# What were the "Best Practices" Identified for Residential Charger Installations?

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## Key Conclusions

- Although at the outset of the EV Project the local permitting authority having jurisdiction (AHJ) typically did not have a permit designation for installation of residential electric vehicle supply equipment (EVSE), many were quick to implement a unique permit for the EVSE and introduced simple online or self-inspection processes.
- Installation of separate, metered electric service for electric vehicle charging, as implemented in some EV Project electric utility service areas, eliminated the need to upgrade the homeowner's electric service panel.
- EV Project personnel met with the local AHJ in many of the project study markets prior to installation of the first EVSE in order to educate them about the EV Project and gain their support. This helped speed up permit application reviews and maintain the project's installation schedule.

## Introduction

The EV Project enrolled over 8,000 residential participants. These participants purchased or leased a Nissan Leaf or Chevrolet Volt. Very shortly thereafter, a Blink EVSE (Figure 1), that is used to recharge their plug-in electric vehicle (PEV), was installed at their residence by the EV Project.

In most communities, installation of electrical equipment such as the EVSE in a residence requires a permit to be issued by the AHJ. At the outset of the EV Project, most AHJs did not have a process for installation of EVSE, because PEV deployment was just getting started across the United States. Because the EV Project was being conducted in their jurisdiction, these AHJs needed to develop a process. The resulting permitting processes proved to be one of the most varied aspects of the EV Project's charging infrastructure deployment activity.

EV Project personnel managed installations of these residential EVSE. As a result, the EV Project team was in a position to be able to identify "best practices" for residential installations, including the ideal residential installation site and best permitting processes.

## Background

In exchange for permission to collect data from their vehicle and EVSE, participating Nissan Leaf and Chevrolet Volt drivers were provided with a free Blink charging unit (i.e., EVSE) and credit toward the cost of installation at their residence. Although the participating driver (i.e., home owner) was responsible for any installation costs that exceeded the credit, the installation credit frequently resulted in the EVSE being installed at their home free of cost to the driver.


**Figure 1. Blink residential EVSE.**

A survey of the licensed electrical contractors from each of the EV Project markets was conducted to determine the appropriate installation credit for a "typical" residence and to qualify interested electrical contractors as part of the EV Project's Certified Contract Network (CCN). Qualification included technical capabilities, experience, and the ability to work under contracting requirements imposed on the EV Project, including Davis-Bacon Act conformance. From this process, over 30 electrical contractors were qualified as part of the EV Project CCN and the initial residential installation cost credit was set to fully cover the cost of a "typical" residential installation.

The EV Project managed installation of EVSE by having the CCN use a team of two or three electrical contracting professionals that were located in each region working with the local CCN electrical contractors and permitting authorities to approve installation cost estimates and coordinate installation work. Best practices surrounding installation of the Blink residential EVSE were gathered from experience of the entire EV Project team. Experience of both field and management personnel generated observations that may be of value to future residential EVSE installations.

## Observations

### Permitting Practices

The typical process for obtaining a permit from the local AHJ is completing an application and submitting it in person at a local municipal office. The application is then processed and reviewed. When approved, a fee is paid and a permit is issued. In some cases, this process also includes site inspections both before and after installation.

Using this typical permit process for the EV Project, a CCN contractor spent an uncertain amount of time completing the application form with information that may have come from multiple sources (e.g., homeowner, Blink hardware, etc.), travelling to the municipal authority's office, and waiting for processing. In some instances, the CCN contractor was unable to obtain the permit on the first trip, prompting a second trip and adding to the costs for all involved.

The previously published EV Project paper, "How do Residential Charging Installation Costs Vary by Geographic Location?"[1] provides data on the cost of the permit itself. That paper identified that the average permit fee charged by the AHJs represented 8.6% of the installation cost. Although this represents less than 10% of the cost of the installation, it does not include the cost of time spent by the CCN obtaining the permit. While the costs incurred for time spent were not specifically captured, they were often cited by CCN staff in the less progressive jurisdictions as a significant administrative expense associated with and billable to the installation.

The best permitting practices observed by the EV Project were those that minimized both cost and time for the applicant. Most of the AHJs that reduced the application time also had lower permit fees.

Two practices utilized by AHJs minimized cost and time: (1) online applications and (2) self-certification by the installation contractor.

