Streamlining the Permitting and Inspection Process for Plug-In Electric Vehicle Home Charger Installations

Report and Recommendations, Version 2

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COLLABORATIVE

This report was developed by the California Plug-In Electric Vehicle Collaborative, a multi-stakeholder partnership working to ensure a strong and enduring transition to a plug-in electric vehicle marketplace. Members played guiding and consulting roles in developing this report, although individual organizations may not formally endorse every recommendation.

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Executive Summary

The mass-market introduction of plug-in electric vehicles (PEVs) like the Chevrolet Volt and Nissan Leaf in late 2010 spurred the need to install electric vehicle supply equipment (EVSE), or charging stations, in many PEV owners' homes. The process of planning and executing residential EVSE installation requires the coordination of many participants. The resulting cost, timing, and complexity depend on how each participant manages his or her own steps and how effectively they hand off the job to each other.

The need for coordination is especially evident during the permitting and inspection steps of the EVSE installation process. Many factors impact the process. How much autonomy do the local jurisdictions have to implement and interpret the code? How do the permitting documentation requirements vary? Are local inspectors familiar with the charging station products being installed (and with the vehicles themselves)? Ultimately, all stakeholders, including electricians and contractors, EVSE hardware and service providers, utilities, city officials, and vehicle manufacturers, will need to understand how these factors contribute to the overall customer experience. Establishing a common understanding is an important step toward standardizing the home charging station installation process across all markets.

This paper characterizes key aspects of the installation process as they relate to permitting and inspection considerations and highlights common challenges and questions that arise. Through discussion, examples, and recommendations, it also seeks to address a troubling trend: the permitting and inspection process for charging equipment installations is becoming more onerous in some jurisdictions over time. For example, it appears that local jurisdictions are increasingly requiring formal plan checks, which increase the cost of the permit and the time to issue the permit. Furthermore, the complexity of the installation does not necessarily correlate to the complexity of the permitting process.

This paper provides recommendations and references so that practitioners can design streamlined procedures for permitting and inspection in their jurisdiction. It also identifies additional informational resources.

The key recommendations of this report are as follows:

1. *Establish a unique EVSE permit application for PEV charging equipment.*
2. *Adopt a permit process that is online (if available) or over-the-counter.*
3. *Create simple, template-based forms for electricians and residents. If a review of the installation information is required, completed forms should be required at the time of the inspection.*
4. *Establish a unique EVSE permit fee which is comparable to 240V circuit installations.*
5. *Avoid requiring electrician attendance during the inspection.*
6. *Develop an outreach and education program for internal and external stakeholders. Include relevant staff and key departments in all training and outreach efforts involving PEVs and PEV charging.*

Finally, while it might be tempting to characterize current learning as “best practices,” it must be acknowledged that the industry is only taking its first steps toward widespread adoption of PEVs and PEV charging. Over time, all stakeholders, PEV owners included, will become more familiar with and effective at completing the home charging installation process. Therefore, it is strongly encouraged when implementing any recommendation in the near term that approaches remain flexible and adaptive to accommodate future learning.

Homeowner Decisions

A PEV owner has many options, decisions to make, and steps to take to establish his or her charging setup at home. The installation process for a dedicated PEV EVSE generally follows these steps:

1. The customer researches what charging station options exist given his vehicle choice, utility rate options/plans, and the factors that contribute to the total cost.[1]
2. The customer decides what charging station option(s) to pursue.
3. An electrical contractor assesses the customer's home electrical situation and identifies the actions required to install 4. charging.
4. Where time-of-use (TOU) electricity rate options are available, the customer and/or electrical contractor coordinate with the local utility company to identify TOU options, such as choosing between a whole-house TOU or dedicated electric vehicle (EV) TOU meter.
5. Based on the overall assessment, the customer finalizes his choice.
6. The homeowner or electrical contractor obtains a permit to complete the desired installation.
7. The installation (e.g. new branch circuit, EVSE, etc.) is completed.
    a. The charge station is ready for use OR
    b. The utility completes the installation of an additional dedicated meter and energizes the circuit (as necessary). The charge station is ready for use.
8. If necessary, the EVSE is provisioned and a customer account is generated.
9. The installation is inspected by a local official (i.e. the authority having jurisdiction).

The PEV owner will need to evaluate many installation details; his or her subsequent choices can significantly impact the home installation process, as discussed below.

AC Level 1 EVSE – Currently, vehicle manufacturers include a Level 1 (L1) EVSE, or 120V AC single-phase "cord-set," with the purchase of the vehicle. A L1 EVSE operates up to 1.44 kW at 12A or up to 1.92 kW at 16A; some L1 EVSE can be adjusted to lower amperage charging.[2,3i] In most cases, a new owner can drive the vehicle home and immediately plug into a standard 120V outlet. The charging rate, which typically delivers 3–4 miles of range per hour of charging, is capable of replenishing the battery when the vehicle is not being used (e.g. overnight).

When choosing L1, a homeowner should have an electrician verify the integrity and suitability of the specific circuit and outlet. The installation of a new dedicated circuit may be required. There are some newly released outlets on the market specifically designed for the heavy use of a L1 cord-set.

AC Level 2 EVSE – When L1 charging is not readily available (e.g. inadequate circuit), or when a customer prefers a faster means of charging the battery, a PEV owner may choose to install a Level 2 (L2) EVSE, or 240V AC single-phase "charge station" which can operate up to 80A.[4] Most L2 EVSE are capable of supporting 3.3kW charging today, but 6.6kW and >10kW charging are also being introduced.[5] The 3.3kW charging rate, for example, delivers 6–10 miles of range per hour of charging. L2 charging equipment will require a dedicated 240V circuit except in cases where a 240V circuit may already exist in a garage from a previous purpose.

Utility Metering Arrangements – Many utilities in California, such as Los Angeles Department of Water & Power (LADWP), Pacific Gas & Electric (PG&E), Sacramento Municipal Utility District (SMUD), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE), give customers an option of choosing a whole-house or dedicated EV TOU electricity rate for their home and/or PEV. A TOU program with its lower off-peak rate may be a great opportunity to lower the cost of charging a PEV, depending on when a customer intends to charge the vehicle (e.g. daytime vs. nighttime).

