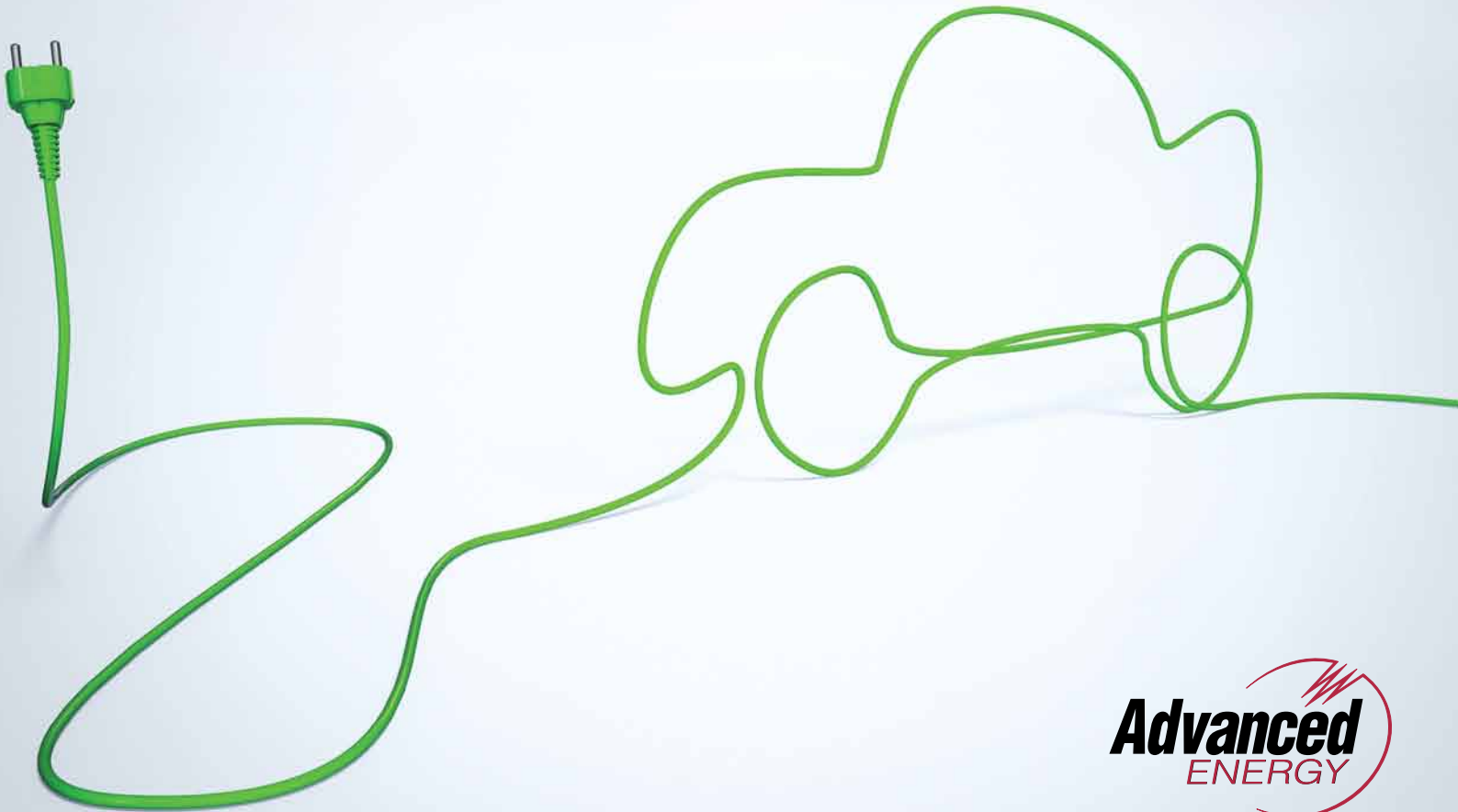


CHARGING STATION INSTALLATION HANDBOOK

for Electrical Contractors
and Inspectors



You understand and agree that the installation, operation, maintenance and inspection of electrical charging stations for electric vehicles is an extremely complex and dangerous activity.

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CHARGING STATION INSTALLATION HANDBOOK

for Electrical Contractors and Inspectors

Version 2.0

This handbook was made possible through the support of Duke Energy, Progress Energy, the North Carolina Electric Membership Corporation and Dominion North Carolina Power, as well as the City of Raleigh, who supplied information and shared best practices regarding charging station installation.

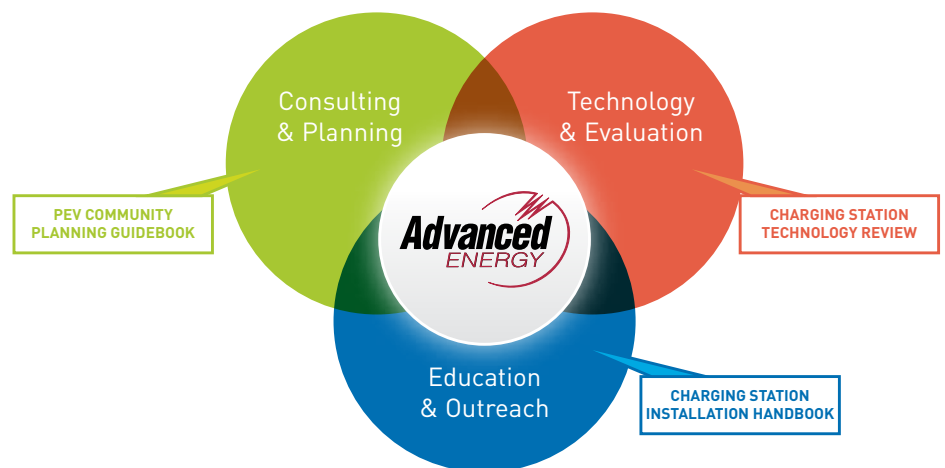
Your Feedback Matters!

With publication of Version 2.0 of the Charging Station Installation Handbook for Electrical Contractors and Inspectors, Advanced Energy is currently seeking feedback on the information presented, methods used and best practices. This feedback will then be reviewed and incorporated into the next version of the handbook. To provide your feedback, please visit www.AdvancedEnergy.org/HandbookFeedback.

DRIVING THE FUTURE OF TRANSPORTATION

Advanced Energy's Electric Transportation sector is working to assist utilities, charging station vendors, municipalities and all initial stakeholders in understanding, planning and implementing electric transportation initiatives. As your trusted resource for advancing electric transportation, we can assist you in creating a strong foundation for successful change through:

- ▲ Consulting and Planning
- ▲ Technical Evaluation
- ▲ Education and Outreach



The future of transportation is here! As more and more consumers purchase plug-in electric vehicles (PEVs), the demand for electrical charging stations will increase. As such, contractors will receive more requests to install charging stations – from new construction and existing homes to retail outlets, corporate campuses and parking decks. With this evolving technology, electrical inspectors will also be challenged as requests for approvals increase and the scope of installation varies.

We're here to help. Our handbook includes overviews, guidelines and checklists to help contractors and inspectors deal with the influx of requests.

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CHARGING LEVELS

With the imminent rollout/adoption of PEVs, there is a clear and present need for electric vehicle supply equipment (EVSE), most commonly referred to as charging stations. Charging stations are the point of power for electric vehicles, ranging in style and charging levels and subject to standards and codes. It is important to note while an EVSE is normally referred to as a charging station, for Level 1 & 2 stations, it is not a battery charger. Only Level 3 and DC Fast Chargers include an actual charger. The main purpose of a charging station is to establish communication with the vehicle and to transfer power to the PEV while providing proper grounding, shock protection, overload protection and general safety. The PEV will have an onboard battery management system and charger.



There are four levels of charging, offering a range in charge time and infrastructure simplicity. For infrastructure planning purposes, charging stations are considered to be continuous loads.

CHARGING LEVEL

FEATURES

Level 1	<ul style="list-style-type: none">▲ 120 VAC, 15 or 20 A circuit based on the standard American home outlet▲ Will take the longest time – eight to 10 hour full charge*▲ Simplest; easily accessible for vehicle owners▲ Uses amount of power similar to a hair dryer or microwave▲ Suited for low-speed NEVs and some PEVs with short electric-only range; may also be well suited for locations where a PEV will be parked for extended periods (days/weeks)
Level 2	<ul style="list-style-type: none">▲ 208/240 VAC, 80 A maximum current (100 A circuit)▲ Will use only the SAE J1772 specified plug▲ Uses amount of power similar to large appliances, such as air conditioners or clothes dryers▲ Requires two to three hour full charge*
Level 3	<ul style="list-style-type: none">▲ Accepted standard has not yet been established▲ Will likely not be used in homes due to costs
DC Fast Charge	<ul style="list-style-type: none">▲ 480 VDC / 100 A (and up) fast charge▲ 80% charge in around 30 minutes*

**Estimated charge time based on a vehicle utilizing 40 miles of electric-only driving between charges.*

Level 2 charging is likely to be the most common form of vehicle charging in the foreseeable future. The majority of this document refers to the installation of Level 2 conductive charging stations.

