CHARGING FORWARD

A TOOLKIT FOR PLANNING AND FUNDING URBAN ELECTRIC MOBILITY INFRASTRUCTURE

U.S. Department of Transportation

Joint Office of Energy and Transportation

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LIST OF ABBREVIATIONS

ABBREVIATION	TERM
ACEEE	American Council for an Energy-Efficient Economy
ADA	Americans with Disabilities Act
AFC	Alternative Fuel Corridor
AFDC	Alternative Fuels Data Center
AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation
ATVM	Advanced Technology Vehicles Manufacturing
AVTC	Advanced Vehicle Technology Competitions
BEB	Battery electric bus
BEV	Battery electric vehicle
BIL	Bipartisan Infrastructure Law
CCS connector	Combined Charging System connector
CE	Categorical exclusion
CHAdeMO connector	**"CHArge de MOve,"** equivalent to "charge for moving"
CMAQ	Congestion Mitigation and Air Quality Improvement
Co-ops	Cooperatives
CWA	Clean Water Act
DERA	Diesel Emissions Reduction Act
DC	Direct current
DCFC	Direct current fast charging
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
DOT	Department of transportation
DSIRE	Database of State Incentives for Renewables & Efficiency
EA	Environmental assessment
EERE	U.S. DOE Office of Energy Efficiency and Renewable Energy
EDA	U.S. Economic Development Agency
EIS	Environmental impact statement
EO	Executive order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973
ESB	Electric school bus
EV	Electric vehicle
EVITP	Electric Vehicle Infrastructure Training Program
EVSE	Electric vehicle supply equipment
EZMT	Energy Zones Mapping Tool

ABBREVIATION	TERM
FAA	USDOT Federal Aviation Administration
FCEV	Fuel-cell electric vehicle
FEMA	Federal Emergency Management Agency
FHWA	USDOT Federal Highway Administration
FLAP	Federal Lands Access Program
FOA	Funding Opportunity Announcement
FTA	USDOT Federal Transit Administration
GARVEE	Grant Anticipation Revenue Vehicle
GHG	Greenhouse gas
HEV	Hybrid electric vehicle
IRA	Inflation Reduction Act
ILIT	Infrastructure Location Identification Toolkit
IOU	Investor-owned utilities
IRA	Inflation Reduction Act
IRS	Internal Revenue Service
kW	Kilowatt
kWh	Kilowatt hour
LDV	Light-duty vehicle
MARAD	USDOT Maritime Administration
MPGe	Miles per gallon of gasoline equivalent
MPO	Metropolitan planning organization
NACTO	National Association of City Transportation Officials
NASEO	National Association of State Energy Officials
NEPA	National Environmental Policy Act
NESCAUM	Northeast States for Coordinated Air Use Management
NHPA	National Historic Preservation Act of 1966
NHS	National Highway System
NOFO	Notice of Funding Opportunity
NPIAS	National Plan of Integrated Airport Systems
NREL	National Renewable Energy Laboratory
O&M	Operations and maintenance
OST	USDOT Office of the Secretary of Transportation
PHEV	Plug-in hybrid electric vehicle
POU	Publicly owned utilities
P3	Public-private partnerships
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
RFID	Radio-frequency identification
RPM	Revolutions per minute

ABBREVIATION	TERM
RTPO	Regional transportation planning organization
ROUTES	Rural Opportunities to Use Transportation for Economic Success
SBA	U.S. Small Business Administration
SCEP	U.S. DOE Office of State and Community Energy Programs
SEP	U.S. DOE State Energy Program
SIB	State Infrastructure Bank
STIP	Statewide Transportation Improvement Program
SUV	Sport utility vehicle
TCRP	Transit Cooperative Research Program
TIFIA	Transportation Infrastructure Finance and Innovation Act
TIP	Transportation Improvement Program
TNC	Transportation network company
UPWP	Unified Planning Work Program
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
VGI	Vehicle-to-grid integration
VTO	U.S. DOE Vehicle Technologies Office
VW	Volkswagen
V1G	Unidirectional vehicle-to-grid
V2G	Bidirectional vehicle-to-grid
WOTUS	Waters of the United States
ZEV	Zero emission vehicle

SECTION 1

INTRODUCTION

The Urban Electric Mobility Toolkit serves as a one-stop resource to help urban communities scope, plan, and identify ways to fund electric vehicle (EV) charging infrastructure, supporting diverse forms of electric mobility including travel by personal vehicle, transit, micromobility (e.g., electric bicycles and scooters), and ride-sharing services. Urban communities, metropolitan planning organizations (MPOs), transportation providers, businesses, and property owners and developers can use the toolkit to identify key partners for an electric charging project, take advantage of relevant planning tools, and identify available funding or financing to help make that project a reality.

The rapid growth in electric mobility today is part of a fundamental shift in transportation, a change that promises substantial benefits to individuals, businesses, communities, and the entire Nation. Together with USDOT's **Rural EV Toolkit,** this Urban Electric Mobility Toolkit reflects the Federal Government's commitment to providing all Americans, regardless of where they live, the opportunity to benefit from the lower operating costs, reduced maintenance needs, and improved performance that electric mobility provides. In addition, all communities—including underserved communities—should have access to the economic opportunities and improved air quality that electric mobility offers. Providing more Americans with the option to utilize EVs is one element in the Federal Government's long-term strategy to eliminate climate-related emissions from transportation, alongside investments in other mobility modes that give Americans real choices in how to travel.

This transformation of the U.S. transportation system combined with Buy America requirements that maximize the use of American-made products and materials provides the Federal Government with an opportunity to support the creation of good-paying jobs with the free and fair choice to join a union and the incorporation of strong labor standards and diverse workforce programs, in particular registered apprenticeships, labor management partnerships, and Local Hire agreements, in project planning stages and program delivery. Federal funding can also be used to support wealth creation through the inclusion of local inclusive economic development and entrepreneurship.

About **71 percent** of Americans live in communities with a population of 50,000 or greater. In high-density urban environments, people seek out diverse mobility options based on differences in convenience, cost, and environmental impact. Depending on the trip purpose, **distance**, and personal preferences and needs, people may choose to walk, bike, use a scooter, take transit, use a shared vehicle, or drive. Cities increasingly seek to design their streets and provide infrastructure to help facilitate these choices and ensure all options are as sustainable, accessible, and cost-effective as possible. Electrification of these mobility options, including shared mobility, will help reduce costs for consumers and meet the diverse transportation needs of urban areas while minimizing the environmental impacts of transportation.

Publicly accessible charging stations, along with charging options for electric transit, will play a key role in achieving a large-scale national transition to electric mobility. While most EV owners will primarily charge their vehicles at home or at work, many individuals and businesses will also depend on public charging to enable access to electric mobility options. These include renters, residents of multifamily housing, and others who may not have accessory parking in which to set up their own chargers at home, as well as drivers on longer trips and people using shared micromobility devices. Increasing the availability of affordable and accessible public charging can help make electric mobility of all types more convenient for residents and visitors of urban areas, including people with disabilities, and give electric mobility users the confidence that they will be able to recharge when and where they need to, just as reliably as they can refuel a conventional vehicle today.

The Biden-Harris Administration has **set a goal** to make half of all new vehicles sold in the U.S. in 2030 zero-emissions vehicles, and to build a convenient and equitable network of 500,000 chargers to help make EVs accessible to all Americans for both local and long-distance trips.

On November 15, 2021, President Biden signed the **Bipartisan Infrastructure Law**, also referred to as the Infrastructure Investment and Jobs Act, which contains up to $7.5 billion in new funding for EV charging stations, makes EV charging infrastructure eligible for additional Federal funding programs, and provides funding for numerous other electric mobility-related initiatives. This funding will benefit communities across the country by providing a ready source of capital for electric mobility infrastructure projects.

More recently, on August 16, 2022, President Biden signed the Inflation Reduction Act (IRA), which will be the largest investment in addressing climate change in U.S. history and includes **several funding programs and tax credits** for EVs and charging infrastructure. Underlying these new EV-related laws, the Biden-Harris Administration's **Justice40 Initiative** establishes a goal that 40 percent of the benefits from Federal investment in clean energy and energy efficiency, clean transportation, and climate change, among other key areas, flow to disadvantaged communities.

To prepare for the growing number of plug-in electric vehicles on the road, State and local leaders can advance their communities' **EV readiness** by developing EV-related infrastructure, policies, and services. While the path to installing and operating EV charging infrastructure varies across States, municipalities, and utilities, organizations and initiatives have made strides in advancing EV readiness across the United States. For example, in Austin, Texas an electric utility partnered with local governments and planning organizations to develop a regional **EV action plan**, and cities like Orlando, Florida have adopted an **EV Readiness code** for new construction projects.

Urban communities are also collaborating and exchanging knowledge in support of EV readiness. The Metropolitan Mayors Caucus convenes municipal leaders from across the greater Chicago area and has developed an **EV Readiness guide and checklist** for its member communities. In a national initiative, the Climate Mayors network of more than 400 U.S. mayors launched the **Climate Mayors EV Purchasing Collaborative** to support cities in transitioning their fleets to electric and assessing infrastructure options. Importantly, regional EV readiness will require coordination beyond city lines, with States, local governments, transportation planning agencies, electric service providers, and other stakeholders working together to address regional challenges, including developing an EV workforce to install and maintain a growing EV infrastructure network. Funding and innovative financing opportunities for electric mobility-related initiatives also continue to develop. Many States and utilities offer funding and financial incentives for EV infrastructure, showing a continued commitment to EV readiness.

While there is significant information available on how to plan and develop charging infrastructure, these resources are spread across Federal agencies and do not specifically address the diverse forms of electric mobility available to Americans living in urban areas. Similarly, funding programs for electric mobility infrastructure are distributed across numerous Federal and State agencies, making it difficult for stakeholders to determine which programs they are eligible for. Equipped with the resources in this toolkit, urban communities will have the tools and information they need to start planning and implementing electric mobility infrastructure projects and to ultimately realize the benefits of electric mobility.

TOOLKIT OVERVIEW

This toolkit is intended for a variety of urban stakeholders, including States, local communities, transportation providers, nonprofits, businesses, and individuals. The toolkit covers infrastructure for different types of electric mobility whether owned individually or shared in a fleet, including light-duty passenger vehicles (such as sedans, sport utility vehicles (SUVs), and pickup trucks), micromobility (including electric bikes and scooters), transit and school buses, and medium- and heavy-duty vehicles. This toolkit generally uses the term "EV" to refer to light-duty electric passenger vehicles, and "electric mobility" to refer to the broader range of electric transportation options.

This toolkit covers the stages of electric mobility infrastructure development in the following sections:

- **Section 2: Electric Mobility Basics** provides a brief overview of types of EVs; the three charging levels for EVs (which correlate to charging speed capacity); and an overview of electric micromobility and electric transit.
- **Section 3: Benefits and Implementation Challenges of Urban Mobility Electrification** introduces the benefits to communities and individuals associated with electric mobility and charging infrastructure, as well as some of the challenges and evolving strategies to be able to realize those benefits.
- **Section 4: Partnership Opportunities** discusses key partners and stakeholders for electric mobility infrastructure projects, including regional and local coalitions, planning and transit agencies, utilities, and site hosts.
- **Section 5: Electric Mobility Infrastructure Planning for Urban Areas** summarizes the different scales of electric mobility infrastructure planning and project delivery, provides a walk-through of the key technical considerations in planning a new installation, including for transit and micromobility, and discusses methods to support an equitable planning process.
- **Section 6: Electric Mobility Infrastructure Funding and Financing for Urban Areas** provides information on Federal funding programs and other funding-related resources that may reduce the financial burden of implementing electric mobility infrastructure. At the end of this section, the **Urban Electric Mobility Infrastructure Funding Table** provides a comprehensive list of Federal funding programs applicable to different types of urban electric mobility charging projects.
- **Appendix A: Resources for Electric Mobility Infrastructure Planning** provides an annotated list of planning support tools and other resources, and **Appendix B: Environmental Statutes and Executive Orders** discusses requirements relevant to electric mobility infrastructure planning.

Sidebars throughout the document provide relevant examples and highlight key concepts.

Many of the activities described in this toolkit can—and often do—happen in parallel, so the user can expect to jump between sections as needed. Toolkit users are encouraged to treat this document not as a sequential list of instructions, but as a companion in the process of completing a project.

SECTION 2

ELECTRIC MOBILITY BASICS

Electric mobility includes light-, medium-, and heavy-duty electric vehicles, electric micromobility devices, and transit vehicles. The electric light-duty vehicle market is evolving rapidly, with **models available** in a range of vehicle types, from motorcycles, compact cars, and sedans to SUVs and pickup trucks. Some EVs operate solely on batteries, while others are plug-in hybrid models with both an electric motor and an internal combustion engine. This section provides an overview of the types of electric mobility and types of charging infrastructure, including specifics pertaining to battery electric buses (BEBs) used in transit applications, electric school buses (ESBs), and electric micromobility.

VEHICLE TYPES

There are three types of electric vehicles available on the market:

- **Battery electric vehicles (BEVs)**—also referred to as "all-electric vehicles"—run on electricity only and are recharged from an external power source. They are propelled by one or more electric motors powered by rechargeable battery packs. **Almost all BEVs**, including **electric motorcycles**, can travel at least 100 miles on a charge, and many new vehicles coming on the market offer an all-electric range of 200–300 miles or more. Included among BEVs are electric buses such as BEBs and ESBs.
- **Plug-in hybrid electric vehicles (PHEVs)** also use batteries to power an electric motor and can be recharged from an external power source, but they incorporate a smaller internal combustion engine that can recharge the battery (or in some models, directly power the wheels) to allow for longer driving ranges. PHEVs can usually drive moderate distances in "EV mode" using only the battery, typically from 20 to 50 miles in **current models**. This significantly reduces their gasoline use and emissions under typical driving conditions, since **most trips are short**. PHEVs use **14 to 47 percent less fuel** than conventional vehicles if their batteries are fully charged. When electricity is unavailable, PHEVs can run on gasoline alone.
- **Fuel cell electric vehicles (FCEVs)** use a highly efficient electrochemical process to convert hydrogen into electricity, which powers an electric motor. FCEVs on the market today are not designed for recharging their battery from an external source. Rather, they are fueled with compressed hydrogen gas that is stored in a tank on the vehicle.

This toolkit uses the term "EV" to refer to both BEVs and PHEVs,[1] since these vehicles can be recharged from external sources and are capable of operating with zero tailpipe emissions. This toolkit focuses primarily on EVs and does not address FCEVs unless otherwise noted.

CHARGER LEVELS AND SPEEDS

Many factors influence EV charging speed including the EV battery's state of charge, battery deterioration, use of power while charging, ambient temperature, and power level of EV charging equipment. EVs can be charged using three charging levels. The slowest, **Level 1** equipment, provides charging through a common residential 120-volt (120V) alternating current (AC) outlet. Level 1 chargers can take 40-50 hours to charge a light-duty BEV from empty, 5-8 hours to charge an electric motorcycle, and 5-6 hours to charge a PHEV.

Level 2 equipment offers charging through 240V (in residential applications) or 208V (in commercial applications) electrical service, and is common for home, workplace, and public charging. Level 2 chargers can charge a light-duty BEV from empty in 4–10 hours, an electric motorcycle in 1–4 hours, and a PHEV in 1–2 hours.

The fastest speed, **direct current fast charging** (DCFC) equipment, enables rapid charging along heavy-traffic corridors at installed stations. DCFC equipment can charge a light-duty BEV to 80 percent in 20 minutes to 1 hour and some **electric motorcycles** in 5–30 minutes. Most PHEVs and some electric motorcycles currently on the market are not capable of using DCFCs.

1 Hybrid electric vehicles (HEVs), powered by a combination of an internal combustion engine with electric motors running off a battery pack for greater efficiency, have batteries that cannot be recharged from an external source, and are not considered EVs.

EV Charging Minimum Standards Rule

The Federal Highway Administration (FHWA), with support from the Joint Office of Energy & Transportation, unveiled new national standards for federally funded EV chargers in February 2023. These new standards aim to ensure that charging is a predictable and reliable experience for EV drivers. This includes ensuring that drivers can easily find a charger, drivers experience consistent price communication and payment methods, chargers work when drivers need them, and chargers are designed to be compatible with future capabilities.

The rule establishes minimum technical standards for charging stations, including required number of charging ports, connector types, power level, availability, payment methods, uptime/reliability, EV charger infrastructure network connectivity, and interoperability, among other standards and requirements.

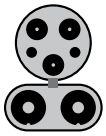
Level 2 and DCFC equipment have been deployed at various public locations including, for example, at grocery stores, theaters, or coffee shops. When selecting a charger type, consider its voltages, resulting charging and vehicle dwell times, and estimated upfront and ongoing costs, discussed further in the *Installation Planning* section. Figure 2-1 shows typical Level 2 and DCFC charging stations.

Table 2-1 summarizes the typical power output, charging time, and locations for the different charger types. Different vehicles have different charge ports. For DCFC, the Combined Charging System (CCS) connector is based on an open international standard and is common on vehicles manufactured in North America and Europe; the CHArge de Move (CHAdeMO) connector was a previous standard for Japanese-manufactured vehicles. Tesla vehicles have a proprietary connector that works for all charging speeds, including at Tesla's "Supercharger" DCFC stations, while non-Tesla vehicles require adapters at these stations.

Note that **charging speed slows** as the battery gets closer to full to prevent damage to the battery; therefore, it is more cost- and time-efficient to charge the battery part-way rather than to 100 percent. For example, with direct current (DC) fast charging it can take about as long to charge the last 10 percent of an EV battery as the first 90 percent. For more information on the power requirements of different chargers, see the *Utility Planning* section.

Figure 2-1: Level 2 chargers (left) are common in home, workplace, and public settings and can charge a BEV from empty in 4–10 hours. DCFC chargers (right) are common as public chargers and along highway corridors and can charge a BEV to 80 percent in under an hour. (Source: Kelly Buckland [left]; Joint Office of Energy & Transportation [right].

Table 2-1. Overview of EV chargers: power output, plug type, and charge time for light-duty vehicles. (Adapted from Alternative Fuels Data Center)

	LEVEL 1	LEVEL 2	DC FAST CHARGING
Connector Type	J1772 connector	J1772 connector	CCS connector  CHAdeMO connector Tesla connector
Typical Power Output	1 kW	7 kW-19 kW	50-350 kW
Estimated Light-Duty PHEV Charge Time from Empty[2]	5-6 hours	1-2 hours	N/A
Estimated Light-Duty BEV Charge Time from Empty[3]	40-50 hours	4-10 hours	20 minutes-1 hour[4]
Estimated Light-Duty Electric Range per Hour of Charging	2-5 miles	10-20 miles	180-240 miles
Typical Locations	Home	Home, Workplace, and Public	Public

2 Assuming an 8-kWh battery; most plug-in hybrids do not work with fast chargers.

3 Assuming a 60-kWh battery.

4 To 80 percent charge.

ELECTRIC MICROMOBILITY BASICS

Electric **micromobility** includes any small, low-speed, electric-powered transportation device, including electric-assist bicycles (e-bikes), electric scooters (e-scooters), and other small, lightweight, wheeled electric-powered conveyances. The upfront capital cost of electric micromobility is less than that of BEVs.

Electric micromobility devices are typically charged using common residential 120V AC outlets. Depending on micromobility device battery capacity and charger (cable or dock) specifications, charging times can **range from 2.5 to 9 hours**.[5] Micromobility range can be from 20 miles to **more than 100 miles** for an e-bike, and for e-scooters from an average of 12 miles to **more than 30 miles**. This market is also evolving rapidly; for example an e-bike battery that can be **charged in 20 minutes** and an e-bike with a **300-mile range** are available.

ELECTRIC BUS BASICS

Similar to the BEVs discussed above, BEBs and ESBs run on electricity only and require recharging their onboard battery packs from an external power source.[6] The average range for BEBs and ESBs varies based on the battery pack capacity and is significantly impacted by weather, driving behavior of the operators, topography, and ridership load.

BEBs are categorized as long-/extended-range or fast-charge depending on the size of their battery packs. Long-/extended-range BEBs have larger battery packs (250–660 kWh) and are meant to only be charged once or twice per day. In contrast, fast-charge BEBs have smaller battery packs (50–250 kWh) that can receive more frequent high-powered charges.

A type of BEB, ESBs tend to have smaller battery packs as they often operate on shorter routes with a midday break during school hours for charging. Because of this use pattern, ESB equipped with bidirectional batteries are also uniquely suited for Vehicle-to-Grid (V2G) or Vehicle-to-Building (V2B) arrangements in which the ESB **provides energy storage** that can moderate the cost of electricity during peak times, store power generated from intermittent renewable sources, provide backup power in case of power outages, and ultimately bring financial benefits to school districts as they sell power back to the grid.

There are three types of charging infrastructure for BEBs, all of which can be installed at the maintenance or storage facility (depot) or on-route:

- **Plug-in charging** has both AC and DC options to charge at a low power (40–125 kW). The number of buses accommodated will depend on the configuration of chargers and ports, which are often installed in depots as buses are generally charged for multiple hours or overnight. Larger batteries typical of BEBs (250–660 kWh) require long charging time at low power. There are a **number** of **faster** (up to 350 kW) plug-in charging **solutions** available for transit vehicles. Even faster plug-in charging options are under development, with a **1 MW standard** introduced in summer 2022.
- **Wireless inductive charging** uses floor-mounted receiver pads that are charged using a magnetic field produced by a transmitter embedded in the roadway. This system uses a low to medium power level (50–250 kW).

5 An e-bike charging time calculator allows users to estimate charge duration based on battery capacity, level of discharge, and charger specification inputs.

6 For more detailed information on BEBs, ESBs, and their charging infrastructure, see the Transit Cooperative Research Program's "Guidebook for Deploying Zero-Emission Transit Buses" and the National Renewable Energy Laboratory's "Electrifying Transit: A Guidebook for Implementing Battery Electric Buses."

Figure 2-2: Plug-in charging (top) charges at a low power (40–125 kW) (Source: Adobe Stock).
Wireless inductive charging (middle) uses floor-mounted charging pads and charges at a lower power (50–250 kW), (Source: Society of Automotive Engineers).
Overhead conductive charging (bottom) charges at a higher power level (165–600 kW). (Source: Adobe Stock).

- **Overhead conductive (pantograph) charging** requires a physical connection between the charger and the onboard battery through a pantograph apparatus or overhead wires. In-service electric buses can be recharged through a pantograph charging system while stationary in 5–20 minutes at a higher power level (165–600 kW). **In-motion charging (IMC) trolleybuses**, which use overhead catenary wires installed on only 20–40 percent of the bus route and otherwise use battery power, charge at a low power level while moving.

Section 5: Electric Mobility Infrastructure Planning for Urban Areas contains more information about transit electrification planning, including cost considerations regarding charging infrastructure.

SECTION 3

BENEFITS AND IMPLEMENTATION CHALLENGES OF URBAN MOBILITY ELECTRIFICATION

EV charging infrastructure expansion to date has mostly been concentrated in cities and along major highways. The **50 most populous metropolitan areas** accounted for 80 percent of new 2019 U.S. EV registrations, even though they only house 55 percent of the U.S. population. As of 2022, **158 communities** in the U.S. were served by shared e-scooters, 35 were served by dockless bikeshare, and 61 docked bikeshare systems were in operation, many of which now deploy e-bikes. Also as of September 2022, about **5,500 zero emission transit buses** were on the road in the U.S., and more than **13,000 electric school buses** were on order, delivered, or operating. Urban residents, businesses, and communities are well-positioned to realize the significant economic, environmental, and health benefits from electric mobility.

This section describes the benefits that electric mobility can provide to individual electric mobility users and to urban communities as a whole, with additional consideration of the unique benefits of electric micromobility and electric transit. It also discusses key challenges in implementing electric mobility charging infrastructure in urban areas along with emerging solutions for overcoming these challenges. As emphasized in *Section 5: Electric Mobility Infrastructure Planning for Urban Areas*, urban planners should work to ensure these benefits are equitably distributed across the community.

BENEFITS TO INDIVIDUALS

Electric mobility offers numerous benefits to individual vehicle owners and businesses, including lower operating and maintenance costs, the ability to charge vehicles in a variety of locations, and the ability to provide a backup power source during outages or natural disasters. In addition, individuals have an increasing choice of EV options as the market expands. Electric micromobility can provide even lower purchase, operating, and maintenance costs relative to EVs, while also providing increased access to jobs and services and expanded travel options for underserved communities. Electric micromobility can also mitigate individual experiences of traffic congestion, crowded transit, or limited parking, and if scaled across many adopters, can yield a host of other benefits.

LOWER VEHICLE FUEL AND MAINTENANCE COSTS

Although EVs can have a higher purchase price than similar gasoline- or diesel-fueled vehicles, their lower maintenance and fuel costs can yield significant savings for as long as an EV is owned. For most electric vehicle owners, even when their purchase prices are higher, their fuel and maintenance savings will **result in a lower total cost of ownership**.

Moreover, **some automakers** project the upfront costs of EVs will continue to decrease, reaching purchase price parity with conventional vehicles around 2025 to 2030. At the same time, new and revised **tax credits** under the 2022 Inflation Reduction Act are designed to help consumers overcome financial barriers to obtaining electric vehicles.

EVs take advantage of the inherent high efficiency of electric motors, making the average EV **3.6 times more energy efficient** than a similar conventional vehicle. EVs also use **regenerative braking**, which allows the vehicle to recapture energy when braking. Because EVs are more efficient than conventional vehicles, they use far less energy and, considering the **lower cost of electricity** compared to gasoline, have substantially lower operating costs. Efficiency for EVs is typically expressed in miles per gallon of gasoline equivalent (MPGe), which represents the number of miles a vehicle can travel using a quantity of electricity with the same energy content as a gallon of gasoline (**33 kilowatt-hours [kWh]**).[7] Most light-duty BEVs and PHEVs in electric mode can **exceed 130 MPGe** and can drive 100 miles consuming only 25–40 kWh. At the same time, EVs generally perform better than their conventional counterparts, with quicker and smoother acceleration and better towing capacity due to the fact that electric motors generate full torque at all revolutions per minute (RPMs) and EVs **do not need a transmission**.

While the cost of charging will depend on the cost of electricity in particular areas, the high fuel economy of EVs leads to **lower fueling costs** compared to gasoline or diesel vehicles. For example, the electricity required to drive an EV **15,000 miles** in a year costs an average of $600, while the gasoline required to drive the same distance averages $2,700,

7 Electric vehicle efficiency can also be expressed as kilowatt-hours per 100 miles or miles per kilowatt-hour. This calculator enables easy conversion between these units of measure.

representing a savings of over $2,100 per year.[8] Argonne National Laboratory's **EVolution tool** allows users to compare the expected fuel usage and costs of specific EVs and conventional gasoline vehicles based on gas and electricity prices in a given area.

In addition to fuel savings, average maintenance and repair costs for an EV are up to **50 percent lower** than a conventional vehicle, as EVs are free of many vehicle components that require regular maintenance (e.g., engine oil, spark plugs, air filter, transmission fluid). The use of regenerative braking also reduces brake maintenance costs. These cost savings are important for urban households, for which transportation is a **significant part of the household budget**, as seen as seen in Table 3-1. Drivers who switch to an EV could potentially save thousands of dollars in maintenance costs over the vehicle's lifetime.

Table 3-1. Average annual transportation expenditures of urban households, 2020.

(Source: Bureau of Labor Statistics)

Mean annual household transportation expenditure	**$9,822**
Transportation share of all annual household expenditures	**15.7%**

Electric micromobility options are available at much lower price points than EVs or gasoline- or diesel-fueled vehicles, which helps explain why in the U.S. in 2020 **more than twice as many e-bikes** were sold compared to EVs. Even with EV sales doubling in 2021, e-bike sales were still almost **45 percent higher**. Budget model e-bikes are now available for $1,500 or less, with mid-range models (including cargo models) costing up to about $4,000. E-bike testing has demonstrated between **2,200 and 3,800 MPGe**—18 to 29 times more efficient than an EV with 130 MPGe. Operating costs for an e-bike are generally less than $0.10 per charge and estimated to be **$30–$50 per year** for regular usage. E-bikes may be cost-competitive with annual expenditures on public transportation for some individuals who use transit as their primary mode of transportation. And owning an e-bike or e-cargo bike instead of a car could potentially save tens of thousands of dollars over the vehicle's lifetime.

READILY AVAILABLE FUELING INFRASTRUCTURE

EVs can be charged at home, as well as at workplaces, public facilities, grocery stores, and other locations that offer parking with EV chargers. While EV charging takes longer than refueling a vehicle with gasoline, convenient **at-home** and **workplace** charging is sufficient to support most urban travel and eliminates the need to drive to a gas station, saving time and money. In fact, **more than 80 percent** of EV drivers rely on home charging. For longer trips, the **growing number** of publicly available DCFC stations can provide a near-full charge (80 percent) in under an hour. Additionally, owners of public or private vehicle fleets can establish EV charging infrastructure for business use at their own office locations or fleet depots. Charging stations will become even more accessible to drivers in all parts of the country as projects funded by the Bipartisan Infrastructure Law are implemented.

Micromobility devices frequently do not require dedicated charging infrastructure and may also be charged at home or at work. Personally owned electric micromobility can be readily charged at home, regardless of whether households have access to car parking. Devices with removable batteries can also be charged at work or other non-home locations. New York City is one of the first

8 The analysis assumes 55 percent city driving and 45 percent highway driving, and fuel costs of $3.999/gallon.

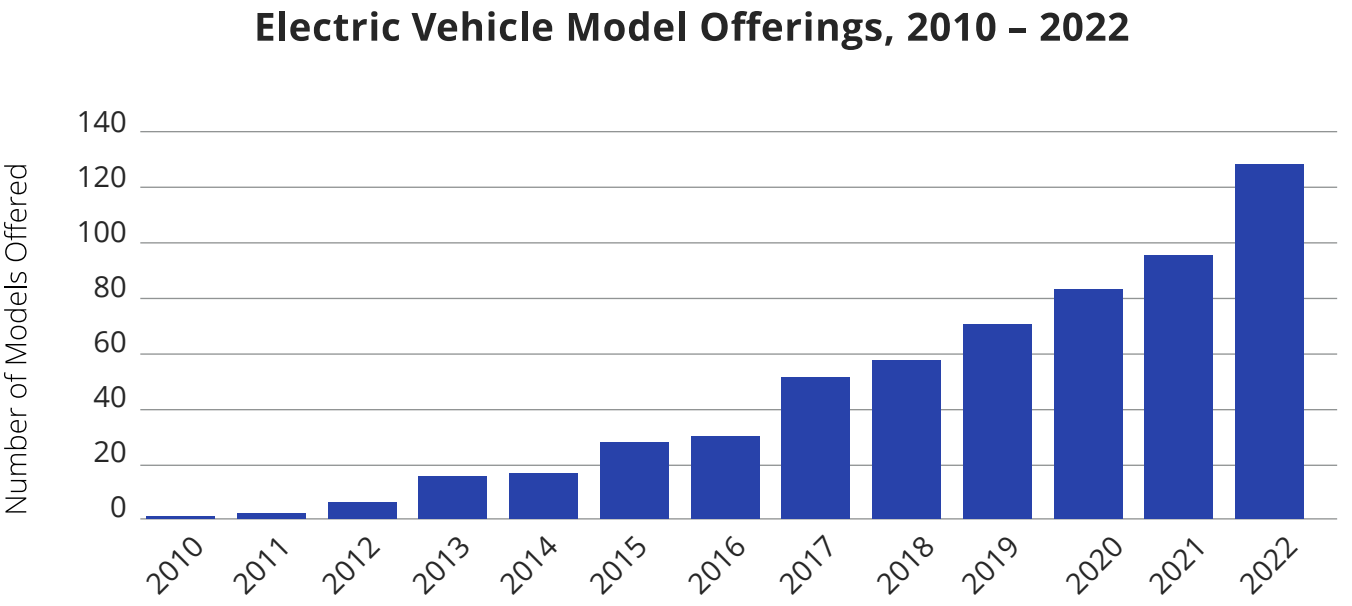


Figure 3-1. Light-duty electric vehicle models by year. EVs include BEVs and PHEVs. (Source: DOE Alternative Fuels Data Center)

cities in the U.S. to **plan for publicly accessible e-bike and e-scooter charging** for personally-owned micromobility, indicating a likely nationwide trend. This type of universal micromobility charging station is also being developed by multiple **private sector actors**. For shared electric micromobility, service providers currently depend on either dock-based charging or battery swaps. The potential **shift to docked e-scooters** by some operators would address both the charging challenge (by eliminating the need for battery swaps) while also mitigating issues with e-scooter parking that can result in walkway obstructions, which have been a source of tension from the dockless systems.

VEHICLE OPTIONS

The number of light-duty EV models for sale in the United States is growing at a rapid pace. In 2010, there was only one EV model on the market, while by 2022, that number had grown to **129 models** (see Figure 3-1). The expanding EV marketplace includes a wide array of vehicle types and styles, including cars, SUVs, and light-duty trucks, at price points ranging from entry level to luxury models. This is in addition to a steeply growing number of options for electric motorcycles, micromobility, and transit buses. The variety of vehicle types can meet diverse user needs. Smaller cars and compact SUVs are the most popular light-duty EVs in highly urban States, but **electric bicycles have outsold** even these. The U.S. imported almost 790,000 electric bikes in 2021, up from about 463,000 in 2020—finishing a second full year in which e-bikes topped electric cars.

For information on available EV car models, see the Department of Energy (DOE) **Alternative Fuel and Advanced Vehicle Search tool** as well as the **car finder page** at Fueleconomy.gov.

About **30 models of BEBs and 15 models of ESBs** are available in the U.S. market as of summer 2022.

As of 2021, there are **273 cities** in the United States with shared bicycle and/or scooter systems with 202,000 micromobility devices available for use on an average day. Across the United States, shared micromobility systems enabled 107.6 million trips including docked and dockless bicycles, conventional and electric bicycles, and e-scooters. Bikeshare systems are providing more electric options for

riders; in 2021, e-scooters accounted for almost half of all trips, up from approximately third in 2020, and e-bike trips almost doubled the 2020 level.

The number of models of e-bikes, e-cargo bikes, and e-scooters has increased dramatically in recent years, and this will likely continue. E-bikes are available in three classes defined at 23 U.S.C. § 217(j)(2): Class 1 provides pedal assistance and has a maximum assisted speed of 20 mph; Class 2 provides throttle assistance and has a maximum assisted speed of 20 mph; and Class 3 provides pedal assistance and has a maximum assisted speed of 28 mph.

RESILIENCE AND POWER ON THE GO

Some EVs can themselves serve as a power source for electrical tools, equipment, and lighting for commercial and recreational purposes. When coupled with bidirectional chargers, EV batteries can even power homes during blackouts and extreme weather events in place of diesel generators. Several automakers have released EVs with **bidirectional charging** capability. While the amount of time that an EV could offer backup power depends on the size of the battery, at least one recent model could **power a house for up to three days** based on daily average usage of 30 kWh. EVs can be complementary to residential renewable energy generation like rooftop solar by providing battery storage capacity, acting as a backup power source for homes and potentially selling energy back to the grid at high-demand times.

Shared micromobility such as bikeshare systems can provide redundancy and fill service gaps during unplanned infrastructure failures and planned repairs (e.g., during extreme weather- or pandemic-related transit closures). For example, during **Hurricane Ida** in 2021, New York City's bikeshare system broke its single day ridership record with over 126,000 trips.

BENEFITS TO COMMUNITIES

Electric mobility—and the charging infrastructure that supports it—also offers benefits to urban communities. This includes economic development opportunities from offering people a place to charge their vehicles, workforce development, health benefits from improved air quality, lower greenhouse gas emissions, and quieter vehicles.

ECONOMIC DEVELOPMENT

Given current limits on the range of EVs, those drivers may be especially attuned to the availability of charging stations along their routes and plan their stops accordingly. Given the time required even when using fast charging infrastructure, EV drivers may also be inclined to **combine** their refueling stops with other activities, including visits to local stores, restaurants, parks, and attractions in the vicinity. Providing EV charging stations can thus enable urban communities to draw regional travelers driving EVs and to stay connected to the broader EV charging network, benefiting both local residents and outside **visitors** alike, as well as bringing in **revenue** for local businesses.