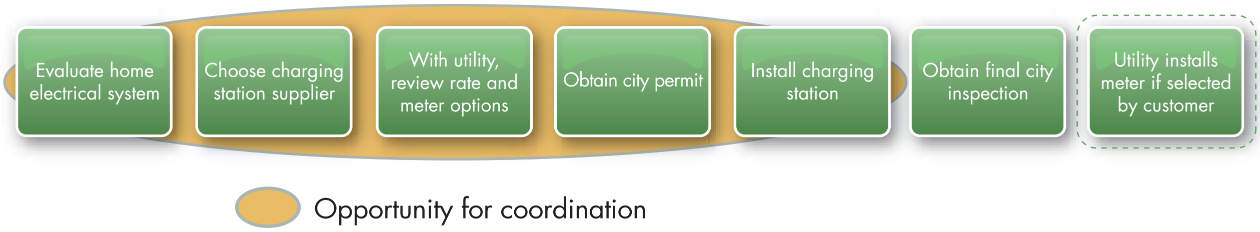
Utilities typically assume responsibility for the meter and meter installation, so a whole-house TOU may require only programming (or an exchange) of the existing household meter—no additional equipment or installation is necessary. Alternatively, choosing a dedicated EV TOU rate requires an additional meter to measure the electricity used to charge the PEV. In this case, a customer will be responsible for installing equipment (e.g. meter socket and conduit) to support the additional meter. Where government or utility incentive programs are available, they typically can be applied to this portion of the customer's installation expense.

Home Electrical Service and Service Panel Upgrades – The existing capacity of the electrical service panel in the home will dictate the flexibility a homeowner has to install an additional circuit. For example, smaller homes in older neighborhoods may have 60A or 100A service panels. A home in a new subdivision may have a 200A panel. The electric utility service line to the residence may require an upgrade as well, especially if a service panel upgrade is also being requested. Where an electrical service and panel upgrade may be necessary, a PEV owner (or electrical contractor acting on behalf of the customer) will need to consult with the utility to understand coordination, timing, and cost impacts. Typically, a service upgrade will require a significant amount of coordination.

Discussion – Common Considerations for Installation and Equipment

This section discusses charging level, TOU rates and panel upgrades – all significant considerations affecting the residential EVSE installation process. The steps for installing a L2 charging station at home are illustrated in Figure 1.

Figure 1: Steps for Installing L2 Charging at Home
(Source: *Taking Charge,* PEV Collaborative 2010)



Charging Level

PEV owners' preference for L1 versus L2 charging is still being evaluated and the results are expected to evolve over time. Because nearly 80% of commutes are less than 40 miles each day, vehicle usage data suggest L1 charging could accommodate PEV owners on most days. On average, 7.9 kWh of electricity is consumed per charging event – well within the potential to complete overnight with 120V.[6,7] At the same time, however, a variety of incentive programs are currently available for PEV owners who install L2 charging and participate in data sharing efforts with electric vehicle service providers and government agencies working to understand the benefits and impacts of PEVs.[8] These incentive programs vary and might not be available beyond 2012. As these special offers disappear, there may be increased interest in L1 charging at home due to its lower cost. As the PEV industry matures, it will need to observe trends to determine the relative value of one charging level versus another.

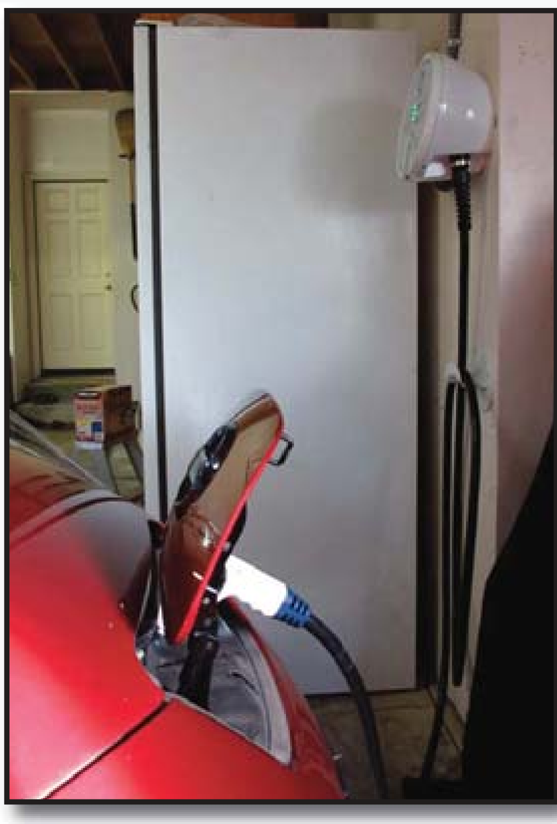
PEV owners' choice of charging equipment may also be influenced by the type of PEV they drive. Some PEV owners might be comfortable managing their daily range with overnight L1 charging while others might be more inclined to ensure the battery is always fully charged. A battery electric vehicle (BEV) with a large battery might cause an owner to consider L2 charging. Specific trends may emerge for owners of BEVs, extended range electric vehicles (EREVs), or plug-in hybrid electric vehicles (PHEVs). As PEVs become more widespread, and as incentive programs conclude, a clearer and more market-based distribution will emerge.

TOU Electricity Rate

Beyond the type of charging station being installed, a customer might also consider a TOU rate to lower the cost to charge her PEV. Generally, utilities offer these rate options to support off-peak charging when they have more available capacity. Furthermore, off-peak charging reduces impacts to the grid and local distribution equipment.

A customer will need to evaluate how his charging preferences or typical household electricity usage would impact his overall cost to charge his PEV. To support customer decision making, some utilities provide online evaluation tools or services.[9] If a customer chooses a dedicated EV rate (and hence the associated dedicated meter) he will incur an additional up-front cost for the equipment and installation.

The dedicated meter installation also will take more time due to additional planning, permitting, and coordination activities.[10] Each customer will need to evaluate if the savings from the EV-only TOU rate and the effect on his overall electric bill (i.e., amount and timing of non-PEV usage) outweigh the cost to install the second meter.



Panel Upgrade

A current or prospective PEV owner might also have to consider upgrading her electrical service and/or electrical service panel. Previous estimates indicated nearly one in five customers would require an upgrade.[11] More recent experience and analysis show that only a few customers require a panel upgrade to support their charging needs.[12i] While researching whether or not a PEV can fit into her lifestyle, a customer may come to learn that her home may require a service or panel upgrade and decide to delay her PEV purchase – or that L1 charging is a viable alternative.

Codes and Standards

Whether the residential installation involves a new 120V circuit or a major service upgrade, local permitting officials, also known as the Authority Having Jurisdiction (AHJ), will need to be involved. The AHJ will verify that the equipment is installed according to the proper rules and regulations. While a few technically skilled PEV owners may be able to complete this effort themselves, it is more typical for a certified electrician, electrical contractor, or installer to manage these steps to ensure a new circuit or EVSE is installed properly. Table 1 summarizes some of the relevant codes and standards.

