

# RESIDENTIAL CHARGING STATION INSTALLATION HANDBOOK

for Single-Family  
Homeowners and Renters

Version 4.0



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This handbook was made possible through the support of Duke Energy, the North Carolina Electric Membership Corporation, Dominion Energy and Plug-in NC.

# DRIVING THE FUTURE OF TRANSPORTATION

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Advanced Energy is working to assist utilities, charging station vendors, municipalities and all stakeholders in understanding, planning for 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



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Our day-to-day means of transportation is changing, and the more communities and consumers know about Plug-in Electric Vehicles (PEVs), the more prepared they will be to embrace them. This handbook has been developed to assist in assessing your options for vehicle charging at a multifamily home.

For more than 10 years, Advanced Energy has been collaborating with stakeholders across the United States on PEV technologies and initiatives. We share our expertise with you to simplify the integration of electric transportation into your community.

Advanced Energy works with North Carolina Stakeholders to promote PEV readiness through Plug-in NC.

To learn more, please visit [www.advancedenergy.org](http://www.advancedenergy.org) and [www.pluginnc.com](http://www.pluginnc.com).

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# SINGLE FAMILY HOUSING

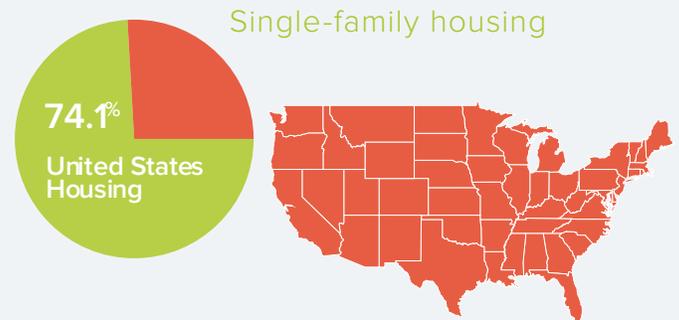
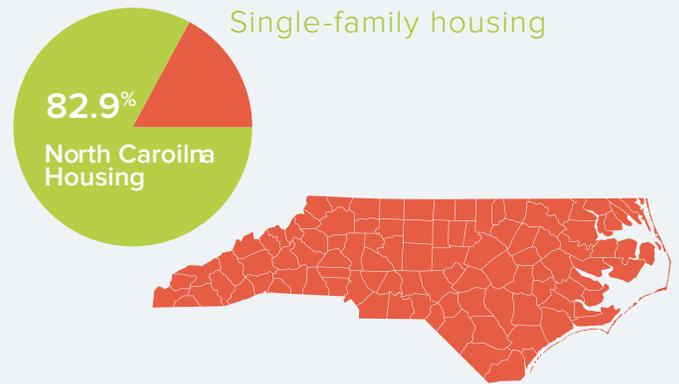
The type of residence you call home may influence your ability to install on-site vehicle charging equipment. Some residence types pose unique challenges for a PEV owner, such as shared parking scenarios or a third-party approval process, which may be addressed by considering alternative charging scenarios. This document covers considerations for charging station installations at single-family and homes.

## Single Family



A single-family home is a building occupied by just one household or family, and consists of just one dwelling unit or suite. Most single family homes are free-standing and do not share property with any other house or dwelling.

