXECUTIVE SUMMARY

Building a network of electric vehicle charging stations is a core challenge to achieving Massachusetts' transition to a clean energy economy.

According to the Massachusetts Clean Energy and Climate Plans for 2025/2030 and 2050, Massachusetts must transition nearly all Commonwealth vehicles to be zero-emission, including electric vehicles. The Commonwealth will need to have more than 200,000 electric vehicles on the road by 2025 and 900,000 light-duty electric vehicles on the road by 2030 to achieve the transportation sector sublimits. The CECP also finds that more than 25,000 electric trucks and buses will need to be on the road to achieve 2030 emission limits. By 2050, our climate plan finds that nearly all the light- and heavy-duty vehicles operating in the Commonwealth must be zero-emission.

Achieving this level of electric vehicle penetration will require new infrastructure for vehicle charging. This EVICC Initial Assessment finds that approximately 10,000 publicly accessible fast charging ports will be necessary to support the light-duty vehicle fleet by 2030, in addition to 35,000 publicly accessible Level 2 stations, as well as more than 700,000 residential and workplace charging stations. This represents a build-out of between six and 15 times our current electric vehicle charging infrastructure and could add as much as 1,400 megawatts (MW) of additional peak demand on the electric grid. Additional analysis will be required to provide a full assessment of the number and location of charging stations necessary to support medium- and heavy-duty fleet electrification.

In August 2022, An Act Driving Clean Energy and Offshore Wind was signed into law. Recognizing the need for Massachusetts to develop a comprehensive plan for transportation emission reduction, the Electric Vehicle Infrastructure Coordinating Council (EVICC) was created to establish an equitable, interconnected, accessible and reliable electric vehicle charging network.

Over the past few months, the members of the EVICC have consulted with leading industry experts on the deployment of electric vehicle infrastructure. We have met with stakeholders such as the utilities, the electric vehicle supply manufacturers, and fleet operators. We have conducted analyses projecting electric vehicle charging infrastructure need. We have held seven public meetings and conducted three public hearings in diverse areas of the Commonwealth to listen to people's ideas on how to improve our electric vehicle charging network.

This initial assessment is the product of our first few months of consultation and conversation. This assessment will identify some of the key issues that are emerging on electric vehicle charging infrastructure. It will show some of the preliminary findings of our electric vehicle infrastructure analysis and provide initial recommendations on policy changes to support the transition to electric vehicles (EVs).

Background

For more than a century, our transportation system has depended on internal combustion vehicles that consume liquid fuel distributed through publicly accessible service stations that allow a driver with an internal combustion engine vehicle to go from an empty gas tank to a full one within a few minutes. These gas stations are supported by an energy infrastructure network of pipelines, wells, and refineries that have developed over decades to serve our transportation needs. The business model that has developed around most of these stations in this notoriously low-margin industry is that they sell consumers the gasoline or diesel fuel near cost and then do double duty as a high-margin convenience store selling snacks and household items.

The network of electric vehicle charging stations is in early development, but the EV charging ecosystem is complex. Unlike liquid fuels, refueling an electric vehicle can happen in almost any place where a vehicle is parked and there is electricity; however, electric vehicle charging is slower than using liquid fuels. Plugged in to a regular 110-V outlet (a Level 1 plug), an electric car will gain about three miles of range of charge in an hour of charging. Plugged in to a 240-V outlet (a Level 2 plug), an EV will get about 25 miles of charge in an hour. Plugged in to a 150-kW fast charger (commonly referred to as a direct current fast charger, or DCFC), an EV will get about 200 miles of charge in an hour.

Changing charging locations and charging times mean that drivers will pursue multiple strategies to

EV charging speeds

Charger type	Outlet	Miles of charge per hour
Level 1	110-V	~3
Level 2	240-V	~25
DC fast charger	Direct current (150-kW)	~200

- **Workplaces**. Workplace charging is a valuable opportunity to encourage the EV transition for some drivers.

- **Depots**. Fleet vehicles, including electrification of medium and heavy-duty vehicles, will require charging primarily in depots, which will need significant new investments to support electrification.

- **Major roadways**. Public fast charging stations will play a critical role to support long distance trips and heavy use days for both light-duty and heavy-duty vehicles.

maintain a state of charge and develop habits that fit their circumstances. The two biggest variables that result in different methods than those used to refuel internal combustion engine vehicles (ICEV) are ease of electricity access and the fact that it takes longer to charge an EV than it does to refuel an ICEV. Electric vehicle charging installations, and the business models that support electric vehicle charging, will consequently be more diverse and distributed. Broad categories of charging locations include:

- **Homes**. Most electric vehicle charging happens at home and overnight. A driver with access to 240-V Level 2 charging near their home can effectively fully refuel their vehicle by morning, while an ordinary plug (a Level 1 charger) can provide 30–40 miles of charge overnight.

- **Multi-unit dwellings**. Multi-unit dwellings will require focused attention, given the potential expense of these projects and the limited incentive for building owners to invest in EV charging.

- **Community locations**. Public Level 2 charging in community locations can be an alternative to home charging for tenants, travelers, and people who do not have access to off-street parking, particularly in long dwell time locations and travel destinations.

Current publicly available charging stations in Massachusetts

As of August 2023, there are 2,623 publicly accessible charging station locations operating in Massachusetts, supporting 6,082 total ports.[1] This includes 646 ports at 154 fast-charging locations.[2] Of these, 545 fast-charging ports are run by Tesla, which are currently only available to Tesla owners; however, Tesla is in the process of integrating other leading manufacturers to use their network beginning in 2024 and beyond. There are also 5,436 publicly accessible Level 2 charging ports. The overall distribution of public charging stations in Massachusetts is shown in Figure 1.1.

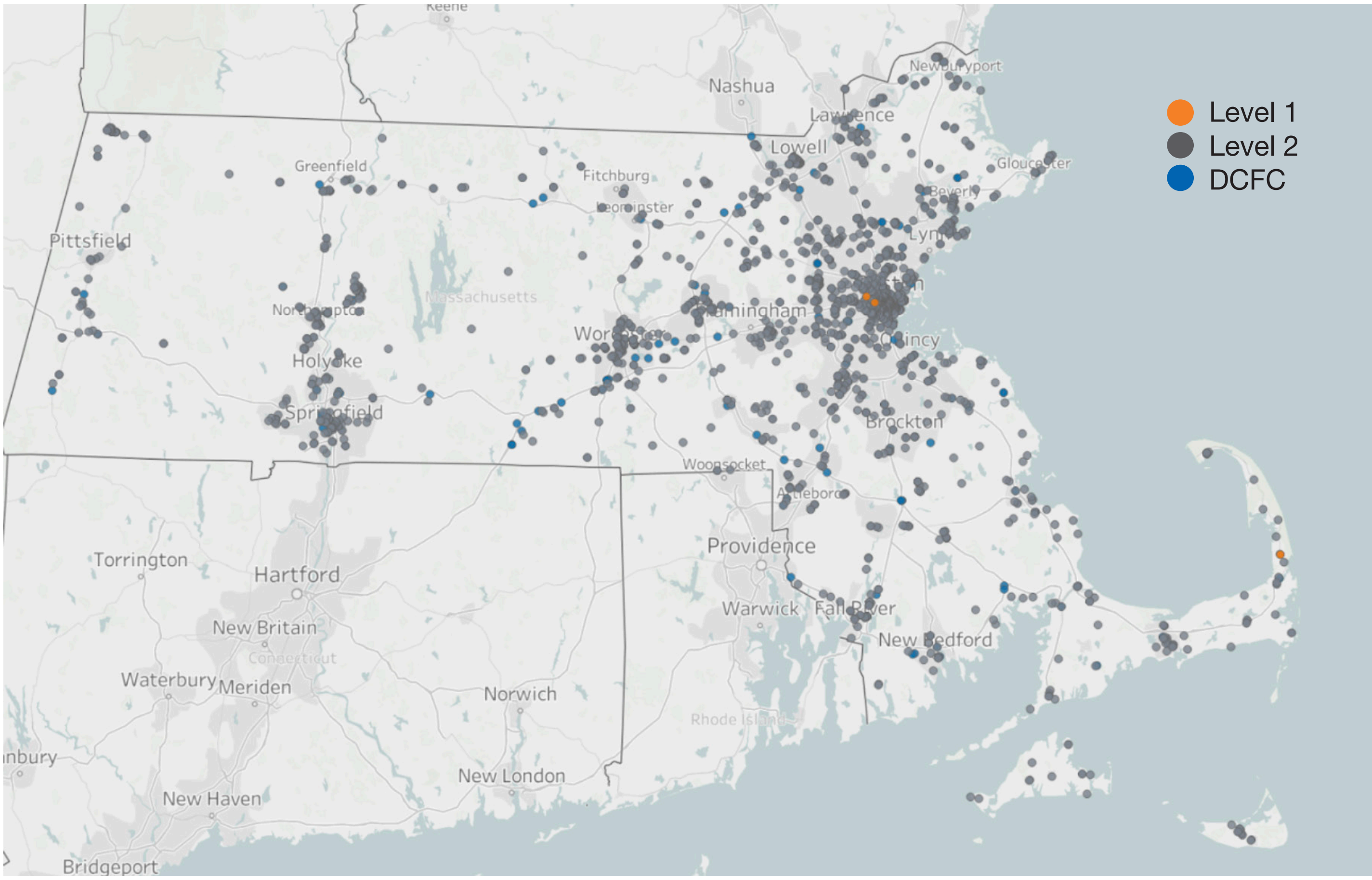
The state does not currently have reliable data on the number of charging stations that are not open to the public, such as home charging or charging in fleet depot locations.

Current policies to promote EV charging infrastructure

Massachusetts has many programs available right now or in development to support deployment of nearly every aspect of our electric vehicle charging infrastructure network.

1 Alternative Fuels Data Center, “Alternative fueling station counts by state,” U.S. Department of Energy. Accessed June 2, 2023, https://afdc.energy.gov/stations/states.
2 *Ibid.*

Figure 1.1 — Levels 1, 2, and 3 (DCFC) charging stations across Massachusetts



Source: 2023 Mapbox © OpenStreetMap. Data from U.S. Department of Energy Alternative Fuels Data Center.

In December 2022, the Department of Public Utilities (DPU) authorized nearly $400 million in electric vehicle infrastructure investments by the state's three investor-owned utilities: National Grid, Eversource, and Unitil. Utility customers, both residential and non-residential, may qualify for significant rebates for the installation of make-ready infrastructure, and in some cases for electric vehicle charging equipment. These upgrades include:

- Rebates of up to $1,400 for residents of single family and multifamily homes;
- Up to 100% of costs for charging stations in multi-unit dwellings;
- Make-ready incentives for fleet depots; and
- Make-ready infrastructure for publicly accessible Level 2 and fast charging stations.

The Massachusetts Department of Transportation (MassDOT) is slated to spend $63 million on fast charging stations over the next five years along highway corridors as part of the National Electric Vehicle Infrastructure (NEVI) program established in the federal Bipartisan Infrastructure Law (BIL). These obligated funds will ensure that every major highway will have a NEVI-compliant fast charging station every 50 miles, including at least four ports of 150-kW charging each. In addition, MassDOT is applying for federal funding to support deployment of on-site storage to reduce the transmission and distribution infrastructure impacts from these stations.

The Massachusetts Department of Environmental Protection (MassDEP) offers additional rebates to support electrification of publicly accessible charging in multi-unit dwellings, workplaces, and publicly accessible locations.

The Department of Energy Resources (DOER) has a Green Communities program and a Leading by Example program support charging infrastructure for municipalities and state agencies, respectively.

The EVICC has heard from several commenters that the array of current and potential programs, in addition to federal incentives and programs offered at the municipal level or by municipal light plants (MLPs), is confusing to customers. In orders in 2022 and early 2023, the DPU determined that the EDCs must deduct Massachusetts Electric Vehicle Incentive Program and other state or federal funding from the combined make-ready and electric vehicle supply equipment incentives a program participant is eligible to receive from utility programs. The EVICC heard concerns about when incentive programs can “stack” funding sources and when overlapping incentives will be deducted from utility programs. The EVICC recommends reducing duplicative incentive programs and simplifying the process for customers and the agencies that oversee these programs will take steps to address the concerns raised by stakeholders. One way to address these concerns is to establish a transportation clearinghouse that serves as a one-stop shop for information about EV and EVSE programs in Massachusetts.

Projection of EV charging infrastructure needed in 2030

To assess the scale of the buildout of electric vehicle charging infrastructure, EEA is currently conducting an analysis with Synapse, the Center for Sustainable Energy, and RSG to project charging infrastructure needs in the Commonwealth through 2030. This analysis is taking a close look at projected traffic patterns in all Massachusetts communities out to 2030. Based on this projection, the consultant team will identify the type and quantity of stations that needed in different communities across the Commonwealth.

The preliminary results of this analysis confirm that an acceleration of electric vehicle charging infrastructure is required to keep Massachusetts on path to achieving our CECP benchmarks for electric vehicle penetration. This represents a 15-fold growth in public fast charging stations from current installed numbers and a six-fold growth in public Level 2 charging stations by 2030. Table 1.1 illustrates a study by Synapse Energy Economics projecting a growth in EVs to 970,000 vehicles and the infrastructure that will be required to accommodate it.

We are continuing to refine this analysis on how many and where stations will be needed, looking at factors such as peak driving days along long-distance highway corridors, the amenities available at different locations, and proximity to multi-family housing. It is also possible that the required number

Table 1.1. — Charging demand for ~970,000-EV scenario*

Location	EV count	Charger type	Port count	EV/port ratio	Source
Single-family home	730,000	Level 1	160,000	4.6	EV Pro Lite
		Level 2	400,000	1.8	EV Pro Lite
Multi-family home	240,000	Level 1	6,000	40.0	EV Pro Lite
		Level 2	15,000	16.0	EV Pro Lite
Workplace	970,000	Level 2	33,000	29.4	EV Pro Lite
Public	970,000	Level 2	35,000	~28	Observed ratios†
		DC fast charger	10,000	~98	Observed ratios

Source: Synapse
* Note that while the CECP finds there Is a need for 900,000 EVs by 2030, the modeling performed for this initial assessment shows 970,000 EVs on the road by 2030.
† Based on the ratios of EVs to Level 2 and DC fast chargers observed in other jurisdictions

of charging ports is overstated. The EVICC will continue to refine its analysis, particularly with respect to DC fast chargers, which will significantly increase the amount of electricity demand and grid infrastructure necessary to meet that demand if not managed properly.

Improving the driver experience

The EVICC heard significant concerns raised by stakeholders and consumer advocates about the reliability of the current electric vehicle charging network, particularly public fast chargers that support long electric vehicle trips. Recent analysis in California indicates that fast charging stations may be inoperable more than 20% of the time, for reasons as varied as payment processing errors, software errors, and broken connectors. As Richard Ezike of the federal Joint Office of Energy and Transportation told the Council, poor fast charging reliability "is an existential threat to the EV industry."

Based on these concerns, the EVICC recommends that the state pass legislation requiring publicly accessible charging stations to register with the Division of Standards (DOS) so that they can be regularly inspected by that agency. Such legislation can also help address additional questions brought up by stakeholders, including fair and transparent pricing of electric vehicle charging and safety requirements. MassDOT and other state agencies will prioritize charging uptime and a commitment to operations and maintenance in procuring contracts for charging stations. The Executive Office of Energy and Environmental Affairs (EEA) and Massachusetts Clean Energy Council (MassCEC) will partner together to encourage fast charging business models that are consistent with stations that are regularly maintained and in working order.

Integrating EV charging to the electrical grid

Our EV infrastructure analysis speaks to the significant challenges facing Massachusetts in building the transmission and distribution infrastructure necessary to support vehicle electrification. Overall, Synapse's numbers indicate a potential growth of up to 1,400 MW in peak demand from electric vehicle charging by 2030, however, with effective managed charging programs, the actual average load from EV charging was modeled to be between 630 and 700 MW. If cars are charged immediately when plugged in at homes and workplaces, it could add about 1,200 MW to summertime peak demand (about 10% of current day peak demand). If charging is shifted to primarily happen overnight, average load during peak times is projected to be 470 MW. It is also important to note that much of this energy infrastructure could end up sited in dense urban areas: the city of Boston alone is projected to require more than 1,300 fast charging ports by 2030, adding as much as 200 MW of potential electric load to the system.

In our deliberations, EVICC members have heard repeatedly from stakeholders about the challenge of integrating electric vehicle charging infrastructure onto the grid. Two recent reports conducted by National Grid demonstrate the scale of the transmission and distribution infrastructure challenge facing Massachusetts:

- One study conducted in collaboration with National Grid, Rocky Mountain Institute, CALSTART, and others looked at the potential for charging needs to support heavy duty vehicles operating along highway corridors in Massachusetts and New York.[3] They found that as EV penetration rises, the average highway rest stop could require as much load as a major sports stadium or a small town. The study notes that it may take four to eight years for sites that require transmission-level interconnection. This work typically begins when a customer requests new or increased electric service, meaning there could be significant delays without efforts to plan in advance for large charging sites.

- Another analysis, conducted by National Grid in partnership with Hitachi, looked at distribution feeders near medium and heavy-duty fleet depots in Massachusetts.[4] This study found that 68% of distribution feeders studied will need to be upgraded to support medium and heavy-duty fleet electrification. This is potentially

3 National Grid, CALSTART, Rocky Mountain Institute, Stable Auto, Geotab, "Electric highways: accelerating and optimizing fast-charging deployment for carbon-free transportation," accessed July 28, 2023: https://www.nationalgrid.com/document/148616/download.

4 National Grid and Hitachi Energy, "The road to transportation decarbonization: understanding grid impacts of electric fleets," September 2021. From https://www.nationalgridus.com/media/pdfs/microsites/ev-fleet-program/understandinggridimpactsofelectricfleets.pdf, accessed July 28, 2023.

a major obstacle to rapid fleet electrification, as upgrading grid infrastructure can take years to permit and construct. As many of these fleet depots are in dense urban areas, where the energy infrastructure burden of these upgrades will fall disproportionately in environmental justice communities. The study found that on-site storage and renewable generation could help speed projects by deferring or avoiding distribution upgrades.

This is not a future problem. Limits in our distribution and transmission infrastructure are interfering with transportation electrification projects right now. For example, the initial results from the MassCEC Mass Fleet Advisor program, which provides technical support to medium- and heavy-duty fleet operators looking to transition to electric vehicles, found that nearly all the proposed projects require significant utility upgrades as well as customer-side investments such as electric panel upgrades. Some of these investments will take years to install. These upgrades are delaying projects and discouraging even highly motivated fleet operators from moving forward with electric vehicle purchases.

Stakeholders mentioned multiple strategies to reduce potential transmission and distribution burdens. These techniques work by making our electric vehicle charging network more dynamic and capable of responding to grid conditions in real time.

- Demand response programs, now required for participants in utility charging incentive programs, can encourage charging during off-peak times or during times of high penetration of renewable energy.

- Time-of-use rates will provide EV drivers with an additional incentive to charge their vehicles during off-peak hours.

- On-site storage can act as an alternative to high-powered grid connections for fast-charging stations, reducing transmission costs and speeding the completion of projects.

- Mobile charging can provide a temporary solution for fleet operators that need charging installations installed quickly and efficiently.

- Co-locating charging stations with storage, solar, and microgrids can support installations with minimal or no grid connections.

- Bidirectional charging can allow electric vehicles to sell electricity back onto the grid (V2G) or can be used by property owners to improve reliability and reduce building energy costs (V2B) and could fully unlock the potential of electric vehicles to be used as grid resources.

By increasing the efficiency of the electric grid, these technologies have the potential to produce significant public benefits, including reduced costs for ratepayers, reduced energy footprint, particularly in urban areas already overburdened with transportation and electricity infrastructure, reduced emissions associated with high emission "peaker" plants, and potentially faster installations of projects if large grid upgrades are not required to interconnect EVSEs.

The EVICC recommends that state agencies work together, both through the EVICC and through the parallel Grid Modernization Advisory Council process, on policies and investments to minimize the transmission and distribution infrastructure necessary to support the electric vehicle transition. These policies should consider increased incentives, financing, technical, and procurement support, and rate design to promote strategies and technologies that will support efficient grid allocation and turn EVs and EV charging stations into a grid resource.

Expanding access to EV charging to all residents

Massachusetts is committed to an equitable transition to clean transportation. That means making investments that will support all Massachusetts drivers gaining access to electric vehicle charging infrastructure, including hard-to-reach consumers such as tenants, low- and moderate-income residents, rural communities, and environmental justice populations.

Some Massachusetts drivers who will require focused attention and policy support include:

- **Garage orphans**. Approximately a third of Massachusetts residents lack access to any kind of off-street parking. Most of these residents park their vehicles overnight on the street. These residents disproportionately live in dense urban areas, including Gateway Cities such as Boston, Springfield, Worchester, Lowell, Lawrence, New Bedford, and Holyoke, among others.

- **Tenants**. Even tenants who have access to off-street parking face obstacles to garage orphans in installing electric vehicle charging infrastructure. Landlords lack the incentive to make an installation that will not directly benefit the property owner, while tenants may either lack permission to install charging equipment or simply may not plan to stay in that location long enough for an investment in charging infrastructure to be worthwhile.

- **Rural communities**. While rural residents drive the most and have the greatest potential to save money and reduce emissions by making the switch to an electric vehicle, the challenge of providing sufficient public charging infrastructure is particularly acute in dispersed low-density communities.

The EVICC has heard from many stakeholders on how we can best expand access to charging infrastructure and recommends moving forward with a suite of policies and investments that can expand access to electric vehicle charging infrastructure for all residents, while also ensuring that the energy infrastructure burdens are distributed equitably. These policies include:

- Working with municipalities to promote curbside charging and charging in safe locations that can support overnight charging in residential communities.

- Considering “right to charge” legislation that will help tenants and people living in condominiums install charging infrastructure.

- Encouraging electrification of alternative vehicle ownership modes, such as electric vehicle carsharing and electrification of ride-hailing services.

- Exploring how bidirectional charging can support vehicle electrification for low-income residents living in public housing or other multi-unit dwellings.

- Recognizing that charging stations in rural areas may have low utilization indefinitely into the future, Massachusetts will provide targeted support for rural charging stations.

Recommended next steps

This initial assessment represents an important step towards building an equitable electric vehicle infrastructure for all Massachusetts residents, but the work of the EVICC is ongoing. Some specific recommended next steps include:

Recommended legislative actions

1. New legislation requiring publicly accessible electric vehicle chargers to register with the Division of Standards so that they can be regularly inspected. Whereas DOS currently has the statutory authority to inspect such charging stations, it lacks the ability to require their registration, which impedes DOS’s ability to know where they are located. In addition, because inspections will require sophisticated equipment and training, legislation should ensure that such inspections are centralized within DOS and not shared with municipalities. Finally, DOS will investigate new regulations, via the authority of both existing statutes and new legislation, to ensure adequate consumer protections are in place that fall within its purview.

2. The Healey-Driscoll Administration will work with the legislature to pass “right to charge” legislation that will help tenants and people living in condominiums install charging infrastructure.

3. The Department of Energy Resources (DOER) will work with the legislature to update appliance standards for EVSEs to the latest ENERGY STAR standards.

4. EEA, DOER, and DOS will coordinate with the legislature to ensure that there are no overlapping or contradictory provisions between existing

language in G.L. c. 25A and any new legislation that is enacted to provide DOS with the requisite authority to carry out inspections of publicly available EVSEs.

Agency-specific recommendations

1. DOER will work with municipalities to develop guidance and support for programs to expand curbside charging and overnight charging infrastructure for tenants and garage orphans.

2. Executive branch agencies will focus the deployment of publicly available funds for environmental justice populations and into rural areas, with a particular focus on reaching low-income residents, to ensure that the transition to electric vehicles is equitable.

3. MassDOT will pursue options to communicate EV charging station locations on highway signage and/or elsewhere.

4. EEA and other state agencies will develop programs to reduce the transmission and distribution infrastructure burden of electric vehicle chargers by using policies such as time-of-use rates and technologies such as on-site storage and bidirectional charging to turn electric vehicles and electric vehicle charging stations into grid assets.

5. EEA, DOER, and DPU will encourage electrification of alternative vehicle ownership modes, such as electric vehicle carsharing and electrification of ride-hailing services.

6. DOS will develop new regulations to ensure that publicly accessible electric vehicle chargers are registered, inspected, and tested to improve uptime.

7. DOS will also develop new regulations that apply consumer protections to EVSEs, including, but not limited to signage and price disclosure requirements; protections against price gouging; standardized EVSE connection equipment; and limiting the sale of consumer data collected.

8. EEA and DOER will work with other agencies (e.g., Operational Services Division (OSD), MassDEP, the Department of Capital Asset Management and Maintenance (DCAMM), the Massachusetts Clean Energy Center (MassCEC), MassDOT, and the MBTA) and cities and towns responsible for procuring EVSE to coordinate procurement processes, and, if necessary, develop recommendations for the legislature to align processes.

EVICC next steps

1. EEA will lead the EVICC in developing a plan to use the $50 million in the Charging Infrastructure Deployment Fund. This plan will be developed consistent with the recommendations in this initial assessment and will draw from future findings that the EVICC makes regarding EV infrastructure needs.

2. The EVICC will refine its assessment of charging station needs by providing focused attention on the need for public fast charging to support long distance trips, including on peak travel days.

3. The EVICC will incorporate data on the need for charging station and infrastructure upgrades associated with electrification of medium- and heavy-duty fleets.

4. The EVICC will continue work with the Grid Modernization Advisory Council, utilities, and other stakeholders to proactively manage the grid impacts of expanded electric vehicle charging infrastructure.

5. The EVICC will consider methods to obtain more information on precisely where electric vehicles are being garaged so that electric utilities can better plan for load growth.

6. The EVICC will consider accessibility and location safety requirements that might be necessary to develop for charging stations located at multi-unit dwellings and/or workplaces, which may not be covered under the rules DOS adopts for publicly available charging stations.

7. The EVICC will consider establishing a transportation clearinghouse website for information on EVs, EVSE, and funding opportunities for stakeholders in the Commonwealth.

8. The EVICC will further research EVSE and related infrastructure costs and how those costs will be allocated between the public and private domains.

9. The EVICC will collaborate with state fleet operators to collect data to determine the highest priority locations for electric vehicle charging at state facilities and direct resources to facilitate charging installations at those locations.

10. The EVICC will work with MassCEC and the Executive Office of Labor and Workforce Development to ensure there is a trained workforce of licensed electricians with an Electric Vehicle Infrastructure Training Program (EVITP) certification ready to deploy new EVSE, ensuring populations historically left out of the clean energy workforce are offered opportunities.

SECTION

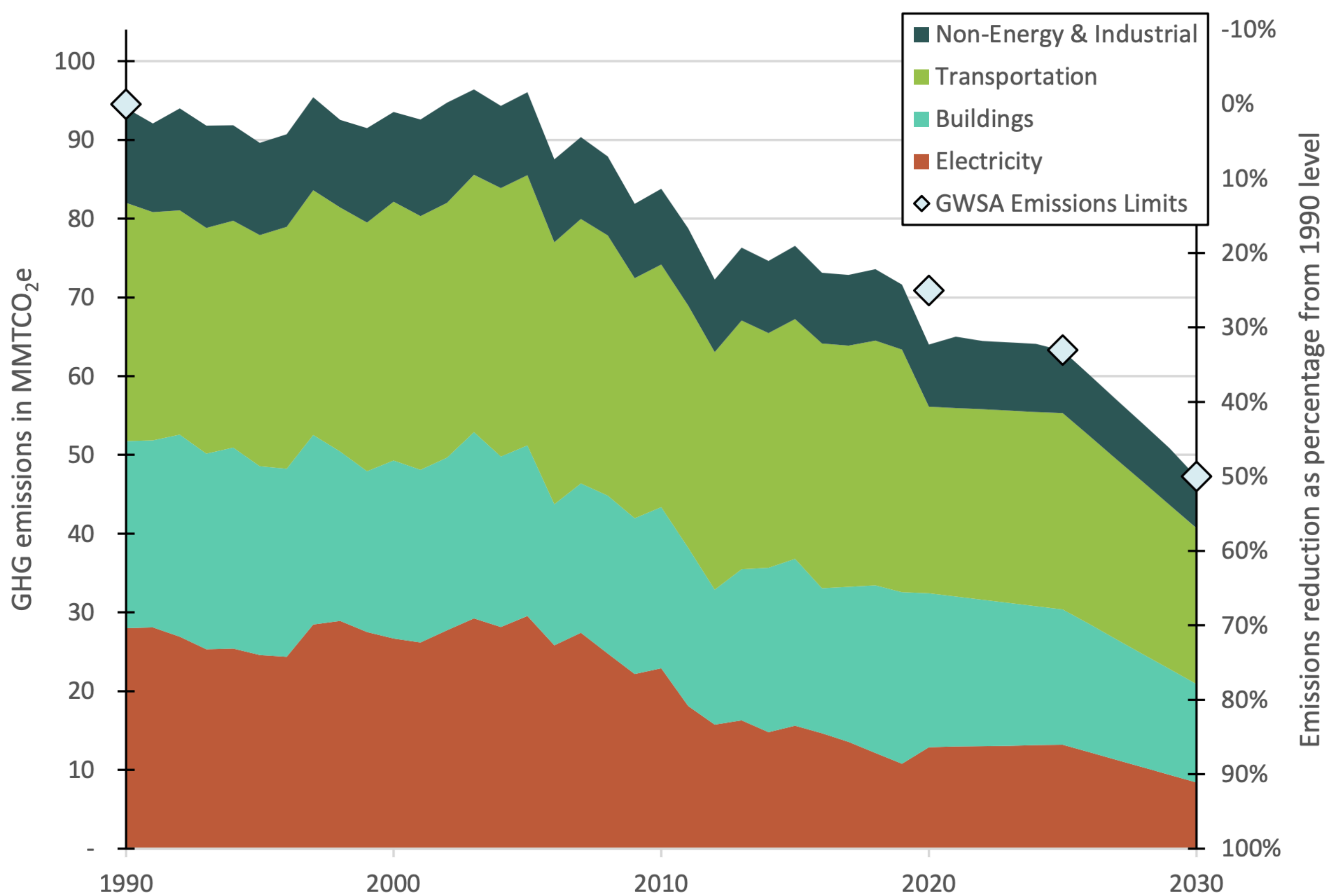
In March 2021, An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy, which amends the Global Warming Solutions Act of 2008, was signed into law.