While it may require substantial investment in charging infrastructure to realize these outcomes, much of those costs can be covered by a variety of funding opportunities. Many public and private organizations offer grants, loans, or financial incentives to help individuals, businesses, and communities purchase both EVs and EV chargers. For example, the Internal Revenue Service (IRS) **Alternative Fuel Vehicle Refueling Property Credit** provides a tax credit for EV charging stations placed into service. See *Section 6: Electric Mobility Infrastructure Funding and Financing for Urban Areas* for information on Federal funding programs that could support entities in planning for and purchasing electric mobility charging infrastructure.

IMPROVED AIR QUALITY

The tailpipe emissions from internal combustion engine vehicles cause **air pollution, which leads to adverse health impacts**. These impacts are predominant in urban areas, which encompass **most areas designated to be in non-attainment** with Federal air quality standards. Urban residents **experience significantly more unhealthy air-quality days** than rural residents, including about 12 times more excessive ozone days and 12 times more excessive PM2.5 days per year.

Battery electric vehicles, including BEBs and ESBs, run with **zero tailpipe emissions**, while plug-in hybrid electric vehicles produce some emissions when they operate on gasoline, but less than comparable conventional vehicles. As a result, EVs can reduce air pollution around urban homes and businesses and provide health benefits. According to the **American Lung Association**, transitioning to a nationwide electric transportation system by 2050 would save approximately 6,300 lives every year and avoid 93,000 asthma attacks and 416,000 lost work days annually. Commercial drivers do not breathe toxic exhaust in EVs as they drive or idle, reducing **health impacts** such as fatigue that can reduce driver attentiveness and safety. Due to regenerative braking, EVs also have less **brake dust pollution** than conventional vehicles. These health benefits are particularly important for areas overburdened by pollution, which are predominantly **certain communities of color and low-income communities**.

LOWER GREENHOUSE GAS EMISSIONS

The effects of climate change are felt in different ways in different communities, but examples in urban areas include increased frequency and severity of storms and flooding, and increased heat and droughts. The transportation sector is responsible for **29 percent** of all U.S. greenhouse gas (GHG) emissions, more than any other U.S. sector, and approximately **60 percent** of these emissions come from passenger vehicles. Compared to conventional vehicles, EVs have significantly **lower GHG emissions**, especially if electricity is generated with renewable energy sources like hydroelectric, solar, or wind.

In addition, transitioning from conventional vehicles to electric micromobility can contribute to climate change mitigation and national emission reduction goals. According to the National Renewable Energy Laboratory, high adoption of shared micromobility can save **2.3 billion** gasoline-equivalent gallons per year nationwide.

LESS NOISE POLLUTION

Urban areas have an **average background noise level of 60 decibels**, with regular spikes up to 85 decibels or more, and the two largest sources of this environmental noise are transportation and industrial activity. The World Health Organization has found **that traffic noise is second only to air pollution** in impacting public health, and various studies have linked noise exposure to increased risk for insomnia, high stress levels, cardiometabolic diseases, and cardiovascular diseases and strokes. In contrast to an internal combustion engine vehicle, EVs, including BEBs and ESBs, can be virtually inaudible due to a lack of engine noise. This is especially true in urban centers and residential areas, where most vehicle noise is created by engines and not by wind and tire noise, as on highways. The reduction of noise levels through the introduction of EVs offers community benefits by reducing general noise pollution, as well as **individual benefits for the driver** of the vehicle, **potentially lowering stress level**. At the same time, enough sound level is important for the safety of people walking, biking, and rolling, particularly for those who are vision-impaired, who rely on being able hear vehicles to safely navigate streets and parking lots. Light-duty electric vehicles are **currently regulated** to produce minimum sound levels when driven at low speed. Similar solutions **could be applied** in the future to heavy electric vehicles such as buses and trucks.

BENEFITS OF INCREASED TRANSPORTATION OPTIONS

While giving more people the choice to shift to EVs has many benefits, including reducing costs and dependence on foreign sources of energy, it does not mitigate the other challenges to urban transportation systems. In contrast, increasing the use of electric micromobility and electric transit can align with many cities' goals of reducing traffic congestion, pressure on parking, and the use of raw materials and associated waste streams. These benefits are in addition to the relatively greater affordability, more readily available fueling infrastructure, and lower greenhouse gas emissions previously described.

ACCESS, MOBILITY, AND EQUITY

Electric micromobility devices, paired with safe active transportation infrastructure, can help to close the first- and last-mile gaps to transit and can offer individuals greater access to jobs, health care, and other services. Electric and adaptive micromobility devices may also increase mobility for older adults, parents with young children, or individuals with disabilities, as they are less strenuous to operate than traditional bicycles or scooters. Micromobility can also help to expand travel options for underserved communities because of their lower upfront and operating costs compared to traditional vehicles. Shared micromobility has no upfront capital costs for users. According to **NACTO**, the average 12-minute scooter share trip costs $2.80 to $4.70 depending on the system. Many shared micromobility providers offer discounted fare structures, credit-free access, and non-smartphone access for lower income and unbanked individuals.

TRAFFIC CONGESTION AND INFRASTRUCTURE

Replacing single-occupancy vehicle trips with micromobility or transit trips can be beneficial in terms of reducing overall traffic congestion, as real-world examples have quantified. The City of Atlanta temporarily banned micromobility usage in the fall of 2019, a policy that **was found** to have increased travel times by about 10 percent for daily commuting and by 37 percent for large events. Extrapolated nationally, researchers estimate that banning existing micromobility services would lead to more than $530 million in annual congestion-related costs (using a value of time of $26/hour). Making both electric micromobility and electric transit available to more residents is one way of reducing or avoiding increased traffic congestion. Decreasing demand for future car trips by increasing the supply of alternative mode options will also influence future infrastructure needs.

PARKING, LAND USE, AND HOUSING

Space dedicated to vehicle parking is estimated to comprise a **significant fraction of the land area** and **housing cost** in U.S. cities. As many communities across the country face housing affordability challenges, there is continued attention to opportunities for repurposing land for new housing as well as a **movement** toward reducing or eliminating parking requirements. A shift at scale of existing or future trips to electric micromobility and transit could reduce demand for dedicating space to vehicle movement and storage therefore enabling other uses of limited urban land area.

RAW MATERIALS

Raw material availability and ownership as well as supply chain constraints are important factors in the speed of the transition to EVs. Argonne National Laboratory reports that an **EV battery pack can weigh** between 140 kg for a compact EV and more than 650 kg for an electric SUV, including nickel, cobalt, manganese, and lithium. In contrast, e-bike and e-scooter batteries typically weigh from 3 to 10 kg. EVs have total vehicle weights starting from about 1,200 kg and as high as 3,000 kg, while electric micromobility vehicles range from about 10 kg for e-scooters to 30 kg for an e-bike, and electric cargo bikes as high as 40 or 50 kg. This is almost two orders of magnitude in difference between EVs and electric micromobility, demonstrating that the use of micromobility modes when possible and at-scale can significantly impact the consumption of raw materials.

IMPLEMENTATION CHALLENGES AND EVOLVING SOLUTIONS FOR URBAN COMMUNITIES

While the electric mobility market has accelerated substantially and charging infrastructure continues to grow, several key challenges remain. This section outlines these challenges, with a particular focus on concerns for urban areas. It also introduces emerging solutions for addressing these challenges and references sections of the toolkit where these solutions are described in more detail.

UPFRONT VEHICLE AND CHARGING INFRASTRUCTURE COSTS

EV prices span a wide range, **with some new models starting as low as $25,600** and others costing over $90,000. While the cost of EVs continues to decrease, the initial expense of EV charging infrastructure and the higher cost of most EVs available today still pose a barrier to EV purchases. In 2022, the **average cost** of a new non-luxury light-duty vehicle overall was nearly $44,600, while comparable EVs available cost over $65,000 on average before applicable tax credits (9 percent

DEVELOPING TOMORROW'S EV WORKFORCE

As the American workforce adapts to the growing needs of the EV industry, researchers are working to understand the potential workforce impacts of a large-scale transition to EVs. As with any new industry, many new jobs will be created, while others may be eliminated. Some studies have pointed to the uncertainties around net job creation from EV manufacturing. It is expected that most automotive-parts manufacturing jobs will not change significantly, although this will vary based on job type.

In terms of overall impact, a 2021 report by Energy and Environmental Research found that the Biden Administration's plan to have 500,000 fast chargers by 2030 would "generate workforce needs of around 28,950 job-years from 2021 to 2030." That report also analyzed California's workforce needs and found that the greatest needs for light-duty EV charging infrastructure would be for electricians and electrical contractors, general contractors, and planning and design consultants.

Federal action in EV workforce development is spearheaded by DOE, which supports relevant programs for EVs and other kinds of alternative fuels and alternative fuel vehicles—including efforts to train technicians, first responders, and code and safety officials. A major expansion of DOE's efforts will focus on building a clean mobility workforce to support the decarbonization of the transportation sector by 2050. DOE-funded activities in EV workforce development include the Clean Cities University Workforce Development Program, which places interns at Clean Cities coalitions around the United States to support work on infrastructure deployment, data collection, outreach and education, and marketing. This program includes a specific focus on representing diverse populations. DOE and the Joint Office of Energy and Transportation are also developing other initiatives with external partners to help workers transition from a fossil fuel-based set of skills to a new clean energy set of skills.

The Electric Vehicle Infrastructure Training Program (EVITP) provides training and certification for electricians installing EVSE. The EVITP is the only EV charging-specific, brand-neutral training program that exists today and is utilized by both large and small contractors. It was created through a collaboration of many stakeholders to provide qualified electricians for the installation, operations, and maintenance of EVSE.

Additional advanced mobility workforce education programs are in development to enable upskilling and reskilling of the workforce to support the decarbonization of the transportation sector and fill future clean energy jobs, including at colleges and universities, as well as technical and vocational schools. Many have developed next-generation training curriculums providing workforce education on EV repair and emergency response and charging infrastructure installation and servicing. The National Alternative Fuels Training Consortium (NAFTC) hosted at West Virginia University (Morgantown) maintains a national training center network offering these and other EV-focused technical programs at schools across the country, including many within major cities. Other programs such as the NC Clean Energy Technology Center at North Carolina State University (Raleigh) offer in-person and virtual education and outreach to the general public on EVs and EV charging, as well as services to help organizations analyze their fleets to determine how to best approach EV adoption and charging infrastructure planning.

Other examples of activity in EV workforce development include:

- The National Auto Dealers' Association is partnering with Chargeway to develop a program to improve knowledge of EVs among sales staff.
- ChargerHelp! provides maintenance and repair services for EVSE and has a workforce development program focused on training workers from the local service area.

higher than the average EV price in 2021). New EV models have recently trended toward larger platforms (SUVs and trucks) and more luxurious trims, which has driven up average EV pricing, along with increased consumer demand and supply-chain constraints. Medium- and heavy-duty EVs are also **comparatively more expensive to purchase** than their diesel counterparts.

As noted previously, EVs have a lower total cost of ownership than conventional vehicles due to **lower fuel and maintenance costs**, and therefore have the potential to yield significant savings for households. However, the upfront purchase price can be a barrier for many, particularly for low-income individuals. In addition, many people are not accustomed to considering the total cost of ownership when purchasing a vehicle, so they may perceive the cost of owning an EV over time to be higher than it really is.

The cost of purchasing or leasing an EV is expected **to fall** due to increased EV production volumes, innovations in battery storage, declining battery pack costs, wider availability of both used vehicles and non-luxury EV models, and increased competition among automakers producing non-luxury EVs. For example, DOE is investing in reducing battery costs through public-private partnerships that aim to reduce battery costs from more than $120/kWh today to **$60/kWh by 2030**; this would bring EVs to near cost parity with internal combustion engine vehicles. In addition, **tax credits** under the Inflation Reduction Act, signed in 2022, are designed to reduce financial barriers to acquiring new or used electric vehicles.

Investments in charging infrastructure can also be analyzed on a total-cost-of-ownership basis, based on operational needs and the constraints and cost structure of available (or feasible) utility service. Accurately assessing the total cost of ownership of such investments will lead to better long-term decisions and may make investments in charging infrastructure more appealing (see *Lower Vehicle Fuel and Maintenance Costs* for a discussion of total cost of ownership).

A higher volume of EVs on the road will increase the demand for public charging stations and improve the return on investments in these chargers. In addition, innovations in EV charging technologies and designs are expected to further reduce DCFC station costs. At the same time, Federal and State grants, loans, and other incentives continue to play a substantial role in driving down costs and spurring the EV market. For details on funding options, see *Section 6: Electric Mobility Infrastructure Funding and Financing for Urban* Areas.

LIMITED INFRASTRUCTURE AVAILABILITY AND GEOGRAPHIC DISTRIBUTION

While home-, business-, and fleet-based charging are expected to remain the primary ways EV drivers charge their vehicles, the need for expanded public fast charging continues to rise with the growth of EVs.

Consumers are also concerned about the length of time it takes to charge an EV, the user-friendliness of chargers, the need to plan charging stops on long trips, and the relative convenience and safety of charging locations. Reduced battery performance and EV range during winter months are a further concern for communities in cold climates. Placing public DCFC and Level 2 charging along travel corridors and at key destinations in urban areas can help to address these concerns and provide drivers with the confidence that they will be able to charge their vehicles when and where they need to. **The National Electric Vehicle Infrastructure (NEVI) Formula Funds and the State EV Infrastructure Deployment Plans** will help with the buildout of a more reliable public charging network nationwide.

The National Electric Vehicle Infrastructure Standards and Requirements will help standardize the user experience at chargers across the network.

SAFETY FOR MICROMOBILITY USERS

Electric micromobility users are considered "vulnerable road users," who face potential conflict with other road users and increased safety risks when using unprotected or discontinuous bicycle and pedestrian infrastructure. Thoughtfully connected and high-quality bicycle and pedestrian facilities can improve safety for micromobility users. Because of their lower speeds, micromobility devices may not be authorized on all roadways, so additional consideration may be needed to ensure a connected and complete transportation network for all users. As public micromobility charging options expand, consideration of their siting to complement the travel network is critical.

UTILITY UPGRADES AND ELECTRICITY RATES

The increased use of EVs will create a corresponding need for additional electric grid capacity. A **2019 report** published by a technical team of the U.S. DRIVE partnership, a voluntary government-industry partnership, concluded that: "based on historical growth rates, sufficient energy generation and generation capacity is expected to be available to support a growing EV fleet as it evolves over time, even with high EV market growth." It is expected that any incremental needs will be highly localized and in some cases site specific. DOE and the national laboratories are completing additional research and analysis that examines longer-term needs from the electric grid, particularly as medium-and heavy-duty vehicles electrify.

To meet the demands of larger or faster charging installations—such as DCFC stations, medium- and heavy-duty EV charging sites, and commercial EV fleet charging depots—it may be necessary to upgrade the electrical-service wiring running to a facility, or even upgrade certain components of the local power distribution infrastructure. Such upgrades are more likely where the grid infrastructure may be less robust to begin with or absent altogether. Local distribution network upgrades, such as the addition of three-phase power service and the installation of transformers at DCFC sites, can add substantial costs and time to EV charging projects. For more information on assessing the local grid infrastructure, including an explanation of three-phase power, see the *Utility Planning* section.

Utility pricing can also be a challenge for EV charging installations. Without outside incentive programs, the revenue from DCFC stations typically covers only about one-third of their operating costs. This is largely due to utility demand charges, which are premiums charged by some utilities for using large amounts of electricity during peak hours or when high power is drawn at high rates that exceed certain thresholds. Since rate and demand charge structures (discussed more in the *Utility Planning* section) vary greatly between utilities and across States, these costs could have substantial effects on the business case for deploying fast-charging EV infrastructure in urban communities. Ultimately, both affordable charging rates and high station utilization are essential for station operators to earn sufficient revenue to offset the costs of purchasing, installing, and operating charging stations within a reasonable payback period (five years or less).

Early and ongoing coordination with local utilities and assessing opportunities to use off-grid power sources can help address these challenges.

CHARGING STATION PLANNING AND PERMITTING COORDINATION

The electric mobility sector is still developing, and some localities have little experience with permitting and siting charging infrastructure, including co-locating charging for multiple modes. There are also significant differences in geography, technical expertise, staff capacity, and right-of-way policies across local jurisdictions, potentially hindering knowledge exchange. The different processes and timeframes for reviewing and approving permit applications across local jurisdictions can further lead to confusion and frustration for project developers. Therefore, it may be helpful for States and localities to review and clarify their permitting processes and to support training and capacity building within their planning and permitting departments.

To ease this process, prior to seeking permits charging station developers and utilities should conduct thorough planning and analyses of several factors including projected local EV adoption and the associated demand for public charging, local electric grid capacity, right-of-way access and easement issues impacting the siting of charging stations, and other factors.

PUBLIC AWARENESS AND EXPOSURE TO ELECTRIC MOBILITY

Range anxiety—the fear that a vehicle **will run out of charge** mid-trip—remains a concern among potential EV drivers and poses a barrier to EV adoption. For this reason, poor or lacking infrastructure signage along roadway corridors, along with generally insufficient information on the availability of charging infrastructure, still stymies the EV market. Public outreach efforts by entities such as the DOE-designated national network of **Clean Cities coalitions** are critically important for bolstering EV awareness, equitable access, and adoption (for more information, see the Clean Cities Coalitions section). Such outreach efforts can include public education workshops, ride-and-drive events, e-scooter and e-bike test rides, fleet outreach and trainings, taxi and ride-hail partnerships, and highway corridor signage. **The National Electric Vehicle Infrastructure (NEVI) Formula Funds and the State EV Infrastructure Deployment Plans** will help with the buildout of a more reliable public charging network nationwide to reduce range anxiety.

MULTIFAMILY HOUSING

Local government agencies are responsible for establishing EV charging requirements for multifamily housing projects in development. Some cities have minimum parking requirements based on unit type and number of units (e.g., one parking stall for one-bedroom units, two stalls for two-bedroom units). Establishing how many of these spaces are required to be equipped for EV charging is informed by factors such as construction type, new construction versus retrofit, utility infrastructure, and the size of planned parking stalls. Local agencies can work to establish options for encouraging EV readiness in all new construction to ensure all multifamily projects include installation of EV charging infrastructure. Some housing agencies are also working to **provide safe and protected charging** for electric micromobility, in part to improve safety.

Availability of utility infrastructure is the largest challenge in implementing EV charging in multi-unit projects. Installing EV charging infrastructure at the time of construction on a new building is much cheaper than installing the same infrastructure during a building renovation. Most of the cost increase is due to trenching, demolition, and additional permitting costs, all of which are avoided in new construction. Shared micromobility charging may be possible at lower cost per end user.

CURBSIDE CHARGING

In denser residential areas where people rely on on-street parking, at-home charging can be more difficult than in lower density residential areas, where homes have garages or other off-street parking options in which charging infrastructure can be more easily located. Lack of formal on-street charging infrastructure in residential areas may lead to residents running cords from their homes to their vehicles, creating safety hazards and accessibility impediments for sidewalk users. Residential curbside charging, particularly in the case of charging infrastructure paid for and installed by residents, may also raise concerns about maintaining streets and curb space as shared, public resources.

In commercial areas, on-street EV charging must be balanced with other curbside uses, such as pick-up/drop-off zones for passengers, freight delivery, micromobility parking and charging, and bicycle and pedestrian facilities, as well as anticipated future needs in the public right-of-way. The length of time needed to charge EVs using Level 1 or Level 2 charging equipment may be incompatible with short-term parking priorities typical of commercial districts. Electric mobility infrastructure installed at curbside locations should be sited to avoid impeding pedestrian and micromobility travel and avoid creating accessibility conflicts for people with disabilities. To plan for and prioritize curbside charging infrastructure, FHWA's **Curbside Inventory Report** can serve as a resource.

Users of all modes, including EVs, electric micromobility and electric buses, have a vested interest in current or future access to curb lane infrastructure in the public right-of-way. For example, curb lanes that currently service parking needs may in the future be repurposed to transit-only lanes or protected bicycle and scooter lanes. Implementing EV charging at the curb for street parking access requires significant infrastructure investment. Therefore, when identifying those locations communities may benefit from considering their long-term priorities for improved or expanded sidewalks, a safe and connected bicycle network, dedicated transit lanes, and new public spaces such as plazas or parks. Installing curbside EV charging stations may preclude other changes to the street for years to come, and so installation should align with public space and multimodal strategies.

For more information on curbside site hosts, see Section 4: *Partnership Opportunities*.

Battery-Electric Buses in Baton Rouge

Capital Area Transit System (CATS) in Baton Rouge, Lousiana has experienced many benefits and challenges since incorporating BEBs into their fleet. The agency has received cost savings despite only transitioning 6 of their 60 vehicles to EVs. A primary challenge has been finding staff with experience in EV maintenance, so the agency has focused on training new and existing automotive mechanic staff. In planning for future expansions of EVs in their fleet, CATS will not be able to transition to a fully electric fleet, as they need on-demand vehicles in emergency situations, such as for disaster response and evacuation.

BENEFITS AND IMPLEMENTATION CHALLENGES OF TRANSIT ELECTRIFICATION

The number of transit BEBs currently on order or operating in the U.S. **grew 112 percent** from 2018 to 2021. As of 2021, **more than 1,300 zero-emission transit buses** were delivered or awarded to U.S. transit agencies, although this encompasses only 2 percent of the U.S. transit bus fleet. Similarly, only 1,800 ESBs are operating or have been ordered by school districts, meaning that around **95 percent** of the approximately 500,000 school buses nationwide still run on diesel fuel.

Electric buses, including BEBs, have benefits for transit agencies, as well as the surrounding communities in which the vehicles operate. Electric buses are **more fuel efficient than diesel buses and have fewer moving parts**, potentially decreasing fuel and maintenance costs for transit agencies. At the same time, the surrounding communities will experience environmental benefits as discussed above for electric mobility in general. Electric buses operate more quietly, producing less noise pollution, and have zero harmful tailpipe emissions, which will improve local air quality. **Studies on school buses** have shown the air quality can be worse inside the bus than outside of it, which is particularly harmful for children, as research shows that childhood asthma and related health issues are worsened by air pollution and vehicle emissions. The environmental benefits from electric transit buses and school buses are especially important for communities overburdened by pollution.

Planning for electric buses and charging infrastructure is complex and requires different decision-making than diesel bus deployment, so transit agencies need to invest resources upfront to plan appropriately. The adoption of plug-in, conductive charging, or inductive charging electric buses by transit agencies is not a simple decision of substituting a diesel bus for an electric one and does have challenges to consider, including planning for upfront costs and staff capabilities to operate and maintain these assets. Additionally, operational challenges include variability of battery range and electricity rate structures. For more information, see *"Transit Planning"*.

SECTION 4

PARTNERSHIP OPPORTUNITIES

From providing technical expertise to convening local stakeholders to hosting charging stations, partners play a key role in most electric mobility charging projects. This section describes the following key partners that can assist urban entities in planning, funding, and implementing electric mobility charging, as well as those partners specific to micromobility- and transit-related charging infrastructure:

- **Statewide and Multistate Partners and Initiatives,** including organizations planning for EV corridors, State environmental, energy, and transportation agencies, and multistate initiatives working on climate change and electric vehicles, can help identify key stakeholders and provide technical assistance or funding. **Tribes and Tribal organizations** working on climate change and transportation can identify stakeholders who are working to improve their infrastructure and provide technical assistance or funding.
- **Local and regional planning partners** include Clean Cities coalitions that can help urban entities get started on a charging infrastructure project and transportation planning agencies that can help align charging infrastructure projects with broader transportation planning efforts and available funding. In addition, these partners include shared micromobility and charging infrastructure providers; transit, ride-hailing, taxis, and delivery fleet operators; and others such as cities, academic institutions, and advocacy groups.
- **Electric utilities** are a critical partner in planning for charging infrastructure. In addition to providing technical advice on connecting charging infrastructure to the local electric grid, they are often active long-term partners, taking ownership of some or all aspects of charging infrastructure installations.
- **Charging networks** can own, operate, and maintain charging stations and provide technical expertise on charger technologies.
- **Site hosts**, including tourism destinations, local businesses, transportation facilities, residences (including multi-unit dwellings), and municipal and community sites, can lead charging infrastructure projects or be important partners for entities that wish to implement charging infrastructure but lack dedicated space.

STATEWIDE AND MULTISTATE PARTNERS AND INITIATIVES

Statewide and multistate agencies and groups can play a key role in connecting stakeholders, identifying available funding opportunities, and providing technical expertise. Some of these partners are specific to a particular State or region of the country, while others are national initiatives with affiliated local, State, or regional stakeholder groups.

FHWA'S ALTERNATIVE FUEL CORRIDOR DESIGNATIONS

At the national level, since 2016, FHWA's **Alternative Fuel Corridor (AFC) Designations** have catalyzed the expansion of a national corridor network of EV charging stations along over 75,000 miles (or 33 percent) of the National Highway System (NHS), including nearly 45,000 miles of the Nation's Interstate System (92 percent). All 50 States as well as the District of Columbia and Puerto Rico have one or more designated EV corridors (see Figure 4-1. Map of EV corridors as of January 23, 2023, under FHWA's Alternative Fuel Corridors Program. (Source: FHWA)).

FHWA works with other Federal, State, and local officials and with private industry to facilitate an interstate and major road network of alternative clean fuel stations (EV charging, hydrogen, natural gas, and propane) so commercial and passenger vehicles can reliably travel between cities and regions and across the Nation.

The AFC program engages State and local officials, including State departments of transportation (DOTs) and transportation planning agencies, and frequently collaborates with local Clean Cities coalitions to identify candidate highway segments for this national network. The program also encourages multistate and regional cooperation and collaboration on planning and developing

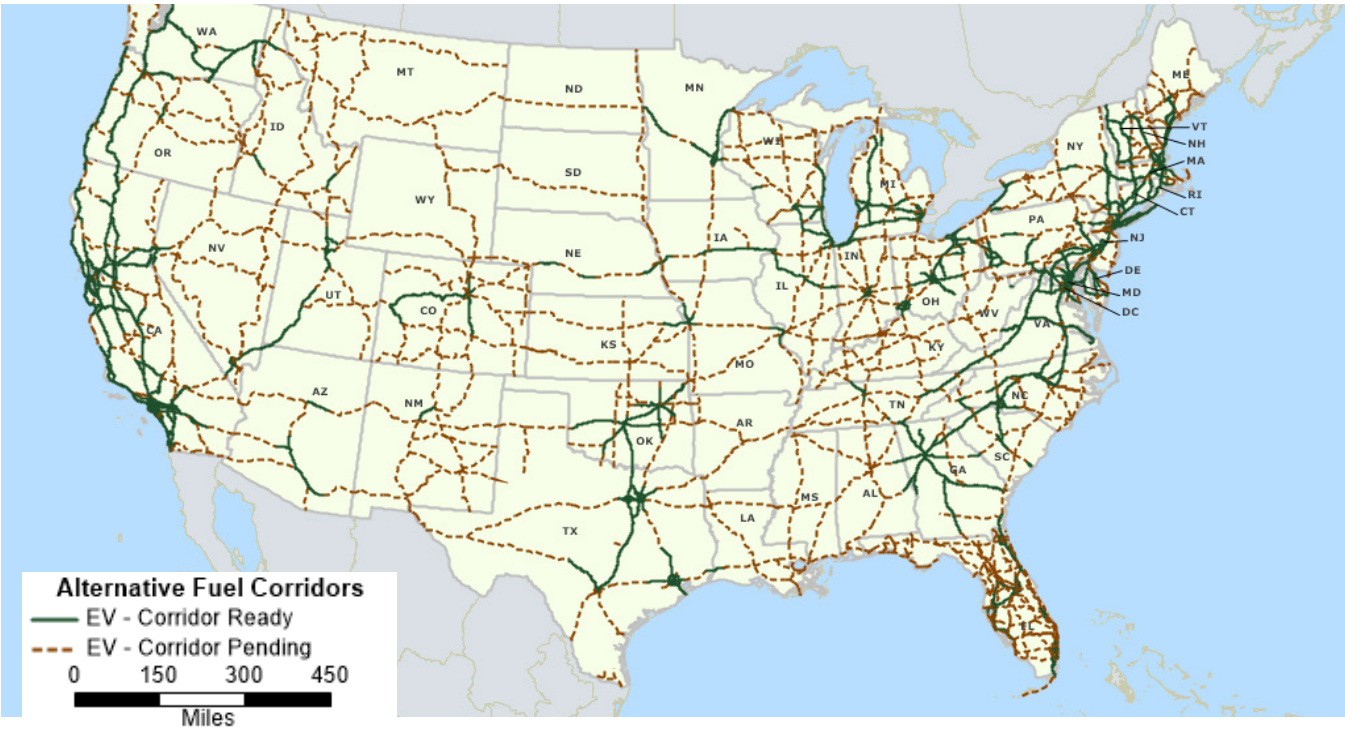


Figure 4-1. Map of EV corridors as of January 23, 2023, under FHWA's Alternative Fuel Corridors Program. (Source: FHWA)

alternative fueling and charging locations along corridors and provides guidance to States on implementing EV charging and other alternative fueling highway signage. Urban entities can participate in the AFC designation process or refer to existing AFC designations to determine where fast charge infrastructure exists or is being planned in a particular area. In addition, until AFCs within a State are determined to be fully built out by FHWA, NEVI formula funding under the Bipartisan Infrastructure Law is required to be spent along EV corridors designated by the AFC program.

EPA REGIONAL DIESEL COLLABORATIVES

The U.S. Environmental Protection Agency's (EPA) **Regional Diesel Collaboratives** work to reduce diesel emissions through strategies like fuel efficiency, alternative fuels, and electrification. These collaboratives involve public-private collaboration to share information, plan projects, leverage funding, and promote the use of vehicles, vessels, and equipment that can use alternative fuel.

Regional collaborative partners typically include State environmental agencies, local governments, EPA regional offices, energy agencies or coalitions, nonprofits, and private-sector companies.

The five Regional Diesel Collaboratives cover the whole United States and may be able to connect urban entities with partners to pursue charging infrastructure projects, particularly around medium- and heavy-duty vehicles. For example, the mission of the **West Coast Collaborative Alternative Fuel Infrastructure Corridor Coalition** is to accelerate the modernization of West Coast transportation corridors by deploying alternative fuel infrastructure for medium- and heavy-duty vehicles and equipment. The collaboratives are especially active in congested urban and metropolitan areas with reduced air quality. They are instrumental in providing technical assistance to entities pursuing Diesel Emissions Reduction Act (DERA) Program grants and rebates, and to school districts applying for EPA's Clean School Bus Program rebates provided under the Bipartisan Infrastructure Law.

STATE DEPARTMENTS OF TRANSPORTATION

State DOTs can offer technical and funding resources to support electric vehicle charging infrastructure as well as construction contracting oversight or other partnering roles. For example, FHWA's **Congestion Mitigation and Air Quality Improvement** (CMAQ) Program apportions funding to State DOTs by statutory formula for projects that improve air quality and provide congestion relief. These CMAQ funds may also be transferred to the Federal Transit Administration (FTA) for administration of eligible transit projects. Electric vehicle projects, including fleet conversions and charging infrastructure, are one of the eligible project categories under CMAQ. In addition, the 2021 Bipartisan Infrastructure Law provides **formula funding through NEVI** to State DOTs for a national electric vehicle formula program and discretionary funding through the **Charging and Fueling Infrastructure Program** (see *Federal Funding Programs* for more information on the Bipartisan Infrastructure Law).

Some State DOTs, such as Iowa DOT, Maine DOT, and Kansas DOT, among others, administer or co-administer with sister State agencies the Volkswagen Environmental Mitigation Trust funds allocated for EV charging infrastructure investment. Several State DOTs also administer State-developed grant programs for EV and other alternative fuel infrastructure; for example, Washington State DOT's **Zero Emission Vehicle Infrastructure Grant Program**.

State DOTs also play a central role in planning and supporting EV infrastructure deployment. All States, as well as the District of Columbia and Puerto Rico, have adopted **State EV Infrastructure Deployment Plans** describing how they will obligate their NEVI formula funds for EV charging infrastructure projects. Many either lead or support the process in their State for nominating NHS corridors for designation under the FHWA Alternative Fuels Corridor program. They conduct planning for building out and deploying EV infrastructure along the NHS, and they coordinate with other State agencies to help ensure EV readiness through strategic infrastructure planning that focuses on corridors, workplaces, and communities. State DOTs also operate and oversee road and highway signage, and State DOT traffic engineers are responsible for approving and installing EV infrastructure wayfinding signage along NHS corridors.

STATE ENVIRONMENTAL AND ENERGY AGENCIES

State agencies often conduct planning specific to electric vehicles. State-level EV implementation plans can be an important source of information on planned locations for charging infrastructure or gaps in an existing charging network. They may identify funding or other resources available from State agencies or other stakeholders within a State.

State environmental and energy agencies (e.g., a State department of natural resources or State energy office) may also offer programs and funding to support electric mobility charging deployment. State energy offices generally operate under the direction of governors or legislatures and are funded by both State and Federal appropriations. Many State energy offices offer funding or technical assistance programs for EV infrastructure. They may also conduct EV readiness planning or implement State policies related to EVs. The National Association of State Energy Officials (NASEO) **Interactive State Energy Offices Map** provides contact information for each State energy office.

State agencies, typically the environmental or air quality agency, also administer settlement funds from the 2016 **Volkswagen decision.** The U.S. government and Volkswagen (VW) have resolved allegations that VW violated the Clean Air Act, and

the enforcement settlement provides nearly $3 billion to States through an Environmental Mitigation Trust. The settlement also commits VW to invest $2 billion in zero emission vehicle infrastructure. VW created a subsidiary company, Electrify America, to manage the $2 billion zero emission vehicle investment. Each State designated a lead agency that manages the State's allocated funding from the Environmental Mitigation Trust, which can be spent on projects including EVs and EV charging stations. See the National Association of Clean Air Agencies webpage for **contact information** for each State's lead agency.

ADDITIONAL MULTISTATE INITIATIVES

Many States and regions of the country have partnerships and initiatives around electric mobility. These groups may focus on improving air quality generally (e.g., **Northeast States for Coordinated Air Use Management**); developing or advocating for State-level or regional policies to encourage EVs (e.g., Regional Electric Vehicle (**REV) West, REV Midwest** and the **Transportation and Climate Initiative**); partnering on EV charging infrastructure (e.g., **Northeast Electric Vehicle Network**, **West Coast Electric Highway**); or advancing a multimodal electric future (e.g., the **Coalition Helping American Rebuild and Go Electric**). The **E-Bike Incentive Programs of North America Tracker** is a helpful resource that includes implementation and funding details of existing and past programs. Entities interested in pursuing electric mobility projects can connect with these types of groups for technical assistance, connections to project partners, or funding. For more information on multistate climate initiatives, see the **Center for Climate and Energy Solutions**. The Alternative Fuels Data Center's **State Information tool** also has details on potential partners in each State, including contact information for relevant State agencies and information on completed or ongoing EV charging projects.

Municipal Fleet Electrification Partnership in Austin, Texas with the Climate Mayors Electric Vehicle Purchasing Collaborative

Austin, Texas has purchased over **130 electric vehicles** to transition their municipal fleet to an all-electric fleet. These vehicles have been purchased through the **Climate Mayors Electric Vehicle Purchasing Collaborative**, a partnership between Climate Mayors, the Electrification Coalition, and an organization servicing government and nonprofit agencies. As Austin continues to procure electric vehicles for their municipal fleet, the city is working with an Austin-based utility company to support the growing fleet.

LOCAL AND REGIONAL PLANNING PARTNERS

Like statewide and multistate partners, local and regional planning organizations can play a key role in connecting stakeholders and identifying available funding, as well as in providing technical expertise. Clean Cities coalitions comprise a national initiative with affiliated local, State, or regional stakeholder groups that provide both technical assistance at all project stages and access to local partners for electric mobility charging projects. Planning agencies accept input from stakeholders to develop transportation plans for the coming years, providing opportunities to partner on coordination of charging infrastructure projects within a city, or throughout a region or State, and for programming funding that flows through these planning agencies to such projects.