## U.S Housing Market

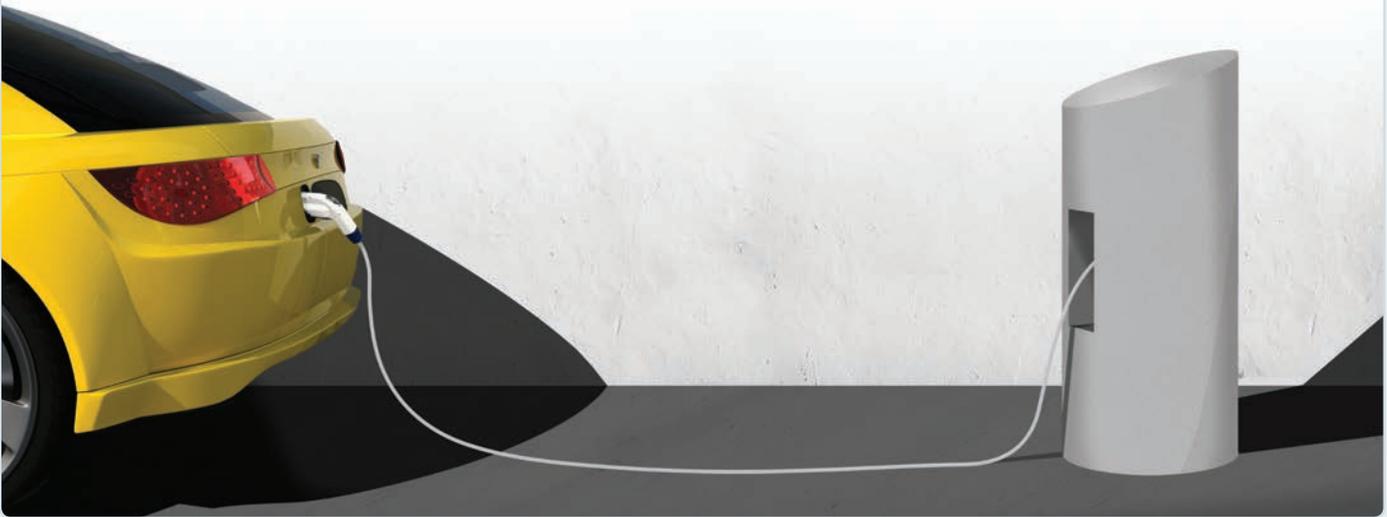




# PLUG-IN ELECTRIC VEHICLES 101

## VEHICLE TYPES

Any vehicle using electricity as either its primary fuel, or in collaboration with a conventional engine to help improve its efficiency, can be referred to as an electric drive vehicle. With any evolving technology, there are variations. As such, electric drive vehicles can generally be classified into two categories, Hybrid Electric Vehicles and Plug-In Electric Vehicles.



### Hybrid Electric Vehicles (HEVs)

A highway-capable vehicle utilizing liquid fuels (such as gasoline) to generate energy, but incorporating an energy storage system (such as a battery) to capture excess electricity and energy from external sources, which in turn increases the overall efficiency of the vehicle (reducing fuel consumption and emissions). This type of vehicle cannot be plugged into an electricity source in order to charge the battery. Instead, it charges the battery by using a combination of regenerative braking and power from the internal combustion engine (ICE). HEVs can be classified as either mild hybrids or full hybrids.

- + **MILD HYBRIDS** have an electric motor that allows the engine to be turned off when the vehicle is coasting, braking or idling. The electric motor assists the engine when extra power is needed, but cannot propel the vehicle on its own.
- + **FULL HYBRIDS** have the ability to power the vehicle using only the engine, only the electric motor, or a combination of both. The Toyota Prius is an example of a full hybrid.

Toyota Prius





# PLUG-IN ELECTRIC VEHICLES 101

## PLUG-IN Electric Vehicles (PEVs)

A PEV is a vehicle that plugs into the electric power grid to receive energy for propulsion, they include:

### + **PLUG-IN HYBRID ELECTRIC VEHICLES (PHEVs)**

- ▲ Similar to hybrid electric vehicles
- ▲ Includes additional battery capacity that recharges from the electric power grid
- ▲ Additional energy storage capacity allows the vehicle to drive using only electricity for 10 to 60 miles (depending on the vehicle's battery size)
- ▲ Can be Parallel or Series

#### **PARALLEL PHEVs**

- + Uses both ICE and/or an electric motor for propulsion
- + ICE can also act as a generator to recharge the batteries
- + Batteries can also be recharged through regenerative braking or by accessing the electrical grid
- + Have an essentially unlimited range due to the presence of the ICE

#### **SERIES PHEVs**

#### **ALSO KNOWN AS EXTENDED RANGE ELECTRIC VEHICLES (EREVs):**

- + Uses an electric motor for propulsion
- + Also utilizes an ICE to run a generator that recharges the vehicle's batteries
- + Batteries can also be recharged through regenerative braking or by accessing the electrical grid
- + Have an essentially unlimited range due to the presence of ICE

### + **BATTERY-ELECTRIC VEHICLES (BEVs):**

- ▲ Any vehicle driven solely by an electric motor and has no internal combustion engine
- ▲ BEVs typically have much larger batteries than PHEVs since all energy for propulsion must come from the battery