This Act requires the Secretary of Energy and Environmental Affairs to set limits on greenhouse gas (GHG) emissions for 2025 and 2030, including both economy-wide emissions reduction requirements and specifically on major sources of global warming pollution.[1] These statutory limits must be accompanied by a comprehensive plan to achieve the required emissions reductions.

The Clean Energy and Climate Plans (CECPs) for 2025/2030 and 2050 establish economy-wide limits and sector specific sublimits for reducing greenhouse gas emissions. As part of a letter issued contemporaneously with the CECP in 2022, the Secretary of the Executive Office of Energy and Environmental Affairs determined that the Commonwealth's economy-wide emissions limits will be a 33% reduction in 2025, a 50% reduction in 2030, and an 85% reduction (and net-zero overall) in 2050 against a baseline established in 1990, as shown in Figure 2.1. Table 2.1 details CECP 2025/2030 sector-specific sublimits against a 1990 baseline.

1 Commonwealth of Massachusetts, "Massachusetts Clean Energy and Climate Plan for 2050," Mass.gov, December 2022. https://www.mass.gov/doc/2050-clean-energy-and-climate-plan/download.

Figure 2.1 — Historical and modeled greenhouse gas emissions and statutorily required emissions reduction



Source: Massachusetts Clean Energy and Climate Plan for 2025/2030

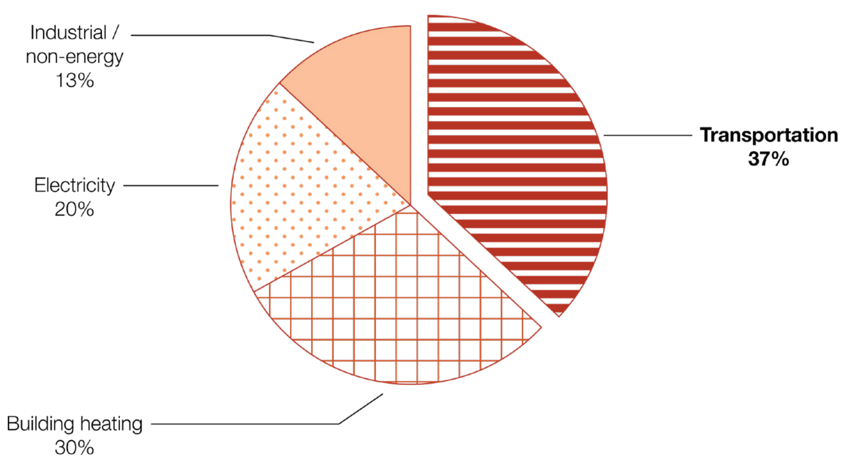
Table 2.1. — Clean Energy and Climate Plan 2025/2030 sector-specific emissions sublimits

Sector	1990 baseline (MMBtu)	2025 sublimit (MMBtu)	2030 sublimit (MMBtu)	Percent change: 1990 to 2030
Transportation	30.2	24.9	19.8	−34%
Buildings	23.8	17.2	12.5	−47%
Electric	28.0	13.2	8.4	−70%
Non-energy and industrial	12.1	7.9	6.3	−48%

Source: Massachuestts Clean Energy and Climate Plan for 2025/2030

At 37% of total emissions, the transportation sector represents the largest contributor to the Commonwealth's total greenhouse gas emissions (see Figure 2.2). The CECP proposes to address emissions from transportation by promoting a dramatic increase in sales of electric vehicles, representing a 67% increase in EV and plug-in hybrid electric vehicle sales from 2022 to 2025 and an additional 78% increase from 2025 to 2030 (see Figure 2.3). This widescale effort to electrify the transportation sector in Massachusetts is an effort to meet the sector-specific sublimit of reducing transportation emissions by 86% as compared to 1990 levels by 2050 (see Figure 2.4).

Figure 2.2. — Sources of greenhouse gas emissions across Massachusetts (2020 data)



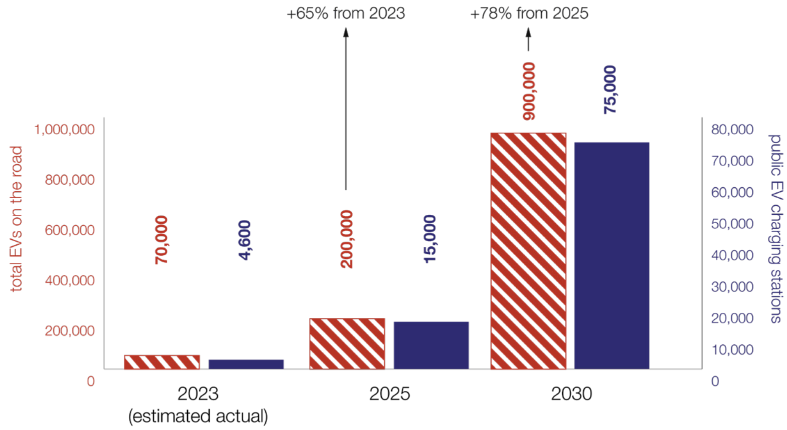
Source: Massachuestts Clean Energy and Climate Plan for 2025/2030

The CECP highlighted the importance of workforce development strategies to support an expanded and more diverse pipeline of clean energy workers. The recently released report, Powering the Future: A Massachusetts Clean Energy Workforce Needs Assessment, included an analysis of the anticipated demand for additional workers based on the "phased" decarbonization scenario from the 2025/2030 CECP. According to this modeling, the alternative transportation sector will need to more than double (+117%) by 2030, with a projected increase of 3,800+ jobs. The largest occupational impact will be among electricians, of whom at least an additional 2,100 will be needed to install EV charging infrastructure.

Accommodating this influx of electrified transportation will require a concerted effort to develop charging infrastructure across the state, with thoughtful consideration and anticipation of a range of needs. Established pursuant to "An Act Driving Clean Energy and Offshore Wind," the Electric Vehicle Infrastructure Coordinating Council (EVICC) is required to "assess and report on strategies and plans to deploy electric vehicle charging infrastructure to establish an equitable, interconnected, accessible, and reliable electric vehicle charging network."

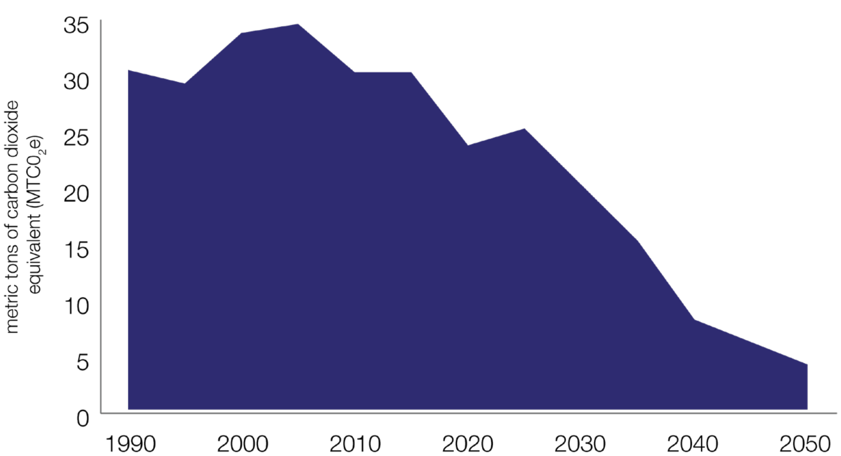
The EVICC is also required to regularly seek data and input related to electric vehicle charging stations, fueling stations and related infrastructure, equipment, equipment maintenance and technology, from stakeholders, which shall include, but not be limited to, investor-owned and publicly owned electric utilities, state and local transportation agencies, companies involved in products, services, technologies and data collection related to clean energy charging and fueling, automobile manufacturers, groups representing environmental, energy and climate perspectives, and groups representing consumers including, but not limited to, low-income consumers.

Figure 2.3. — Massachusetts EVs and EV charger targets: 2025 and 2030



Source: Massachuestts Clean Energy and Climate Plan for 2025/2030

Figure 2.4. — Massachusetts transportation emissions history and projected reduction targets, 1990–2050



Source: Massachuestts Clean Energy and Climate Plan for 2025/2030

Beginning in May 2023, the EVICC hosted seven public meetings and three public hearings to meet its deadline of providing this initial assessment to the Legislature by August 11, 2023. The EVICC's timing also coincided with the work of the Grid Modernization Advisory Council, which is charged with reviewing electric utility plans to proactively upgrade the electric distribution system. All EVICC meeting minutes, public comments, presentation slides, and other materials are available at **https://www.mass.gov/info-details/electric-vehicle-infrastructure-coordinating-council-evicc**.

Alignment with state and federal legislation

Electrifying the transportation sector in Massachusetts aligns with several related plans geared toward decarbonization: the Massachusetts 2050 Decarbonization Roadmap, the CECPs for 2025/2030 and 2050 and the National Electric Vehicle Infrastructure Program Deployment Plan for Massachusetts.

Massachusetts 2050 Decarbonization Roadmap (December 2020)[2]

The Commonwealth of Massachusetts has committed to achieving net zero greenhouse gas emissions by 2050. Commissioned by the Executive Office of Energy and Environmental Affairs (EEA), the 2050 Decarbonization Roadmap (Roadmap) was designed to support the Commonwealth in this goal. The Roadmap provides a comprehensive understanding of the strategies and transitions necessary to achieve net zero by 2050 and the tradeoffs between different decarbonization pathways. The research for this report was focused on the following guiding question: how can the Commonwealth achieve Net Zero emissions while maintaining a healthy, equitable, and thriving economy?

The Roadmap found that, as of 2020, light-duty transportation vehicles were responsible for 27% of Massachusetts statewide emissions and medium- and heavy-duty transportation vehicles, rail, and aviation are responsible for 14% of statewide emissions. The Roadmap identified that to decarbonize by 2050, emissions from light-duty transportation will need to be reduced to nearly

2 Executive Office of Energy and Environmental Affairs, "Massachusetts 2050 Decarbonization Roadmap," Mass.gov, 2020. https://www.mass.gov/doc/ma-2050-decarbonization-roadmap/download.

zero, with the primary strategy to reduce light-duty transportation emissions being switching from fossil-fueled vehicles to zero emissions vehicles. This is supported by maintaining and supporting existing public transit systems, reducing single-occupancy vehicle use where possible, making complementary land use decisions, and supporting active transportation infrastructure such as bike lanes and sidewalks.

Additionally, the Roadmap identified that battery-electric technology is emerging as a viable strategy for many medium- and heavy-duty vehicle classes. Given the diversity of duty-cycles and performance requirements, it is likely that an array of solutions, including hydrogen fuel cells and zero-carbon fuels, will complement electrification for these vehicles. Deployment of battery electric vehicles (BEVs) and hydrogen fuel cell electric vehicles (FCEVs) in the medium- and heavy-duty vehicle classes will require retrofits to depots and fueling stations to provide electric charging and/or hydrogen services.

Massachusetts Clean Energy and Climate Plans for 2025/2030 (August 2022) and 2050 (December 2022)[3]

The Massachusetts CECPs for 2025/2030 and 2050 expresses the state's collective vision for a future in which there is minimal reliance on fossil fuels for heating homes, powering vehicles, or operating the electric grid, and reflects confidence that Massachusetts can help lead the clean energy transition. Doing so will mean more well-paying jobs, improved public health, reduced consumer costs, and better quality of life for all residents. The plan includes a portfolio of strategies and policies designed to achieve sector-specific greenhouse gas emissions sublimits by 2025, 2030, and 2050, including for transportation, buildings, electricity generation, industrial emissions, and non-energy emission sources such as leaks of natural gas and refrigerants.

The transportation strategy in the CECPs is focused on two major goals. The first is to reduce total vehicle miles traveled (VMT) by offering more alternatives to personal transportation. By investing in public transit, building more housing within walking distance, and improving pedestrian infrastructure, the likelihood that consumers will choose these methods as opposed to driving is greatly increased. The second goal is to rapidly transition on road vehicles to EVs to lower GHG emissions and air pollutants.

To ensure that the future of driving is all-electric, Massachusetts will implement vehicle emissions standards, including Advanced Clean Cars II and Advanced Clean Trucks regulations that require that vehicle manufacturers continue to expand their investments in electric technologies in all classes. The Commonwealth will focus on supporting both personal and fleet vehicles such as school and transit buses as well as delivery trucks and trucks for hire. State programs and electric utility programs will help deploy the charging infrastructure necessary to support the EV transition along highways, in parking lots, multi-unit dwellings, and fleet depots.

As the number of EVs on the road increases, managing electric vehicle charging will be a growing priority for the Commonwealth as demand increases impact the grid. Technologies and policies including demand-side management, increased substation capacity, and educating customers on the best times to charge their vehicles will ease the integration of EVs onto the electric grid. The 2025/2030 and 2050 CECPs call for proactive management of EV charging to maximize the benefits of EV adoption and minimize the costs to all consumers.

Starting in 2023, DOER is leading the newly created Grid Modernization Advisory Council (GMAC), which works on holistic distribution system planning in coordination with electric distribution companies (EDCs). The GMAC will engage stakeholders to invest in electric distribution systems that will achieve statewide GHG emission reduction goals and increase transparency in the grid planning process.

3 Commonwealth of Massachusetts, "Massachusetts Clean Energy and Climate Plan for 2050," Mass.gov, December 2022. https://www.mass.gov/doc/2050-clean-energy-and-climate-plan/download.

Table 2.2. — National Electric Vehicle Infrastructure goals, performance metrics, and targets

Goal	Performance metric	Five-year target
Completeness – major highway corridors important for long-distance trip making will have regular opportunities for travelers to recharge electric vehicles.	Electric vehicle alternative fuel corridors in Massachusetts, with gaps of more than 50 miles between 4 x 150-kW port DC fast charger stations located no more than one mile from highways, expressed as percentage of total miles of electric vehicle alternative fuel corridors designated in 2022	0%
Financial sustainability – charging stations will become financially self-sustaining as soon as feasible after the initial investment of NEVI program funds and matching funding sources.	Percent of installed stations receiving public investment five years from final station commissioning	0%
Reliability – DC fast charger stations will be readily available to travelers on Massachusetts' long-distance travel corridor network, including its designated Alternative Fuel Corridors.	Average "uptime" of chargers, measured over one year at a site level	97%
Equity – disadvantaged communities will have access to DC fast chargers for long-distance travel that meets or exceeds the access to DC fast charger of non-disadvantaged communities.	Ratio of % of state's population in EJ communities that are within five miles of a zone served by NEVI-funded DC fast charger to the % of non-EJ community population within 5 miles of those zones.	>1.0

Source: National Electric Vehicle Infrastructure

National Electric Vehicle Infrastructure (NEVI) Program Deployment Plan for Massachusetts (August 2022)[4]

The Massachusetts Department of Transportation (MassDOT) issued a request for information (RFI) related to its National Electric Vehicle Infrastructure (NEVI) Program Deployment Plan on June 1, 2023. The RFI provided an overview of the NEVI program and MassDOT's NEVI Plan, including MassDOT's development strategy, goals, and proposed solicitation process and contracting approach. Table 2.2 shows a summary of NEVI's goals, performance metrics, and targets at five years.

The RFI included 28 detailed questions seeking information that will assist MassDOT in structuring the solicitation, contracting, technical, and financial approach to delivering the NEVI program to maximize the opportunity for success and to promote competition and industry buy-in. MassDOT received 27 responses to the RFI.

4 Massachusetts Department of Transportation, "National Electric Vehicle Infrastructure Deployment Plan for Massachusetts," August 2, 2022. From https://www.mass.gov/doc/massdot-nevi-plan/download, accessed August 8, 2023.

There were several common themes throughout the responses. Again, these are themes from respondents to MassDOT's RFI and are not MassDOT statements:

- **Key risks**. Utility coordination, local land-use and permitting processes, and supply chain-related supply and pricing constraints are three key risks to the NEVI program.
- **Term**. While a five-year contract term is feasible, a ten-year or longer term would more efficiently account for the lifespan of electric vehicle charging equipment and associated revenue-generating opportunities.
- **Fee structure**. A consumer fee structure based on kWh would be most efficient and equitable.

MassDOT issued the RFI to gain more insight into how to prepare an informed request for proposals (RFP). MassDOT continues to develop its procurement strategy, informed by information received in the RFI, and expects to issue an RFP in the winter.

Despite substantial growth in electric vehicle sales and charging infrastructure over the past decade, the current landscape of EVs and EV charging in Massachusetts remains a burgeoning market.

This section outlines the current state of EV charging infrastructure costs, both for installers and consumers; state and federal incentive programs; current EV charging demographics; and current policies, laws, and regulations governing EV charging infrastructure in Massachusetts.

Costs

Table 3.1 shows cost ranges of EV charging equipment and installation and charging speeds of each charger type. The ranges vary based on the type of charger, the number of charger features, and the type of mounting system used.

Electricity rates and cost per kWh can differ based on geographic location, time of year, and the time of day that charging occurs. In March 2023, the national average cost of electricity was $0.107/kWh. Under these rates, at three miles per kWh, costs are $0.033 per mile or roughly $6 to charge a 200-mile range from home.[1] Public charging costs are $0.30–$0.60/kWh to charge an EV, ultimately costing up to $45 to charge a 200-mile range.[2] Notably, Massachusetts generally has electric rates that are typically much higher than the national average. Rates can also vary considerably between seasons in Massachusetts, with rates typically increasing during winter months. The availability of retail choice, the increasing popularity of municipal aggregation, and the existence of 41 distinct municipal lighting

1 Clare Mulroy, "How much does it cost to charge an electric vehicle? Here's what you can expect," USA Today, April 26, 2023. https://www.usatoday.com/story/news/2023/03/08/how-much-does-it-cost-charge-electric-car/11392871002/.

2 Luke Ocean, "The average costs of using car charging stations," Mach 1 Services. From https://www.mach1services.com/costs-of-using-car-charging-stations/, accessed August 8, 2023.

Table 3.1. — EVSE capital cost assumptions

Charger hardware		Unit cost per port	Install cost per port[a]	References
Level 1 residential	Low: High:	$0 $0[b]	$100 $1,000	Fixr.com 2022; Courtney 2021; HomeAdvisor 2022
Level 2 residential	Low: High:	$400 $1,200	$500 $1,700	Borlaug et al. 2020; Fixr.com 2022; Courtney 2021; HomeAdvisor 2022
Level 2 commercial	Low: High:	$2,200 $4,600	$2,200 $6,000	Nicholas 2019; Nelder and Rogers 2019; Borlaug et al. 2020; Bloomberg New Energy Finance 2020; Pournazeri 2022
DC 150 kW	Low: High:	$66,400 $102,200	$45,800 $94,000	Nicholas 2019; Nelder and Rogers 2019; Borlaug et al. 2020; Bloomberg New Energy Finance 2020; Borlaug et al. 2021; Gladstein, Neandross & Associates 2021; Bennett et al. 2022
DC 250 kW	Low: High:	$91,400 $134,800	$54,750 $105,950	Inferred from DC 150-kW and 350-kW costs
DC 350+ kW	Low: High:	$116,400 $167,400	$63,700 $117,900	Nicholas 2019; Bloomberg New Energy Finance 2020; Borlaug et al. 2021; Gladstein, Neandross & Associates 2021; Bennett et al. 2022

[a] These ranges do not span the set of all possible situations. They are meant to be plausible optimistic (low) and pessimistic (high) estimates for assessing network capital costs at scale. In some cases, it was not possible to verify exactly what was included in each study's estimate for installation costs, thus some discrepancies may be present across sources.
[b] Level 1 chargers tend to be included with the purchase of a PEV and are thus excluded as an infrastructure cost from this analys.s
Source: National Renewable Energy Laboratory

plants and three investor-owned utilities also creates an environment where there is significant variability between the retail rates charged to different end-use consumers across the Commonwealth, making it challenging to have a truly representative example of the typical costs of charging.

Charging costs vary depending on location, charger type, service provider, and charging speed. Additionally, many chargers charge end-use customers by the minute and not on a per kWh basis, which makes comparisons challenging. Level 3 or DC fast chargers tend to be the most costly of the chargers, costing between \$0.40–\$0.60/kWh, whereas Level 2 chargers are typically between \$0.20–\$0.25/kWh.[3] Tesla's superchargers cost an average of \$0.28/kWh and require either a Tesla or a North American Charging Standard (NACS) adapter.[4] Tesla recently announced that it will open its supercharger network to General Motors and Ford EVs, adding 7,500 chargers to the available network, with additional manufacturers planning to follow suit as well.[5]

Many car companies offer free charging for a limited time as an incentive to purchase an EV. For example, early adopters of Tesla were awarded free charging on Tesla's supercharger network. Now, automakers are partnering with Electrify America to award compliment charging up to a certain number of kWh or time periods. Table 3.2 highlights some of these incentives.

Public funding for EV infrastructure

The U.S. federal government and the Commonwealth of Massachusetts have a variety of funding programs to promote charging infrastructure acquisition and installations for municipalities and private and public institutions to expand the country's network of EV charging stations. Tables 3.3–3.5 summarize these incentives.

3 *Ibid.*
4 *Ibid.*

5 Tom Krishner, "With GM and Ford embracing Tesla's EV technology, here's what it means for consumers," Associated Press, June 9, 2023. From https://apnews.com/article/tesla-connector-gm-ford-electric-vehicle-charging-a180cc55bbe3d7d7738a2690ca22ab0d, accessed July 28, 2023.

Case study: EV permitting requirements in West Hollywood, California

For new construction, the City's EV requirements necessitate an electrical permit, at minimum, and the plan check process will ensure compliance with both EV and accessibility requirements before construction begins. Please note:

- EVCS permitting is included as part of the building permit for new construction
- Projects must specify EV infrastructure and plan for accessibility on original plans/construction documents

For existing buildings, to bring the City into substantial conformance with the State requirements AB 1236 (2015), West Hollywood adopted Ordinance No. 18-1028 that further streamlines its approval process for qualifying EVCS. Applicants voluntarily planning to install a charging station at an existing building must accurately complete the application checklist and zone clearance application in order to be issued all necessary permits.

Source: City of West Hollywood Planning and Development Services, "EV charge up west Hollywood." From https://www.weho.org/city-government/city-departments/community-development-department/building-and-safety/ev-charge-up-west-hollywood, accessed June 14, 2023.

Table 3.2. — Charging incentives from automakers

Car model	Charging network	Charging offer
Audi E-Tron GT	Electrify America	Unlimited DC fast charging for three years
Audi E-Tron and Q4 E-Tron	Electrify America	250 kWh of charging within two years
BMW i4 Gran Coupe and iX	Electrify America	Unlimited DC fast charging, up to 30 minutes per charging session for two years
Chevrolet Bolt EV, Bolt EUV	EVgo	$500 credit to EVgo stations and up to $1,250 toward installation costs for a home EVSE
Ford Mustang Mach-E F-150 Lightning	Electrify America	250 kWh of charging within two years
Hyundai Ioniq 5	Electrify America	Unlimited DC fast charger, up to 30 minutes per charging session, for two years
Hyundai Kona Electric Ioniq Electric	Electrify America	250 kWh of charging within three years of purchase (worth ~1,000 miles)
Kia EV6	Electrify America	1,000 kWh of charging for three years (worth ~ 4,000 miles)
Lucid Air	Electrify America	Unlimited DC fast charging for three years
Mazda MX-30	ChargePoint	$500 credit to ChargePoint station charging or toward purchasing a ChargePoint home charger
Mercedes-Benz EQS and EQB Mercedes-Benz EQE	Electrify America	Unlimited DC fast charger, up to 30 minutes per session, for two years
Nissan Ariya	EVgo	First 10,000 Ariya reservations by 1/31/2022 were eligible for a free two-year EVgo membership and a $500 credit to EVgo stations (~5,000 miles)
Nissan Leaf	EVgo	$250 credit to EVgo stations to use within one year of purchase
Polestar 2	Electrify America	Unlimited DC fast charger, up to 30 minutes per charging, for two years
Porsche Taycan and Taycan Cross Turismo	Electrify AMerica	Unlimited DC fast charger, for 30 minutes per session, and/or 60 minutes per session for slower charging both up to three years
Rivian R1T and R1S	Building two proprietary charging networks—L2 and DC fast charger	Free trial membership for a year that includes unlimited free charging at Rivian chargers
Toyota bZ4X	EVgo	Unlimited DC fast charger for one year
Volkswagen ID.4	Electrify America	Unlimited DC fast charger, up to 30 minutes per charge, for three years
Volvo C40 Recharge and XC40 Recharge	Electrify America	250 kWh of charging for up to three years; plus a free one year subscription to Electrify American Pass Plus (discounted charging)

Source: Fred Meier, “Which new electric vehicles come with free charging?” Cars.com, June 29, 2023. From https://www.cars.com/articles/which-new-electric-vehicles-come-with-free-charging-449786/, accessed August 7, 2023.

Table 3.3. — Summary of MassDOT charging infrastructure funding

Program title	National Electric Vehicle Infrastructure (NEVI) program	Charging and Fueling Infrastructure (CFI) grant
Program purpose	To eliminate 50-mile gaps between DCFCs on the alternative fuel corridor (AFC) and prioritize by demand and equity criteria	To incorporate battery storage for NEVI implementation sites to deploy publicly accessible EV charging and fueling infrastructure
Recipients	17 MassDOT-owned service plazas	State or political subdivision of States; metropolitan planning organizations; units of local governments; U.S. territories; Indian tribes; authorities, agencies, instrumentalities or entities owned by one or more entities listed above
Program details	Bidders propose an additional three to five sites	
Funding	$55-60 million in funding for MA to build direct current fast chargers (DCFC)	Up to $700 million
Timeframe	RFI released in June 2023	Deadline was June 13, 2023

Source: Massachusetts Department of Transportation

Table 3.4. — Summary of DOER charging infrastructure funding

Program title	Leading by Example: fleet EVSE deployment grants for state entitites	Green Communities: EVSE deployment grants for municipalities
Program purpose	To transition state fleets to electric vehicles and to improve the ease of adoption	Installation of publicly accessible and/or fleet EV charging stations; strives to help all cities and towns find long-term energy solutions
Recipients	State-owned or leased buildings	Eligible Green Communities
Program details	LBE grant to address existing deployment hurdles (e.g., acquisition and installation of charging stations) to meet state fleet ZEV requirements	Charging station funding is offered through competitive grants for eligible Green Communities
Funding	$1.4 million in total; 100% of installed cost	Max of $7,500 per charging station
Timeframe	Until funding is depleted	Competitive grant opportunities are offered annually in two blocks as long as funding is available
Notes	Max grant per agency is based on fleet size; additional funding for agencies with 40% or more of fleet charging for environmental justice communities	Requirements: must provide location and type of charging station; grant cannot exceed implementation cost; must meet Massachusetts appliance efficiency standards

Source: Massachusetts Department of Energy Resources

Table 3.5. — Summary of MassDEP charging infrastructure funding

Program title	Direct current fast charging program (DCFC)	Workplace and fleet charging (WPF)	Multi-unit dwelling and educational campus charging (MUDC)	Public access charging (PAC)	Fleets
Program purpose	Help property owners with publicly accessible parking and educational campuses acquire charging stations	Support employers and fleet operators in acquiring EV charging stations	Support multi-unit dwelling owners and educational campuses acquire EV charging stations	Support property owners and managers with publicly accessible parking acquire stations	Purchase or lease EVs
Recipients	Property owners	Employers and fleet operators with 15+ employees	Multi-unit dwellings	Non-residential public, private, or non-profit sites available for public use	All public entities
Program details	Educational campuses must have at least 15 students Owners must have publicly accessible parking	Employees must be in non-residential places of business	Multi-unit dwellings must have 5+ residential units and educational campuses with at least 15 students on site		
Funding	$13.1 million -- up to $50,000 per station (up to 100% of $50,000/charger for government-owned properties; up to 80% for non-government owned; up to 60% for educational campuses)	$6.25 million allocated	$2.5 million allocated; ≤$50,000 per address (up to 60% of eligible costs)	$15 million allocated; ≤$50,000 per address (up to 100% of eligible costs on government property and 80% on non-government property)	$2 million allocated for EVs; ≤25 vehicles per entity
Timeframe	Application period has closed	Accepting applications now. First-come, first serve until funding is gone.	Accepting applications now. First-come, first serve until funding is gone.	Accepting applications now. First-come, first serve until funding is gone.	Accepting applications now. First-come, first serve until funding is gone.
Notes	Requirements: must be practically accessible to the general public 24/7	Requirements: in a non-residential location; EV fleets must be garaged in MA	Requirements: multi-unit dwellings with five or more units or campuses with 15+ students on-site	Requirements: must be accessible to the public for a min of 12 hours per day, seven days per week in a non-residential location	Funding parameters: ≤$7,500 for battery electric vehicles (BEVs) ≤$5,000 for a BEV lease ≤$5,000 for plug-in hybrid EVs ≤$3,000 for a PHEV lease $750 for zero emission electric motorcycles (ZEMs) Note: charging station funding eligible under the WPF program

Source: Massachusetts Department of Environmental Protection

Table 3.6. — Summary of utility charging infrastructure funding

Program title	NSTAR Electric	National Grid	Unitil
Residential segment	• Make-ready rebates[1] • EVSE rebates (low-income and multi-unit dwellings only) • EMS rebates (case-by-case, multi-unit dwellings only) • 20+ unit dwelling site plans	• Make-ready rebates[1] • EVSE rebates (low-income and multi-unit dwellings only) • EMS rebates (case-by-case, multi-unit dwellings only) • 20+ unit dwelling site plans	• Make-ready rebates • EVSE rebates (low-income only)
Public and workplace segment	• Make-ready rebates[2] • EVSE rebates (publicly accessible sites only) • EMS rebates (case-by-case)	• Make-ready rebates[2] • EVSE rebates (publicly accessible sites only) • EMS rebates (case-by-case) • Make-ready rebates for Level 1 charging at long-dwell time parking	Make-ready rebates
Fleet segment	• Make-ready rebates (light-duty only) • Public light-duty fleet EVSE rebates • Public fleet assessment	• Make-ready rebates • Public fleet EVSE rebates • Public fleet assessment	n/a
Networking rebates	Publicly accessible sites and multi-unit dwellings	Publicly accessible sites and multi-unit dwellings	n/a
Funding	$188 million	$206 million	$998,000
Timeframe	Four years	Four years	Five years
Environmental justice	• EJ MD/HD fleet make-ready and EVSE rebates pilot • DCFC charging hubs in environmental justice communities • Highest EVSE rebates to those serving income-based EJ populations (sliding scale)[3,4] • EJ deployment target[5,6]	• Highest EVSE rebates to those serving income-based EJ populations (sliding scale)[3,4] • EJ deployment target[5,6]	(The majority of Unitil's service territory serves environmental justice populations)
Managed charging	n/a	Off-peak charging rebates (residential and fleet customers only)	n/a
Rate design	Demand charge alternative	Demand charge alternative	• Demand charge alternative • EV time-of-use rate

Source: Massachusetts Department of Public Utilities

1. For multi-unit dwellings, NSTAR Electric and National Grid may provide up to 150% of the average cost of customer-side infrastructure, not to exceed actual installation cost, on a case-by-case basis.
2. For the public and workplace segment, NSTAR Electric and National Grid may provide up to 150% of the average cost of customer-side infrastructure, not to exceed actual installation cost, on a case-by-case basis.
3. For the publicly accessible public and workplace segment and multi-unit dwelling sites: (1) a 100% EVSE rebate in environmental justice neighborhoods that meet the EJ criteria based on income; (2) a 75% EVSE rebate in environmental justice neighborhoods that meet any of the other EJ criteria; and (3) a 50 percent EVSE rebate for non-environmental justice neighborhoods.
4. For public fleets: (1) a 100% EVSE rebate for public fleets that are registered in an EJ community that meets the EJ criteria based on income or operate more than 50% of the time within census block groups that meet the EJ criteria based on income; (2) a 75% EVSE rebate for public fleets that are registered in an EJ neighborhood that meets the EJ criteria based on any of the other EJ criteria or operate more than 50 percent of the time within census block groups that meet the EJ criteria based on any of the other EJ criteria; and (3) a 50 percent EVSE rebate for public fleets in non-environmental justice neighborhoods.
5. For the public and workplace segment and multi-unit dwellings, the port deployment targets in environmental justice neighborhoods are 35% and 28.5% for NSTAR Electric and National Grid, respectively.
6. For the fleet segment, the port deployment targets in environmental justice neighborhoods are 40% for both NSTAR Electric and National Grid.