CLEAN CITIES COALITIONS

Through DOE's national network of **Clean Cities coalitions**, more than 75 coalitions create networks of local stakeholders that advance alternative fuels through public-private partnerships. These coalitions have extensive experience promoting alternative fuel vehicle adoption and alternative fuel infrastructure deployment. Each coalition is led by an on-the-ground Clean Cities coordinator who tailors projects and activities for the local community.

Clean Cities coalitions are well positioned to help connect urban entities with local partners for developing and executing electric mobility charging projects. These coalitions engage with more than 20,000 stakeholders across the United States.

Typical coalition members include:

- Automotive businesses and dealerships;
- Utility, fuel, and charging systems providers;
- Vehicle fleet owners and operators;
- State and local government agencies (e.g., environmental, energy, transportation, planning, and public health agencies); and
- Community organizations and nonprofits.

In addition to connecting local stakeholders working on electric mobility, coalitions can provide technical assistance on specific charging infrastructure projects and connect urban entities with available funding opportunities and incentives. The network of Clean Cities coalitions also enables urban entities to tap into national expertise, including research from DOE's National Laboratories and the Joint Office of Energy and Transportation. DOE's Vehicle Technologies Office designates Clean Cities coalitions working locally to foster the Nation's economic, environmental, and energy security. DOE provides coalitions resources and information to help transportation stakeholders evaluate options and achieve goals around electrification and alternative fuels, advanced vehicles, mobility solutions, and other fuel-saving strategies. DOE also often encourages project teams to partner with Clean Cities coalitions on applications to competitive funding opportunities for demonstrating and deploying electric vehicles and charging infrastructure.

Coalitions are often based in cities or operate statewide with a heavy focus on metropolitan areas. To learn more about coalition activities in a particular city or State and to identify contacts, see Figure 4-2. Map of Clean Cities coalition locations. (Source: DOE, 2023) and the **Clean Cities coalition contact directory**.

PLANNING AGENCIES

Transportation planning agencies are important partners in electric mobility charging projects, so it is beneficial for site-level planners and other urban entities to identify the organization conducting transportation planning in their community. In metropolitan areas with a population over 50,000, the responsibility for transportation planning lies with MPOs.[9] Outside urban communities, depending on the State, the State DOT, a regional transportation planning organization (RTPO), regional planning council, or local government may conduct transportation planning.

Urban entities can engage with MPOs around electric vehicles in several ways. Urban entities can visit MPO websites to view existing planning documents and identify information relevant to EV infrastructure planning. Typical transportation planning products include:

- **Work Programs:** The Unified Planning Work Program (UPWP) for MPOs is an annual funding document that identifies transportation studies,

9 MPOs are located in Census-designated areas of over 50,000 in population and have Federal requirements to plan for the transportation needs of the metropolitan planning area.

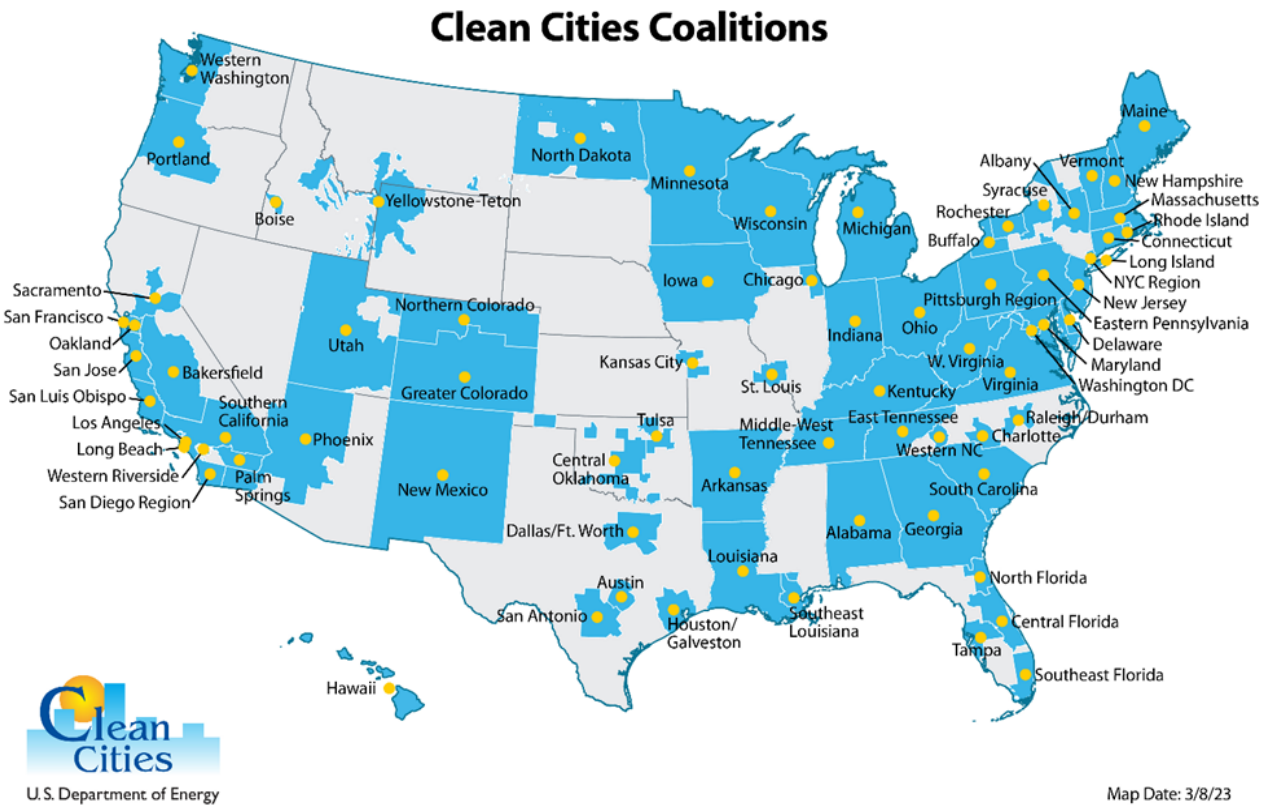


Figure 4-2. Map of Clean Cities coalition locations. (Source: DOE, 2023)

tasks, or research that the agency will perform. These could include studies related to EV charging networks and gaps in a region.

- **Transportation Improvement Programs:** MPOs develop four-year, fiscally constrained Transportation Improvement Programs (TIPs), which outline specific transportation projects and strategies with committed funding. State DOTs develop a similar Statewide TIP (STIP), which incorporates MPO, Tribal, and RTPO TIPs but also identifies projects in rural areas and small urban areas not covered by MPOs or RTPOs. TIPs could include specific, funded projects to install EV charging stations. They could also identify when major transportation projects are occurring in their area to better coordinate charging infrastructure installations with these projects.
- **Long-Range Transportation Plans:** Regional, Metropolitan, or Statewide Long-Range Transportation Plans cover a minimum of 20-years and identify goals and strategies for how the agency plans to invest in the transportation system. Long-range plans may include goals that facilitate investments in EVs and EV charging infrastructure, such as improving air quality in a region, supporting growing demand for charging stations, and meeting climate resilience goals. They may also include more specific strategies like installing EV corridors along State highways.

The development of UPWPs, TIPs, and Long-Range Transportation Plans all provide an opportunity for urban entities to work with planning agencies to consider EVs and the EV infrastructure needs and the agencies' goals, programs, and funding decisions. Transportation planning agencies are required to obtain public and stakeholder input in the development of these transportation planning products. Most MPOs have information on their websites listing opportunities to attend public meetings and to provide comments on draft plans.

Figure 4-3. Examples of shared micromobility charging infrastructure for e-bikes and e-scooters. (Source: Smart Cities Dive and TechCrunch)

MICROMOBILITY PARTNERS

Deploying micromobility charging infrastructure involves a smaller ecosystem of partners including city and university planning agencies, shared micromobility providers, micromobility charging infrastructure providers, and site hosts.

Shared micromobility providers are public or private entities that own, manage, and operate shared micromobility fleets (e.g., bikeshare and scooter share). Partnerships with these providers are critical to bringing shared micromobility to urban communities. Providers' operations vary, and they may charge micromobility devices through **on-street charging at docking stations**, **swapping removable batteries and charging them offsite**, or **charging the entire device remotely**.

Independent companies have emerged that provide interoperable/universal charging solutions for micromobility devices, including centralized lockers for charging many e-scooters simultaneously, as well as solar- or battery-powered on-street parking corrals. These charging infrastructure providers may service either shared or privately owned micromobility devices.

On-site charging for shared and/or privately owned micromobility devices may be deployed in partnership with site hosts (see the section on *Site Hosts* for more information on potential site hosts for a project.

LOCAL TRANSIT, RIDE-HAILING, TAXI, AND DELIVERY FLEETS

Partnerships with local fleet owners and operators can be advantageous for municipalities that are looking to increase EV usage in their communities to decrease emissions and improve air quality, as well as for owners and operators who would like to lower their operational costs. Partners for the electrification of fleets for transit, ride-hailing, taxis, and deliveries may also include equipment manufacturers, utilities, regulators, and charging providers.

In transit electrification, the local or regional transit agency will be the key partner to incorporate BEBs into the fleet, while the local school district will be the key partner to incorporate ESBs. These entities manage all components of their fleet from planning and procurement to operations and maintenance, and will have, or will be able to collect, the data

necessary to make decisions about next steps for fleet electrification. The transit agency or school district will also work with other partners, such as vehicle manufacturers, as discussed in Partners for Electric Bus Fleet Operators. Local and regional government staff and officials can **play different roles to encourage EV adoption** by transit agencies and school districts, including education, building up to electrification commitments, securing electric bus grants, and assisting with build out charging infrastructure. For more information on planning, see *Section 5: Electric Mobility Infrastructure Planningfor Urban Areas.*

Despite only contributing a **small fraction of vehicle miles** in most cities, partnerships with ride-hailing companies or transportation network companies (TNCs) and taxi companies can provide benefits to all involved stakeholders. The decarbonization of rides associated with TNCs is important because about **half of all ride-hailing trips** either displace cleaner forms of transport (public transit, walking, or biking) or are a car trip that would otherwise not have happened, and each ride-hailing trip causes about **69 percent more GHG emissions** than the trips that they replace. Full-time TNC drivers travel approximately **three times as many miles** per year as the average American, which, along with taxi drivers, creates a large potential demand for charging infrastructure once more of the fleet vehicles are electric. Similarly, the growth in e-commerce is increasing needs for urban last-mile freight delivery. The potential demand of TNCs, taxis, and delivery services could lead to them serving as **"anchor tenants"** for high-speed public charging, which may enable broader deployment across urban areas by providing early users.

Local and regional government staff and officials can provide valuable assistance through educational campaigns, either partnering with TNCs to educate their drivers or partnering directly with taxi and delivery companies, to share information on available resources and financial assistance for fleet electrification. This **upfront investment in education** may be especially important for ride-hailing drivers, as they often wait to replace their car until necessary, but then need to rapidly decide which new car to get. Additionally, local and regional governments can use partnerships with TNCs, taxi companies, and delivery companies to **develop charging infrastructure in the region** by sharing data and comparing options for the number of charging points, the best locations for drivers, and

Community Partnership: EV Transportation Service for Seniors & Youth in St. Louis

The **St. Louis Vehicle Electrification Rides for Seniors (SiLVERS) project** provides free transportation to seniors and youth to connect people to social services. The program has a total of 5 vehicles with 5 charging stations between the 2 destinations: a local community center for children and seniors and a senior center. The project emerged through the American Climate Challenge, which was a partnership between the City of St. Louis, a nonprofit environmental advocacy group, and a philanthropic organization. The project was created through a partnership of local community-based organizations, including the local community center, the local senior center, the St. Louis Agency on Aging, and a nonprofit organization. DOE's Vehicle Technologies Office provided funding to help purchase the vehicles and infrastructure and to collect data on the benefits of the project. The SiLVERS program aims to further the City's sustainability goals.

the appropriate power levels. **There are a variety of levers** that regulators, officials, and planners could use to encourage the development of partnerships with, and the electrification of, TNCs, taxi companies, and delivery companies including: regulations, subsidies, incentives, and direct assistance to companies.

For more information on planning for the electrification of municipal fleets, TNCs, taxi companies, and urban delivery services, see *Other Fleet Planning*.

OTHER LOCAL AND REGIONAL PARTNERS

City governments and city councils can work with their MPO to help integrate EV charging and transportation needs with other local priorities around energy, environment, housing, and economic and workforce development. These organizations can also use MPO planning documents and other information to directly plan for and identify resources to implement electric mobility charging infrastructure.

Higher education institutions including colleges, universities, and technical and vocational schools, can also serve as valuable resources and potential project partners, including through the DOT's **University Transportation Centers**. Numerous institutions are carrying out grant-funded EV demonstration projects and charging infrastructure planning and analysis in urban areas. University of North Carolina (UNC) at Charlotte is leading a DOE-funded project to design, test, and evaluate a scalable curbside electric vehicle charging station solution utilizing existing infrastructure to meet the growing market demands for electric vehicles. Under the project, UNC Charlotte has partnered with Duke Energy, the City of Charlotte, and the Centralina Regional Council to develop and deploy the **PoleVolt curbside EV charging system**, which uses existing streetlight infrastructure to reduce charging infrastructure installation costs by up to 50 percent. As another DOE-funded project example, **Tulane University** is deploying and demonstrating four new battery electric shuttle buses and supporting charging stations to serve the university's shuttle route linking Tulane's uptown and downtown campuses in New Orleans. Tulane will collect and analyze key electric bus data, and share operation, performance, and cost information with other university fleets. Lastly, colleges and universities serve as excellent charging infrastructure site hosts for students and visitors in addition to institutional EV fleets.

Additional local and regional partners can assist with EV education and outreach. Car dealerships may be expanding their sales of EVs and can help progress EV education for consumers. For example, DOE has funded a project (**DRIVE Electric USA)** to facilitate collaboration with automotive dealerships and other essential partners under the banner of statewide EV initiatives. EV advocacy organizations can also be valuable partners in raising awareness around EVs, facilitating demonstration projects, and guiding equitable deployment. For example, the nonprofit advocacy group Southern Alliance for Clean Energy, launched the **Driving on Sunshine electric vehicle roadshow** in 2019 to participate in events across Florida and offer test drives in EVs while educating the public on the benefits of electric transportation. Additionally, advocacy organizations or other professionals that focus on affordable housing development and/or environmentally focused housing development may be partners for promoting electric mobility charging at multi-unit dwellings and other residential sites and helping encourage the adoption of EVs by residents.

UTILITIES

Electric utilities are responsible for the delivery of electricity to homes and businesses, including metering, billing, and customer service. Accordingly, utilities play an essential part in the rollout of EV charging infrastructure, and they are among the first partners that should be considered for electric mobility charging installations. Some coordination with the local utility is necessary in almost all charging station installations, as the stations will likely be reliant on electricity from the local utility. Following a new service connection request, the utility will look to determine whether the grid can meet the request based on the utility's service capacity and the project timeline. With all EV infrastructure projects, it is important to engage with the local utility from the beginning—even in the conceptual stage. This can avoid costly, time-consuming changes later in the process.

Utilities have a strong interest in the deployment of charging infrastructure, and they have been investing heavily in both the deployment of EVs and the rollout of charging infrastructure. In the first seven months of 2020, State regulators approved more than **$760 million** in proposed utility investments in transportation electrification. The majority of these programs involve either direct utility ownership of charging infrastructure installations or "make-ready" programs in which utilities pay for necessary site upgrades.[10] See Figure 4-4 for an overview of roles a utility can play in a charging infrastructure project. Furthermore, the Electric Highway Coalition—which comprises 14 major utilities representing more than 60 million residential customers across 29 States and the District of Columbia—**announced in March 2021** a plan to build "one seamless network of chargers from West Texas to the Gulf of Mexico and all the way up the Eastern Seaboard."

	KEY ROLES IN EVSE INSTALLATIONS			
POTENTIAL PARTNERS	**Electricity Provider**	**EVSE Operator**	**EVSE Owner**	**Site Host**
Utility	X	X	X	
Charging Network Provider		X	X	
Property Owner		X	X	X
Tenant		X	X	X

Figure 4-4. Key roles involved in charging infrastructure installations (electricity provider, charging infrastructure owner, charging infrastructure operator, site host) and the various combinations of entities that fill those roles (utility, property owner, tenant, charging network provider). (Source: USDOT Volpe Center)

Partnering with a utility can be useful or necessary for:

- Addressing grid-level constraints that may arise in project planning (see *Types of Charging Infrastructure Planning* for a discussion of community- and corridor-level planning). A utility can also help with site selection by providing valuable information about the limitations and costs related to electricity supply at each potential site.
- Working through multiple stages of the project planning process—for example, to understand local grid limitations or needs for upgrades, to determine the best ownership model, to determine electricity rates and pricing structures, and to provide technical and programmatic support for electric mobility charging installations (see the *Project Planning Checklist*).

See Project Development and Scoping for more information on different ownership models.

Identifying financial opportunities, such as rebates and other forms of financial support directly from the utility, or potentially partnering with utilities on proposals (see *Funding Resource Clearinghouses* for resources to help identify local utility funding programs).

TYPES OF UTILITIES

The nearly **3,000 electric utilities** in the United States fall into three categories:

- **Investor-owned utilities (IOUs)** are the most prevalent, serving nearly **75 percent** of customers nationwide. They are owned by shareholders, and their rate structures and other operational aspects are highly regulated. IOUs originally began in larger cities—where the higher density of demand made a stronger business case for investing in electricity distribution infrastructure—and today operate in almost every State.
- **Publicly owned utilities (POUs)** are utilities run by Federal, State, or municipal entities and, in some cases, political subdivisions. Historically, POUs began in smaller cities and towns that did not initially attract interest or investment from IOUs. While POUs are generally smaller (serving an average of about 12,000 customers each) and may lack the resources of a large IOU, they are not subject to the same stringent regulations as IOUs and may have more **flexibility** in terms of ownership models, rates, and other partnering opportunities.
- **Cooperatives (co-ops)** are not-for-profit member-owned utilities that are usually located in rural and suburban areas and have a **presence** in 47 States. Co-ops expanded rapidly after the 1936 **Rural Electrification Act** to bring electricity to communities not served by IOUs or municipal utilities. Co-ops tend to be smaller (serving an average of about 24,000 customers each), but like POUs, they are not subject to the same stringent rate structure and operational regulations as IOUs.

Utility Partnerships: King County Metro and Local Utility Company Seattle City Lights Charging Facility

King County Metro partnered with Seattle-based utility company City Light to create a **charging facility** to provide accessible electric public transit for King County, and reduce noise and air pollution. The **facility** can charge nine buses simultaneously and incorporates an "interchangeable design," meaning that battery-electric buses can charge at any station. City Light provided direct support throughout the project, working with King County Metro on the design, build, testing, expediting electrical service, and ensuring the most efficient use of the utility electric grid power. The new facility is part of King County Metro's goal of transitioning to a zero-emissions fleet by 2035.

IDENTIFYING OPPORTUNITIES AND MAKING CONTACT

Given that individual counties may have multiple utilities and potentially multiple types of utilities operating within their boundaries, prospective charging infrastructure site planners should become familiar with all the utilities in their region and determine which utility serves their prospective charging infrastructure site. This will let site planners identify all options for potential partnering, which could be important given the wide range of EV programs and varying levels of interest and involvement among utilities. For information on the

territory served by each utility in the United States, including basic information about each utility, see this **map of electric utility service territories**.[11]

There are also State-level resources for identifying utilities, including maps or directories, such as the following examples:

- **Virginia: Electric Service Territories**
- **Illinois: Electric Utilities in Illinois Map**

To make contact with a utility, it may be best to first work through a larger coalition or regional partnership. For site planners not working with a coalition, the next best approach may be to work with charging network providers, who often have well-established relationships with local utilities (see the *Charging Networks* section).

Another option is to contact the utility directly. As noted earlier, utilities may have widely varying interest in—and resources devoted to—EV infrastructure. Many utilities have prominent information on their websites about electric vehicles and EV infrastructure, and often this information targets entities looking to invest in charging infrastructure.

Lastly, in areas with smaller utilities, or where EV rollout has been slower and information is sparse, it may be worthwhile to contact one of the national organizations representing utilities. These larger national resources can provide charging infrastructure site planners with ideas about the types of opportunities available. Even if the local utility does not have a well-developed program, knowing what type of utility it is and how to get information at the national level might help with understanding the available partnership options. National resources might also open the door for

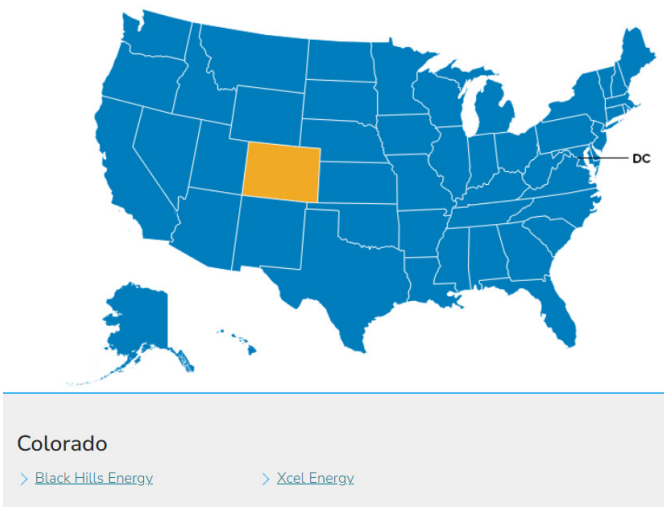


Figure 4-5. Example of information on utility programs for EVs, from a portal provided by Edison Electric Institute. (Source: Edison Electric Institute)

larger electric mobility charging developers to propose new partnership programs with their utilities.

The three main national organizations representing utilities are the **Edison Electric Institute**, which represents IOUs (of particular interest is a portal for all EV-related programs of any IOU in any State, as shown in Figure 4-5. Example of information on utility programs for EVs, from a portal provided by Edison Electric Institute. (Source: Edison Electric Institute)); the **American Public Power Association**, which represents POUs; and the **National Rural Electric Cooperative Association**, which represents co-ops (serving both rural and suburban areas).

The DOE Alternative Fuels Data Center compiles an up-to-date list of utility incentives in its **Laws and Incentives** database. Information provided includes utility-level incentives for vehicles and charging stations as well as any special EV rate cases. This information is available at the State and utility levels.

11 To view this map, filter out (un-select) all layers except for "Electric Retail Service Territories."

CHARGING NETWORKS

Many public charging stations are owned or operated by private charging network companies. These **charging networks** may require a membership to recharge an EV at their stations, although some States do not allow membership requirements if the charging network uses public subsidies. Chargers installed with funding that is administered under title 23, United States Code, are subject to **23 CFR 680** which requires that memberships not be required for use, nor can they be cause for delay, limit, or curtailed power flow to vehicles. Network companies also must provide third-party software developers with station information to allow users to locate and get directions to their charging stations. The DOE Alternative Fuels Data Center also provides this location information through its **Locate Stations** page. Charging networks will also offer different payment methods and pricing models; note that chargers installed with funding administered under title 23, United States Code, are subject to 23 CFR 680, which provides requirements for uniform pricing display and payment methods. For additional information, see *Determine Pricing, Payment, and Access*.

For site planners pursuing a **networked charging station**—a charging station that is connected to the Internet through cellular or wired broadband service to enable payment, access management, and usage monitoring—a charging network can be a logical partner to engage early in the site-level planning process. As partners, charging networks can bring technical expertise and facilitate connections to other important project stakeholders, such as architects, engineers, and contractors. They also develop training resources, such as **specifications** and **installation guides,** for EV installers.

Once charging stations are installed and activated, the network can help a site owner or tenant set up the **charging station policies**, including pricing, access control, administration rights, and advertisements. Note that chargers installed with most Federal funding sources will be subject to 23 CFR 680, which establishes minimum standards for many of these types of policies. In addition, a charging network can provide advice to the charging infrastructure site planner on best practices for running the charging station based on experience with other sites, including those in similar contexts or geographic locations.

As discussed in Section 5 (under *Decide on Ownership Model*), both utilities and utility customers can own and operate charging stations. In addition to utilities, it is also common for charging network companies to own and operate charging infrastructure on property owned or leased by the site host. For example, several charging network companies partner with **retail locations** such as fast food chains and shopping malls to provide network-owned and -operated direct current (DC) fast charging. Alternatively, site hosts can pursue business models in which they own the equipment while the charging network maintains and operates the equipment. The exact options for these roles **depend** on the network and equipment provider chosen.

Several resources are available to help locate charging network companies and the business models and partnering roles they offer, as summarized in the *Select Equipment and Network Provider*.[12]

12 See "EV Charging Station Business Models" section starting on page 14: **https://www.penndot.gov/ProjectAndPrograms/Planning/Documents/Final%20(ver7-12-21)%20PennDOT%20I81-I78%20AFC%20Deployment%20Plan%20Report.pdf**

SITE HOSTS

A **site host** is the owner or occupant of land on which an EV charging station or electric mobility charging hub is built. Site hosts represent a variety of industries and land use types, including:

- Tourist destinations and public lands;
- Businesses and institutions, such as offices, hotels, shops, universities, and restaurants;
- Transportation facilities, such as airports and fleet depots; and
- Community sites, such as a public library or city hall.

Additionally, site hosts have different reasons to provide EV and/or multimodal electric charging services, including:

- Attracting or retaining visitors or customers using electric mobility;
- Attracting or retaining employees using electric mobility;
- Earning revenue from user fees for electric mobility charging;
- Supporting a new fleet of electric vehicles, e-micromobility devices, or buses;
- Piloting technology, including for research projects; and
- Encouraging more widespread adoption of electric mobility for environmental and public health benefits.

Site hosts can provide public or private electric mobility charging stations. For example, municipal governments may choose to let anybody access the charging infrastructure and plug in their vehicles at publicly accessible community sites. Retail centers may also opt to install public chargers with the intent of attracting customers. In contrast, some companies

offering workplace charging at an office location may choose to restrict charging infrastructure access to just their employees. Similarly, hotels may install charging infrastructure in a private parking lot as a service only to hotel customers.

Of the approximately 13,000 privately owned Level 2 and DCFC stations nationwide, **about 14 percent restrict access** to select groups, such as site tenants, employees, visitors, and fleet drivers. Across all 53,100 privately, publicly, and utility-owned Level 2 and DCFC stations, just 2.5 percent are private access only.

While site hosts can initiate electric mobility charging planning and installation, they can also be key partners for other entities looking to install and operate EV charging stations. Public-private partnerships (P3s) involve partnerships between public agencies (such as local governments and transportation authorities) and private companies to produce publicly accessible infrastructure. Benefits of using a P3 project delivery method can include leveraging private funding or financing for a project, accelerating project delivery, and minimizing risk for a public agency. Legislation enabling P3s varies

Partnerships Success Story: Charging Infrastructure at Local Markets

In 2016, a California-based grocery store chain partnered with an EV fast charging company **to install EV charging stations in several of their locations**, including their stores in San Diego, Encinitas, and Hermosa Beach. As of 2020, customers have charged their EVs for over 1.8 million minutes. which prevented over 950 metric tons of GHG emissions.

across States, producing a variety of contracting options. Check **FHWA's Innovative Program Delivery Listing of State Legislation** to determine which statutory framework can be used for a local project.

The following subsections discuss different types of site hosts to help urban entities identify possible partners.

TOURIST DESTINATIONS

Tourist destinations include any sites of natural, cultural, or historical interest for visitors, as well as nearby gateway communities that provide services to these visitors. Often, popular tourist destinations provide transportation services such as parking, shuttles, and bicycle rentals to improve the visitor experience and attract future visitors. As EVs become more commonplace, tourist destinations could provide charging infrastructure as another transportation service, allowing visitors to park and charge their EVs while visiting other site amenities, such as gift shops, restaurants, and attractions. For example, the National Park Service recently developed an **electric vehicle charging map** showing charging infrastructure available to visitors at park units across the country.

Common tourist destinations in urban areas and potential partners for urban charging infrastructure projects include public parks, waterfront areas, and monuments owned by Federal, State, or local government entities, and cultural institutions, including museums and public universities. Publicly available charging infrastructure at existing attractions helps to encourage visitors with EVs to visit and to support the local economy. In addition, encouraging the use of EVs in these areas helps to reduce air pollution and noise, improving the experience for visitors.

Additionally, urban areas provide many opportunities for charging infrastructure at venues that may not always be publicly accessible but provide a charging option for attendees at specific times, such as at sports stadiums or event venues. For example, the **Mercedes-Benz Stadium in Atlanta** includes charging infrastructure for up to 48 cars at a time at DCFC chargers, for those with a parking pass to the specific parking lots.

LOCAL BUSINESSES AND INSTITUTIONS

Many types of local businesses—such as grocery stores and restaurants—can serve as site hosts to public EV charging stations. According to the U.S. Department of Energy's **Alternative Fuels Data Center** (AFDC), as of November 2022 there were more than 11,000 privately owned but publicly accessible Level 2 charging stations in the United States, with chargers hosted by hotels, restaurants, gas stations, car dealerships, shopping centers, airports, parking lots, banks, and other site hosts.

Like tourist destinations, local businesses can realize economic benefits from hosting a charging station. As discussed in the toolkit sections on *Project Development and Scoping* and *Operational Planning*, local businesses may own or operate the charging infrastructure and charge users a fee to plug in. Alternatively, local businesses may provide

free charging or otherwise allow the utility, network company, or other third party to own or operate the charging infrastructure. In these latter arrangements, the business owner may attract more customers and customer spending.

MULTIFAMILY HOUSING

Multifamily housing includes apartment buildings, condominiums, and townhouses as well as mixed-use developments with a combination of residential and retail, office, cultural, or other non-residential space. In 2019, approximately **31 percent of residences** in the U.S. were multifamily homes, and in 2021, **construction was completed** on around 12,000 multifamily buildings containing 371,000 housing units, compared to 970,000 new single-family homes.

Multifamily housing serves all segments of the population and varies greatly in costs and amenities. Multifamily housing may be designated or subsidized for students, older adults, and low-income families and individuals, and is an important source of affordable housing for renters. According to the **National Multifamily Housing Council**, around 43 million U.S. households are renters, with 36 percent of renters living in apartment buildings. Of these apartment households, about 74 percent have at least one vehicle. Ensuring the 26 percent of apartment households who do not own vehicles have access to the electrification transition through electric transit, electric school buses, and electric micromobility is a critical component of transportation equity.

Real estate developers are crucial partners in installing EV chargers in new multifamily construction. Several municipalities are adding EV provisions to their **building codes**, local ordinances, and zoning requirements to promote EV-ready parking. In existing buildings, residents may face challenges unilaterally installing home charging; therefore, landlords, homeowners' associations, or other property managers need to be engaged to retrofit existing parking with EV chargers. Some cities and States offer grants and financial incentives to expand access to home charging for residents of multifamily housing, such as Vermont's pilot **Multiunit Dwelling Electric Vehicle Charging Grant** Program. DOE's Vehicle Technologies Office funded several projects that included innovative approaches to deploying EV chargers at multifamily housing and **developed considerations** for similar projects. Another DOE-funded project, Vehicle Charging Innovations at Multi-Unit Dwellings, provided a **set of tools** for multi-unit building owners, residents, and homeowner associations to facilitate the discussions around installing EV chargers in these buildings.

TRANSPORTATION FACILITIES

Transportation facilities, such as airports and park-and-rides, also serve as important site hosts. Airports are ideal hosts for a range of charging infrastructure. DCFC stations in short-term parking lots could serve EV drivers who are waiting to pick people up at the airport, while Level 1 charging is sufficient for long-term parking lots to serve travelers leaving for multiday trips. For example, the Port of Seattle and the Washington State Department of Transportation collaborated with EV charging companies in a public-private partnership to install two fast-charging EV stations at the **Seattle-Tacoma Airport's cell phone lot**. Rental car companies at or near airports are also potential site hosts as they seek to electrify their own fleets. See **Electric Vehicle Charging Stations at Airport Parking Facilities** for additional information on the relevant policy, planning, and implementation considerations for partnering with an airport facility manager.

Mass transit parking lots offer an opportunity for electric mobility charging and may only require

Level 2 charging due to the long parking dwell time for commuters. These facilities would particularly serve EV-driving renters that do not have access to chargers at home. For example, **Bay Area Rapid Transit (BART) in California** first installed EV charging stations in 2017 at the Warm Spring Station, with 42 Level 2 charging ports for BART riders. The agency also installed four Level 2 charging ports at the Lafayette BART station. BART installed these original charging stations as part of a pilot to study their use and effectiveness, and incorporated this information into their **BART Electric Vehicle Charging Policy**, which was adopted in November 2021 and will guide future charging infrastructure installment.

Though not necessarily publicly accessible, fleet depots are crucial site hosts for fleet owners to transition to EVs. In most cases, transit agencies and privately owned truck and bus fleets will want dedicated EV charging infrastructure that is not open to the public. However, some types of fleet charging, like charging infrastructure serving municipal fleets or vehicles operated by community-based organizations, could also serve the public during set hours.

COMMUNITY SITES

Municipal, county, and Tribal governments are crucial partners as community site owners. Community sites such as libraries, schools, business districts, and even public facilities like **curbside parking** spaces play an important role in ensuring widespread access to EV charging. For example, renters may not have options for home-based charging unless their landlords choose to install charging infrastructure. Residents who have only Level 1 charging capabilities at home may find they need to travel long distances on single trips, not have sufficient downtime at home for charging, or experience financial burden from home charging, particularly during peak times for electricity use.

Twin Cities All-Electric Car-Sharing Network

In 2021, the cities of St. Paul and Minneapolis launched an **all-electric car-sharing service**, with a local nonprofit organization. This car-sharing service has over 150 vehicles parked at **70 curbside car-charging stations** in a 35-square mile "Home Area." These charging stations include a spot for the car-sharing vehicle and a spot for a personal vehicle. The nonprofit organization will manage the operations of this service.

In higher density neighborhoods, curbside charging options can serve residents and businesses that are reliant on street parking. For example, New York City is installing 120 Level 2 charging ports as part of a **four-year pilot project**, with locations selected based on projected demand and stakeholder input. Similarly, the City of Melrose, Massachusetts mounted EV chargers on **electric utility poles** to serve visitors to the nearby town center. For information on "lessons learned" from DOE-funded curbside EV charging, EV carshare, and EV mobility hub projects, see **funded project summaries** from DOE's Clean Cities Coalition Network. Also, consideration is needed of other potential uses of the curb, such as bike or transit lanes or pedestrian space. Urban EV charging stations can benefit more residents of the neighborhood by also providing charging for e-bikes, e-scooters, and/or electric car-share vehicles.

EV chargers that are publicly available, especially those with unrestricted access, can fill the gaps in EV charging to make an electric vehicle a feasible option for residents with diverse transportation needs.

PARTNERS FOR ELECTRIC BUS FLEET OPERATORS

The deployment of charging infrastructure for BEBs by transit agencies requires coordination with many of the same partners described above for light-duty EV chargers. Relationships and coordination with State and Federal agencies can provide access to information, resources, and funding to assist in the planning for and development of infrastructure. Local governments are a key partner to ensure that the installation of infrastructure follows local laws and regulations.

Additionally, electric utilities are investing in transit and school bus electrification programs. Utilities are **partnering with school districts** to lower their electricity costs through smart charging programs or by **financing upfront costs** for charging infrastructure. As discussed above, early and continuous coordination with the utility helps to build a relationship and ensure that the utility can meet the needs of the transit agency. Depending on the size of the infrastructure investment, the transit agency could be a large, new customer for the utility, which will require early planning on both sides. This early coordination can also allow the transit agency to discuss their infrastructure needs, existing or planned rate schedules, and opportunities to plan charging sessions to minimize costs. Transit agencies may also want to reach out to their local government to discuss **alternatives for electricity purchase or generation**, such as on-site energy generation and storage, power purchase agreements, or community microgrids.

Other partners for transit agencies include bus manufacturers, which help agencies understand their vehicle options and infrastructure needs and plan for each deployment. Labor unions are another key partner, as the usage of BEBs requires employees to take on new job tasks to test, operate, and maintain the buses. Early communication with these partners will help transit agencies address any concerns during the planning process and prior to implementation. Other sources of transit electrification support include **the Zero Emission Bus Resource Alliance (ZEBRA)**, a professional association for transit agencies that began in 2015 to bring together transit leaders to share information and research, and the World Resources Institute's **Electric School Bus Initiative**, which provides guides, tools, and other resources. The **Joint Office of Energy and Transportation** has technical assistance resources available by request for both school bus and transit bus deployments.