### + **NEIGHBORHOOD ELECTRIC VEHICLES (NEVs):**

- ▲ Includes any four-wheeled all-electric vehicle that is limited to a top speed of 25 miles per hour (mph)
- ▲ Typically lightweight
- ▲ Utilizes a small electric motor and battery pack
- ▲ Obtains a typical range of 20 to 50 miles; most states only allow NEVs on roads with speed limits of 35 to 45 mph or less
- ▲ Typically less expensive to produce than highway-capable vehicles
- ▲ Most commonly used as fleet vehicles for maintenance, security, etc. They are also often used at universities, retirement communities, or other large campuses/facilities



All-Electric Nissan LEAF



# CHARGING 101

## Charging Stations

Charging stations are the point of power for electric vehicles, ranging in style and charging levels. 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.

### Charging Levels

There are several levels of charging, offering a range in charge time and infrastructure simplicity:

Charging Level	Voltage & Current	Charging Time (Average)*	Equipment
AC Level 1	120 VAC, 16 amps	8-10 hours for a full charge	Manufacturer-provided cord with standard J1772 connector (requires a dedicated outlet)
AC Level 2	208 or 240 VAC, up to 80 amps	2-3 hours for a full charge	Level 2 hardware sold separate from car, with standard J1772 connector
DC Fast Charge (aka DC Level 2 by SAE definition)	200-500 VDC 200 amps	20 minutes for an 80% charge	Separate equipment with SAE combo connector and/or Japanese CHAdeMO connector

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

\*\*Tesla has its own version of DC Fast Charge and AC Level 2.

Because Level 1 charging does not require the installation of special charging equipment and the equipment is supplied with the vehicle, it is widely regarded as the simplest and most easily accessible charging method for drivers. However, for EV drivers, due to the lengthy charge time, most charging stations are expected to be Level 2. AC Level 1 is appropriate for PHEVs with smaller batteries such as the plug-in Prius.

Because of their high-speed charging capability, DC Fast Chargers will primarily be commercial-grade charging, with potential applications at highway rest stops, fueling stations, fleet bases, commercial parking lots, and car dealers.

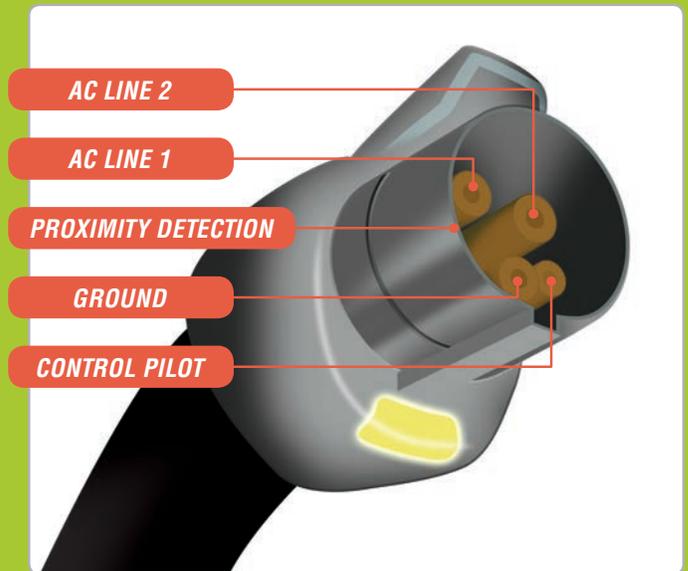


# CHARGING 101

## Codes and 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. These standards will ensure all charging stations and PEVs have a common charging plug and receptacle, meaning any charging station will be able to plug into any PEV. The two main standards are SAE J1772 and SAE J2293, which reference other SAE, Underwriters Laboratories (UL) and National Electrical Code (NEC) standards or codes. The purpose of the two main SAE standards is to minimize costs and maximize simplicity for PEV owners.

SAE J2293-1 and J2293-2 are considered “umbrella documents” by reference of other SAE documents related to electric vehicles. Their scope includes the process of the charging stations establishing communication with the PEV, exchanging data and allowing the charging stations to transfer electricity through the cord to the PEV.



SAE J1772 Type Connector – for AC L1 and L2

SAE 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 coupler
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

More information concerning SAE, UL and NEC Standards can be found in the Applicable Codes & Standards section of Advanced Energy’s Charging Station Installation Handbook [www.pluginnc.com](http://www.pluginnc.com).



