Guidelines for the Installation of Electric Vehicle Charging Stations at State-Owned Facilities

Revised:
January 26, 2020

Prepared By:
DEEP

Table of Contents

Acronyms 4
Executive summary 5
Overview 6
Installation/Operation Process Diagram 8
EV Charging Infrastructure: Successful Installation and Usage 10
Agencies Leading By Example 10
Gauging Agency Need 10
Sample Survey 10
Identifying Agency Champions 11
Site Design Considerations 12
Installation 12
Charge Level 12
Interoperability 14
Proximity to Power 14
Mounting Approach 15
Charger Costs 15
Charger Protection 17
Number of Cord Sets 17
Parking Space Dimensions 17
Environmental Conditions and Hazards 18
Technology and Network 19
Access 21
Accessibility 21
Lighting 21
Signage and Way Finding 21
Pedestrian Traffic 23
Operation 24
Host-Operator Agreements 24
Visibility & Location in Lot 24

Data Collection and Metering 24
Insurance and Indemnification 24
Length of Stay 24
Future-Proofing 25
Fees Collection 25
Obtaining Necessary Permits 27
Inspections 27
State Contracts 28
EVSE Procurement Contract 28
Other Procurement Contracts 28
Maintaining and using EV Charging Stations 29
Testing and Maintenance 29
Consistent Consumer Experience 29
Reservation Options 29
Charge to Users 30
Suggested Courtesies Governing Charging Station Usage 30
References 32
Image References 34

ACRONYMS

ADA	Americans with Disabilities Act
BEV	Battery Electric Vehicle
CCS	Combined Charging System
DAS	Department of Administrative Services
DAS CS	Department of Administrative Services Construction Services
DCFC	Direct Current Fast Charging
DEEP	Department of Energy and Environmental Protection
DER	Distributed Energy Resource
DOT	Department of Transportation
EDC	Electric Distribution Company
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCEV	Fuel Cell Electric Vehicle
GHG	Greenhouse Gas
ICE	Internal Combustion Engine
LDV	Light-Duty Vehicle
OCPP	Open Charge Point Protocol
PEV	Plug-In Electric Vehicle
PHEV	Plug-In Hybrid Electric Vehicle
RFID	Radio Frequency Identification
TCI	Transportation Climate Initiative
ZEV MOU	Zero-Emission Vehicle Memorandum of Understanding

EXECUTIVE SUMMARY

The Guidelines for the Installation of Electric Vehicle Charging Stations at State-Owned Facilities are a detailed description of the process for the procurement and installation of electric vehicle supply equipment (EVSE), also referred to as charging stations, at State-owned facilities. These guidelines serve as part of Connecticut's comprehensive strategy to achieve wide-scale electric vehicle deployment, reduce harmful criteria pollutants from the transportation sector, meet federal health-based air quality standards, and mitigate communities' exposure to toxins emitted from mobile sources. It contains helpful information for facility and fleet managers, ranging from identifying how many EVSE stations will be needed, outlining the process of getting the EV chargers installed, to ensuring your agency has plan in place that provides a positive user experience that results in a maintenance plan that works for your agency needs.

OVERVIEW

As one of eleven states signing onto the Zero-Emission Vehicle Memorandum of Understanding (ZEV MOU), Connecticut has committed to an ambitious goal of putting up to 125,000 electric vehicles (EVs) on the road by 2025. Publicly available Electric vehicle supply equipment (EVSE) deployment will need to be scaled up concurrently to handle the increased number of ZEVs that will be on the road in the coming years. The expansion of public EV charging has been found to reduce range anxiety and encourage higher EV penetration rates as consumers become more confident in charging accessibility. As stated in the EV Roadmap, these updated guidelines are in response to the rapid advancement in EV and EVSE technologies and continued focus on electrification of State-owned fleets. The purpose of this document is to provide facility managers and procurement experts the available tools and information necessary to facilitate EV charging infrastructure deployment.

Connecticut's public fleet, which is overseen by the Department of Administrative Services (DAS), is comprised of more than 3,600 vehicles that support the day-to-day business operations of more than 94 State agencies and log approximately 30.5 million miles per year. Fleet vehicles' high annual mileage, operational costs, and public exposure make them cost-effective and attractive candidates for electrification. Compared to internal combustion engine (ICE) vehicles, EVs can be less costly to run when accounting for the operable lifetime costs of maintenance, fuel, and other ancillary costs. The focus on Connecticut's public fleet stems from Executive Order No.1 signed by Governor Ned Lamont on April 24, 2019 and Public Act 19-117, which requires that on and after January 1, 2030 at least 50 percent of all Light Duty Vehicles (LDV) purchased or leased by the State shall be EVs. To put Connecticut on a pathway to achieve this goal, the State aims to establish a detailed fleet transition plan outlining annual vehicle procurement targets, beginning with a recommended five percent of procured vehicles in 2021. The fleet transition plan should include a target date after which the State should only procure EVs, with very limited exceptions. For procurements, DAS and Connecticut State agencies should consider battery electric vehicles (BEVs) first and plug-in hybrid vehicles (PHEVs) second. For use cases in which BEVs are unavailable for purchase or would compromise public health and safety, DAS should allow exceptions to procure hybrid or ICE vehicles. Converting the state fleet from ICE vehicles to EVs will require significant investments in charging infrastructure as well as commitment to invest in education to achieve buy-in from State agencies necessary to produce optimal results.

To date, there are nearly 2.4 million LDVs registered in Connecticut. Expanding EV charging infrastructure is crucial to encouraging EV adoption and sustaining local growth of the EV market. There are currently 398 publicly accessible EV charging stations with a total of 1110 charging ports in the State, including 55 DC Fast Charging (DCFC) locations with 242 charging ports. A significant increase in workplace Level 2 charging ports, public Level 2 charging ports, and public DCFC ports is necessary to meet Connecticut's EV goals. While steadily increasing, private investment in EVSE deployment has not scaled at the pace necessary to meet Connecticut's 2025 ZEV MOU target. As such, additional public funding will be necessary to support additional development of the State's Level 2 and DCFC EVSE network and Connecticut's ongoing commitment to meet the goals of the ZEV MOU and statutory greenhouse gas (GHG) emission reduction targets.

EVs are no longer coming, they are here!