Table 1: Relevant Codes and Standards

North America	
UL 2595	Electric Vehicle Supply Equipment
UL 2251	Plugs, Receptacles and Couplers for Electric Vehicles
UL 1998	Firmware Operation – Software in Programmable Components
SAE J1772	SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler
FCC Part 15	EMI / RFI Subpart B Compliant
Safety	
Safety Device	CCID20 with Ground Assistance
NEC Article 625	Electric Vehicle Supply Equipment
UL 2231-1 & -2	Personal Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements
UL 62	Standard for Safety of Flexible Cord

The two most notable references for electric vehicle charging equipment are Society of Automotive Engineers (SAE) J1772 and National Electrical Code (NEC) Article 625, also known as NFPA 70. SAE defines charging level ratings, coupler functions, charging configurations, and charging equipment terminology. NEC defines the installation requirements and highlights the listing or independent certification by a National Recognized Testing Laboratory (NRTL) such as Underwriters Laboratories (UL) or ETL (formerly known as Edison Testing Laboratories). NRTL listing is one way to ensure that a piece of equipment meets the necessary requirements of the building code and helps to ensure a safe charging experience.[13] Together, these standards ensure safe, reliable access to electricity while charging a PEV.

SAE J1772– The SAE J1772 standard defines the charging level ratings and the connector architecture.[14] Table 2 defines the charging levels:

Table 2: Charging Level Ratings

- **AC L1:** 120V AC single phase
  - Configuration current 12, 16A
  - Configuration power 1.44, 1.92kW
- **AC L2:** 240V AC single phase
  - Rated Current ≤ 80A
  - Rated Power ≤ 19.2kW
- **AC L3:** TBD
  - AC single or 3ϕ ?
- **DC L1:** 200 – 450V DC
  - Rated Current ≤ 80A
  - Rated Power ≤ 19.2kW
- **DC L2:** 200 – 450V DC
  - Rated Current ≤ 200A
  - Rated Power ≤ 90kW
- **DC L3:** TBD
  - 200 – 600V DC ?
  - Rated Current ≤ 400A?
  - Rated Power ≤ 240kW?

In addition, SAE defines the architecture of the coupler and its functions. Each coupler utilizes five pins – two power pins, a ground pin, a proximity pin, and a control pilot pin. The ground pin is the first to engage and the last to disengage. The proximity pin prevents the vehicle from moving while it is charging. The control pilot pin is the last to engage and the first to disengage. It communicates the available charge rate so the accurate current (amperes) can be determined for the vehicle being charged.

NFPA 70: National Electrical Code (NEC). The most current published version is 2011.[15, 16] NEC defines the national electrical code and is then adopted and amended by each jurisdiction. The specific EVSE installation requirements are defined by Article 625 – Electric Vehicle Charging System. The scope of Article 625 is defined in 625.1:

> *The provisions of this article cover the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means and the installation of equipment and devices related to electric vehicle charging.*

Additional sections of Article 625 can be found within NEC, such as:

NEC 625.5 – Listed or Labeled
NEC 625.9 – Wiring Methods
NEC 625.13 – Electric Vehicle Supply Equipment (EVSE)
NEC 625.14 – Rating
NEC 625.18 – Interlock
NEC 625.19 – Automatic De-energization of Cable
NEC 625.21 – Overcurrent Protection
NEC 625.29 – Indoor Sites (e.g. battery ventilation requirements)
NEC 625.30 – Outdoor Sites

Discussion – Common Considerations for Codes and Standards

From a practical perspective, codes and standards are only enforceable as adopted by law. Typically, a state, and then a local jurisdiction, will adopt a code, such as NEC, into law as written or with additional considerations, which are typically more stringent than the original code.[17] These rules are enforced during the home installation process.

Local Official Interpretation

While local officials, such as plan checkers or electrical inspectors, are clearly knowledgeable about the NEC, there are areas where interpretation or assessment is common or necessary. Sometimes, however, local inspectors have raised questions that have needlessly delayed installations.

Battery Ventilation

For example, some officials have raised questions about the vehicle during the course of EVSE installation permitting or inspection process.[18] Specifically, questions relating to Section 29 - Indoor Sites (NEC 625.29) involving the venting requirements for batteries, have been raised. In a few cases, the inspection failed or was placed on hold until an inspector was satisfied with the explanation related to the vehicle. This is unfortunate, given that ventilation is not required for PEVs with lithium-ion batteries. General Motors' Volt Program has offered the following response to inspector concerns and questions:

> ***The Chevrolet Volt's lithium ion battery cells do not off-gas during charge and therefore do not require ventilation. The Volt's Li-ion battery cells are hermetically sealed, and because of their organic solvent-based electrolytes, do not generate (nor emit) gases during charging. Venting during charging is usually associated with the electrolyte systems in lead acid or nickel metal-hydride batteries. Furthermore, in accordance with National Electrical Code (Article 625), the Volt can be charged using an EVSE labeled "Ventilation Not Required." Alternatively, an EVSE labeled "Ventilation Not Required" does not have the proper interlock to charge an electric vehicle that requires ventilation. That is, an EVSE labeled***

> ***"Ventilation Not Required" will not charge a PEV whose batteries off-gas during charge. Furthermore, a vehicle that requires ventilation will not charge with an EVSE not capable of supplying ventilation.[19]***

As noted above, the NEC ensures that the proper ventilation equipment is available since it requires specific engineering controls (i.e. SAE-designed equipment) that prevent different types of batteries (i.e., those requiring ventilation and those not requiring ventilation) from using charging stations interchangeably.

EVSE Design

Another example of delayed permitting and/or approval during a final inspection relates to the interpretation of cord-and-plug connected EVSE under Chapter 13 Electric Vehicle Supply Equipment (625.13). The cord-and-plug connected EVSE takes advantage of a standard 240V outlet rather than a hardwired connection. Where the charging station has been approved by a NRTL for this type of installation, the charge station may be installed with a short (<6 feet) cord and plug and effectively "plugged" into the 240V outlet instead of being installed with a hard-wired connection. These EVSE are often called "portable" since they can be removed, such as when moving residences. The code panel review, formerly approved in the Tentative Interim Amendment (TIA) 11-2, indicated that EVSE meeting the requirements of 625.18, 625.19 and 625.29 can be cord-and-plug connected even when the voltage is greater than 120 VAC.[20]

If an inspector is not familiar with the language or the intent of the code, electrical contractors must provide specific references to codes, official statements, or contact information at other jurisdictions to support the decision-making process. It is not uncommon for these situations to require multiple trips to obtain a permit or pass an inspection, thereby potentially delaying the installation and/or increasing the cost to complete. As the PEV market expands, the industry will need to work closely with local officials to ensure proper knowledge and familiarity in order to avoid potentially unnecessary delays and increased costs of installation.