# CHARGING 101

## AC Level 2 Equipment Styles

Types of charging stations will differ based on site-specific requirements. The differences between models are primarily related to durability, weatherization, data logging functionality, remote communications capability and payment systems. Most charging stations in residential locations are likely to be Level 2. Currently, there are three primary mounting styles for charging stations:

### + **FLOOR-MOUNT (BOLLARD-STYLE)**

- ▲ Unit is mounted to the ground and wired through the base
- ▲ Typically requires concrete work
- ▲ Typically have largest footprint

### + **WALL/POLE-MOUNT**

- ▲ Unit is mounted to a wall or pole, as applicable
- ▲ Able to be mounted to and wired through garage wall
- ▲ Flexible placement options
- ▲ Takes up less space than floor-mount

### + **CEILING-MOUNT**

- ▲ Mounted to and wired through ceiling
- ▲ Minimizes trip hazard and vehicle impact risk
- ▲ Physical space must exist and not be obstructed by overhead garage door
- ▲ May require space on wall to store the J1772 plug

**NOTE** Floor-style units are the least desirable for garage installations and should typically be avoided in such scenarios. Wall/pole-mount stations and ceiling-mount stations will typically work well provided that sufficient space exists for mounting.



# CHARGING CYCLE

While workplace and public charging stations are necessary for PEV owners to overcome concerns about where and when they may be able to charge, residential (or home) charging is likely to make up the majority of charging scenarios for PEV owners. Additionally, overnight charging may allow you to take advantage of off-peak electrical rates, if they are offered by your utility provider.

Data from the EVProject indicates that 74 percent of Nissan LEAF and 80 percent of Chevy VOLT recorded charging events occurred at residential charging locations and 97 percent of electricity consumed for vehicle charging was from residential charging locations<sup>1</sup>.



a PEV driver, will likely charge their vehicle overnight at home using Level 1 or Level 2 charging. Charging at home provides PEV drivers with the stability and security of reliable and accessible charging.

<sup>1</sup> EV Project Q2 2013 Report, Ecotality North America.

# WHY DRIVE ELECTRIC?



## ***Cost Savings***

- ▲ If you drove 12,000 miles in a year, an all-electric vehicle could save you over \$1,300 a year in fuel savings alone!



## ***Environmental Improvements***

- ▲ Plug-in electric vehicles do not produce vehicle emissions while in all-electric mode, and they are cleaner even when the emission from the generation of electricity is considered. In cases where electricity is generated with renewable, hydro or nuclear resources, electric vehicles are truly emission and pollution free.



## ***Energy Independence***

- ▲ Plug-in electric vehicles are fueled with locally-generated electricity, not imported oil. Conventional transportation is wholly dependent on petroleum and results in the U.S. spending over \$1 billion per day on foreign oil. Electricity generation in the United States uses a diverse mix of domestic sources, and only one percent comes from oil.



## ***Economic Development***

- ▲ As the demand for electric vehicles increase, more opportunities will be created for research and development, manufacturing, electrical contracting and green tourism. In North Carolina, there has been an increase in battery and charging equipment manufacturing, lithium mining and battery recycling.



## ***Power Sustainability***

- ▲ Plug-in electric vehicles can help encourage sustainability through renewable fuels, grid reliability and power outage response. They support greater integration of renewable generation, help manage peak loads, optimize energy efficiency, and enable future potential for vehicle-to-grid energy storage and power supply.