APPLICABLE CODES & STANDARDS

Society of Automotive Engineers and National Electrical Code Standards

In order to ensure common standards for vehicle charging, the Society of Automotive Engineers (SAE) has developed standards for energy transfer and a common cord set. These standards will ensure all PEVs have a common charging 'plug,' meaning any PEV will be able to plug into any charging station. The two main standards are SAE J1772 and SAE J2293, which reference other SAE, National Electrical Code (NEC) and Underwriters Laboratories (UL) standards or codes.

SAE STANDARDS FOR CHARGING STATIONS

Standard	Description
J1772	Electrical and mechanical aspects of the cord set; references UL for safety and shock protection as well as the NEC for the cord and couple
J2293	Standard for the electric vehicle energy transfer system. This system encompasses what goes from the charging station to the car.
J2293-1	Functionality requirements and system architecture
J2293-2	Communication requirements and network architecture

NEC STANDARDS FOR CHARGING STATIONS

Standard	Description
NEC 110.11	Deteriorating Agents
NEC 110.28	Enclosure Types
NEC 110.26	Electrical Equipment Spacing
NEC 110.26 (A)(2)	Width of Working Space
NEC 110.27(B)	Guarding of Live Parts – Prevent Physical Damage
NEC 210.70(A)(2)	Lighting Outlets Required – Dwelling Units – Additional Locations
NEC 300.4	Protection [of conductors] Against Physical Damage
NEC 334.15	Exposed Work [requirements for nonmetallic-sheathed cable]
NEC 334.30	Securing and supporting nonmetallic-sheathed cable
NEC 625.1 – 625.5	General (Scope, Definitions, Other Articles, Voltage, Listed/Labeled)
NEC 625.9 (A-F)	Wiring Methods (Electric Vehicle Coupler)
NEC 625.13 – 625.19	Equipment Construction
NEC 625.21 – 625.26	Control and Protection
NEC 626.28 – 625.30	Electric Vehicle Supply Equipment Locations

UL Standards

In conjunction with other PEV and charging station standards in development, UL is currently developing safety standards for charging electric vehicles. There are five primary standards:

UL STANDARDS FOR CHARGING STATIONS

Standard	Description
UL 62	Standard for flexible cords and cables required by NEC 625
UL 2202	Charging station design and construction
UL 2231	Charging station shock prevention measures define proper grounding and ground fault interruption
UL 2251	Cord design and safety covers the plug, cord, receptacle, connectors and other items related to the charging cord set. Also verifies the cord's safety and ability to carry its rated load.
UL Subject 2594	Charging station safety covers off-board equipment that supplies power to a vehicle, including PEV power outlets, cord sets, or standalone charging station

APPLICABLE CODES & STANDARDS



Americans with Disabilities Act Standards

At the time of publication, Americans with Disabilities Act (ADA) standards specifically addressing the installation of charging stations in public parking areas (e.g., lots, decks, on-street, etc.) have not been established. However, ADA regulations apply to all government and commercial sites and charging station installation cannot violate the ADA compliance by making a site or a feature of the site non-compliant. Sites must be designed so that the facility (or part of the facility) is readily accessible to and usable by individuals with disabilities. In addition to national regulations, many states and cities have adopted individual and more restrictive regulations. It is recommended to check with your state and local government to see if any additional ADA regulations have been adopted.

The following are national standards and codes that guide ADA compliance:

▲ **2009 International Building Code — ANSI A117.1**

This standard contains technical criteria to make sites, facilities, buildings and elements of the sites accessible to and usable by people with physical disabilities. The intent of this standard is to allow a person with a physical disability to independently get to, enter and use a site, facility, building or element of the site.

▲ **2010 ADA Standards — 28 CFR part 36**

The 2010 ADA standards, published by the U.S. Department of Justice, sets minimum requirements for newly designed and constructed or altered state and local government facilities, public accommodations and commercial facilities to be readily accessible to and usable by individuals with disabilities.

In the absence of specific accessibility standards for electric vehicle charging stations, some states and municipalities have developed their own guidelines. Currently, there is some variation in how these regions have chosen to address accessibility standards. The recommendations in this Handbook are merely suggestions gathered from the most widely used approaches to achieving accessibility in charging station installations. The ultimate decision for inclusion of accessibility in the design of charging station installation is the responsibility of the property owner.

The following sections outline the areas of disabled-accessibility to be considered when installing a charging station.

Vehicle Parking Restrictions

The primary purpose of electric vehicle charging stalls is for the user to charge the electric vehicle's battery and not for vehicular parking; therefore an accessibly-sized space should not be reserved exclusively for those with disabilities. Instead, it is recommended the accessibly-sized stalls be available for use by both disabled and non-disabled electric vehicle drivers. The accessibly-sized charging stalls should include signage marking the stall for electric vehicle drivers only. Federal regulations indicate that disabled drivers have the highest priority in parking and may park anywhere, without restriction, meaning that the following vehicles may use ADA-compliant charging station stalls:

- ▲ Disabled marked internal combustion vehicles;
- ▲ Disabled marked electric vehicles; and
- ▲ Non-disabled marked electric vehicles.

In order to reserve the charging station for the exclusive rights of a disabled driver, the station may be placed in a "marked accessible" parking space. This means the primary purpose of the stall would be for parking of disabled-marked vehicles, and charging would be the secondary purpose.

Number of Accessible Charging Stations

There are various methods currently being used for calculating the required number of disabled-accessible charging station stalls. The most prevalent method is to require one accessible charging station stall for every 25 charging station stalls. For van accessible stalls, one in every 10 accessible stalls should be van accessible

Charging Stations at Site	Accessible Stalls	Van Accessible Stalls
1	1	1
2-25	1	1
26-50	2	1
51-75	3	1
76-100	4	1

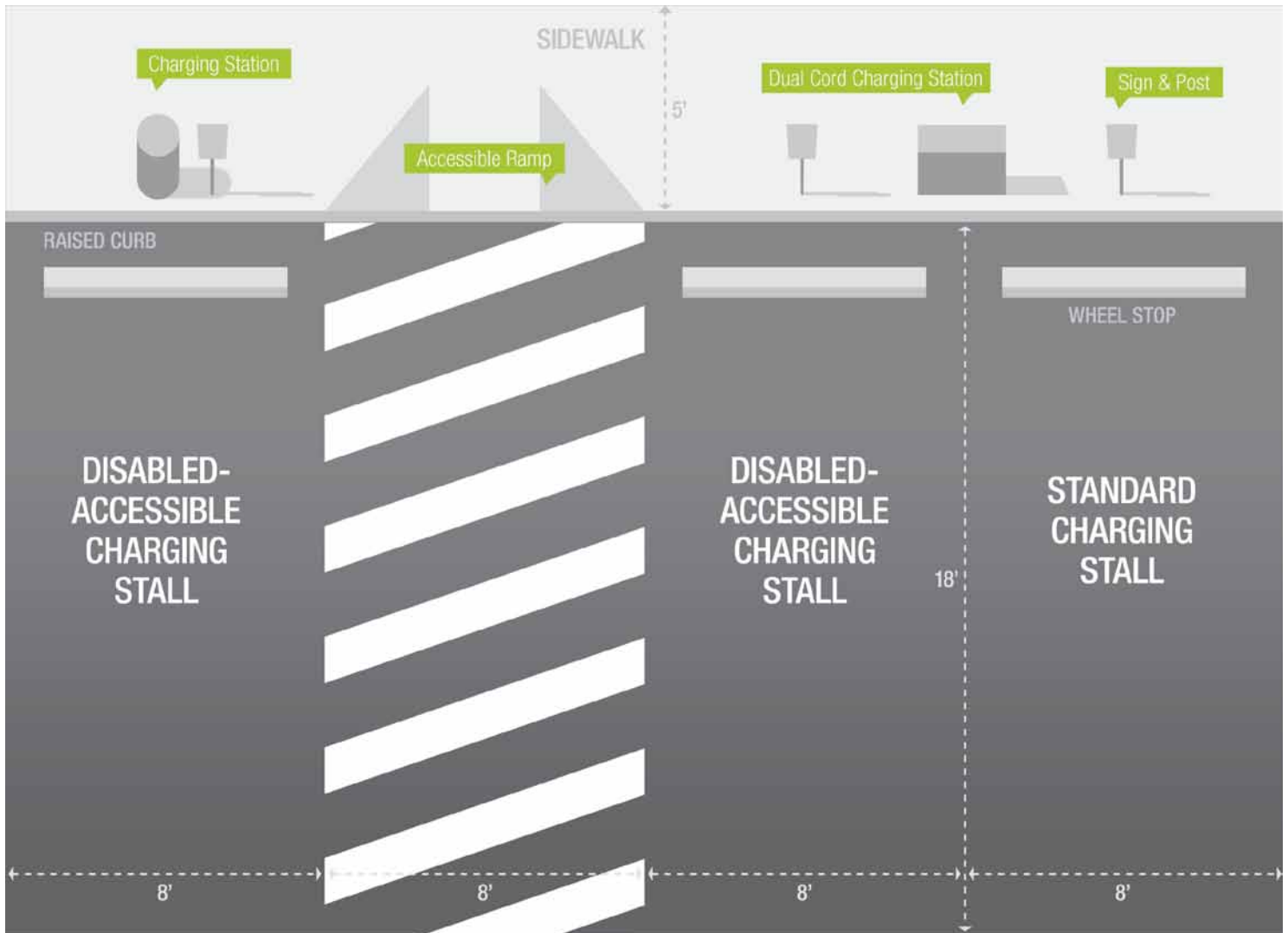
Charging Station Placement and Design Criteria

For the placement of the charging station, there are some existing standards which apply, including:

- ▲ **Reach Ranges (ANSI A117.1 Section 308.2.1)**
Indicates the controls should be designed so that where a forward reach is unobstructed, the high forward reach should be 48 inches maximum and the low forward reach should be 15 inches minimum above the floor.
- ▲ **Operable Parts (ANSI A117.1 Section 309)**
Ensures all operable parts are in compliance with the code including, clear floor space, height and operation.
- ▲ **Automatic Teller Machines (ATMs) and Fare Machines (ANSI A117.1- Section 707)**
Contains regulations such as operable parts and clear floor space. This section applies to charging stations and associated payment and fare machines.