Permitting Processes

The process for permitting residential EVSE installation varies by jurisdiction.

Given that the installation of charging equipment might be as simple as adding a 120V or 240V branch circuit, some home charging installations can be very straightforward. In these cases, the electrical contractor, who is usually local to the area, typically understands the permitting process – the requirements, procedures, and best practices of a jurisdiction. In fact, it is not uncommon for an electrician to know a building and planning official or electrical inspector by name. The contractor and all stakeholders gain valuable experience over time, especially as processes are repeatable.

When the installation is not as simple, or when the permitting process is complicated by differences in adjacent jurisdictions or within the same jurisdiction—a potential when individual staff members have varying familiarity and experience with PEV charging installation rules—the different approaches directly and adversely impact the cost, timing, and customer's experience. Following is a discussion of the wide range of current permitting processes for EVSE installations.

<u>No Permit Necessary</u> – A few jurisdictions have characterized a branch circuit installation for electric vehicle charging equipment as a minor improvement and do not require a permit to be pulled for the installation.[21] The details may vary based on the type of branch circuit being installed or the training and experience of a specific electrical contractor.

<u>Permit Required, Online System</u> – Some jurisdictions have invested in online permitting and inspection portals. The jurisdiction defines what is acceptable to be permitted through the online system. As a result, the upfront paperwork and time to complete the necessary permit application is reduced. This places the responsibility on both the electrician and electrical inspector to understand what scopes-of-work are acceptable (for online submittal).

<u>Permit Required, Over-the-Counter (OTC) with Scope-of-Work Only</u> – This process is similar to the online system except that the electrical contractor deals directly with a city official noting the type of job being completed. There is no detailed overview of the installation and the permit is obtained immediately. The city inspector, after the installation is completed, takes the responsibility of ensuring that the installation has been completed properly.

Permit Required, OTC with Plan Check – Plan check is defined as a technical review of the installation and will typically require additional documentation from the electrician. For example, depending on the jurisdiction, a general or detailed site plan, line drawing (wiring diagram), equipment specification sheet, and/or load calculation may be requested. There are jurisdictions that publish a specific EV Installation Checklist to determine what documentation will be necessary during the plan check.

The city official at the counter will review in detail these documents to ensure that the installation will meet requirements. In these cases, the permit will be obtained only if the official agrees that the documentation shows an acceptable installation. While adding time and cost to the upfront permit application process, plan checks are intended to speed up the actual onsite inspection time since an inspector has documents that can be compared to the actual installation.

Permit Required, Plan Check – The same technical review occurs, but not immediately. Instead, an official or third-party contractor reviews the documents according to the jurisdiction's process timeline; it is not uncommon for the timeframe to be a few days to a few weeks.

Discussion – Common Considerations for the Residential EVSE Permitting Process

Variables in the permitting process can significantly affect residential EVSE installation cost, timing, and complexity. These variables can include local requirements for EVSE-specific installations, the electrician's familiarity with these local requirements, the type of EVSE installation, and an individual permitting official's experience with EVSE installations.[22] While electricians typically make it a habit to call city officials ahead to understand these requirements, the requirements are not always clear since officials may have limited (or no) experience with EVSE installations. The following discussion characterizes common issues that arise during the permitting process.

> ***Variables in the permitting process can significantly affect residential EVSE installation cost, timing, and complexity.***

Required Permitting Documentation

To obtain a permit, documentation requirements have ranged from none, such as in online systems, to a full set including a site plan, line drawings, load calculations, and installation guide. In most cases, a simple, hand-drawn diagram has been sufficient. Other cases, however, have required professional drawings. A load calculation requires an electrician to thoroughly assess the typical electrical usage in the home, including major appliances.

These documentation requirements are not uniformly applied across jurisdictions. It might be expected that simpler or straightforward installations, such as a simple 240V circuit installation, would reduce the documentation requirements. Likewise, it might be expected that more complex installations, such as the addition of a dedicated EV TOU meter, would require further review and consideration, and therefore more documentation to understand the installation plan. However, post-installation feedback

has revealed the opposite can occur. For example, the City of Los Angeles does not require any additional documentation for an installation of a dedicated meter and the County of Riverside has required full plan check and extensive documentation for a standard 240V circuit and EVSE installation in a garage.

If an electrician is not properly prepared with the necessary documentation, or if a permitting official requires any additional documentation, the permit will not be issued and repeat home and permitting office visits will be necessary. Many electricians agree that consistent documentation and permitting requirements, directly related to the complexity of the installation, would be an important step in supporting a timely and less costly process.

Plan Check

While processes for permitting the installation of a basic 120V/240V circuit are established and generally do not require a formal review, some jurisdictions have added a plan check requirement for a 240V circuit when associated with a L2 EVSE. This step, which typically requires a formal review by an official, can take a few hours to a few weeks. If the installation is delayed, an electrician may need to complete additional office visits to provide documentation and answer questions, increasing the cost of the installation. One reason given for a plan check is to ensure a successful inspection during the first visit by the inspector.[23] In this case, the inspection official needs only to review the installation against the submitted plans which theoretically makes the inspection simpler, straightforward, and timely.

Online permitting systems largely eliminate plan check requirements. Where these systems are in place, an electrician can obtain a real-time permit for a charging station installation that meets a certain set of requirements. For example, the City of Los Angeles allows nearly all EVSE installations to be permitted in this manner, including those that involve a dedicated EV TOU meter.[24] In these cases, the inspector will review the installation to ensure it is completed according to safety and code requirements. This approach places significant responsibility on the electrician to ensure the installation is done correctly the first time and that the documentation, such as load calculations, are available for review; otherwise, additional time and visits will be required.

The schedule and cost impact of these additional process requirements can be significant. An online system allows for timely access to the necessary permits so an electrician can begin an installation immediately. This streamlined process can be valuable when it allows an electrician to complete a less-complicated installation during an initial site visit, thereby saving the customer the bother of a second visit and reducing the overall cost.

On the other hand, an over-the-counter plan check requires additional planning by the electrician. While an electrician typically is able to obtain the permit immediately, after an official reviews the documentation, he or she must plan for travel and potential wait times for the review to be completed. Time and travel add costs to the installation. One electrician has stated that plan check process “ruins my day” since no other work can be planned around obtaining the permit. Some larger electrical contractors may have dedicated staff to complete plan check, but additional staff entails higher costs, as well as time and effort.

In some cases, an electrician must deliver plan check documentation for official review within a certain timeframe. This requirement is typical when a jurisdiction has a backlog of submitted plans or sends the documents out to a contracted third-party reviewer who completes this work in a specific timeframe. In these cases, a customer and electrician must wait a few days to a few weeks to receive approval, conditional approval, or request for more information in order to receive the permit. In some cases, a customer may be able to pay an additional fee to expedite the review.