# RESIDENTIAL INSTALLATIONS

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

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

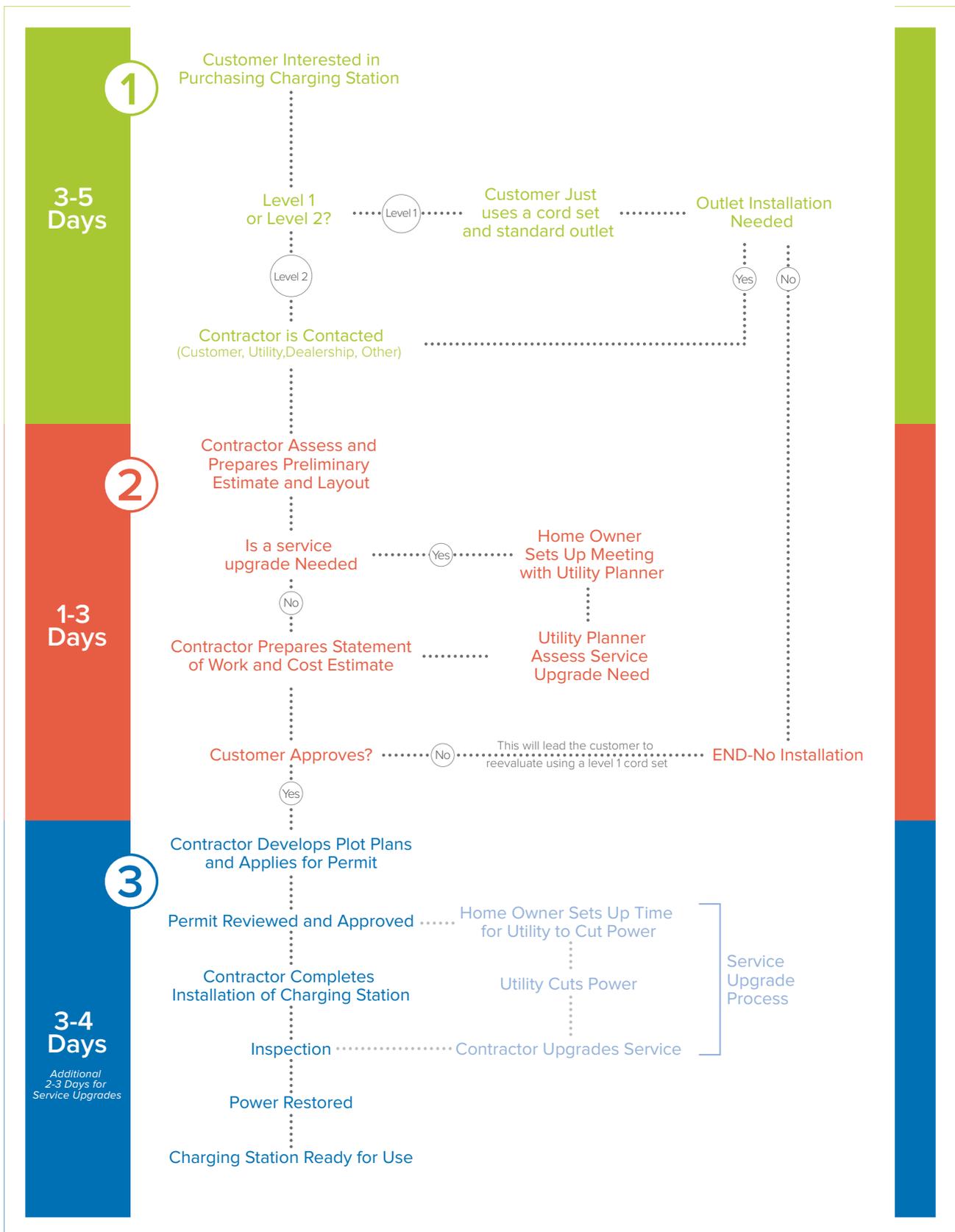
STEP 1: ASSESS CHARGING OPTIONS

STEP 2: EVALUATE EQUIPMENT

STEP 3: PREPARE FOR INSTALL



# RESIDENTIAL INSTALLATION: PROCESS OVERVIEW



# STEP 1: ASSESSING YOUR CHARGING OPTIONS

The first step in assessing your charging options will be to determine your current or planned parking scenario. The intended use, such as daytime or night-time charging, should also be considered when determining a vehicle-parking and charging location. Parking scenarios may vary greatly, from private garages, carports, and driveways to on-street parking.

Each parking scenario has unique features and issues to be addressed when considering vehicle charging. For example, outdoor parking will require weather resistant equipment and unrestricted spaces will need to address public safety.

Typical residential parking scenarios can be characterized as:



Residential  
Garage



Residential  
Carport/Driveway



On-Street Parking

# PARKING LOCATIONS



## Residential Garage

- ▲ Simple, most basic installation
- ▲ AC Level 1 or Level 2 charging
- ▲ Time-of-day 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
- ▲ Historical home considerations may need to be addressed (See Appendix A)



## 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
- ▲ Installations of charging stations in a road Right of Way (ROW) may require an Encroachment Agreement from the owner or property entity. (See Appendix C)



# 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 driver 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.



# 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 driver 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 that require a cord to be wrapped around or draped over the vehicle in order to reach the charging port.