SECTION 5

ELECTRIC MOBILITY INFRASTRUCTURE PLANNING FOR URBAN AREAS

This section describes best practices for planning electric mobility infrastructure, emphasizing key issues that often arise in urban areas. Many of these issues are based on the challenges identified in *Section 3: Benefits and Challenges of Urban Vehicle Electrification*. In addition, electric mobility infrastructure planning in urban areas significantly differs from planning in rural areas. For example, many EV drivers in urban areas may not have access to home charging to meet their day-to-day charging needs. Therefore, enhancing public charging infrastructure to support those without at-home chargers, such as through the convenient location of DCFC stations at locations with other amenities, may be a higher priority among urban communities.

To support electric mobility infrastructure planning in urban areas, this section walks through a project planning checklist and identifies specific resources to support the planning process. For a list of planning tools and resources, see *Appendix A: Resources for Electric Mobility Infrastructure Planning.*

GUIDING PRINCIPLES FOR PLANNING AND IMPLEMENTATION

As electric mobility technology evolves, so does the process for electric mobility infrastructure planning and implementation. Furthermore, each region, community, and charging site host faces unique needs and constraints. Therefore, the following guiding principles—rather than hard-and-fast rules—can help site hosts and other stakeholders find their own (potentially unique) path through the electric mobility planning process:

- **There is no one-size-fits-all approach**. The needs and goals for each project and region will vary greatly. In an urban area, different neighborhoods in the city and the suburbs will vary in terms of prevalence of multifamily housing, car ownership, and non-residential visitors, which will affect charging demand. The investment required for some charging installations can be complicated, but not every installation needs to be large, costly, or overly complex. For instance, even a few Level 2 public chargers may be enough to mitigate range anxiety for visitors or offer residents an overnight charging option.
- **Many planning processes may be executed in parallel** rather than strictly sequential order. The path to project completion is often not linear. Planners and stakeholders may gain new information throughout the many stages of a project and may need to revisit and revise earlier steps of the process. For example, project budgets often need to be revised based on information gathered in the site-selection process. Parallel execution of some planning processes may also facilitate faster completion of an electric mobility project.
- **Coordinate early and often with key stakeholders.** Stakeholder engagement is a crucial component of successful transportation infrastructure projects. For electric mobility infrastructure specifically, the local electric utility can provide essential information and technical support throughout the life of a project, from site selection to final installation. Additionally, charger manufacturers, charging networks, and installers often offer a wealth of technical expertise and vital connections to utilities and other stakeholders. Manufacturers and dealers of the vehicles being considered can provide feedback on any infrastructure considerations specific to a particular vehicle (for example, electric school buses that only use DC fast charging). Early coordination with entities considering electric fleets, such as transit agencies, can help facilitate collocation or shared use of charging infrastructure. Depending on the region, technical assistance from a local Clean Cities coalition may also be available to provide a manufacturer-independent technology overview and assistance in making the best use of planning tools. Good technical partners will often have more up-to-date information than what's available online. See See *Section 4: Partnership Opportunities* for more indepth discussion of potential partners.
- **Stakeholders may have different needs and perspectives.** The goals of planners, owners, and operators do not always align with the needs of the communities that host the installations. It is important to consider the diverse populations impacted by infrastructure projects, engage these community members in the planning process, and address their needs and concerns in project siting and design. See the *Equity Considerations in*

planning section for guidance and resources to help ensure that a project's benefits and costs are fairly distributed throughout the community.

- **Invest in planning and build for flexibility.** Large, complex charging installations may require expensive upgrades to the site's electrical service or even to the nearby power grid and extensive site preparation. To avoid the need for even more upgrades in the future, consider both the current charging needs and expected future needs. Designing infrastructure to accommodate future growth in demand—for example, through **modular charging stations** that allow for incremental increases in power—may be worth the extra installation costs. This approach can also reduce **site preparation costs**, as it may be cheaper and easier in the long run to "dig once" and lay electrical conduit for electric mobility charging (and any other activity requiring electrical service) at one time instead of cutting concrete multiple times during future projects. Ensuring site locations do not preclude future investments in priority corridors for multimodal travel can also help mitigate future costs.

TYPES OF CHARGING INFRASTRUCTURE PLANNING

This section discusses four types of electric mobility infrastructure planning:

- **Corridor-level planning** supports infrastructure along roads and highways that facilitate interregional travel.
- **Community-level planning** considers infrastructure solutions to meet diverse needs within a particular region or city, including consideration of current and future mode share.
- **Site-level planning** focuses on the procurement and installation of EV chargers for a predetermined location.
- **Fleet planning** introduces electric mobility infrastructure planning for transit, micromobility, ride-hailing/taxi, and last-mile delivery fleets, and can be at a corridor, community, or site level.

Figure 5-1 illustrates the spatial relationship between three levels of planning introduced above: corridor, community, and site. The relevant level of planning likely depends on the planning lead and the project

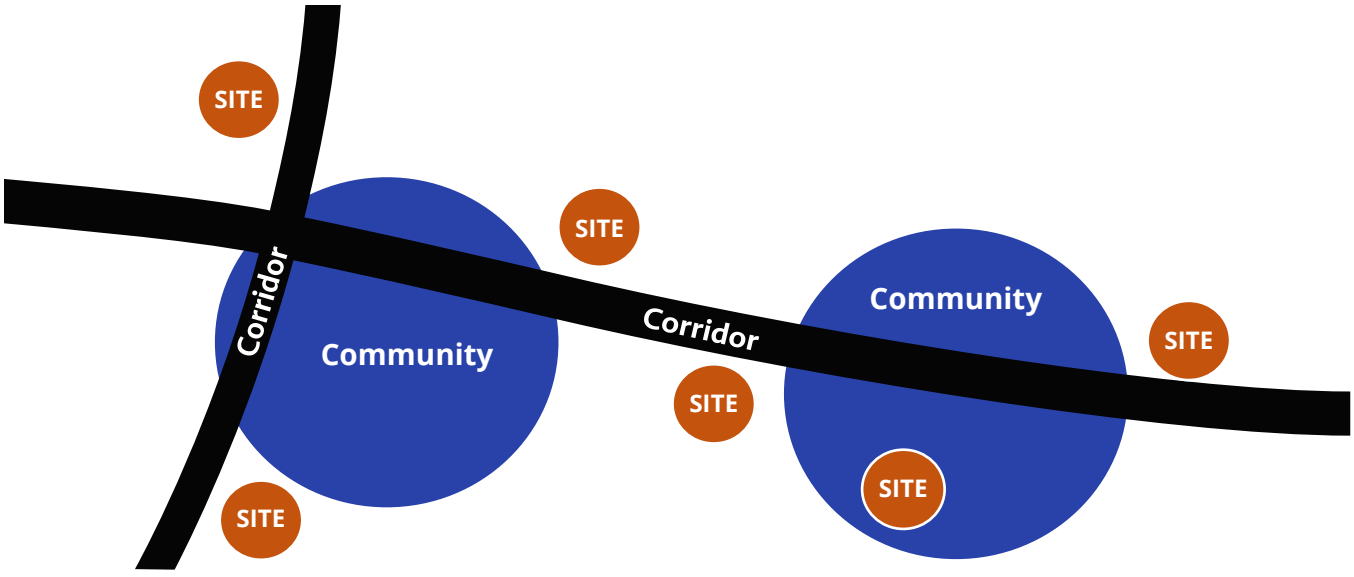


Figure 5-1. Three levels of EVSE planning: community, corridor, and site. (Source: USDOT Volpe Center)

stage. For example, local and regional leaders may initially engage in community-level planning, while State DOTs and Tribal organizations are well-positioned to pursue corridor-level planning. Both entity types, however, may transition to site-specific planning after identifying preferred locations for new charging infrastructure. In contrast, independent charging site hosts—such as owners of businesses, workplaces, multifamily housing, and single-family homes—will likely conduct site-level planning only.

The following sections identify useful resources for each type of planning and list planning considerations unique to urban areas.

CORRIDOR-LEVEL PLANNING

Corridor-level planning addresses the needs of interregional and interstate travelers and freight operators. Therefore, State DOTs, Tribal organizations, regional planning agencies, and county governments are best positioned to conduct this type of planning. Below are key considerations for corridor-level planning in urban areas:

- The corridor-based approach may be especially fitting for smaller urban areas without a sufficient base of local EV adopters to support installations. A corridor-based approach offers entities the opportunity to tap into broader regional—or even national—bases of travelers and freight operators that may use a corridor in that area with station locations that are still relatively convenient for local users.
- To meet the needs of EV drivers, corridor charging typically needs to be fast, providing as close a refueling experience to filling up with gasoline as possible. Therefore, corridors generally need DCFCs, which are more expensive and require more electric grid infrastructure. However, if travelers make longer stops at certain attractions along corridors, Level 2 chargers at those locations may be adequate.
- **Alternative Fuels Corridors** will ultimately provide nationwide coverage of EV chargers along designated major roads and will help connect neighboring urban areas.

The following resources provide useful information on corridor-level planning:

- **FHWA's Alternative Fuels Corridors program website:** This website provides resources on building out infrastructure and includes several State and regional corridor-level planning documents, including a series of **Alternative Fuels Corridor Deployment Plans** documenting strategies for filling fast-charge infrastructure gaps along interstate corridors.
- **State National Electric Vehicle Infrastructure (NEVI) Planning Websites:** This listing includes links to websites with information about State plans for the National Electric Vehicle Infrastructure (NEVI) Formula Program. All 50 States, the District of Columbia, and Puerto Rico have submitted interstate and EV infrastructure deployment plans (focused on interstates, U.S. and State highways), **which can be found here**, as required under the NEVI Formula Program funded by BIL.
- **FHWA's Regional Convenings** webpage: This resource compiles meeting materials and summary reports from a series of five regional meetings with alternative fuel corridor partners. Meetings occurred in 2018 and 2019 throughout the United States. An example meeting output and corridor-planning resource is the **stakeholder responsibility matrix** from the Intermountain Western Alternative Fuels Corridor Convening.
- **The DOE Alternative Fuels Data Center's (AFDC) Corridor Measurement Tool:** This tool enables users to measure the driving distance between EV charging stations.

- **FHWA Alternative Fuel Corridors interactive map:** This online application allows users to explore potential new corridors for EV charging stations.
- **NACTO Curb Appeal Guide:** This whitepaper identifies management strategies for improving transit reliability and supporting safer streets by making room for transit or better managing demands on the urban curb.
- **ITE Curbside Management Practitioners Guide:** This resource provides recommendations for optimizing curb space allocation.

COMMUNITY-LEVEL PLANNING

State, Tribal, and local governments; transportation planning agencies; transit agencies; and community organizations may all engage in community-level planning for electric vehicle infrastructure. In contrast to corridor-level planning, which seeks to meet the needs of those "passing through," community-level planning engages local stakeholders to serve a particular neighborhood, city, or region. Below are a few key considerations for community-level planning in urban areas:

- Entities can tap into regional coalitions and look to national-level organizations to help establish partnerships for community-level planning. Regional transportation planning organizations and metropolitan planning organizations can also help with community-level planning for electric mobility infrastructure.
- Planners can integrate electric mobility infrastructure projects into larger community and transportation planning initiatives, such as projects to expand bike lanes, add a bus route, or otherwise reduce or divert car traffic. Coordinated planning and siting can help ensure sufficient utilization while meeting diverse mobility needs.
- Communities are made up of diverse stakeholders with different needs and perspectives which should be considered in the planning process. For example, curbside charging stations and the adoption of "EV-ready" building codes can help ensure residents of multifamily housing have access to public or private charging options.
- Tourism may generate a high percentage of traffic in some areas. Since tourists may have different travel patterns (e.g., higher traffic and charging station utilization during holidays and weekends), they are likely to place different demands on the types of charging installations needed and the locations of these installations.

Requiring Electric Vehicle Charging Infrastructure in New Buildings

The City and County of Denver (CCD) adopted new EV Infrastructure building codes that will help homeowners and employers install electric vehicle chargers. **CCD's 2019 building and fire codes** require new homes or townhouses to have electrical equipment that allows for easy installation of EV charging infrastructure. Additionally, the **Denver EV Action Plan** mentions that new EV multifamily and workplace building codes have provided even more opportunities for community members to charge their EVs.

In 2019, Seattle City Council voted to **adopt legislation that alters the land use code**. The **legislation** requires all new buildings in Seattle that provide off-street parking spaces to also include electrical power outlets. The inclusion of electrical power outlets will make it easier to install electric vehicle chargers. The legislation aims to reduce barriers to owning electric vehicles.

The following resources from AFDC provide useful information on community-level planning:

- **Plug-In Electric Vehicle Readiness**: This is AFDC's primary portal for information to help communities and regions assess existing conditions, identify opportunities, develop partnerships, and conduct education and outreach.
- **A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects**: This is a comprehensive summary of lessons learned from DOE's 16 Clean Cities EV Readiness projects with coverage of 24 States across the country.
- **Electric Vehicle Infrastructure Projection Tool**: This online tool helps communities and regions estimate the overall quantity and type of EV charging infrastructure needed.

SITE-LEVEL PLANNING

Site-level planning can occur as a top-down, coordinated approach among local leaders and stakeholders (including community- and corridor-level planners) or as a bottom-up, individual approach initiated by site hosts, such as local business owners. Below are a few key considerations for site-level planning in urban areas:

- Urban charging demand will be a combination of overnight residential charging, DCFC charging for owners without home charging, and visitors to the area, requiring a variety of types of chargers in different locations to serve all their needs.
- As in community-level planning, entities can look to regional coalitions and national-level organizations to help establish partnerships.
- Cities can consider **co-locating electric mobility charging infrastructure** with other transportation options in a multimodal hub (e.g., electric mobility charging, a bike share station, and a bus stop all at the same location). This approach provides residents with convenient choices among transportation options and facilitates transfers between different modes. DOE's Vehicle Technologies Office recently funded several EV mobility hub projects and developed **considerations for similar projects**.

AFDC provides a **general overview** of the site-level planning process in addition to the following more detailed resources for specific types of sites:

- **Home charging**
- **Charging for multifamily housing**
- **Workplace charging**
- **Public charging**
- **Fleet charging**

MICROMOBILITY PLANNING

Given the shorter distance of many trips taken with micromobility devices, micromobility charging infrastructure planning typically occurs at the community- or site-level.

Charging of micromobility devices may take place at home, at work, or in public places. For example, **Oregon** has integrated micromobility charging infrastructure with standard EV charging stations as part of the West Coast Electric Highway.

One challenge of micromobility infrastructure planning is the lack of standardization and universal/interoperable charging equipment. Micromobility devices use proprietary charging cables (which may or may not be affixed to the devices) or docks that connect to standard wall outlets. Some advocates have suggested **USB-C technology** could serve as an interoperable standard for micromobility charging. Massachusetts' recent transportation bond bill includes provisions to address this challenge by funding installation of **universal e-bike charging stations**.

Micromobility devices may have removable or fixed batteries, with implications for charging infrastructure.[13] E-bikes with removable batteries can be serviced at indoor charging stations. For example, **lockers** that contain proprietary charging cables where riders can charge their e-bike batteries for free are currently deployed in select tourism locations in the United Kingdom. E-bikes with fixed batteries can be charged at **fast charging stations** located outdoors. **Integrated** parking and charging stations that are designed to work across multiple e-bike and battery brands offer another option for outdoor charging. State and local governments may partner with micromobility charging equipment companies to create charging sites in public locations.

Different operational models for charging shared micromobility devices are discussed in the *Micromobility Partners* section.

FLEET CHARGING

Transit Planning

Planning for the adoption of electric buses and the installation of charging infrastructure will likely be driven by the transit agency, in coordination with the many partners previously discussed. Many existing resources provide guidance on incorporating BEBs into service, such as the Transit Cooperative Research Program's (TCRP) **Guidebook for Deploying Zero-Emission Transit Buses** and the National Renewable Energy Laboratory's **Electrifying Transit: A Guidebook for Implementing Battery Electric Buses**. These resources provide step-by-step considerations through all the phases of planning, purchase and deployment of buses and infrastructure, operations and maintenance, and performance monitoring.

City of Chicago Tests Electric Buses

In April 2021, **the Chicago Transit Authority (CTA) started to test electric buses with passengers**. The buses can run between 75–120 miles on a single charge. To allow for the testing, the CTA installed **quick-charging stations** at various stations and bus turn arounds. The quick charging stations allow the bus to charge on-route because of the fast turnaround time. This test is part of the CTA's initiative to transition to an all-electric bus fleet by 2040.

The usage of BEBs requires the purchase not only of the vehicles, but also the upfront costs of purchasing and installing the charging infrastructure, which may require utility upgrades and maintenance facility modifications. The charging infrastructure for BEBs will need to be carefully considered as it does not scale efficiently, meaning that there will be incremental costs and space requirements as fleet size increases. The operation of BEBs will require hiring new staff and/or training existing staff in the operation and maintenance of BEBs to ensure the efficient use and maintenance of the vehicles. Due to these complexities, it is important that transit agencies plan effectively for the purchase of BEBs and charging infrastructure and consider the role of technologies such as In Motion Charging (IMC) electric trolleybuses (see sidebar) to ensure a system that best fits their needs and constraints.

In addition to the planning required to incorporate BEBs into a fleet, the transit agency will need additional planning to guide the operation of BEBs. Each BEB purchased will have an expected range, but weather (with reduced range in cold and hot temperatures), operators' driving style, topography, and ridership load all affect that range. These external factors mean that transit agencies will

13 Removable and fixed batteries also have implications for the transportation of micromobility via other modes. For example, the battery constitutes a hazardous material when taking an electric micromobility device on an airplane. Although lithium batteries can represent a fire risk, the Consumer Product Safety Commission finds that electric micromobility products certified to the voluntary UL 2272 Standard for electrical systems for personal e-mobility devices do not pose a fire hazard.

experience variability in range projections; however, tracking of range over time can help to predict this variability and mitigate potential impacts to service. If electricity rates are high, electrifying buses can have a significant impact on operational costs. To minimize this uncertainty, transit agencies should discuss rate structures with their utility company to identify any opportunities to lessen costs. For more information on partnering with utilities, see the sections on *Utilities and Partners for Electric Bus Fleet Operators*.

Transit agencies will need to consider their objectives, resources, and constraints prior to purchasing and deploying buses and charging infrastructure. Data collected through **fleet and**

On-Route Charging for Electric Buses

The Indianapolis Public Transportation Corporation, IndyGo, is testing **on-route wireless chargers** for electric bus rapid transit buses for the Red Line. The electric buses are charged through inductive charging, a wireless power transfer process. The chargers are wireless pads in the ground. A bus drives over the pad, stops, and lowers to **activate the charger**. The full process takes 10-15 minutes. In 2021, IndyGo opened the first charging station at the end of the Red Line.

Additionally, the **Greater Dayton Regional Transit Authority (RTA)** and the **San Francisco Municipal Transit Agency (SFMTA) have rolled out In Motion Charging (IMC) trolleybuses**. **IMC trolleybuses** recharge their batteries while running under catenary wires on part of a route and then operate off-wire under battery power for other parts of the route. When returning to catenary wire, the IMC trolleybus **automatically reconnects to the wire** in 3−15 seconds while passengers board at a stop. The dual-mode IMC technology can help transit agencies overcome two major challenges of relying solely on BEBs for electrification. First, it can provide agencies with high bus utilization and avoid having to potentially purchase more buses, since IMC trolleybuses can run continuously and do not have to come out of service for midday charging. Second, agencies can potentially avoid expensive grid upgrades that can be required for BEB depot electrification, as the technology requires significantly less grid power to charge than DCFC. The technology has also been able to handle the hilly terrain of San Francisco, a challenge for some BEBs.

IMC trolleybus in Dayton (source: Masstransitmag.com)

route assessments can help agencies understand their transportation and energy needs. For example, **TCRP recommends** designing smaller deployment projects to test implementation and then planning iteratively, with internal and external stakeholder engagement, to build out the BEB fleet. Each phase of deployment can be discussed with bus manufacturers to help plan for the needs of each acquisition. The needs assessment phase should consider the various factors that will influence decisions in bus and charging infrastructure purchasing, including route structure and length (to understand energy requirements), bus schedules and demand, bus depot capacity, utility rate schedule and costs, and local climate and topography. Tools that may assist with this needs assessment include FTA's **Transit Greenhouse Gas Emissions Estimator**, which estimates annual GHG emissions of transit projects based on the construction, operation, and maintenance phases of transit facilities and vehicles, and the FTA **Transit Bus Electrification Tool**, which estimates the partial lifecycle GHG emission savings associated with replacing standard bus fleets with low-emission or zero-emission transit buses. Transit agencies may also be able to secure technical assistance with deploying electric buses through the **Joint Office of Energy and Transportation**.

Other Fleet Planning

Planning for light-duty commercial vehicles covers a range of high-mileage vehicle types, including those that are owned by individuals, such as ride-hailing vehicles; by a private entity, such as taxis and last-mile delivery vehicles; and by a public entity, such as local government fleets.

Although many similarities exist between ride-hailing vehicles and taxis, planning for the electrification of these fleets will need to consider the **differences in their business models**, including vehicle ownership and access to maintenance and charging facilities. For widespread electrification of these fleets to occur, challenges of EV ownership and usage for TNC and taxi drivers will need to be addressed, including the upfront cost of the EV, the technological suitability (i.e., the daily range requirements) of the vehicle, availability of charging stations, and time required to charge. Additionally, TNCs and taxi companies may need to prepare for **potentially new processes** for vehicle repair and maintenance, safety and security, and driver training.

The electrification of ride-hailing and taxi companies will likely **require two types of charging infrastructure**: Level 2 at taxi company garages for long charges between shifts; and DCFC equipment for short charges during shifts for both TNC and taxi drivers. **A robust network of DC ports will likely be required** even by fleets with overnight charging access, as charge duration will be dependent on weather conditions and travel demand. However, providing access to overnight charging generally reduces the size of the DCFC network required to support the fleets. When planning charging infrastructure for ride-hailing and taxi fleets, the potential conflicting use of charging stations with private car users should be considered, including whether fleet vehicles should have priority access. However, these two user groups **may be complementary** if fleet drivers are less likely to charge at the same times as private vehicle owners, such as early evening when they are in a busy shift.

To encourage the electrification of ride-hailing and taxi companies, all the partners involved in the planning efforts should consider how to reduce the total cost of ownership for EVs, including both direct costs of vehicle purchase and charging, as well as the indirect costs of time spent charging. To reduce direct costs, planners might consider **rebates or point-of-sale benefits, tax credits**, **promoting**

used EVs or scrap-and-replace incentives, short-term rentals of EVs, and **exemptions or discounted rates on ride-hailing taxes and fees.** To reduce indirect costs, planners can consider the **layout and availability** of the charging network, including providing amenities at charging locations and prioritizing high-traffic areas such as downtowns and airports; providing **HOV lane access and airport pickup priority access** to reduce downtime in traffic; and **offering financial incentives to EV drivers** through premiums paid by the company or rider.

Urban last-mile delivery fleet vehicle charging may take place at centralized logistics depots, shared or dedicated "beyond the depot" charging hubs, or public charging infrastructure. For example, **New York City** is pursuing installation of up to 100 truck chargers throughout the city and charging infrastructure at the Hunts Point Food Distribution Center. Santa Monica, California is conducting a **zero emission delivery zone pilot** offering priority curb space and supportive charging infrastructure for light electric trucks in a portion of the central business district.

Delivery service providers may obtain EV charging infrastructure through different ownership models, including customer-owned and charging-as-a-service approaches. For more information on ownership models, see the *Project Development and Scoping section* of this toolkit. Delivery service providers should consider the level of EV chargers needed, including the use of DCFC chargers to reduce downtime for fleet vehicles. If relying on public charging infrastructure, delivery service providers must consider whether chargers are physically accessible to larger vehicles. Fleet managers may also take advantage of incentive programs by charging delivery vehicles during off-peak hours. For example, a New York utility offers monthly cash **incentives** for light-duty fleets that avoid charging during summer afternoon peak demand periods.

The EPA's SmartWay program, compiles **resources** related to commercial electric truck charging, including a **roadmap** developed by the North American Council for Freight Efficiency and a **guidebook for fleet managers** on commercial truck charging.

Local governments are subject to many of the same considerations as other fleet managers with respect to fleet charging. A few examples highlight municipal experience with EV infrastructure planning and implementation:

- New York City has **built out EV chargers** for its increasingly electrified municipal fleet, with over 1,000 chargers, including solar-powered chargers, a mobile charger, and 90 DCFC chargers. New York allows public access to some of its chargers for a fee.
- Seattle's **Green Fleet program** includes extensive EV charging infrastructure to support its growing electrified municipal fleet. The city has installed one Level 2 charger for each BEV and PHEV in its fleet, with an additional DCFC charger for rapid charging needs. Seattle's experience highlights the importance of planning for fleet charging before procuring the EVs, optimizing the number of chargers based on fleet characteristics, and locating chargers at central and satellite locations.

Local governments may leverage resources initially designed for Federal use, including FEMP's **Electric Vehicle Supply Equipment Planning Form**, which is a questionnaire that can assist facility and/or fleet managers with EV infrastructure planning.

PROJECT PLANNING CHECKLIST

This section walks through a general checklist for electric mobility project planning. Figure 5-2 provides an overview of the checklist, with the following subsections discussing each checklist item in more detail. Most of these checklist items apply to site-level planners, such as charging site hosts or other entities tasked with identifying a project's size, cost, and plan for execution. However, some points—such as site selection and electric grid planning—are also relevant to community or corridor planners, especially since high-level planning may affect the set of candidate charging sites.

Also, as noted in the *Guiding Principles for Planning and Implementation*, the planning checklist is not necessarily a series of sequential steps. Instead, site-level planners may need to think about multiple issues simultaneously and possibly revisit individual checklist items throughout the planning process.

PROJECT DEVELOPMENT AND SCOPING

Establish Overall Project Scale

Determine the project's scope, preliminary budget, timeline, and funding mechanism. Site-level planners may need to continually revise the project scale as they learn more about costs and other constraints specific to their site. To prepare for initial project

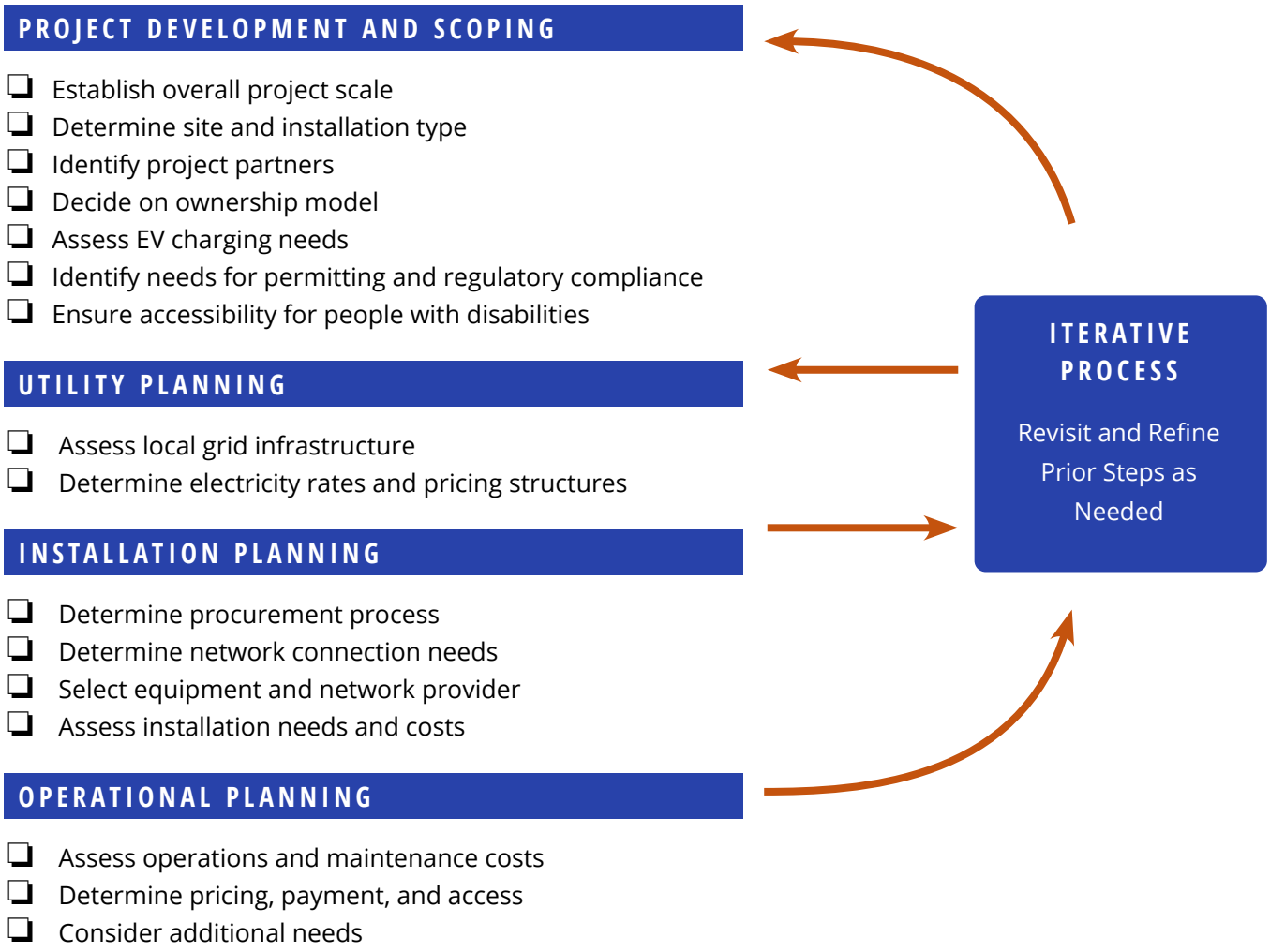


Figure 5-2. Key steps in planning EVSE projects. (Adapted from AFDC's "Infrastructure Development Checklist")

scoping conversations, planners should develop a sense of expected interest or demand for all modes of electric mobility charging, whether present or in the future, and should begin to familiarize themselves with the types of EV and micromobility chargers; approximate costs; and available funding opportunities. On estimating demand, *Assess EV Charging Needs* provides technical guidance while *Equity Considerations in Planning* suggests methods to engage community members early in the planning process.

For fleet managers specifically, Rocky Mountain Institute (RMI) has **prepared a summary** of what to expect (e.g., number of chargers needed, costs, and challenges) when electrifying fleets of different sizes.

Determine Site and Installation Type

In a top-down approach to planning, site-level planners work closely with a regional coalition to identify the best location for an EV charging station. Higher-level coordination can help integrate electric mobility infrastructure planning with other community-level or corridor-level planning efforts, including goals to more equitably meet community needs. For example, curbside charging could serve multifamily housing residents or others who may not have EV charging spaces at home, in addition to the general public. **Pole-mounted chargers**—typically lower power chargers connected to streetlights and utility poles— as currently piloted in **Kansas City** and the **City of Melrose,** can also meet charging needs while using existing electrical infrastructure and preserving the flexibility of relocating chargers in the future.

Site-specific technical, economic, and regulatory factors will also need to be considered in initial site selection. The local utility can conduct a site assessment to help planners avoid particularly problematic or costly sites for a charging installation. In addition, consult the municipal public works department to ensure construction at a potential site will not disrupt underground water and gas pipelines and telecommunication lines.

In a bottom-up approach, individual charging site hosts may already understand their unique site-specific constraints and choose to install charging stations on their own property. Site hosts could still potentially benefit from partnering with utility coalitions and other stakeholders to achieve cost reductions (by leveraging other purchases of equipment and services) or to increase charging station utilization.

In either case, attention should be paid to avoid locations that would prevent desired improvements to multimodal travel in the future.

NYC DOT Curbside Charging Pilot Program

New York City DOT (NYC DOT) partnered with a local energy company to install **120 Level 2 curbside chargers throughout NYC** as part of a pilot program. Together, NYC DOT and the energy company used information from projected demands for charging, geographic diversity, and stakeholders to decide on optimal curbside locations for the chargers. In addition to installing chargers, NYC DOT added a new parking regulation that only allows users who are actively charging their EVs to be able to park at parking spaces next to chargers. After installation, the chargers have been managed and operated by the charging network company.

This pilot program was a part of a larger effort to reduce the city's GHG emissions by 80 percent by 2050 and to create **PlugNYC: a comprehensive network of publicly available EV charging stations**.

Engage Project Stakeholders

Planners need to engage project stakeholders, such as electric utilities, local government agencies, and members of the community. It is best to connect with utilities early in the planning process to inform them of the project and facilitate utility advance infrastructure planning, to learn about their different EV-related policies and programs, and to understand any project constraints. Also, it is helpful to explore any local government incentives and programs offered to residents and businesses to install EV chargers, and to communicate with local leaders about where publicly available charging would be valuable. See the section on *"Partnership Opportunities"* for a more in-depth discussion of potential project partners.

It is important to holistically plan for a multimodal future when siting charging stations in the public right-of-way, accounting for future transit, micromobility, and bicycle corridors. Many cities have planned but not yet built out their networks of protected bike lanes and bus lanes, which are incompatible with EV charging at the curb. If a city has not yet adopted plans for a connected, protected bike and transit network, planners should consider developing these before installing curbside charging stations and locking in curb usage. Public charging stations should be sited in a manner that is compatible with future transportation needs and goals.

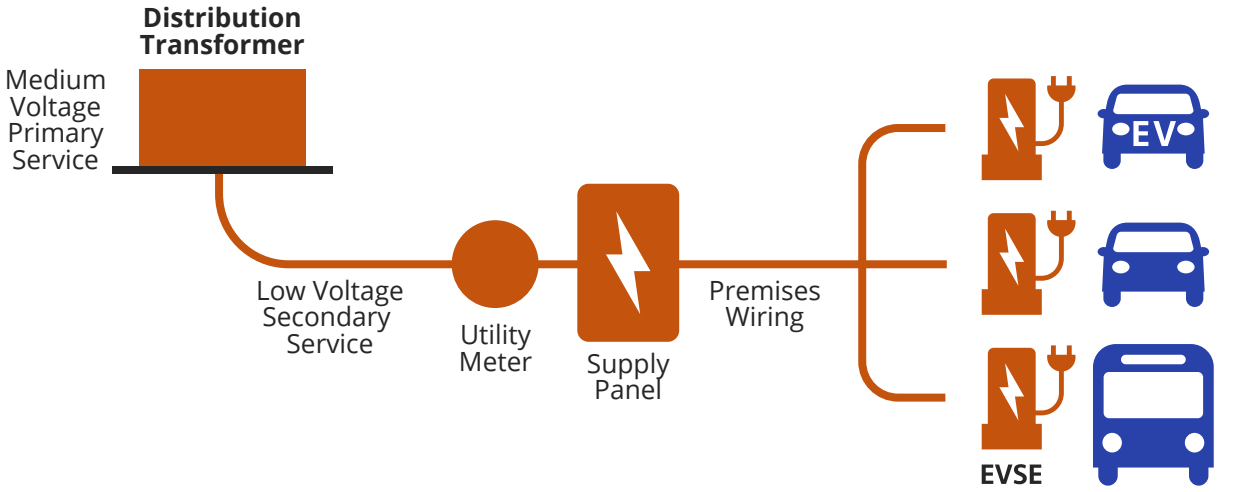
For many projects, it will be important to also get input from the broader community early in the project planning process. This will help ensure that the project meets the community's needs and avoids unanticipated changes later on. See the section on *Engagement and Outreach Methods* for more discussion on strategies for equitable community engagement in electric mobility infrastructure projects.

Decide on Ownership Model

Site-level planners need to determine who will own, operate, and maintain the chargers and related electrical infrastructure. In general, either the utility or the utility customer can own and operate the chargers. The utility customer can be the site host—a property owner or tenant—or a third party, such as a charging network company. With third-party ownership and operation, the site host does not directly profit from the charging station revenue but may see an increased number of visitors. For example, visiting EV drivers may purchase items from a retailer's business while charging their vehicles.