Table 3.7. — Summary of U.S. Department of Transportation charging infrastructure funding

Program title	National Electric Vehicle Infrastructure Formula	Rebuilding American Infrastructure with Sustainability and Equity (RAISE)	Discretionary Grant Program for Charging and Fueling Infrastructure (CFI)
Program purpose	Deploy EV charging infrastructure and to establish an interconnected national network	Invest in road, rail, transit and port projects with a focus on ZEV infrastructure and EV charging	Deploy publicly accessible EV charging infrastructure
Recipients	States, D.C., and Puerto Rico	States, tribes, localities, transportation providers	States, tribes, localities, MPOs, U.S. territories
Program details	Grant range is \$13.6 million to \$407.8 million	Grant ranges: Capital awards: \$1.1 million—\$25 million Planning activities: \$260,000—\$25 million	Grant range: Corridor program: >\$1 million Community program: \$500,000–\$15 million
Funding	\$5 billion		\$2.5 million (\$1.25 million to Corridor Program and \$1.25 million to Community Program)
Timeframe	FY 2022 to FY 2026	Given on an annual basis	Deadline extended to June 13, 2023

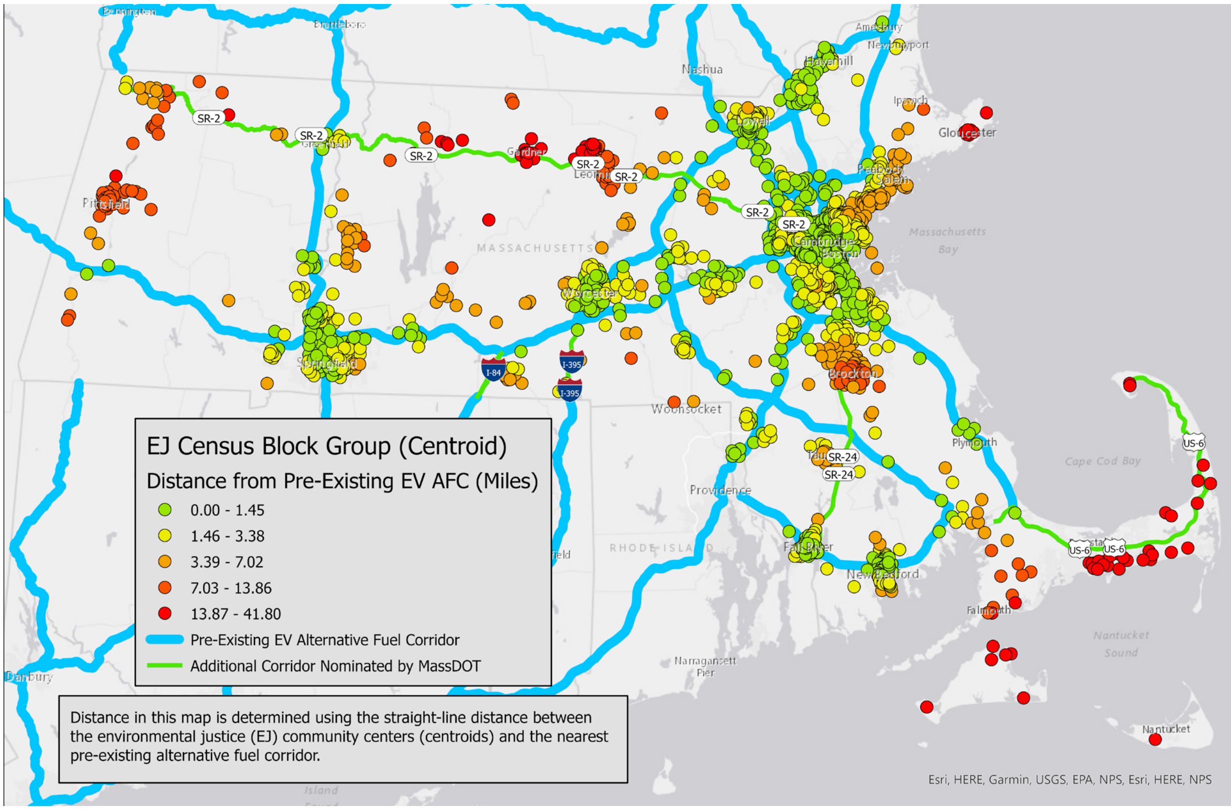
Source: U.S. Department of Transportation

Table 3.8. — Summary of charging infrastructure federal tax incentives

Program title	Alternative Fuel Infrastructure tax credit
Program purpose	Expand EV charging infrastructure available
Recipients	Nonprofits, private sector, individuals
Program details	30% of eligible project costs, maximum \$100,000 (or \$1,000 for consumer EV users)
Timeframe	Ongoing through 2032
Notes	Alternative Fuel Infrastructure tax credit

Source: U.S. Internal Revenue Service

Figure 3.1 — Environmental justice census block groups and distances from EV alternative fuel corridors



Source: Massachusetts Department of Transportation: National Electric Vehicle Infrastructure Deployment Plan for Massachusetts
Note that this map shows the Rounds 1-5 EV alternative fuel corridors and does not include more newly designated EV alternative fuel corridors, which cover most of the environmental justice census block groups shown in red above. See Figure 3.6 for an updated map of alternative fuel corridors.

On December 30, 2022, the DPU approved utility EV programs for NSTAR Electric, National Grid and Unitil. The DPU also approved EV demand charge alternative rates for each company and a residential EV time of use rate for Unitil. Table 3.6 shows a summary of current utility EV programs. Federal charging incentives are summarized in Tables 3.7 and 3.8.

Current landscape of electric vehicle charging infrastructure

Recent electric vehicle purchase data

MassDOT recently launched the Massachusetts Vehicle Census, (MVC) an online state-level database that records total vehicles in Massachusetts, average daily mileage, vehicle use, fuel class, and vehicle type. The database is intended to share potential trends and consumer behavior shifts, though it does not currently track in-state vehicle purchases.[6] As of 2023, the state has 5.26 million active vehicles, of which 159,305 (3.03%) are hybrid and 70,761 (1.32%) are zero-emission vehicles.[7] Since 2020, the number of hybrid vehicles has increased by 51,686 (48.03%) vehicles and the number of ZEVs has increased by 42,899 (153.97%).[8] MassDOT plans to release Phase 2 of the MVC in the fall with data available at more granular geographic levels (i.e., block group).

Average driver trip lengths

An understanding of the average distance and duration of a Massachusetts driver's trip is critical to determining the optimal locations for EV

6 GeoDOT, "Massachusetts vehicle census," Mass.gov. Accessed July 30, 2023, https://geodot-homepage-massdot.hub.arcgis.com/pages/massvehiclecensus.
7 *Ibid.*
8 *Ibid.*

infrastructure. It is estimated that more than 97% of trips in Massachusetts are shorter than 50 miles with 2% of trips being between 50 and 100 miles and only 0.5% being 100 miles or greater.[9] More than 57% of all trips in the state are less than three miles.[10]

Population, demographic, and household geographical data

MassDOT conducted a spatial analysis of the state, identifying the environmental justice census block groups in Massachusetts that were farthest from existing alternative fuel corridors for electric vehicles.[11] This assessment is the first step in ensuring that all communities in the Commonwealth are equitably served by the corridors. Figure 3.1 highlights environmental justice census block groups in the state and their distance to EV alternative fuel corridors.[12]

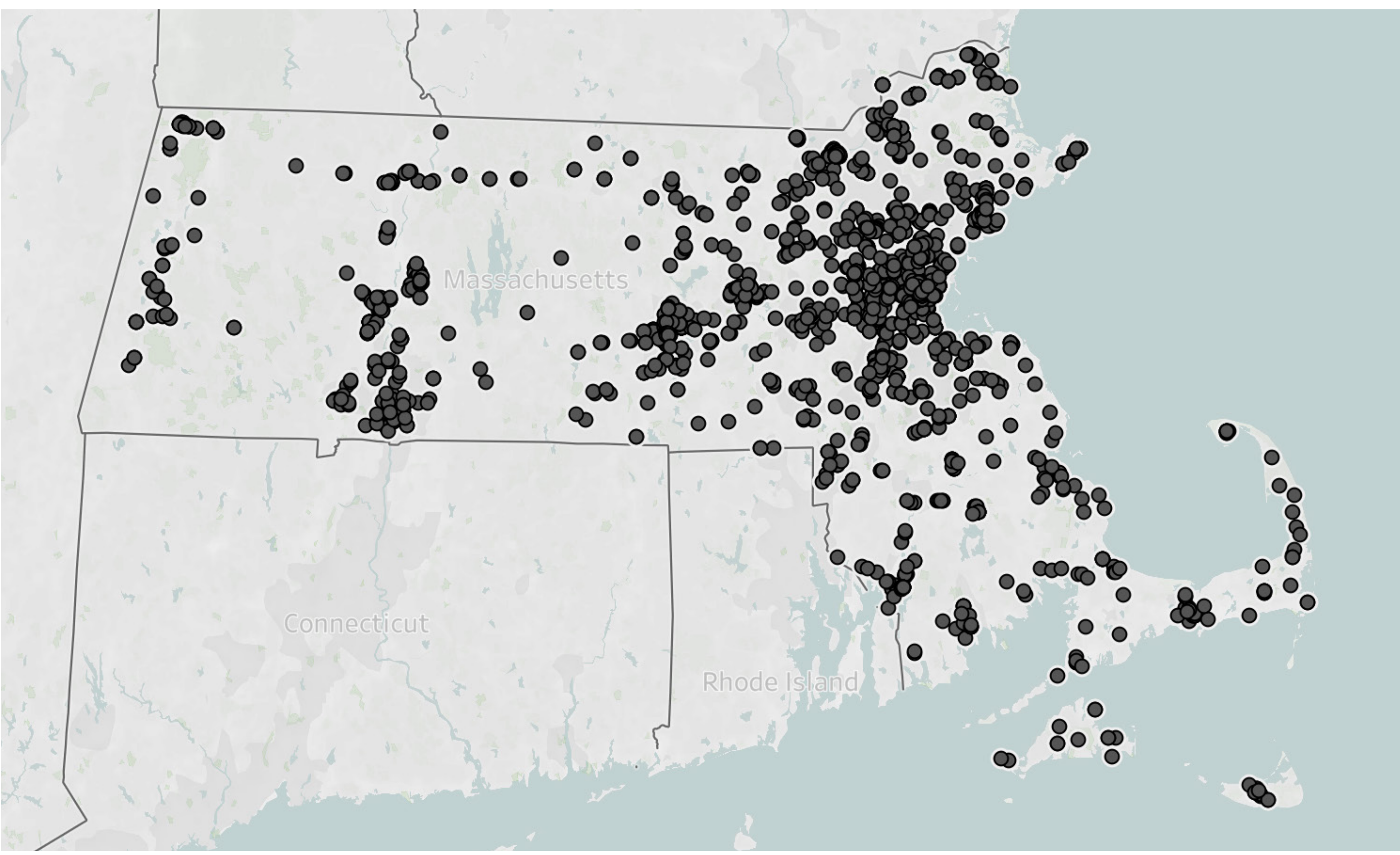
Existing charging station locations

As of August 2023, there are 2,623 publicly accessible charging station locations operating in Massachusetts, supporting 6,082 total ports.[13] This

9 MassDOT, "NEVI plan," 2022.
10 *Ibid.*

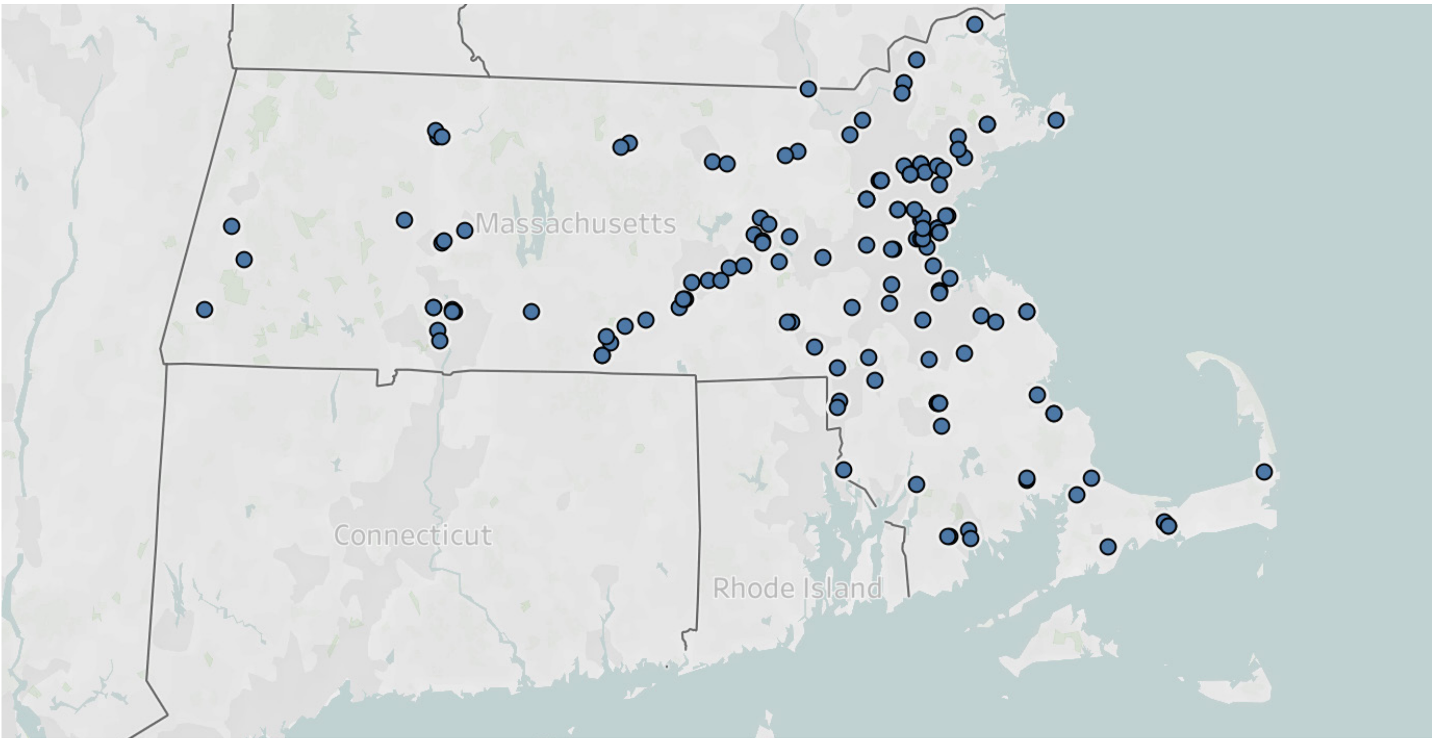
11 In accordance with 23 U.S.C. 151, the U.S. Federal Highways Administration has designated alternative fuel corridors to support installation of EV charging, hydrogen, propane, and natural gas fueling infrastructure at strategic locations along major national highways. These corridors have been updated and redesignated on an annual basis by soliciting nominations from State and local officials.
12 MassDOT, "NEVI plan," 2022.
13 Alternative Fuels Data Center, "Alternative fueling station counts by state," U.S. Department of Energy. Accessed June 2, 2023, https://afdc.energy.gov/stations/states.

Figure 3.2 — Public Level 2 charging stations across Massachusetts



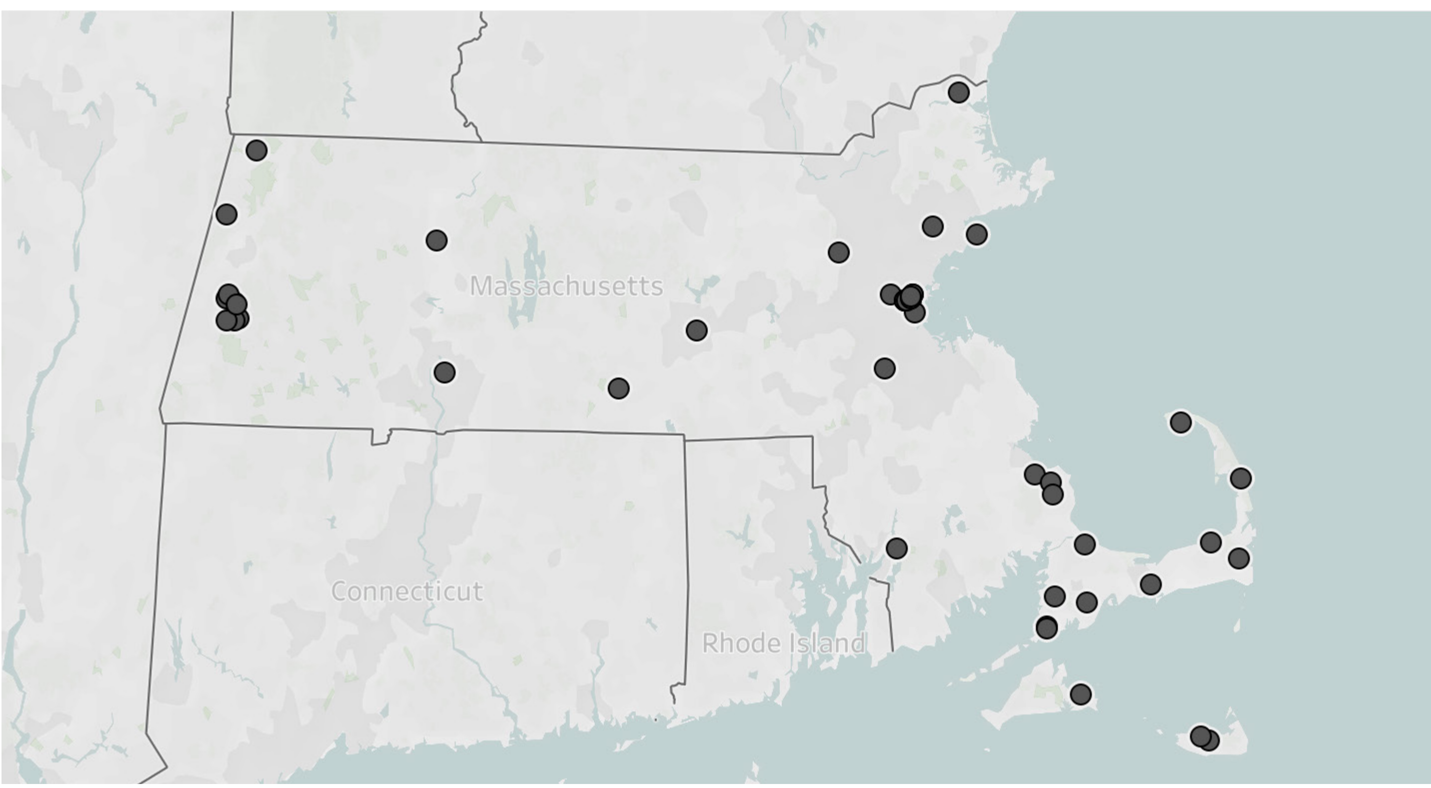
Source: 2023 Mapbox © OpenStreetMap. Data from U.S. Department of Energy Alternative Fuels Data Center.

Figure 3.3 — Public DC fast charging stations across Massachusetts



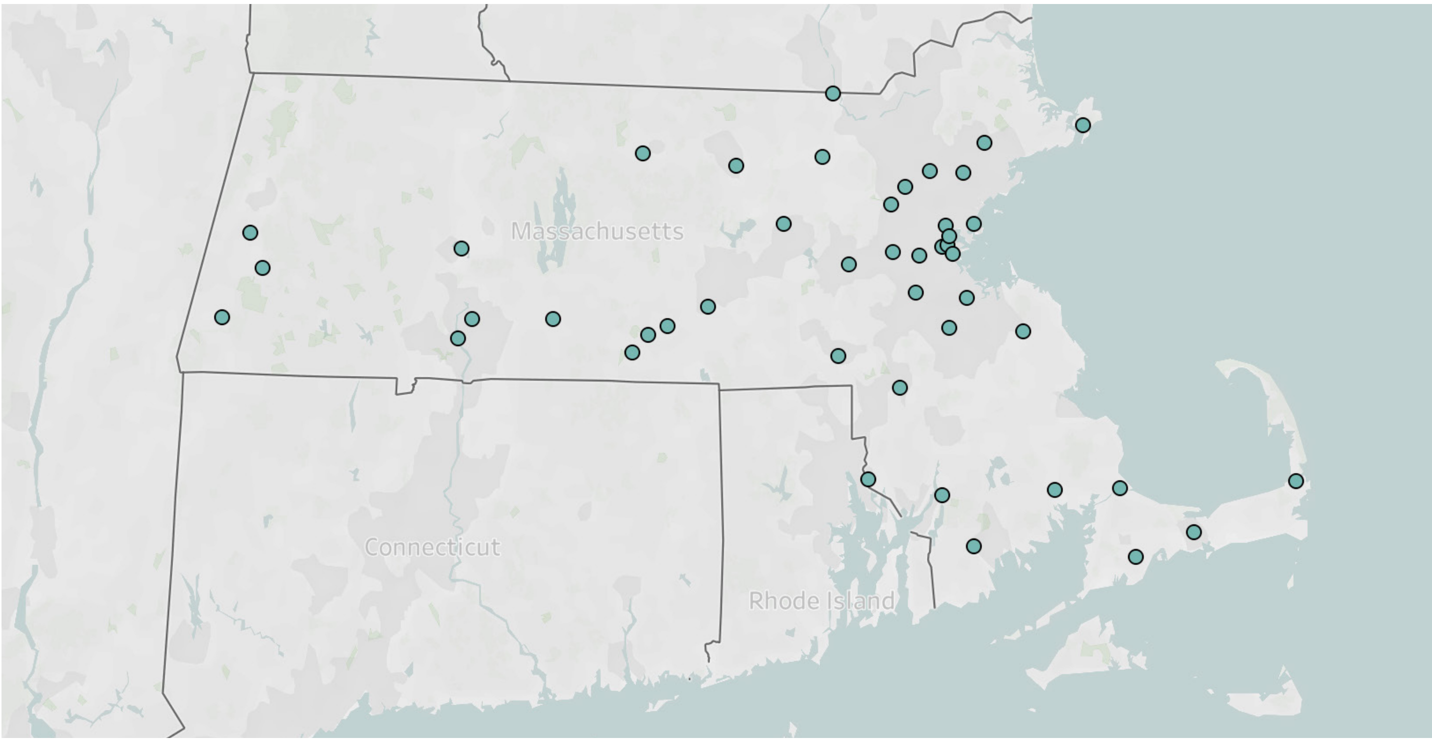
Source: 2023 Mapbox © OpenStreetMap. Data from U.S. Department of Energy Alternative Fuels Data Center.

Figure 3.4 — Tesla Level 2 charging stations across Massachusetts



Source: 2023 Mapbox © OpenStreetMap. Data from U.S. Department of Energy Alternative Fuels Data Center.

Figure 3.5 — Tesla DC fast charging stations across Massachusetts



Source: 2023 Mapbox © OpenStreetMap. Data from U.S. Department of Energy Alternative Fuels Data Center.

includes 646 ports at 154 fast-charging locations.[14] Of these, 545 fast-charging ports are run by Tesla, which are currently only available to Tesla owners; however, Tesla is in the process of integrating other leading manufacturers to use their network beginning in 2024 and beyond. There are also 5,436 publicly accessible Level 2 charging ports. The maps in Figures 3.2–3.5 show locations of public Level 2 and DC fast chargers across Massachusetts public stations, as well as Tesla charging locations.

Current guidance on siting and statewide permitting

As of June 2023, no U.S. state yet has a statewide permitting requirement for EVSE installations. California has guidance from local permitting requirements, such as in West Hollywood, Sonoma County, and Fresno.[15] Recommendations on permitting, inspections, maintenance, and safety can be found in Section 4: The User Experience.

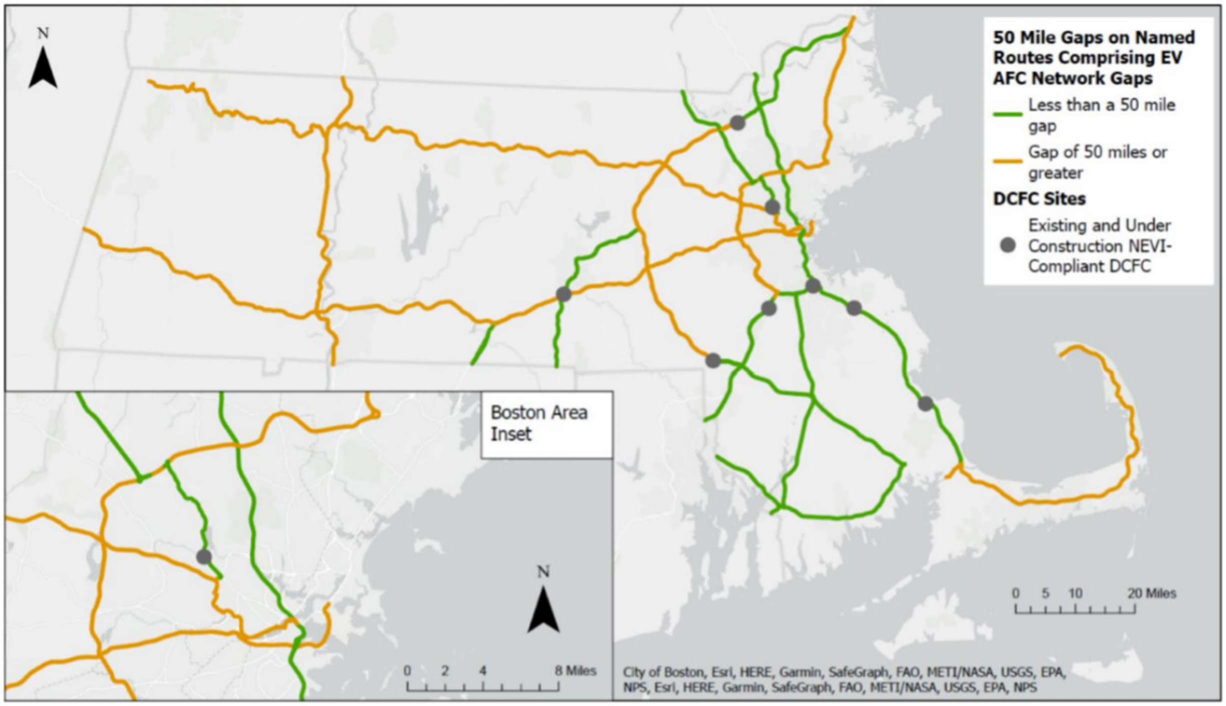
NEVI guidance on standards for publicly accessible electric vehicles

The National Electric Vehicle Infrastructure (NEVI) rules, created by the Federal Highway Administration and U.S. Department of Transportation, "establishes regulations setting minimum standards and requirements for projects funded under the NEVI Formula Program and projects for the construction of publicly accessible electric vehicle (EV) chargers under certain statutory authorities, including any EV charging infrastructure project funded with Federal funds that is treated as a project on a Federal-aid

14 *Ibid.*

15 Governor's Office of Business and Economic Development, "Permitting electric vehicle charging stations: best practices," CA.gov. From https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/permitting-electric-vehicle-charging-stations-best-practices/, accessed June 14, 2023.