# ON-STREET PARKING



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

- ▲ See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the end of this handbook.

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.

# STEP 2: EQUIPMENT SELECTION

Charging stations are the source of power for PEVs and range in style, charging speed, cost and installation complexity. In order to ensure proper technology selection and charging station placement, it is important to understand the intended use of the charging station(s).

## AC Level 1 Charging

Level 1 charging requires no additional equipment installation for vehicle charging. A charging adapter is generally supplied by the vehicle manufacturer and comes with a user manual with operating instructions.

### Best practices for using the Level 1 charging adapter are:

**Cord Safety:** Ensure sufficient space around electrical equipment for safe operation. Charging cords should be used and stored in such a way as to minimize the obstruction of typical walking paths. Mounting a wall peg or hook near the electrical power source may aid safe storage and cord management.

**Lighting:** A well-lit parking area can reduce tripping hazards and aid operation of the vehicle charging equipment (e.g. plugging into the vehicle port). Adequate lighting can also reduce risks of vandalism.

**Weatherization:** Weatherization should be considered when using any outdoor power source. Indoor and outdoor outlets vary in performance requirements and types of materials used. A watertight outside outlet cover allows the outlet to stay covered even when in use (e.g. with a cord plugged in). The National Electrical Code also requires the use of ground fault circuit interrupter (GFCI) outlets in outdoor settings. A GFCI outlet trips itself off when it senses a current leakage or a short circuit.

**Electrical Safety:** Follow the manufacturer's operating instruction for use of all charging equipment. A dedicated AC 120 volt electrical circuit and outlet are recommended for battery charging. If the circuit is shared, and another electrical device is being used at the same time the vehicle is being charged, the breaker may trip or other hazards may occur. Consult a professional electrician to evaluate your electrical system's integrity and safety and/or to install a dedicated circuit if one is not already available.

**Cord Security:** Most Level 1 charging cords have a place at the bottom of the connector handle to insert a small lock (such as a luggage lock). Lock the handle while charging to prevent removal of the charging cord from your vehicle and safeguard your equipment from theft.



# STEP 2: EQUIPMENT SELECTION

## AC Level 2 Charging

Level 2 charging offers a faster vehicle charging option than Level 1. For Level 2 charging, there are a variety of stations available that can suit your needs depending on your parking structure and situation. The table below summarizes the most common charging station types.

Some level 2 charging units come a cord-and-plug model (removable units that plug into a standard 208/240 volt outlet) and a hard-wired model (units that are wired directly to your home's electrical system). Modular models are easier to install as they can be plugged directly into to a standard

Parking / Mount Type	Wall-Mounted	Ceiling-Mounted	Pedestal-Mounted
Garage	X	X	
Car Ports/Driveway	X		X
On-street			X

208/240 volt outlet, which are typical of your larger home appliances, such as a clothes dryer. It is recommended that you have your electrical wiring inspected for safety and integrity prior to adding additional loads to your home. In some situations, a service panel upgrade may also be required.

Best practices for using Level 2 charging stations are:

**Cord Safety:** Ensure sufficient space around electrical equipment for safe operation. Charging cords should be used and stored in such a way as to minimize the obstruction of typical walking paths.

**Lighting:** A well-lit parking area can reduce tripping hazards and aid operation of the vehicle charging equipment (e.g. plugging into the vehicle port). Adequate lighting can also reduce risks of vandalism.

**Weatherization:** Weatherization should be considered when using any outdoor power source. The National Electrical Code also requires the use of ground fault circuit interrupter (GFCI) outlets in outdoor settings. A GFCI outlet trips itself off when it senses a current leakage or a short circuit.

**Electrical Safety:** Follow the manufacturer's operating instruction for installation and use of all charging equipment. A dedicated AC 240 volt/40 amp electrical circuit and outlet are recommended for Level 2 charging. If the circuit is shared, and another electrical device is being used at the same time the vehicle is being charged, the breaker may trip or other hazards may occur. Consult a professional electrician to evaluate your electrical system's integrity and safety and/or to install a dedicated circuit if one is not already available.