As illustrated in Figure 5-3, there are also several possible **ownership arrangements** between the utility and utility customer (e.g., the site host or other third-party):

- In a **"traditional"** approach, the utility provides all equipment and wiring needed from the public power lines to the facility, including the meter. The customer then pays for, owns, and maintains all front-of-meter wiring and the EV chargers, often with utility rebates. In this approach, the customer has full ownership and control over on-site wiring and chargers but also makes larger upfront investment than in alternate models.
- In a **"make ready"** model, the utility installs, owns, and maintains all the wiring leading up to the chargers and makes any needed service or meter upgrades. The customer owns and maintains just the EV chargers. This option typically involves new utility service and is helpful for site hosts that do not want to invest in on-site wiring upgrades.
- An **"EV supply equipment (EVSE) only"** model applies when the customer already has most of the needed on-site wiring. The utility still provides the equipment and wiring needed from the public power lines to the facility (as in the "traditional"



	UTILITY SERVICE	PREMISES WIRING	EVSE
1. Traditional	**Electric Company**	**Customer**	**Customer**
2. Make Ready	**Electric Company**	**Electric Company**	**Customer**
3. EVSE Only	**Electric Company**	**Customer**	**Electric Company**
4. Full Ownership	**Electric Company**	**Electric Company**	**Electric Company**

Figure 5-3. Various approaches to ownership of EV charging infrastructure. (Source: AVISTA, 2020)

and "make ready" approaches), and additionally installs and owns the charging equipment. However, little to no on-site wiring upgrades are needed.

- In a **"full [utility] ownership"** model, the utility owns and maintains all equipment, wiring, and chargers. In return, the utility collects payment from users of the EV charging station. For large investments like DCFC installations, this approach can help ensure long-term operability and public access.

State regulations may impact how utilities own and manage EV charging infrastructure. These regulations vary widely[14] and therefore pose different considerations for potential business models and arrangements among site hosts, electric utilities, and charging station network operators. AFDC's **Laws and Incentives database** contains information on State-level utility regulations regarding how electricity is sold and potentially re-sold by charger operators. In addition to regulations on who can sell power, States have different taxes and fees on electricity sold by EV charging hosts, which may affect the financial bottom line and discourage potential hosts. If a site-level planner wants to pursue a model involving utility ownership or operation of the chargers, it may be best to inquire upfront with the local utility about the available options. For additional discussion on the pricing-related decisions for different business models, see *Determine Pricing, Payment, and Access*.

14 For example, see the definition of a public utility in Virginia.

Assess EV Charging Needs

When determining the number and types of chargers needed at a location, it is important to assess:

- **The expected total demand for charging** (e.g., number of vehicles per day, types of vehicles). Does the expected demand support the overall business case for the installation?
- **The expected demand profile.** Will demand be steady throughout the day, or will there be peaks in demand at certain times of day?

Installations should be sized to handle peak demand periods. Site-level planners should consider how the installation size and project scope accommodates peak demand, as well as ways to limit those peaks (e.g., shifting charging demand from higher-demand times to less-busy times) (see Figure 5-4). The local utility may have additional recommendations on how to reduce peak demand to avoid demand charges or exceeding available power supply (see also *Utility Planning*). Options may include integrating energy storage technologies into the charging installation (e.g., **on-site batteries**) and utilizing "**smart charging**" strategies, such as automatically adjusting charging speeds and times to meet demand at a lower cost.

Appendix A: Resources for EV Infrastructure Planning includes several tools—such as **Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite** and the **GIS EV Planning Toolbox for MPOs**—to help estimate charging and energy needs.

Identify Needs for Permitting and Regulatory Compliance

To ensure a project's viability, it is important to identify regulatory requirements and necessary permits. For example, for projects that receive Federal funding, it is important to consider requirements to purchase certain products from American manufacturers (**Buy America** provisions), and requirements for contractors to pay locally prevailing wages on construction projects (**Davis-Bacon and Related Acts**). The *Federal Funding Application Process* section provides more information on considerations for projects receiving Federal grants and loans.

Electric mobility infrastructure projects must also comply with applicable environmental laws and regulations. The National Environmental Policy Act (NEPA) requires all Federal agencies to consider their actions' impacts to the environment as part of their decision-making process. Compliance with NEPA and any other applicable environmental laws, such as the Endangered Species Act, Clean Water Act, and National Historic Preservation Act, is required for projects that receive Federal funding or require Federal approval. The Federal agency taking primary responsibility for the environmental review process will work with the applicant for Federal funding or approval to identify which environmental statutes and executive orders will apply to the project. Many charging projects will require only a minimal environmental review due to their small footprint and lack of potential to cause significant environmental impacts. *Appendix B* contains brief overviews of the environmental statutes and executive orders that USDOT anticipates will most commonly apply to EV infrastructure projects, though each project will be individually evaluated. Check with the partnering Federal agency for more detailed guidance on the environmental review process.[15]

Beyond Federal laws, regulations, and permitting, the project sponsor will also need to meet relevant State and local requirements. As specific requirements vary by community or even type of site, it is important to check with local officials to confirm all applicable requirements and to ensure compliance throughout the project's lifespan. At the same time, States and

15 For example, see FHWA's **Environmental Review Toolkit** and FTA's **Environmental Review Process** webpage.

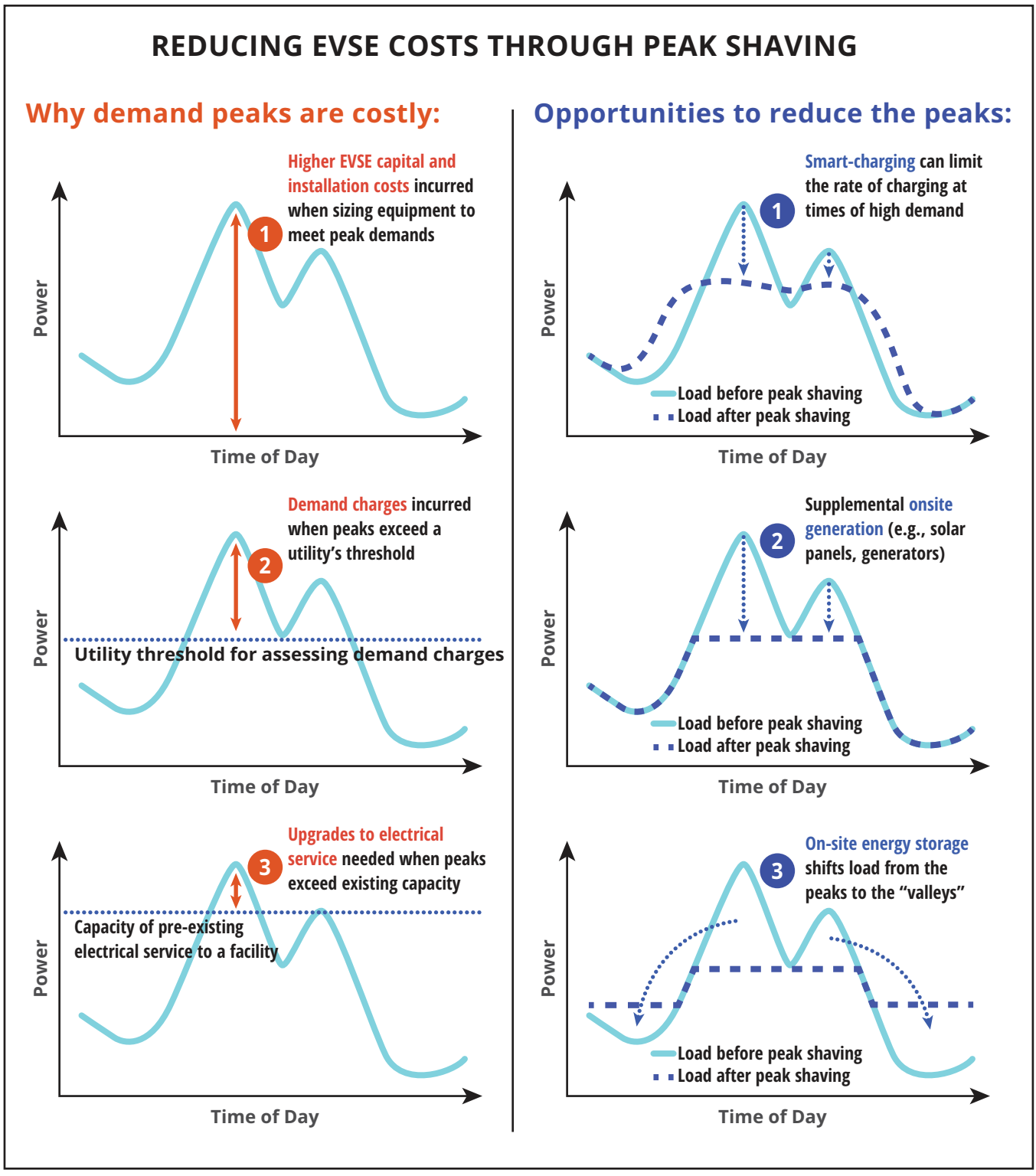


Figure 5-4. Reducing an installation's peak demands through processes known as "peak shaving" can save significant costs, both initially and over the life of an installation. Of these options, only smart charging can reduce the necessary capacity of the EV charging installation. On-site generation and energy storage only reduce demand on the grid electricity supply—they do not reduce demand for charging power from the EV charging station. (Graphic adapted from Peak Shaving Control Method for Energy Storage.

localities should review and clarify their permitting process for EV charger installation and training their permitting staff. For example, to facilitate the deployment of EV charging infrastructure, several cities—such as the **City of Orlando** and the **City of Manteca**—are working to streamline and elucidate the permitting process.

Ensure Accessibility for People with Disabilities

The **Americans with Disabilities Act** (ADA) prohibits discrimination on the basis of disability by public entities (e.g., cities and States) and places of public accommodation or commercial facilities. The **Architectural Barriers Act** (ABA) requires that buildings or facilities designed, built, or altered with Federal dollars or leased by Federal agencies be accessible. Under both of these statutes, the U.S. Access Board is responsible for developing minimum guidelines for accessible facilities. Those guidelines become enforceable standards when adopted into regulations by the applicable Federal agencies under those statutes (USDOT and the U.S. Department of Justice (DOJ) for the ADA; the Department of Defense, U.S. Postal Service, General Services Administration, and Department of Housing and Urban Development for the ABA).

The U.S. Access Board is in the process of developing minimum guidelines for all aspects of accessible EV charging stations. In the meantime, entities subject to the ADA or ABA are already required to comply with numerous **accessibility standards** applicable to the design and construction of buildings and facilities, including EV charging stations. For areas and elements not already covered by applicable standards, the U.S. Access Board provides **design recommendations for accessible electric vehicle charging stations**. The Access Board guide differentiates between accessible parking spaces and EV charging spaces because of differences in how people with disabilities may need to maneuver near their vehicle to access chargers and the vehicle's charging inlet.

Access Board design recommendations cover both accessible mobility features and accessible communication features of EV charging stations. Under the ADA and ABA Accessibility Standards, EV charging stations must comply with the technical requirements for floor and ground surfaces (**§302**), clear floor or ground space (**§305**), reach ranges (**§308**), operable parts (**§309**), accessible routes (**§402**), and other provisions when needed, such as some of the provisions in parking (**§502**), signs (**§703**), and fare machines (**§707**). EV chargers developed, procured, maintained, or used by Federal agencies must also comply with the revised Section 508 Standards, which requires that the charger's user interface be accessible.

ADA-compliant charging installations provide unobstructed access to equipment with easy-to-use controls, enough space for the driver with a disability to exit or enter the vehicle and allow for free movement around the charger and connection point on the vehicle. Because EV charging inlet locations vary across vehicle makes and models, charging spaces should provide a variety of access aisle locations and charger configurations to allow maneuverability around all sides of the electric vehicle.

There are no ADA and ABA standards requiring a minimum number of chargers that must be accessible at an EV charging station. In the absence of such standards, a "reasonable number" should be accessible to and usable by people with disabilities.

Many States have developed their own standards or guidelines[16] for accessible design, so site-level planners should consult their local governing

16 For example, see North Carolina's **Accessibility for Public Charging Stations factsheet** and Ohio and Virginia's **EV Charging for Persons with Disabilities**.

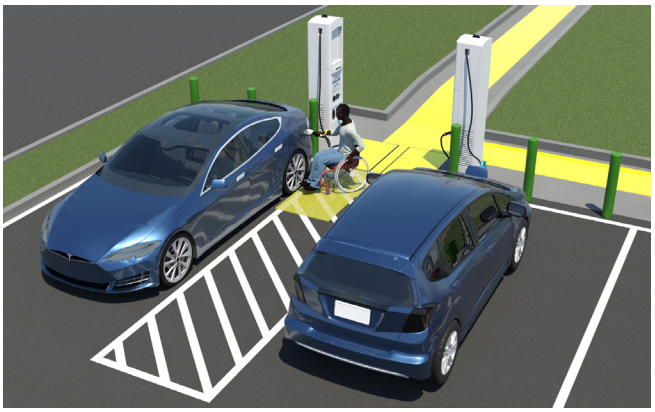


Figure 5-5. Examples of accessible parking with EV chargers. (Sources: North Carolina Plug-In Electric Vehicle Task Force (left); U.S. Access Board (right)

bodies for additional guidance in ensuring ADA-compliant parking and charging stations. These design standards and guidelines highlight additional accessibility considerations such as ensuring that protective bollards, wheel stops, and curbs do not block access to the charger; designing site layout to mitigate cable tripping hazards; and providing assistance to drivers with disabilities for heavier DCFC cables and connectors requiring more force to insert into EV inlets.

UTILITY PLANNING

Assess Local Grid Infrastructure

As noted earlier, coordinating with the local utility can be beneficial throughout the life of a project, but this coordination becomes essential at this stage of the planning process. Sites with many Level 2 chargers are more likely to strain elements of the existing local grid than sites with a single Level 1 or Level 2 charger. While the installer can make on-site modifications, any necessary electrical supply upgrades (e.g., higher-capacity supply wires, transformers) may need to involve the local electric utility. In addition, as illustrated in Figure 5-6, three-phase power is required for DC fast charging. Unlike single-phase circuits which have a single "live" wire and a neutral wire, three-phase circuits have three live wires, each with its own alternating current signal, and can deliver substantially more power to the charging system. In urban areas, **three-phase power** is typically available on major streets while residences and side streets are served with single-phase power. Reach out to the local utility to discuss charging needs and understand the available power supply. Early coordination also helps ensure that major infrastructure upgrades, such as the installation of substations, do not incur avoidable costs and project delays during the implementation process.

Charging installations using off-grid power sources may provide an appealing option for avoiding expensive grid upgrades by shaving peak demand and, if combined with on-site energy storage, potential for building in resilience against power outages. There are some emerging resources for planning installations with off-grid charging through distributed (on-site) electricity generation and on-site energy storage. Some companies are pursuing large-scale EV charging using distributed renewable power. There are also potential hybrid approaches that use both grid-power and off-grid power—for example, using batteries or generators to supplement grid power to meet peak power demands. These "peak shaving" strategies can enable higher-power charging without electricity infrastructure upgrades and can help avoid incurring demand charges. Other

ELECTRICITY SUPPLY REQUIREMENTS

What ultimately determines the speed of EV charging is the electric ***power*** (measured in watts or kilowatts) delivered to the vehicle. ***Power*** is a function of the ***voltage*** (in Volts) of the electrical supply and the ***current*** (in amps) flowing through the circuit (Power = Voltage x Current).

However, the power delivered to a battery may be limited by internal components on each vehicle, so not all vehicles will be able to charge at the highest rate of the EV charging equipment. Furthermore, three-phase electricity supply is needed for DC fast charging, so a lack of access to three-phase power will limit options for some EVSE installations.

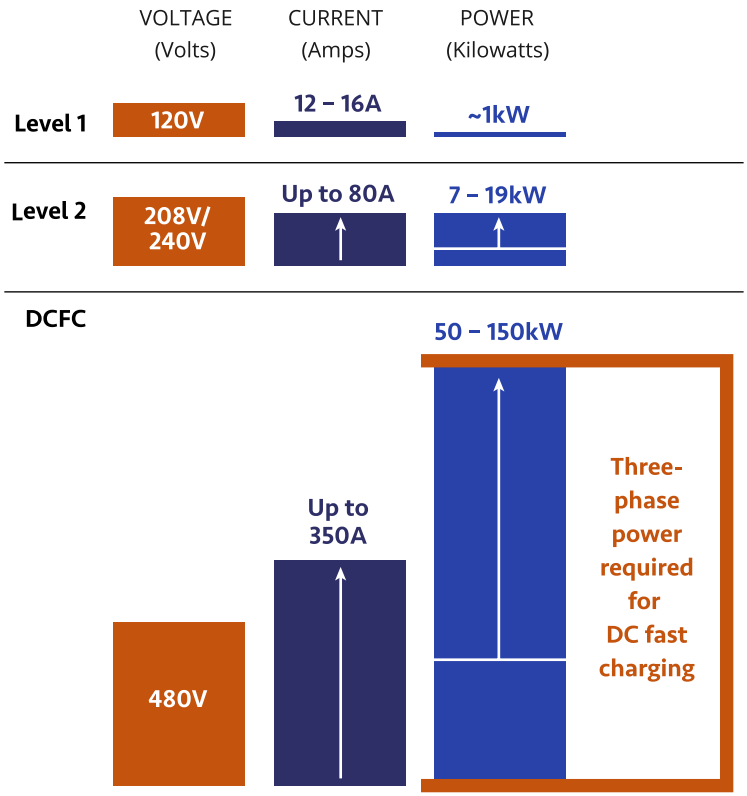


Figure 5-6. Electricity supply needs of different charging speeds, including the importance of three-phase power for fast charging. (Source: USDOT Volpe Center)

companies provide charging systems that fully integrate batteries with a site's low-power electricity supply to provide fast charging in places where it may not otherwise be possible.

Determine Electricity Rates and Pricing Structures

It is essential to coordinate with utilities early in the planning process to understand aspects of electricity pricing that may significantly impact the financial viability of an EV charging installation. This includes basic electricity pricing (e.g., different rates for residential and commercial customers) as well as demand charges and time-of-use rates.

Demand charges are extra fees that many utilities charge to commercial and industrial customers to help cover their costs of investing in infrastructure to meet peak demands. Demand charges are applied per kilowatt (kW) of power required at a point in time and are charged on top of the costs of cumulative energy used (in kilowatt-hours, or kWh) over a billing period. They are charged by utilities when a customer's peak demand exceeds a certain threshold, usually in the 20 kW to 50 kW range. **The fees**, usually ranging from $3 to $40 per kW, are determined by the highest amount of power drawn during any interval (typically 15 minutes) during a billing period and are added to a customer's monthly bill. For example, if an on-site EV charging station causes peak demands to exceed the utility's threshold for just 15 minutes of a given month, the facility operator may be charged up to $2,000 extra for that month. Utilities may also vary their demand charges based on the season and time of day.

The use of DCFC chargers or the simultaneous use of several Level 2 chargers can increase a facility's peak electricity demand and trigger expensive demand charges. These demand charges increase the price of individual charging sessions and deter drivers from using the charging station. Some utilities offer programs and other solutions to reduce the initial impacts of demand charges[17] for cases where initial charger utilization may be low, and small additional charges can significantly impact the business case for owning and operating EV infrastructure. In addition, if site hosts raise prices for their customers to cover the additional expense, demand charges could make EV charging prohibitively expensive to low-income populations and thus hinder equitable access to the energy, environmental, and economic benefits of EV ownership.

Time-of-use rates provide reduced electricity costs at certain times of the day to encourage EV charging when overall demand on the grid is low (e.g., at nighttime), helping the utility smooth out its overall demand profile. Time-of-use rates are applied per kWh used during the specified time period.

Contact your local utility to understand the costs of electricity that may apply to a particular charging station. Also ask about time-of-use rates or other special EV charging rates. Resources like the **Utility Rate Database** also provide a convenient method to research rates for utility companies across the U.S.

Note that a charging station's electricity usage will be **measured by the electrical meter** to which the charger is connected. Owners and managers of multifamily and mixed-use buildings should determine if they need to set policies on charger access and/or recoup the cost of electricity through user payment (e.g., by kWh, by minute, or through parking premiums), depending on whether the chargers are on a dedicated, common area, or group meter.

17 See the utility case studies in the **2021 Western Governors Association report** for example programs.

INSTALLATION PLANNING

Determine Procurement Process

Some entities (e.g., public agencies) may need to follow formal procurement processes or other guidelines to obtain the necessary equipment and services for electric mobility infrastructure installations. Importantly, these procurement rules or guidelines could affect other aspects of the planning process. For example, the Northeast States for Coordinated Air Use Management (NESCAUM) has developed **model language** for State EV infrastructure grant and procurement contracts to establish a baseline for important aspects of charging station operations, such as station access, uptime (or availability), pricing transparency, and payment options. Additionally, many localities have the option of purchasing EVSE through established State contracts, which can provide savings over bidding per contract. Agencies should note the requirements under 23 CFR 680 and 2 CFR 200 and other applicable Federal regulations if the procurement will be conducted using funding that

Success Story: Off-Peak Charging for Massachusetts Residents

In 2022, an electricity company introduced its Off-Peak Charging Program to residential customers in Massachusetts. Once users enroll in the program, they can receive a $50 enrollment incentive in addition to a rebate of five cents per kWh used for EV charging during off-peak hours (9 p.m. through 1 p.m. on business days) during summer months. This rebate decreases to three cents per kWh during non-summer months. This program aims to improve the electric grid's resilience by incentivizing charging during off-peak hours.

is administered under title 23, United States Code. State departments of transportation should also note the requirements under 23 CFR 635 and 23 CFR 636.

The timing of EVSE procurement may also be an important factor. For example, in cases where fleets are transitioning to EVs, EV charger procurement should be done well in advance of vehicle procurement, to ensure that chargers are installed and ready for use in advance of the transition.

Determine Communications Network Connection Needs

The installing entity will need to decide if the stations will be networked or non-networked. Networked chargers connect to the Internet or cellular service to collect payment by credit card or smart phone, transmit utilization data, including current charger availability, and support remote customer service and firmware updates. They also introduce a range of opportunities related to vehicle-to-grid integration (VGI), including unidirectional control from the grid to the vehicle (often referred to as "V1G"), which allows the grid operator to control the rate of charging to reduce demand peaks, and vehicle-to-grid capabilities (or "V2G"), which allow bi-directional communication and bi-directional flow of electricity between vehicles and the grid, allowing vehicles to provide additional grid services.

Non-networked chargers provide basic charging capabilities without an Internet connection or any advanced monitoring or payment capabilities. As a result, non-networked chargers must either collect payment through a different means (e.g., through an attendant or at a nearby establishment) or provide complimentary EV charging.

Select Equipment and Network Provider

Equipment and network providers can fill important gaps in knowledge on EV charger types, needs, and capabilities. For equipment and network selection, resources such as the **Go Electric Drive "EVSE Products, Charging Network and Service Providers"** tool can help facilitate comparison between current choices on the market.[18] The **ENERGY STAR certified EVSE list** helps with selecting the most energy-efficient models. The California Energy Commission **EV Charger Selection Guide** provides side-by-side specification comparisons of available hardware, software, and payment system options and a product photo library. An alternative approach for locating providers is to contact one of the main industry associations, such as **Electric Drive Transportation Association**, **Plug-In America**, or **Zero Emission Transportation Association**.

To ensure hardware-software compatibility across vendors, many equipment and network providers adopt standard protocols such as the **Open Charge Point Protocol** (OCPP) and the **Open Charge Point Interface** protocol (OCPI) though use of these protocols is not required in the U.S. (nor do they apply to non-networked chargers).

18 Alternatively for equipment: https://pluginamerica.org/get-equipped/

Assess Installation Needs and Costs

Information on EV charging demand, siting, and electrical capacity can inform which types of EV chargers are selected and how many to install. Refer to the section on *Charger Speeds* for information on available charger types, namely Level 1, Level 2, and DCFC. When selecting a charger type, consider its voltages, resulting charging and vehicle dwell times, and estimated upfront and ongoing costs.

While local costs can vary significantly from the national average, a 2019 report by the International Council on Clean Transportation estimates that **hardware and installation costs** for networked Level 2 chargers is around $6,000 for a single-port pedestal capable of charging one vehicle and $11,000 for a dual-port pedestal that can charge two vehicles at once. Costs for non-networked chargers are significantly less at around $4,000 for a single-port and $8,000 for a dual-port charger. For DCFC units, typical costs range from $70,000 to $120,000. See the decision tree in **Figure 5-7** for additional guidance in selecting a charger type.

As described in DOE's **2015 EVSE cost report** and in a **2019 report by RMI**, site- and project-specific factors that may affect the cost estimate include the trenching distance to lay the electric conduit and local labor costs. Also, per-charger installation costs typically decrease significantly when additional chargers are installed on the same site and at the same time. Similarly, overall installation costs can be lower if a site completes all trenching for all conduits at once, even if the charging units themselves are not planned for installation until a later date. Innovative solutions like installation of **solar-powered chargers** may also decrease conduit needed. An EV charger installer can perform a site assessment to provide more tailored cost estimates for the types of chargers that meet project needs.

Additionally, a thorough assessment of installation needs and costs should include any upgrades needed to on-site electrical wiring (which is in addition to upgrades that the utility may need to do on their side of the meter). This step should also include consulting with a certified electrical contractor. The Electric Vehicle Infrastructure Training Program (EVITP) provides a **State-by-State listing** of available certified contractors. States vary widely in terms of the availability of certified contractors. The equipment or network provider can also be a source of information for locating qualified EV charger installers.

OPERATIONAL PLANNING

Assess Operations and Maintenance (O&M) Costs

While early estimates of O&M costs may not be very precise, they will be essential to overall financial planning and ensuring that the project scope and business model are viable. Charging stations require ongoing maintenance in the form of general inspections, repairs, cleaning equipment, and ensuring cables are securely stored. Repairing broken chargers can be costly if the chargers are no longer under warranty, so it is important to determine whether the site host, charging network, or charger installer will be responsible for the costs and to specify expectations (e.g., around response time) in maintenance contracts. For preliminary planning, however, AFDC recommends that station owners plan for annual maintenance costs of $400 per charger. Additionally, as discussed in the *Utility Planning* section, total spending on electricity depends on the utility's pricing structure, demand charges, and time-of-use rates and should be discussed with the local utility. AFDC provides additional information on **O&M costs** as well as other considerations for operating an EV charging station.

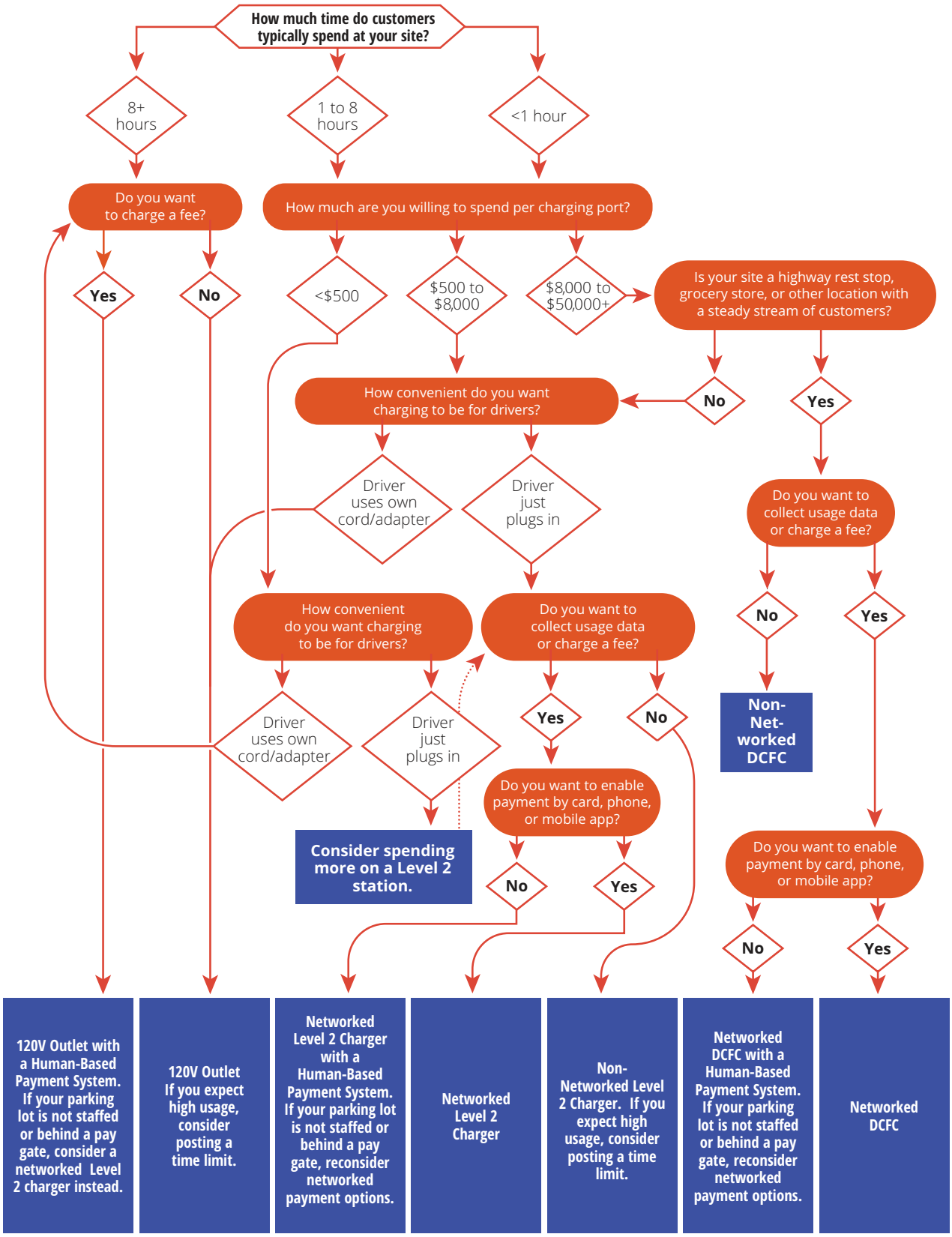


Figure 5-7. Charger selection decision tree. Note that chargers installed with funding that is administered under title 23, United States Code, are subject to 23 CFR 680, which establishes minimum technical standards for charging stations and will affect aspects of the charger selection process. (Source: Adapted from Plugincars.com, 2014)

Beyond the cost of electricity and maintenance, some EV charging station operators may also pay a subscription fee to the network company to facilitate or manage pricing, charger access, and data collection and analysis. According to a **2014 article by RMI**, these fees tend to cost around $250 annually but vary based on the capabilities of the software. Site owners may also be subject to credit card fees, which are typically a small percentage of total transactions. However, these credit card fees may be included in the subscription fees paid to the network company.

Finally, some network companies alternatively adopt a hybrid pricing model in which the site host and partner network agree to split both the costs and revenues. EV charging station operators may wish to recoup O&M costs by charging for charger use or pursuing innovative business models like selling advertising space at the charger location.

Determine Pricing, Payment, and Access

EV charging station owners and operators will have to decide among a range of options for pricing (e.g., per kWh, per unit time, by monthly subscription); payment (e.g., at the charging unit, over the phone, at a nearby establishment); and access (membership-based or open access). Agencies should note payment-related requirements under 23 CFR 680 and other applicable Federal regulations when using most types of Federal funding. Note that 23 CFR 680.116(a) requires that the price for charging must be based on the price for electricity to charge in $/kWh. For example, as illustrated by **Shift2Electric's metering and payment table**, employers offering workplace EV charging should think about whether or how to request payment for charger use and how to bill for use. Employers should also consider whether to allow the public to access their chargers. Note that as per 23 CFR 680.106(f)(2), chargers installed with funding administered under title 23, United States Code, are subject to 23 CFR 680, which requires that memberships not be required for use, nor can they be cause for delay, limit, or curtailed power flow to vehicles.

Possible pricing models depend on who owns and operates the EV chargers. Generally, site hosts who own and operate their own EV chargers can set their own prices. Some site hosts may opt to offer free charging to EV drivers. Free charging is more common for Level 1 and Level 2 chargers, which cost less to own and operate than DC fast chargers. For example, hotels or workplaces may wish to provide Level 1 or Level 2 EV charging as a complimentary service to their customers or employees.

Site hosts can alternatively decide to require payment from EV charging customers. Lower prices could attract customers while still offsetting electricity costs, including demand charges incurred through DC fast charging. Higher prices, on the other hand, could help the site host make a direct profit from EV charging. When setting prices, keep in mind that potential customers may be able to use mobile apps to locate other nearby networked chargers and to review ratings and comments from other customers.

For non-networked chargers, which do not have payment collection capabilities, site hosts can collect fees through radio-frequency identification (RFID) capabilities, mobile applications, or in-person payments, such as with an attendant or at a nearby establishment. When setting prices, note that States have differing regulations. Some States classify charging station operators as public utilities, which can affect how they are allowed to charge for usage.

Network companies operating EV chargers may offer pay-as-you-go pricing as above or alternatively may offer **subscription memberships** at prices on the order of $4 to $8 per month. Subscription-

Success Story: Providing Free Public Charging in Brookline, Massachusetts

Between 2011 and 2017, the **Town of Brookline installed EV charging stations** at several town-owned parking lots. These Level 2 dual port charging stations are **free to use** and publicly available, except for one station that is only used for the Building Departments' EVs. The Town of Brookline used a rebate from a utility company and local grants to fund these charging stations.

based access may also be a feasible pricing model for employers and multifamily housing managers providing private EV chargers restricted to employees and residents.

Site hosts should also consider policies for use and should clearly communicate those policies with potential users. For example, businesses may wish to restrict EV charging spots for customer use only. As another example, for EV chargers shared among multifamily housing residents, building managers may want to specify charging time limits or to implement dwell time or idling fees (applied per minute) discouraging drivers from occupying an EV charging space while not actively charging. Services such as text alerts when a vehicle is mostly charged can facilitate shared charging station access.

Consider Additional Needs

Additional factors to consider in planning include station visibility, **signage**, and security. Adequate on-site lighting makes charging stations safer and more accessible for users. A **report by the City of Houston** mentions that installing motion sensing security lights or cameras and placing EV charging stations in or within sight of heavily trafficked areas may discourage vandalism. If vandalism does occur, the exterior materials used for chargers can often be easily cleaned. Additionally, the copper in charging cables can be **stolen and resold**. Although cord replacement is sometimes covered by insurance, site owners should check insurance and warranty policies for coverage on theft and vandalism.

Cybersecurity is also important in ensuring a reliable and resilient EV ecosystem. The public and private sectors **are working together** to share cybersecurity best practices and develop standards for EV charging infrastructure. For general guidance, the National Institute of Standards and Technology's **Cybersecurity Framework** can help organizations manage and reduce cybersecurity risk.

Entities can also promote available charging services by adding station data to EVSE search tools, including the **AFDC Station Locator.** Tourism boards and departments can also be valuable partners in advertising locations of charging stations—for example, the New Mexico Tourism Department published a **travel planning tool** that includes the locations of EV charging stations across the State. To support ease of use, consider options for communicating station information and policies (such as restrictions on time of day or duration for

Station and Wayfinding Signage

Station and wayfinding signage help make EV users aware of available charging stations. Station signage, painted parking spots, and other ways to differentiate the charging area and improve station visibility. Station signage also helps communicate station policies such as vehicle restrictions and charging time limits. Wayfinding signage, on the other hand, assists EV users in navigating to charging stations from other locations.

public charging) through on-site signage, on the site host's website, and in languages other than English.

While some of these factors are not likely to present a major hurdle to project implementation, it is a good idea to identify any additional needs early and factor them into the overall planning process.