Figure 3.6 — Locations of DC fast-charging stations ≤1 mile from a major transportation corridor



Source: Massachusetts Department of Transportation

highway."[16] These rules went into effect on March 30, 2023.

NEVI's final rule requires transparency around the procurement process, including the number of bids received, identification of the awardee, financial summary of the contract terms (in accordance with applicable state public record laws).[17] The rule establishes the supply and output power level for each type of charging port, as well as technical interoperability, data protection, and security standards that apply to charger hardware and from the charger to the network, and the charging network to the grid. These rules include:

- Any time a charging station is installed, the charging station must have a minimum of four charging ports (either a DC fast charging or alternating current [AC] Level 2 port or combination). Any installed DC fast charging ports must be able to accommodate a combined charging system (CCS) Type 1 connector.
- Each charging station located along an alternative fuel corridor must be available to users 24 hours a day, seven days a week.
- Charging stations must provide a contactless payment method that accepts major debit and credit cards and allows payment through text message or by an automated toll-free number.
- Information about the location, pricing, real-time availability, and accessibility of EV charging infrastructure must be made available to third-party software developers free of charge.
- Prices for using the equipment to charge an EV must be displayed in real time, and other additional fees must be clearly displayed and explained.

16 Federal Highway Administration, "National electric vehicle infrastructure standards and requirements," Federal Register: The Daily Journal of the United States Government, National Archives, February 28, 2023. From https://www.federalregister.gov/documents/2023/02/28/2023-03500/national-electric-vehicle-infrastructure-standards-and-requirements, accessed June 17, 2023.
17 *Ibid.*

- Use of revenue or income from an EV charging station is limited to debt service; reasonable return on investment of any private person financing the EV charging station project, as determined by the recipient of federal funding; and costs necessary for the improvement and operation of the EV charging station, among other uses.

- The EV charging infrastructure may be installed and maintained only by employees with the appropriate licenses, training, and certifications.

- Other federal requirements including the Americans with Disability Act, Davis-Bacon wage requirements, Title VI of the Civil Rights Act, and the National Environmental Policy Act also apply to EV charger projects.

Current laws and policies governing EV charging infrastructure

While at present there are no state or federal standards for the installation, maintenance, or other provisions of EV charging infrastructure, multiple policies govern them:

Workplace charging

The U.S. General Services Administration (GSA) electric vehicle charging on federal property law allows any federal agency to install EVSE for federal employees.[18] Employees then reimburse the federal agencies for the cost of procurement, installation, and use of the EVSE. Massachusetts' Executive Order 594 requires that executive branch agencies and public institutions of higher education must collectively increase the number of charging stations on state properties to 350 charging stations in 2025 and 500 charging stations in 2030.

Fleets

Massachusetts' Executive Order 594 requires executive branch agencies and public institutions of higher education to acquire zero-emissions vehicles (ZEVs) to bring the state fleet to 100% ZEVs by 2050.

MassDEP regulation 310 CMR 7.41, Large Entity Reporting Requirement, requires fleet owners to submit a one-time report to MassDEP six months after the regulation is promulgated on medium- and heavy-duty (MHD) vehicle type and usage characteristics. The reports will allow Massachusetts to assess how to develop charging infrastructure and programs to support and accelerate the MHD zero emission vehicle (ZEV) market in Massachusetts. Information that must be reported includes the number of vehicles, general information about the vehicle home base where vehicles are domiciled or assigned to determine suitability for electrification, and information about vehicle operating characteristics, such as fuel, vehicle type, typical mileage per day and year, typical replacement cycle, whether the vehicle has predictable usage patterns, and whether the vehicle returns to a home base daily, remains near base, remains parked for 8+ hours, or is used to support emergencies.[19]

Payment methods

G.L. c. 25A § 16 requires that public charging stations that require payment must offer users publicly accessible ways to pay. It also provides that users should not be required to pay membership or subscription fees; however, owners of charging stations may have separate price schedules conditional on a subscription or membership.[20]

St. 2016 c. 448 § 4 permits DOER to adopt interoperability billing standards for network roaming payment methods for electric vehicle charging stations, which it has not yet done to date.[21]

Data collection

G.L. c. 25A § 16 requires owners and operators of public charging stations to disclose on an ongoing basis to the United States Department of Energy National Renewable Energy Laboratory (NREL), or other publicly available database designated by the department of energy resources, the station's

18 Fixing America's Surface Transportation Act (FAST Act), Pub. L. No. 114-94 (2015), Section 1413. See https://www.govinfo.gov/app/details/PLAW-114publ94.

19 Mass. State Environmental Code, Title 5, 310 CMR 7.41
20 Mass. Gen. Laws c. 25A § 16
21 Mass. Acts of 2016 c. 448 § 4

geographic location, hours of operation, charging level, hardware compatibility, schedule of fees, accepted methods of payment and the amount of network roaming charges for nonmembers, if any.[22]

Appliance standards

The Massachusetts Appliance Energy and Water Efficiency Standards, 225 CMR 9.03(21), require that EVSE sold or installed in the Commonwealth meet the qualification criteria included in the scope of the ENERGY STAR Program Requirements Product Specification for Electric Vehicle Supply Equipment, Version 1.0 (Rev. Apr-2017) and be listed on the State Appliance Standards Database (SASD).[23]

Rates

In Massachusetts, rate structures, including demand charges, are regulated by the DPU and vary by utility. Demand charges currently range from about $7 to $33 per kW for the two major investor-owned electric utilities, Eversource and National Grid. In conjunction with the submission of their coordinated EV charging infrastructure plans, and as required by Section 29 of Chapter 383 of the Acts of 2020, the investor-owned utilities operating in the Commonwealth jointly filed for a proposed reduction in demand charges for EV charging sites in July 2021, under which demand charges would be substantially reduced for charging equipment with lower utilization levels. In June 2023, the DPU approved the investor-owned utilities' proposed tariffs, which went into effect as of July 1, 2023, and should dramatically reduce operating costs for EV charging sites with lower utilization rates.[24,25]

Parking

G.L. c. 40 § 22A allows municipalities to restrict parking areas for ZEVs and provides that a person found responsible for a violation of the restricted parking area may be subject to a penalty of no more than $50 and the vehicle may be removed from the parking spot.[26,27]

The Commonwealth's building code requires that any new commercial construction with more than 15 parking spots must have at least one parking spot that is made ready for charging stations meaning the spot has a dedicated circuit for EV charging stations.

Installation and maintenance

By July 1, 2024, MassDOT, MBTA, and regional transit authorities must establish provisions for the installation and maintenance of public EV charging stations at the following locations:

- All service plazas located on the Massachusetts Turnpike;
- A minimum of five commuter rail station parking lots;
- A minimum of five subway station parking lots; and,
- A minimum of one ferry terminal parking lot.[28]

22 Mass. Gen. Laws c. 25A § 16
23 Mass. State Environmental Code, Title 5, 225 CMR 9.03(21)
24 Mass. Acts of 2020 c. 383 § 29
25 D.P.U. 21-90/21-91/21-92, available at https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/16827694.
26 Mass. Gen. Laws c. 40 § 22A;
27 780 CMR 13.00 Subsection C405.10. Available at: https://www.mass.gov/massachusetts-state-building-code-780-cmr
28 Mass. State Acts of 2022 c. 179 § 89(b).

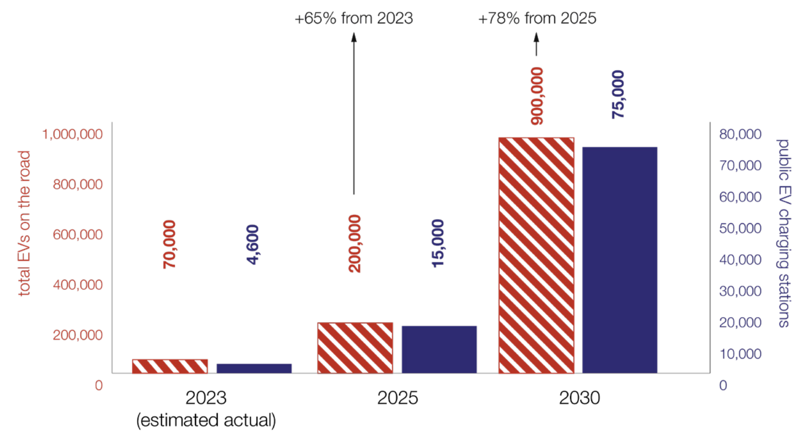
SECTION

4. FUTURE NEEDS

Massachusetts has set a target of 900,000 electric vehicles on the road by 2030—fifteen times today's number.

As of 2023, approximately 70,000 zero-emission vehicles were registered in Massachusetts and 4,600 EV public charging stations were deployed statewide.[1,2] The CECP proposes to promote a dramatic increase in sales of electric vehicles (see Figure 4.1) with a target of 900,000 EVs—fifteen times today's number. To accommodate this influx of electric vehicles, the EVICC has been charged with developing future projections of charging demand, locations, and timeframes, as well as implications for the electrical grid.

Figure 4.1. — Massachusetts EVs and EV charger targets: 2025 and 2030



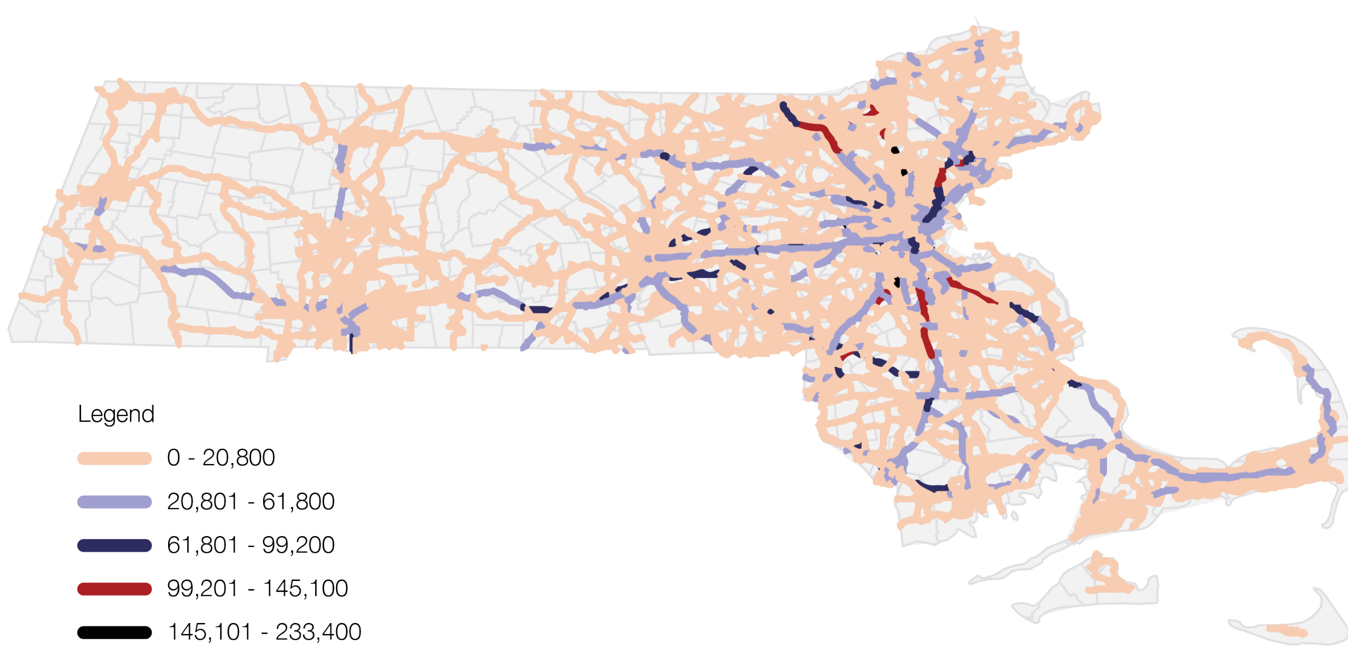
Source: Massachuestts Clean Energy and Climate Plan for 2025/2030

Projection of 2030 EV infrastructure needs

To calculate future EV infrastructure needs, consultants Synapse Energy Economics et al. combined several data sets using traffic data and forecasted growth in demand from VisionEval, a planning model operated by the Collaborative Development of New Strategic Planning Models

1 Massachusetts Vehicle Census, mass.gov. See https://geodot-homepage-massdot.hub.arcgis.com/pages/massvehiclecensus.
2 Data from PlugShare, www.plugshare.com.

Figure 4.1 — Average annual daily traffic volume in Massachusetts (2021 data)



Source: Synapse, VisionEval

Table 4.1. — Summary of variables contributing to 2030 and 2050 transportation forecast

Variable	2015 average	2030 average	2050 average	2050 change	2030 change
Daily CO_2 (lbs)	117,209,782	88,504,150	50,229,974	–57%	–24%
Population	6,919,637	7,175,210	7,515,975	9%	4%
Total workers	3,345,147	3,641,801	4,037,339	21%	9%
Daily vehicle trips	13,003,097	14,724,335	17,019,318	31%	13%
Daily vehicle miles traveled	16.4	18.3	20.9	27%	12%

Source: Synapse

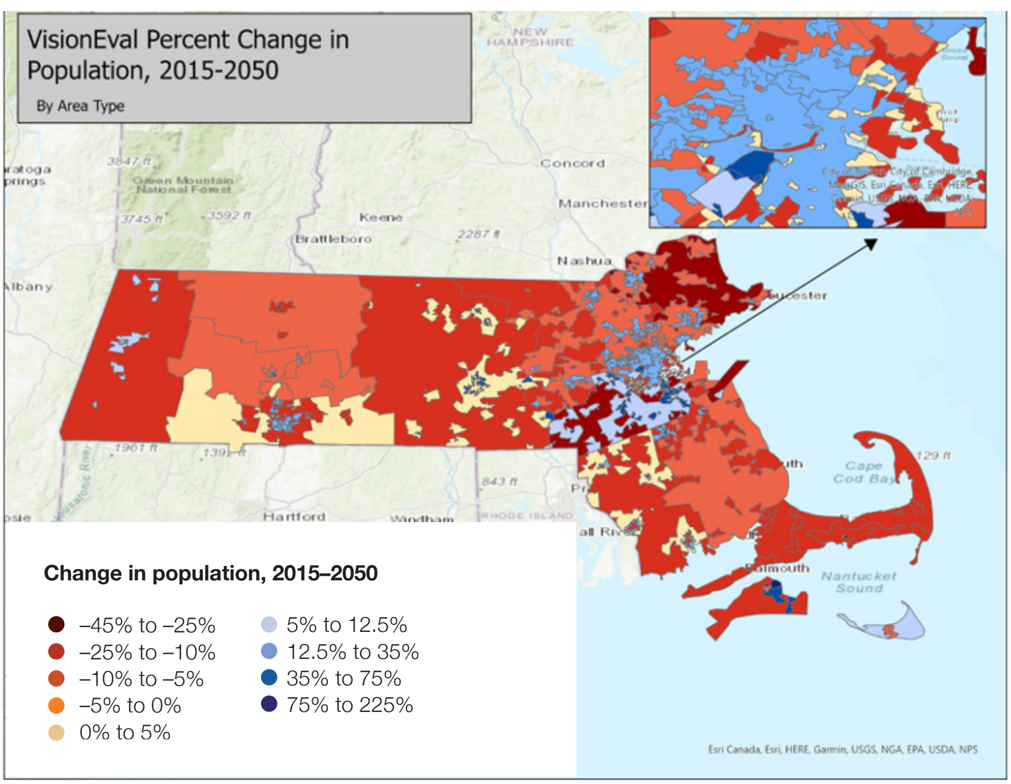
Pools Fund. They first looked at annual average daily vehicle miles traveled using 2021 data from the Highway Performance Monitoring System of the Federal Highway Administration. Figure 4.1 illustrates their findings.

Synapse and its partners also used VisionEval to create predictions for 2030 and 2050 information on potential EV demand, such as housing, population, and employment. Their findings are illustrated in Table 4.1.

According to Synapse, in 2030, most EVs on the road will be relatively new. Charger allocations are then based on the location of EV registrations, housing types, workplace locations, and various measures of traffic volumes. Public charger allocation also accounts for amenities such as food, stores, and restrooms.

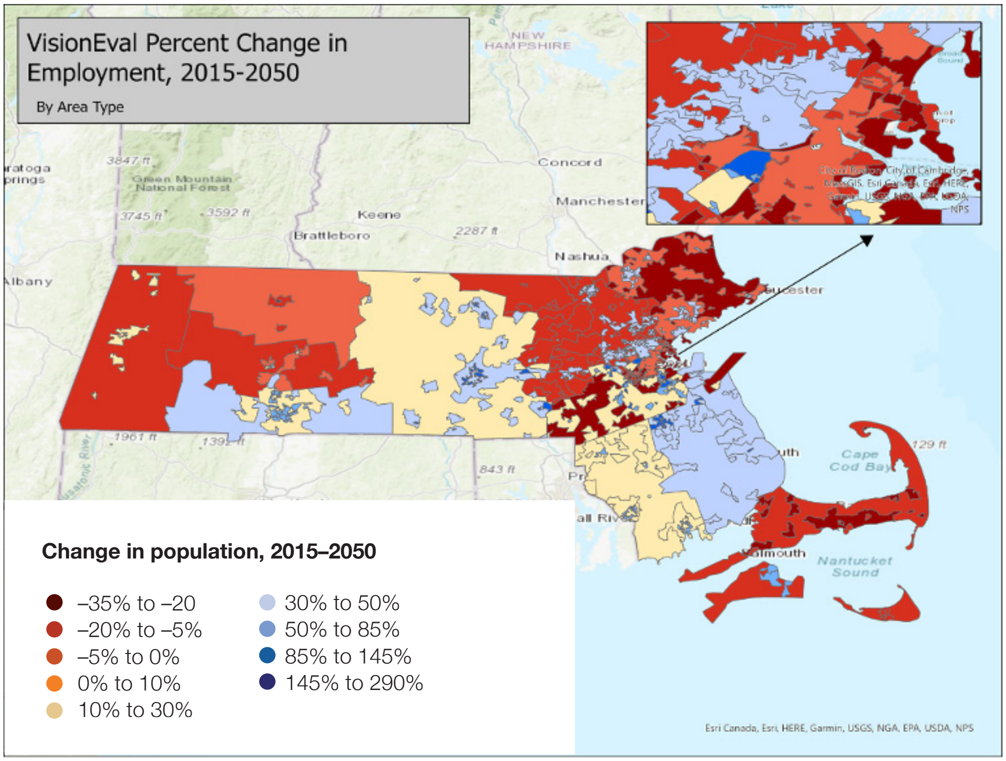
Predicted changes in areas of population, employment, and housing types, 2015–2050, are illustrated in Figures 4.2–4.5.

Figure 4.2 — Predicted population change in Massachusetts, 2015–2050



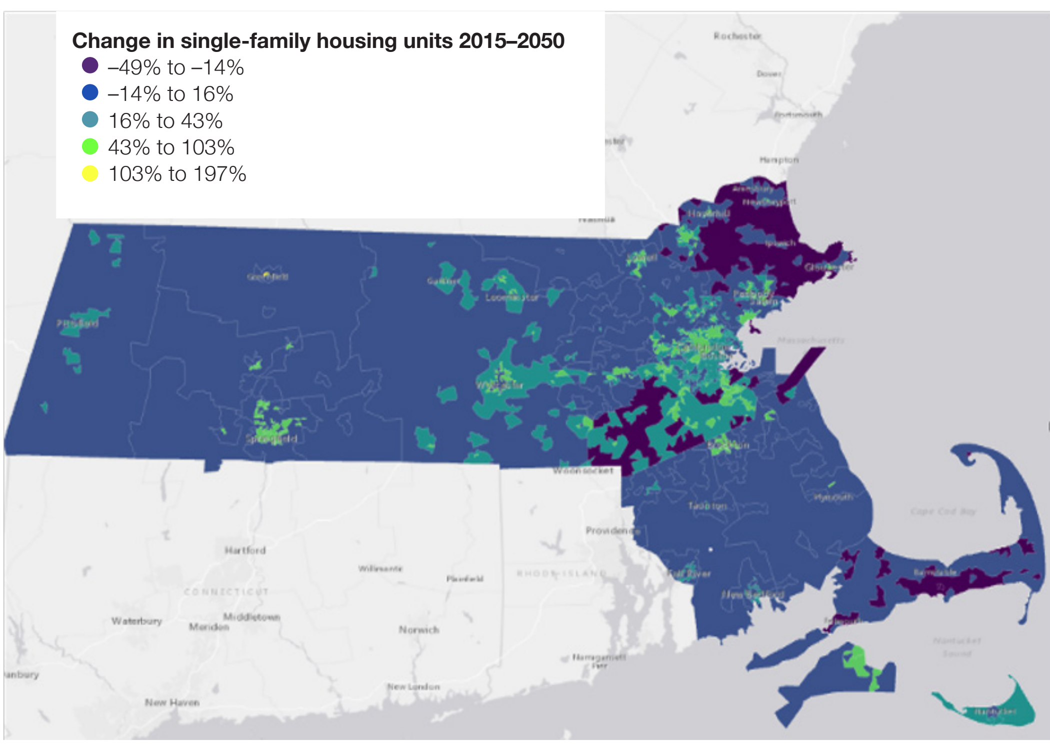
Source: Synapse, VisionEval

Figure 4.3 — Predicted employment change in Massachusetts, 2015–2050



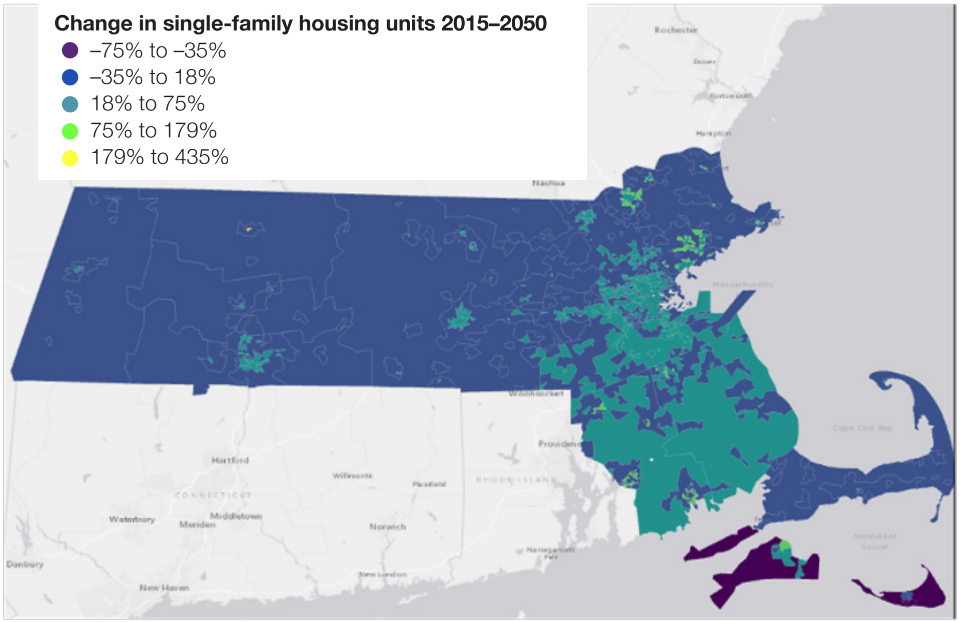
Source: Synapse, VisionEval

Figure 4.4 — Predicted changes in single-family housing units in Massachusetts, 2015–2030



Source: Synapse, VisionEval

Figure 4.5 — Predicted changes in multi-family housing units in Massachusetts, 2015–2030



Source: Synapse, VisionEval

Synapse also developed models based on annual peak road travel times—Independence Day and Thanksgiving—to account for the potential need for electric vehicle infrastructure to serve seasonal peak demands as well as ongoing annual needs. Results in Figure 4.6, for example, show that western Massachusetts and Cape Cod have summer peak travel that is much greater than the annual average, whereas central and western arteries have more of a Thanksgiving peak impact than much of eastern part of the state. The Synapse team used peak traffic volumes on each road segment as one input when weighting where public chargers would be sited.

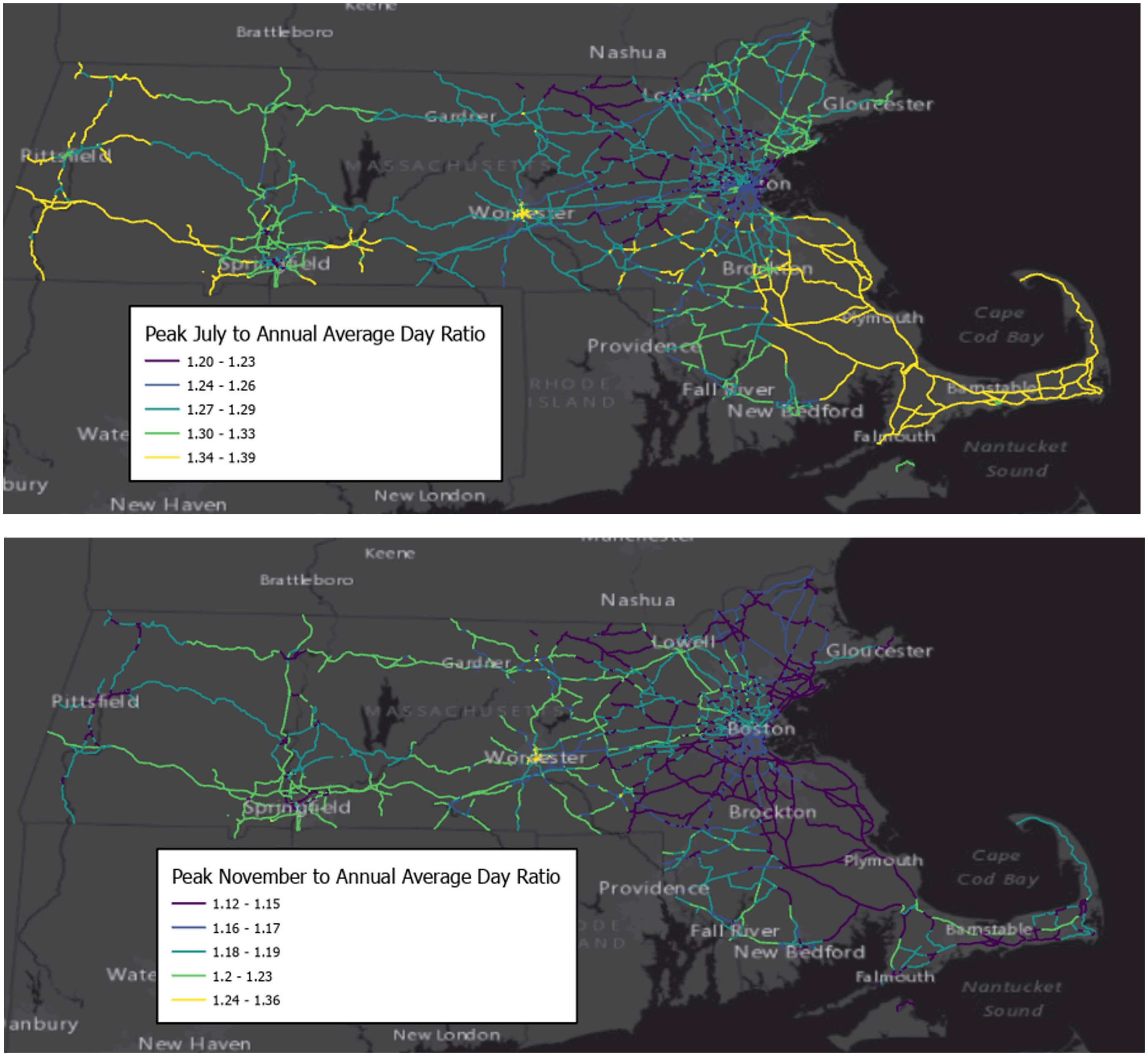
Table 4.2 shows a breakdown of the number of estimated ports needed by location category. For the purposes of this study, Synapse used a figure of 970,000 EVs on the road by 2030.