Dedicated TOU Meters for PEV Charging

Installing a dedicated EV TOU meter to obtain an EV-specific electricity rate adds a layer of complexity to the EVSE installation. It requires the electric utility to be involved in the installation process, adding time and cost to the overall effort. Early in the PEV experience, some permitting officials expressed concern that a meter dedicated for EV charging in a garage might enable un-permitted garage apartments. This concern should have dissipated now that all of California’s largest utilities – LADWP, PG&E, SCE, SDG&E, and SMUD – currently offer and “endorse” dedicated EV TOU programs.[25]

Some local permitting officials have also sought utility approval of these EV-only TOU meter installations. In most cases, and over time, utility outreach and labeling requirements have addressed these concerns. Although more jurisdictions are becoming comfortable with the practice of installing an additional meter to measure and bill for the PEV, further questions are expected, and PEV owners may need to take further action to assure city officials that the additional meter remains dedicated to PEV charging.

Consistent and straightforward requirements are essential to streamlining permitting and inspection procedures.

Overall, these challenges illustrate a potential trade-off between the upfront documentation effort when applying for a permit and the final inspection process. To reduce inspection time, some jurisdictions place more emphasis on the upfront documentation requirements and review. The result may not always be saved time, however, since documentation requirements and their associated review have proven to vary dramatically across jurisdictions and even within a jurisdiction. These variations in process and experiences to date exemplify why consistent and straightforward requirements are essential to streamlining permitting and inspection procedures, and, ultimately, reducing cost and complexity.

Inspection Processes

After a permit is pulled, a city official's inspection completes the process to ensure the home-charging station installation was finished according to local safety codes and standards. Typically, a PEV owner or electrician notifies the inspection authority that the installation is complete and ready for the review. An inspector is typically available within 24 to 48 hours to complete the inspection, but depending on the availability of the PEV owner and/or electrician, the timing of the inspection could be extended longer to accommodate schedules. In some locations, such as rural areas, an inspector might have a set schedule working specific areas on a weekly or even a monthly basis.

Discussion – Common Considerations for the Inspection Process

Among the factors that can facilitate an efficient inspection are the official's familiarity with EVSE installations, personal interpretation of the code, and region-specific requirements.

Familiarity with PEV Charging Installations

A key consideration is the inspector's familiarity with the specific product or installation type. In most cases, a designated electrical inspector completes inspections of all electrical installations. Sometimes, however, a general building inspector completes an electrical installation review. Although inspectors complete rigorous training and take their safety role very seriously, it is possible for an inspector to be less familiar with the product, installation type, or the code on a particular subject. In these cases, more time to review and/or investigate an installation may be required. Usually the electrician can expedite this review by being prepared. For example, as discussed earlier, an inspector may be less familiar with the "ventilation" issue and may be inclined to ask for specific references to confirm that current battery technology does not require ventilation.

Code Interpretation

Another issue that arises focuses on specific interpretations of the code. In these cases, an inspector identifies something he or she considers a deficiency and requests further work to be completed. For example, some inspectors have identified the need for a separate disconnect, or lockout breaker, based on their review of the code or comparison to similar, non-EVSE installations. In other examples, general safety considerations beyond the EVSE installation are applied, such as requiring concrete pads around additional meters. These examples highlight how a relatively simple "240V circuit" installation can grow in scope when the EVSE product is added.

Local Requirements

Some local rules that require an electrician to be present during the inspection result in additional workload. From the jurisdiction's perspective, this requirement allows the inspector to ask questions directly of the installer, (versus engaging a potentially less knowledgeable customer), and allows for any minor modifications to be made immediately. In some even stricter cases, an electrician is expected to complete the installation in front of an inspector. For example, one electrician was required to complete the "torque" procedures while an inspector observed. These types of additional inspection requirements can add considerable time and cost to the overall installation process, especially for standard installations.

Factors that can facilitate an efficient inspection:

1. ***The official's familiarity with EVSE installations***
2. ***The official's personal interpretation of the code***
3. ***Region-specific requirements***

Each of these factors can delay the final approval, increase the cost of the installation, and frustrate the participating parties, including the inspector, the electrician, and, most importantly, the customer.

Permitting Costs

There are two primary cost components of permitting a residential EVSE installation: 1) the permit fee, itself, and 2) the electrician's indirect costs to complete the paperwork, including time and material necessary.[26] For a jurisdiction issuing a permit, the cost of the permit should cover the time necessary to issue the permit (including necessary plan checks), as well as the time to inspect the installation. However, the manner in which a permit fee is calculated varies; a flat-fee can be based on a published fee schedule, the total project cost, or the scale of the project. Furthermore, a separate plan check fee may also be applied. According to national data from SPX, permit fees have ranged from $0 to $624.[27] In California, the average permit fee is among the highest in the nation, $208 in Southern California and $185 in Northern California.[28] The range of permit fees in California is illustrated in Table 3.[29]

Table 3[30]

Jurisdiction	Permit Fee (SPX)
Mountain View	$56.51
Yorba Linda	$62.25
City of Los Angeles	$97.20
Irvine	$98.00
Alameda County	$161.40
San Francisco	$164.20
Menlo Park	$207.00
Palo Alto	$250.00
Riverside County	$260.71
Anaheim	$261.00
Malibu	$624.00

Discussion – Common Cost Considerations for the Permitting Process

The typical cost of a residential EVSE installation can range from $300 to $1,900.[31] The associated permit fees typically contribute 5% to 20% of the total cost of the installation and can vary in adjacent jurisdictions and, potentially, within the same jurisdiction.[32] Depending on jurisdictions' permitting and inspection processes, additional indirect costs associated with the electrician's time and materials—examples include plan check or required attendance at the inspection—can accrue. At prevailing wages, the additional two to three hours of work can increase the installation cost by $100 to $300.[33]

Electricians have described circumstances where they took on these permitting costs, which were not factored into their original bid, rather than pass them along to the customer. They accepted the loss because a customer's understanding of the permitting process is limited, and, as the direct contact with the customer, they generally try to minimize frustration and ensure satisfaction.

Comparing Two Southern California Cities

City #1
An EVSE installation involved a dedicated EV TOU meter in a Southern California city. The city charged a $250 permit fee and a $140 plan check fee.[34] The total installation cost, approximately $2,400, included three additional hours of labor for the electrician to complete the plan check documents and travel to obtain the permits.

City #2
A comparable job in a different Southern California city cost approximately $1,800.[35] Therefore, in the former case, the permitting-related fees accounted for almost 17% of the installation cost and increased the total cost to the customer by hundreds of dollars.