Another consideration for accessibility in charging station placement includes the distance to the facility. Several of the existing ADA Charging Station guidelines have concluded the charging station itself is considered the facility of destination, thus it is not required for the charging station to be on the shortest accessible path to the nearest building. This means the path from the vehicle to the charging station must be ADA-compliant, but the path from the charging stall to the facility does not necessarily need to be the closest to the facility on the site. The State of California recommends the accessible charging stall should be located within 200 feet of the facility's main entrance for new construction (it does not provide a minimum guidance for existing facilities).

APPLICABLE CODES & STANDARDS



Accessible Charging Station Stall Dimensions

The dimensions for an accessible charging station stall should provide adequate room for the disabled user to maneuver around all sides of the vehicle. This is required because different electric vehicle models have different charging port locations (front, side, back).

▲ Stall Dimensions

The dimensions for an accessibly sized stall should be 8x18-feet with an adjacent five-foot aisle for accessible vehicles, and an eight-foot accessible aisle for accessible vans. Additionally there should be enough room to allow for

a 36-inch accessible path from the vehicle to the charging station. Some jurisdictions have indicated that they would prefer for the van accessible spaces to be 11-feet with a five-foot access aisle. This meets the overall width criteria, but allows for more room for the 36-inch path of travel.

- ▲ The 36-inch accessible route from the vehicles to the charging station and the adjacent access aisle must meet slope criteria as specified in the ANSI Standards (ANSI A117.1 - 403.3). Maximum of 1:20 running slope and 1:48 cross slope. Please refer to the regulations for guidance.

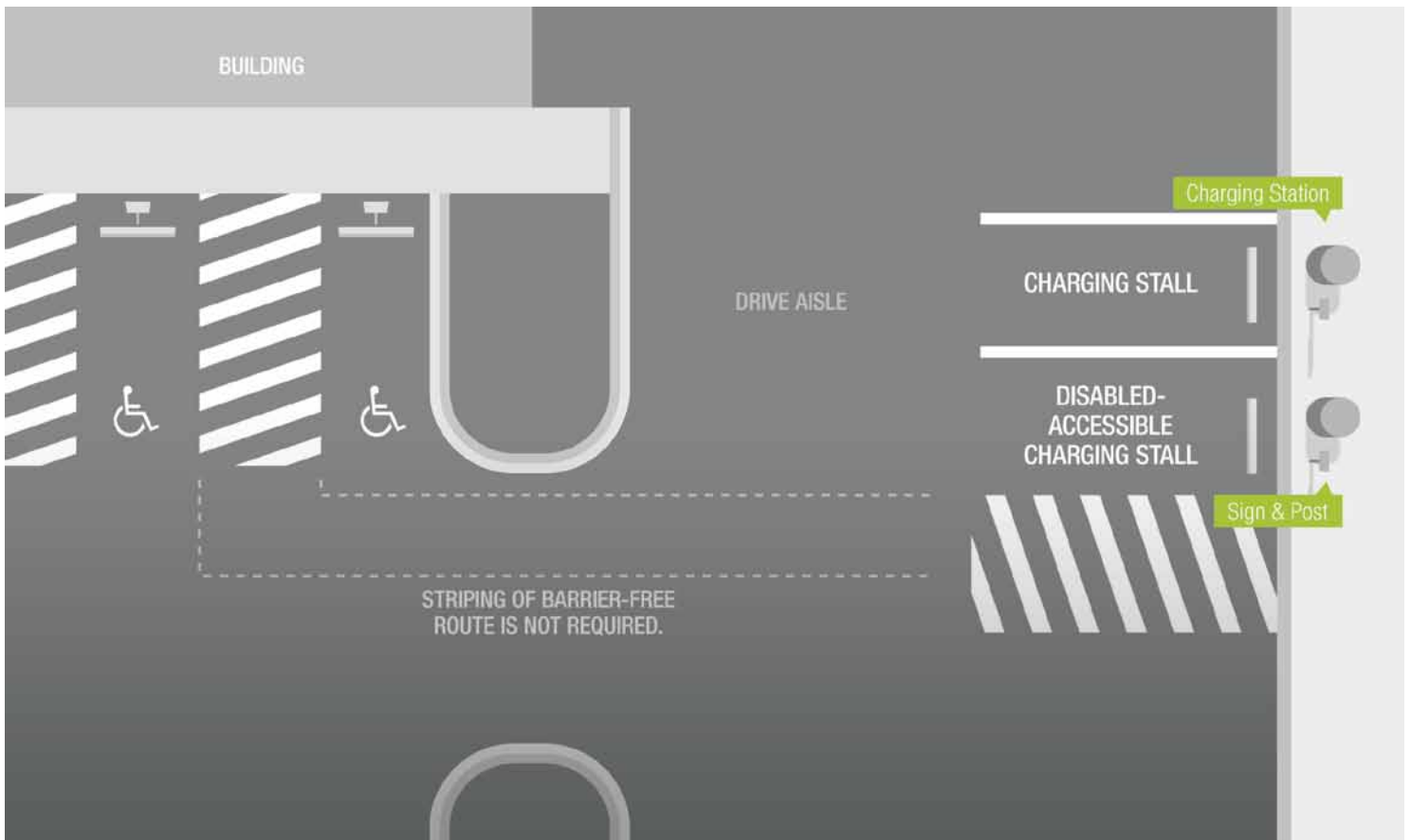
▲ Obstruction

As mentioned, there should be room to allow for a 36-inch accessible route from the vehicle to the charging station. This means that special attention should be paid to any features which may obstruct this path of travel.

- + **Wheel Stops** Ensure that all wheel stops are placed so that the disabled user can travel from the vehicle to the charging station.
- + **Bollards or other protection for the charging station** Bollard installation for charging station protection should not obstruct ADA accessibility.
- + **Cord Management** Install the charging station so that the cord will not be located in the path of travel for the disabled user.

Access Aisle

There are many variations in the recommendations for access aisles with charging stations. These range from installing a striped accessible aisle from the accessible charging stall to the entrance of the site's facility, to installing no access aisle at all. It appears the most common method used is the following: Accessible electric vehicle stalls should be located close to the building or facility entrance and should be connected to a barrier-free path of travel. It is not necessary to designate the path of travel as an accessible route as designated in ANSI 117.1.



INSTALLATION LOCATIONS



Single-Family Housing



Multi-Family Housing

Residential Garage

- ▲ Simple, most basic installation
- ▲ Level 1 or 2 charging
- ▲ Charging typically occurs early evening/overnight
- ▲ Limits exposure to the elements
- ▲ Prevents unwanted access

Carport/Driveway

- ▲ Increased exposure to the elements
- ▲ External cords present increased potential for trip hazards
- ▲ Requires greater ability to withstand weather and physical damage

On-Street Parking

- ▲ Parking location does not usually belong to the homeowner
- ▲ No means of ensuring necessary space will be available when needed
- ▲ Presence of sidewalk presents increased potential for trip hazards; possible reason for inspection failure from permitting entity
- ▲ Potential solutions of installing a curb-cut or a driveway require approval/permits from local municipality or permitting entity

- ▲ Similar to single-family housing in terms of time-of-day charging and general power requirements, but installation requirements may be more similar to parking lots and decks
- ▲ More difficulty in ability to reserve a space and utilize a circuit that can be directly tied to the vehicle owner, leading to a more often need for a new meter and/or communications
- ▲ Will likely need to involve the homeowners association (HOA)/property management.