Table 4.2. — Charging demand for ~970,000-EV scenario*

Location	EV count	Charger type	Port count	EV/port ratio	Source
Single-family home	730,000	Level 1	160,000	4.6	EV Pro Lite
		Level 2	400,000	1.8	EV Pro Lite
Multi-family home	240,000	Level 1	6,000	40.0	EV Pro Lite
		Level 2	15,000	16.0	EV Pro Lite
Workplace	970,000	Level 2	33,000	29.4	EV Pro Lite
Public	970,000	Level 2	35,000	~28	Observed ratios†
		DC fast charger	10,000	~98	Observed ratios

Source: Synapse
* Note that while the CECP finds there Is a need for 900,000 EVs by 2030, the modeling performed for this initial assessment shows 970,000 EVs on the road by 2030. † Based on the ratios of EVs to Level 2 and DC fast chargers observed in other jurisdictions

Figure 4.6— Predicted traffic patterns, peak road trip seasons (July and November) in Massachusetts, 2030



Source: Synapse, VisionEval

Types and locations of EV charging stations

Approximately 80% of EV charging occurs at home, with the workplace being the second most common charging location.[3] Downtown area parking lots also saw high usage rates.[4] In thinking through placement of public EV charging infrastructure, factors such as cost, user behavior, and demand are important considerations.

DC fast chargers

Drivers are more likely to need DC fast chargers along major corridors.[5] The level of demand expected on each alternative fuel corridor segment was measured in total trips greater than 100 miles in length using the segment during the peak hour of each week, with the highest demand segments on the Massachusetts Turnpike (Interstate 90) and I-84 between I-495 and the Connecticut border. The next highest segments include I-290 and I-495 from Worcester to the Maine border, I-95 from Maine to Canton, and the Mass Pike west of Springfield.[6] The MassDOT NEVI Program Deployment Plan outlines the designated highway corridors in need of EVSE. This data is highlighted in Table 4.3 as prioritized by corridors located within environmental justice neighborhoods.[7]

Figure 4.7 summarizes Synapse's findings on the distribution of DC fast chargers based on forecasted 2030 demand.

Level 2 chargers

Level 2 charging stations are best suited for areas where vehicles are parked for extended periods of times, such as shopping malls, airports, commuter lots, and downtown parking lots with easy access to a variety of venues.[8]

Table 4.3 — Equity ranking of electrification zones based on populations within environmental justice neighborhoods

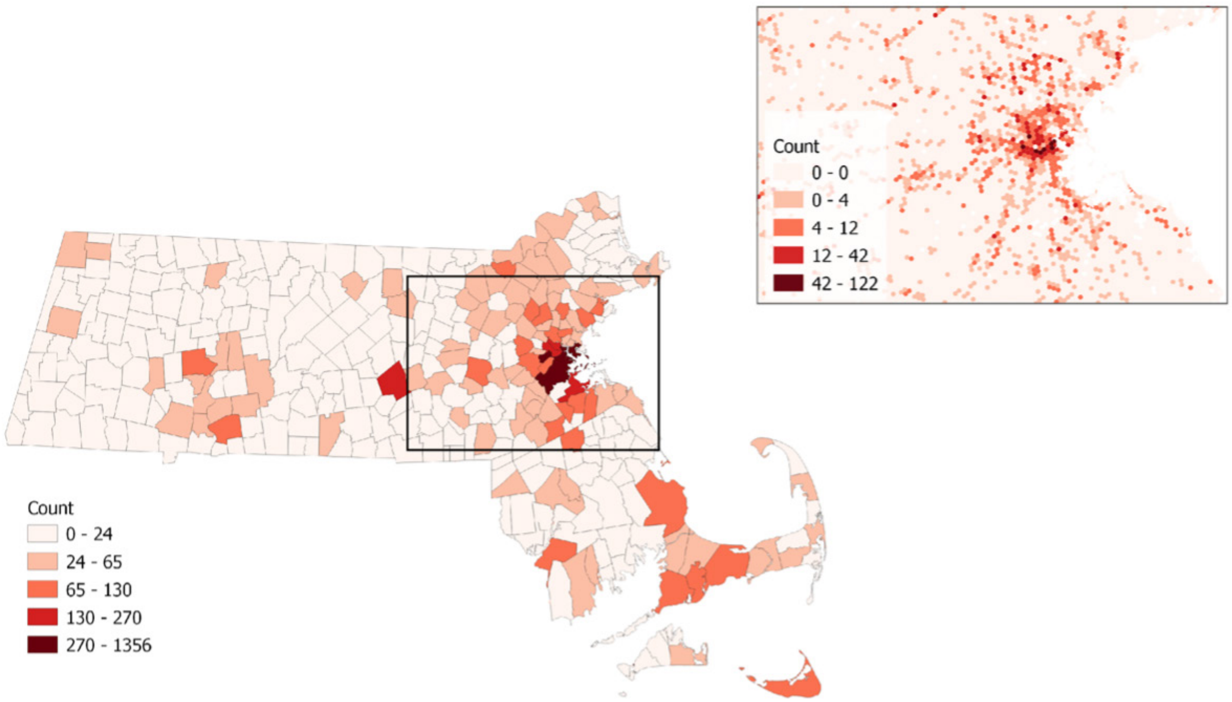
Equity rank	Electrification zone	% of population within environmental justice neighborhoods
1	U.S. 3 South	67%
2	I–90 East	64%
3	I–90 West	64%
4	I–93	63%
5	I–91	60%
6	SR 24	59%
7	SR 2 East	57%
8	I–195	52%
9	SR 2 West	50%
10	I–395	50%
11	I–495 North	50%
12	U.S. 3 North	42%
13	SR 3 / U.S. 6	38%
14	I–95	35%
15	I–495	23%

Source: MassDOT NEVI submission

It may also be helpful to promote Level 2 stations in locations where state and federal electric vehicle claims on rebates are low with the intention of promoting EV adoption in those areas. Massachusetts Offers Rebates for Electric Vehicles (MOR-EV), a program designed to provide incentives to purchase electric vehicles, particularly for environmental justice populations, offers data that could be used as an approximation of an area's

3 National Renewable Energy Laboratory (NREL), "Incorporating residential smart electric vehicle charging in home energy management systems," April 2021. From https://www.nrel.gov/docs/fy21osti/78540.pdf, accessed June 19, 2023.
4 *Ibid.*
5 Fuels Institute Electric Vehicle Council, "EV consumer behavior," Transportation Energy, June 2021. From https://www.transportationenergy.org/wp-content/uploads/2022/11/21FI_-EVC_ConsumerBehaviorReport_V07-FINAL.pdf, accessed June 18, 2023.
6 *Ibid.*
7 MassDOT, "NEVI plan," 2022.
8 MassDOT, "NEVI plan," 2022.

Figure 4.7 — Anticipated demand for DC fast chargers in 2030



Source: Synapse, VisionEval

EV owner density.[9] Another resource is the Mass Vehicle Census, published by MassDOT and the Metropolitan Area Planning Council, which offers an interactive dashboard on vehicle types in the state. MassDOT will release additional data in fall 2023 to account for EV owners who did not apply for rebates.[10]

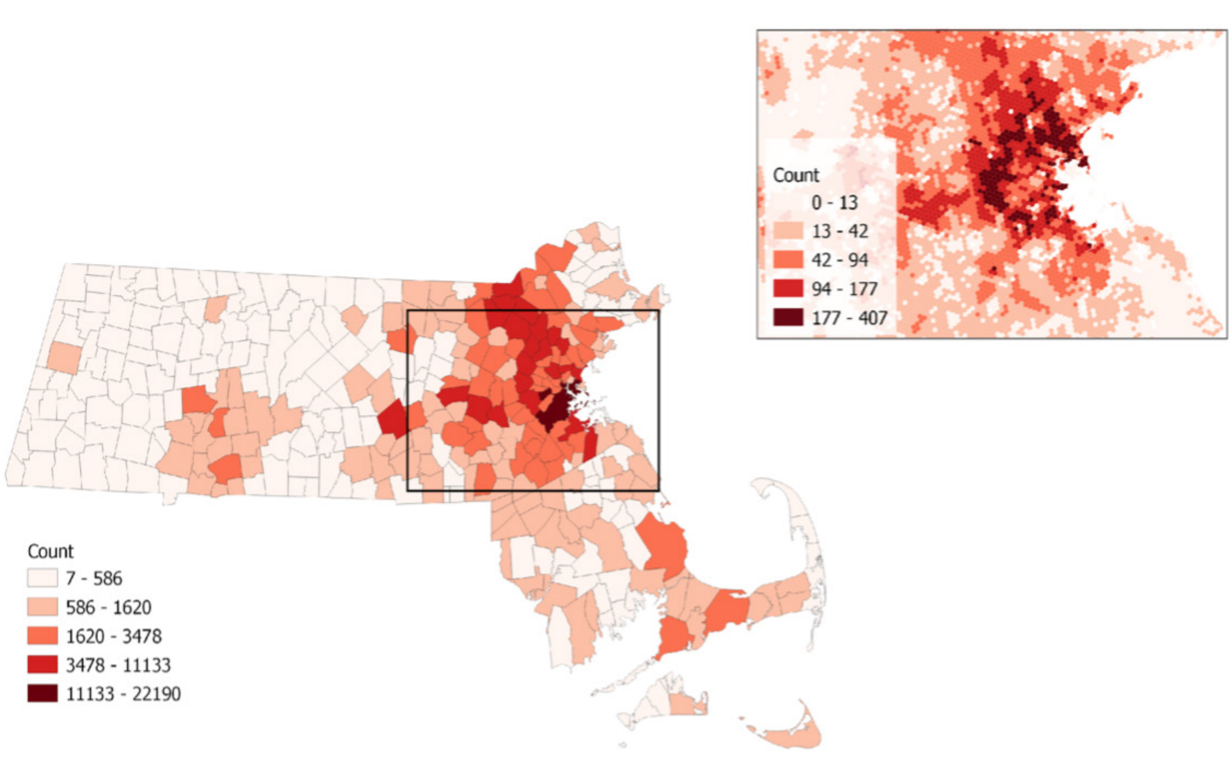
Figures 4.8–4.11 illustrate Synapse's findings on the distribution of Level 2 chargers for single-family, multi-family, workplace, and public charging based on forecasted 2030 demand. The National Renewable Energy Laboratory's EVI-Pro Lite model provides estimates of the number of EV chargers of different types needed to serve a fleet of a given size. The Synapse team has adopted this model's results for each class other than public charging (both Level 2 and DC fast chargers). For public charging, the team compared the models' results with real-world charger and EV numbers from 17 states. Averaging across those states, the team calculated that the observed ratio of EVs to chargers different noticeably from EVI-Pro Lite's results. EVI-Pro Lite suggests more public Level 2 charging and about 3 times fewer public DC fast chargers than generally observed in these states.

Note that there are reasonable arguments as to whether the higher or lower electric vehicle infrastructure results from these two methods will prove to be more accurate. Higher numbers of DC fast chargers, for example, would be required if later adopters of EVs are less likely to have home charging (e.g., they live in rentals or multi-family housing) or if per-EV miles driven increases as multi-vehicle households go electric. At the same time, there may be more workplace charging available in the future; today's relatively immature market requires extra chargers for customer confidence; future chargers may be faster; and/or vehicles may have larger range and therefore less of a need to charge "on the go."

9 Center for Sustainable Energy, "MOR-EV program statistics," Massachusetts Offers Rebates for Electric Vehicles, June 6, 2023. Accessed June 18, 2023, https://mor-ev.org/program-statistics.

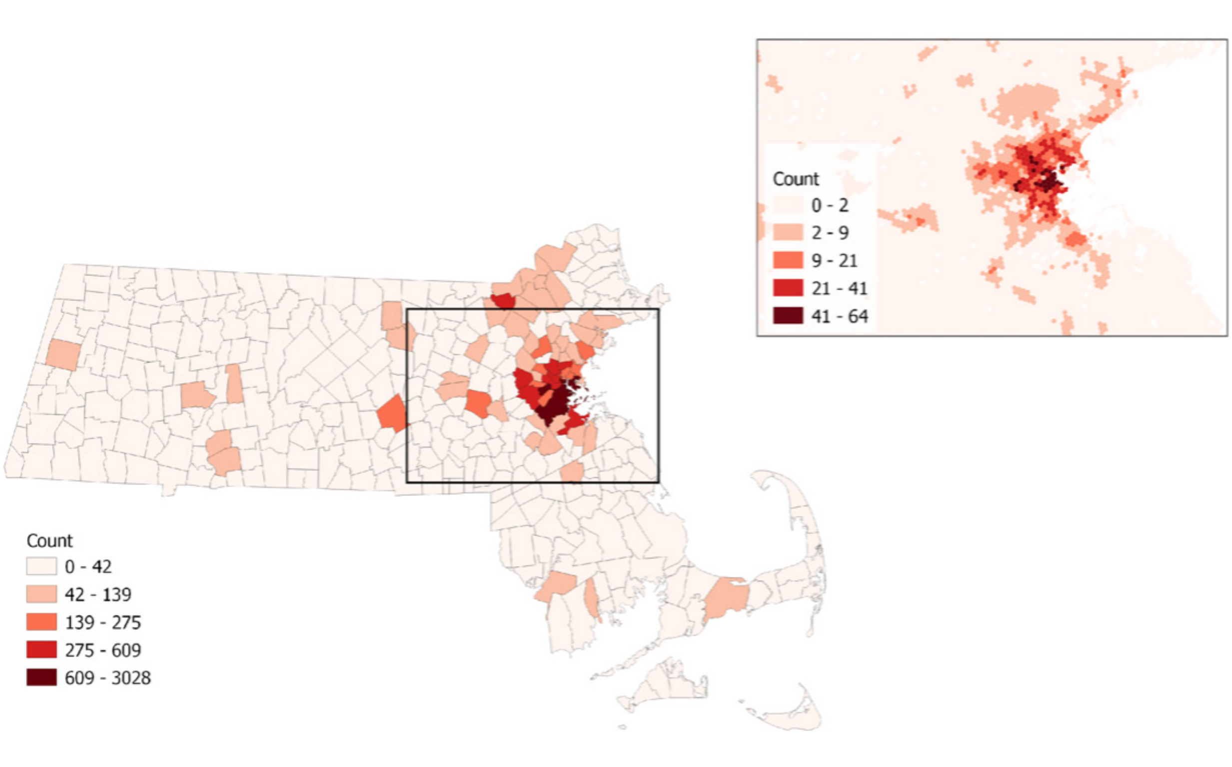
10 Massachusetts Vehicle Census, mass.gov. See https://geodot-homepage-massdot.hub.arcgis.com/pages/massvehiclecensus.

Figure 4.8 — Anticipated Level 2 single-family home charging in 2030



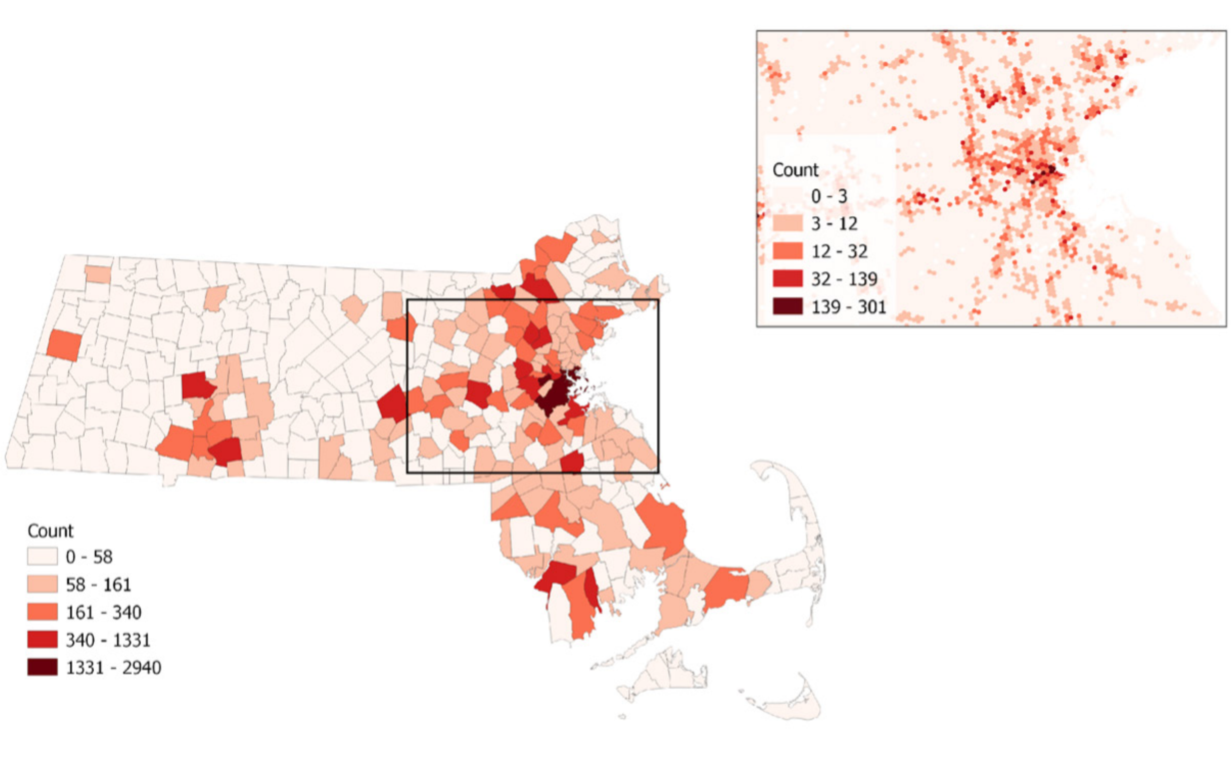
Source: Synapse, VisionEval

Figure 4.9 — Anticipated Level 2 multi-family home charging in 2030



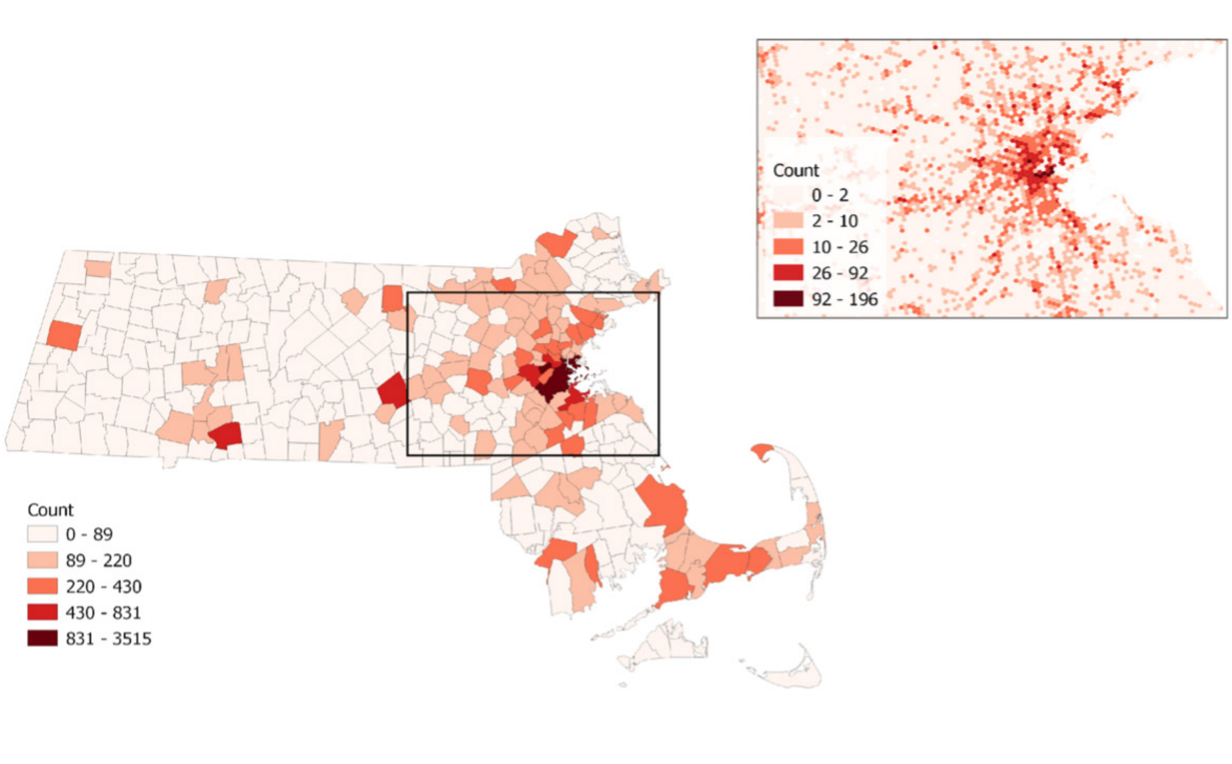
Source: Synapse, VisionEval

Figure 4.10 — Anticipated Level 2 workplace charging demand in 2030



Source: Synapse, VisionEval

Figure 4.11 — Anticipated Level 2 public charging demand in 2030



Source: Synapse, VisionEval

5. THE USER EXPERIENCE

Drivers face a range of challenges in making the transition to electric vehicles, with public charging accessibility and "range anxiety" being at the top of the list.

According to the Green Energy Consumers Alliance, which operates the Drive Green program, several concerns crop up among EV drivers:[1]

1. **There is a learning curve with EV charging**. Understanding the different charging levels and speeds, charging standards, and costs associated with where and how to charge can be hurdles for new EV drivers. These concerns fade quickly when users work out the logistics of home charging, unless they are confronting additional challenges of access (see Section 6: Improving Access).

2. **Finding the right public charger can be a challenge**. There are several competing brands and networks that drivers need to become familiar with to know how to find public chargers. This is made more challenging if drivers are not comfortable using smartphones.

3. **Locations often feel unsafe or unwelcoming.** Public EV charging can be located in areas with poor lighting without access to safe places to wait for a charge. Under the best of circumstances, EV charging stations are in well-lit, high-traffic areas, and are within easy or safe walking distances to food, shops, and/or bathrooms where a family could comfortably spend 40 minutes.

4. **Pricing at public stations is confusing**. Parking or charging could be free or have an hourly rate. Charging could be by the kilowatt hour. Pricing often varies by location, and there may be additional charges if a fully charged vehicle remains plugged in.

5. **Stations are unreliable**. Stations may be offline when a driver pulls up to charge. This is particularly frustrating when the station is a DC fast charger—e.g., when a user needs a 40-minute charge to get to a long-distance destination, as opposed to anywhere from a four- to 36-hour charge at a Level 2 charger. Contacting the helpline may solve the problem, but it may lead to longer wait times—and it's not always clear whose responsibility it is to fix a charging station.

6. **At-home charging rates lack strong incentives for off-peak charging**. Drivers would like rate transparency to schedule their charging times during off-peak hours and be rewarded for doing the right thing.

Maximizing uptime of EV charging stations

Uptime is the percentage of time that a charger is fully operational and able to deliver power as intended.[2] This metric measures the functionality of chargers and the success of charging. In February 2023, the U.S. Federal Highway Administration (FHWA) mandated that each charging port have an annual uptime of 97% or greater.[3]

Obstacles to maximizing uptime

There is currently a nationwide push to expand the number of chargers and charging stations, but there has yet to be a reliable or standardized method of calculating charging uptimes.[4]

EV chargers often require more maintenance and upkeep than gas stations.[5] The most common causes of non-functioning stations are network failures, broken connectors, unresponsive screens,

1 Vanderspek, Anna, "Massachusetts electric vehicle drivers' experience," a presentation given to EVICC on June 22, 2023. From https://www.mass.gov/info-details/electric-vehicle-infrastructure-coordinating-council-evicc. See Green Energy Consumer's Alliance at www.greenenergyconsumers.org for more information.

2 Northeast Corridor Steering Committee, "Northeast corridor regional strategy for electric vehicle charging infrastructure 2018–2021," Northeast States for Coordinated Air Use Management (NESCAUM), May 16, 2018. https://www.nescaum.org/documents/northeast-regional-charging-strategy-2018.pdf/view.

3 Federal Highway Administration, "Standards and requirements," 2023.

4 *Ibid.*

5 Mitchell Russ, "Public EV chargers: will they ever be as reliable as a gas pump?" *Los Angeles Times*, April 27, 2023.

Table 5.1 — The functional state of the 657 combined charging system (CCS) DC fast charging service equipment studied

State of EVSEs	Stations: Quantity	Stations: % of total
Functioning		
Charged for two minutes	375	57.1%
Occupied by EV and charging	101	15.4%
Total	476	72.5%
Not functioning		
Connector broken	6	0.9%
Blank or non-responsive screen	23	3.5%
Error message on screen	24	3.7%
Connection or network error	7	1.1%
Payment system failure	47	7.2%
Charge initiation failure	42	6.4%
Total	149	22.7%
Station design failure		
Cable would not reach (at three locations, the space was too small to back into safely)	32	4.9%

Source: David Rempel, et al., "Reliability of open public electric vehicle direct current fast chargers," SSRN Electronic Journal, April 7, 2022.
Note: an EVSE includes all the system components in a kiosk necessary to deliver a charge to a single connector.

and payment system failures.[6] Neglecting repairs, particularly broken cables and connectors, software failure, and physical damage, results in downtime for charging stations and inconvenience for EV owners. To counter this, one energy service company, Energy5, recommends that inspections should be conducted weekly or monthly, depending on the usage of the charging station.[7]

In 2019, the Northeast States for Coordinated Air Use Management (NESCAUM) published a report recommending that each publicly accessible DC fast charging station have a required uptime of 99% operational 24 hours per day, seven days a week.[8]

6 David Rempel et al., "Reliability of open public electric vehicle direct current fast chargers," SSRN Electronic Journal, April 7, 2022. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4077554.

7 Energy5, "Best practices for maintaining and repairing EV charging stations," April 5, 2023. https://energy5.com/best-practices-for-maintaining-and-repairing-ev-charging-stations.

8 Kathy Kinsey, Elaine O'Grady, and Jesse Way, "Building reliable EV charging networks: Model state grant and procurement contract provisions for public EV charging," Northeast States for Coordinated Air Use Management (NESCAUM), May 2019, https://www.nescaum.org/documents/model-contract-provisions-for-public-evse-5-24-19.pdf.

Table 5.2 — Functional state of EVSEs by the top three service providers

	ChargePoint		Electrify America		EVgo	
State of EVSEs	**Quantity**	**% of total**	**Quantity**	**% of total**	**Quantity**	**% of total**
Functioning						
Charged for two minutes	21	47.7%	228	60.2%	120	55.6%
Occupied by EV and charging	6	13.6%	52	13.7%	37	17.1%
Total	27	61.4%	280	73.9%	157	72.7%
Not functioning						
Connector broken	0	0.0%	2	0.5%	3	1.4%
Blank or non-responsive screen	4	9.1%	13	3.4%	5	2.3%
Error message on screen	4	9.1%	17	4.5%	3	1.4%
Connection or network error	0	0.0%	0	0.0%	6	2.8%
Payment system failure	3	6.8%	25	6.6%	16	7.4%
Charge initiation failure	5	11.4%	15	4.0%	22	10.2%
Total	16	36.4%	72	19.0%	55	25.5%
Station design failure						
Cable would not reach (at three locations, the space was too small to back into safely)	1	2.3%	27	7.1%	4	1.9%
TOTAL	44	100%	379	100%	216	100%

Source: David Rempel, et al., "Reliability of open public electric vehicle direct current fast chargers," SSRN Electronic Journal, April 7, 2022.

Recommended approach to improving EV charger uptime[9,10]

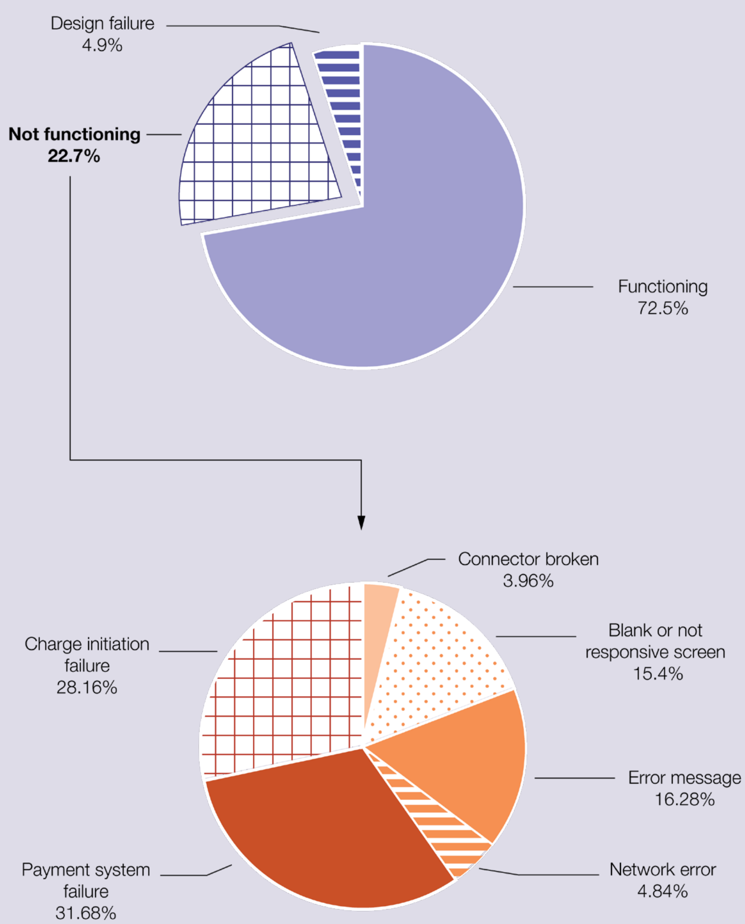
- Improve data collection and transparency to know when systems are and are not functioning properly
- Develop a shared definition of and methodology to calculate uptime
- Develop a better understanding of downtime (time when a station is not operational) and excluded time (time when power is out or something similar)
- Establish a minimum requirement for charging stations uptime
- Establish an easy way for consumers to call in service malfunctions or systems in need of repair

9 Kathy Kinsey, Elaine O'Grady, and Jesse Way, "Building reliable EV charging networks: Model state grant and procurement contract provisions for public EV charging," Northeast States for Coordinated Air Use Management (NESCAUM), May 2019. https://www.nescaum.org/documents/model-contract-provisions-for-public-evse-5-24-19.pdf.