A consistent process will enable electricians to adequately predict both direct and indirect permitting costs. As discussed, it appears that permitting and documentation requirements are becoming more complicated over time, and therefore dramatically impacting the cost of the installation. Overall, the goal must be to lower installation costs, including any avoidable costs associated with the permitting process.

Stakeholder Preparation

Early adopters of any technology can be characterized as highly engaged advocates. PEV owners are no different. They can be enthusiastic helpers, information resources, and vocal spokespeople about their positive – or negative – experiences when dealing with their home-charger installation and interacting with their local governments. In short, they play an influential role in shaping the broader public perception of PEVs. Therefore, local government and industry stakeholders who are prepared, and are familiar with the technology and the processes are important points of contact for these early PEV customers.

Key stakeholders from industry, local jurisdictions, electricians, and utilities must work together to ensure that learning and best practices are transferred within and across organizations. These exchanges can be broad:

- Electricians can benefit from understanding utility processes, local permitting procedures, and standard practices for documentation.[36]
- Charging station service providers and installers can adapt their training programs to align with local requirements and communicate customary practices in a particular jurisdiction.
- Automakers and dealers can learn how best to educate and communicate with those shopping for or purchasing a PEV.
- Local officials can benefit from interactions with industry and other local officials. Through industry contacts they can develop a better understanding of the technology, and from dialogue with other officials they can learn best practices for streamlining their permitting process.

Engaging all stakeholders and creating opportunities and tools for information exchange, especially across sectors, is critical and sets the stage for widespread market expansion of PEVs. Some of this information exchange is already occurring.

In May and June 2012, the California PEV Collaborative hosted six California Community PEV Readiness Workshops in six regions across the state.[37] The PEVC also created a Community PEV Readiness Toolkit to support the workshop series.[38] While additional workshops targeting local readiness are anticipated, some stakeholders have already initiated their own training at the grassroots level. The South Bay Cities Council of Governments, for example, hosted an EV Charging Infrastructure Workshop in May 2012 and a California Electric Vehicle Codes and Standards Seminar in June 2012.[39]

Discussion – Common Considerations for Educating Local Officials

Educating local officials may be the most critical element of a plan to streamline the permitting and inspection process. When officials lack familiarity with or exchange incorrect information about the technology or process, it can create confusion, frustration, and additional cost. As discussed earlier in

this document, it can result in inconsistent application of codes and standards, variable documentation requirements, or permitting cost discrepancies within a jurisdiction. These challenges may delay market adoption of PEVs due both to real obstacles and to perceived barriers.

By developing and implementing an education and outreach plan for internal and external stakeholders a jurisdiction can ensure that its employees on the front lines are aware of and able to address questions and concerns, particularly as they interact with highly engaged early adopters. Local government staff and key departments should be included in any training and outreach efforts around PEVs and PEV charging. It is equally important that residents and electricians have access to clear, simple information about permitting processes. Simple fact sheets and online information on the jurisdiction's website are relatively easy, low-cost solutions. For example, the cities of San Diego and Berkeley have created "How to" guides for residents on the process of installing a charging station.[40,41]

In addition, taking the time to work through a specific permitting process for home charging station installations will ensure that each stakeholder experiences a consistent, predictable process. PEV owners will clearly understand the requirements, electricians will understand expectations, and officials will have the familiarity and background necessary to properly approve an installation.

Staff curriculum should include:

- PEV offerings and technology overview
- EVSE offerings overview
- NEC considerations for PEV charging stations
- Installation process overview—strongly consider local electrician participation
- Utility considerations—strongly consider local utility participation

General internal outreach should include:

- PEV offerings and technology overview
- EVSE offerings overview
- Installation process overview
- Department's plan to support PEV owners

A jurisdiction that implements these elements can make significant progress toward simplifying the permitting and inspection steps of the residential installation process. These steps will result in time-efficient installation and lower costs to the PEV owner. Furthermore, these steps can reduce complexity and potential uncertainty experienced by each of the parties. At the most fundamental level, it fosters awareness and appreciation of each stakeholder's needs and priorities.

Recommendations

As described in this paper, there is no current "standard" process for permitting and inspection of residential EVSE installations; the process can vary significantly based on many factors, including the number of steps required for completion.

Reducing cost and complexity of the residential EVSE installation is an important step toward enabling mass-market adoption of PEVs. Moreover, continued complexity and/or increasing costs may discourage PEV owners from taking the proper steps to install EVSE safely and correctly. Varying processes generate customer confusion and dissatisfaction as individuals compare the cost and time to complete the installation.

The most important step toward streamlining the permitting and inspection process is to create consistency for PEV owners, local officials, and electricians. Ideally, one uniform permitting process for EVSE would enable electricians to be prepared more easily. In the absence of one uniform process, setting consistent guidelines based on typical EVSE installations would be favorable. In either case, an EVSE permitting process should be created and published online so local residents and electricians can easily locate permitting information.

A "Best Practice" permitting process for EVSE would include the following elements:

1. **A Unique EVSE Permit** – A unique permit application for electric vehicle charging equipment would allow PEV owners and electricians to know exactly what is required to complete the permit process. The application might be equivalent to what is required for a 240V circuit installation, but identifying it as an EVSE permit provides quick reference and guidance for inquiries. In most cases, jurisdictions with distinct EVSE permits have also researched and fully understand the process a PEV owner must take to complete the installation.

2. **Online (if available) or Over-the-Counter Permit Process** – Jurisdictions can support PEV adoption by reducing the complexity and time to permit an EVSE. Online permitting, when available, provides a PEV owner and electrician an opportunity to immediately schedule an installation. In some cases, the installation may be completed right after the electrician provides an estimate to the PEV owner. Avoiding multiple trips to the installation location and jurisdiction permitting office can significantly reduce cost.

When online permitting is not available or feasible, a simple over-the-counter permit process can suffice. In these cases, the electrician would provide a simple scope of work along with the specification sheet for the EVSE in order to obtain the permit. A plan check could be avoided for the vast majority of standard EVSE installations.[42] A jurisdiction should determine what is standard and non-standard. An over-the-counter process reduces the time and effort to obtain the permit and facilitates scheduling and completing the installation, whereas a plan check requires multiple trips and coordination to schedule and complete the installation.

3. Template-Based Forms – If a jurisdiction requires formal documentation to be submitted to receive the permit, it is strongly recommended that simple, straightforward forms be provided for PEV owners or electricians to complete. Providing template-based forms ensures that all required information is available during the permitting process. As noted above, if plan check is not required for EVSE installations, but the required documentation is necessary, it is recommended this documentation be made available for review at the time of the inspection. Required documentation might include:

- Site plan (simple)
- Specification sheet
- Line drawing (simple)
- Load calculation (required: 60A or 100A panels)

A predictable process enables electricians to confidently quote the fees for the permitting and inspection portion of the installation. It further avoids unnecessary hourly labor charges for repeat trips to the jurisdictions and/or installation location.