Apartment Buildings

- ▲ Lack of property ownership on the part of the vehicle owner
- ▲ Charging infrastructure will need to be owned and maintained by the apartment building/ parking owner
- ▲ Limited potential to directly tie the charging station into an existing apartment electric circuit
- ▲ Building/parking owner will likely need a new utility meter to charge directly to the vehicle owner or may need to develop another means to recoup costs without charging for electricity

Condominiums and Townhomes

- ▲ Vehicle owner may have limited ownership of resources
- ▲ Parking spaces may be reserved for specific persons
- ▲ HOA or other organization typically involved and must approve installations
- ▲ Limited ability to utilize an existing meter or panel



Non-Residential

Mixed-Use

Mixed-Use locations are a combination of multi-family housing and retail parking. Unless parking is specifically designated, these parking locations should be treated as retail locations.

Workplace

- ▲ Second most common location for charging infrastructure
- ▲ Charging occurs during the day and may overlap with a utility's peak hours
- ▲ Can serve both fleet vehicles and company employees
- ▲ Typical usage duration is lower than residential charging, but greater than public or retail charging
- ▲ Potential for multiple vehicles to use the same charging station leads to greater probability that the station may require data collection and communication capabilities

Long-Term

- ▲ Parking in which vehicles are likely to be left for more than a day, such as airport and other multi-modal transit locations
- ▲ Due to duration of parking, this scenario will typically be best served with a Level 1 connection

Retail

- ▲ Organization offers charging to customers, rather than tenants or employees
- ▲ Charging will occur during the day and by multiple vehicles, which increases the need for charging control strategies and data collection
- ▲ Retailers offering charging to customers may seek reimbursement for the cost of providing the equipment and electricity
- ▲ NOTE: Reselling of power is illegal in most locations throughout the United States; however many retailers may look to find various means of recovering the cost of installation. If this were to occur, additional communications would be required along with a payment system.

Public

- ▲ Parking is provided by a municipality, other government organization or private company which is not seeking to sell any additional product or serve employee needs
- ▲ Many organizations may look to provide free charging to either encourage the adoption of plug-in vehicles or to provide an offering that will bring additional vehicles to a particular lot or deck. If not, organizations may require communications and data collection to assist with cost recovery to support the provision of charging.

INSTALLATION PREPARATION

When contacted regarding the installation of a charging station, planning is vital. Taking the time up front to gather specific information will allow for time savings over the course of the installation.

The following information provides a general overview of the installation process, and is broken down into three phases:

PHASE 1
PREP WORK

PHASE 2
ON-SITE EVALUATION

Please note the following series of checklists provides a simplified version of this process based on location.



PHASE 1 PREP WORK

After gathering initial information from the customer, it is important to suggest actions the customer can take in order to save time during the installation process.

Contacting the Utility

The customer should contact their local utility to inform them vehicle charging infrastructure will be installed at the site.

The customer should ask their utility the following questions:

- Are there any incentives or different rate structures that may save the customer cost in installation or ongoing electricity cost?
- What is the size of the electrical service to the site? The utility may be able to provide knowledge as to the likelihood of needing a service upgrade based on the existing service and the intended number of charging stations.

If there has been a determined need for a service upgrade or a new meter, an appointment should be made with a utility planner to visit the site. When possible, this should be coordinated with the contractor.

The customer may find it easier to allow the contractor to speak directly with the utility regarding the installation. If so, the customer will need to contact their utility and provide permission for the contractor to speak with the utility regarding the particular site.

Contacting the Local Permit Office

Different jurisdictions may have slightly different requirements or processes regarding the permitting, installation and inspection of charging stations. The contractor should contact the permitting office with jurisdiction over the installation site to identify specific requirements. Requirements of interest are listed below.

Concealment

While uncommon, certain municipalities may require charging stations are concealed with a hedge, fence or other object.

Engineering Calculations

Municipalities may require load calculations to be performed and/or stamped by a licensed engineer.

This can vary based on the location and number of charging stations to be installed.

If engineering calculations are required, the contractor should coordinate the assessment time with the visit of a utility planner (if deemed necessary), the initial contractor visit and the customer's schedule. If these cannot be coordinated, each visit should be encouraged to happen as quickly as possible and all information should be reported to the contractor.

PHASE 1 PREP WORK

Site Information

Address _____

An address must be available in order to obtain a permit in most areas. If an address does not exist for the parking area, the building address for the supporting parking site may be used in many areas. In some cases where a dedicated meter is installed, a new address may need to be applied for. The local permitting entity should be contacted for questions regarding addressing.

Identify as one of the following:

	SINGLE-FAMILY OR DUPLEX	MULTI-FAMILY	MIXED USE	RETAIL	WORKPLACE	PUBLIC
Garage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			
Driveway/Carport	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Parking Lot		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Parking Deck		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
On-Street	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does Customer have ownership of the site in which charging station(s) will be installed? YES NO

NO Does the customer have necessary approval to install charging station(s) at site? YES NO

YES The customer should have authorization form available upon site visit and/or be willing to sign forms claiming permission to install charging station(s) at the site.

NO The customer will need to obtain approval from site owner.

Intended Uses

In order to ensure proper technology selection and charging station placement, it is important to understand the intended use of the charging station(s). The intended use should be one or more of the following:

- Personal |
 Fleet |
 Employee |
 Customer |
 Visitor

Customer Decisions

The customer will make a number of decisions regarding the installation. All decisions should be reviewed to ensure requirements will be met and to avoid potential problems. Remaining decisions should be finalized following the initial on-site portion of this process.

Vehicle Type



Neighborhood Electric Vehicles have a maximum speed of 25 miles per hour and typically have different charging requirements than highway-capable vehicles.



Electric vehicles include plug-in hybrids and all-electric vehicles. Plug-in hybrids typically have smaller batteries than all-electric vehicles; however, infrastructure needs are typically the same.

Vehicle Make _____

Model _____

This information will allow for knowledge of the vehicle's power inlet location as well as any specific requirements or suggestions the vehicle manufacturer may have. The following items may be known or desired by the customer. It is important to note this difference.

Charging Station Make _____

Model _____

From this information, the contractor can determine important information regarding the charging station including the following:

Mounting Type



Vehicle Charging

Number of Vehicle Charging _____

Connectors per Charging Station _____

Communications Requirements

- Ethernet Cellular Wi-Fi
 None Other (specify) _____
-

NEMA Enclosure Type _____

Physical Dimensions

Height _____ Width _____ Depth _____

Base Dimensions (for bollard units): _____

Cord Length _____

**Ensure Charging Station meets necessary UL standards*

Number of charging stations to be installed:

It is important to understand whether this number refers to number of stations or the number of cord sets (which references the number of vehicles that can be served simultaneously).

Have specific parking spaces been selected?

- YES NO

Has a power source been selected?

- YES NO

YES Does the customer have ownership of the power source? YES NO

YES The customer must provide proof of approval and/ or be willing to sign documentation claiming necessary approval. This circumstance may result in the need for a separate utility billing meter.

NO Does the customer have approval to use the power source? YES NO

Approval must be gained prior to installation. Use of a power source without necessary approval is considered electricity theft and is illegal.

NO The contractor will need to aid in this decision during the on-site portion of this process.

PHASE 2 ON-SITE EVALUATION

Charging Station Selection Guidelines

Once the necessary information is gathered and appointments are coordinated, the contractor will visit the site. The first site visit will answer any additional questions and resolve any decisions yet to be made. The charging station selected will influence the site selection and vice versa. If the customer has selected both the charging station and the site in advance, it will be important to check the NEC is adhered to and potential problems are avoided.

Whether a charging station has already been selected or still needs to be selected, contractors should ensure the charging station meets the following guidelines:

The selected charging station:		✓ YES	✗ NO
1	Meets UL requirements and is listed by UL or another nationally recognized testing laboratory.	<input type="radio"/>	<input type="radio"/>
2	Has an appropriate NEMA rated enclosure (NEC 110.28) based on environment and customer needs, such as weatherization or greater levels of resistance to water and corrosive agents (see NEMA Enclosure Type Table, pg. 32).	<input type="radio"/>	<input type="radio"/>
3	Has been selected based on customer's vehicle (most vehicles require the maximum of a 240V / 32A circuit (40A breaker), though some vehicles may have different requirements.	<input type="radio"/>	<input type="radio"/>
4	Cord is less than 25' in length (NEC 625.17).	<input type="radio"/>	<input type="radio"/>
5	Cord length is determined to reach a vehicle's charging inlet without excessive slack.	<input type="radio"/>	<input type="radio"/>
6	Cord management methodologies have been considered to reduce the risk of tripping hazards and accidental damage to the connector.	<input type="radio"/>	<input type="radio"/>
	Mounting type selection has been based on requirements to meet site guidelines		
7	<ul style="list-style-type: none"> ▲ Bollard-mount works best in carports/driveways, parking lots and on-street parking locations. ▲ Wall-mount works best where a wall or pole exists or can be installed at reasonable cost and while maintaining site guidelines. ▲ Ceiling-mount works best in residential and parking garages or in any location where a sturdy overhead structure can be installed at low cost and within site guidelines. 	<input type="radio"/>	<input type="radio"/>
8	Communications are not required. Speak with customer and the local utility to determine whether communications are desired or may be beneficial to the customer.	<input type="radio"/>	<input type="radio"/>

CHARGING STATION INSTALLATION GUIDELINES

Number of Charging Stations

Number of charging stations should be defined as the total number of cord sets.
This must be determined before moving on to further steps in the evaluation process.