10 NESCAUM, "Northeast corridor regional strategy," 2018.

Case study: San Francisco Bay Area charging uptimes

In 2022, researchers at the University of California Berkeley conducted a study to understand the uptime of charging stations in the San Francisco Bay Area. Of the 181 public DC fast charger stations studied, more than 22% of chargers were found to be nonfunctional when tested. Table 5.1 summarizes the functionality of the evaluated chargers, including the reasons why the charger was non-functioning. The study also analyzed the functionality of the stationary equipment by the top three service providers (see Table 5.2). When 10% of the EVSEs were reassessed following the first assessment, there was no change in functionality.



Sources: Fred Lambert, "Study finds more than a quarter of charging stations were nonfunctional," Electrek, June 16, 2022. https://electrek.co/2022/06/16/study-finds-more-than-fourth-charging-stations-were-non-functional/; and David Rempel et al., "Reliability of open public electric vehicle direct current fast chargers," SSRN Electronic Journal, April 7, 2022. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4077554.

- Identify a responsible party for maintaining and repairing stations and electric vehicle supply equipment
- Establish a schedule for operational and functional checkups, including for parts replacement and impacts from weather
- Communicate to consumers and EV drivers when a station is not working
- Document best practices for EV charging providers to improve uptime
- Keep a record of service outages and repair services
- Require that repairs are initiated within 24 hours of an incident report

Ensuring a smooth and predictable customer experience

The importance of maintenance

Consistent and reliable maintenance of EV charging stations is essential to a predictable customer experience. According to Energy5, the most common types of maintenance for EV charging stations include software updates, electricity and network costs, and repairs:[11]

- Software updates are essential to ensuring charging stations operate efficiently. Maintenance costs for Level 2 chargers can range from $50 to $500 per year depending on the manufacturer and type of charging station; costs for DC fast chargers tend to be higher.

- Electricity and internet connectivity are required for charging stations to operate. Electricity costs vary depending on location. Network costs can range from $20 to $100 per month.

- Charging stations can malfunction or break, requiring repairs. The cost of repairs can range from $100 to $1,000 depending on the severity of the problem; again, DC fast chargers tend to be more expensive than Level 2 chargers.

11 Energy5, "Maintaining and repairing," 2023.

As discussed in Section 5: Future Needs, conducting regular inspections means issues are identified quickly and corrective action can be taken before more significant problems arise. Per Energy5, the following should be checked during inspections:

- Electrical cables and connections
- Charge ports and cables
- Charging station software updates
- Physical damage or vandalism[12]

One option electric vehicle supply equipment owners have is to enter into a service agreement with the EV charging station manufacturer or a third-party service provider. These agreements typically include regular cleaning, repairs, and software updates for the charging stations. Costs range from $100 to $300 per station per year, which can vary depending on the agreed-upon level of support and type of charger.[13]

It's worth noting that the U.S. Department of Energy says the following about charging infrastructure maintenance:

> While actual maintenance costs vary, station owners should estimate average maintenance costs of up to $400 annually, per charger. Most networks also offer a maintenance plan for an additional annual fee. According to the California Energy Commission's Electric Vehicle Charger Selection Guide (PDF), annual extended warranties for DC fast chargers can cost over $800 per charger per year. Level 1 and Level 2 chargers may have a fixed-length warranty for a lower cost, but the owner is then responsible for repair costs after the term ends.[14]

EVICC standards and permitting recommendations

The EVICC's initial assessment is required to consider "strategies to maintain electric vehicle charging stations in full and continuous working order." The Division of Standards can contribute to the goal of ensuring that certain electric vehicle

12 *Ibid.*
13 *Ibid.*
14 Alternative Fuels Data Center, "Charging infrastructure operation and maintenance," U.S. Department of Energy. From https://afdc.energy.gov/fuels/electricity_infrastructure_maintenance_and_operation.html, accessed June 26, 2023.

charging stations are maintained in good working order (but not necessarily “full and continuous working order”) by inspecting and testing those EVSEs that provide electricity to electric vehicle owners for a fee. DOS’s inspection authority would not extend to privately installed EVSEs, nor to EVSEs that are open for public use but provide electricity to the user at no cost.

By way of background, DOS is one of the regulatory agencies that comprise the Office of Consumer Affairs and Business Regulation (OCABR), itself a division of the Executive Office of Economic Development. DOS is required by G.L. c. 98, s. 29 to enforce the Commonwealth’s weights and measures laws, which includes the testing of weighing or measuring devices that indicate or register “the price as well as the weight or measure of a commodity offered for sale. . . .” G.L. c. 98, s. 1. Since electricity meets the statute’s definition of commodity, DOS has the existing statutory authority and responsibility to test EVSEs which sell electricity. This testing must be performed in accordance with guidelines issued by the National Institute of Standards and Technology (NIST), a division of the U.S. Department of Commerce. Standards applicable to EVSE testing became effective as of January 1, 2023.

At present, DOS has not developed or implemented a program to inspect public EVSEs that sell electricity to electric vehicle owners. Several steps will be required to ensure that DOS’s EVSE testing, when implemented, reaches all covered devices and that such testing is performed consistently across the Commonwealth:

- Currently, DOS shares device testing responsibilities with municipal sealers: DOS itself conducts device testing in fewer than half of the Commonwealth’s cities and towns, with the remaining municipalities conducting their own device testing. Because EVSE testing requires specialized equipment and training, we recommend that EVSE testing be centralized in DOS for all EVSEs in the Commonwealth. This will ensure consistent and efficient EVSE testing across the Commonwealth.

- Massachusetts does not currently require device owners to register their devices with the Commonwealth. To ensure inspections of devices occur, a database of devices is necessary. We recommend legislation requiring device registration, enabling the creation of a DOS database and authorizing DOS to fine violators.

- A comprehensive EVSE testing program will require funding for testing equipment and staff. We recommend the establishment of an EVSE registration fee, and a DOS-retained revenue account that will be used to fund, wholly or in part, EVSE testing.

Finally, in addition to EVSE testing, there are a variety of other consumer protections that should be applied to EVSEs, including, but not limited to:

1. Signage and price disclosure requirements
2. Protections against price gouging/surge pricing
3. Standardized EVSE connection equipment and accessibility requirements
4. Limiting the sale of consumers’ data collected through EVSE owners’ apps
5. Location safety requirements

SECTION

6. IMPROVING ACCESS

The widespread adoption of electric vehicles greatly depends on ensuring convenient access to charging facilities for all residents.

When charging stations are easily accessible and reliable, drivers can confidently plan their trips relying on the charging network. Conversely, limited or difficult access to charging stations may strongly deter drivers from transitioning to EVs.

Providing access to charging infrastructure for all residents, regardless of income level, housing type, or geographic location, ensures inclusivity in the transition to EVs. Ensuring universal access to EV charging promotes equity, facilitates EV adoption, and reduces barriers to entry. This is a crucial element to be successful in advancing a sustainable transportation system and achieving environmental goals, such as improving air quality and reducing greenhouse gas emissions. Additionally, this approach will prevent the emergence of an "EV divide," where only certain residents can afford and use EVs.

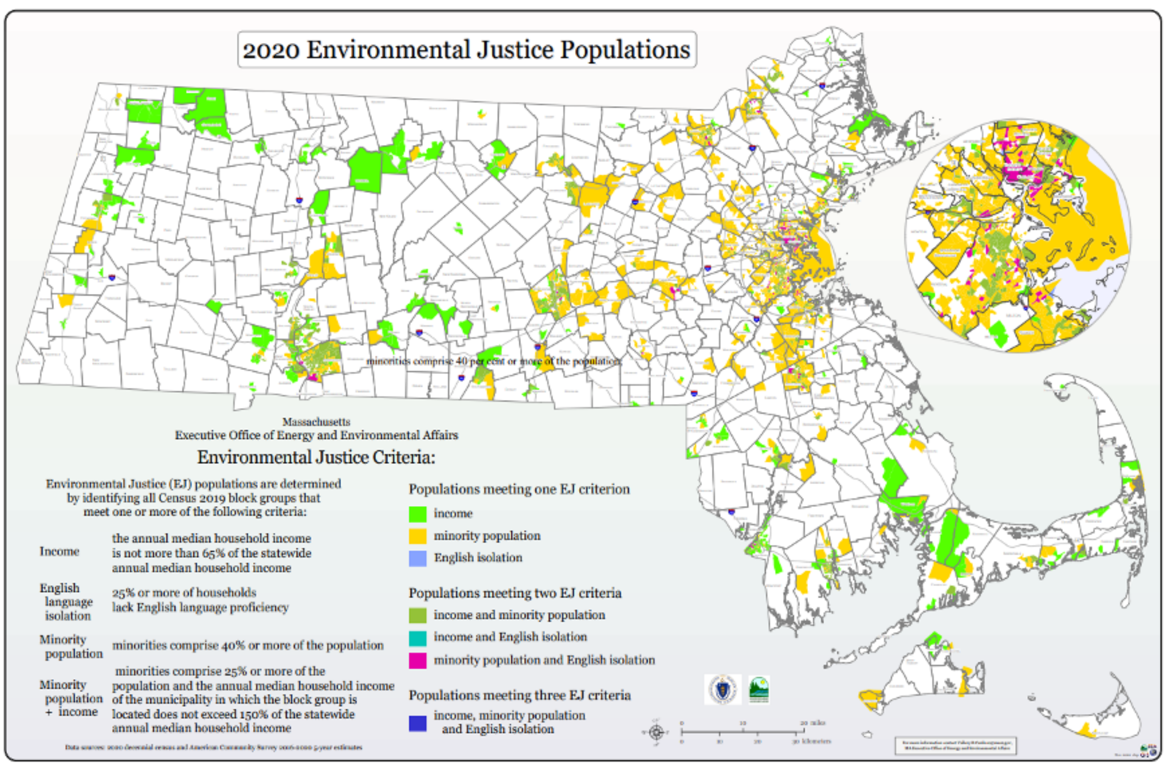
A Fuels Institute Electric Vehicle Council report found that the top demographic of EV owners in 2019 were middle-aged white men with a college degree or higher, earning more than $100,000 annually, and had at least one other vehicle in their household.[1]

Environmental justice populations need public EV charging infrastructure, particularly as economic opportunities for low-income communities can be hindered without reliable transportation. In Massachusetts, more than 3.4 million individuals live in environmental justice census block groups.[2] A map of these areas is shown in Figure 6.1.

1 Fuels Institute Electric Vehicle Council, "EV consumer behavior," Transportation Energy, June 2021. From https://www.transportationenergy.org/wp-content/uploads/2022/11/21FI_-EVC_ConsumerBehaviorReport_V07-FINAL.pdf, accessed June 18, 2023.

2 "2020 environmental justice populations," Mass.gov, November 2020. https://s3.us-east-1.amazonaws.com/download.massgis.digital.mass.gov/shapefiles/census2020/EJ%202020%20updated%20municipal%20statistics%20Nov%202022.pdf.

Figure 6.1. — Environmental justice populations in Massachusetts



Source: Executive Office of Energy and Environmental Affairs
Note that 2022 updates are reflected in an interactive map available at https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212

Environmental justice populations

As EV charging infrastructure develops and cars become more affordable, the population of users will diversify. EVNoire, the nation's largest network of diverse electric vehicle drivers and enthusiasts, is the voice of multicultural EV drivers and the country's first multicultural organization focused on e-mobility, environmental, energy, and transportation equity.

According to EVNoire, the transition to clean transportation will have positive public health, financial, and workforce impacts on environmental justice populations that have historically been disproportionately affected by the negative effects of climate change.[3] EVNoire gathered data in partnership with Consumer Reports, GreenLatinos, and the Union of Concerned Scientists on demand for electric vehicles among populations of color, which found that 52% of Asian, 43% of Latino, 38% of Black, 33% of White Americans would "definitely" or "seriously consider" purchasing or leasing an electric vehicle as their next purchase (see Figure 6.2).[4]

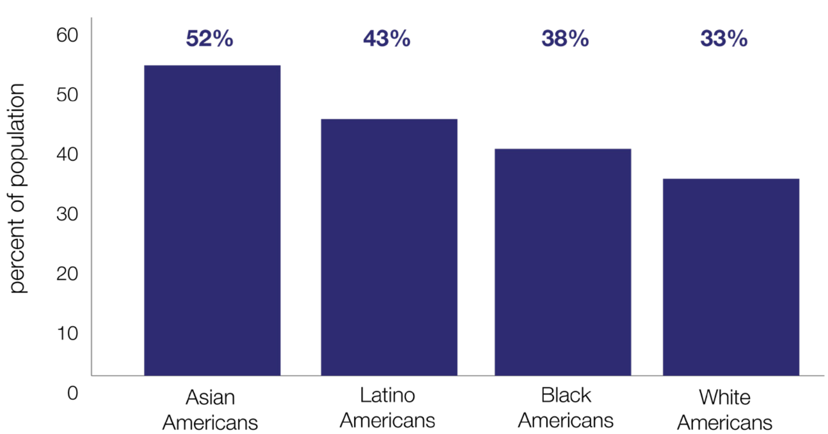
3 See EVICC meeting notes from July 27, 2023.
4 Quinta Warren, "Across racial demographics, interest in purchasing electric vehicles is considerable, but barriers persist," press release from Consumer Reports, EVNoire, GreenLatinos, and the Union of Concerned Scientists. From https://advocacy.consumerreports.org/press_release/across-racial-demographics-interest-in-purchasing-electric-vehicles-is-considerable-but-systemic-barriers-persist/, accessed July 28, 2023.

EVNoire offers the following policy recommendations to improve EV charging access for communities of color:

- Provide benefits to overburdened communities first. Ensure they exceed Justice40 commitments.
- Provide significant incentives for the development of robust networks of charging infrastructure for medium- and heavy-duty vehicles.
- Use available mapping tools to identify overburdened and underserved communities of color.

Source: EVNoire
Note: Justice40 is a federal goal of ensuring that 40 percent of the overall benefits of certain federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution. Justice40 communities are defined differently than environmental justice populations. See https://screeningtool.geoplatform.gov/en/methodology#3/33.47/-97.5 and https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212.

Figure 6.2. — Demographic interest in electric vehicle purchases



Source: Consumer Reports, EVNoire, GreenLatinos, and the Union of Concerned Scientists

As with low- and moderate-income communities, environmental justice (EJ) populations also often bear a disproportionate burden of environmental pollution, including higher levels of air pollution from internal combustion engine vehicles.[5] Strategies to improve charging access for EJ populations include:

1. Develop equitable payment options for eligible users

   There are multiple approaches to develop affordable charging options for eligible users, including those unbanked or underbanked. One possible option includes enabling residents enrolled in Supplemental Nutrition Assistance Program (SNAP) benefits to be eligible for reduced-cost access to charging infrastructure, similar to Metro Boston's Bluebikes program. Another option is to establish a reloadable debit card system for eligible EV users, similar to the Universal ZEV Equity Charging Card demonstration project launched by Valley Clean Air Now (Valley CAN) and the State of California. Locating reduced charging infrastructure in business districts of environmental justice populations to provide access to EV charging and attract outside EV drivers to the business districts should also be considered. That said, because EVs have not yet reached price parity with gas-powered cars and there is not yet a robust market for used EVs, residents of Massachusetts enrolled in SNAP are unlikely to be able to afford an EV at this time.

2. Convey charging station locations using various methods

   Ensure information about accessing charging station locations is conveyed through different means, including physical signage and online platforms (e.g., websites and apps), and in multiple languages. Using multiple methods of communication addresses potential challenges related to digital equity.

   According to 2020 U.S. Census data, 23.9% of all households in Massachusetts reported speaking a non-English language at home as their primary shared language—higher than the national average of 21.5%.[6]

Table 6.1. — Percent of languages other than English spoken at home in Massachusetts

Language	Percent households
Spanish	9.11%
Portuguese	2.95%
Chinese (incl. Mandarin, Cantonese)	2.15%
French (incl. Cajun)	1.37%
Vietnamese	0.79%
Russian	0.65%
Arabic	0.59%
Hindi	0.53%
Italian	0.45%
Other Indo-European languages	0.45%

Source: U.S. Census, American Community Survey, 2020 data.

3. Foster community engagement through outreach and education

   To ensure the success of the strategies mentioned above, it is essential to foster strong community engagement through targeted outreach and educational campaigns. These efforts should aim to raise awareness about the numerous advantages of EVs, how charging stations operate and align with public parking regulations, and available incentives. Promoting EV car sharing should also be part of the educational focus. Outreach and education should be conducted in multiple languages and tailored to the specific demographics of each community.

5 Massachusetts Executive Office of Energy and Environmental Affairs, "Environmental Justice Populations in Massachusetts," Mass.gov. https://www.mass.gov/info-details/environmental-justice-populations-in-massachusetts.

6 U.S. Census, American Community Survey, 2020 data. From https://www.census.gov/programs-surveys/acs/, accessed July 28, 2023.

It is important to involve residents and other stakeholders such as community business organizations in the decision-making process to determine suitable locations for EV charging infrastructure. A successful example is the City of Cambridge, which has effectively utilized a public input map tool to determine the placement of EV charging stations.

The goal is to empower residents by providing them with comprehensive knowledge, resources, and support to facilitate the widespread adoption and integration of EVs into their daily lives. Collectively, these strategies will promote the widespread adoption of EVs and contribute to the development of a sustainable, inclusive, and accessible transportation ecosystem.

Multi-unit dwellings

More than 80% of EV drivers primarily charge their vehicles at home.[7] People living in single-family homes with dedicated parking (e.g., driveways or garages) will mostly charge overnight at their place of residence; however, for many individuals who live in other multi-unit dwellings without accessible charging options, finding suitable and convenient charging locations becomes more challenging. These residents, often referred to as "garage orphans," will frequently park on-street or curbside.

Garage orphans

Drivers that occupy residences without the electrical capacity for chargers or access to a driveway or garage.

The following recommended strategies identify educational initiatives, legislative options, and new technologies, all of which can improve access to EV charging for residents in multi-unit dwellings.

1. **Place charging infrastructure in residential areas with a high concentration of overnight curbside parking**

   As managers of the right-of-way, municipalities and state agencies can strategically install Level 1 and Level 2 charging stations curbside. This approach enables residents of multi-unit dwellings without off-street parking to access charging facilities. Moreover, the visibility of curbside charging stations contributes to increased local EV adoption. Curbside charging can be installed on sidewalks or integrated into existing infrastructure such as streetlights, utility poles, or parking meters. Case studies include Melrose, MA's, Pole-Mounted Pilot Program, Cambridge, MA's Planning for Curbside EV Charging, and New York City's Curbside Charging Pilot Program.[8,]

2. **Encourage municipalities to allow residents and building owners to charge across and under sidewalks**

   This strategy is intended to support residents who drive EVs and do not have access to reliable off-street charging options (e.g., driveways, off-street parking lots, or parking garages), but are allowed to park overnight on the street in front of their residence. After obtaining a permit, and required power cords and ADA-compliant ramps are installed, residents could charge their EVs across the sidewalk in front of their residential properties at existing EV charging stations. The City of Cambridge's Across Sidewalk EV Charging Permit is an example of this approach.[9]

   Another approach to curbside EV charging involves installing a charging post directly into the curb. This design allows EV drivers to charge at the curb without the need to extend a cable across the sidewalk. The curbside charger operates with a detachable cord, ensuring that no cables are left on the street when the charger is not in use. The chargers are powered by utilizing electricity from adjacent buildings by running conduit under the sidewalk. Through this

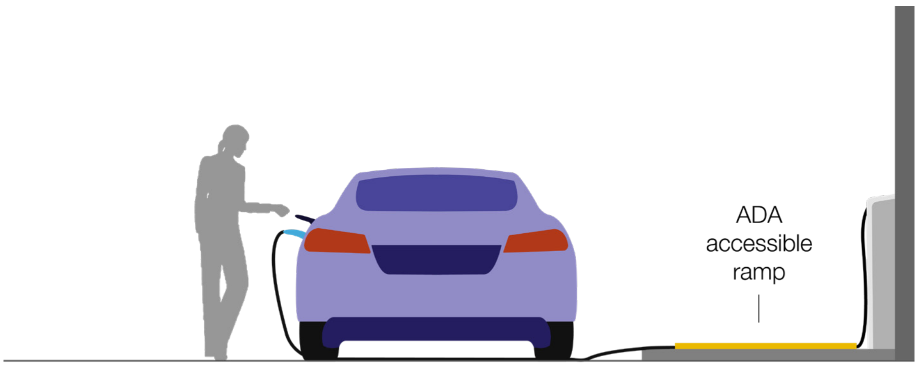
7 U.S. Department of Transportation, "Charging Forward: A Toolkit for Planning and Funding Urban Mobility Infrastructure," Transportation.gov, p. 13, June 2023. https://www.transportation.gov/urban-e-mobility-toolkit/pdf.

8 See https://tinyurl.com/melrose-public-charging and https://www.nyc.gov/html/dot/downloads/pdf/curbside-level-2-charging-pilot-evaluation-report.pdf.

9 See https://cambridgema.viewpointcloud.com/categories/1101/record-types/6871.

model, the EVSE owner pays for the electricity, installation, and maintenance of the EVSE, the EV user pays to charge, and the building owner receives a percentage of what the EV user pays to charge.

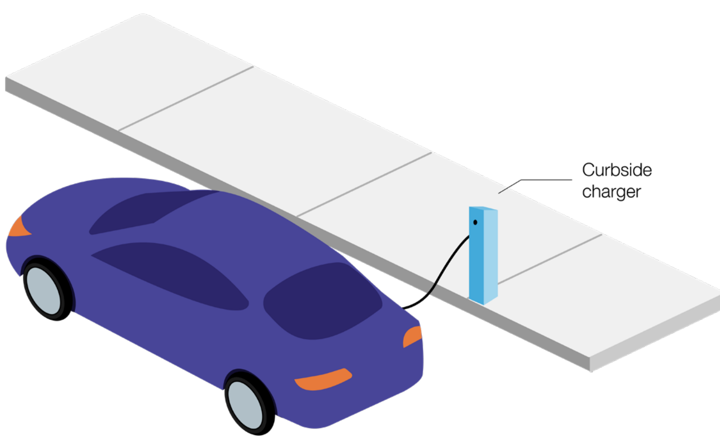
Illustration 6.1. — ADA-compliant ramp for sidewalk charging



Source: GreenerU

This model reduces the need for significant underground trenching, unlike traditional EV stations. Additionally, this model offers a benefit to building owners (e.g., multi-unit dwelling, house, school, house of worship) by providing them with a share of the revenue generated. EV drivers also benefit from this setup as they can charge their vehicles conveniently close to their place of residence. Kerb-e and itselectric are examples of companies that provide this turnkey service that includes installation, management, and maintenance.[10]

Illustration 6.2. — Sidewalk charging



Source: GreenerU

It is important to note that this strategy does not grant residents a designated parking space and residents must follow all parking regulations.

By prioritizing areas where street parking is prevalent, residents without access to off-street parking (e.g., garages or parking lots) can have charging options available nearby. Additionally, it is important to consider the placement of DC fast chargers in proximity to locations with curbside parking. This provides an alternative for EV drivers who might require a quicker charge and/or shared charging arrangements.

3. **Educate and incentivize landlords/property owners to install charging infrastructure**

The Commonwealth can communicate and collaborate with landlords and property owners to promote the installation of EV charging infrastructure in multi-unit dwellings and provide resources to facilitate the process of installing EV charging stations. Developing funding programs that further incentivize the installation of EV charging infrastructure at affordable housing sites such as Vermont's Multi-unit Dwelling Electric Vehicle Charging Grant Program should be considered.[11]

4. **Educate tenants about public charging options to encourage their use**

Educate tenants about nearby public charging infrastructure and encourage their use if they do not have access to dedicated charging facilities (e.g., in off-street parking locations) at their place of residence.

5. **Enact "right to charge" legislation**

"Right to charge" refers to laws or regulations that guarantee residents the legal right to install and use EV charging infrastructure, especially

10 See https://www.kerb-e.com/ and https://www.itselectric.us/

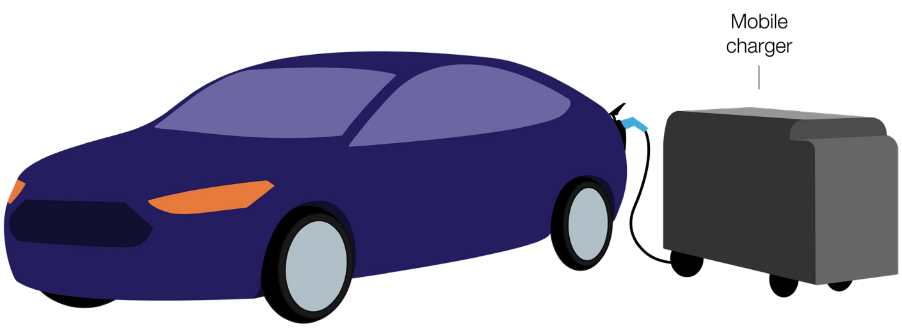
11 See https://accd.vermont.gov/multiunit_dwelling

in multi-unit dwellings or rental properties. California, Colorado, Florida, Hawaii, Illinois, Maryland, New Jersey, New York, Oregon and Virginia have all enacted right-to-charge laws designed to advance residential charging deployment.[12, 13] While "right to charge" ordinances have been adopted in the Cities of Boston and Cambridge, no statewide legislation has been enacted in Massachusetts.[14]

6. **Promote on-demand electric vehicle charging**

   On-demand electric vehicle charging enables EV drivers to charge their vehicles using a portable or mobile charging system. By bringing charging to the EV, drivers can charge their cars in areas where EV charging infrastructure is limited or non-existent, providing a convenient alternative. On-demand electric charging is especially beneficial for residents living in multi-unit dwellings without access to dedicated charging stations. SparkCharge and Freewire's Mobi EV Charger are examples of companies that provide on-demand charging services.[15]

Illustration 6.3. — On-demand charging



Source: GreenerU

Rural communities

Improving access to EV charging in rural areas can be challenging due to low population density and limited existing infrastructure. On average, rural drivers travel more miles than urban drivers and transportation costs are higher for individuals in outlying parts of New England.[16] According to Vermont Energy Investment Corporation (VEIC), improving access to EV charging to rural areas will take upfront market research, campaigns that include rural area coverage, and EV dealer engagement and training, among other strategies elaborated on in this section.[17]

Low- and moderate-income communities

Low- and moderate-income communities frequently bear a disproportionate burden of environmental pollution, including higher levels of air pollution from conventional vehicles.[18] Improving access to EV charging infrastructure in low- and moderate-income communities will foster environmental and economic benefits for all residents. Recommended strategies to improve charging access in these communities include:

1. **Prioritize access to charging infrastructure in low- and moderate-income areas**

   It is essential to prioritize the deployment of EV charging infrastructure in low- and moderate-income areas, where there are often higher levels of pollution and limited accessibility to clean transportation options. The Commonwealth can achieve more equitable access by directing resources and investments among these communities.

12 Eleftheria Kontou, "Right-to-charge laws bring the promise of EVs to apartments, condos, and rentals," Fast Company, July 2023. https://www.fastcompany.com/90917445/right-to-charge-laws-bring-the-promise-of-evs-to-apartments-condos-and-rentals.

13 See https://pluginsites.org/legislation-reference-recharging-equipment-at-multi-unit-housing/.

14 See https://malegislature.gov/Laws/SessionLaws/Acts/2018/Chapter370 and https://lawmtm.com/right-to-charge-bill-for-the-city-of-cambridge.pdf

15 See https://www.jdpower.com/cars/shopping-guides/portable-charging-solutions-for-evs; https://www.sparkcharge.io; and https://freewiretech.com/products/mobi-ev/

16 See https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles

17 Massachusetts Electric Vehicle Infrastructure Coordinating Council meeting minutes, July 27, 2023, available at https://www.mass.gov/info-details/electric-vehicle-infrastructure-coordinating-council-evicc.

18 U.S. Department of Transportation, "Charging Forward: A Toolkit for Planning and Funding Urban Mobility Infrastructure," Transportation.gov, p. 70, June 2023. https://www.transportation.gov/urban-e-mobility-toolkit/pdf.

2. **Coordinate charging with EV car-sharing programs**

   EV car-sharing programs enable residents who may not own a vehicle to use one when needed to access jobs, go shopping, attend school, or go to doctor's appointments. Coordinating charging with EV car-sharing programs will enable households to become car-free or reduce their reliance on private cars. This is particularly important for affordable housing development sites, as it grants low-income residents access to personal transportation at affordable costs.

Based in Boston, Good2Go is an equity-focused, all-electric car-sharing program and offers reduced rates to income-eligible members.[19] This nonprofit's mission is to expand access to clean transportation and provide support to communities disproportionately affected by climate change and pollution. Additionally, as part of the White House EV Acceleration Challenge, Zipcar has committed to dedicating 25% of its EV fleet to empower underserved communities.[20]

Vehicles for hire

According to the Clean Energy and Climate Plan for 2025 and 2030, vehicles for hire, such as transportation network companies like Uber and Lyft, represent a unique opportunity to accelerate EV adoption.[21] The cars that are driven in ride-hailing, car sharing, and taxi fleets are high-mileage, public-facing, and are more likely to be driven by low-income residents and residents of color, many of which live in environmental justice communities. According to Uber, more than half of their drivers are from underserved and/or low-income communities; and according to Lyft, in Massachusetts, 56% of rides start or end in low-income areas.[22] Electrification of vehicles for hire is an opportunity to increase utilization of charging infrastructure in communities with low-income and environmental justice populations, paving the way for broader adoption. It is imperative that vehicles for hire have access to EV charging infrastructure, chargers, and EVs.