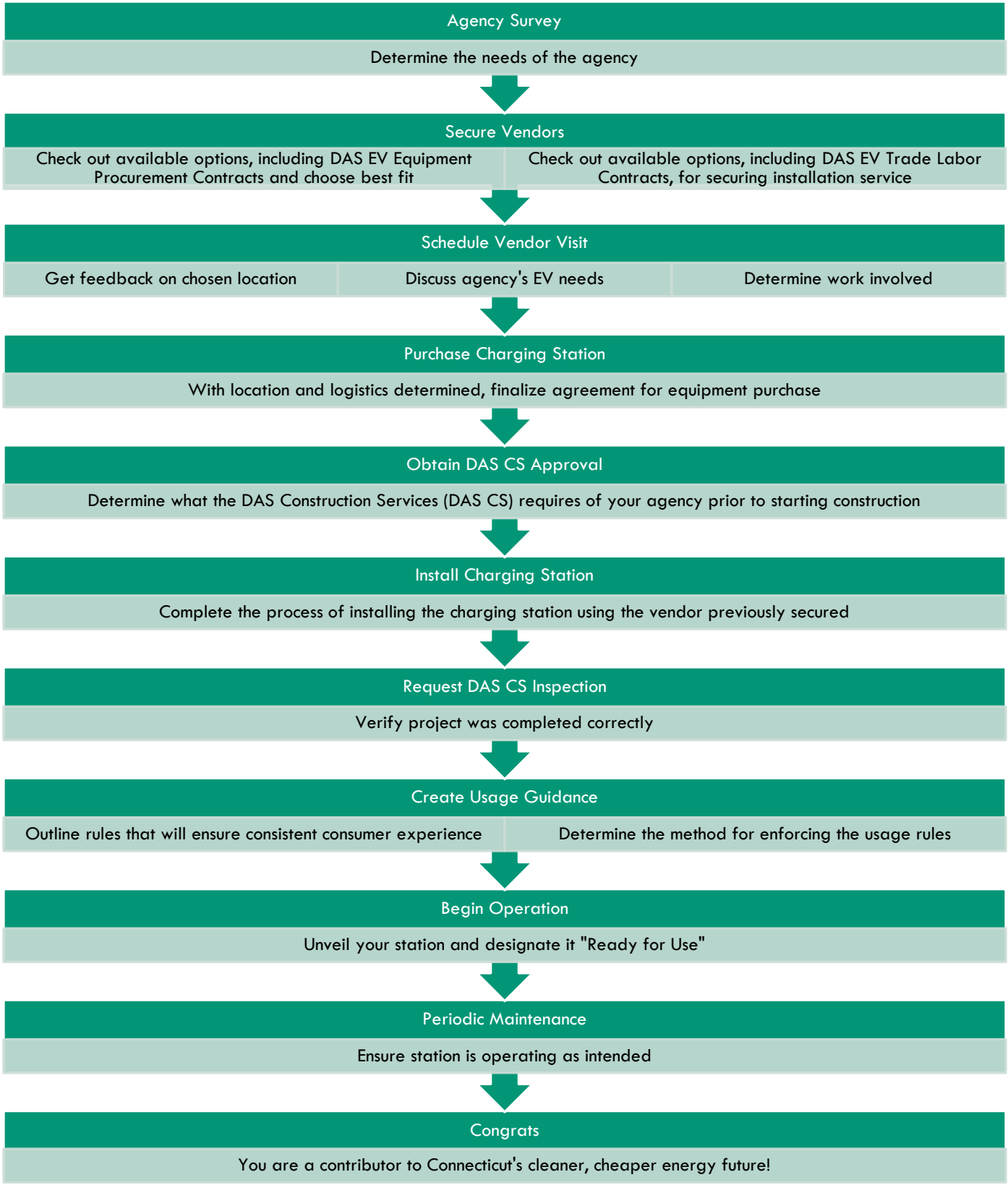
EV registrations in Connecticut increased nearly 26% in 2019

https://evclubct.com/interactive-ev-dashboard-

The information outlined in these guidelines will enable State agency facility managers to successfully install electric vehicle charging stations. Given the lead time requirement necessary for EVSE, Agency Transportation and Facility managers will need to proceed with EVSE procurement and installation will prior to EV procurement. The suggested guidelines for electric vehicle charging station installation vary throughout the State and across the country based on existing laws, regional requirements, and consumer needs. These guidelines consider the parameters within which Connecticut State Agencies operate.

Additionally, DEEP has worked with DAS to establish procurement contracts for the purchase of EV charging equipment, and the installation of this equipment can be facilitated using DAS's Trade Labor contracts. Information about procuring EV charging equipment and installation services are outlined in these guidelines. Below is a flow diagram of the typical process from installation to operation of an EV charging station.

INSTALLATION/OPERATION PROCESS DIAGRAM



The typical installation process begins with a survey to gauge employee interest and determine charging infrastructure needs. State agencies should a list of candidate locations where the EVSE could be located. Following development of initial location planning, State agencies should contact their electric distribution company (EDC) as early as possible in the planning process to assist with site evaluation, equipment selection, cost estimates including charging rate structures, and possibly even financial incentives for EVSE. Fleet operators and mangers should work with their EDC to identify solutions that will minimize distribution system impacts and help realize greater cost savings, including managed charging specific to fleet use case, deployment of distributed energy resources (DERs), and optimizing infrastructure buildout for their use case.

The next phase includes securing a vendor, determining location and logistics, and finalizing the charging station purchase. During this phase, State agencies should identify in contracts, for publicly funded charging stations, the entities responsible for station maintenance and repair, and ensure adequate resources are available to conduct regular inspections, diagnose problems, and service stations in a timely manner.

The following phase involves obtaining DAS Construction Services (CS) approval, installing the charging station, and post DAS CS inspection.

The final phase consists of developing usage guidance, and starting and maintaining operation, which should include periodic inspection and maintenance of the station(s). State agencies should establish, update and circulate best practices to ensure that employees maintain optimal charging behaviors.

EV CHARGING INFRASTRUCTURE: SUCCESSFUL INSTALLATION AND USAGE

AGENCIES LEADING BY EXAMPLE

As part of Governor Ned Lamont's April 2019 Executive Order, "Lead by Example," State agencies will be expected to develop strategies that reduce their impact on air quality, waste disposal, and water consumption by 2030. The installation of EV charging stations at State facilities will create the foundation for incorporating EVs into State fleets, and will provide employees, customers and visitors to State facilities with a visible assurance that a charge is available if needed. The approaches utilized to facilitate light-duty fleet transition are intended to serve as a blueprint for replication in private fleet electrification.

EVs are here to stay!

BloombergNEF's Electric Vehicle Outlook 2020 predicts 10% of total global vehicle sales will be electric by 2025.

https://about.bnef.com/electric-vehicle-outlook/

GAUGING AGENCY NEED

When installing initial charging stations, each agency should assess their fleet to first determine how many vehicles may be replaced by EVs given mandated EV purchasing obligations, in addition to accounting for employee and/or public use of EV charging infrastructure at their facilities. Ultimately, agencies should consider a goal of converting ten percent available parking to at least level 2 charging infrastructure. Agencies may also want to consider if Level 1 charging infrastructure can meet some of their workplace charging needs for employees. Given an anticipated increase in demand for EVs, each agency's initial charging infrastructure should be capable of expansion of EVSE to accommodate the installation of additional charging stations to meet increased demand.

SAMPLE SURVEY

When determining the EVSE needs of the agency, a survey geared towards understanding staff's interest in EVs and current or potential EV charging demands is vital. Important factors to consider include the number and types of EVs they may drive, commute distance profiles, and parking behavior profiles. It is also common for employees to purchase or lease more EVs once charging is available at work. Conduct the survey on a regular basis to remain aware of employee usage and future demand for charging equipment. A sample survey is linked below, which can be used when determining whether the demand is there for additional charging stations at your facilities. This can be modified as necessary to help gauge increasing demand. (See Sample Employee Survey)

IDENTIFYING AGENCY CHAMPIONS

The data obtained from the planning survey will help your agency identify and quantify its need for charging infrastructure. However, the process that takes you from the point of realizing your need for a charging station(s) to the actual installation and operation of the charging station(s) will require a committed project manager. It is important that the project manager be focused on the completion of this task and has previous knowledge of EVs.