Surveying Charging Stations

Contractors are encouraged to use the following checklists for surveying charging station locations. Locations are site-specific and include:



Residential
Garage



Residential
Carport/Driveway



Parking Decks
and spaces



Parking Lots
and Spaces



On-Street Parking
and Spaces



SURVEYING CHARGING STATIONS: RESIDENTIAL GARAGE



1

Consider available space on floor, walls and ceiling.

- ▲ Ensure overhead doors do not conflict, along with other objects.
- ▲ Ensure installation does not conflict with vehicle ability to park in garage.

2

Note the location of the charging port on the expected vehicle.

3

Note whether the homeowner typically backs into the garage or pulls in head-first.

4

Compile steps two and three to determine where the charging port is likely to be when parked in a garage. Eliminate locations in a garage requiring a cord to be wrapped around or draped over the vehicle in order to reach the charging port.

5

Ensure remaining locations best meet guidelines for a residential garage as follows:

LIGHTING

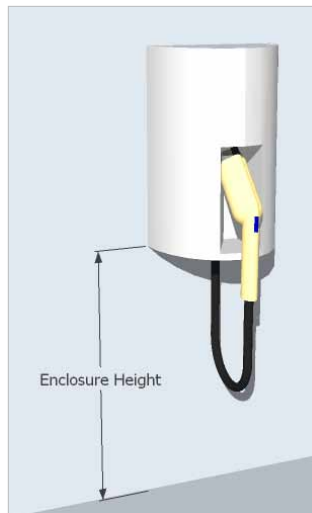
REQUIREMENTS Garages are required by the NEC to provide a switch-controlled lighting outlet (NEC 210.70).

RECOMMENDATION Ensure functionality of lighting in garage.

CONNECTOR HEIGHT

REQUIREMENTS Mount the connector at a height between 18" and 48" from the ground (NEC 625.29).

RECOMMENDATION Mount the station such that the connector is at a height between 36" and 48" from the ground, unless otherwise indicated by the manufacturer.



ENCLOSURE HEIGHT

REQUIREMENTS Per manufacturers' specifications.

RECOMMENDATION Install wall/pole-mount stations and enclosures at a height above 36". Greater heights are typically recommended, provided the connector can be mounted below 48".

SPACE AROUND ENCLOSURE

REQUIREMENTS Ensure sufficient space exists around electrical equipment for safe operation and maintenance (NEC 110.26).

RECOMMENDATION A

A space 30" wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3' from the front of the enclosure without physical obstruction, at a height of 6' 6".



TRIPPING HAZARD MITIGATION

REQUIREMENTS None

RECOMMENDATION Charging stations be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk. Charging stations should also be mounted in close proximity to the vehicle charge port.

PHYSICAL DAMAGE PREVENTION

REQUIREMENTS Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27)

PLACEMENT of the enclosure above 36" may be sufficient in a residential garage. When possible, placement of the charging station out of the line of vehicle travel is advised. If desired, a wheel stop or protective bollards may be installed as well.

6

If spaces are comparable, selection based on cost and/or ease of installation is advised.

If no locations meet criteria, consider locations not based on items #2 and #3 and discuss with customer.



SURVEYING CHARGING STATIONS: RESIDENTIAL CARPORT/DRIVEWAY



- 1** Consider available parking areas.
 - ▲ If a particular charging station has been selected, eliminate surfaces to which it cannot mount.
- 2** Note the location of the charging port on the expected vehicle.
 - ▲ If no vehicle has been selected, most vehicles are expected to have a charging port toward the front end of the vehicle.

- 3** Note whether the homeowner typically backs into the driveway or pulls in head first.
- 4** Compile steps two and three to determine where the charging port is likely to be when parked in a driveway or carport.
 - ▲ Eliminate locations in a garage requiring a cord to be wrapped around or draped over the vehicle in order to reach the charging port.

5

Ensure remaining locations best meet guidelines for a residential carport or driveway as follows:

LIGHTING

REQUIREMENT None

RECOMMENDATION Lighting should minimize the risk of tripping, vehicle impact and vandalism. Charging stations should be installed in a well-lit location. If no lighting exists, the installation of a separate lighting circuit should be discussed with the homeowner. A light level of a minimum of 2 foot candles is recommended.

CONNECTOR HEIGHT

REQUIREMENT Mount the station such that the connector is at a height between 24" and 48" from the ground (NEC 625.30(B)).

RECOMMENDATION Mount the connector at a height between 36" and 48" from the ground unless otherwise indicated by the manufacturer.

ENCLOSURE HEIGHT

REQUIREMENT Per manufacturers' specifications.

RECOMMENDATION For wall/ pole-mount stations, enclosure should be installed at a height above 36". Greater heights are typically recommended, provided the connector can be mounted below 48".

SPACE AROUND ENCLOSURE

REQUIREMENT Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26).

RECOMMENDATION A space of 30" wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3' from the front of the enclosure without physical obstruction, at a height of 6' 6".

TRIPPING HAZARD MITIGATION

REQUIREMENT None

RECOMMENDATION Charging stations should be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk. Charging stations should also be mounted in close proximity to the vehicle charge port.

PHYSICAL DAMAGE PREVENTION

REQUIREMENT Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).

RECOMMENDATION When possible, placement of the charging station out of the line of vehicle travel is advised. Protective bollards can offer significant protection. Wheel stops may be beneficial; however they may present a tripping hazard in poorly lit areas.

6

If spaces are comparable, selection based on cost and/or ease of installation is advised.

If no locations meet criteria, consider locations not based on items #2 and #3 and discuss with customer.



SURVEYING CHARGING STATIONS: PARKING DECKS AND SPACES

1

Select appropriate parking spaces based on the following criteria:

VISIBILITY

- ▲ Locations more visible to drivers and pedestrians are less likely to be vandalized.

PROXIMITY TO BUILDING ENTRANCE OR OTHER DESTINATION

- ▲ Particularly important in locations where vehicle charging is viewed as an incentive, such as retail locations and places of work.

PROXIMITY TO POWER SOURCE

- ▲ Typically an electrical closet, this translates to shorter run length and fewer barriers to avoid or bore through, saving cost.

LENGTH OF PARKING SPACES

- ▲ If there is a difference in length of parking spaces in a parking deck, longer spaces will allow for greater room to fit a charging station while maintaining usability and limiting the risk of vehicle impact.
- ▲ It is important that the installation of a charging station does not shorten parking spaces to below minimum local zoning requirements.

WIDTH OF PARKING SPACES

- ▲ Wider parking spaces decrease the risk of a cord set being damaged if it lies to the side of PEV, connected or otherwise.

LIGHTING

- ▲ A well-lit parking space translates to a lower risk of tripping and damage to the charging station from vehicle impact or vandalism.

ADA ACCESSIBILITY

- ▲ **REQUIREMENT** Not specified
- ▲ **RECOMMENDATION** For any parking deck with accessible parking, the first charging station is able to serve an accessible parking space and for every twenty-fifth additional charging station, another is placed to provide service to an accessible space.

WEATHER

- ▲ If possible, placement of charging station toward the interior of a parking deck can improve the life of a charging station and improve user perception of safety. Charging station enclosures should be selected to meet weather conditions.

2

Survey the charging station at the particular parking space(s)

CONSIDER AVAILABLE SPACE ON FLOOR, WALLS AND CEILING.

- ▲ If a charging station has been selected, only consider appropriate mounting surfaces.

ENSURE REMAINING LOCATIONS BEST MEET GUIDELINES FOR A PARKING DECK AS FOLLOWS:

LIGHTING

- ▲ Lighting in parking decks and lots is typically governed by a location's zoning codes.
- ▲ Ensure lighting is functional and discuss the addition of a separate lighting circuit if lighting levels are determined to be insufficient. Recommended light levels at the charging station are recommended to be five foot candles or higher.

CONNECTOR HEIGHT

- ▲ **REQUIREMENT** Connector will be mounted at a height between 24" and 48" from the ground (NEC 625.30(B)). Most parking decks, unless fully enclosed, are considered to be outdoor locations.
- ▲ **RECOMMENDATION** Connector should be mounted at a height between 36" and 48" from the ground.

ENCLOSURE HEIGHT

- ▲ **REQUIREMENT** Per manufacturers' specifications.
- ▲ **RECOMMENDATION** For wall/ pole-mount stations, the enclosure should be installed at a height above 36". Greater heights are typically recommended, provided the connector can be mounted below 48".

SPACE AROUND ENCLOSURE

- ▲ **REQUIREMENT** Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26).
- ▲ **RECOMMENDATION** A space 30" wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3' from the front of the enclosure without physical obstruction, at a height of 6' 6".

TRIPPING HAZARD MITIGATION

- ▲ **REQUIREMENT** None
- ▲ **RECOMMENDATION** Charging stations be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk.
- ▲ **RECOMMENDATION** Charging stations with multiple cords should be placed to avoid crossing other parking spaces.
- ▲ **RECOMMENDATION** Use informative signage to identify potential tripping hazards.