**Cord Security:** Most Level 2 charging cords have a place at the bottom of the connector handle to insert a small lock (such as a luggage lock). Lock the handle while charging to prevent removal of the charging cord from your vehicle and safeguard your equipment from theft.

**Circuit Re-Closure:** Some models of Level 2 charging stations do not automatically reset in the event of a power interruption or circuit trip, sometimes referred to as cold load pickup. In these events, if your charging station does not have automatic circuit re-closure, the charging session will be terminated and will NOT be automatically restored when the power supply returns to normal. Automatic circuit re-closure is important if you have an all-electric vehicle as your primary source of transportation, as early termination of a charging session may result in significant travel delays.

# COST TO CHARGE YOUR PEV

Charging your battery is much cheaper than fueling a gasoline car. For example, if you were to drive the U.S.-average of 40 miles or less per day (nearly 15,000 per year) at an average electricity cost of \$0.10 a kWh, your typical daily charging cost would be \$1.15, or approximately \$34 per month. Comparing that to a gasoline car with 30 miles per gallon (mpg) paying \$3.50 per gallon of gas, the typical daily fuel cost would be \$4.65, or approximately \$140 per month. Also, all new PEVs offer a timer that allows you to set the charge time for off-peak hours to ensure that you pay the cheapest rate for electricity if they are available in your area.

Expected monthly fuel costs (assuming 40 miles traveled per day):

<b>Gasoline Car</b>	Price per Gallon			
Miles per gallon	\$3.00	\$3.50	\$4.00	\$4.50
20	\$180	\$210	\$240	\$270
25	\$144	\$168	\$192	\$216
30	\$120	\$140	\$160	\$180
35	\$103	\$120	\$137	\$154
40	\$90	\$105	\$120	\$135

<b>Electric Car</b>	Price per kWh			
Miles per kWh	\$0.05	\$0.10	\$0.15	\$0.20
3	\$20	\$40	\$60	\$80
3.5	\$17	\$34	\$51	\$69
4	\$15	\$30	\$45	\$60

## Electric Utility Rate Plans for EVs:

Many electric utilities offer special off-peak charging rate discounts for PEVs and provide guidance on getting your home ready to charge. Typically you will have the option of moving toward a special time-of-use rate for your whole house that will include your PEV, or you can choose to install a second meter just for your PEV use. Some utilities are also considering incentives such as rebates to off-set the cost of installing a charger at your home. There are several utilities that have special PEV programs and tools for calculating vehicle operating costs. Be sure to contact your local utility to find out what they offer.

# STEP 3: INSTALLATION

## Use of Existing Outlets

1

Confirm electrical capacity and safety.

- ▲ The electrical system requirements for your specific equipment will be listed in the manufacturer's specification documents. If you are unsure of how to confirm the available electrical capacity and safety of your system, contact a certified electrical contractor for inspection prior to installation.

2

Contact your utility.

- ▲ Customers 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:
  - ▲ 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.)
  - ▲ Are there any incentives or rate structures that can save me money on the cost of installation or going-forward electricity costs?
- ▲ 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 an electrical 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.

3

Purchase outlet-compatible equipment (as needed).

4

Install equipment.

- ▲ Equipment should be installed according to manufacturer's specifications.

5

Charge vehicle.



# ELECTRICAL WORK 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

### 2 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 stations require two hot lines, a neutral and a ground. 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 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.
- ▲ Provide copy of inspection documents for their records.

14

#### Performance verification

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



# ELECTRICAL UPGRADES AND HARD-WIRE INSTALLATIONS

## 1 Contact your utility.

- ▲ Consumers 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:
  - ▲ 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.)
  - ▲ Are there any incentives or rate structures that can save me money on the cost of installation or going-forward electricity costs?
  - ▲ 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 an electrical 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.

## 2 Consult Electrical Contractor or Equipment Installer.

- ▲ The contractor will be responsible for meeting the applicable code requirement and obtaining the necessary permitting approvals. Specific tasks of the contractor may include:
  - ▲ 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 to be concealed with a hedge, fence or other object. It important to make sure that the concealment does not interfere with the proper operation of the charge station. Requirements of interest are listed below.

### ▲ 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.

## 3 Purchase equipment (as needed).

## 4 Install equipment.

- ▲ Equipment should be installed according to manufacturer's specifications.