There is a strong correlation between the municipalities in which transportation network company drivers reside and those in which the majority of pickups and drop-offs occur (See Table 6.2). As such, these municipalities should be considered higher priority locations for EV charging infrastructure deployment. These higher priority EV infrastructure locations, coupled with incentive programs targeted to help transportation network company drivers purchase or lease an EV, will contribute to meeting the goals in the Clean Energy and Climate Plan for 2025 and 2030.

Table 6.2. — Transportation network company platform usages in Massachusetts municipalities

Top municipalities in which transportation network company drivers reside	Top municipalities for pickups and drop-offs from transportation network company trips
Boston	Boston
Lawrence	Cambridge
Lynn	Brockton
Brockton	Brookline
Malden	Worcester
Quincy	Everett
Revere	Quincy
Worcester	Malden
Everett	Revere
Lowell	Lynn
	Lowell
	Medford
	Chelsea

Source: Transportation Network Company 2022 Rideshare Data Report

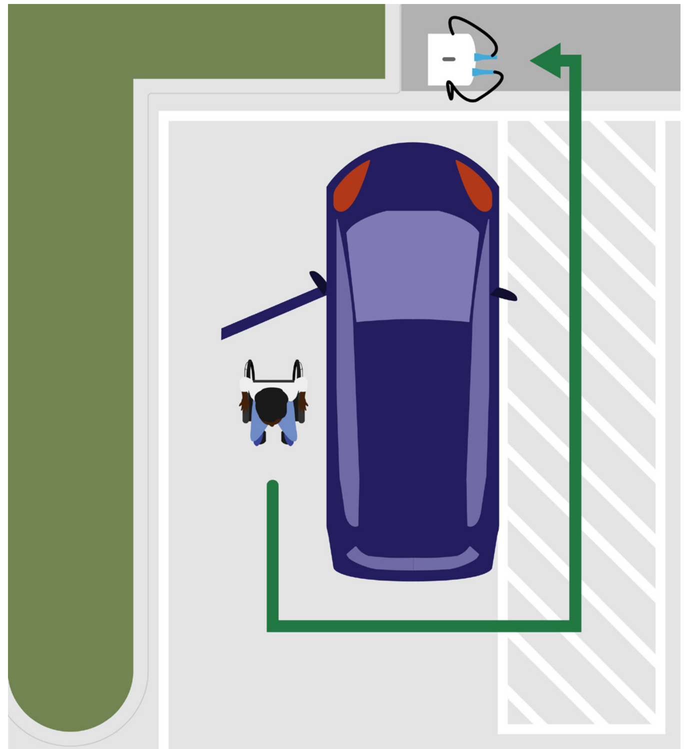
19 See https://evgood2go.org/about/.
20 See https://www.zipcar.com/press/news/ev-white-house-challenge.
21 Massachusetts Clean Energy and Climate Plan for 2025 and 2030
22 Massachusetts Ride for Hire Working Group, Metropolitan Area Planning Council for the Executive Office of Energy and Environmental Affairs, "Final policy brief," May 2021. From https://www.mapc.org/wp-content/uploads/2021/06/RFH_EV_WG_Recommendations-Policy-Brief-1.pdf, accessed August 7, 2023.

Accessibility requirements for EV charging stations

The MassEVIP Public Access Charging program requires that EV charging stations are handicapped accessible.[23] At least 5% of the site's EV charging spaces, but not less than one such space, must be accessible to persons with disabilities. For example, a parking facility with up to 20 EV charging spaces requires at least one accessible EV charging space and a parking facility with 21 to 40 EV charging spaces requires at least two accessible EV charging spaces. Additional guidance is as follows:

- Accessible EV charging spaces can share an access aisle with new or existing accessible parking spaces
- Accessible EV charging spaces may be used by any employees and must not be reserved for employees with disabilities; therefore, spaces should not have markings or signage restricting the space to ADA accessibility only
- There should be ample ground space to accommodate wheelchair users
- There should also be ample space to maneuver around and between bollards
- Avoid installing EVSE on top of curbs where people using wheelchairs would have limited access
- The recommended size for an accessible parking spot is 11 feet wide and 20 feet long; the adjoining access aisles should be at least five feet wide[24]

Illustration 6.4. — Accessible EV charging considerations



Source: GreenerU

23 Massachusetts Department of Environmental Protection, "MassEVIP public access charging (PAC) program requirements," April 6, 2023. https://www.mass.gov/doc/massevip-public-access-charging-requirements/download.

24 U.S. Access Board, "Design recommendations for accessible electric vehicle charging stations," July 17, 2023. https://www.access-board.gov/tad/ev/.

Coordinating public procurement of EVSE goods and services

As Massachusetts moves forward with the implementation of EVSEs, there is an opportunity to coordinate state and municipal procurement processes. Many state, regional, and local entities, such as the Operational Services Division (OSD), the Division of Energy Resources (DOER), the Executive Office of Energy and Environmental Affairs (EEA), the Department of Environmental Protection (DEP), the Department of Capital Asset Management and Maintenance (DCAMM), the Massachusetts Clean Energy Center (MassCEC), the Department of Transportation (MassDOT), the MBTA, and cities and towns are overseeing the procurement of EVSE and/or are directly procuring EVSE.

Municipal procurement is overseen for compliance by the Massachusetts Office of the Inspector General. Procurement of EVSEs using federal grants is overseen by the individual federal funders and guided by federal procurement obligations. Further, installation of EVSEs must comply with state construction statutory obligations, which are reviewed for compliance by the Massachusetts Office of the Attorney General. Lastly, government organizations and political subdivisions can coordinate renewable energy purchasing through power purchase agreements (PPAs).

This plethora of procurement statutes discourages coordination and communication among the oversight organizations, as well as missed opportunities to leverage economies of scale across multiple government entities to secure lower costs. The EVICC can convene the different government oversight organizations to facilitate shared thinking, coordination, and clarity around state, municipal, and federal procurement processes.

Table 6.3. — Procurement statutes relevant to EVSE purchasing

Operational Services Division (OSD)	M.G.L. c.7, §4A
Division of Energy Resources (DOER)	M.G.L. c.25A
Division of Capital Asset Management and Maintenance	M.G.L c.25A & M.G.L. c.149
Municipal Procurement	M.G.L. c.30B
Federal Procurement Regulations	2 CFR 200
State Construction Statutes	M.G.L. c. 30, §39M, M.G.L. c. 149
Group Purchasing/Power Purchase Agreements (PPAs)	M.G.L. c. 164, §137

Source: Commonwealth of Massachusetts

SECTION

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Massachusetts's path to economy-wide decarbonization relies on an expanded role for the power system.

Most future electricity load growth will come from new sources of electricity demand, including transportation electrification from EVs. Increased EV charging, especially from DC fast chargers, fleets and chargers clustered on feeders with limited capacity, may lead to the need for distribution and transmission (T&D) upgrades. There are various programs and/or technologies that have the potential to avoid or reduce T&D upgrades and associated costs. The following are a few examples:

- **EV TOU/TVR rates.** Time-based pricing for EV charging can encourage EV customers to charge during off-peak hours and potentially reduce peak demand.
- **Managed charging.** Managed charging programs such as off-peak charging rebates and EV demand response programs are similar to EV TOU/TVR rates in terms of encouraging customers to charge EVs at appropriate times.
- **Storage and/or distributed generation paired with charging stations.** For large EV charging load, pairing the charger with storage and/or distributed generation such as solar can potentially balance the EV charging load, minimize charging needs at peak times, and provide grid services.
- **Energy management system.** Pairing energy management systems with EV chargers, when appropriate, can help EV customers optimize their EV charging schedule and reduce the stress on the distribution system.
- **Vehicle to grid.** While the vehicle-to-grid technologies are relatively new, they have the potential to provide grid services, if the charging and discharging are optimally managed, that could help reduce the need for T&D upgrades.

This section introduces the distribution and transmission infrastructure considerations as the Commonwealth electrifies transportation and sees more electric load from electric vehicles. It provides an overview of impacts to the grid due to increasing numbers of electric vehicles, key challenges, current efforts, and concludes with ways to mitigate new electricity demand on the grid.

Policies for the power sector account for this increased electric load and recognize the need for additional grid infrastructure, particularly local electric distribution system enhancements. The extent of the required additional infrastructure and associated investments will be location-specific and will depend on when Massachusetts residents and businesses charge their EVs. Equipping the electric distribution system to be able to monitor and control power flows based on changes in load and generation will help keep distribution flexible, reduce overall system costs, and integrate renewable energy.

This section introduces the distribution and transmission infrastructure considerations as the Commonwealth electrifies transportation and sees more electric load from electric vehicles. It provides an overview of impacts to the grid due to increasing numbers of electric vehicles, key challenges, and concludes with current efforts to manage grid needs.

Transmission and distribution infrastructure considerations

As detailed in Section 5: Future Needs, Synapse et al. conducted a study for the Commonwealth and estimated that 78,000 publicly available EV charging ports would be required by 2030. While all of this charging infrastructure will never be fully in use at the same time, based on this number of ports, more than 1,400 MW in peak demand from electric vehicle charging by 2030, however, with effective managed charging programs, the actual average load from EV charging was modeled to be between 630 and 700 MW. If cars are charged immediately when plugged in at homes and workplaces, it could add about 1,200 MW to summertime peak demand (about 10% of current day peak demand). If charging is shifted to primarily happen overnight, average load during peak times is projected to be 470 MW.

These new loads will increase overall dependence on the electricity system, requiring accelerated investment in expanded generation, transmission, and distribution infrastructure. Electric utilities, the Independent System Operator of New England

(ISO-NE), and regulatory agencies will need to adapt load forecasting and system planning practices to respond to accelerated load growth.

In November 2022, National Grid et al. published a study that evaluated fast-charging needs for 71 highway sites through the year 2045. Among their findings was that many fast-charging sites will eventually connect to the high-voltage transmission grid for power, and that some sites could "require as much electricity as a small town."[1] Their findings indicated that transmission "energy highways" often parallel actual highways, and thus charger deployment (particularly larger deployments of fast chargers) can likely be coordinated with grid upgrades.

In 2021, National Grid and Hitachi Energy published a study of the impacts of fleet electrification on the grid.[2] Among their findings was that of the 19 distribution feeders studied, more than 68% of them (13) could eventually need to be upgraded when nearby fleets are fully electrified. One feeder would see an increase to more than three times its rated load from serving fully electric heavy-duty fleets. Impacts would be felt at the substation level, with one substation seeing a 60% increase in peak load from full fleet electrification and an additional 20% load increase from full residential and public fueling electrification.

There are several ways to manage the grid as new electric vehicles increasing electric demand. These are briefly discussed below.

Managed charging and EV load flexibility

As the number of EVs on the road increases, managing electric vehicle charging will be a growing priority for the Commonwealth, its agencies and departments, and the utilities and municipal light plants. EVs will increase demand on the electricity grid. If most people charge their EVs during hours of peak electricity demand, this additional load could over-stress the grid and require additional grid investments that can be avoided with the right strategies addressed through non-wire alternatives.

Technologies and policies including demand-side management, increased substation capacity, and educating customers on the best times to charge their vehicles will ease the integration of EVs onto the electric grid. If EVs mostly charge during times of low grid utilization, they can help maximize the use of grid resources and produce significant cost savings for consumers. The deployment of vehicle-to-grid or vehicle-to-building technologies that allow EVs to act as grid storage could enhance the benefits of EVs. The Commonwealth will need proactive management of EV charging to maximize the benefits of EV adoption and minimize the costs to all consumers.

A 2016 analysis conducted by M.J. Bradley and Associates demonstrates that the potential savings for Massachusetts ratepayers from smart charging are considerable, in the range of $500 million through 2050.[3] The deployment of bi-directional charging could further unlock the ability of electric vehicles to provide additional benefits, including grid services and resilience, such as power outage ride through capability for residents and businesses. Thus, the Commonwealth will require the participation of all incentive recipients in demand management programs starting in 2025, when EV adoption is expected to reach close to 5% of all light-duty vehicles. Massachusetts will work with utilities to develop programs that will require smart charging approaches to be the default choice for EV owners.

One potential benefit of an increase in load from EV charging is that it can lead to lower electricity rates. Studies have shown that if charging load is managed appropriately, utilities can actually increase their net revenues relative to the upfront make-

1 National Grid, CALSTART, Rocky Mountain Institute, Stable Auto, Geotab, "Electric highways: accelerating and optimizing fast-charging deployment for carbon-free transportation." Accessed July 28, 2023: https://www.nationalgrid.com/document/148616/download.

2 National Grid and Hitachi Energy, "The road to transportation decarbonization: understanding grid impacts of electric fleets," September 2021. Accessed July 28, 2023, https://www.nationalgridus.com/media/pdfs/microsites/ev-fleet-program/understandinggridimpactsofelectricfleets.pdf.

3 Dana Lowell, Brian Jones, and David Seamonds, "Electric vehicle cost-benefit analysis," M.J. Bradley & Associates LLC, 2016. https://mjbradley.com/sites/default/files/MA_PEV_CB_Analysis_FINAL_17nov16.pdf.

ready investment costs.[4, 5] It is also the case that certain existing fixed delivery costs will remain the same as load increases, but will be spread over a larger number of kWh. So, while the total revenue requirement remains the same, the rates assessed to end-use customers necessary to achieve that revenue requirement will be lower.

Battery storage as an alternative to grid updates

The most suitable location for a battery energy storage system (BESS) depends on the intended use of the system. Grid-connected BESS can be located in the transmission network, the distribution network, near variable renewable energy sources, such as wind farms or solar fields, or inside EVSE itself.[6] When located in the transmission network, BESS can be used to support the transmission system by potentially deferring transmission upgrades caused by increased load or generation. In addition, they can be used to help meet changes in demand and generation.[7]

When located in the distribution network, BESS can supply all of the same services as BESS located in the transmission network. In addition, it can help compensate for issues related to congestion and power quality. They can be used in areas where placing a conventional generator would otherwise cause issues. Furthermore, BESS can be conveniently located near load sites. This can provide support during outages caused by extreme weather.[8]

BESS placed in close proximity to variable renewable energy sources can be used to store excess energy. BESS placed at these locations can also decrease the transmission capacity needed by storing excess generation and discharging when this energy is needed.

Additional alternatives to building transmission and distribution infrastructure

Other ways to manage charging load from electric vehicles includes requiring an analysis of non-wires alternatives. One example of this could be to collocate energy storage and renewable resources at charging sites to reduce the dependency of vehicle charging on the grid. Some technologies may include:

- **Solar-powered charging stations,** which can be used in remote locations and can reduce strain on the grid, especially when paired with battery storage. In addition, there is potential for revenue generation from excess energy production.[9]

- **AI-optimizing charging**, which provides battery management and autonomous fault detection and recovery.[10] It can optimize charging schedules for increased efficiency and can provide dynamic pricing to determine the most cost-effective time to charge. It can monitor energy demand and distribute electricity in a manner that minimizes waste and prevents grid overload. It can also be used to optimize vehicle-to-grid charging.[11]

- **Bidirectional charging,** which enables electric vehicles to receive energy from charging infrastructure and provide energy to an external load. Employing this mobile battery storage capability adds resilience and demand-response benefits to a site's building infrastructure (see Figure 7.1).[12]

- **Microgrids** that combine battery storage and renewable generation can improve resilience of our electric vehicle charging stations and

4 Melissa Whited and Jason Frost, "EVs Are Driving Rates Down - December 2022 California Update," Synapse Energy, 2022. https://www.synapse-energy.com/evs-are-driving-rates-down-december-2022-california-update.

5 Pamela MacDougall, "Covering infrastructure costs to support commercial EV charging is worth it for utilities and ratepayers," Utility Dive, April 20, 2023. https://www.utilitydive.com/news/commercial-electric-vehicle-ev-make-ready-charging-investment-grid-infrastructure/648158/.

6 National Renewable Energy Laboratory (NREL), "Grid-scale battery storage frequently asked questions," September 2019. Accessed June 20, 2023, https://www.nrel.gov/docs/fy19osti/74426.pdf.

7 *Ibid.*

8 *Ibid.*

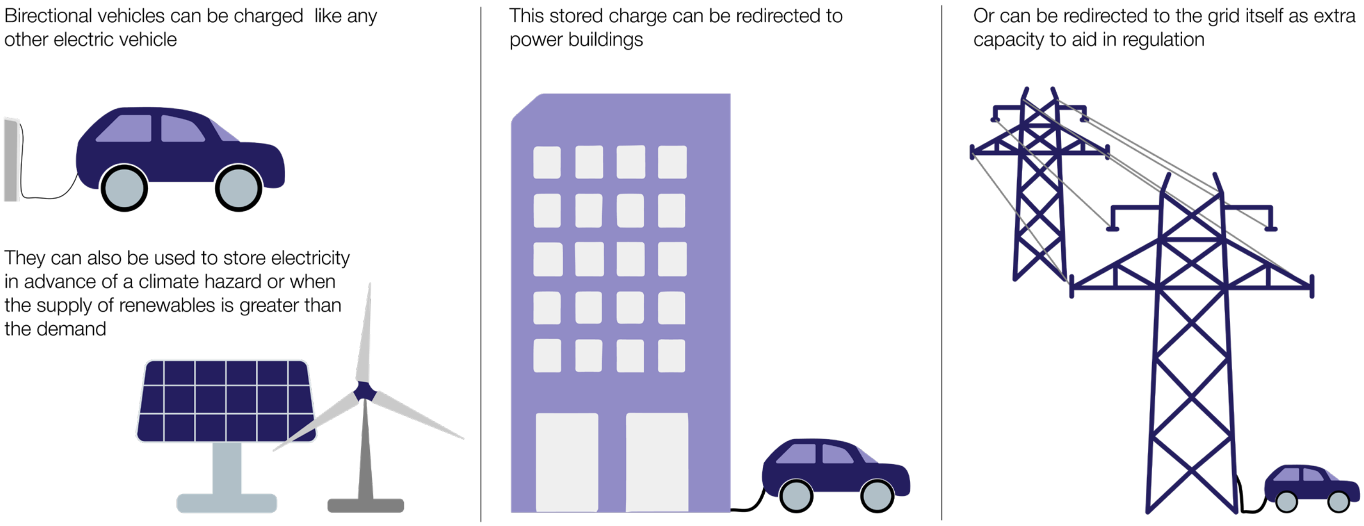
9 Energy5, "Unlocking potential innovations."

10 Electric Era Technologies, "Electric Era is creating the future of car refill for the next generation of drivers." Accessed July 28, 2023, https://electriceratechnologies.com/our-technology#charge.

11 EV charging summit, "Six ways AI will change EV charging," EV Industry Blog. https://evchargingsummit.com/blog/how-ai-will-change-ev-charging/.

12 Federal Energy Management Program (FEMP), "Bidirectional charging and electric vehicles for mobile storage," Energy.gov. Accessed July 7, 2023, https://www.energy.gov/femp/bidirectional-charging-and-electric-vehicles-mobile-storage#:~:text=A%20bidirectional%20EV%20can%20receive,with%20a%20similarly%20capable%20EVSE.

Figure 7.1. — Bidirectional charging



Source: Federal Energy Management Program (FEMP), "Bidirectional charging and electric vehicles for mobile storage."

Highlight: bidirectional charging

Bidirectional charging is valuable since stationary storage and generation must stay at a selected site. Mobile storage can be moved to a site prior to planned outages or arrive shortly after an unexpected power outage to supplement generation or serve as an emergency source. A light-duty EV battery stores about 15–100 kWh, which makes EVs ideal for smaller applications like individual buildings where they can optimize the use of solar energy and replace (or supplement) emergency diesel generators.

One example of the use of bidirectional EVs is at the University of Delaware, which partners with local electric utilities and a regional transmission organization. This agreement requires the university to have their vehicles plugged in and available when needed, which the regional transmission organization pays the university for (market rate). Through this partnership, the university's bidirectional EVs serve as a resilience asset and monetary compensation in addition to their primary purpose of driving. There are several programs in planning stages or already underway in New York State as well as abroad. Denmark is working to create large commercial vehicle-to-grid (V2G) systems and the first commercial V2G hub.

This technology provides multiple benefits in resilience and cost, but also has its limitations. Overuse of an EV's battery can leave it unserviceable, creating concerns about regulations and warranties and about the higher environmental impact from going through batteries at a faster rate. There are also security concerns specifically for V2G capabilities, since if a party gains access to the device, they can damage the charger or deplete the battery. If multiple chargers are controlled, the party could do damage to the electric grid itself. This new technology is something to watch as anticipated issues and complications are worked out by other entities.

Sources: FEMP, "Bidirectional charging and electric vehicles for mobile storage;" Justin Knutson, "The pros and cons of vehicle-to-grid technology: three reasons why auto manufacturers hate it," Impact Solar USA, August 1, 2022, https://www.impactsolar.com/blog/batteries-and-power-storage/vehicle-to-grid-tech/; Marie Baca and Ed Sperling, "The good and bad of bi-directional charging," Semiconductor Engineering, January 11, 2023, https://tinyurl.com/semiengineering-V2G minimize grid impact, and allow for charging infrastructure wholly disconnected from the grid for remote or grid-constrained locations.

Challenges in meeting increased electricity demand

While the potential benefits of EVs are tremendous, achieving a rapid transition will require the state to address many challenges related to transmission and distribution infrastructure and the growing load on the grid due to electrification. Some of these challenges include:

Vehicle-type-driven impacts

The impact on the grid from electric vehicles is dependent on the type and size of EV charging demand. Light-duty passenger vehicles charging at a residential home typically connect to the grid with little to no utility upgrades or intervention today. Medium- to large-duty vehicle fleets, however, have a much larger grid impact. The power demands—and battery sizes—of medium and heavy-duty vehicles require substantially more charging infrastructure than the relatively easy-to-deploy household and public chargers. Further, many medium- and heavy-duty vehicles are operated as parts of fleets which may require additional distribution system upgrades and potential power supply challenges.

Location-driven impacts

The location of vehicle charging is also a factor impacting grid investments and development and fleets in particular, due to their larger electric load requirements, can have a significant impact on local grid infrastructure. Each circuit on the electric distribution system is different, meaning that the specific location a fleet is seeking to connect to will have different implications both in terms of timeline and potential cost for upgrades.

Timeline constraints and interconnection delays

Based on the type of vehicle charging under consideration and the grid condition at the point of interconnection, there may be extended timelines to develop grid infrastructure capable of providing the new electric demand related to permitting, siting, procuring materials and construction, and more.

One example of this can be seen with the MBTA shift to a battery-electric fleet, a significant undertaking that is still in its early stages. The majority of MBTA bus garages will need to be upgraded or replaced before the MBTA can fully shift to a battery-electric fleet, which requires advance planning and seeking out routes and facilities that are feasible to electrify with the technology and infrastructure that is available today.

Cost allocation of grid upgrades

Traditionally, an entity seeking to interconnect a new resource to the electric grid that triggers the need for an upgrade of the grid has been responsible for the full cost of that upgrade. In several areas of the Commonwealth, the cost to upgrade the grid has been too high for any one entity to pay for it, stalling interconnection in multiple locations. The Department of Public Utilities has been investigating cost-sharing methodologies across multiple entities looking to interconnect and ratepayers.[13] While these investigations have primarily focused on upgrades related to solar and storage deployment, load from electrification of vehicles has been a factor considered. There are also many potential lessons that could be learned and applied to cost allocation for grid upgrades necessary to support EVs.

Current efforts to manage grid needs

In addition to the work of EVICC, there is a variety of ongoing activity in the Commonwealth that seeks to understand, support, and improve distribution and transmission infrastructure needs during this transition.

Grid Modernization Advisory Council and electric sector modernization plans

The Department of Energy Resources (DOER) under the Executive Office of Energy and Environmental Affairs is leading the recently created Grid Modernization Advisory Council (GMAC), which is working on holistic distribution system planning in coordination with electric distribution companies.[14]

13 See https://www.mass.gov/doc/provisional-system-planning-summary-0/download#:~:text=20%2D75%2DB.&text=completion%20of%20a%20Group%20Study,DG%20Interconnection%20Tariff%2C%20%C2%A7%203.4.

14 See https://www.mass.gov/info-details/grid-modernization-advisory-council-gmac.

The GMAC is charged with reviewing and providing recommendations to the state's investor-owned EDCs' electric-sector modernization plans (ESMPs) for their respective customer service areas. Each ESMP will include, among other items:

1. A summary of all reviewed, under consideration, or previously approved distribution system investments and alternatives
2. Distribution system improvements to increase system reliability and resiliency for weather and disaster-related risks
3. Distribution system improvements to facilitate transportation and building electrification
4. Forecasts considering five- and ten-year horizons as well as an assessment of demand through 2050

The GMAC is comprised of 18 members who represent the diverse energy communities across the state, including environmental advocacy and environmental justice populations, to encourage efficient investments in the electric distribution systems that will facilitate the achievement of the statewide greenhouse gas emissions limits and sublimits, and increase transparency and stakeholder engagement in the grid planning process. The GMAC will:

- Review and provide recommendations on the above-mentioned electricity distribution; modernization plans to maximize benefits to customers
- Demonstrate that efficient investments can help increase system flexibility
- Facilitate electrification of buildings, transportation, and other sectors
- Improve grid reliability and resiliency
- Minimize or mitigate impacts on ratepayers
- Reduce impacts on and provide benefits to low-income ratepayers

Grid modernization plan investments

The electric utilities in the Commonwealth are making significant grid modernization investments, with a focus on investing in grid-facing and customer-facing technologies and systems that enhance the operation, communication, and control of the distribution system while maintaining reliability and integrating distributed energy resources. Massachusetts is collaborating with utilities and other stakeholders on modernization efforts such as installing advanced metering infrastructure (AMI). AMI can provide real-time energy consumption information valuable in planning and designing customer programs that manage electric load demands and lower system costs and greenhouse gas emissions.[15] In addition to investing in AMI, utilities must increase the acquisition and use of state-of-the-art data analytics to fully enable load flexibility.

Electric utility EV charging infrastructure programs

"Make-ready" programs were also noted as an important incentive that utilities can offer. Make-ready programs include planning, design, and construction for electricity grid infrastructure upgrades needed to serve Level 2 and DC fast charger stations. These may include items such as trenching, dedicated service meters, conduit, and wiring. In Massachusetts, utility rate structures and program designs have been approved that allow utilities to offer and fund make-ready work. The existence of these programs was noted by some stakeholders as a favorable condition in the Commonwealth to minimize the need for other programs (such as NEVI) to fund work on the utility side of the meter.

Between 2018 and 2021, the Massachusetts Department of Public Utilities (DPU) approved multiple utility electric vehicle charging infrastructure programs by Eversource and National Grid for a total of $96 million, enabling deployment of Level 2 and DC fast charging EV charging stations in public and workplace sites and multi-unit dwellings, as well as implementation of off-peak charging rebates for

15 For example, AMI is essential for the implementation of time-varying rates and load flexibility measures. AMI also provides utilities and third-party aggregators with improved visibility of DER assets, facilitating better planning of the distribution system.

residential customers. The costs for the EV programs are currently recovered through an annual cost recovery mechanism outside of base distribution rates.

In 2021, the Department issued an Order (D.P.U. 20-69-A) providing detailed guidance to the EDCs on filing EV charging infrastructure plans. In July 2021, the EDCs submitted their coordinated EV charging infrastructure plans. On December 30, 2022, the Department issued an Order approving a four-year program with a budget of $206 million for National Grid, the Department approved a four program with a budget of $188 million for Eversource, and a five-year program with a budget of $998,000 for Unitil. The costs for these recently approved EV programs will also be recovered through an annual cost recovery mechanism outside of base rates.[16]

16 See https://www.mass.gov/doc/gmac-mtng-4-preread-esmp-relevant-proceedings-and-working-groups-version-2/download.

Managed charging programs

1. **Eversource electric vehicle supply equipment direct load control offering**

   Eversource launched an electric vehicle supply equipment (EVSE) direct load control (DLC) offering beginning August 2019 to residential Eversource electric customers that were EV owners with a qualifying networked Level 2 EVSE manufactured by ChargePoint, Enel X, or SolarEdge. The offering aimed to reduce EV charging load during demand reduction events via DLC of enrolled EVSEs. Demand reduction events could be called on non-holiday weekdays between the hours of 4 p.m. and 8 p.m. Participating customers were provided incentives for the right to throttle their EVSE from Level 2 to Level 1, as well as for access to their charging data. Through September 2021, the program enrolled 487 EVSEs in Massachusetts.

Case study: managed charging in Concord, Mass.

EV Miles participants program their electric vehicles to charge off-peak and receive a monthly bill credit for their participation. Any Concord resident that drives an all-electric or plug-in hybrid vehicle, and has a CMLP residential account can participate.

Program rules:

- Participants must have a CMLP residential electric account.
- Only new and used original equipment manufacturer (OEM) plug-in electric light-duty, highway capable passenger vehicles are eligible for enrollment. (Fuel cell vehicles, electric bikes, electric motorcycles, electric scooters, neighborhood vehicles or conversion or hobbyist EVs are not eligible.)
- Participants must program their electric vehicle or home charger to start charging after 10 PM and end charging by 12 noon, Monday through Friday. Participants may charge 24 hours a day on weekends.
- Participants attest that they programmed their vehicles to charge off-peak, and that they will abide by all program rules.
- Participants agree to release their electric meter or electric vehicle charger data, where available, for the purposes of the program.
- Drivers of all-electric vehicles will receive a $10 monthly credit; drivers of plug-in hybrid vehicles will receive $5 monthly.