SITE DESIGN CONSIDERATIONS

INSTALLATION

CHARGE LEVEL

State agencies that offer workplace charging enable their employees to conveniently charge their EVs while demonstrating their sustainability leadership. Typically, employees' personal vehicles spend several hours per day in parking lots and garages, which is ideal for gradually and efficiently refueling over the course of the workday. There are currently three different levels of charging that can fuel an electric vehicle; Level 1, Level 2 and DC Fast Charging (DCFC).

A **Level 1** charger requires a low investment in electrical infrastructure and equipment; and can typically be installed through a standard 120-volt household outlet, or by a permanently installed charging station, which is recommended for workplace charging. Level 1 charging provides the slowest rate of charging (3- 4 miles per hour) but is well suited for fleets, for example, in a garage where vehicles spend an extended period while not in use.

A **Level 2** charger utilizes a higher voltage (208-240V) and additional equipment in order to refuel electric vehicles. Level 2 charging can provide between 10 and 60 miles of range per hour of charging; and is better suited for public/visitor charging. Currently, Level 2 chargers represent the most installed EVSE at workplaces where charging is offered, because they create a manageable load for EDCs and meet the needs of most EV drivers at work.

DC Fast Charging (DCFC) utilizes high voltages (480–1000V) and can provide 150-1,000 miles of range per charging hour. DCFC has extremely high upfront costs both in expanding electrical infrastructure and installing specialized equipment. While it is the most time-efficient form of charging, DCFC is typically not needed for fleet, employee, or visitor charging, as the majority of users will be at the facility for a while, if not an entire work day, allowing them the opportunity to get a complete charge from a level 1 or 2 charger.

Level 1 Charger

120v

3-4 mi/hr

Level 2 Charger

208-240v

10-60 mi/hr

DCFC

480-1,000v
150-1,000 mi/hr

For employee charging, the choice of Level 1 or 2 varies, and is dependent on several factors, including the number of stations being installed and their location. For example, if the stations are installed at an employee parking area some distance from employees' work location, Level 1 chargers may be appropriate since it is unlikely employees will be returning to the parking area during the workday to move their vehicles. Conversely, if parking is located closer to the work site, Level 2 stations, in conjunction with a reservation system (see Section on *Consistent Consumer Experience*) may be appropriate. If the State agency opts to install level 1 chargers, preparation should be made to provide future level 2 charging as increased needs arise. DEEP recommends that State agencies install Level 1 charging plugs in at least 10 percent of their total parking spaces and evaluate opportunities for installing networked Level 2 EVSE with collocated DERs to meet refueling needs of employees. Table 1 lists the voltage, rate of charge, and typical location for each charging level.

Table 1. Electric Vehicle Charging Infrastructure Specifications in the United States

Charging Level	Voltage	Typical Power	Electric Vehicle Miles of Range per Charging Hour	Location
Level 1	120V AC	1.2-1.4kW AC	3-4 miles	Primarily home and some workplace
Level 2	208-240V AC	3.3-6.6kW AC	10-20 miles	Home, workplace, and public
DCFC	400-1,000V DC	50kW or more	150-1,000 miles	Public, frequently intercity

https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

Charging infrastructure designed to support fleet vehicles should take into account several additional factors, including vehicle quantity, class, and duty cycle(s). LDV fleets are more likely to utilize Level 1 and Level 2 charging infrastructure, whereas medium and heavy-duty vehicle fleets are more likely to rely on DCFC infrastructure due to the vehicle's larger battery size.

DEEP also recommends State agencies include a transparent tracking mechanism or utilize DAS telematics systems with regular reporting to provide for evaluation of program effectiveness and modification based upon lesson learned, technological advances, and market maturation. This can be achieved through networked EVSE. Networking enables chargers to communicate by Wi-Fi or cellular signal to report usage, charge customers, and collect payment information but may create an additional monthly charge.

INTEROPERABILITY

Recharging at a public charging station requires drivers to first determine the compatibility of their EV with the charging station's available connector or connectors. Currently, the most used plug-in connector is the SAE J1772, which is the standard connection for Level 1 and Level 2 charging and is supported by all major vehicle manufacturers and charging system manufacturers. This standardized connector makes virtually every EV compatible with every non-fast charging station.

A standardized connector compatible with all EVs for DCFCs has yet to materialize. Most of the DCFC capable EVs are compatible with at least one of three commonly available connectors. The two most used connectors for DCFCs are CHAdeMO and SAE Combined Charging System (CCS). CHAdeMO is the standard connector for Japanese auto manufacturers, and CCS is the standard connector for American and European automakers. To note, the CHAdeMO connector is currently being phased out in the US and may be less relevant for newer fleet models. Although, it will be still be necessary for the charging of older or used EV models. Tesla, the third available connector, uses its own proprietary connector; limiting its use only to Tesla vehicles. However, using adapters, Tesla vehicles can also be charged at non-Tesla DCFC stations.

Currently, Connecticut imposes no requirement for public EVSE to have multiple types of connectors available; however, it is likely that most public, for-profit EVSE will offer multiple connection options in order to maximize their potential customer base. Until an industry-wide standard connector is established, DEEP recommends all publicly funded, publicly available DCFC station sites should have both CHAdeMO and CCS connections available for use.

PROXIMITY TO POWER

There are three fundamental needs when it comes to powering EVSE: A dedicated circuit for each EVSE unit on the electrical panel, ample electrical capacity from the utility connection to the electrical panel, and sufficient electrical capacity from the electrical panel itself. Complexity of charging station installation and a need for electrical upgrades in any of these areas may increase installation costs.

Site preparation costs associated with cutting, trenching and drilling can be significant, therefore, the greater the distance between the power source and the EV charging station, the higher the installation costs are likely to be. Care should be given to select a location where it is as inexpensive as possible to provide AC Level 1 (120V) or 2 (240V) electrical supply. For example, placing the charging station in a parking garage, near an elevator could reduce the cost of installation because there will be a power source in close vicinity to equipment, thus reducing the amount of site preparation that needs to be done. When installing EVSE at older buildings, existing electrical panels may already be used to maximum capacity. These factors should all be considered during the planning stage of installation and reinforces the need to have an electrical engineer and the EDC involved in the early stages of site evaluation. Providing adequate pre-wiring, or conduit installation, while installing the initial EVSE will significantly reduce installation costs for future expansion.

MOUNTING APPROACH

There are several options available to mount a charging station. An existing wall, pole, column, post or pedestal could be used to mount the charging station. Use of existing walls and poles is less expensive than installing a new post or pedestal.

Pedestal Mount

Overhanging Mount

Wall Mount

Also, mounting on a wall with an existing electrical panel may help to minimize disturbance to existing infrastructure and reduce costs. Alternatively, an overhanging unit can be used to mount the charger overhead. While adding to the cost, this approach would help prolong cord life and minimize trip hazards.

CHARGER COSTS

When selecting a charging station to satisfy your agency's needs, it is important to understand the costs for each available option. Total EVSE costs can be divided into three major components; procurement, compliance, and soft costs; which all need to be accounted for when determining the funding necessary to install, operate, and maintain EVSE. Procurement includes costs regarding charger hardware, managed charging capability, contracts, software, grid hosting capacity, and make-ready infrastructure. Compliance consists of costs related to the payment system, measurement standards compliance, ADA compliance and parking requirements, dual plug types for DCFC, and cost standards. Soft costs cover communication between utilities and providers, futureproofing, building codes and permitting processes, and easement processes.