## 5 Charge vehicle.

# INSTALLATION PROCESS CHECKLIST

ACTION	PERSON RESPONSIBLE	<input type="checkbox"/>
1 Decision made/approval obtained to install charging station ▲ On-Street Parking, Residential Owner (obtaining permit and reserving parking space)	Residential Owner <i>*recommend written approval</i> Property Owner/HOA Owner (must gain approval for installation from HOA/similar group)*	<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 ▲ 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"/>

(provide copy of inspection report to customer)

# APPENDIX A: 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](http://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](http://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](http://www.presnc.org)

# APPENDIX B: ARCHITECTURAL IMPROVEMENT REQUEST FORM (SAMPLE)

To:

Name of Applicant \_\_\_\_\_

Address \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

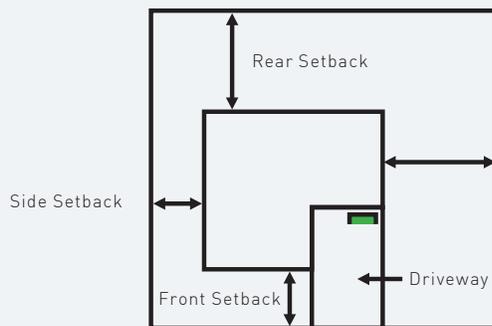
Telephone: (daytime) \_\_\_\_\_ (evening) \_\_\_\_\_

## **Proposed Improvement:**

Applicant must complete the following and submit with application:

- ▲ Detailed written description of improvement,
- ▲ Site plan showing size, shape and location of improvement and distances to residence and adjoining properties,
- ▲ Architectural plans/drawings (for major additions/improvements),
- ▲ Grading plan, if applicable.

## Example Drawings



Plot Plan



Applicant hereby warrants that Applicant shall assume full responsibility for:

- (i) Obtaining all required City, Town or County approvals relating to said improvements.
- (ii) Complying with all applicable City, Town or County ordinances.

Signature of Applicant: \_\_\_\_\_ Date: \_\_\_\_\_

# 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.

## Modular Unit

A non-permanent, removable charging unit that can be plugged into an existing electrical outlet.

## 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

## 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.

# 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.

Advanced Energy, located in Raleigh, North Carolina, is a dynamic and growing nonprofit with a mission to provide economic, environmental and societal benefits through innovative and market-based approaches to energy issues. Founded in 1980, we focus on applied building sciences in residential, commercial and industrial settings; industrial process technologies; renewable energy; motors and drives testing; and emerging technologies initiatives (such as electric transportation). Our facility houses state-of-the-art laboratories where we perform testing and applied research in all of these evolving disciplines. We work collaboratively to demonstrate that industry, government and non-profits can successfully work together to improve the environment and encourage the economy.

Part of our Emerging Markets Division's approach is to help all stakeholders and members of a community understand, plan-for and implement PEV Programs. Successful program implementation requires a comprehensive and replicable plan that addresses the key topics of policy development, barrier resolution, safety, consumer and work-force training, the design and delivery of outreach programs and the creation of local markets for PEVs. With an extensive network comprised of utility partners, charging station vendors and car manufacturers, we have a proven track record for success in consulting and planning, technical evaluation, and education and outreach, such as:

- Developing best practices and methodologies for integration and adoption of electric transportation.
- Contributing to numerous electric utility and U.S. Department of Energy (DOE) funded programs on PEVs
- Developing several guidance documents and tools on PEV infrastructure planning and implementation, including:
  - Charging Station Installation Handbook for Electrical Contractors
  - Community Planning Guide for PEVs
  - Comprehensive PEV planning matrix

Advanced Energy's efforts have led to recognition by the Rocky Mountain Institute, the Clinton Climate Initiative and the International Energy Agency for accomplishments as one of the leading communities in the United States and the world for PEV readiness. One specific program we are particularly proud of is Plug-in NC, which we established in 2011 in collaboration with the N.C. Department of Commerce to bring community stakeholders together in an effort to accelerate the adoption of PEVs and create green jobs in North Carolina.

To learn more about Advanced Energy or Plug-in NC, visit: [www.AdvancedEnergy.org](http://www.AdvancedEnergy.org) and [www.pluginnc.com](http://www.pluginnc.com).



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

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