4. A Unique EVSE Permit Fee – A distinctive, predictable permit fee based on comparable 240V circuit installations is suggested. Defining a repeatable process should enable jurisdictions to properly define their cost to properly permit and inspect an installation. It also provides a transparent cost to the PEV owner and to the electrician who provides the quote.

5. Inspection Without Electrician-Required Attendance – Jurisdictions should avoid requiring an electrician to be present at the time of inspection—a practice that is uncommon, however not unheard of. Given 2–4-hour inspection windows, this practice places a significant time burden on PEV owners and electricians and increases the cost of the installation. It also creates a lost opportunity cost for the electrician. In some cases, inspectors require electricians to complete the installation during the inspection to verify that work, such as proper torque value, has been properly completed. This practice creates additional upward pressure on the overall cost of the installation.

6. **Outreach and Education Plan –** It is strongly recommended that a jurisdiction develop an education and outreach plan for both internal and external stakeholders. Plans that include communications tools and strategies, and opportunities for dialogue, information exchange, and formal training, can empower those on the front lines to support interactions with consumers and electricians. In turn, knowledgeable and credible participants create confidence in the technology and market and lay the foundation for an effective, streamlined installation process.

Jurisdictions that follow these best practices and work to streamline their permitting processes will be well on their way to becoming PEV Ready and will be model cities for the state and beyond.

Appendix

Following are key references for residential charging installation.

Residential Installation Guidelines and Best Practices

Organization	Reference Type	Reference Location
NFPA (NEC)	Code (For Purchase)	http://www.nfpa.org/catalog/product.asp?pid=70HB11&order_src=A882
ICC Tri-Chapter	Code Guideline Code Guideline	Single Family Residence, Policy 17 - http://www.eastbayicc.org/pages/TUCC.php Multi-Dwelling Unit, Commercial, Policy 18 - http://www.eastbayicc.org/pages/TUCC.php
State of Oregon	Code Guideline	Minor Label - http://www.bcd.oregon.gov/notices/Adopted_Rules/2010/070110_electricvehiclesupplyequipment_pr.pdf
Puget Sound Regional Council	Code Guideline EV Infrastructure Guide	http://psrc.org/assets/4326/EVI_full_appendices.pdf
County of Sonoma, CA	Code Guideline EV Infrastructure Guide	http://www.sonoma-county.org/prmd/docs/misc/ev_prog_guidelines.pdf
Ready, Set, Charge, California	EV Infrastructure Guide	www.readysetcharge.org
AFDC (DOE)	EV Infrastructure Guide	http://www.afdc.energy.gov/afdc/vehicles/electric_charging.html
AFDC (DOE)	Case Studies	http://www.afdc.energy.gov/afdc/vehicles/electric_deployment.html
Friends of the Earth	Case Studies (Bay Area)	http://www.foe.org/sites/default/files/Friends%20of%20the%20Earth_EV%20Charger%20Permitting%20Report_FINAL%20_5_.pdf
RMI—Project Get Ready	Case Studies	http://rmi.org/project_get_ready

Forms and Documentation

Organization	Reference Type	Location
AFDC (DOE)	Permit Template	http://www.afdc.energy.gov/afdc/pdfs/EV_charging_template.pdf
City of Beverly Hills, CA	Customer "How to" Guide Permit Checklist	http://www.beverlyhills.org/services/building/electric_vehicles.asp#ChargingStation
City of Berkeley, CA	Customer "How to" Guide	http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=75018
City of Honolulu, HI	Online Permit	http://dppweb.honolulu.gov/DPPWeb/default.asp?PossePresentation=OnlineBuildingPermit&PosseObjectDef=j_OnlineBP
City of Los Angeles, CA	Customer "How to" Guide Online permitting	https://www.ladwp.com/ladwp/cms/ladwp014183.jsp
City of Raleigh, NC	Customer "How to" Guide	http://www.raleighnc.gov/business/content/CityMgrDevServices/Articles/HowToElectricVehicleCharging.html
City of Riverside, CA	Load Calculation Template	http://www.riversideca.gov/utilities/pdf/2011/EV%20Charger%20Guidelines.pdf
City of Sacramento, CA	Customer "How to" Guide Permit Checklist Load Calculation Template	http://www.cityofsacramento.org/dsd/customer-service/documents/CityofSac_ElectricVehiclePermitGuidePacket_Oct_20_11.pdf
City of San Diego	Customer "How to" Guide	http://www.sandiego.gov/development-services/industry/pdf/infobulletin/ib187.pdf
City of San Francisco, CA	Customer "How to" Guide	http://www.sfenvironment.org/downloads/library/home_evse_permit_summary_sheet_v12.pdf
County of Los Angeles, CA	Permit Template	Appendix 8.7 http://www.baclimate.org/images/stories/actionareas/ev/readysetcharge_evguidelines.pdf

Training and Outreach

Organization	Reference Type	Location
EVITP	Electrician Training	http://www.necanet.org/index.cfm?fa=newsAboutNecaItem&articleID=4765 http://www1.eere.energy.gov/cleancities/toolbox/pdfs/electric_vehicle_infrastructure_training.pdf
SCE	Installers Guide	http://www.sce.com/info/electric-car/installers/installers.htm

Endnotes

[1] More information about EVSE choices can be found at http://www.goelectricdrive.com/Charging/FindanEVCharger.aspx

[2] SAE J1772. "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler" 2012-21-02

[3] Many Level 2 EVSEs have a selectable charge rate to minimize the risk of circuit overload. Examples include the Leviton EVC11-300 <http://store.leviton.com/Evr-Green-Portable-Charger-Level-EVC11-300/dp/B00700RZSS> and the Voltec 120V Cordset <http://gm-volt.com/forum/archive/index.php/t-6780.html>

[4] SAE J1772. "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler" 2012-21-02

[5] The actual charging rate is defined by the onboard vehicle battery charger which is located on the vehicle. The EVSE, based on its specifications and rating, supports the charger. To learn about what level of charging is available on vehicles, see specific ratings for each automaker. The virtual showroom at GoElectricDrive is also a good reference <http://goelectricdrive.com/ElectricCars/VirtualShowroom.aspx>

[6] GM-Volt.com. <http://www.gm-volt.com/index.php?s=commuters> or M. Bly, GM. National Conference of State Legislatures <http://www.ncsl.org/documents/transportation/BLY_081011.pdf>

[7] The EV Project. Q4 2011 Report. <http://www.theevproject.com/downloads/documents/Q4%20INL%20EVP%20Report.pdf>

[8] See incentive examples such as The EV Project <http://www.theevproject.com/overview.php> and ChargePoint America <http://chargepointamerica.com/program-info.php>

[9] For example, Southern California Edison, which provides a "Plug-In Car Rate Assistant Tool" at <www.sce.com/ev> as well as a customer rate assessment through their customer service line <800-4EV-INFO>.