EQUITY CONSIDERATIONS IN PLANNING

An **equitable planning process** helps ensure that a project's benefits and costs are fairly distributed throughout the community, including to low-income communities, communities of color, and people with disabilities. Equity concerns that might arise with electric mobility infrastructure projects include a project's affordability, accessibility, reliability, location, safety, and related employment and economic opportunities. Specific issues could include the following:

- Financial accessibility of EV ownership and thus access to the benefits of EV charging infrastructure;
- Financial accessibility for the lowest-cost electric modes such as e-bikes, e-scooters, and electric transit;
- Geographic coverage of electric mobility infrastructure—e.g., presence of EV "charging deserts" with gaps in coverage—as well as the impact of siting on traffic flow and congestion in surrounding neighborhoods;
- Variations in at-home charging capabilities and associated electricity costs and fees, e.g., for renters, residents in multifamily housing, or residents without dedicated parking;
- Safety in accessing and using EV charging stations, including the presence of lighting and security cameras; provided shelter from wind, rain, and other weather conditions; and walkability to nearby amenities.
- Availability of safe infrastructure for micromobility and dedicated infrastructure for public transit to increase feasibility of using and to ensure access to the lowest-cost electric modes for all;
- Accessibility of EV charging equipment for people with disabilities;
- The emergence of State, Tribal, and utility commission-level requirements that utilities plan EV infrastructure in underserved areas, low-income neighborhoods, and communities of color;
- Eligibility for and access to investment opportunities for electric mobility infrastructure; and
- Access to training and employment opportunities—including for **Disadvantaged Business Enterprises**—through the planning, installation, and maintenance of electric mobility infrastructure.

During project planning, consider how benefits and burdens vary for and are distributed across specific populations, including users of differing race and ethnicity, gender, physical and cognitive ability, age,

Boston's Income-Tiered EV Car Share Program

In 2020, the City of Boston partnered with a local EV car share nonprofit to implement **Boston's first income-tiered EV car sharing program**. Low-income users can apply for a reduced rates membership that allows them to access EVs at a lower cost than standard users. This equity-focused project aims to reduce the financial barriers low-income residents face when accessing EVs.

education, income level, and language proficiency.[19] Key recommendations from the American Council for an Energy-Efficient Economy (ACEEE) on **siting for equity** include supporting meaningful community engagement, conducting an outcomes-focused community needs assessment, investing in transit and affordable mobility services, and dedicating funding specifically to address the needs of traditionally underserved populations.

Particularly critical to urban areas is to consider where burdens from conventional vehicles may be concentrated, as EVs offer an alternative to reduce air pollution and noise pollution in communities. **The EPA recognizes that transportation** contributes to smog and poor air quality, which negatively affects health. In particular, the transportation sector is responsible for over 55 percent of pollution from nitrogen oxides, as well as a contributor to emissions of volatile organic compounds and particulate matter. Additionally, **studies show that these impacts disproportionately affect** communities of color and low-income communities, particularly in urban areas, where the sources of air pollution tend to be concentrated, including near high-traffic roadways.

The sections below elaborate on the importance of community engagement and the value of equity data in infrastructure development. See also Appendix A for a compilation of tools and resources to help guide and inform the planning process.

ENGAGEMENT AND OUTREACH METHODS

Community engagement helps ensure that a project meets diverse community needs and supports fair access to electric mobility charging infrastructure and associated benefits. Early and ongoing stakeholder outreach during transportation

19 Note that Title VI of the Civil Rights Act of 1964 prohibits discrimination based on race, color, or national origin (including limited English proficiency) in any program or activity that receives Federal financial assistance.

decision-making is an important method of engagement that invites the input of individuals and groups impacted by a proposed project. This outreach should be focused and meaningful, based on the needs, culture, and characteristics of the relevant neighborhood or community. It should not assume that EVs are the desired or only solution to community mobility needs and should include opportunities for the community to inform future multimodal investments. Accessing and incorporating stakeholder feedback in project planning and implementation helps ensure a project meets impacted individuals' needs and addresses their concerns.[20] In addition, collaborating and coordinating with local organizations and residents is crucial in **mitigating gentrification**—the displacement of local residents as housing and living costs rise—which can occur as community investment increases a neighborhood's perceived desirability.

It is important to identify and leverage the best opportunities to reach a particular community so that all community members' feedback can be collected. Resources like the USDOT's **Promising Practices for Meaningful Public Involvement in Transportation Decision-Making and the TCRP's Public Participation Strategies for Transit** provide guidance and techniques for proactively seeking full representation from the community and incorporating that feedback into a project. Possible strategies include conducting stakeholder interviews, deploying needs assessment surveys, and organizing public comment sessions. For virtual engagement, FHWA's **Virtual Public Involvement** website includes video case studies, fact sheets, and tips for success in using digital technology to involve the public in project planning. As an example, **Culver City** set up a Virtual Meeting Room to introduce their EV Infrastructure Plan and obtain public input, including through an electronic comment box and survey. Regardless of outreach method, reflecting back how input has been incorporated into planning decisions is also important to demonstrate that the project team has meaningfully considered the community's contributions to the process.

USING EQUITY DATA

Analysis of socioeconomic data and **equity-related metrics** (e.g., measures of income distribution, literacy rates, percent of non-English speakers, number of renters, housing or transportation cost-to-income ratios, rates of vehicle ownership, different modes of commute) can help entities understand how resources are currently distributed in their communities, where new electric mobility infrastructure may be most beneficial, and which electric modes should be included in public charging access. Entities can also monitor equity outcomes to evaluate the impact of projects over time. **Datasets and interactive maps** such as the USDOT's **Equitable Transportation Community (ETC) Explorer**, the Council on Environmental Quality's **Climate and Economic Justice Screening Tool (CEJST)**, FHWA's **HEPGIS**, EPA's **EJSCREEN**, DOE's **Low-Income Energy Affordability Data (LEAD) Tool,** and DOE's **Electric Vehicle Charging Justice40 Map** are just a few of the resources available to help entities understand and visualize different population characteristics in their communities. Other resources like **this technical report** from Argonne National Laboratory can help organizations apply these mapping tools to identify priority locations for EV chargers.

20 Public involvement is also a critical component of the Federal environmental review process. See USDOT FHWA's Public Involvement/Public Participation website for more information.

SECTION 6

ELECTRIC MOBILITY INFRASTRUCTURE FUNDING AND FINANCING FOR URBAN AREAS

Grants and loans may be necessary to make electric mobility infrastructure projects feasible since this infrastructure can require significant capital investment. A variety of Federal, State, and local funding and financing options can be used for electric mobility infrastructure. Navigating funding programs can present barriers for applicants that have fewer staff or resources to devote to grant writing and other funding and financing-related activities. The programs described in this toolkit can serve as a starting place for identifying funding. This section focuses on Federal programs and provides tips and guidance for navigating the Federal funding process in the following subsections:

- *Overview of Federal Funding and Financing Programs* describes the types of programs available through Federal agencies.
- *Federal Funding Application Process* gives an overview of how to apply for grants, loans, and other financial assistance through a Federal program.
- *Funding Eligibility Definitions* provides definitions to help potential applicants determine their eligibility for funding programs.
- *Federal Funding Programs* lists major programs available for electric mobility charging in urban areas.
- *Additional Funding Resources* describes resources for identifying funding sources administered by States, local governments, and utilities.

In addition, the *Urban Electric Mobility Infrastructure Funding Table* includes a comprehensive list of relevant Federal programs. Many of the programs referenced in this section are specific to EV infrastructure, while others have broader eligibility but are still applicable for certain electric mobility-related activities.

Identifying funding options can happen at the same time as other activities described in this toolkit, such as researching sites and planning infrastructure. Project planners and potential applicants should not wait until completing other steps before beginning the funding search. After using this toolkit to identify potential funding sources, contact each department or office with questions about program requirements and timing. See *Initial Points of Contact* for field staff contact information for Federal agencies discussed in this toolkit.

OVERVIEW OF FEDERAL FUNDING AND FINANCING PROGRAMS

Federal funding for electric mobility infrastructure can be drawn from several sources, including discretionary and formula grant programs, loan financing programs, and tax incentives. Table 6-1. Types of Federal funding and financing programs. provides an overview of these funding types.

Three agencies administer most Federal funding programs applicable to EV infrastructure: the Department of Transportation, the Department of Energy, and the Environmental Protection Agency. Other agencies provide or oversee some potential funding sources. The following sections provide a description of each relevant agency and how its mission relates to electric mobility infrastructure.

U.S. DEPARTMENT OF TRANSPORTATION (USDOT)

USDOT programs focus on a wide range of EV activities and support infrastructure development, energy efficiency, and equity. USDOT has 11 operating administrations and bureaus, and many of these have programs related to EV activities.

The **Office of the Secretary of Transportation** (OST) provides policy development, oversight, and coordination for the overall planning and direction of USDOT. OST administers some discretionary grant programs.

The **Build America Bureau,** within OST, provides credit assistance and loans to States, municipalities, and other project sponsors. The Bureau operates

Table 6-1. Types of Federal funding and financing programs.

PROGRAM TYPE	DESCRIPTION
Discretionary Grant Funding Programs	For discretionary grant programs, an agency solicits applications and competitively selects projects based on eligibility, evaluation criteria, and departmental or program priorities. Most programs described in this toolkit are discretionary grant programs.
Formula Grant Funding Programs	Formula grant programs apportion funding based on formulas in statute. The recipients of these funds can be States, federally recognized Tribal recipients, cities and counties, or transit agencies. Recipients are responsible for determining how the funds are used according to program guidelines. Entities that do not receive formula funding directly (e.g., nonprofits or transportation providers) may be eligible to receive funding from agencies that initially receive the formula grants.
Loan Financing Programs	Credit assistance programs leverage Federal funds to accelerate project delivery when direct funding programs are not readily available or applicable. Public credit assistance programs may also attract private and other non-Federal co-investment for projects. This can take the form of secured (direct) loans, loan guarantees, and lines of credit.
Tax Incentives (e.g., credits, exemptions, deductions)	The U.S. tax code contains potential funding sources for individuals, non-governmental organizations, and private organizations in the form of tax incentives. Specifically, exemptions, exclusions, and deductions all reduce an entity's taxable income, while credits, preferential tax rates, and deferrals decrease tax liability or even generate cash payments from the government to the taxpayer. The Internal Revenue Service (IRS) is responsible for administering these policies.

multiple funding programs. It also helps borrowers leverage available USDOT credit and funding programs, explore innovative project delivery approaches like public-private partnerships (P3s), and navigate project development processes like permitting.

The **Federal Aviation Administration** (FAA) oversees the safety of civil aviation and operates a network of airport towers, air route traffic control centers, and flight service stations. FAA's relevant grant programs fund zero-emission land vehicles and charging infrastructure for use at airports.

The **Federal Highway Administration** (FHWA) provides stewardship over the construction, maintenance and preservation of the Nation's highways, bridges and tunnels. FHWA also conducts research and provides technical assistance to State and local agencies to improve safety, mobility, and to encourage innovation. Its **electric vehicle funding programs** focus on reducing emissions from road vehicles and increasing access to EV infrastructure. FHWA is also responsible for administering formula and discretionary grant programs for EV charging infrastructure established under the 2021 Bipartisan Infrastructure Law to include the **NEVI Formula Program** and the **Charging and Fueling Infrastructure Discretionary Grant Program**. FHWA can also provide project-specific financing techniques and tools through its **Center for Innovative Finance Support**.

The **Federal Transit Administration** (FTA) helps improve public transportation systems for communities nationwide. FTA's funding programs are

largely focused on providing capital and operating assistance to transit systems. Electrifying transit fleets and related infrastructure are eligible expenses for many FTA programs; the Bipartisan Infrastructure Law allows eligibility for electric vehicle charging infrastructure as part of a joint development project, subject to certain conditions.

The **Maritime Administration** (MARAD) supports the waterborne transportation system and the Nation's maritime infrastructure. MARAD's relevant grant program funds low-emission land vehicles and charging infrastructure for use at marine ports.

U.S. DEPARTMENT OF ENERGY (DOE)

DOE offers a wide range of programs focused on advancing clean energy technologies, decarbonizing the economy, and making energy more affordable, secure, and resilient. DOE's **Vehicle Technologies Office** (VTO) administers most of the DOE programs identified in this toolkit. VTO, which is within the Office of Energy Efficiency and Renewable Energy (EERE), supports the research, development, and deployment of efficient and sustainable transportation technologies, including EVs and related infrastructure. DOE's **Office of State and Community Energy Programs** (SCEP) and DOE's **Loan Programs Office** also administer programs relevant to EV infrastructure.

JOINT OFFICE OF ENERGY AND TRANSPORTATION

Created under the BIL, the **Joint Office of Energy and Transportation** (Joint Office) facilitates collaboration between USDOT and DOE. The Joint Office focuses on supporting the planning and deployment of electric vehicle technologies, such as charging stations, electric school bus fleets, and zero-emission transit. The Joint Office also provides guidance and technical support to potential applicants for BIL-related funding programs. For example, in 2022, the Joint Office assisted States in developing and submitting their plans to FHWA for the use of NEVI Formula Program funds to build out DCFC on designated alternative fuel corridors. The Joint Office will also support applicants pursuing BIL discretionary funds for community charging projects, provide technical assistance to school districts to plan for and deploy clean school buses, and offer technical assistance to transit agencies applying for and/or receiving FTA funding for transit bus electrification projects.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

The mission of the **EPA** is to protect human health and the environment. Programs relevant to EV infrastructure primarily focus on reducing the emissions impacts of the transportation sector. EPA, through its ENERGY STAR Program, develops energy efficiency specifications for Level 1, 2, and DCFC charging equipment and forms partnerships with electric utilities and States to facilitate purchasing of ENERGY STAR certified chargers.

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

HUD develops housing and provides housing and community development assistance and works to ensure fair and equal access to housing for all. HUD supports renters and homeowners through numerous funding and financing programs and technical resources. EV charging infrastructure is an eligible expense under several HUD grant programs. Potential applicants should confirm eligibility with the designated program office and agency contact. In addition, some HUD programs incentivize the adoption of **energy efficiency and other sustainability measures**, which may include EV charger installation. For example, multifamily property owners who receive Federal Housing

Administration-insured financing may qualify for **reduced mortgage insurance premiums** upon achieving green building certification, which typically offer incentive points for EV charger installation or readiness.

U.S. DEPARTMENT OF AGRICULTURE (USDA)

USDA provides leadership on agriculture, natural resources, and rural development, among other topics. USDA funding programs are primarily aimed at helping rural and agricultural communities bolster their economies and realize the benefits of the shift toward electric vehicles. However, USDA's **Natural Resources Conservation Service** administers a relevant grant program supporting the development of urban agriculture.

SMALL BUSINESS ADMINISTRATION (SBA)

The **SBA** helps Americans start, build, and grow businesses. Relevant funding programs enable small businesses to conduct technology research related to EV infrastructure.

U.S. DEPARTMENT OF COMMERCE (DOC)

The mission of the **DOC** is to create the conditions for economic growth and opportunity. All relevant DOC programs are administered by the **Economic Development Agency** (EDA). The EDA promotes innovation and competitiveness, preparing American regions for economic growth and success. Relevant funding and financing programs support a variety of EV activities that promote economic growth.

U.S. DEPARTMENT OF LABOR (DOL)

The mission of the **DOL** is to foster, promote, and develop the welfare of the wage earners, job seekers, and retirees of the United States; improve working conditions; advance opportunities for profitable employment; and assure work-related benefits and rights. Workforce development related to EVs is an activity eligible under DOL's relevant funding program.

INTERNAL REVENUE SERVICE (IRS)

The **IRS** is the Nation's tax collection agency and administers the Internal Revenue Code enacted by Congress. The IRS administers the tax incentive programs identified in this toolkit.

FEDERAL FUNDING APPLICATION PROCESS

The process of acquiring Federal funding differs by program type (e.g., grants, loans) and by agency. However, competitive funding programs (including competitive grants, loans, and loan guarantees) often follow similar processes. The following information identifies some key activities by funding type for those applying for assistance.

GRANTS: TIPS AND RESOURCES

The following tips and resources may provide further insight to applicants throughout the **discretionary grant funding application process**.

Grants.gov

The Office of Management and Budget developed Grants.gov to provide a centralized location for grant seekers to find and apply for Federal funding opportunities. The website houses up-to-date information on over 1,000 grant programs and details on the Federal grant application process. For more information on the grants funding process and supporting resources, visit the Grants.gov **Grants 101** page and review the Grant Lifecycle Timeline.

DOT Navigator

For funding programs overseen by the USDOT, the DOT Navigator provides assistance to find and apply for grants. The website contains documentation and resources about the variety of funding programs the DOT offers with a focus on programs recently created by legislative or executive action. The website also contains pages dedicated to specific modes and transportation priorities.

Funding Announcements

Notices of Funding Opportunities (NOFOs) and Funding Opportunity Announcements (FOAs) are formal announcements of Federal funding availability issued by the awarding office. Announcements provide details on eligible applicants and activities, evaluation criteria, funding priorities, and submission deadlines. Obtain and read the NOFOs or FOAs for funding programs when considering applying.

Match Requirements

Many Federal grant programs require the applicant to provide some of the project funding; this is referred to as either "required match" or "cost share." Applicant match requirements vary widely by program. As an example, a funding opportunity may include the following phrase: "The Federal share of project costs under this program is limited to 80 percent." In this case, if the total project cost is $100,000, the Federal agency will provide no more than $80,000, with at least $20,000 coming from the grant recipient. Most grants with match requirements require the recipient to prove it has the necessary funds to provide the match amount before the grant is awarded. In some cases, recipients are allowed to use other Federal funding or in-kind resources (e.g., staff time) as a project match, or they can use another grant to cover the cost share requirements. It is important to note that the same funding typically cannot be used as a match for more than one Federal grant. Take note of the funding match requirements for programs prior to applying for grants.

Justice40 Initiative

The Biden-Harris Administration established the **Justice40 Initiative** with a goal to direct at least 40 percent of the benefits of certain Federal funding programs to disadvantaged communities. The initiative is intended to bring resources to communities most impacted by climate change, pollution, and environmental hazards, and to address gaps in transportation infrastructure and public services. The initiative allows Federal departments to prioritize projects that align with Justice40 goals and meaningfully engage local community leaders. **Several tools,** including the USDOT's **Equitable Transportation Community (ETC) Explorer** and the Council on Environmental Quality's **Climate and Economic Justice Screening Tool (CEJST),** exist to help grant applicants identify historically underserved and overburdened communities.

Buy America Provision

The use of Federal funds may trigger domestic preference requirements to purchase certain products from American manufacturers. The specific requirements that apply (typically referred to as Buy America or Buy American) may vary depending on the source of the Federal funds. Federal funding programs will typically include direction on compliance with **Buy America** in the grant NOFO or in the details of a loan agreement. In February 2023, FHWA issued a Build America, Buy America **implementation plan** for EV charging equipment. The plan incentivizes companies to invest in domestic production of EV charging components, while providing a transition period for companies to onshore their supply chains. The plan requires that

Federally funded EV chargers be assembled in the United States and must contain at least 55 percent domestic content (on a cost-basis) by July 2024.

Urban Area Definitions

Many Federal funding programs differentiate urban and rural areas to determine application requirements or establish funding suballocations and priorities. There are many different definitions of "rural" and "urban," so it is important to read the terms of the NOFO or check with the granting agency. Often, there may be differing application requirements for urban and rural areas. The **USDOT Rural Eligibility Map** provides information on rural and non-rural definitions and locations for different USDOT programs.

Some urban areas may receive priority consideration for certain grant programs if they meet requirements related to community poverty or marginalization. For example, some programs consider whether an urban area is an Area of Persistent Poverty or Historically Disadvantaged Community as part of the evaluation process. Federal agencies establish their own criteria and priorities, so applicants should consult the NOFO of their desired program to determine if it includes language around disadvantaged communities and consult with the program contact if they are unsure of their eligibility.

Tribal Transportation Self-Governance

Tribes are eligible for numerous Federal funding programs. USDOT's **Tribal Transportation Self-Governance Program** provides federally recognized Tribes and Tribal organizations with greater control, flexibility, and decision-making authority over Federal funds used to carry out Tribal transportation programs, functions, services, and activities in Tribal communities. Under the program, Federal funds awarded to a Tribe or Tribal organization will be transferred in advance to the Tribe or Tribal organization in accordance with the terms of a funding agreement to carry out Tribal transportation programs and activities.

FINANCING PROGRAMS: TIPS AND RESOURCES

The following tips and resources may provide further insight to applicants throughout the exploration of innovative finance techniques and the financing application process.

Financing Options

Applicants may be eligible to take advantage of multiple Federal or State loan programs or other innovative finance tools. Financing options may vary by location depending on State regulations. These options include the following:

- **Loans:** A disbursement of funds by a lender to a borrower under a contract that requires repayment of such funds with or without interest.
- **Loan Guarantees:** A contingent liability created when the government assures a private lender who has made a loan to a borrower that the lender will be repaid to the extent of a guarantee in the event of default by the debtor.
- **State Infrastructure Banks:** Revolving loan funds established by States to finance transportation projects. Where established, State Infrastructure Banks may lend to public and private project sponsors.
- **Bonds:** A unit of corporate debt issued by companies or governments to finance projects, including a fixed or variable interest rate paid to bondholders.
- **Community Development Financial Institutions:** Private financial institutions dedicated to delivering responsible, affordable lending to help low-income, low-wealth, and other disadvantaged people and communities.
- **Tax Credits:** An amount of money that taxpayers (individuals or businesses) can subtract from taxes owed to their government.
- **Public-Private Partnerships (P3s):** Contractual agreements between a public agency and a private entity that allow for greater private participation in the delivery of projects. In transportation projects, this participation typically involves the private sector taking on additional project risks such as design, construction, finance, long-term operation, and traffic revenue.
- **Grant Anticipation Revenue Vehicles (GARVEEs):** Securities (debt instruments) issued when monies are anticipated from a specific source to advance the upfront funding of a particular need. In the case of transportation finance, the GARVEE repayment source is expected Federal aid grants.
- **Transportation Infrastructure Finance and Innovation Act program (TIFIA):** The **TIFIA program** offers credit assistance for large-scale infrastructure projects of national significance. Credit assistance can include subordinated loans to fill the gap between existing financing through the private market and total project costs, as well as loan guarantees and lines of credit. The program is designed to leverage private investments in the national transportation system.
- **Value Capture:** Strategy to capture the value property owners realize through transportation and other public improvements through special assessments and taxation on those properties. Refer to the FHWA **Center for Innovative Finance Support** for more information on value capture.

Pre-Application Consultation

Contacting a Federal loan or finance program office prior to applying or submitting a letter of inquiry can help applicants better determine their eligibility for the program, any pre-requisites to application, and potentially even assist in project scoping. In addition to individual program offices, the **FHWA Center for Innovative Finance** can help applicants understand a broad range of innovative financing options relevant to their project. Gathering input on financing options early in project scoping can help applicants determine how to structure their projects and any potential barriers to entry in a funding program based on project characteristics or State legislation.

Financing Amount

Some Federal programs allow applicants to finance all or a portion of project costs using loans. The maximum amount of a loan or the proportion of project costs allowed to be financed through each program varies widely. For example, the TIFIA program can provide loans covering up to 33 percent of total anticipated costs for most projects. Loan programs may require that the recipient prove it is creditworthy and has other financing for the project in place prior to consideration for a loan. Take note of the maximum funding available through loan programs prior to applying for financing.

Post-Award Reporting and Servicing

Consider the reporting requirements for a loan or other innovative finance tool. General information about a program's reporting requirements can be found on the respective program website. Adhere to the schedule for debt service on loans and other financing mechanisms. Note whether the program takes an ownership interest in any capital equipment which would have to be resolved if the equipment is taken out of service before the end of its useful life. Comply with relevant local, State, and Federal regulations. Contact the administering agency's program point of contact for additional guidance throughout the post-award phase.

INITIAL POINTS OF CONTACT

The Federal agencies discussed in this toolkit have field-level staff who are available to answer questions about the funding programs they administer. After identifying programs in the Federal Funding Programs section, prospective applicants may reach out to the field staff for additional help and resources. Below is the contact information for field staff at key agencies:

- **FHWA Field Offices**
- **FTA Regional Offices**
- **DOE Vehicle Technologies Office/Technology Integration Regional Manager Contacts**
- **DOE Clean Cities Coalition Contact Directory**
- **EPA Regional Offices**

FUNDING ELIGIBILITY DEFINITIONS

This section provides definitions to help guide potential applicants through the funding programs listed in the *Federal Funding Programs* and *Urban Electric Mobility Infrastructure Funding Table* sections. Table 6-2 lists electric mobility-related activities that Federal programs can be used to fund and Table 6-3 lists potential applicant types. Before applying, review each program's webpage to understand specific eligibility requirements.

Table 6-2. Electric mobility-related activities and definitions.

ELECTRIC MOBILITY ACTIVITY	DESCRIPTION
LDV Charging	Purchase and installation of EV charging infrastructure for light-duty vehicles (LDVs), primarily Level 2 and DCFC charging infrastructure. LDVs include passenger vehicles and light-duty trucks with a gross vehicle rating of 10,000 pounds or less. Cars, SUVs, and pickup trucks are examples of LDVs.
Public Transportation Charging	Purchase and installation of electric transit vehicle charging infrastructure as part of capital projects, most commonly for electric buses.
Commercial Charging	Purchase and installation of EV charging infrastructure to support freight transportation, agricultural activities, and other commercial uses. Infrastructure under this category is specific to vehicles larger than LDVs (medium- and heavy-duty vehicles).
Micromobility	Purchase and implementation of electric bicycles, electric scooters, and associated docks, equipment, and other capital costs.
Infrastructure Planning	Planning for EV charging infrastructure and related projects. Certain funding programs specify project planning (e.g., design, budget, engineering) as an eligible activity, separate from the implementation or acquisition activities.
Workforce Development	Workforce development and training related to EV infrastructure.
Vehicle Acquisition	EV acquisition (or replacements) and engine conversion for LDVs, transit vehicles (e.g., electric buses), or commercial EVs (e.g., freight trucks or agricultural equipment). (Note: this toolkit does not include funding programs exclusively intended for buying EVs; rather, this designation identifies which infrastructure-focused programs could also be used for buying EVs.)

Table 6-3. Eligible applicant types and definitions.

APPLICANT TYPE	DESCRIPTION
States	State governments, agencies, and authorities (e.g., State departments of transportation, State energy offices, and interstate compacts), including those of Puerto Rico and U.S. territories.
Localities	Local and regional governments and agencies such as counties, municipalities, local law enforcement, and regional planning organizations.
Tribes	Federally recognized Tribal governments.
Transportation Providers	Transportation providers and operators such as airports, rail carriers, port authorities, transit providers, and private-sector transportation companies. (Note: Most transportation providers also qualify under another applicant type, since most providers are operated by either the State, local, or Tribal government or a private-sector provider. This category is used in the table for programs that specifically indicate "transportation providers" as an eligible party.)
Nonprofits	Nonprofit organizations.
Private Sector	Any privately owned business or organization that does not qualify as a nonprofit.
Individuals	A person not operating as a representative of any of the stakeholders defined above.

FEDERAL FUNDING PROGRAMS

While the funding table at the end of this section provides a comprehensive list of available programs, the following overview highlights some of the most relevant and widely used programs for electric mobility infrastructure. These "key programs" are organized by an administering agency.

The Bipartisan Infrastructure Law (BIL)

On November 15, 2021, President Biden signed the Bipartisan Infrastructure Law (BIL), which contains significant new funding for EV charging stations. Key new USDOT programs include the National Electric Vehicle Infrastructure (NEVI) Formula Program ($5 billion) and the Discretionary Grant Program for Charging and Fueling Infrastructure ($2.5 billion). The law also makes the installation of EV charging infrastructure an eligible expense under the USDOT Surface Transportation Block Grant formula program. Additionally, BIL provides funding to USDOT, DOE, and EPA for the deployment of electric school buses and ferries, port electrification, a domestic supply chain for battery production, and battery recycling, among other EV-related initiatives.

USDOT KEY PROGRAMS

National Electric Vehicle Infrastructure Formula Program (FHWA)

The **National Electric Vehicle Infrastructure Formula Program (**NEVI), created under BIL, apportions a total of $5 billion to States, the District of Columbia, and Puerto Rico over five years, from Fiscal Year 2022 through 2026, to strategically deploy EV charging infrastructure and to establish an interconnected national network to facilitate station data collection, access, and reliability. Program funds can be used for the acquisition, installation, network connection, operation, and maintenance of EV charging stations, as well as long-term EV charging station data sharing. Initially, funding under this program is directed to designated Alternative Fuel Corridors (AFCs) for electric vehicles to build out this national network, with DC fast chargers every 50 miles and within one mile of the corridor unless a discretionary exception has been granted. FHWA funded projects must meet the **EV Charging Minimum Standards Rule**, issued in February 2023. Once a State's AFC network is fully built out, funding may be used on any public road or in other publicly accessible locations.

States are required to submit annual plans on how they will strategically and equitably use their NEVI funds for EV infrastructure deployment. Many States have **created websites** with information on their plans, and many are soliciting public input. The **Joint Office of Energy and Transportation** provides key technical assistance and guidance to States in developing and implementing their plans. Some State plans are **considering how micromobility can be incorporated**, such as collocation of electric bicycle docking stations near DCFC stations to capitalize on grid improvements.

- **Eligible electric mobility activities:** LDV charging, public transportation or carshare fleet charging, infrastructure planning, workforce development.
- **Eligible applicants:** States
- **FY22-FY26 formula grant range (to States)**: $13,600,000 – $407,800,000
- **Frequency:** Funding is allocated to State DOTs on an annual basis.
- **Match requirement:** The Federal share of eligible project costs is 80 percent. Private and State funds can be used to provide the remaining cost-share.

Charging and Fueling Infrastructure Discretionary Grant Program (FHWA)

The **Charging and Fueling Infrastructure (CFI) Discretionary Grant Program,** created under BIL, is a competitive grant program to strategically deploy publicly accessible electric vehicle charging infrastructure as well as hydrogen, propane, and natural gas fueling infrastructure along designated Alternative Fuel Corridors or in other publicly accessible locations. At least 50 percent of CFI funding must be used for a community grant program where priority is given to projects that expand access to EV charging and alternative fueling infrastructure within low- and moderate-income neighborhoods, communities with a low ratio of private parking spaces, or in rural areas. FHWA funded projects must meet the **EV Charging Minimum Standards Rule**, issued in February 2023.

- **Eligible electric mobility activities:** For Community Grants, publicly accessible electric vehicle charging infrastructure.
- **Eligible applicants:** States, Tribes, localities, MPOs, and U.S. Territories (corridor and community projects). Additional eligible entities for community-based projects are State or local authorities with ownership of publicly accessible transportation facilities, which could

Success Story: Using CMAQ Funds for Electric Bus Charging

In 2022, Knoxville Area Transit received **$1.6 million** in funding from the CMAQ Program to install on-route overhead charging infrastructure for electric buses. In order to use the CMAQ funds, there must be a $400,000 match in local funds. Together, these funds will be used to install rapid charging infrastructure at the Knoxville Station Transit Center. The new charging infrastructure will enable bus services to operate throughout the day without solely relying on an initial full charge.

include housing authorities, parks authorities, public stadium authorities, public development authorities, etc.

- **Grant range:**
  - Corridor Program: $1,000,000 – no maximum
  - Community Program: $500,000 - $15,000,000
- **Frequency:** Annual

Congestion Mitigation and Air Quality Improvement Program (FHWA)

The **Congestion Mitigation and Air Quality Improvement** (CMAQ) program provides a flexible funding source to State and local governments for transportation projects and programs to help meet the requirements of the Clean Air Act. CMAQ funds are apportioned to each State and administered through State DOTs. Funding is available for transportation projects that reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards; States without such areas may use CMAQ funds for Surface Transportation Block Grant eligible projects. Funds may be used for a transportation project or program that is likely to achieve these objectives and is included in the region's current transportation plan. EV charging infrastructure is considered eligible under this program. The Bipartisan Infrastructure Law added a new eligibility for shared micromobility, including bikesharing and shared scooter systems. CMAQ funds may be transferred to FTA for administration of eligible transit projects. FHWA funded projects must meet the EV Charging Minimum Standards Rule, issued in February 2023.

- **Eligible electric mobility activities:** LDV charging, commercial charging, public transportation charging, workforce development, vehicle acquisition, shared micromobility.
- **Eligible applicants:** States, Tribes, localities. Transportation providers and nonprofits are eligible if they enter into an agreement with an eligible project sponsor to cooperatively implement a CMAQ project through a public-private agreement or partnership.
- **FY20 formula grant range (to States):** $10,000,000 – $488,000,000
- **Frequency:** Funding is allocated to State DOTs on an annual basis.
- **Match requirement:** Generally, the Federal share is 80 percent, but there are some exceptions as outlined in 23 U.S.C. 120(c)(1).

Transportation Alternatives Program (FHWA)

The **Transportation Alternatives** (TA) Set-Aside from the Surface Transportation Block Grant (STBG) Program provides funding for a variety of generally smaller-scale transportation projects such as pedestrian and bicycle facilities; construction of turnouts, overlooks, and viewing areas; community improvements such as historic preservation and vegetation management; environmental mitigation related to stormwater and habitat connectivity; recreational trails; safe routes to school projects; and vulnerable road user safety assessments. FHWA considers shared micromobility projects as eligible for the TA Set-Aside.

- **Eligible electric mobility activities:** Shared micromobility.
- **Eligible applicants:** States, Tribes, localities, natural resource or public land agencies, regional transportation authorities, transit agencies, MPOs, nonprofits.
- **FY22 grant totals (by State):** $5,300,000 – $113,000,000
- **Frequency:** Annual apportionments. Project application cycles vary by State.
- **Match requirement:** The Federal share of eligible project costs is generally 80 percent. States can use a number of flexibilities, including some new ones under the BIL, to increase the Federal share for specific projects to 100 percent. Specifically, an **upward sliding scale adjustment** is available to States based on public land area (23 U.S.C. 120). Flexibilities for safety, Federal lands, and Recreational Trails Program projects are described in more detail in the *Federal Share and Flexibilities for Increasing Federal Share* section of the **TA Set-Aside Guidance**.

Federal Lands Access Program (FHWA)

The **Federal Lands Access Program** (FLAP) provides funds for projects on transportation facilities that are located on or adjacent to, or that provide access to, Federal lands (e.g., national parks, national forests). Projects are typically located within 10 miles of the Federal land boundary; this can include urban areas which are adjacent to Federal lands. Funds are distributed by formula among States that have Federal lands. State DOTs, Tribes, and local governments interested in EV infrastructure can apply through their State for FLAP funding for charging infrastructure and transportation planning. FHWA funded projects must meet the EV Charging Minimum Standards Rule, issued in February 2023.

- **Eligible electric mobility activities:** LDV charging, public transportation charging, commercial charging infrastructure planning, workforce development, vehicle acquisition.
- **Eligible applicants:** States, Tribes, localities
- **FY22 formula grant range (to States):** $21,000 - $31,000,000 (projects are selected by a Programming Decision Committee established in each State).
- **Frequency:** Varies by State.
- **Match requirement:** The Federal share of eligible project costs is 80 percent. A sliding scale provision may apply for States with higher percentages of Federal lands.

Success Story: Low-No Discretionary Program

In 2021, the Anaheim Transportation Network (ATN) received a **$2.01 million grant** to replace aging diesel buses with battery electric buses. Through this grant, ATN is on track to achieve the goal of operating a 100 percent zero emission electric fleet by 2028 to improve air quality.

Grants for Buses and Bus Facilities Programs (FTA)

FTA offers grant funding for transit agencies and State, local, or Tribal government agencies to replace, rehabilitate, and purchase buses and related equipment, including vehicles that produce low or no emissions for public transportation services. The program includes both formula and competitive grants. The **Grants for Buses and Bus Facilities Formula Program** provides funding to States and transit agencies through a statutory formula. The statute also includes two discretionary programs through which applicants can receive funding for EV transit infrastructure and EV transit fleet acquisition: the **Grants for Buses and Bus Facilities Discretionary Program** and the **Low or**

No Emission Vehicle Discretionary Program. Note that participants in this grant program can obtain technical assistance through the Joint Office.

- **Eligible electric mobility activities:** Public transportation charging, transit vehicle acquisition.
- **Eligible applicants:**
  - **Formula Grant:** States, transportation providers.
  - **Grants for Buses and Bus Facilities (Discretionary):** States, Tribes, localities, transportation providers.
  - **Low-No (Discretionary):** States, Tribes, localities, transportation providers.
- **FY22 grant ranges:**
  - **Grants for Buses and Bus Facilities** (**Discretionary**): $115,000 – $54,000,000.
  - **Low-No** (**Discretionary**): $167,257 – $116,000,000.
- **Frequency:** Annual.