Online permitting was uncommon in late 2010 and 2011 when the EV Project began to install residential EVSE. However, in response to the permit review workload imposed by the EV Project, some AHJs implemented online permitting, significantly simplifying the permitting process. Most installations of EVSE qualified for online or simple permits, unless a plan check was required to verify that sufficient electrical service capacity existed at the home. Online permitting typically consisted of an online form and payment of fees by credit or debit card. The permit was issued electronically using the information provided on the application.

The best example of a self-certification or self-inspection program was in Oregon, where the Oregon Building Code Department included EVSE installations in a "minor installation label program." A summary of this process can be found in the appendix. It is interesting to note that the date on this document precedes the initial deliveries of Nissan Leafs and Chevrolet Volts by 10 months. Local government and businesses in Oregon consistently led by example and took action to encourage the adoption and use of PEVs and the charging infrastructure to support them.

### Best Installation Conditions

In addition to identifying the best practices associated with residential permitting, managing installation of thousands of Blink charging units in homes across the country enabled the EV Project team to identify the features of an "ideal" residential EVSE installation. In this case, "ideal" is defined as the simplest and, therefore, quite likely is the least expensive installation.

The primary features of an "ideal" residential installation include the following:

- Utilization of plug-in EVSE rather than requiring the EVSE be hard-wired to its power source. This allowed installation of the circuit to be completed independent of the actual EVSE installation and presence of the PEV, providing more flexibility for contractors and home owners in scheduling installations.
- An electric service panel with at least two open spaces (to allow installation of a double-pole breaker) and at least 200 amps of total service capacity. (example shown in Figure 2).

**Figure 2. Circuit breaker panel and space for two circuit breakers to support Level 2 EVSE.**

- Clear wall AND floor space around the EVSE installation location (Figure 3).
- Electrical distribution panel nearby (within 8 ft) the EVSE installation location (Figure 4 depicts good installation conditions).

Figure 3. Clear floor and wall access to Blink EVSE.

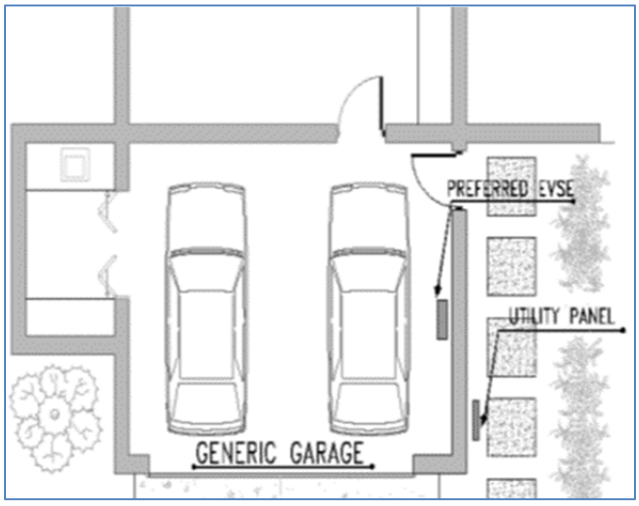


Figure 4. EVSE and service panel near PEV.

Other features of an ideal installation include the following:

- The EVSE installation location includes communication capability via the internet. The best methods for communication found during the EV Project include the following:
  - EVSE is easily within range of a wireless internet modem owned by the homeowner.
  - An ethernet connection is available at the EVSE location.
  - A Wi-Fi signal booster or powerline device can be used to provide internet connectivity.
- A separate meter is installed (i.e., dedicated for electric vehicle charging, as depicted in Figures 5 and 6), allowing the EVSE to be installed without affecting the existing service and eliminating any need to upgrade the electric service panel to accommodate the EVSE load and circuit breaker.

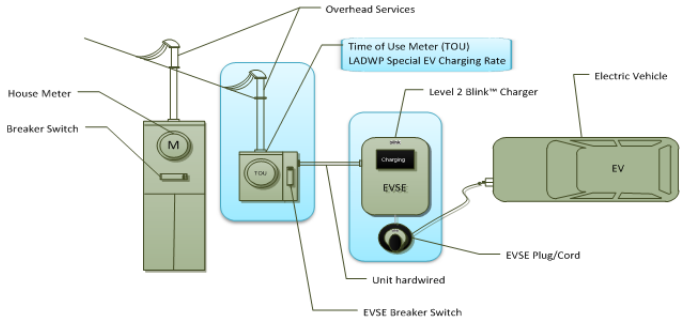


Figure 5. Metered circuit dedicated to electric vehicle charging and separate whole house electrical service panel.

Figure 6. Time-of-Use second metered circuit.