In August 2019, the International Council on Clean Transportation organized a study detailing estimated charging equipment costs across U.S metropolitan areas through 2025. The following tables list their findings. Table 2 compares average costs between charging levels based on networking capability and number of chargers. As shown, dual chargers reduce per-charger cost and the addition of networking significantly increases hardware costs. Table 3 illustrates that per-charger cost decreases as the chargers per site increase. Similarly, Table 4 describes how installation costs are proportional to the number of chargers per site. The costs listed in the tables do not factor costs for signage, striping, lighting, and security cameras. These costs are given to be used only as rough estimates.

Table 2. Per Charger Public and Workplace Charger Hardware Cost

Level	Type	Chargers per Pedestal	Per-Charger Cost
Level 1	Non-networked	One	$813
Level 1	Non-networked	Two	$596
Level 2	Non-networked	One	$1,182
Level 2	Non-networked	Two	$938
Level 2	Networked	One	$3,127
Level 2	Networked	Two	$2,793
DCFC	Networked 50kW	One	$28,401
DCFC	Networked 150kW	One	$75,000
DCFC	Networked 350kW	One	$140,000

Table 3. Installation Costs for Level 2 Public and Workplace Charger, by Charger per Site

	1 Charger per Site	2 Chargers per Site	3-5 Chargers per Site	6+ Chargers per Site
Labor	$1,544	$1,827	$1,647	$1,316
Materials	$1,112	$1,039	$1,272	$874
Permit	$82	$62	$59	$38
Tax	$96	$89	$110	$75
Total	**$2,836**	**$3,020**	**$3,090**	**$2,305**

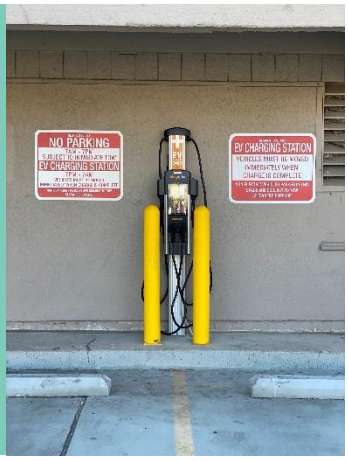
Table 4. Installation Costs per DCFC by Power Level and Chargers per Site

	50kW				150kW				350kW			
	1 Charger per Site	2 Chargers per Site	3-5 Chargers per Site	6-50 Chargers per Site	1 Charger per Site	2 Chargers per Site	3-5 Chargers per Site	6-50 Chargers per Site	1 Charger per Site	2 Chargers per Site	3-5 Chargers per Site	6-50 Chargers per Site
Labor	$19,200	$15,20	$11,200	$7,200	$20,160	$15,960	$11,760	$7,560	$27,840	$22,040	$16,240	$10,440
Materials	$26,000	$20,800	$15,600	$10,400	$27,300	$21,840	$16,380	$10,920	$37,700	$30,160	$22,620	$15,080
Permit	$200	$150	$100	$50	$210	$158	$105	$53	$290	$218	$145	$73
Taxes	$106	$85	$64	$42	$111	$89	$67	$45	$154	$123	$92	$62
Total	$45,506	$36,235	$26,964	$17,692	$47,781	$38,047	$28,312	$18,577	$65,984	$52,541	$39,097	$25,654

https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

CHARGER PROTECTION

EVSE with Bollards



While designing your electric vehicle EVSE, ensure they are protected from vehicle collision. This is especially imperative for the side of the charging station that a vehicle will approach. CT State law will require protective barriers which include guard posts (bollards), but may also utilize wheel stops, curb protection or wall-mounted bollards, but be mindful that the accessible reach to the device control panel is appropriately maintained. Although there are currently no accessibility requirements specific to EVSE, it is advised that every effort is made to make the charging station accessible by all. (See section on *Accessibility*).

NUMBER OF CORD SETS

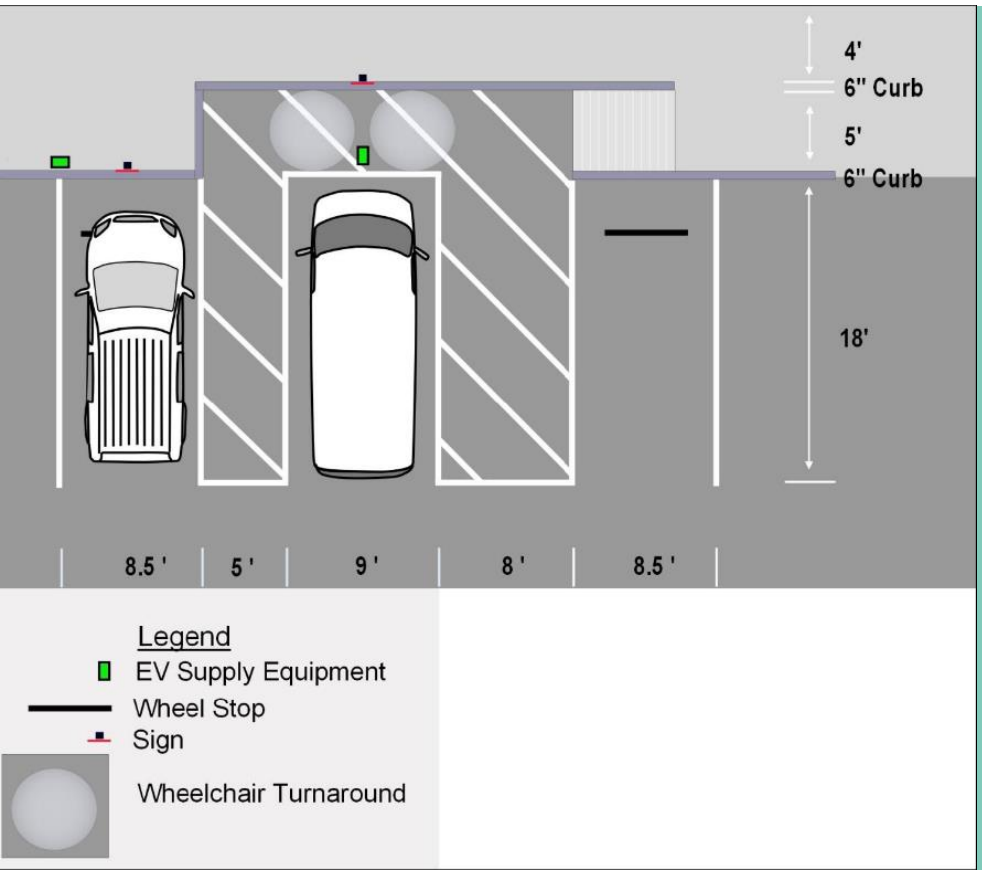
Most EVSE can accommodate two cord sets, although it is possible to have just one cord set on a unit. It's important to verify with your contractor that the availability of two cords on your charging station translates to the ability for two vehicles to be charged simultaneously and at the same amperage. An agency should determine their best option while considering the placement of the charging station within the parking area and the needs of the targeted users (See section on *Visibility and Location in Lot*).