PHYSICAL DAMAGE PREVENTION

- ▲ **REQUIREMENT** Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).
- ▲ **RECOMMENDATION** When possible, placement of the charging station out of the line of vehicle travel is advised. Protective bollards can offer significant protection where there is sufficient space. Wheel stops may be beneficial; however they may present a tripping hazard in poorly lit areas.

ADA CONSIDERATIONS

- ▲ **REQUIREMENT** For ADA routes, a pathway must be maintained to a width of 36". Neither the charging station nor its cord may decrease the width of a pathway to below 36".



SURVEYING CHARGING STATIONS: PARKING LOTS AND SPACES

1

Select appropriate parking spaces based on the following criteria:

VISIBILITY

- ▲ Locations more visible to drivers and pedestrians are less likely to be vandalized.

PROXIMITY TO BUILDING ENTRANCE OR OTHER DESTINATION

- ▲ Particularly important in locations where vehicle charging is viewed as an incentive, such as retail locations and places of work.

PROXIMITY TO POWER SOURCE

- ▲ Selecting spaces close to an existing transformer or panel with sufficient electrical capacity will save cost.

AVOIDANCE OF EXISTING INFRASTRUCTURE AND LANDSCAPING

- ▲ Installing charging stations close to existing infrastructure or trees can cause damage which may result in higher costs, potential hazards and other undesirable outcomes.

LENGTH OF PARKING SPACES

- ▲ If there is a difference in length of parking spaces in a parking deck, longer parking spaces will allow for greater room to fit a charging station while maintaining usability and limiting the risk of vehicle impact. It is important the installation of a charging station does not shorten parking spaces to below minimum local zoning requirements.

WIDTH OF PARKING SPACES

- ▲ Wider parking spaces decrease the risk of a cord set being damaged if it lies to the side of PEV, connected or otherwise. Additionally, wider spaces

provided space for proper operation of the charging station and plugging the PEV in should the charge port be located in the side of the vehicle.

LIGHTING

- ▲ A well-lit parking space may reduce the risk of tripping and damage to the charging station from vehicle impact or vandalism. Additionally, it may aid in the operation of the charging station, including plugging the vehicle in.

ADA ACCESSIBILITY

- ▲ Although at the time this handbook was published, there are no official ADA requirements specifically for vehicle charging station, it is recommended that for any parking lot with accessible parking, the first charging station is able to serve an accessible parking space and for every twenty-fifth additional charging station, another is placed to provide service to an accessible space.

2

Survey the charging station at the particular parking space(s)

CONSIDER AVAILABLE SPACE ON FLOOR, WALLS AND CEILING.

- ▲ If a charging station mounting type has been selected, eliminate types of location that do not match (ie: ceiling-mount units may not work on walls).
- ▲ Ensure installation does not conflict with vehicle's ability to park within the space and to adequately use the charging station and plug in the vehicle.

PARKING LOTS CAN BE ASSUMED TO USE HEAD-IN PARKING FOR CONSISTENCY.

IF A CHARGING STATION HAS BEEN SELECTED, OR IF A PARTICULAR MODEL IS DESIRED, NOTE THE NUMBER OF CORD SETS PER CHARGING STATION.

- ▲ The charging station should be placed to provide direct access to each parking space without a cord being draped across another space and without blocking walking paths.

ENSURE REMAINING LOCATIONS BEST MEET GUIDELINES FOR A PARKING LOT AS FOLLOWS:

LIGHTING

- ▲ **REQUIREMENT** Lighting in parking lots is typically governed by local zoning codes. Review local codes to ensure compliance.
- ▲ **RECOMMENDATION** Ensure lighting is functional and discuss the addition of a separate lighting circuit if lighting levels are determined to be insufficient. Lighting levels are recommended to be two foot candles or higher.

CONNECTOR HEIGHT

- ▲ **REQUIREMENT** Connector will be mounted at a height between 24" and 48" from the ground (NEC 625.30(B)).
- ▲ **RECOMMENDATION** Connector should be mounted at a height between 36" and 48" from the ground.

ENCLOSURE HEIGHT

- ▲ **REQUIREMENTS** Per manufacturers' specifications.
- ▲ **RECOMMENDATION** For wall/pole-mount stations, the enclosure should be installed at a height above 36". Greater heights are typically recommended, provided the connector can be mounted below 48".

SPACE AROUND ENCLOSURE

REQUIREMENTS

- ▲ Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26).

- ▲ A space 30" wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3' from the front of the enclosure without physical obstruction, at a height of 6' 6".

TRIPPING HAZARD MITIGATION

- ▲ **REQUIREMENT** None
- ▲ **RECOMMENDATION** Charging stations should be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk.

PHYSICAL DAMAGE PREVENTION

- ▲ **REQUIREMENT** Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).
- ▲ **RECOMMENDATION** When possible, placement of the charging station out of the line of vehicle travel is advised. Protective bollards can offer significant protection where there is sufficient space. Wheel stops may be beneficial in areas where bollards are not feasible.

ADA CONSIDERATIONS

- ▲ For ADA routes, a pathway must be maintained to a width of 36". Neither the charging station nor its cord may decrease the width of a pathway to below 36".
- ▲ Charging stations should not be placed if a cord will drape across a pathway. The width of the pathway should be kept as great as possible in order to minimize liability.



SURVEYING CHARGING STATIONS: ON-STREET PARKING & SPACES



1

Select appropriate parking spaces based on the following criteria:

VISIBILITY

- ▲ Installations along streets with high foot and vehicle traffic, especially at night, are less likely to be vandalized.

PROXIMITY TO POWER SOURCE

- ▲ Selecting spaces close to an existing transformer or panel with sufficient electrical capacity will save cost.

AVOIDANCE OF EXISTING INFRASTRUCTURE AND LANDSCAPING

- ▲ Installing charging stations and conduit close to existing infrastructure or trees can cause damage which may result in higher costs and potential hazards.

LIGHTING

- ▲ A well-lit parking space may reduce the risk of tripping and damage to the charging station from vehicle impact or vandalism.

ADA ACCESSIBILITY

- ▲ At the time this handbook was published, there were no official ADA requirements for vehicle charging specifically, but it is recommended that installations at accessible spaces should be considered in public streets where accessible parking exists.

2

Survey the charging station at the particular parking space(s).

CONSIDER AVAILABLE MOUNTING SPACES

- ▲ Most on-street charging stations will be either floor-mount or pole-mount units.

FOR PULL-IN SPACES, CHARGING STATIONS SHOULD BE PLACED IN FRONT OF THE SPACE AND EITHER CENTERED ON THE SPACE OR PLACED BETWEEN TWO SPACES.

- ▲ Centered stations can serve one vehicle while stations placed between spaces can serve two vehicles. Charging stations with two connectors should be placed between spaces. Charging stations with more than two connectors should not be used in on-street locations.

FOR PARALLEL PARKING LOCATIONS, THE CHARGING STATION SHOULD BE INSTALLED AT THE FRONT THIRD OF A PARKED VEHICLE, BASED ON THE DIRECTION OF TRAFFIC FLOW.

- ▲ Charging stations with single connectors are typically recommended due to the lower potential trip hazard versus a station with multiple connectors.

ENSURE REMAINING LOCATIONS BEST MEET GUIDELINES FOR ON-STREET PARKING AS FOLLOWS:

LIGHTING

- ▲ Lighting on streets is typically governed by local zoning codes. Review local codes to ensure compliance.
- ▲ Ensure lighting is functional and discuss the addition of a separate lighting circuit if lighting levels are determined to be insufficient. Lighting levels are recommended to be two foot candles or higher.

CONNECTOR HEIGHT

- ▲ **REQUIREMENT** Connector will be mounted at a height between 24" and 48" from the ground (NEC 625. 30(B)).
- ▲ **RECOMMENDATION** Connector should be mounted at a height between 36" and 48" from the ground.

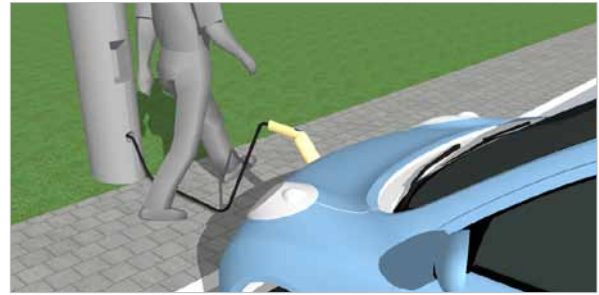
ENCLOSURE HEIGHT

- ▲ **REQUIREMENTS** Per manufacturers' specifications.
- ▲ **RECOMMENDATIONS** For wall/ pole-mount stations, it is advised the enclosure be installed at a height above 36". Greater heights are typically recommended, provided the connector can be mounted below 48".

SPACE AROUND ENCLOSURE

REQUIREMENTS

- ▲ Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26)
- ▲ A space 30" wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3' from the front of the enclosure without physical obstruction, at a height of 6' 6".