Because the EV Project trained its CCN and provided installation estimates to PEV drivers interested in participating in the EV Project, the vast majority of residential installations that proceeded to completion had many of these “ideal” conditions. The most common exception was lack of a strong wireless internet signal at the EVSE location.

The worst condition for a residential installation was the need to upgrade the electric service to the residence (e.g., new panel, larger utility service, etc.). This was particularly expensive for residences fed underground by the electric utility. The need for an electric service upgrade almost always caused the installation cost to significantly exceed the available credit, with most potential participants declining to enroll as a result.

## Conclusions

By virtue of the nascent nature of the EV industry in 2010 and the EV Project's obligation to deploy over 8,000 residential electric vehicle charging units, local electrical contractors, electric vehicle drivers, and local permitting authorities were simultaneously introduced to a new product to be installed in homes across the country.

These EVSE installations exposed electrical contractors to a new business opportunity and electric vehicle drivers to new technology in their garage. It also encouraged many local permitting authorities to use the EV Project and the installation of EVSE to streamline their permitting processes for this and other simple residential improvements. This was the most significant "best practice" for installation of residential EVSE. Today, most jurisdictions use online permitting for simple residential additions or modifications; however, this was not the case in 2011.

## About The EV Project

The EV Project was the largest PEV infrastructure demonstration project in the world, equally funded by the U.S. Department of Energy (DOE) through the American Recovery and Reinvestment Act and private sector partners. The EV Project deployed over 12,000 alternating current Level 2 charging stations for residential and commercial use and over 100 dual-port direct current fast chargers in 17 U.S. regions. Approximately 8,300 Nissan LEAFs™, Chevrolet Volts, and Smart ForTwo Electric Drive vehicles were enrolled in the project.

Project participants gave written consent for EV Project researchers to collect and analyze data from their vehicles and/or charging units. Data collected from the vehicles and charging infrastructure represented almost 125 million miles of driving and 4 million charging events. The data collection phase of the EV Project ran from January 1, 2011, through December 31, 2013. Idaho National Laboratory is responsible for analyzing the data and publishing summary reports, technical papers, and lessons learned on vehicle and charging unit use.

## Company Profile

Idaho National Laboratory is one of DOE's 10 multi-program national laboratories. The laboratory performs work in each of DOE's strategic goal areas: energy, national security, science, and the environment. Idaho National Laboratory is the nation's leading center for nuclear energy research and development. Day-to-day management and operation of the laboratory is the responsibility of Battelle Energy Alliance.

For more information, visit avt.inl.gov/evproject.shtml and avt.inl.gov/chargepoint.shtml.

## References

[1] http://avt.inel.gov/evproject.shtml#LessonsLearned EV Project lesson learned white paper, "How do Residential Charging Installation Costs Vary by Geographic Location?"

# APPENDIX

**Expediting the permit process for installation of EVSE**

Dennis Clements, Chief Electrical Inspector, Oregon Building Code Department

2/12/10

E-permitting

Purchasing permits on line through BCD's e-permitting program is available to electrical contractors in most areas affected by the roll out of the Nissan Leaf demonstration project. The inspection of installations of Electric Vehicle Supply Equipment, (EVSE), is the same whether the permit was purchased on line or over the counter. Below is a list of the local jurisdictions that are currently participating in the e-permitting program as of 2/1/10;

Portland, Lake Oswego, Troutdale
Washington County
Clackamas County
Yamhill County
Marion County
Salem
Corvallis
Lebanon
Lane County

Use of Minor Installation Labels

Currently, the minor label program can be used by electrical contractors for the installation of branch circuits up to 30 amps at 240 volts. Given this amperage limitation and the fact that the home based EVSE will require a 40 amp 240 volt circuit, the division is investigating another avenue of allowing the use of a minor label for the installation of a 40 amp, 240 volt branch circuit and the connection of EVSE in one and two family dwellings, where the EVSE is in an attached garage.

The minor installation label program was developed and implemented for repair and maintenance activities, and expanded to include electrical installations that are simple and straight forward. The installation labels are about a tenth the cost of a regular permit, and only a tenth of the installations get inspected.

Nine out of ten installations done under the minor label program will not be inspected to be sure that the existing service equipment has adequate capacity for the additional load of the EVSE. Older homes with 60 or 100 amp electrical services, and all-electric homes with no natural gas service may not have the capacity to safely supply the existing loads and the additional load. It may be prudent to require 100% inspection of the first hundred installations.

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