PARKING SPACE DIMENSIONS

In order to ensure safe and easy movement around the charging station, it is recommended that an agency's first charging station installation be configured for ADA compliance and that 10% of additional charging station spots be ADA compliant. It is important to note that requirements and best practices in this area do change. See the image below for one such acceptable configuration for ADA compliance. The Department of Transportation (DOT) Code Enforcement group recommends that the ADA EV charging space be van accessible and a dual head charging station be placed on the sidewalk between parking spaces tight to the granite curb. The length of the charger cord should be capable of reaching EVs from either side. Existing handicapped space should be left untouched.

If you have only one EV charging station, make the associated parking space ADA accessible.

Signage or additional notifications denoting "EV Charging Only" is encouraged. Similarly, a sticker stating relevant assistance information on the head of the EV charger is also beneficial. (See section on Signage)



ADA Accessibility

ENVIRONMENTAL CONDITIONS AND HAZARDS

Environmental conditions can pose a threat to equipment. While EVSE designed for outdoor use operate safely under wet conditions, installations in flood plains or near irrigation systems such as sprinklers should be avoided. Wall or pole mounted equipment should be considered where localized pooling could occur. Cold weather charging is especially problematic while using the charging cable, because snow and ice can encase the cable if it is lying on the ground or otherwise exposed. This can be mitigated with equipment with a retractable cable which remains flexible in extreme cold conditions.

Tripping, as a result of an extended EV cord, is a common and manageable hazard associated with EVSE. The charging station should be in an area of minimum pedestrian traffic. In addition, consideration might be given to the installation of an overhead support or trolley system to allow the cord to hang above the vehicle in the area of the EV inlet. The utilization of retractable cords would also minimize or eliminate tripping hazards.

TECHNOLOGY AND NETWORK

To standardize the statewide EV charging network, charging equipment with payment technology systems that comply with open, non-proprietary communication protocols should be selected. Open communication protocols ensure that electric vehicle charging equipment includes computer hardware for payment systems that can accommodate software from a variety of payment processing services. This means that the equipment should be able to accept all major credit and debit cards without the need to subscribe to an outside service. Open communication protocols also permit the flexibility of contracting different software and network providers, as may become necessary throughout the life of the charging station.

EV network providers are typically companies that manage a network of public chargers, and provide services to both users and operators, such as equipment maintenance alerts, application-based charger information (available chargers, network maps, etc.), and user support.

There are several potential user benefits of networked EV charging station systems. For example, smartphones and internet enabled device applications may feature maps of nearby publicly accessible charging station and provide driving directions to their locations. These applications may also function to reserve a charging session at a chosen EV charging station, to receive email or SMS text message alerts to tell when a charging session is completed or interrupted, and to report a problem with a charging station.

Some potential operator benefits of a networked system includes the opportunity to view and download charging history and approximate carbon savings associated with the charging station; the ability to set time-of-day charging options to take advantage of off-peak electricity rates; maintenance reminders and other notification on the charging station's display; and centralize account control for fleet vehicles (see the Section on *Data Collection and Metering*).

There are several open protocols being utilized for EV charging today, each with its own capabilities. Different protocols allow for communication between different elements of the EV charging asset chain. Table 5 explains some of the open protocols commonly in use today.

Table 5. Open Non-Proprietary Communications Protocols

Standard	Description
OCPP/OSCP	Open Charge Point Protocol (OCPP) and Open Smart Charge Protocol (OSCP) allow for communications between the EVSE and the charging network administrator. These protocols allow changing network administrators without creating a stranded physical asset. OSCP allows for communication between the EVSE and an energy management system and can be used for smart charging support and load balancing.
OpenADR 2.0	The Open Automated Demand Response (OpenADR) provides an open standardized way for electric providers and system operators to communicate with EV charging network operators. OpenADR was originally developed as a peak load management tool.
OCPI	The Open Charge Point Interface (OCPI) protocol supplies correct charge station information such as location, availability and pricing, managing bilateral roaming, and allows for real-time billing and mobile access to EVSE.
ISO/IEC 15118	This protocol enables the managed charging capabilities of a vehicle. This protocol specifies the communication between the EV and EVSE and supports EV authentication, metering, and pricing messages.
IEEE 2030.5/SEP 2.0	Capable of exchanging information pertaining to pricing, demand response, and energy use. This protocol can integrate a variety of DER including EVs and EVSE.

DEEP does not recommend that any one protocol, or combination stack of protocols, be used over another, rather the decision should be left to site hosts, utilities, and charging station operators based on their business needs. However, any publicly funded charging station should operate using open non-proprietary communications protocols in order to avoid stranding assets and to improve the interoperability within the public charging network.

ACCESS

ACCESSIBILITY

The primary function of a parking space with an electric vehicle charging station should be EV charging. The U.S. Department of Energy provides Americans with Disabilities Act Requirements for Workplace Charging Installation guidelines to assist employers with meeting Americans with Disabilities Act (ADA) requirements for accessibility. Any agency installing EVSE should also consult their safety office regarding the status of such standards. DEEP recommends that at least one charging station stall per facility should be ADA van accessible. While efforts should be made to ensure that the parking space is ADA accessible to the extent practicable, it should not be identified with signage that would mistakenly indicate that it is available for use by individuals with disabilities who are solely parking and not charging.

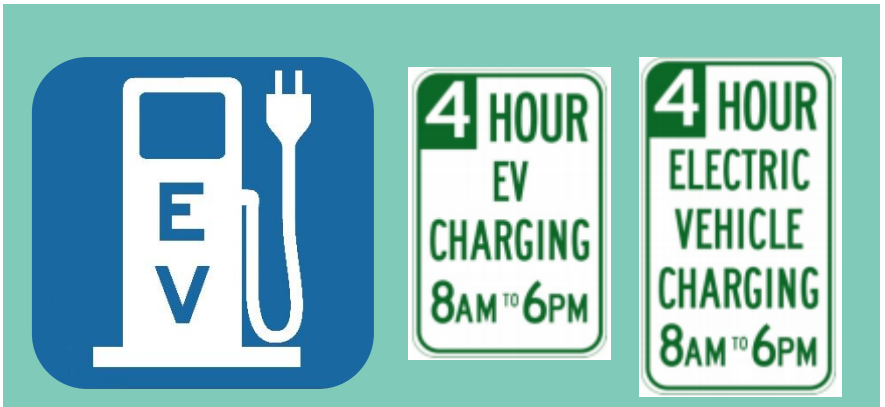
LIGHTING

Lighting at the charging station makes the station more visible to the EV driver, enhances driver safety and helps to deter vandalism to the equipment. Where charging station equipment is installed, lighting levels should be compliant with local codes, as lights that are too dim can increase the likelihood of tripping hazards. Installing an EV charging station may also present an opportunity for needed lighting upgrades at parking facilities.

SIGNAGE AND WAY FINDING

Making your EV charging station visible to motorists will help EV drivers locate it. Tiered wayfinding signage that guides EV drivers from highly traveled roadways to charging stations is one way of increasing the station's visibility. Agencies should follow the U.S. Department of Transportation Federal Highway Administration (FHWA) guidance for placement and usage of signs. This information can be found in the FHWA Guide. The following is a list of suggestions that should help supplement FHWA guidance.