[10] Current estimate on the total percentage of customers choosing dedicated EV TOU rates is approximately 3-5% of customers. PG&E comments to California PUC on Feb 21, 2012 estimate 2,800 PEVs in PG&E service territory with 100 customers choosing the E9B rate, or approximate 3.5%. <http://docs.cpuc.ca.gov/efile/CM/160429.pdf>

[11] Enid Joffe, Clean Fuel Connection, Inc.. Lessons Learned: Evaluation of Prior EVSE Installations. 28 July 2010. <http://www.cleanfuelconnection.com/presentations/Plug-In-2010-Joffe-Lessons-Prior-EVSE-Install.pdf>

[12] SPX <http://www.autonews.com/Assets/html/green-car-conference/_pdf/Tanvir-Arfi-Presentation.pdf>

[13] Intertek Certification Overview <http://www.intertek.com/uploadedFiles/Intertek/Divisions/Commercial_and_Electrical/Media/PDF/Battery/Electric-Vehicle-Supply-Equipment-EVSE-Certification.pdf>

[14] SAE J1772. “SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler” 2012-21-02. Presentation: http://www.sae.org/smartgrid/chargingspeeds.pdf

[15] The next revision cycle for NEC is 2014.

[16] A task force has been formed (Code Making Panel -12) to address gaps and revisions in Article 625. http://mydocs.epri.com/docs/publicmeetingmaterials/1112/PDNNSH5Q3Z2/Day%202%20PlugIn%20Electric%20Vehicle%20Codes%20Standards/D2_11%20G%20Nieminski%20On-road%20report.pdf

[17] Rob Colgan comments at pre-convention workshop on plug-in electric vehicles and charging installations. NECA Conference. San Diego, California. October 22, 2011.

[18] Post-installation feedback.

[19] General Motors’ response to questions on venting requirements with lithium-ion batteries.

[20] NFPA 70. Tentative Interim Amendment (TIA) 11-2. Issued: 19 Oct 2011. <http://www.nfpa.org/Assets/files/AboutTheCodes/70/TIA70-11-2.pdf>

[21] The State of Oregon provides an example of the electrical minor label designation for the installation of a branch circuit not to exceed 40 amps/250 volts to service a home-based EVSE.
<http://www.bcd.oregon.gov/notices/Adopted_Rules/2010/070110_electricvehiclesupplyequipment_pr.pdf>
<http://www.bcd.oregon.gov/programs/minorlabel/minor_label_programs.html#2>

[22] While it might be expected that procedures should be consistent within the same jurisdiction, electricians have noted real-world differences between individuals, as well as over time.

[23] The County of Los Angeles’ Public Works Department drafted a checklist for permitting and inspection. Noted in *Ready, Set, Charge California!: A Guide to EV Ready Communities*. <http://www.baclimate.org/impact/evguidelines.html>.

[24] City of Los Angeles e-Permit Process. http://ladbs.org/LADBSWeb/e-permit.jsf

[25] Please refer directly to each utility’s website on specific rates, including:
LADWP: https://www.ladwp.com/electricrates
PG&E: http://www.pge.com/myhome/environment/whatyoucando/electricdrivevehicles/rateoptions/
SDG&E: http://sdge.com/clean-energy/electric-vehicles/ev-rates
SCE: http://www.sce.com/info/electric-car/residential/fueling-rates.htm
SMUD: https://www.smud.org/en/residential/environment/plug-in-electric-vehicles/PEV-rates.htm

[26] Another economic impact is opportunity cost of the electrician. If an electrician is unfamiliar with the jurisdiction, or knows a specific jurisdiction may be unpredictable, the electrician may delay or cancel other work.

[27] Includes data from national installations completed from late 2010 through December 2011.

[28] SPX <http://www.autonews.com/Assets/html/green-car-conference/_pdf/Tanvir-Arfi-Presentation.pdf>

[29] Permit fees should be reviewed by searching jurisdictions. The Friends of the Earth report, *A Survey of Bay Area Permitting Procedures for Electric Vehicle Charging Infrastructure* (Feb 2010) reports permit data for California. <http://www.suv.org/sites/default/files/Friends%20of%20the%20Earth_EV%20Charger%20Permitting%20Report_FINAL%20_5_.pdf>

[30] A permit fee may range. Table 3 provides a single representative example from installations completed by SPX. In some jurisdictions, a flat fee is available while at other times the fee may be calculated based on the value of the work being performed or the size of the house.

[31] Electrification Coalition: Electrification Roadmap. November 2009.
<http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf>
Additional:
Plugin…Recharge at <http://www.pluginrecharge.com/2011/08/residential-evse-roundup.html>
SPX at <http://www.homecharging.spx.com/volt/Display.aspx?id=26&menu=24>
PluginCars at <http://www.plugincars.com/aerovironment-ev-pioneer-becomes-charging-leader-107821.html>

[32] Based on national data from SPX taking into account total cost of the installation.

[33] Information on Davis-Bacon can be viewed at <http://www.wdol.gov> or <http://www.dol.gov/whd/contracts/dbra.htm>

[34] Post-installation feedback

[35] Ibid

[36] Electric Vehicle Infrastructure Training Program (EVITP) has been designated as a best practice by the U.S. Department of Energy. This industry collaboration has been established to develop a curriculum to train and certify electricians on the installation charging equipment. <http://www1.eere.energy.gov/cleancities/evitp.html>

[37] http://www.evcollaborative.org/news-events

[38] http://www.pevcollaborative.org/toolkit

[39] South Bay Cities Council of Governments; EV Charging Infrastructure Workshop: http://www.southbaycities.org/node/1152 and California Electric Vehicle Codes and Standards Seminar: http://www.southbaycities.org/node/1168

[40] City of San Diego, Information Bulletin 187. May 2012.
http://www.sandiego.gov/development-services/industry/pdf/infobulletin/ib187.pdf

[41] City of Berkeley, CA. Residential Plug-In Electric Vehicle Charging Station Permit Guide. March 2012.
http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=75018

[42] A plan check may be required for installations which exceed a standard 240V circuit and EVSE installation, such as when an EVSE installation is accompanied by a service panel upgrade. In these cases, a jurisdiction's standard processes would apply for the service panel upgrade, which may require a plan check.

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