TRIPPING HAZARD MITIGATION

- ▲ **REQUIREMENTS** None
- ▲ **RECOMMENDATIONS** Charging stations should be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk.



PHYSICAL DAMAGE PREVENTION

- ▲ **REQUIREMENTS** Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).
- ▲ **RECOMMENDATIONS** Use protective bollards for on-street locations. Wheel stops may be beneficial in preventing vehicles from impacting the bollards.

ADA CONSIDERATIONS

- ▲ For ADA routes, a pathway must be maintained to a width of 36". Neither the charging station nor its cord may decrease the width of a pathway to below 36".
- ▲ Charging stations should not be placed if a cord will drape across a pathway. The width of the pathway should be kept as great as possible in order to minimize liability. A pathway width of more than 48" is highly recommended and greater widths are recommended when possible.

INSTALLATION PREPARATION

Following the initial site visit, the contractor should prepare for the installation phase of the process. Complete the following checklist:

- Price quote submitted to customer and approved.
Ensure total cost of installation including utility upgrades and all other work is understood by the customer.
 - Order equipment including selected charging station(s).
 - If determined to be necessary, Engineering calculations are performed and stamped.
Contact local permit department for questions regarding the need for load calculations.
 - Site plan modification complete with necessary diagrams.
Typically required for parking lots, decks and on-street parking
 - Service upgrade and/or new service assessment complete or unnecessary.
 - Permit application complete with site plan modification, load calculations and any other information deemed necessary by the local permitting department
- Permit is approved.
 - Scheduling (all necessary parties are contacted and scheduled)
 - Additional contractors
 - Boring
 - Concrete
 - Paving or Other Surface Restoration
 - Utility work
 - Utility marking
 - Service upgrade
 - New service
 - Meter pull
 - Utility marking of existing power lines, gas lines and other infrastructure should take place prior to installation. Utilize “Call Before You Dig” services.

INSTALLATION AND INSPECTION

Installation will vary based on type of site and number of stations to be installed; however, the processes will be similar.

1 Post permit at site in visible location

Excavation

- ▲ Excavation includes any removal of material for the purpose of running conduit and/or wiring as well as being able to install a charging station.
- ▲ Typical actions include removal of drywall, insulation, pavers and concrete or pavement, as well as hand digging, trenching, boring and drilling.
- ▲ **NOTE** In areas where existing infrastructure is in place (determined from utility marking), hand excavation is generally advised versus mechanical excavation.

3 Run Conduit from power source to station location

- ▲ Conduit should be run in most locations. Residential garages may allow for the use of nonmetallic-sheathed cable and do not require conduit to be run.
- ▲ For charging stations rated more than 60 amperes, a separate disconnect is required (NEC 625.23) and should be installed when running conduit. Some customers may desire a separate disconnect for stations rated below 60 amperes as well. A separate disconnect should be visible from the charging station.
- ▲ Note: Chapter 3 of the NEC addresses wiring methods and materials. Many options exist. Contractors are strongly advised to examine requirements for installation sites and types of wiring and conduit to be used.

LESSON LEARNED An interpretation of the NEC does not consider removable pavers to be sufficient in decreasing required depth of conduit.

4 Rough Inspection

- ▲ An initial electrical inspection should take place after conduit has been run and prior to connecting equipment and running wires.
- ▲ If the installation does not pass inspection, the contractor will need to correct any items discussed by the inspector and schedule a second rough inspection prior to moving on to the next step.
- ▲ **NOTE** For some installations, typically detached or semi-detached homes, this may be the only inspection required.

5 Pull Wires

- ▲ Charging equipment is considered to be a continuous load.
- ▲ Conductors should be sized to support 125 percent of the rated equipment load (NEC 625.21).

6 Prepare mounting surface per charging station manufacturer instruction

- ▲ Floor-mount: typically requires a concrete foundation allowing conductors to enter through the base of the charging station and appropriate installation of J-bolts based on station base plate.
- ▲ Wall/ Pole/ Ceiling-mount: brackets may be installed to allow for the mounting of the charging equipment.

7 Mount Charging station(s)

- ▲ Ensure equipment is level and mounted in accordance with manufacturer instructions

8

Install protective bollard(s) and/or wheel stop(s) if necessary

9

Install any electrical panels or sub-panels that may be necessary

10

Utility work performed

- ▲ Service upgrades, new service or and/ or new meter is installed. The utility may also pull a meter in order to allow for the charging station wires to be connected to a panel.

11

Make electrical connection

12

Perform Finish Work

- ▲ Replacement of drywall
- ▲ Burial of conduit and conductors
- ▲ Filled and compacted as necessary
- ▲ Replacement of walking surfaces
 - ▲ Concrete
 - ▲ Asphalt
 - ▲ Pavers

NOTE If any existing infrastructure has been damaged during excavation or installation, repairs should be made prior to finish work.



13

Final Inspection

- ▲ If required, the inspector will examine wiring, connections, mounting and finish work, and ensure the charging station is safe for operation in its given location

14

Performance Verification

- ▲ If possible, the contractor should verify the charging station functions properly



INSTALLATION PROCESS CHECKLIST

ACTION	PERSON RESPONSIBLE	<input type="checkbox"/>
1 Decision made/approval obtained to install charging station <ul style="list-style-type: none"> ▲ Single-Family home (excludes street parking) ▲ Multi-Family Home ▲ Individual Townhome/Condominium ▲ Apartment Complexes ▲ Workplace, Retail, Public Lots/Decks ▲ On-Street Parking, Residential Owner (obtaining permit and reserving parking space) ▲ On-Street Parking, Non-Residential 	Residential Owner Property Owner/HOA Owner (must gain approval for installation from HOA/similar group) Parking Owner Parking Owner Residential Owner Right of Way Owner	<input type="checkbox"/>
2 Charging level and number of charging stations determined	Owner	<input type="checkbox"/>
3 Charging station(s) selected	Owner	<input type="checkbox"/>
4 Parking space(s) selected	Owner	<input type="checkbox"/>
5 Power source selected	Owner/Utility	<input type="checkbox"/>
6 Installation estimate made	Contractor	<input type="checkbox"/>
7 Site plan created; Need for electrical upgrade determined	Contractor/Utility	<input type="checkbox"/>
8 Estimate approved/accepted	Owner/Contractor	<input type="checkbox"/>
9 Permit application filed	Contractor	<input type="checkbox"/>
10 Electrical upgrade completed, if required <ul style="list-style-type: none"> ▲ Panel upgrade/new panel ▲ Service upgrade/new service ▲ New meter 	Utility Contractor Utility Utility	<input type="checkbox"/>
11 Power restored	Utility	<input type="checkbox"/>
12 Installation	Contractor	<input type="checkbox"/>
13 Inspection	Inspector	<input type="checkbox"/>
14 Work completed/Performance verified	Contractor	<input type="checkbox"/>

ADDITIONAL CHECKLISTS

New Construction Installation

Self Check	✓ YES	✗ NO
1 Homeowner has purchased/is highly likely to purchase a PEV.	<input type="radio"/>	<input type="radio"/>
2 Homeowner has identified/purchased a charging station.	<input type="radio"/>	<input type="radio"/>
3 Homeowner has made appropriate arrangements with utility planner/provider.	<input type="radio"/>	<input type="radio"/>
4 Charging station is at appropriate charging level for building type.	<input type="radio"/>	<input type="radio"/>
5 Conduit and equipment have been properly sized for building type.	<input type="radio"/>	<input type="radio"/>
6 Conduit has been run to the optimal location for charging station use.	<input type="radio"/>	<input type="radio"/>
7 Type of enclosure being used has been verified/meets NEMA specifications.	<input type="radio"/>	<input type="radio"/>
8 Possible deteriorating agents such as dust, salt, pressurized water have been identified and considered before placement.	<input type="radio"/>	<input type="radio"/>
9 Electrical equipment has sufficient space in front of it to allow for maintenance/necessary access. (Space equal to the width of the charging station or 30 inches, whichever is greater, to a distance of three feet in front of charging station has been maintained).	<input type="radio"/>	<input type="radio"/>
10 Placement does not allow for vehicular damage.	<input type="radio"/>	<input type="radio"/>
11 Placement is in well-lit location.	<input type="radio"/>	<input type="radio"/>
12 Need for ventilation system has been determined.	<input type="radio"/>	<input type="radio"/>

GLOSSARY

Charging Station

Device that transfers power to a PEV while providing proper grounding, shock protection, overload protection and general communication.

Electric Vehicle Supply Equipment (EVSE)

The official term for electric vehicle charging infrastructure; more commonly referred to as charging stations.

J1772 Standard

Defines a common charging plug for PEV charging stations

Mounting Style

Refers to placement/location of charging stations such as: Bollard (Floor), Wall, Ceiling or Pole mount

NEC

National Electrical Code

NEMA

National Electrical Manufacturers Association

PEV

Plug-in Electric Vehicles

Power Supply Owner

Depends on location; can have a variety of owners ranging from the electric utility to the customer. Important to identify the owner of the power supply and develop an agreement that allows for the power supply to be used. Note: if the customer is not the parking and power supply owner, it will be important to gain approval from applicable groups, such as home owner associations, prior to any installation work.