- Signage be placed at the entrance of the EV charging station's location, with supplemental arrows to help guide individuals to the station (if needed). Consistency and visibility of signage throughout a city, state or region can help drivers locate charging stations regardless of network access.
- Signage should clearly show that the parking spot is only to be used by an EV that is physically charging. Signage serves to deter people parking non-electric vehicles in EV spots and should state if non-electric vehicles are subject to fines or towing. Other signage should be installed immediately adjacent to and visible from the EV charging station and should include



EV Charging Station Only Signage

station parking restrictions, operation instructions, hours and days of operation, and contact or registration information if the operator has questions about the charger. Information on any fees, operating instructions, and terms of use should also be posted and be clearly visible in day or night-time conditions. This blue EV pump sign is used in Connecticut as the universal image guiding EV drivers to accessible charging stations.

EV Charging Station at DEEP Headquarters

- The pavement of the EV parking spot should be painted to clearly indicate to others that the spot is designated for electric vehicles. Pavement markings, like striped markings used for spaces reserved for handicapped parking; as well as markings on vertical surfaces should be used to identify EV charging spaces. Often both a parking spot and a curb is painted to identify a spot designated for EVs.

Proper signage will go a long way towards avoiding ICE-ing. (See image below) The term "ICE-ing" refers to the practice of drivers parking ICE vehicles in spaces specifically designated for EV charging. ICE-ing whether intentional or not, inconveniences EV drivers and prevents them from charging their vehicles. Similarly, unplugged EVs parked in EV charging spaces represent another inconvenience to EV drivers needing to charge their vehicles. Connecticut has passed legislation penalizing infractions for ICE-ing and unplugged EVs parked in charging spaces. Section 16-19ggg of the Connecticut General Statutes enables owners and operators of public EVSE to set forth restrictions on the amount of time that an EV may be charged at its station and made it illegal for ICE vehicles to park in an pubic EV parking space reserved for BEVs and PHEVs. The Connecticut Centralized Infractions Bureau set a $60 fine with additional fees for $43 with a total penalty of $103 for ICE-ing. DEEP will collaborate with state and municipal law enforcement authorities to develop educational materials to assist with enforcement of ICE-ing infractions.

PEDESTRIAN TRAFFIC

EVSE and cord sets should not interfere with pedestrian routes. EVSE should not be placed in a location that would cause a cord to pose a tripping hazard (See the section on *Hazards*). Pedestrian paths should be considered when designing where to install an EV charging station. Charging station site choices should consider building entryways, existing pathways, street crossings, and meeting points, so as not to impede pedestrians.

OPERATION

HOST-OPERATOR AGREEMENTS

Under the host-operator model, a third-party company can assist the State agency with site design, EVSE selection, network management, data collection and visibility, demand response programs, and payment requirements. It is up to each Agency to decide if they will assume the responsibilities of operating and maintaining the charging station themselves or enlist a separate operator to do so. If the decision is made to have a third-party agent operate the charging station, an agreement outlining each party's obligations should be created and costs to use the EVSE should be understood up front. Agencies should contact CT DAS to learn if third party vendor agreements are available.

VISIBILITY & LOCATION IN LOT

Ideal station location is convenient and visible to both current and potential EV drivers. If the charging station will be for public use, it should be prominently placed, allowing it to be easily found by potential users. In addition, vehicle and pedestrian traffic patterns, both within and surrounding the proposed station location should be carefully evaluated to ensure station accessibility and user safety. If the charging station will be used primarily for employee or fleet charging, a more economically efficient location within the parking area may be chosen. It is also important to make sure the charging station area is always well lit to ensure safety and prevent vandalism (See *Lighting* section).

DATA COLLECTION AND METERING

The charging station will need to communicate with the utility grid to measure and meter the amount of electricity being used, so the EDC may need to be contacted. Depending on how an agency plans to bill and track usage of the charging station, it may be beneficial to have the charging station on its own separate meter. A separate utility meter, dedicated to the charging station, will allow easier tracking at the charger, especially if the charging station is not equipped with data collection equipment. Equipment usage or tracking software is an additional service which may incur further costs beyond purchasing and installation costs. It will also provide additional information which will better help the owner/operator understand how the station is being utilized. DEEP recommends that any publicly funded charging infrastructure deployment program require a transparent tracking mechanism with regular reporting to provide for program effectiveness evaluation and modification based upon lessons learned, technological advances, and market maturation.

INSURANCE AND INDEMNIFICATION

It is important to review your current insurance coverage to determine what, if any, changes are needed as a result of the addition of a charging station to your facility. The agency or State property may be self-insured.

LENGTH OF STAY

When deciding on of the appropriate charging level (1, 2, DCFC) to install, it is important to consider who the typical user of your charging station will be. If the typical user will be charging over long periods of time, for example an employee vehicle parked in a lot for eight hours or more daily, you may not require

more than Level 1 EVSE. However, these stations should be capable of being upgraded to Level 2 as the number of EVs and EV drivers increase. It is important to remember that a Level 1 charger can only service one EV during the workday, while a Level 2 charger is able to service more than one EV during the workday. If the typical user will be a visitor to your facility, or if the station will be used for both employees and visitors, then Level 2 may be the most efficient and cost-effective level to install.

It is also important to devise a policy of use for the charging station. This should cover issues relating to how the charger is utilized by patrons. It should cover topics such as whether reservations are required for the spot, how a reservation can be made, how long an EV is allowed to charge, what happens if the allotted time is exceeded, etc. (see Section on Consistent Consumer Experience).

FUTURE-PROOFING

As the market penetration of long range EVs increases, lower powered DCFC stations will be less likely to meet drivers' needs and become obsolete, creating stranded or underutilized assets. To avoid stranded assets and costly future electric grid upgrades, all new investments in the make-ready portion of electrical infrastructure (all conduit and wiring up to the charger stub) supporting DCFC stations should support chargers with a minimum capacity of 150kW. This requirement will allow for station operators to install 50kW EVSE to meet the needs of most EVs that are on the road today, but will also provide for future charging station upgrades without the need to for modifications to the utility infrastructure as advances in battery technology call for a faster rate of charge.

As greater numbers of high-powered DCFC stations are deployed in Connecticut, efforts must be taken to avoid exacerbating peak demand periods. At sites with multiple EV charging ports, incorporating renewable energy sources or storing energy in batteries for later use will help curb the high demand caused by multiple vehicle charging simultaneously. When selecting a charging station location, site hosts and developers should consider existing and future needs for incorporating on-site distributed energy resources, and prioritize areas that can easily accommodate these assets, which in turn could reduce the cost of future upgrades.

Many charging station locations will require the installation of additional chargers and connectors as EV penetration rates increase. Site host should consider whether there is adequate real estate at a charging location to accommodate additional chargers if needed. Similarly, the need for sufficient space to accommodate additional chargers and adequate utility infrastructure, are also important considerations when planning Level 2 EVSE installation.

EVSE should utilize open communication protocol standards rather than proprietary networks. Open networks provide the freedom to switch network management providers without having to purchase new stations (See *Technology* Section). They also allow for modifications and upgrades to your station that may be required as the technology changes.