Source: Town of Concord EV Miles Program

The DPU invited Eversource to file new EV load management offering proposals as part of its 2022-2024 energy efficiency plan, but it has not filed as of this report.

2. **National Grid EV direct load control offering**

   National Grid provided an EV DLC offering to owners of eligible EVs from original equipment manufacturers (OEMs)—BMW, Chevrolet, Ford, and Honda—in Massachusetts beginning May 2021. The offering aimed to reduce EV charging load during demand reduction events via DLC of enrolled EVs. Demand reduction events could be called between 2 p.m. and 7 p.m. on non-holiday weekdays and weekends from June to September 2021. Participating customers received an incentive upon program enrollment, and a per-event rebate based on level of charging or a flat annual incentive that was distributed if customers did not participate in any peak events. Through September 2021, there were 105 EVs (53 BEVs and 52 PHEVs) enrolled. The DPU invited National Grid to file new EV load management offering proposals as part of its 2022-2024 energy efficiency plan, but it has not filed as of this report.

3. **National Grid off-peak charging offering**

   National Grid first introduced an off-peak charging offering in March 2021 and tested it from July through September 2021 to National Grid electric customers with a qualifying EV. The offering aimed to reduce EV charging load between the hours of 7 a.m. and 11 p.m. on weekdays and weekends by way of an off-peak charging rebate. An additional bonus incentive was provided to customers that reduced charging between 5 p.m. and 8 p.m. Through September 2021, 192 vehicles were enrolled in the offering. The DPU approved an extension of the residential off-peak charging rebate program through 2025, and the expansion of program eligibility includes up to 1,000 fleet EVs.

4. **Electricity distribution centers' time-of-use rate**

   Pursuant to Section 90 of the 2022 Clean Energy Act, electricity distribution centers must submit proposals to the DPU on or before August 11, 2023, for approval to offer a time-of-use (TOU) rate designed to reflect the cost of providing electricity to a consumer charging an EV at an EV charging station at different times of the day. The DPU is required to issue at least one order on these proposals by no later than October 31, 2025.

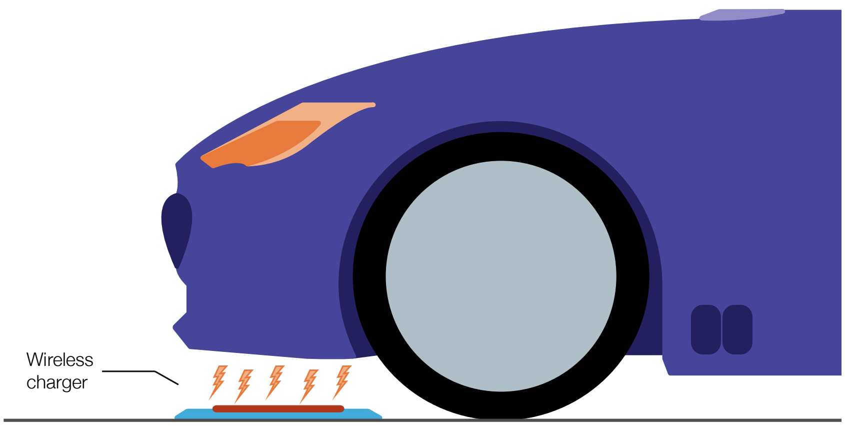
8. TECHNOLOGICAL ADVANCES

Technological advances in electric vehicle charging have the potential to transform the market, create new charging options, and lower costs for consumers and ratepayers.

Among these potential advances are:

- **Wireless charging**, also known as induction charging, eliminates the need for cables and increases convenience. Resonant magnetic fields are used to transfer energy to the vehicle's battery. To use this technology, the driver would park on a charging pad.[1]

Illustration 8.1. — Wireless charging



Source: GreenerU

- **Electrified roads** use an electrified rail on the road that allows for charging on the go. When a car passes over an electrified rail in the road, its movable arm detects its location and efficiently recharges the vehicle.

- **Networked charging** refers to a group of charging stations all owned and operated by a company. Examples include ChargePoint, EVgo, and Tesla Superchargers. These stations are connected to an internet network and can be programmed, tracked, and sometimes repaired online. Payment options can be attached to networked stations, though it is not required. Importantly, networked charging enables the collection and analysis of data on who is using the stations, when they are using them, the types of cars they drive, energy consumption, energy cost, emissions avoided, etc., data that can help the Commonwealth with policymaking.

- **Smart charging** also streamlines the management of charging stations, making the operation of the infrastructure simpler. Setting fees is one example of this; networked stations have a simple process for managing how much it costs for people to charge at stations, and they support changing that amount over time. Many factors go into setting a price for charging and non-networked stations make it difficult to set or alter charging fees. Smart charging also streamlines the process for controlling access to chargers for particular groups of EV drivers, enabling different groups to power up at different times of day (ex: allowing employee access during the day and public charging after hours). Controlling access to non-networked stations requires a PIN code or physical key to be given to users, which can be easily forgotten or lost.[2]

Smart charging

Smart charging refers to charging systems that connect operators, infrastructure, and vehicles with the purpose of collecting data to optimize energy use.

1 Energy5, "Unlocking the potential innovations transforming the EV charging station sector." July 13, 2023. https://energy5.com/unlocking-the-potential-innovations-transforming-the-ev-charging-station-sector.

2 Jones, "Networked electric vehicle charging stations," 2018.

Examples of networks using smart charging to their advantage

- The largest public fast charging network in the U.S., EVgo, uses a data analytics platform to optimize the placement of its charging stations based on usage patterns, traffic patterns, and proximity to amenities such as restaurants, shopping centers, and tourist attractions.
- The largest EV charging network in the world, ChargePoint, uses data analytics to monitor the performance of its charging stations, identify potential issues, and dispatch service technicians proactively, reducing downtime and increasing revenue.
- A subsidiary of EDF Renewables, PowerFlex, uses data analytics to optimize the usage of its charging stations, reducing the strain on the grid during peak hours and incentivizing off-peak charging by offering discounted rates.

Source: Energy5, "Optimizing the performance," 2023.

Cybersecurity concerns

Cybersecurity of electric vehicle charging stations is a growing concern as electric vehicle charging infrastructure expands. The federal Joint Office of Energy and Transportation are currently working to develop model cybersecurity language and policies for procurements under the National Electric Vehicle Infrastructure (NEVI) program. Accepted best practices in this space include establishing a cybersecurity team that operates for the life of the contract and evaluates data on security risks and security-related contract language. Cybersecurity will be an important evaluation criterion for all MassDOT procurements and will be incorporated into additional procurements in state programs.

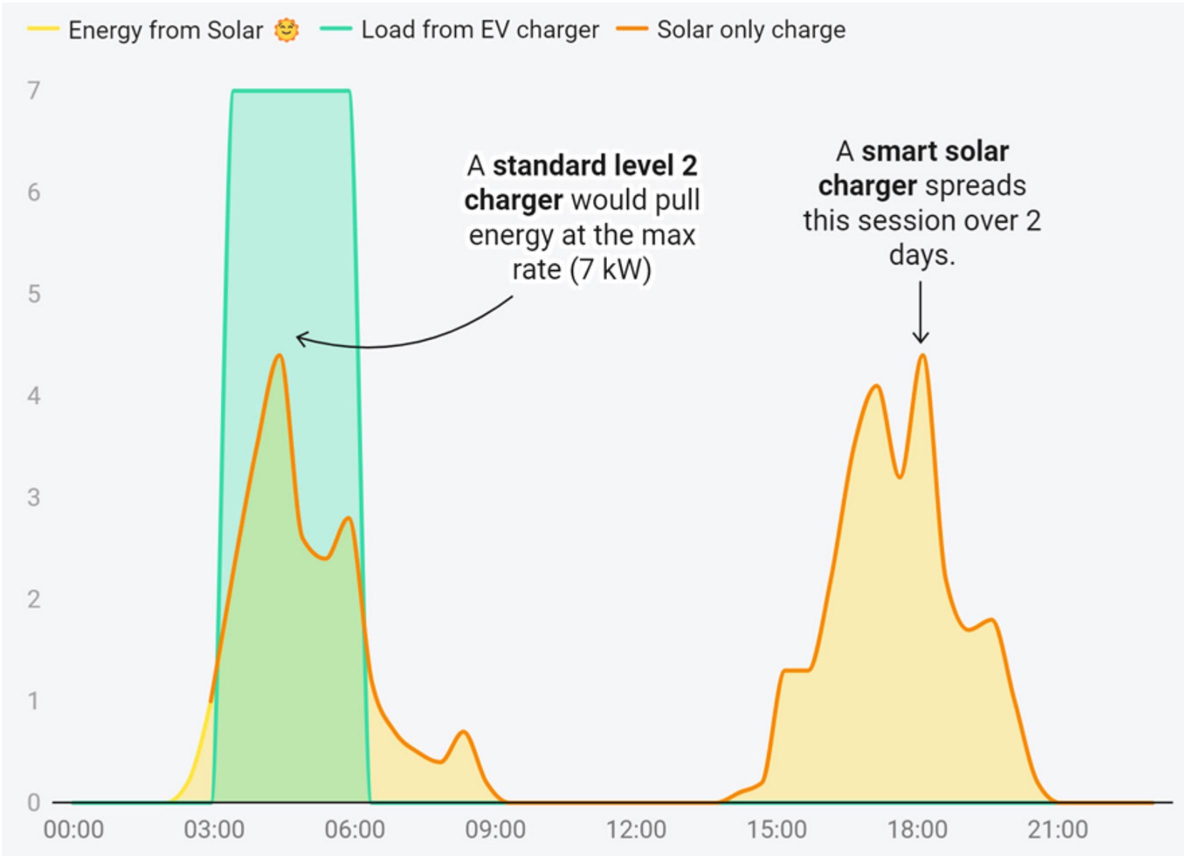
Load management with solar

The integration of solar energy helps to offset the pull on the grid and decreases the cost of charging to the user. Solar charging stations collect data on the generation of electricity from solar arrays and the electricity available to use.[3] These charging stations divert available energy from the grid directly to the electric vehicle.[4] Smart solar charging can assess the level of power generated and control the charging, pull, and capacity demanded by the vehicle to maximize environmental and financial benefits.[5] More so, smart chargers communicate with circuits to assess the available load and then adjust the power sent to the charger to prevent power outages.[6] Figure 8.1 illustrates how load management and solar charging maximizes solar generation and cost savings.

3 Danny Thai, "Exploring the benefits of smart EV charging," Zecar, May 13, 2023. From https://zecar.com/resources/everything-you-need-to-know-about-smart-ev-charging-ultimate-guide, accessed July 28, 2023.

4 *Ibid.*
5 *Ibid.*
6 *Ibid.*

Figure 8.1 — Load management with solar charging



Source: zecar, created with DataWrapper

SECTION

9. SUMMARY OF RECOMMENDATIONS

This initial assessment represents an important step towards building an equitable electric vehicle infrastructure for all Massachusetts residents, but the work of the EVICC is ongoing.

Recommended legislative actions

1. New legislation requiring publicly accessible electric vehicle chargers to register with the Division of Standards so that they can be regularly inspected. Whereas DOS currently has the statutory authority to inspect such charging stations, it lacks the ability to require their registration, which impedes DOS's ability to know where they are located. In addition, because inspections will require sophisticated equipment and training, legislation should ensure that such inspections are centralized within DOS and not shared with municipalities. Finally, DOS will investigate new regulations, via the authority of both existing statutes and new legislation, to ensure adequate consumer protections are in place that fall within its purview.

2. The Healey-Driscoll Administration will work with the legislature to pass "right to charge" legislation that will help tenants and people living in condominiums install charging infrastructure.

3. The Department of Energy Resources (DOER) will work with the legislature to update appliance standards for EVSEs to the latest ENERGY STAR standards.

4. EEA, DOER, and DOS will coordinate with the legislature to ensure that there are no overlapping or contradictory provisions between existing language in G.L. c. 25A and any new legislation that is enacted to provide DOS with the requisite authority to carry out inspections of publicly available EVSEs.

Agency-specific recommendations

1. DOER will work with municipalities to develop guidance and support for programs to expand curbside charging and overnight charging infrastructure for tenants and garage orphans.

2. Executive branch agencies will focus the deployment of publicly available funds for environmental justice populations and into rural areas, with a particular focus on reaching low-income residents, to ensure that the transition to electric vehicles is equitable.

3. MassDOT will pursue options to communicate EV charging station locations on highway signage and/or elsewhere.

4. EEA and other state agencies will develop programs to reduce the transmission and distribution infrastructure burden of electric vehicle chargers by using policies such as time-of-use rates and technologies such as on-site storage and bidirectional charging to turn electric vehicles and electric vehicle charging stations into grid assets.

5. EEA, DOER, and DPU will encourage electrification of alternative vehicle ownership modes, such as electric vehicle car sharing and electrification of ride-hailing services.

6. DOS will develop new regulations to ensure that publicly accessible electric vehicle chargers are registered, inspected, and tested to improve uptime.

7. DOS will also develop new regulations that apply consumer protections to EVSEs, including, but not limited to signage and price disclosure requirements; protections against price gouging; standardized EVSE connection equipment; and limiting the sale of consumer data collected.

8. EEA and DOER will work with other agencies (e.g., Operational Services Division (OSD), MassDEP, the Department of Capital Asset Management and Maintenance (DCAMM), the Massachusetts Clean Energy Center (MassCEC), MassDOT, and the MBTA) and cities and towns responsible for procuring EVSE to coordinate procurement processes, and, if necessary, develop recommendations for the legislature to align processes.

EVICC next steps

1. EEA will lead the EVICC in developing a plan to use the $50 million in the Charging Infrastructure Deployment Fund. This plan will be developed consistent with the recommendations in this initial assessment and will draw from future findings that the EVICC makes regarding EV infrastructure needs.

2. The EVICC will refine its assessment of charging station needs by providing focused attention on the need for public fast charging to support long distance trips, including on peak travel days.

3. The EVICC will incorporate data on the need for charging station and infrastructure upgrades associated with electrification of medium- and heavy-duty fleets.

4. The EVICC will continue work with the Grid Modernization Advisory Council, utilities, and other stakeholders to proactively manage the grid impacts of expanded electric vehicle charging infrastructure.

5. The EVICC will consider methods to obtain more information on precisely where electric vehicles are being garaged so that electric utilities can better plan for load growth.

6. The EVICC will consider accessibility and location safety requirements that might be necessary to develop for charging stations located at multi-unit dwellings and/or workplaces, which may not be covered under the rules DOS adopts for publicly available charging stations.

7. The EVICC will consider establishing a transportation clearinghouse website for information on EVs, EVSE, and funding opportunities for stakeholders in the Commonwealth.

8. The EVICC will further research EVSE and related infrastructure costs and how those costs will be allocated between the public and private domains.

9. The EVICC will collaborate with state fleet operators to collect data to determine the highest priority locations for electric vehicle charging at state facilities and direct resources to facilitate charging installations at those locations.

10. The EVICC will work with MassCEC and the Executive Office of Labor and Workforce Development to ensure there is a trained workforce of licensed electricians with an Electric Vehicle Infrastructure Training Program (EVITP) certification ready to deploy new EVSE, ensuring populations historically left out of the clean energy workforce are offered opportunities.

SECTION

10. APPENDIX

An Act Driving Clean Energy and Offshore Wind, St. 2022 c. 179 § 81

(a) There shall be within the executive office of energy and environmental affairs, but not subject to the control of the office, an intergovernmental coordinating council to implement an electric vehicle charging infrastructure deployment plan. The council shall consist of the following 11 members: the secretary of energy and environmental affairs or designee, who shall designate the chair of the council; the commissioner of environmental protection or designee; the commissioner of energy resources or designee; the secretary of the Massachusetts Department of Transportation or designee; the general manager of the Massachusetts Bay Transportation Authority or designee; the secretary of housing and economic development or designee; the secretary of administration and finance or designee; the executive director of a regional planning agency or designee, who shall be appointed by the governor; the commissioner of public utilities or designee; and the chairs of the joint committee on telecommunications, utilities and energy or their designees, who shall serve as non-voting members with respect to any spending matter. The council shall assess and report on strategies and plans necessary to deploy electric vehicle charging infrastructure to establish an equitable, interconnected, accessible and reliable electric vehicle charging network. The deployment plan shall facilitate: (i) compliance with the greenhouse gas emissions limits and sublimits set pursuant to sections 3 and 3A of chapter 21N of the General Laws, with emphasis on compliance with the emissions limits and sublimits set for 2025 and 2030; (ii) attainment of the numerical benchmarks for electric vehicles and electric vehicle charging stations set pursuant to section 5 of said chapter 21N; (iii) cessation, by December 31, 2035, of in-state sales of non-zero-emission vehicles; and (iv) advancement of access to, and affordability of, electric vehicle charging and fueling.

The assessment shall include, but not be limited to: (i) the present condition of, and future needs for, road and highway electrification; (ii) estimates of the number and type of electric vehicle charging stations needed in public and private sector settings including, but not limited to, parking lots for public transit stations, commercial and industrial settings and single occupancy, double occupancy and multiple-occupancy residential structures; (iii) suggestions for optimal locations for electric vehicle charging stations in urban, suburban and rural areas including, but not limited to, low-income and moderate-income communities; (iv) discussion of distribution, transmission and storage infrastructure and technology needed; (v) discussion of present and projected future costs and methods of financing those costs; (vi) discussion of technological advances in charging stations and related infrastructure, equipment and technology including, but not limited to, advances that may aid in collecting data, connecting via remote communications, providing mobile charging, assisting in grid management and assisting in the integration of renewable energy resources; (vii) discussion of strategies to maintain electric vehicle charging stations in full and continuous working order; (viii) recommendations to assist governmental and private sector officials in installing charging stations and related infrastructure, equipment and technology, including within proximity of on-street parking; and (ix) identification and discussion of current policies and recommendations for policies, laws and regulatory actions that may facilitate the provision of charging stations and related infrastructure, equipment and technology including, but not limited to, cybersecurity requirements and best practices.

(b) The council shall regularly seek data and input related to electric vehicle charging stations, fueling stations and related infrastructure, equipment, equipment maintenance and technology, from stakeholders, which stakeholders shall include, but not be limited to, investor-owned and publicly-owned electric utilities, state and local transportation agencies, companies involved in products, services, technologies and data collection related to clean energy charging and fueling, automobile manufacturers, groups representing environmental, energy and climate perspectives, and groups representing consumers including, but not limited to, low-income consumers.

(c) The executive office of energy and environmental affairs shall provide administrative support to the council. In conducting and updating the assessment under this section, the council shall hold at least 3 public hearings in geographically diverse areas of the commonwealth.

(d) The council shall issue an initial assessment to the senate and house committees on ways and means and the joint committee on telecommunications, utilities and energy not later than 12 months after the effective date of this act and shall reconsider and revise its assessment at least once every 2 years. The council shall make its assessments publicly available on the website of each secretariat with a member serving on the council.

(e) There is hereby established and set up on the books of the commonwealth a separate fund to be known as the Charging Infrastructure Deployment Fund for the purpose of ensuring a holistic, coordinated and comprehensive deployment of electric vehicle charging infrastructure. The fund shall be credited with: (i) revenue from appropriations or other money authorized by the general court and specifically designated to be credited to the fund; (ii) interest earned on such revenue; and (iii) funds from public and private sources and other gifts, grants and donations. All amounts credited to the fund shall be expended solely for activities and expenditures consistent with the purposes of this section, including the ordinary and necessary expenses of administration and operation of the fund; provided, however, that no expenditure made from the fund shall cause the fund to become deficient at any point during the fiscal year. Any money remaining in the fund at the end of a fiscal year shall not revert to the General Fund.

Table 10.1 — Geographic distribution of public chargers along major thoroughfares in Massachusetts

	Charger type														
	Level 1		Level 2					Level 3 (DC fast charger)							
	NEMA 5-15		J1772		Tesla Destination*			CCS		CHAdeMO		CCS/ CHAdeMO		Tesla Supercharger	
Route	Stns	Ports	Stns	Ports	Stns (Tesla only)	Stns (Tesla and J1772)	Ports (Tesla and J1772)	Stns	Ports	Stns	Ports	Stns	Ports	Stns	Ports
Rte 2 (Orange to Cambridge)	2	2	117	249	0	1	2	0	0	0	0	5	7	3	24
Rte 3 (Bourne to Braintree)	0	0	38	73	2	1	7	0	0	1	1	4	14	2	20
Rte 3 (Burlington to Tyngsborough)	0	0	30	51	0	0	0	0	0	0	0	1	1	0	0
Rte 6 (Bourne to Eastham)	0	0	27	57	0	0	0	0	1	0	0	1	1	3	32
Rte 24 (Fall River to Randolph)	0	0	45	79	1	0	2	0	0	0	0	5	5	2	20
Rte 25 (Wareham to Bourne)	0	0	5	22	0	0	0	0	0	0	0	1	1	0	0
I-84 (Holland to Sturbridge)	0	0	1	6	0	0	0	0	0	0	0	3	6	1	12
I-90 (West Stockbridge to Boston)	1	1	438	916	8	10	53	0	1	1	1	4	13	10	92
I-91 (Longmeadow to Bernardston)	0	0	91	184	1	0	4	0	1	1	1	6	7	2	20
I-93 (Canton to Methuen)	0	0	454	939	5	6	0	0	0	2	2	7	16	5	46
I-95 Attleboro-Canton	0	0	29	58	1	0	2	0	0	0	0	0	0	0	0
I-95 (128) Canton-Peabody	0	0	176	395	2	0	4	0	0	3	3	8	12	5	48
I-95 Peabody-Salisbury	0	0	15	23	1	1	4	0	0	0	0	3	4	1	12
Rte 128 (Peabody to Gloucester)	0	0	26	49	0	0	0	0	0	0	0	1	2	1	8
Rte 140 (New Bedford to Taunton)	0	0	14	23	0	0	0	0	0	0	0	2	2	0	0
Rte 146 (Uxbridge to Millbury)	0	0	6	12	0	0	0	0	0	0	0	0	0	0	0
I-190 (Worcester to Leominster)	0	0	59	116	0	0	0	0	0	0	0	0	0	1	8
I-195 (Seekonk to Wareham)	0	0	26	60	0	0	0	0	4	0	0	3	6	3	32
I-290 (Auburn to Marlborough)	0	0	84	182	0	0	0	0	0	0	0	6	19	1	8
I-295 Attleboro to North Attleboro	0	0	6	9	0	0	0	0	0	1	1	1	2	0	0
I-395 (Webster to Auburn)	0	0	6	10	0	0	0	0	0	0	0	3	11	1	8
I-495 (Wareham to Salisbury)	0	0	215	478	0	1	2	0	0	0	0	16	26	6	60

*Tesla Destination Stations are Level 2 public charging stations that utilize the Tesla Wall Connector. A limited number of Tesla Destination charging stations have J1772 ports available as well. The distribution of port types is unknown.
Source: U.S. Department of Energy Alternative Fuels Data Center

Table 10.2 — Massachusetts municipalities with publicly available EVSE infrastructure and number of stations

Abington	1	Charlton	9	Freetown	3	Lynnfield	2
Acton	10	Chatham	2	Gardner	4	Malden	27
Agawam	7	Chelmsford	16	Georgetown	3	Manchester	3
Allston	1	Chelsea	2	Gill	1	Mansfield	4
Amesbury	15	Cheshire	1	Gloucester	7	Marblehead	6
Amherst	35	Chestnut Hill	2	Grafton	2	Marion	2
Andover	12	Chicopee	9	Great Barrington	5	Marlborough	54
Andover	1	Chilmark	2	Greenfield	16	Marshfield	2
Aquinnah	2	Cohasset	8	Groton	6	Mashpee	2
Arlington	8	Concord	9	Groveland	1	Mattapan	1
Ashburnham	2	Dalton	1	Hadley	10	Maynard	9
Athol	3	Danvers	14	Halifax	2	Medfield	4
Attleboro	5	Dartmouth	6	Hamilton	3	Medford	12
Auburn	16	Dedham	7	Hancock	1	Medway	7
Avon	1	Deerfield	2	Hanover	3	Melrose	16
Ayer	4	Dennis	1	Hanson	1	Mendon	1
Baldwinville	1	Devens	1	Hardwick	1	Methuen	14
Barnstable	15	Dighton	3	Harvard	1	Middleborough	14
Barre	1	Dorchester	1	Harwich	7	Milford	7
Becket	1	Douglas	1	Hathorne	1	Millbury	7
Bedford	8	Dracut	2	Haverhill	14	Milton	2
Belchertown	1	Dudley	2	Hingham	5	Montague	4
Bellingham	1	Duxbury	2	Holyoke	12	Nantucket	12
Belmont	4	East Boston	2	Hopkinton	2	Natick	17
Beverly	34	East Brookfield	2	Hudson	4	Needham	12
Billerica	8	East Cambridge	1	Hyannis	11	New Bedford	18
Blackstone	2	East Freetown	1	Ipswich	3	Newbury	1
Bolton	2	East Longmeadow	2	Jamaica Plain	2	Newburyport	7
Boston	424	East Wareham	1	Kingston	3	Newton	40
Bourne	6	Eastham	2	Lancaster	4	Norfolk	1
Boxborough	1	Easthampton	13	Lawrence	25	North Adams	5
Boxford	3	Easton	3	Lee	7	North Andover	5
Braintree	12	Edgartown	4	Leicester	2	North Attleboro	14
Brewster	1	Erving	5	Lenox	9	North Billerica	1
Bridgewater	16	Essex	1	Leominster	6	North Grafton	5
Brockton	21	Everett	1	Lexington	21	North Reading	2
Brookline	4	Fall River	33	Leyden	1	Northampton	31
Burlington	28	Falmouth	7	Lincoln	1	Northborough	3
Buzzards Bay	1	Feeding Hills	1	Littleton	5	Northfield	1
Cambridge	206	Fitchburg	7	Longmeadow	1	Norton	4
Canton	15	Foxborough	5	Lowell	57	Norwell	5
Carlisle	3	Framingham	20	Ludlow	3	Norwood	32
Charlemont	1	Franklin	9	Lynn	6	Oak Bluffs	1

(continued on following page)

Table 10.2 — Continued

Orange	2	Salisbury	1	Sudbury	1	West Newbury	4
Orleans	5	Sandwich	6	Sutton	2	West Springfield	14
Oxford	1	Saugus	6	Swampscott	3	West Tisbury	4
Palmer	3	Scituate	3	Swansea	4	West Yarmouth	2
Peabody	3	Seekonk	2	Taunton	5	Westborough	7
Pembroke	1	Sharon	1	Templeton	2	Westfield	14
Pittsfield	7	Shelburne Falls	2	Tewksbury	11	Westford	13
Plainville	5	Sherborn	1	Topsfield	3	Weston	4
Plymouth	25	Shrewsbury	8	Truro	1	Westport	2
Princeton	1	Somerset	3	Turners Falls	2	Westwood	8
Provincetown	8	Somerville	32	Tyngsborough	7	Weymouth	14
Quincy	25	South Deerfield	2	Uxbridge	1	Whately	2
Raynham	4	South Hadley	6	Vineyard Haven	1	Whitman	1
Reading	6	Southborough	4	Wakefield	18	Williamsburg	2
Revere	18	Southbridge	1	Walpole	5	Williamstown	21
Rochester	1	Spencer	3	Waltham	87	Wilmington	25
Rockland	4	Springfield	41	Wareham	4	Winchendon	2
Rockport	9	Sterling	8	Watertown	20	Woburn	14
Rowley	4	Stockbridge	4	Wayland	6	Worcester	129
Roxbury	1	Stoneham	9	Wellesley	13	Wrentham	1
Sagamore Beach	1	Stoughton	12	Wellfleet	3	Yarmouth	5
Salem	30	Sturbridge	5	Wenham	2		

Source: U.S. Department of Energy Alternative Fuels Data Center

Table 10.3 — Massachusetts municipalities without publicly available EVSE infrastructure

Acushnet	Cummington	Hinsdale	Monson	Randolph	Wales
Adams	Dover	Holbrook	Monterey	Rehoboth	Ware
Alford	Dracut	Holden	Montgomery	Richmond	Warren
Ashby	Dunstable	Holland	Mount Washington	Rowe	Warwick
Ashfield	East Bridgewater	Holliston	Nahant	Royalston	Washington
Ashland	East Longmeadow	Hopedale	New Ashford	Russell	Webster
Berkeley	Egremont	Hubbardston	New Braintree	Rutland	Wendell
Berlin	Everett	Hull	New Marlborough	Savoy	West Boylston
Bernardston	Fairhaven	Huntington	New Salem	Sheffield	West Bridgewater
Boylston	Florida	Lanesborough	North Brookfield	Shirley	West Brookfield
Brimfield	Georgetown	Leverett	Northbridge	Shutesbury	West Stockbridge
Brookfield	Goshen	Leyden	Oakham	Southampton	Westhampton
Buckland	Gosnold	Lunenburg	Otis	Southwick	Westminster
Carver	Granby	Mattapoisett	Paxton	Stow	Wilbraham
Chester	Granville	Merrimac	Pelham	Sunderland	Winchester
Chesterfield	Groveland	Middlefield	Pepperell	Tisbury	Windsor
Clarksburg	Hampden	Middleton	Peru	Tolland	Winthrop
Clinton	Hatfield	Millis	Petersham	Townsend	Worthington
Colrain	Hawley	Millville	Phillipston	Tyringham	
Conway	Heath	Monroe	Plympton	Upton	

Source: U.S. Department of Energy Alternative Fuels Data Center