Match requirement: The Federal share of net capital project costs are 80 percent for eligible project costs, 85 percent for bus acquisitions compliant with the Clean Air Act or ADA, and 90 percent for bus-related equipment and facilities that are compliant with the Clean Air Act or ADA.

Rebuilding American Infrastructure with Sustainability and Equity (OST)

The **Rebuilding American Infrastructure with Sustainability and Equity** (RAISE, formerly known as BUILD and TIGER) discretionary grant program provides an opportunity for USDOT to invest in road, rail, transit, and port projects that achieve national objectives. The eligibility requirements of RAISE allow project sponsors at the State and local levels to obtain funding for multimodal, multi-jurisdictional projects that are more difficult to support through traditional USDOT programs. In FY21, RAISE increased its program focus on zero-emission vehicle infrastructure, including EV charging.

Success Story: RAISE Grant in Newport, RI

In 2022, USDOT's RAISE program awarded **$22.37 million** to the Rhode Island Public Transit Authority (RIPTA) to purchase 25 battery-electric buses. This grant will allow RIPTA to electrify all the transit services in Newport, RI by purchasing new electric buses, installing the necessary charging infrastructure, and upgrading facilities.

- **Eligible electric mobility activities:** LDV charging, infrastructure planning, commercial charging, public transportation charging.
- **Eligible applicants:** States, Tribes, localities, transportation providers.
- **FY22 grant ranges:**
  - **Capital Awards:** $1,100,000 – $25,000,000
  - **Planning Activities:** $260,000 – $25,000,000
- **Frequency:** Annual
- **Match requirement:** The Federal share of net capital project costs is 80 percent for urban projects and 100 percent for projects located in Areas of Persistent Poverty, Historically Disadvantaged Communities, or rural areas.

DOE KEY PROGRAMS

Vehicle Technologies Office (VTO) Funding Opportunity Announcements

DOE's VTO supports high-impact projects that can significantly advance its mission to reduce petroleum reliance by developing and deploying more energy efficient and sustainable transportation technologies. VTO regularly updates its **Funding Opportunity** website with information on available VTO FOAs. Specific topics and funding amounts for VTO FOAs vary from year to year depending on program

priorities and stakeholder needs. Historically, many of these funding opportunities have supported transportation electrification projects, including the planning and installation of EV charging infrastructure; EV demonstration and deployment; and EV data collection and analysis. Sign up for the **VTO Newsletter** to receive notifications of future VTO FOAs.

- **Eligible electric mobility activities:** Varies (past FOAs included LDV charging, infrastructure planning, commercial charging, public transportation charging).
- **Eligible applicants:** States, Tribes, localities, transportation providers, nonprofits, private sector, individuals.
- **Grant range:** Varies.
- **Frequency:** Varies.

State Energy Program (Office of State and Community Energy Programs)

The **DOE State Energy Program (SEP)** provides annual formula funding and technical assistance to all 50 States, five territories, and the District of Columbia to enhance energy security, advance State-led energy initiatives, and increase energy affordability. States may choose to allocate funds for transportation projects, including planning and projects that promote access to EVs and buildout of EV charging infrastructure. Eligible activities include planning support for light-, medium-, and heavy-duty vehicle usage and associated charging needs, equitable charging access, public fleet and transit electrification, grid security and resilience associated with transportation electrification. A State energy office can provide information about program guidance and eligibility for a particular State.

- **Eligible electric mobility activities:** LDV, commercial, fleet, and public transportation charging, EV education and access, and infrastructure and mobility planning.
- **Eligible applicants:** States energy offices.
- **Grant range:** Varies by State based on annual formula allocation.
- **Frequency:** Annual, based on Congressional appropriations.

Title XVII Innovative Clean Energy (Loan Programs Office)

DOE's Loan Programs Office has loan guarantee authority for innovative deployment projects under the **Title 17 Innovative Energy Loan Guarantee Program**. Projects that support innovative renewable energy and energy efficiency projects (including charging infrastructure) in the United States can be eligible for loan guarantees to support project deployment costs.

- **Eligible electric mobility activities:** LDV charging (Level 2 or DCFC that brings an innovation to market) including equipment procurement and site construction activities.
- **Eligible applicants:** Project developers (State and local governments, private developers), charging companies.
- **Maximum grant amount:** Varies. LPO typically provides a maximum of 50 to 70 percent of total project cost funding.
- **Frequency:** Applications accepted year-round.

EPA KEY PROGRAMS

Diesel Emissions Reduction Act (DERA) Program

The EPA's DERA Program funds grants and rebates that protect human health and improve air quality by reducing harmful emissions from diesel engines. The program can be used to replace heavy-duty diesel vehicles and equipment with electric vehicles and chargers. DERA has multiple grant programs for different types of applicants and projects including **National Grants**, **Tribal and Insular Area Grants**,

Success Story: DERA Funds for School Buses

In 2019, the Bay Shore Union Free School District in New York received a grant from the DERA program of **almost $700,000** to replace four diesel-powered school buses with electric school buses. In addition to funding the procurement of the new buses, this grant also supported purchasing and installing charging stations.

State Grants, and **School Bus Rebates**. In 2021, EPA additionally offered a $7 million funding opportunity for electric school bus rebates in underserved communities funded by the American Rescue Plan Act of 2021.

- **Eligible electric mobility activities:** Commercial charging; public transportation charging; vehicle acquisition (specifically, the replacement or retrofit of heavy-duty diesel vehicles, engines, and equipment with lower emissions technology, such as EVs and their charging infrastructure. Commercial and public transportation charging equipment is only eligible in combination with vehicle acquisition projects.)
- **Eligible applicants:**
  - **National:** States, Tribes, localities, transportation providers (public only), nonprofits.
  - **Tribal and Insular Area:** States (U.S. territories only), Tribes.
  - **State:** States.
  - **School Bus Operators:** States, Tribes, localities, private sector. Targeted to underserved communities..
- **FY20 award ranges:**
  - **National:** $44,000 - $300,000.
  - **Tribal and Insular Area:** $155,000 - $520,000.
  - **State:** $81,000 - $680,000.
  - **School Bus Rebates:** $20,000 - $300,000.
- **Frequency:** Annual.

Clean School Bus Program

EPA's **Clean School Bus Program** (CSB) created under BIL provides $5 billion over five years, from FYs 2022 to 2026, to replace existing school buses with clean and zero-emission models. EPA made available up to $965 million in 2022 for zero-emission and low-emission school bus rebates as the first funding opportunity. Applicants in the 2022 CSB Rebates Program could request funding for the replacement of up to 25 school buses. In addition, 2022 CSB Rebate recipients can use funds for charging infrastructure for up to $20,000 per bus in high-priority school districts and up to $13,000 per bus for all other eligible school districts. The 2022 Clean School Bus Rebates Program was the first of several funding opportunities for the multiyear CSB Program. EPA anticipates running both a grant and rebate competition in FY 2023. Note that participants in this grant program can obtain technical assistance through the Joint Office.

- **Eligible electric mobility activities:** Vehicle acquisition, charging infrastructure.
- **Eligible applicants:** State or local governmental entities that are responsible for providing school bus service to one or more public school systems, or the purchase of school buses; Indian Tribes, Tribal organizations, or tribally controlled schools responsible for providing school bus service to one or more schools funded by the Bureau of Indian Affairs, or the purchase of school buses; Eligible Contractors; Nonprofit School Transportation Associations.

- **FY22 award ranges (for zero-emission buses):**
  - **Serving high-priority school districts:** Maximum of $285,000 – $375,000 per bus.
  - **Serving other eligible school districts:** Maximum of $190,000 – $250,000 per bus.
- **Frequency:** EPA anticipates offering multiple funding opportunities through FY 2026; see **https://www.epa.gov/cleanschoolbus** for more information.

IRS FEDERAL TAX INCENTIVES

Alternative Fuel Vehicle Refueling Property Credit (IRS)

As expanded by the Inflation Reduction Act (IRA), EV charging infrastructure installed through December 31, 2032, is eligible for a **tax credit** of 30 percent of the cost, not to exceed $100,000. Eligible fueling equipment **must be installed** in census tracts where the poverty rate is at least 20 percent, or the median family income is less than 80 percent of the State median family income level. Consumers who purchased qualified residential charging equipment prior to December 31, 2032, may receive a tax credit of up to $1,000.

- **Eligible electric mobility activities:** LDV charging, commercial charging, public transportation charging.
- **Eligible applicants:** Nonprofits, private sector, individuals.
- **Maximum credit amount:** 30 percent of eligible project costs, maximum $100,000 (or $1,000 for consumer EV users).
- **Frequency:** Ongoing, through 2032.

ADDITIONAL FUNDING RESOURCES

The programs described thus far are Federal funding programs to which entities apply or receive funding directly through a Federal agency. However, additional funding programs are administered by States, local governments, and utilities. Many of these programs are specific to a particular region. This section contains resources with databases and contact information to help potential applicants identify region-specific funding programs and incentives for electric mobility infrastructure.

FUNDING RESOURCE CLEARINGHOUSES

The following resources can help project planners and potential applicants find local, State, and utility funding and financing programs for EV infrastructure projects. They contain filterable lists of funding programs, contact information for a regional agent who can identify relevant funding and financing programs, or both.

Alternative Fuels Data Center (AFDC)

The AFDC **Laws & Incentives page** contains a filterable search tool that provides lists of programs and regulations from DOE and State governments (see Figure 6-1). AFDC also has a **State Laws and Incentives interactive map** that can further help entities find region-specific resources.

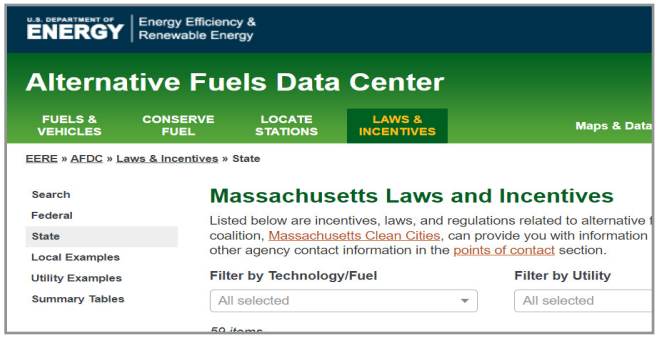


Figure 6-1. AFDC State-specific resources page for Massachusetts.

Clean Cities Coalitions

As discussed in the *Clean Cities Coalitions* section, Clean Cities coalitions can be an important partner for conceptualizing potential projects as well as identifying stakeholders, funding programs, and resources for electric mobility projects in a specific region. Connect with a regional Clean Cities coalition to learn about area-specific funding programs (see the Clean Cities Coalition Network **contact directory**).

Database of State Incentives for Renewables & Efficiency (DSIRE)

DSIRE is a comprehensive source of information on incentives and policies that support renewable energy and energy efficiency in the United States. Established in 1995, DSIRE is operated by the North Carolina Clean Energy Technology Center at N.C. State University. Users can select their State in the database to reveal various incentive programs for which they could qualify; users can filter and search within these programs to identify potential funding for electric mobility infrastructure projects.

STATE-LEVEL FUNDING PROGRAMS

Several grant and financing programs for electric mobility infrastructure are administered at the State level. Refer to the links to learn about applying to a State's programs or contacting a State administering office.

State Energy Offices

Each State and U.S. territory has its own energy office that advances energy policies, informs regulatory processes, and supports energy technology research, demonstration, and deployment. State energy offices generally operate under the direction of governors or legislatures and are funded by both State and Federal appropriations. Electric mobility infrastructure is eligible for funding through many State energy offices.

The National Association of State Energy Offices (NASEO) comprises 56 State and territory energy offices. NASEO's **Interactive State Energy Offices Map** provides contact information for each State energy office, which can provide information on funding opportunities for charging infrastructure.

State Infrastructure Banks (SIBs)

SIBs provide an alternative financing option for applicants that is managed at the State level. A SIB is a revolving infrastructure investment fund capitalized using Federal and State appropriations and providing loans or credit enhancement to individual projects to accelerate project delivery. SIB loans can finance up to the entire project cost, dependent on individual SIB structures and project characteristics. Thirty-three States have established SIBs with varying bank structures. For more information on SIBs and to determine whether a particular State has a SIB, visit the **FHWA Center for Innovative Finance Support's website**.

VW Settlement Funds

Volkswagen (VW) provided approximately $3 billion to an Environmental Mitigation Trust as part of an enforcement settlement between the U.S. government and VW to resolve allegations that VW violated the Clean Air Act. States, the District of Columbia, Puerto Rico, and federally recognized

Tribes may be beneficiaries. Beneficiaries have a defined list of actions for which they may use the funds; EV infrastructure and acquisition activities are included in the list of eligible actions, but States determine the specific projects to fund. Each State has a lead agency that can help identify potential VW Settlement funding opportunities. The National Association of Clean Air Agencies provides **contact information** for each State's lead agency.

URBAN ELECTRIC MOBILITY INFRASTRUCTURE FUNDING TABLE

Following is a list of Federal programs that can fund electric mobility infrastructure in urban areas, sorted alphabetically by agency. The table notes the type of electric mobility activities that are eligible for funding under different programs as well as the eligible entities.

Table 6-4. Urban electric mobility infrastructure funding.

AGENCY/ OFFICE	PROGRAM NAME	PROGRAM TYPE	PROGRAM DESCRIPTION	ELIGIBLE PARTIES	LDV CHARGING	TRANSIT CHARGING	COMMERCIAL CHARGING	MICROMOBILITY	INFRASTRUCTURE PLANNING	WORKFORCE DEVELOPMENT	VEHICLE ACQUISITION
DOC EDA	Build to Scale Program	Grant (Discretionary)	Provides funds for organizations to aid companies in developing the next generation of tech-based economic development initiatives, including commercial EV technology implementation.	States, Tribes, Localities, Nonprofits			•			•	
	FY2020 EDA Public Works and Economic Adjustment Assistance Program	Grant (Discretionary)	Provides investments that support construction, non-construction, technical assistance, and revolving loan fund projects designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	States, Tribes, Localities, Nonprofits, Universities	•		•		•	•	
	Planning and Local Technical Assistance Program	Grant (Discretionary)	Awards funding to eligible recipients (within Economic Development Districts) to create and implement regional economic development plans designed to build capacity and guide the economic prosperity and resiliency of an area or region.	States, Tribes, Localities, Nonprofits					•	•	
	Research and National Technical Assistance	Grant (Discretionary)	Supports research and technical assistance projects designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	States, Tribes, Localities, Nonprofits					•		

AGENCY/ OFFICE	PROGRAM NAME	PROGRAM TYPE	PROGRAM DESCRIPTION	ELIGIBLE PARTIES	LDV CHARGING	TRANSIT CHARGING	COMMERCIAL CHARGING	MICROMOBILITY	INFRASTRUCTURE PLANNING	WORKFORCE DEVELOPMENT	VEHICLE ACQUISITION
DOE	Property Assessed Clean Energy Programs	Loan (Innovative Finance)	Allows a commercial or residential property owner to finance the upfront cost of energy or other eligible improvements on a property and then pay the costs back over time through a voluntary assessment, the assessment is attached to the property instead of the individual.	Nonprofits, Private Sector, Individuals	•						
DOE Loan Programs Office	Advanced Technology Vehicles Manufacturing (ATVM) Loan Program	Loan (Innovative Finance)	Supports the manufacture of eligible light-duty vehicles and qualifying components under the ATVM Loan Program.	States, Localities, Private Sector	•						
	Title XVII Innovative Clean Energy Loan Guarantees	Loan Guarantee (Innovative Finance)	Provides loan guarantees for innovative renewable energy and energy efficiency projects. Only projects that bring an innovation to market—specifically innovations that have been deployed three or fewer times in last five years—are eligible. For example, the addition of grid services or new software and hardware components to a charging site deployment may support eligibility.	States, Tribes, Localities, Transportation Providers, Nonprofits, Private Sector	•				•		
DOE VTO	Vehicle Technologies Office Funding Opportunities	Various	Supports high-impact projects that can significantly advance its mission to reduce petroleum reliance by developing and deploying more energy efficient and sustainable transportation technologies. VTO regularly updates its FOAs with information on available VTO grant opportunities.	States, Tribes, Localities, Transportation Providers, Nonprofits, Private Sector, Individuals	•	•	•		•	•	•

AGENCY/ OFFICE	PROGRAM NAME	PROGRAM TYPE	PROGRAM DESCRIPTION	ELIGIBLE PARTIES	LDV CHARGING	TRANSIT CHARGING	COMMERCIAL CHARGING	MICROMOBILITY	INFRASTRUCTURE PLANNING	WORKFORCE DEVELOPMENT	VEHICLE ACQUISITION
DOE Office of State and Community Energy Programs	State Energy Program	Grant (Formula)	Provides annual formula funding and technical assistance to States, territories, and the District of Columbia to enhance energy security, advance State-led energy initiatives, and increase energy affordability. States may choose to allocate funds for transportation projects, including planning and projects that promote access to EVs and buildout of EV charging infrastructure. Contact the State energy office for more information about program guidance and eligibility for a particular State.	States	•	•	•		•		
	Energy Efficiency and Conservation Block Grant (EECBG) Program	Grant (Formula and Discretionary)	Designed to assist states, local governments, and Tribes in implementing strategies to reduce energy use, to reduce fossil fuel emissions, and to improve energy efficiency. Through the Bipartisan Infrastructure Law (BIL), EECBG Program funding recipients can now use their allocations for zero-emission transportation and/or associated infrastructure.	States, Tribes, Localities	•	•	•		•		
DOT FAA	Airport Zero Emissions Vehicle and Infrastructure Pilot Program	Grant (Discretionary)	Improves airport air quality and facilitates use of zero emissions technologies at airports by funding the purchase of Zero Emission Vehicles (ZEV) and to construct or modify infrastructure needed to use ZEVs. Eligible parties must be airport sponsors that are in the National Plan of Integrated Airport Systems (NPIAS).	States, Tribes, Localities, Transportation Providers	•	•			•		•
	Voluntary Airport Low Emissions Program	Grant (Discretionary)	Improves airport air quality and provides air quality credits for future airport development, airport sponsors can use funds to finance low-emission vehicles, refueling and recharging stations, gate electrification, and other airport air quality improvements. Eligible parties must be Commercial airport sponsors that are in the NPIAS and located in areas that do not meet National Ambient Air Quality Standards.	States, Tribes, Localities, Transportation Providers	•	•			•		•

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DOT FHWA	Advanced Transportation and Congestion Management Technologies Deployment	Grant (Discretionary)	This program provides grants to eligible entities to develop model deployment sites for large-scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. Demonstration projects could include EV charging infrastructure integrated with intelligent transportation systems with the Smart Grid and other energy distribution and charging systems or associated with advanced mobility and access technologies such as dynamic ridesharing.	States, Localities, Transportation Providers, Research or Academic Institutions	•	•					
	Carbon Reduction Program	Grant (Formula)	This formula grant program provides funding to States for projects designed to reduce transportation emissions.	States	•	•	•		•	•	•
	Charging and Fueling Infrastructure Grant Program	Grant (Discretionary)	This program will strategically deploy publicly accessible EV charging infrastructure and hydrogen, propane, and natural gas fueling infrastructure along Alternative Fuel Corridors and in community locations such as parking facilities, public schools, public parks, or along public roads.	States, Tribes, Metropolitan Planning Organizations, Localities, U.S. Territories; State or local authorities with ownership of publicly accessible transportation facilities (for community-based projects only)	•	•	•		•		
	Congestion Mitigation & Air Quality Improvement Program	Grant (Formula)	Provides a flexible funding source to State and Localities for transportation projects and programs to help meet the requirements of the Clean Air Act. Funding is available to reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards.	States, Tribes, Localities; Transportation providers and nonprofits if they enter into an agreement with an eligible project sponsor	•	•	•	•			

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DOT FHWA	Federal Land Access Program	Grant (Formula)	Aims to improve transportation to and within Federal lands by improving transportation facilities that provide access to, are adjacent to, or are located within Federal lands.	States, Tribes, Localities	•	•	•				
	Federal Lands Transportation Program	Grant (Formula)	The program focuses on improving Federal lands transportation facilities that are located on, adjacent to, or provide access to Federal lands and which are owned and maintained by Federal land management agencies. Funds are distributed to Federal land management agencies.	Federal Land Management Agencies	•	•	•				
	National Electric Vehicle Infrastructure (NEVI) Formula Program	Grant (Formula)	The NEVI formula program provides funding to States to strategically deploy EV charging stations and to establish an interconnected network to facilitate data collection, access, and reliability. The program may fund the acquisition, installation, network connection, operation and maintenance of EV charging stations, as well as long-term EV charging station data sharing.	States	•	•					
	National Highway Freight Program	Grant (Formula)	Funds projects that improve the efficient movement of freight on the National Highway Freight Network.	States			•		•		•
	National Highway Performance Program	Grant (Formula)	Provides support for the condition and performance of the National Highway System (NHS), for the construction of new facilities on the NHS, and to ensure that Federal funds are directed to support progress toward the achievement of performance targets established in a State's asset management plan for the NHS.	States	•	•				•	
	Nationally Significant Federal Lands and Tribal Projects Program	Grant (Discretionary)	Provides funding for the construction, reconstruction, and rehabilitation of nationally significant projects within, adjacent to, or accessing Federal and Tribal lands. This Program provides an opportunity to address significant challenges across the Nation for transportation facilities that serve Federal and Tribal lands.	Federal Land Management Agencies, Tribal Governments, Localities, Transit Agencies, Multijurisdictional group made of up eligible applicants	•						

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DOT FHWA	Puerto Rico Highway Program	Grant (Formula)	Carries out priorities of the highway program in the Commonwealth of Puerto Rico.	Puerto Rico	•	•	•		•	•	•
	Reduction of Truck Emissions at Port Facilities	Grant (Discretionary)	Provides discretionary grants to fund projects that reduce emissions at ports, including through the advancement of port electrification, with projects subject to requirements as if on a Federal-aid highway.	State DOTs, Localities, MPOs, Research or academic institutions, Multijurisdictional groups made of up eligible applicants			•				
	State Planning and Research	Grant (Formula)	Provides funding for making transportation investment decisions throughout the State. The goals of the funding are to develop cooperative planning efforts that support transportation investment decisions statewide.	States					•		
	Surface Transportation Block Grant Program	Grant (Formula)	Provides flexible funding that may be used by States and Localities for projects to preserve and improve the conditions and performance on any Federal-aid highway, bridge and tunnel projects on any public road, pedestrian and bicycle infrastructure, and transit capital projects, including intercity bus terminals.	States	•	•	•		•	•	
	Territorial Highway Program	Grant (Formula)	Assists each U.S. territory in the construction and improvement of a system of arterial and collector highways and necessary inter-island connectors.	U.S. territories (other than Puerto Rico)	•	•	•		•	•	
	Transportation Alternatives (set aside of Surface Transportation Block Grant program)	Grant (Formula)	The Transportation Alternatives (TA) Set-Aside from the Surface Transportation Block Grant (STBG) Program provides funding for a variety of generally smaller-scale transportation projects such as pedestrian and bicycle facilities, construction of turnouts, overlooks, and viewing areas, community improvements such as historic preservation and vegetation management, environmental mitigation related to stormwater and habitat connectivity, recreational trails, safe routes to school projects, and vulnerable road user safety assessments.	States, Localities, Regional Transportation Authorities, Transit Agencies, Public Lands, School Districts and Schools, Tribes, MPOs	•	•	•		•	•	

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DOT FTA	Accelerating Innovative Mobility	Grant (Discretionary)	Promotes forward-thinking approaches to improve transit financing, planning, system design, and service. Program also supports innovative approaches to advance strategies that promote accessibility, including equitable and equivalent accessibility for all travelers.	States, Tribes, Localities, Transportation Providers, Nonprofits, Private Sector				•			
	Area of Persistent Poverty Program	Grant (Discretionary)	Supports planning, engineering and technical studies, or financial planning to improve transit services in areas experiencing long-term economic distress.	States, Localities, Transportation Providers, Nonprofits	•	•			•		
	Electric or Low-Emitting Ferry Grant Program	Grant (Discretionary)	Supports the transition of passenger ferries to low or zero emission technologies.	Designated or direct recipient of FTA's Urbanized Area Formula Program (Section 5307) or Formula Grants for Rural Areas (Section 5311)					•		
	Enhanced Mobility of Seniors & Individuals with Disabilities	Grant (Formula)	Provides formula funding to States for the purpose of assisting private nonprofit groups in meeting the transportation needs of older adults and people with disabilities when the transportation service provided is unavailable, insufficient, or inappropriate to meeting these needs. Subrecipients: private nonprofit groups providing transportation to these groups.	States		•			•		•
	Grants for Buses and Bus Facilities Discretionary Program	Grant (Discretionary)	Makes Federal resources available to replace, rehabilitate, and purchase buses and related equipment and to construct bus-related facilities, including technological changes or innovations to modify low- or no-emission vehicles or facilities.	States, Tribes, Localities, Transportation Providers		•				•	•
	Grants for Buses and Bus Facilities Formula Program	Grant (Formula)	Provides funding to States, local governmental authorities, and transit agencies through a statutory formula to replace, rehabilitate, and purchase buses and related equipment and to construct bus-related facilities. Subrecipients: public agencies or private nonprofit organizations engaged in public transportation.	States, Tribes, Localities, Transportation Providers		•				•	•

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DOT FTA	Integrated Mobility Innovation	Grant (Discretionary)	Supports the transit industry's ability to leverage and integrate mobility innovations with existing services, while examining the impact of innovations on agency operations and the traveler experience.	States, Localities, Tribes, Transportation Providers		•		•	•		
	Low or No Emission Vehicle Program	Grant (Discretionary)	Provides funding to States, local authorities, and Indian Tribes for the purchase or lease of zero-emission and low-emission transit buses, as well as acquisition, construction, and leasing of required supporting facilities.	States, Tribes, Localities, Transportation Providers		•				•	•
	Passenger Ferry Grant Program	Grant (Discretionary)	Provides competitive funding for projects that support passenger ferry systems in urbanized areas. Funding can be used to support the transition to low and zero-emission technologies.	Designated recipients and eligible direct recipients of FTA's Urbanized Area Formula Program (Section 5307), States and federally recognized Tribes that operate a public ferry		•					•
	Public Transportation Innovation	Grant (Discretionary)	Provides funding to develop innovative products and services assisting transit agencies in better meeting the needs of their customers.	States, Localities, Transportation Providers, Nonprofits, Private Sector					•		
	Urbanized Area Formula Funding	Grant (Formula)	Provides capital, planning, and operating assistance to urbanized areas and to governors for transit capital and operating assistance in urbanized areas and for transportation-related planning. An urbanized area is an incorporated area with a population of 50,000 or more that is designated as such by the U.S. Department of Commerce, Bureau of the Census. Funding can support rural areas if the service provided also impacts a rural area.	States, Tribes, Localities, Transportation Providers		•			•	•	•

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DOT MARAD	America's Marine Highway Program	Grant (Discretionary)	Funds previously designated Marine Highway Projects that support the development and expansion of documented vessels or port and landside infrastructure.	States, Tribes, Localities, Transportation Providers, Private Sector	•		•		•		•
	Port Infrastructure Development Program	Grant (Discretionary)	Makes grants to improve facilities related to coastal seaports or Great Lakes ports. Funds are awarded as discretionary grants on a competitive basis for projects that will improve the safety, efficiency, or reliability of the movement of goods into, out of, around, or within a port.	States, Tribes, Localities, Transportation Providers	•				•		•
DOT OST	Rebuilding American Infrastructure with Sustainability and Equity	Grant (Discretionary)	Provides a unique opportunity for the USDOT to invest in road, rail, transit, and port projects that achieve national objectives. Starting in FY21, RAISE has substantially increased program focus on ZEV infrastructure, including EV charging.	States, Tribes, Localities, Transportation Providers	•	•	•		•		
	Strengthening Mobility and Revolutionizing Transportation (SMART) Grants	Grant (Discretionary)	The Office of the Secretary's Strengthening Mobility and Revolutionizing Transportation Grant program provides supplemental funding grants to rural, midsized, and large communities to conduct demonstration projects focused on advanced smart city or community technologies and systems in a variety of communities to improve transportation efficiency and safety.	States, Tribes, Localities, Transportation Providers, Toll Authorities, MPOs							
DOT OST Build America Bureau	Infrastructure for Rebuilding America (INFRA)	Grant (Discretionary)	Advances the Administration's priorities of rebuilding America's infrastructure and creating jobs by funding highway and rail projects of regional and national economic significance that position America to win the 21st century.	States, Tribes, Localities, Transportation Providers	•		•		•		

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EPA	Clean School Bus Program	Rebates and Grants (Discretionary)	Fifty percent of the funds are authorized for zero-emission school buses and 50 percent of the funds are authorized for alternative fuels and clean school buses. Funds may be prioritized for high-need local educational agencies, rural or low-income areas, or Tribal schools, as well as entities that have matching funds available. The EPA is authorized to provide funds to cover up to 100 percent of the costs of the replacement bus, as well as provide funding for charging infrastructure for electric school buses.	State or local governmental entities that are responsible for providing school bus service to one or more public school systems, or the purchase of school buses; Indian Tribes, Tribal organizations, or Tribally controlled schools responsible for providing school bus service to one or more schools funded by the Bureau of Indian Affairs, or the purchase of school buses; Eligible Contractors; Nonprofit School Transportation Associations		•				•	•
	National Grants: Diesel Emissions Reduction Act	Grant (Discretionary)	Awards funding to eligible government agencies and nonprofits for eligible diesel emissions reduction solutions, including the replacement of heavy-duty diesel vehicles with EVs.	States, Tribes, Localities, Transportation Providers, Nonprofits		•	•				•
	School Bus Rebates: Diesel Emissions Reduction Act	Grant (Discretionary)	Awards funding to public and private fleet owners for the replacement of old diesel school buses with cleaner buses, including EVs. Anticipated: rebates for electric school bus replacements in underserved communities.	States, Tribes, Localities, Private Sector		•					•
	State Grants: Diesel Emissions Reduction Act	Grant (Formula)	Allocates DERA funds to eligible U.S. States and territories for the establishment of diesel emissions reduction programs. States can prioritize specific eligible diesel emissions reduction solutions under DERA, including the replacement of heavy-duty diesel vehicles with EVs.	States		•	•				•

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EPA	Tribal and Insular Area Grants: Diesel Emissions Reduction Act	Grant (Discretionary)	Awards funding to eligible Tribes and Insular Areas for eligible diesel emissions reduction solutions, including the replacement of heavy-duty diesel vehicles with EVs.	States, Tribes		•	•				•
IRS	Alternative Fuel Vehicle Refueling Property Credit	Tax Credit	EV charging infrastructure installed through December 31, 2032, is eligible for a tax credit of 30 percent of the cost, not to exceed $100,000. Charging station owners who install qualified equipment at multiple sites are allowed to use the credit toward each location. Consumers who purchase qualified residential charging equipment prior to December 31, 2032, may receive a tax credit of up to $1,000.	Nonprofits, Private Sector, Individuals	•	•	•				
SBA	Small Business Innovation Research	Grant (Discretionary)	Enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization.	Private Sector, Individuals					•		
	Small Business Technology Transfer	Grant (Discretionary)	Enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization.	Private Sector, Individuals					•		
USDA NRCS	Urban Agriculture and Innovative Production	Grant (Discretionary)	Assists eligible entities with projects that support the development of urban agriculture and innovative production.	Tribes, Localities, Nonprofits	•		•		•		

APPENDIX A

RESOURCES FOR ELECTRIC MOBILITY INFRASTRUCTURE PLANNING

This section compiles resources and tools for electric mobility infrastructure planning and implementation. Resources are organized by subject area and are labeled with resource type, namely (i) calculators and software, (ii) datasets and maps, and (iii) additional guidance and reference.

A.1: CHARGING AND ENERGY NEEDS

- **Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite**, DOE – *Calculator/Software*
  Web app to help estimate the amount of EV charging a State (or alternatively, a specific urban/suburban area) needs to support a user-supplied number of plug-in EVs. Reports the number of Level 2 and DCFC plugs needed and (for urban/suburban areas) graphs a weekday electric load profile. Provides statistics on the current amount of charging plugs and EVs in the State or region as reference numbers. This tool is a part of the EVI-X Modeling Suite of Electric Vehicle Charging Infrastructure Analysis Tools, which has tools for network planning, site design, and financial analysis. Note: May be most useful for State-level planning.
  Links:
  - EVI-Pro Lite: **https://afdc.energy.gov/evi-pro-lite**
  - EVI-X Modeling Suite: **https://www.nrel.gov/transportation/evi-x.html**
- **Alternative Fueling Station Locator**, DOE – Dataset/Map
  Interactive web map containing all alternative vehicle fueling stations in the United States and Canada, including EV charging stations. Users can filter by charger and connector type, public or private access, owner type, and possible payment methods and can download the underlying data.
  Link: **https://afdc.energy.gov/stations/#/find/nearest**
- **Electric Vehicle Charging Needs Assessment**, NASEO – Guidance/Reference
  A report on key barriers and opportunities for investment in EV infrastructure in the Intermountain West. Includes analysis and findings based on a questionnaire issued to EV stakeholders in eight States. The appendix summarizes current EV infrastructure gaps, questionnaire responses, and opportunities for each individual State.
  Link: **https://www.naseo.org/data/sites/1/documents/publications/EVWest_NeedsAssessment_Final.pdf**
- **Regional EV Charging Infrastructure Location Identification Toolkit (ILIT)**, M.J. Bradley & Associates – Calculator/Software
  A collection of tools to assess the suitability of potential DCFC sites in the Northeast, Mid-Atlantic, and Southeast States, from North Carolina to Maine. The tools include the Microsoft Excel-based ILIT Model to identify and rank candidate locations based on user priorities, the online Results Mapper to analyze and visualize the candidate locations, and the online Data Viewer to overlay and explore geographic information system data layers with different economic, demographic, and environmental metrics.
  Link: **https://www.sustainability.com/thinking/regional-ev-charging-infrastructure-location-identification/**
- **Southeast Regional Electric Vehicle Information Exchange (SE REVI)** Planning and Deployment Map, National Association of State Energy Officials – Dataset/Map
- Interactive web map with information on EV infrastructure planning, policy development, and program implementation in the Southeastern region of the U.S. (Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, and the U.S. Virgin Islands). This map was designed to help coordinate EV infrastructure planning and identify charging station gaps. Users can turn layers on or off as needed.