FEES COLLECTION

The State is prohibited from re-selling electricity; however, a user fee may be charged for the operation and maintenance of the equipment. Rates are subject to the discretion of the Agency, but those fees should not be excessive as to discourage use of the station. Since users of the charging station will be allowed to make payments using credit/debit cards, it is important to discuss payment provisions with the Agency's Accounting division to ensure that collection of credit card payments are handled in accordance with the

revenue collection requirements outlined in the State's Accounting Manual. According to the State's Accounting Manual, an Agency must invoice all revenues. Therefore, if a third party is collecting payments on behalf of the Agency for EV charging, the Agency is required to invoice that third party for all revenues received for EV charging, then in turn make a payment to said third party for any transaction fees incurred.

Each newly installed publicly funded, publicly accessible charging station should be capable of accepting payments, with appropriate consumer protections, via credit card reader and at least one other accessible form of payment. DEEP will work with the Connecticut Department of Consumer Protection's Division of Food and Standards to establish charging station pricing and billing standards. To date, opportunities for funding offered by the State for the installation of EVSE have required that such stations provide charging services to users at no cost for the first three years. Exceptions have been made to this requirement in instances where a compelling case was provided for the need to collect fees.

OBTAINING NECESSARY PERMITS

All agencies should consult their facilities management during the planning stages of charging station installation to determine the necessary approvals required for the installation.

Most projects that are solely the installation of an electric vehicle charging station will fall below the $500,000 threshold (for most agencies) making them Agency Administered projects. Most executive branch agencies (DOT, UConn are exceptions) are required to obtain approval from the DAS Division of Construction Services (DCS) to self-administer a project. Details regarding who is required to obtain approval, as well as the process steps are outlined in the Agency Administered Projects Procedure Manual located in the DCS website library.

In any construction situation, it is always beneficial to send a sketch of the proposed project to DCS' Code Unit. This will allow them to identify any code violations prior to the contractor starting the project and eliminating the need to redo the work after it has been inspected. The current contact for DCS' Code Unit is:

Darren Hobbs
Phone: 860-897-6914
Email: Darren.Hobbes@ct.gov

INSPECTIONS

For agencies that do not have inspection staff, following the installation of an electric vehicle charging station, arrangements should be made for the unit(s) to be inspected by DCS. DCS currently has a 48 – 72-hour turnaround time from date of inspection request to date of inspection. The current contact for scheduling site inspections is:

Diana Whitehead
Phone: 860-713-5620
Email: Diana.Whitehead@ct.gov

STATE CONTRACTS

EVSE PROCUREMENT CONTRACT

The State of Connecticut is working to expand the use of EVSE throughout Connecticut. With the continued growth of EVs on Connecticut roads, the number of vendors from which to purchase charging equipment has grown. However, municipalities or State agencies that are looking to purchase EV charging equipment, are able to purchase from the State procurement Contract 13PSX0316 on Connecticut's State Contracting Portal. This contract is set to expire 5/31/2021, but it is expected to be renewed.

OTHER PROCUREMENT CONTRACTS

Electrical installation services, along with any other construction needs, may be contracted using the DAS Trade Labor contract. Any additional services, such as pavement marking and signage, can be procured using standard state purchasing practices. EVs for your agency's fleet can also be procured using DAS contracts.

MAINTAINING AND USING EV CHARGING STATIONS

TESTING AND MAINTENANCE

Cleaning and testing of the functionality of the charging station is very important towards maximizing uptime. Uptime maximization refers to the amount of time that a charging station is functioning properly and available for use and is necessary to establish a reliable EVSE network and build consumer confidence. User confidence declines when a charging station is inoperable due to regular maintenance or because it is broken requiring repair. Clearly defined operations and maintenance programs are necessary to minimize and prevent downtime.

Identify in contracts, for publicly funded EVSE, the entities responsible for station maintenance and repair, and ensure adequate resources are available to conduct regular inspections, diagnose problems, and service stations in a timely manner. While establishing service contracts, agencies can explore the extent of any maintenance agreement they wish with equipment vendors, determine the duration of their agreement, and negotiate extended warranties. DEEP suggests the provision of public funding for public charging equipment should be conditioned on an agreement from the recipient of the funding to ensure the operation and maintenance of the equipment is consistent with accepted operational and maintenance schedules and standards.

After installation of the charging station, it is normal for the vendor/installer to inspect the unit to ensure it is installed correctly and working as intended. The warranty period typically begins following such an inspection. It is recommended that repairs are always performed swiftly and as necessary to keep the charging station running smoothly. The location surrounding the charging station should also be kept clean and structurally sound. For example, the pavement surrounding the charging station should be kept in good repair.

To minimize downtime, State agencies should effectively communicate with EV drivers in real time the availability of open chargers and parking spaces and scheduled maintenance plans. Suggested options include utilizing signage, mobile phone apps, and onboard technology installed in EVs.

CONSISTENT CONSUMER EXPERIENCE

RESERVATION OPTIONS

Rules governing the operation and usage of the charging station will be needed to ensure that the station is utilized as efficiently as possible. One such rule surrounds time allotment for the usage of the charging station. Specifically, the Agency/Operator of the charger should post or publish a time limit for the use of the charging station, making it clear that vehicles are not allowed to remain parked at the charging station longer than the specified amount of time. Also, the Agency should make it clear that parking spaces with EVSE should only be use while actively charging.

Recommendations

- Clearly display allotted Charge Time (ex. 4 hours max)
- Post "No Parking Unless Charging" signage
- Develop a reservation system available to agency EV drivers

If necessary, the Agency can choose to develop a reservation system. At a small scale, this can take the form of a physical sign-up sheet, an online form, or a facilitated channel of communication between EV drivers. Some EV network providers also have systems built into their user applications that allow drivers to reserve chargers. As the number of EV drivers at an agency increases, the need for a reservation system beyond basic communication between EV drivers may arise.

CHARGE TO USERS

The decision to charge consumers for using EVSE is left up to each agency. Some believe that a minimal fee should be charged, if only to mentally prepare the user for the eventuality of a fee when, with the rise in EV deployment, it becomes an absolute necessity to charge for the service. Others believe that offering usage of the charging station as a free service, even if only initially, will be an attractive benefit of EV ownership that may incent additional drivers to consider EVs as a viable alternative to conventional fuel vehicles. At a minimum, the agency should consider the operation, maintenance, and varying utility rates associated with the installation of an EV charging station, before deciding fees. As previously mentioned, publicly funded stations, to date, have primarily been offered at no cost to the user for the first few years of operation.

SUGGESTED COURTESIES GOVERNING CHARGING STATION USAGE

There are certain actions that will go a long way in ensuring the safe and cooperative use of your agencies charging station. It may be beneficial to post a list of "EV Charging Etiquette or Courtesies" in an area close to the charging station as a reminder to users. The list can be as extensive as necessary, but lengthy rules may deter users from reading it. Below are some items that may be useful to include on this list:

1. **EV spots are for EVs**: It is not acceptable for an internal combustion engine (ICE) car to park in a spot designated for a plug-in car. This does not mean pure EV drivers have the right to unplug plug-in hybrids because they have a back-up ICE, UNLESS the plugged-in car is clearly finished charging. The driver doing the unplugging should leave a note explaining why the car was unplugged. The note should be polite and include your contact information. NOTE: Unplugging a vehicle that has already been charged also applies to plug-in vehicles other than hybrids; and the responsibility to be polite to the other driver also applies.

2. **No Nasty Notes**: EV drivers should never leave nasty notes for other drivers parked in an EV spot. If any vehicle, other than a plug-in vehicle, is parked in an EV spot, notify security

3. **Charge Only When Necessary**: Do not plug-in solely because a charger is available. The spot should be left free for EV drivers who may need to charge in order to complete their travels.