UL Standards

Safety standards for charging electric vehicles developed by Underwriters Laboratories

Utility Contractor

Individual from utility that provides service upgrade, new service, new electric panel or new meter if/when needed

Utility Planner Verifies the need for a utility contractor to be brought in following the assessment of the electrical contractor. In any event, the electric utility should be notified of installations in order to ensure grid reliability.

APPENDIX A

NEMA ENCLOSURE TYPE

		Indoor Enclosures						Outdoor (Weatherproof) Enclosures									
		1	2	5	12	12K	13	3	3R	3S	3X	3RX	3SX	4	4X	6	6P
REQUIREMENTS	Sufficient for Indoor Applications	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Sufficient for Outdoor Applications							•	•	•	•	•	•	•	•	•	•
RECOMMENDATIONS	Dust Resistant			•	•	•	•	•		•	•		•	•	•	•	•
	Salt Resistant										•	•	•		•		•
	Pressurized Water Resistant													•	•	•	•
	Able to be Submersed															•	•
	Ice Resistant									•			•				

Notes

Naming convention is in reference to Table 110.20 in the National Electric Code (2008). See the most recent edition for any updates.

All NEMA enclosures are acceptable for permit and inspection with indoor applications. The determination of whether a location is considered 'indoors' is at the discretion of the inspector.

Outdoor enclosures provide weatherproofing capability. Such enclosures will pass inspection for the majority of outdoor applications, as well as indoor applications.

Dust resistance for indoor enclosures refers to settling dust while resistance for outdoor enclosures refers to windblown dust. Dust resistant enclosures are also considered 'raintight'.

Enclosures are resistant to corrosive agents including salt. This may be a consideration when installing charging stations in coastal areas and areas where roads are salted.

The resistance to pressurized water may be a consideration when charging stations are expected to be cleaned with a hose or power washer. Such enclosures are referred to as 'watertight'.

The ability to withstand submersion may be a consideration when installing charging infrastructure in a floodplain. NEMA 6P enclosures are resistant to prolonged submersion.

Ice resistant enclosures are able to operate while covered in ice. This may be a consideration for extreme instances in which ice covering is likely.

APPENDIX B

SPECIAL INSTALLATION CASE: HISTORICAL HOMES

The Regulation of Historic Homes

A historic property is an official building, structure, object, site or district worthy of preservation for its significance in American history, architecture, archaeology and culture. The National Register of Historic Places is a government agency that registers and lists the nation's historic properties. Its purpose is to ensure that properties significant in national, state and local history are considered in the planning of federal activities, and to encourage historic preservation at the state and local government level and within the private sector. The listing of a property in the National Register places no restrictions on what a private property owner using private resources can do to maintain or alter their property. Each state has a Historic Preservation Office and associated local historic preservation commissions that oversee historic preservation in the state and may have established local preservation laws that must be adhered to.

PEV Charging in Historic Homes and Areas in North Carolina

The North Carolina State Historic Preservation Office does not issue statewide laws or guidelines for historic areas. Local historic preservation commissions are responsible for the design review guidelines for historic landmarks or districts based on procedures and standards required by the enabling legislation.

At the writing of this report, no local commissions that were queried have guidelines or regulations specifically addressing PEV charging stations on historic properties. However, the expectation is that charging stations will be treated as any other “above-ground utility structure” installation, such as satellite dishes, HVAC equipment, electric panels, etc. A general guideline with such installations is that they should be installed so they are not visible from a public right-of-way or a surrounding yard. Often, they are located on a rear roof elevation or on the ground behind the building. Landscaping can also be used to conceal these structures.

Design review of a proposed charging station installation might be based on size, location and appearance of the charging station. Consideration would also be given to the installation of required power



lines. Power for the station would need to be carefully routed for the protection of large trees and other landscaping on the property.

In addition to aesthetic considerations, a concern for PEV charging in historic properties is the available electrical capacity. Supplying a 40 amp circuit for a PEV charging station might pose challenges for some homes and buildings if they haven't had an electrical service upgrade.

Overall, the queried local preservation commissions did not foresee charging station installation being a problem, but they acknowledged that each commission would have to review the installations on a case-by-case basis.

Resources

North Carolina State Historic Preservation Office

www.hpo.ncdcr.gov/default.htm

North Carolina Historic Preservation Commissions

A complete list of all historic preservation commissions in North Carolina

www.hpo.ncdcr.gov/commstaf.htm

Preservation North Carolina

A private non-profit membership organization that conducts preservation advocacy, education, and stewardship programs, as well as operates a fund for the sale of historic properties

www.presnc.org

RAMP UP YOUR KNOWLEDGE

There's more to successfully implementing electric transportation than just installing charging stations. In fact, communities and municipalities should be wary of installing free or low-cost systems without proper planning.

As adoption and integration of PEVs becomes more mainstream, there is a need to review, analyze, test and evaluate available charging stations. Additionally, communities will need to have a clear understanding of each vendor's offerings in order to determine the best solution for each site. Education and outreach efforts are integral components. From workshops, training and webinars to web-based tools and best practices guides, Advanced Energy continues to drive the future of electric transportation.

Equipment Evaluation

Advanced Energy's interactive, web-based tool – Charging Station Technology Review for Plug-in Electric Vehicles – compares charging stations from various vendors across the United States. A result of an ongoing comprehensive review of technical information submitted by commercial vendors, service providers and other interested parties on EVSE, this online tool includes an overview of:

- ▲ Charging equipment and related systems/services
- ▲ Use of "smart charging" concepts
- ▲ Projected maintenance/repair schedules and costs
- ▲ Anticipated charging station billing models/systems

Learn more at <http://www.advancedenergy.org/transportation/evse/>.



Prepare for the Road Ahead

Preparation for electric vehicles begins with a good plan. It may be tempting to jump forward with implementation, but experience in rollout cities across North Carolina has shown the benefits of taking the time to assemble a planning team, educating the planning team on PEVs, and defining short- and long-term goals.

It's not a question of if PEVs are adopted into mainstream culture – it's knowing that your local government, public utilities, permitting offices, electricians and code inspectors and other key stakeholders will be ready to support the demand as it occurs. We can help!

From stakeholder development and decision support to on-site assessments, performance evaluations and codes and standards guidance, our unique model allows us to guide you remotely – providing the technical knowledge to keep you on track and moving forward.

Advanced Energy's "Train-the-Trainer" approach builds your local training capacity, providing you with the ongoing capability to educate staff and new hires. Through classroom style and hands-on workshops, we work with communities to initially educate trainers on performing the critical details needed for successful completion of the tasks mentioned throughout this handbook. Additionally, our courses can also be customized to fit your specific needs.

Proper planning defines critical requirements, eliminates unnecessary work, streamlines necessary work and avoids implementation problems. Collaborative input from business, industry, government and academia will greatly contribute to efforts and viability. Advanced Energy also offers a Community Planning Guide to Electric Transportation to help communities:

- ▲ Identify opportunities
- ▲ Educate consumers
- ▲ Establish a sound infrastructure
- ▲ Develop relationships
- ▲ Explore opportunities for economic development

WHY ADVANCED ENERGY?

The electric transportation experts at Advanced Energy know handing a community a list of recommendations does not solve all of the challenges that must be overcome to move electric transportation forward; however, we help define ways to accomplish tasks smarter. We get excited about solving problems that no one else has solved, and we embrace new ideas and new ways of thinking. Our passion is to stimulate communities, utility partners and consumers with innovative technologies and ideas, to offer solutions, and to bring transformation and viability to the marketplace, enriching the lives of many.

Advanced Energy's Electric Transportation sector is working to assist communities in understanding, planning and implementing electric transportation initiatives. An established figure in the development and deployment of plug-in electric vehicle technologies, Advanced Energy has worked with our utility partners since 1991 to understand the potential of electric transportation through the conversion of several vehicles to all electric. We shifted our focus in 2001 from all electric vehicles to plug-in hybrids with the creation of the Plug-In Hybrid Electric School Bus Program. In 2003 we issued a comprehensive study showing the potential energy and emissions benefits of creating plug-in hybrid school buses. Through partnerships developed by Advanced Energy, we successfully facilitated the creation of the world's first commercially available plug-in hybrid vehicle through this program in 2007.

Advanced Energy also works with municipalities, electric utilities and National Laboratories monitoring and evaluating the performance of numerous fleets of plug-in hybrid vehicles across the country. Advanced Energy currently manages the NC Get Ready program to accelerate the adoption of electrified transportation in North Carolina – one of the key initiatives in the nation making a true commitment to the widespread acceptance of electrified transportation. NC Get Ready is supported by a consortium of cities, government officials, industry leaders and not-for-profit organizations. The electric utilities Progress Energy and Duke Energy are also key supporters of this initiative. Today we continue to advance electric transportation through associations, supply-chain consulting, applied research, and decision support. For more information, visit www.AdvancedEnergy.org.



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