Link: **https://tdec.maps.arcgis.com/apps/Viewer/index.html?appid=565b9fbfd245418d8958562ec8661e3c**

A.2: COST ANALYSIS

- **EV Charging Financial Analysis Tool**, Atlas Public Policy – Calculator/Software
  A sophisticated Microsoft Excel-based tool that performs a detailed financial analysis of owning and operating EV charging stations. Allows users to evaluate various business arrangements including P3s. Generates a summary dashboard as well as sensitivity analyses and financial accounting statements.
  Link: **https://atlaspolicy.com/rand/ev-charging-financial-analysis-tool/**
- **Dashboard for Rapid Vehicle Electrification (DRVE) Tool**, Electrification Coalition - Calculator/Software
  Microsoft Excel-based tool that helps users compare their existing conventional fleet vehicles with EV alternatives. Outputs include cost of ownership and emissions based on the regional electric grid. Users can customize the market, charging, and procurement settings to explore different scenarios.
  Link: **https://www.electrificationcoalition.org/drve/**
- **Vehicle and Infrastructure Cash-Flow Evaluation (VICE) Battery Electric Bus Model**, NREL – Calculator/Software
  Microsoft Excel-based tool to help bus fleet operators determine the cost and payback period of battery electric buses (BEB) and charging infrastructure. Considers the acquisition, fuel, maintenance, and operation costs of a baseline diesel bus fleet and an alternative BEB fleet with EV charging. Provides default input values that users can further customize.
  Link: **https://afdc.energy.gov/vice_model/**
- **Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool**, Argonne National Laboratory – Calculator/Software
  A tool to calculate the economic and environmental costs and benefits of alternative fuel vehicles including EVs. Estimates petroleum use, emissions of greenhouse gases and air pollutants, and cost of ownership for a variety of vehicle types. Includes a function to calculate payback on EV infrastructure and incorporates EV charging infrastructure into calculations of total cost of ownership for fleets. AFLEET is available as both an online tool and a Microsoft Excel file.
  Link: **https://afleet.es.anl.gov/home**
- **JOBS Model**, Argonne National Laboratory – Calculator/Software
  Spreadsheet-based tools to estimate the economic impacts of deploying alternative fuel equipment and infrastructure, including EV charging stations. The tools have default input values, but users are encouraged to input their own project-specific data for more accurate results.
  Link: **https://www.anl.gov/esia/jobs-models**
- **Costs and Emissions Appraisal Tool for Transit Buses**, World Resources Institute – Calculator/Software
  Microsoft Excel-based tool to help bus operators assess the costs and emissions reductions from a transition to alternative fuel fleets. Considers financing, capital, infrastructure, overhaul, maintenance, fuel, and operations costs as well as several greenhouse gases and EPA criteria pollutants. Users can input their own fuel and fleet data or use the built-in defaults.
  Link: **https://www.wri.org/research/costs-and-emissions-appraisal-tool-transit-buses**
- **National DERA Awarded Grants**, EPA – Guidance/Reference
  A list of previously awarded National DERA grants, searchable by keyword (example: "electric"). Users can generate ideas for project proposals or estimate project costs from past awards.
  Link: **https://www.epa.gov/dera/national-dera-awarded-grants**

- **Low or No Emission Vehicle Program**, FTA – Guidance/Reference
  This competitive grant program provides funding for acquiring low- or zero-emission buses and related infrastructure. Users can view projects that have been awarded funding in previous fiscal years to brainstorm ideas for project proposals and estimate project costs from past awards.
  Link: **https://www.transit.dot.gov/lowno**
- **Financial Analysis of Battery Electric Transit Buses (2020),** NREL – Guidance/Reference
  Report to be used as a first screen to determine which fleets may be most suitable for BEB investment by using a model to determine the net present value and the payback period for investment in BEBs and charging infrastructure.
  Link: **https://afdc.energy.gov/files/u/publication/financial_analysis_be_transit_buses.pdf**

A.3: ENVIRONMENTAL AND SOCIAL IMPACT

- **CMAQ Emissions Calculator Toolkit**, USDOT FHWA – Calculator/Software
  Series of tools to generate estimates of a project's air quality benefits. FHWA developed these tools to help project sponsors with both project justification and annual reporting for the Congestion Mitigation and Air Quality Improvement (CMAQ) Program. The Alternative Fuels Tool within this suite of tools calculates emissions benefits for projects purchasing EVs and related charging infrastructure.
  Link: **https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/**
- **Transit Greenhouse Gas Emissions Estimator**, USDOT FTA – Calculator/Software
  A Microsoft Excel-based tool that estimates annual GHG emissions of transit projects based on the construction, operation, and/or maintenance phases of transit facilities and vehicles. Provides coarse but informative estimates for a broad range of transit projects.
  Link: **https://www.transit.dot.gov/regulations-and-guidance/environmental-programs/ftas-transit-greenhouse-gas-emissions-estimator**
- Transit Bus Electrification Tool, USDOT FTA – Calculator/Software
  A Microsoft Excel-based spreadsheet tool that allows users to estimate the partial lifecycle of GHG emission savings associated with replacing standard bus fleets with low-emission or zero-emission transit buses.
  Link: **https://www.transit.dot.gov/regulations-and-programs/environmental-programs/fta-transit-bus-electrification-tool**
- **AFLEET Charging and Fueling Infrastructure (CFI) Emissions Tool**, Argonne National Laboratory – Calculator/Software
  A Microsoft Excel-based tool developed to calculate well-to-wheel GHG emissions and vehicle operation air pollutant emissions in support of proposals to FHWA's Charging and Fueling Infrastructure Discretionary Grant Program. The tool enables analysis of various alternative fueling types, including electric vehicle charging.
  Link: **https://afleet.es.anl.gov/infrastructure-emissions/**
- **Green Vehicle Guide: Electric Vehicle Myths,** EPA – Guidance/Reference
  A list of five common myths around light-duty EVs regarding their impact on the climate and technological capabilities.
  Link: **https://www.epa.gov/greenvehicles/electric-vehicle-myths**
- **Co-Benefits Risk Assessment (COBRA)**, EPA – Calculator/Software
  Screening tool that enables State, local, and Tribal government staff and others interested

in the effects of air pollution to estimate the air quality and health benefits of different emissions scenarios.
Link: **https://cobra.epa.gov/**

- **Toolfinder: Tools and Resources for Measuring Electrification Impacts**, EPA - Guidance/Reference
  Sortable collection of tools and resources to evaluate the environmental and economic impacts of electrification initiatives. Users answer eight screening questions to receive a list of tools and resources appropriate for assessing their programs.
  Link: **https://www.epa.gov/statelocalenergy/tools-and-resources-help-measure-electrification-impacts-find-your-tool**

A.4: EQUITABLE PLANNING

- **Climate and Economic Justice Screening Tool (CEJST)**, White House Council on Environmental Quality – Dataset/Map
  Interactive map to help users identify census tracts with disadvantaged communities considered overburdened by pollution and historically underserved. Users can also download underlying data and shapefiles. The tool was developed by the White House Council on Environmental Quality to guide Federal investment around climate, clean energy, affordable and sustainable housing, clean water, among other areas as part of the Biden-Harris Administration's Justice40 Initiative.
  Link: **https://screeningtool.geoplatform.gov/en/#5.35/33.706/-92.434**
- **Equitable Transportation Community (ETC) Explorer**, USDOT – Dataset/Map
  Interactive web application that uses 2020 census tracts and data to explore the cumulative burden communities experience as a result of underinvestment in transportation. The dashboard enables users to explore indicators of transportation insecurity, climate and disaster risk, environmental burden, health vulnerability, and social vulnerability.
  Link: **https://www.transportation.gov/priorities/equity/justice40/etc-explorer**
- **Promising Practices for Meaningful Public Involvement in Transportation Decision-Making**, USDOT – Guidance/Reference
  Resource from USDOT to help funding recipients meaningfully involve the public in transportation decision-making. USDOT defines meaningful public involvement as "a process that proactively seeks full representation from the community, considers public comments and feedback, and incorporates that feedback into a project, program, or plan." The guide includes appendices with relevant requirements and several public involvement techniques to consider.
  Link: **https://www.transportation.gov/public-involvement**
- **HEPGIS**, USDOT FHWA – Dataset/Map
  Interactive map enabling users to navigate, view, and print geospatial maps and download the underlying data. Combines several data sources to produce various layers for transportation and equity analyses. Allows users to map FHWA's current and pending alternative fuel corridor designations. Also includes layers for population demographics, economic well-being, and commute times as well as for air quality, safety, congestion, and other performance metrics.
  Link: **https://hepgis.fhwa.dot.gov/fhwagis/**
- **Screening Tool for Equity Analysis (STEAP)**, USDOT FHWA – Dataset/Map
  Interactive web map that outputs Title VI and environmental justice population summaries surrounding project locations. Users can either select a highway or draw a line representing the

location of the project and the tool will output a summary report of the populations within a buffer of the project.
Link: **https://hepgis.fhwa.dot.gov/fhwagis/buffertool/**

- **Low-Income Energy Affordability Data (LEAD) Tool,** DOE – Dataset/Map
  Interactive web map that allows users to explore estimated energy characteristics of low- and medium-income households at the national, State, county, city, or census tract level. Users can combine and compare selected geographic areas to better understand the energy burden facing low-income communities.
  Link: **https://www.energy.gov/eere/slsc/low-income-energy-affordability-data-lead-tool**
- **Using Mapping Tools to Prioritize Electric Vehicle Charger Benefits to Underserved Communities**, Argonne National Laboratory – Guidance/Reference
  A report to guide Federal, State, and local organizations in applying mapping tools to identify priority locations to install EV chargers while pursuing equity-focused goals. The report conclusion lists over 50 mapping layers that could be considered when planning EV charging infrastructure from an equity perspective.
  Link: **https://www.osti.gov/biblio/1870157/**
- **EJSCREEN**, EPA – Dataset/Map
  Interactive tool that combines environmental and demographic indicators into maps and reports. Helps users identify minority or low-income populations and potential environmental quality burdens.
  Link: **https://www.epa.gov/ejscreen**
- **Data.census.gov**, U.S. Census Bureau – Dataset/Map
  Website to explore Census data and annual American Community Survey and American Housing Survey data. Includes dynamic table and maps generators with extensive filter options including by geography, topic, and year.
  Link: **https://data.census.gov/cedsci/**
- **Virtual Public Involvement (VPI): Video Case Studies**, USDOT FHWA – Guidance/Reference
  A collection of videos featuring conversations with transportation agencies and example strategies for using digital technology to engage the public in transportation decision-making, project development and planning, and environmental review. Videos on virtual engagement tools include accompanying fact sheets with additional case studies, considerations, and tips for success.
  Link: **https://www.fhwa.dot.gov/planning/public_involvement/vpi/case_studies/**
- **Practical Approaches for Involving Traditionally Underserved Populations in Transportation Decisionmaking (2012)**, National Academies of Sciences, Engineering, and Medicine – Guidance/Reference
  Report that describes effective approaches to engage traditionally underrepresented populations in transportation decision-making. Describes specific methods of outreach and engagement and includes case studies from across the United States. Also lists several data sources and tools for inventorying a community's social and economic characteristics.
  Link: **https://doi.org/10.17226/22813**
- **EV Charging Justice40 Map Tool**, Argonne National Laboratory – Dataset/Map
  Web map designed to inform users if their projects are located in disadvantaged communities (DACs). Users can input the addresses of their projects or navigate to them. Users may also turn map layers on or off if needed.
  Link: **https://www.anl.gov/esia/electric-vehicle-charging-equity-considerations**
- **Energy Zones Mapping Tool (EZMT),** Argonne National Laboratory – Dataset/Map

Public, web-based system designed for energy infrastructure planning and analysis, especially evaluating the many factors influencing siting decisions. Argonne is expanding the EZMT to include electric vehicle charging station data and siting factors, including a strong emphasis on energy justice and equity metrics. Users can interactively design and query maps from the library of over 340 mapping layers, download data, and run models to map locations best fitting a set of siting criteria.
Link: **https://ezmt.anl.gov/**

- **Geospatial Energy Mapper (GEM)**, Argonne National Laboratory – Dataset/Map
  An interactive, web-based tool that enables users to locate areas for clean power generation and energy transmission corridors. GEM is a user-friendly modeling tool built on the core data and capabilities of the Energy Zones Mapping Tool (EZMT, which continues to be a robust tool for users with strong GIS interest). GEM features an improved user interface, updated data, and additional capabilities. Argonne National Laboratory hosts the tool with funding from the U.S. Department of Energy (DOE) Office of Electricity.
  Link: **https://gem.anl.gov/**
- **Community Tool Box: Assessing Community Needs and Resources (Chapter 3)**, University of Kansas – Guidance/Reference
  Online textbook with guidance and methods to help community leaders and decision makers assess community needs. Chapter 3 of the toolbox provides guidance specifically on identifying and assessing community needs.
  Link: **https://ctb.ku.edu/en/table-of-contents/assessment/assessing-community-needs-and-resources**
- **Electric Vehicles for All: An Equity Toolkit**, Greenlining – Guidance/Reference
  Guide to making EVs affordable, practical, and accessible to low-income communities and communities of color. This toolkit also includes information on increasing EV awareness and diversifying the EV market. Note: This toolkit relies heavily on California examples but the information can be applied to projects in other locations.
  Link: **https://greenlining.org/resources/electric-vehicles-for-all/**
- **E-DRIVE: Evaluation & Development of Regional Infrastructure for Vehicle Electrification**, ERM Group – Dataset/Map
  The Evaluation & Development of Regional Infrastructure for Vehicle Electrification (E-DRIVE) model is a user-friendly analytical tool to support the planning of electric vehicle fast charging infrastructure throughout the United States.
  Link: **https://www.sustainability.com/thinking/e-drive/**

A.5: LAWS, REGULATIONS, AND INCENTIVES

- **AFDC State Information**, DOE – Dataset/Map
  State-specific dashboards presenting State laws and incentives, fueling stations, energy data, fuel prices, construction projects, case studies, Clean Cities coalition contacts, and links to other resources. Covers alternative fuels beyond just electricity.
  Link: **https://afdc.energy.gov/states/**
- **AFDC Laws and Incentives Database**, DOE – Dataset/Map
  Searchable database of Federal and State laws, regulations, and incentives related to EVs, EV infrastructure, and other alternative fuel technologies. Includes some State-specific EV-related definitions, policies, and implementation plans.
  Link: **https://afdc.energy.gov/laws/search**
- **Federal Tax Credits for New All-Electric and**

Plug-in Hybrid Vehicles, DOE – Dataset/Map
Searchable database containing information on the EVs and PHEVs that are eligible for Federal tax credits. Users may search by manufacturer or filter by EVs or PHEVs.
Link: **https://www.fueleconomy.gov/feg/taxevb.shtml**

A.6: IMPLEMENTATION, INSTALLATION, AND MAINTENANCE

- **Clean Cities Coalition Locations**, DOE – Dataset/Map
  Region-specific dashboards with contact information and summary data for regional Clean Cities coalitions, which are DOE-designated organizations providing technical assistance to local stakeholders pursuing alternative fuel and fuel-saving technologies.
  Link: **https://cleancities.energy.gov/coalitions/locations/**
- **EV Utility Finder (EV U-Finder)**, DOE – Dataset/Map
  Database used to find the contact information of nearby EV infrastructure utility partners. Users are only required to input their ZIP code and are provided with information about local utility partners and incentives.
  Link: **https://www.energy.gov/eere/femp/articles/ev-utility-finder-ev-u-finder**
- **Find A Contractor**, The Electric Vehicle Infrastructure Training Program (EVITP) – Dataset/Map
  Online map and database to identify EVITP-certified EVSE installers. EVITP is an organization of industry stakeholders that provides training and certification for electricians installing EV chargers.
  Link: **https://evitp.org/find-a-contractor/**
- **Alternative Fuel Toolkit**, USDOT FHWA and Oregon DOT – Guidance/Reference
  A compilation of guidance on deploying and supporting alternative fuel vehicles based on a series of in-person stakeholder workshops. Identifies maps and calculators to support alternative fuel planning and provides workshop summaries, facilitation materials, case studies, and webinars on further developing the market for alternative fuel vehicles.
  Link: **http://altfueltoolkit.org/**
- **Plug-in Electric Vehicle Handbooks**, DOE – Guidance/Reference
  Series of DOE Clean Cities resources on EV acquisition, maintenance, and charging infrastructure for different types of users.
  Links by user:
  - Consumers: **https://afdc.energy.gov/files/u/publication/pev_consumer_handbook.pdf**
  - Fleet managers: **https://afdc.energy.gov/files/pdfs/pev_handbook.pdf**
  - Workplace charging hosts: **https://afdc.energy.gov/files/u/publication/pev_workplace_charging_hosts.pdf**
  - Public charging hosts: **https://afdc.energy.gov/files/pdfs/51227.pdf**
- **Alternative Fuels Corridor Deployment Plans**, FHWA – Guidance/Reference
  A list of the deployment plans and contacts for the five 2019 recipients of the Alternative Fuels Corridor Deployment Plans project funding. These deployment plans can serve as examples for other transportation providers interested in EV infrastructure along a corridor.
  Link: **https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/deployment_plan/**
- **Electric Vehicle Charging Station Permitting Guidebook (2019)**, California Governor's Office of Business and Economic Development – Guidance/Reference
  Guide to planning and installing EV charging

stations in California with best practices from experienced station developers and local jurisdictions. The guidebook covers site selection, permitting, accessibility, connecting to the grid, and construction and operations. Also includes a list of key terms, a zero emission vehicle readiness score card, and a checklist to streamline EV charging station planning.
Link: **https://static.business.ca.gov/wp-content/uploads/2019/10/GoBIZ-EVCharging-Guidebook.pdf**

- **Workplace Charging Planning Tools**, Shift2Electric – Calculator/Software
  WorkplaceCharging.com is run by Shift2Electric, an EV market and business consulting and training company. This page provides four tools to help businesses plan and implement charging stations, including a Power and Energy Calculator and a Workplace Charging Survey Tool.
  Link: **https://www.workplacecharging.com/tools**
- **Guidebook for Deploying Zero-Emission Transit Buses (2021)**, TCRP – Guidance/Reference
  Guidebook for public transit agencies on best practices, case studies, and lessons learned from deployments of electric buses and related fueling infrastructure, as well as a report on current planning practices and deployment approaches.
  Link: **https://www.trb.org/Publications/Blurbs/180811.aspx**
- **Electrifying Transit: A Guidebook for Implementing Battery Electric Buses (2021)**, NREL – Guidance/Reference
  Guidebook on the decisions and considerations required for successful BEB implementation, including introduction to BEBs, benefits and barriers, charging infrastructure considerations, operation and maintenance, and more.
  Link: **https://www.nrel.gov/docs/fy21osti/76932.pdf**
- **Electric Vehicle Toolkit**, Transportation Authority of Marin – Guidance/Reference
  Guide to fleet electrification and installing or upgrading charging infrastructure for agencies around Marin, CA.
  Link: **https://www.tam.ca.gov/projects-programs/evtoolkit/**

A.7: TECHNOLOGY OPTIONS

- **ENERGY STAR EV Charger Buying Guidance**, EPA – Guidance/Reference
  Webpage that describes the types of EV chargers and the value of EPA's ENERGY STAR product label. Links to a searchable database of ENERGY STAR certified EV chargers. Also links to additional resources for specific users such as property managers, fleet managers, and government agencies.
  Link: **https://www.energystar.gov/products/other/ev_chargers**
- **SmartWay Technology**, EPA – Guidance/Reference
  The EPA SmartWay program offers guidance, benchmarking tools, and resources for improving fuel efficiency and reducing harmful air emissions from freight transportation. Technical resources include information on EPA-verified cleaner, fuel saving technologies and auxiliary power systems including shore power for trucks, locomotives, and oceangoing vessels.
  Links:
  - SmartWay: **https://www.epa.gov/smartway**
  - Technology: **https://www.epa.gov/verified-diesel-tech/smartway-technology**
  - For heavy-duty fleets: **https://www.epa.gov/smartway/smartway-heavy-duty-truck-electrification-resources**

- **Electric Vehicle Charger Selection Guide**, California Energy Commission – Guidance/Reference
  This guide is to help site hosts and others learn about, evaluate, and compare the features of EV charging equipment, including both hardware and software.
  Link: **https://afdc.energy.gov/files/u/publication/EV_Charger_Selection_Guide_2018-01-112.pdf**
- **Get Equipped**, Plug In America – Guidance/Reference
  Webpage with filterable lists of Level 2 home chargers, EV-related software, and charger add-ons. Also includes data and results from EV battery user surveys.
  Link: **https://pluginamerica.org/get-equipped/**

A.8: EDUCATIONAL MATERIALS

- **Workplace Charging Employer Workshop Toolkit**, DOE – Guidance/Reference
  Guidance from DOE Clean Cities on hosting informational events with employers to educate them on workplace charging programs. Webpage includes sample materials and templates both for meeting hosts (e.g., a workshop agenda template) and for the employers/potential workplace charging hosts who attend the events (e.g., employee interest surveys and outreach materials).
  Link: **https://cleancities.energy.gov/technical-assistance/workplace-charging/**
- **Alternative Fuels Corridor Webinars**, USDOT – Guidance/Reference
  A list of past convenings and webinars on the Alternative Fuels Corridor initiative, with links to the event recordings for reference.
  Link: **https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/webinars/**
- **Electric Truck Bootcamps**, North American Council on Freight Efficiency – Guidance/Reference
  An educational series by the North American Council on Freight Efficiency about electric trucks, appropriate for fleet managers, utility planners, policymakers, and other stakeholders.
  Link: **https://runonless.com/bootcamp/**
- **SE Michigan Council of Government's EV Resource Kit & Planning Hub**, Southeast Michigan Council of Governments – Guidance/Reference
  Guide to the electrification of vehicles for communities in Southeast Michigan. Includes background information on EVs and charging infrastructure, zoning and planning ordinances, local case studies, best practices, and funding opportunities.
  Link: **https://southeast-michigan-ev-resource-kit-and-planning-hub-semcog.hub.arcgis.com/**
- **EV Municipal Toolkit**, ElectrifyNY – Guidance/Reference
  Guide to transportation electrification in urban areas in New York. This toolkit includes information on electrifying municipal fleets and public transit, ensuring the accessibility of charging infrastructure, and funding opportunities and incentives.
  Link: **https://electrifyny.org/ev-municipal-toolkit/**
- **Planning for Electric Vehicles**, Municipal Research and Services Center of Washington – Guidance/Reference
  Guide to planning for electric vehicles and charging infrastructure for local governments in Washington State. This resource includes information on Washington State statutes for the EVs, local codes for EV charging infrastructure, and local incentives and resources.
  Link: **https://mrsc.org/Home/Explore-Topics/Environment/Sustainability/Planning-for-Electric-Vehicles.aspx**

A.9: VEHICLE COMPARISONS

- **Vehicle Cost Calculator**, DOE – Calculator/Software
  Web tool that uses basic information about driving habits to calculate total cost of ownership and emissions for different vehicle makes and models. Inputs include estimates of normal daily use, additional mileage for other trips, and State to determine electricity price.
  Link: **https://afdc.energy.gov/calc/**
- **EVolution: E-Drive Vehicle Education**, Argonne National Laboratory – Calculator/Software
  Web app that allows users to compare the expected fuel usage and costs of specific EVs and conventional gasoline vehicles based on zip code. Generates location-based estimates of gas and electricity prices, daily mileage and travel time, and other travel factors that users can further customize and provides nearby options for public charging. Reports and compares the fuel efficiency, fuel costs, costs of ownership, and GHG emissions of the selected vehicles based on the vehicle operating assumptions.
  Link: **https://evolution.es.anl.gov/**
- **EV Explorer**, University of California, Davis – Calculator/Software
  Online map and calculator that lets users compare annual energy costs for up to four vehicles, including gasoline and electric vehicles. Users input a single origin and destination and can change commute frequency, update fuel costs, and specify access to EV chargers.
  Link: **https://phev.ucdavis.edu/project/ev-explorer/**
- **FuelEconomy.gov Trip Calculator**, EPA and DOE – Calculator/Software
  Includes a tool to find and compare cars as well as a trip calculator. Users can compare fuel costs, GHG emissions, and efficiency across EV and conventional vehicle models, and use the trip calculator to estimate fuel costs for individual trips between an origin and destination.
  Links:
  - Find and compare cars: **https://www.fueleconomy.gov/feg/findacar.shtml**
  - Trip calculator: **https://www.fueleconomy.gov/trip/**
- **Electric Mobility Cost Calculators**, Eco Cost Savings – Calculator/Software
  Calculator estimating cost per charge, per mile, per month, and per year for e-scooters, e-bikes, and EVs.
  Link: **https://ecocostsavings.com/escooter-vs-ebike-vs-ecar-charging-cost-comparison/**

APPENDIX B

ENVIRONMENTAL STATUTES AND EXECUTIVE ORDERS

This section describes some environmental statutes and executive orders (EOs) that may commonly be relevant to EV infrastructure.

B.1: NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)[21]

NEPA was signed into law on January 1, 1970, "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality." NEPA requires all Federal agencies to consider their actions' impacts to the human environment as part of their decision-making process; compliance with NEPA and related environmental laws is required for EV infrastructure projects that receive Federal funding or require Federal approval.

The implementing regulations for **NEPA** established three levels of analysis (also called "classes of action"):

- **Categorical exclusions (CE)**: Projects that the Federal agency has determined will not individually or cumulatively have a significant impact on the environment. They are actions that:
  - Do not induce significant impacts to planned growth or land use for the area;
  - Do not require the relocation of significant numbers of people;
  - Do not have a significant impact on any natural, cultural, recreational, historic or other resource;
  - Do not involve significant air, noise, or water quality impacts;
  - Do not have significant impacts on travel patterns; or
  - Do not otherwise, either individually or cumulatively, have any significant environmental impacts.

Minimal documentation will be required by the agency to document that the environmental impacts of the project have been considered and that the agency agrees that a CE is appropriate. Please note that a project's status as a CE does not mean that it is automatically excluded from compliance with other environmental regulations.

- **Environmental assessment (EA)**: An EA is a concise public document that must be prepared by the project sponsor in consultation with the Federal lead agency for each action that is not a CE and does not clearly require the preparation of an environmental impact statement (EIS), or where the agency concludes an EA would assist in determining the need for an EIS. The EA process is completed when the agency signs a Finding of No Significant Impact or determines that an EIS must be prepared.
- **Environmental impact statement (EIS)**: An EIS is a detailed environmental document that must be prepared when the Federal lead agency determines that the project is likely to have a significant impact on the environment. An EIS includes the detailed research and analyses conducted to determine and disclose the nature of the environmental effects of the proposed action. EISs are often prepared by an environmental consultant that is hired by the project sponsor in consultation with the agency. The EIS process follows a specific set of steps with multiple public comment periods. It is concluded when the agency issues a Record of Decision.

Each Federal agency establishes its own procedures that further establish the requirements of NEPA as it applies to their specific actions. For more information, see the Council on Environmental Quality's **Agency NEPA Implementing Procedures** page.

NEPA is an umbrella law, which means that it is used to coordinate and demonstrate compliance with

21 42 U.S.C. §§4321-4370h, 40 CFR Parts 1500-1508

other environmental requirements. Under the NEPA umbrella, reviews under special resource laws are integrated into the NEPA process, to the maximum extent possible, and are incorporated into the resulting NEPA document.

When preparing to conduct an environmental review for an EV charging project, the scope and footprint of the project will need to be accurately determined. This includes identifying the ground that will be impacted by the charger and any supporting utilities, the properties that are in the view of the chargers, and any other projects that are connected to the project.[22] Applicants for Federal funding and approval should seek to minimize the environmental impacts of their projects. In addition to having a smaller impact on the environment, this will maximize the project's ability to fall within a CE, which is, in general, the fastest and least expensive level of NEPA review, and may also affect the applicant's ability to receive approvals from environmental permitting agencies.

B.2: NATIONAL HISTORIC PRESERVATION ACT OF 1966 (NHPA)[23]

Section 106 of the NHPA requires Federal agencies to consider the effects undertakings[24] will have on properties or districts eligible for or listed in the National Register of Historic Places[25] (historic properties) and any properties of traditional religious and cultural importance to Tribes.

A Section 106 review is required when a Federal agency determines that their undertaking has the potential to impact a historic property.

An EV infrastructure project receiving Federal funding or requiring Federal approval will be considered a Federal undertaking. The potential to affect historic properties will primarily depend on the planned location of the project and its proximity to historic properties or cultural resources. EV projects placed in existing parking lots or structures that are outside of the boundaries of a historic property will have a low probability of impacting an historic property. Most electric powerlines will be buried within 18 to 24 inches below the ground in narrow trenches. In existing parking lots, where grading and placement of substrate occurred during the construction process, the ground impacted by the placement is likely to be previously disturbed and will therefore typically have a low probability of containing subsurface historic properties. Similarly, if the project is not within or immediately adjacent to a property eligible or listed on the National Register, or a traditional cultural place, the project is unlikely to impact an above-ground historic property. However, the agency will individually evaluate each project.

For a project with a potential to affect a historic property or cultural resource, agencies are required to consult with State historic preservation offices, Tribal historic preservation offices, Indian Tribes (to include Alaska Natives), and Native Hawaiian organizations. This consultation will help to gather additional information on the presence of a historic property; determine and/or confirm the nature and severity of the potential impact; and, if necessary, determine mitigation measures that will avoid, minimize, or compensate for the impact. This is different than Tribal Consultation as directed by Executive Order 13175 and DOT's Tribal Policy 5301.1A.

22 Proposed actions are connected if they automatically trigger other actions that may require an EIS (the highest level of NEPA review); cannot or will not proceed unless other actions are taken previously or simultaneously, or if the actions are interdependent parts of a larger action and depend upon the larger action for their justification (40 CFR 1501.9(e)(1)).

23 54 U.S.C. §300101-307108, 36 CFR Part 800

24 An "undertaking" is a project, activity, or program funded, permitted, licensed, or approved by a Federal agency

25 "Historic properties" include prehistoric or historic districts, sites, buildings, structures, or objects that are eligible for or already listed in the National Register of Historic Places (National Register), and any artifacts, records, and remains (surface or subsurface) that are related to and located within historic properties and any properties of traditional religious and cultural importance to Tribes or Native Hawaiian Organizations.

B.3: ENDANGERED SPECIES ACT OF 1973 (ESA)[26]

The ESA was signed into law in 1973 and protects threatened and endangered species of plants and animals (referred to as "listed species") and their critical habitat.[27] Section 7(a)(1) of the ESA specifically requires Federal agencies to use their authority to conserve protected resources, and Section 7(a)(2) established a process by which the lead Federal agency consults with the U.S. Fish and Wildlife Service and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (collectively called "the Services") to determine if its actions will impact a protected resource. While the ESA applies to private actions as well, Section 7 has established a consultation process for Federal agencies to work with the Services to determine if their actions have the potential to negatively impact listed species or their critical habitat.

If a project has no potential to impact a listed species or critical habitat, or if none are present in the project area, according to a species list obtained by the agency or by contacting a Service's field office, no consultation with the Services is required. If a protected resource may be present, the agency will conduct a consultation process. There are two types of consultation under Section 7 of the ESA: informal and formal.

- **Informal Consultation**: If a proposed action may affect a listed species or critical habitat, the agency and a Service will likely conduct informal consultation. If the agency determines that the proposed project will have no effect on the listed species or critical habitat, the consultation process is complete. If the agency determines the project may affect but is not likely to adversely affect a listed species or critical habitat, and the Service agrees, the Service will provide written concurrence and no further action is necessary.
- **Formal Consultation**: If the agency determines, through an evaluation called a biological assessment or through other type of review, that the proposed project is likely to adversely affect a listed species or critical habitat, then formal consultation is required. This consultation is a longer and more complex process that requires close coordination with the Service and may require additional surveys or studies to further evaluate the nature of the adverse effect. Following consultation, the Service will respond to the agency with a biological opinion, which provides its conclusion that a project is or is not likely to jeopardize the continued existence of a listed species or critical habitat.

B.4: EO 11988, "FLOODPLAIN MANAGEMENT"[28]

In 1977, President Jimmy Carter issued EO 11988, which regulates activities within Federal Emergency Management Agency (FEMA)-designated floodplains. Examples of floodplain-impacting activities include adding fill to a floodplain, changing the grades of slopes, or restricting the movement of water across a floodplain. If a floodplain may be adversely impacted, Federal agencies are required to consider alternatives that may have smaller or no impacts in order to prevent potential loss of property or life. Adverse impacts to floodplains may require a public notice and comment period and may also be regulated and/or prohibited by State or local governments.

26 54 U.S.C. §§300101-307108, 36 CFR Part 800

27 Critical habitats are areas within the geographic areas occupied by a species when it was listed that contain physical and biological features essential for the conservation of a listed species and that may need special management or protection; this may include areas that were not occupied at the time of listing but are essential to a species' conservation.

28 3 CFR Part 1977, 42 FR 26951

Because of their low profiles, Federal agencies usually can fund or approve the placement of parking lots in floodplains because they will not impact the flow of floodwater. For entities looking to place an EV charging station in a new or existing parking lot, applicants will need to determine if the property is located with a floodplain that has been identified by FEMA. Several concerns exist with locating charging infrastructure in a floodplain:

- **Safety**: If a project sponsor seeks to place charging infrastructure in a floodplain, they will need to confirm with the manufacturer that it can be safely inundated with floodwater up to the height of the base flood elevation,[29] or the project sponsor will need to elevate the charger or elevation of the relevant parking lot.
- **Access**: Project sponsors will need to evaluate decreased or fully blocked access if the charger location or roads leading to the site are within a floodplain and become inundated.

B.5: CLEAN WATER ACT (CWA)[30]

The CWA became law in 1972 and aims to protect "waters of the United States" (WOTUS), which includes jurisdictional wetlands and navigable waters that fall within the jurisdiction of the U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA). WOTUS include territorial seas and traditional navigable waters (e.g., the Mississippi River, the Great Lakes, and the Erie Canal); tributaries, lakes, ponds, and impoundments of jurisdictional waters that contribute surface water flow to the previous category; and adjacent wetlands that physically touch other jurisdictional waters.

Section 404 of the CWA, jointly overseen by the EPA and USACE, regulates "discharges of dredge and fill material" into jurisdictional waters. A Section 404 permit will be needed for an EV infrastructure project that would require the placement of fill material in a stream, river, or wetland. The project sponsor will need to contact the USACE to determine if jurisdictional waters may be impacted by an EV infrastructure project.

Unlike streams and rivers, wetlands can be hard to identify. If site photos and available online maps indicate that a wetland may be present on or near the project site, the project sponsor may need to hire an environmental consultant to perform a wetland delineation (a study of a site's soil, plant species, and presence of water to determine if a wetland is present, and, if so, the location of its boundaries). USACE will use this information to determine if a Section 404 permit is required.

B.6: SECTION 4(F) OF THE USDOT ACT OF 1966[31]

Section 4(f) of the USDOT Act of 1966 provides for the consideration of publicly owned parks and recreation lands, wildlife and waterfowl refuges, and public and private historic sites (Section 4(f) properties) during USDOT transportation project development. 23 CFR 774.3 prohibits the approval of a project if there is a "use" of a 4(f) property unless there is no feasible and prudent avoidance alternative to the use of the land, and the action includes all possible planning to minimize harm to the property resulting from the use, or the use of the property, including any measure(s) to minimize harm (such as any avoidance, minimization, mitigation, or enhancement measures) committed to by the project, will have a de minimis impact.

When considering if the project will result in a use of a Section 4(f) property, project sponsors should consider permanent impacts such as land acquisition that incorporates land into a project, and

29 The base flood elevation is the elevation of surface water resulting from a flood that has a 1 percent chance of being equaled or exceeded in any given year.

30 33 U.S.C. 1344, 33 CFR Part 323

31 23 U.S.C. §138, 23 CFR Part 774

temporary impacts like short-term easements or construction activities that may cross or limit access to a Section 4(f) property. If a project may use or is adjacent to a Section 4(f) property, project sponsors are encouraged to consult the agency for further guidance.

B.7: EO 12898, "FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS" AND EO 14096, "REVITALIZING OUR NATION'S COMMITMENT TO ENVIRONMENTAL JUSTICE FOR ALL"

EO 12898, signed by President Bill Clinton in 1994, directs Federal agencies to ensure that their actions do not have a disproportionally high and adverse environmental or human health effect on minority populations or low-income populations, referred to as "EJ populations." Federal agencies must also ensure full and fair participation by EJ populations in the transportation decision-making process and that agency actions allow for an equitable distribution of benefits and burdens.

More recently, in April 2023, President Biden signed Executive Order 14096, "Revitalizing Our Nation's Commitment to Environmental Justice for All," which builds on and supplements the foundational efforts of EO 12898 and directs Federal agencies, as appropriate and consistent with applicable law, to identify, analyze, and address disproportionate and adverse human health and environmental effects and hazards of Federal activities, including those related to climate change. It also directs agencies to actively facilitate meaningful public participation and just treatment of all people in agency decision-making. Additionally, USDOT Order 5610.2C sets the overall EJ policy for USDOT, and FHWA has issued additional EJ guidance.

Electric mobility infrastructure projects play a critical role in reducing the disproportionate exposure of harmful GHG emissions on EJ communities due to their ability to reduce vehicle-caused emissions. Agencies must ensure that the benefits of electric mobility projects are equitably provided to EJ communities. An example of a benefit-related EJ violation would be the selection of a location alternative that is also not accessible to EJ communities in the project's general area. Additionally, agencies cannot allow disproportionate harm to EJ communities caused by a project's construction or operation. The agency can help project sponsors work through the EJ analysis process (which may require consultation with potentially impacted EJ communities) and, if necessary, the development of mitigation measures.

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