EV Charging Etiquette

EV Spots are for EVs

No Nasty Notes

Charge Only When Necessary

It's OK to Ask for a Charge

Safety First

4. **Charge Up and Move On**: EV drivers should only occupy a charging spot while their vehicle is being charged. Once the vehicle is charged, the driver should be prepared to unplug and move their car as soon as possible. This is applicable even in situation s where there is a maximum allotted time for a charging station. If the car is charged before that time runs out, it should be moved once charged.

5. **It's OK to Ask for a Charge**: If the charging spot you need is being used, and you are able to park next to the car that is currently charging, it is ok to leave a note asking the driver to plug you in after his or her charging is complete. Conversely, if you receive a similar note, you should do the same for the requesting driver. If there is a fee for the use of the charging station, there is no obligation to honor that request and incur a fee. The choice is yours.

6. **Safety First**: It is important to charge safely. After charging, return cords and connectors to their holders to avoid tripping hazards and damage to the charger.

REFERENCES

ADA Requirements for Workplace Charging Installation: Guidance in Complying with Americans with Disabilities Act Requirements. Workplace Charging Challenge, U.S. Department of Energy. November 2014. Retrieved December 3, 2020 from https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf

Alternative Fueling Station Counts by State. U.S Department of Energy. January 2021. Retrieved January 6, 2021 from https://afdc.energy.gov/stations/states

Charging Station Installation Handbook for Electrical Contractors and Inspectors. Advanced Energy. May 2013. Retrieved December 30, 2013 from https://publicservice.vermont.gov/sites/dps/files/documents/Transportation_LandUse/Goal1/ESVE%20Handbook%20for%20Electrical%20Contractors.pdf

Charging While You Work: A Guide for Expanding Electric Vehicle Infrastructure in the Workplace. Minnesota Pollution Control Agency. December 2012. Retrieved December 6, 2013 from https://www.pca.state.mn.us/sites/default/files/charging-while-you-work-guide.pdf

Nelder, Chris and Rogers, Emily. Reducing EV Charging Infrastructure Costs. Rocky Mountain Institute. December 2019. Retrieved November 17, 2020 from https://rmi.org/wp-content/uploads/2020/01/RMI-EV-Charging-Infrastructure-Costs.pdf

Costs Associated with Non-Residential Electric Vehicle Supply Equipment. United States Department of Energy. November 2015. Retrieved May 28, 2020 from https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

Electric Vehicle Charging Etiquette. PluginCars. April 2019. Retrieved June 18, 2014 from https://www.plugincars.com/eight-rules-electric-vehicle-etiquette-127513.html

Electric Vehicle Charging Infrastructure Deployment Guidelines for the Oregon I-5 Metro Areas of Portland, Salem, Corvallis and Eugene. Electric Transportation Engineering Company. April 2010. Retrieved December 30, 2013 from http://74.121.199.247/sites/default/files/pdf/EVProj/EVChrgInfraDeployGuidelinesOregonVer3.2.pdf

Electric Vehicle Roadmap for Connecticut. 2020. Retrieved November 16, 2020 from http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/f7ed4932eec438d0852585520001c81b/$FILE/EV%20Roadmap%20for%20Connecticut.pdf

Kresch, Barry. January 2020 CT EV Dashboard. EV Club of CT. January 2020. Retrieved November 16, 2020 from https://evclubct.com/interactive-ev-dashboard-january-2020/

Low Cost Workplace EV Charging. Energy Central. June 2014. Retrieved June 18, 2014 from https://energycentral.com/c/sc/low-cost-workplace-ev-charging

Nicholas, Michael. Estimating Electric Vehicle Charging Infrastructure Costs Across Major U.S Metropolitan Areas. The International Council on Clean Transportation. August 2019. Retrieved November 17, 2020 from https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

OCPP 1.5: A Functional Description. Open Charge Alliance. Retrieved December 6, 2013 from https://www.openchargealliance.org/

Plug-In Electric Handbook for Public Charging Station Hosts. National Renewable Energy Laboratory. April 2012. Retrieved December 5, 2013 from https://www.nrel.gov/docs/fy12osti/51227.pdf

Plugging in at Work: How to Effectively Install, Share and Manage Electric Vehicle Charging Stations. California Plug-In Electric Vehicle Collaborative. November 2015. Retrieved November 16, 2020 from https://portal.ct.gov/-/media/DEEP/air/mobile/EVConnecticut/201511PluggingatWorkpdf.pdf

Ready Set Charge California. Association of Bay Area Governments; Bay Area Climate Collaborative; Clean Fuel Connection; EV Communities Alliance; LightMoves Consulting. November 2011. Retrieved December 9, 2013 from https://www.cleancitieseastbay.org/readysetcharge_evguidelines.pdf

Site Design for Electric Vehicle Charging Stations. Sustainable Transportation Strategies. July 2012. Retrieved April 10, 2014 from https://www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Site-Design-for-EV-Charging-Stations.pdf

Siting Electric Vehicle Charging Stations. Sustainable Transportation Strategies. April 2012. Retrieved December 30, 2013 from https://www.hrccc.org/wp-content/uploads/Siting-EV-Charging-Stations-FINAL-12.pdf

Siting Plug-in Electric Vehicle Charging. Drive Electric Florida. December 2012. Retrieved December 30, 2013 from http://energysmartflorida.com/environment/pdf/siting-vehicle-charging.pdf

Understanding Electric Vehicle Charging. Plug In America. January 2011. Retrieved April 02, 2014 from https://pluginamerica.org/understanding-electric-vehicle-charging/

Zero Emission Vehicle Signs and Pavement Markings. California Department of Transportation. March 2013. Retrieved January 6, 2021 from https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/f0018447-13-01-a11y.pdf

IMAGE REFERENCES

Front Cover	**Electric Car Charging** Courtesy of Andrew Roberts, Unsplash
Page 12	**Level 1 Charger** Courtesy of "Costs Associated with Non-Residential Electric Vehicle Supply Equipment" by United States Department of Energy
Page 12	**Level 2 Charger** Courtesy of NREL 49705
Page 12	**DCFC** Courtesy of NREL 49706
Page 15	**Pedestal Mount** Courtesy of "Electric Vehicle Charging Station (EVSE) with Level 1 and Level 2 Charging (J17720)" by Traderd- Own work. Licensed under Creative Commons Attribution- Share Alike 3.0 via Wikimedia Commons
Page 15	**Wall Mount** Courtesy of "Phillips Chevrolet's Solar Charging Station for Electric Vehicles" by Phillips Chevy- Own Work. Licensed under Creative Commons Attribution- Share Alike 3.0 via Wikimedia Commons
Page 15	**Overhanging Mount** Courtesy of "Site Design for Electric Vehicle Charging Stations" by Sustainable Transportation Strategies
Page 17	**EVSE with Bollards** Courtesy of NREL 62417
Page 18	**ADA Accessibility** Courtesy of "Site Design for Electric Vehicle Charging Stations" by Sustainable Transportation Strategies
Page 21	**EV Charging Only Sign** Courtesy of Connecticut Department of Transportation
Page 22	**EV Charging Station at DEEP Headquarters** Courtesy of DEEP