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ATTACHMENT A

The Utility Role in Supporting Plug-In Electric Vehicle Charging

Staff Issues Paper
Energy Division
California Public Utilities Commission
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Introduction

This paper discusses utility role and boundary issues associated with plug-in electric vehicle (PEV) charging. Much of the paper focuses on metering issues, but topics related to other aspects of the utility-customer boundary and streamlining of the charging infrastructure installation process are also addressed.

The paper is organized into five parts:

1. General Metering Background
2. PEV Metering Arrangements for Single Family Homes
3. PEV Metering Arrangements for other Customer types
4. Utility Role in PEV Adoption
5. Conclusions, Recommendations, and Questions

Throughout this document, the use of the term 'customer' refers to either the utility accountholder or the charging company that is providing charging services (i.e., the entity that is responsible for the electricity bill for a particular location *or* account).

Section 1: General Metering Background

This section provides background information on metering and how it relates to PEVs, including: PEV charging equipment, utility metering, and meter cost information; party responses to the metering questions posed in the Order Instituting Rulemaking 09-08-009; and several related issues such as PEV charging equipment interactions with the smart grid and the Low Carbon Fuel Standard (LCFS) requirements.

1.1 PEV Charging Equipment

Certain parties expect that Level 2 electric vehicle service equipment (EVSE) will be the preferred charging equipment for residential and commercial PEV users in the long-term.[1] The following equipment and permits are needed for customers who install PEV Level 2 charging equipment at their home or business.

- Adequately-size service panel: Each electricity customer has a service panel that divides the electric circuits and includes a circuit breaker to safely manage electricity consumption.
- Adequate wiring to the charging location: customers will need wiring of the appropriate gauge installed to serve their EVSE. This wiring will extend from the panel to the EVSE.
- EVSE equipment: charging equipment designed to safely manage the voltage used to recharge the PEV battery, meeting applicable electric code requirements.
- City/County Permits for any electrical or land use changes.

Customers using Level 1 charging equipment will likely not need to install EVSE or need panel changes. These customers may only need wiring from the panel to a traditional 3-prong outlet. Separate EVSE equipment may be unnecessary for customers using low voltage levels to fuel their vehicle.

Customers installing direct current (DC) charging equipment will need additional wiring and charging equipment. Panel upgrades and additional permitting requirements are likely for DC charging installations at residential and commercial service locations.

An additional hardware component is the electric meter. The following sections explain the functions and characteristics of an electric meter.

1.2 Metering Basics: What can and can't a meter do?

In its simplest form, an electric meter measures the current going through a circuit at a specific location in the power system, most frequently at the point of service to a customer account.[2] Although parties ascribed numerous functions to the meter, the meters' functions are limited to:

- Measuring the accumulated current going through a given wire;
- Recording the current readings under different time intervals;
- Storing meter data internally; and

[1] PG&E opening comments at p.5.
[2] Energy Policy Research Institute (EPRI), "Accuracy of Digital Meters" May 2010 (p. 2)

- Communicating data (wirelessly or over wires).

The AMI meters currently being deployed by the three investor-owned utilities (IOUs) cannot do the following:

- Measure or store data for multiple subloads;
- Respond to demand response or load management signals; or
- Calculate or process billing information.

Meters have four characteristics:

- *Accuracy:* Meter 'accuracy' is defined as the variance of the demand measurement versus the demand delivery. For example, a meter with 1% accuracy would produce meter measurements that may vary by +/- 1% of the actual load delivered. Smaller accuracy ratings reflect greater measurement precision. Electricity meters generally range in accuracy from 5% to .25%. Mechanical electricity meters traditionally used by utilities have 2% accuracy, while the Advanced Meter Infrastructure (AMI) meters currently being installed by California's IOUs are rated at .25% accuracy.
- *Data measurement granularity:* Current AMI meters being installed in each IOU territory can measure a single customers usage under different time intervals. Each IOUs' AMI meter is required to track load at a minimum granularity of hourly intervals.[3]
- *Data Storage Capability:* Meters have memory cards that can store past usage data. AMI meters generally store one day to one month of data.[4]
- *Communication functions:* A meter needs some method to communicate its usage data to the utility. Traditionally, meters required manual, on-site reading by utility meter readers. The AMI meters currently being installed by California's three major IOUs have embedded software that wirelessly communicates usage and other information to the utility back office. Most meters can be configured to communication with the utility and/or with a Home Area Network (HAN). Communication with a HAN could occur through one of several communication protocols (Zigbee, Z-Wave, HomePlug, or others).

The performance of utility-owned meters is verified by the utility. The utility is also responsible for 'sealing' their meter after it has been installed and responding to customer complaints regarding its accuracy. Non-utility owned meters are verified by the California Department of Food and Agriculture and sealed by the local County Sealer.[5]

1.3 Meter Costs

Meter cost depends on the functionality of the meter and the installation cost. According to a KEMA report on CSI metering requirements, meter hardware can range in cost from $35 (for a simple socket meter with no remote communication functionality) to over $1,000 for meters capable of advanced submetering and sophisticated communication

[3] KEMA Report, 2009.
[4] Ibid.
[5] Verbal communication with Matt Stevens of the California Department of Food and Agriculture, Division of Measurement Standards on Aug 24th, 2010.

functions.[6] KEMA estimates that the average residential solid-state AMI meter costs about $151, which includes remote communication functions and installation cost.

1.4 Party Perspectives on PEV Metering Issues

Several themes that emerged from the October 2009 written responses to questions posed in the Aug 24, 2009 AFV rulemaking are summarized below.

Consider different functionalities that can be included in the meter. Parties assumed a range of functions that should be included in the meter, including:

- Customer price signals (Environmental Coalition)[7]
- Load management functionality (Environmental Coalition, University of Delaware, General Motors, SDG&E, PG&E)[8]
- TOU load tracking ability (Tesla and PG&E)[9]
- Vehicle to grid functionality (Tesla)[10]
- Two way communication functions (PG&E)[11]
- Neighborhood level communication functions to avoid local distribution impacts (TURN)[12]
- Ability to charge for highway/excise taxes (Environmental Coalition)[13]
- Net metering to facilitate vehicle-to-grid power flow (University of Delaware)[14]

Address the EV/Smart Grid nexus. Many parties recognized a need for the meter to be able to communicate with the smart grid (Coulomb, Environmental Coalition, General Motors, SDG&E, TURN).[15] While PG&E and SDG&E thought that PEV meters should rely on the smart grid, Better Place discouraged the Commission from requiring metering that relied on the smart grid.[16]

Consider LCFS credit issues. Numerous parties suggested that direct metering would be needed for measuring LCFS credits.[17]

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[6] Ibid. (page 7-6).
[7] Environmental Coalition opening comments at p.16.
[8] Environmental Coalition opening comments at p. 16, University of Delaware opening comments at p. 2, General Motors opening comments at p. 2, SDG&E opening comments at p. 8, PG&E opening comments at p. 4.
[9] Tesla opening comments at p. 2 and PG&E opening comments at p. 4.
[10] Ibid.
[11] PG&E opening comments at p. 4.
[12] TURN opening comments at p. 5.
[13] Environmental Coalition opening comments at p. 16, SDG&E opening comments at p. 8.
[14] University of Delaware opening comments at p. 2.
[15] Coulomb Technologies opening comments at p. 10, Environmental Coalition opening comments at p. 16, General Motors opening comments at p. 2, SDG&E opening comments at p. 8, TURN opening comments at p. 4.
[16] Better Place opening comments at p. 5, PG&E opening comments at p. 5, SDG&E presentation at the March 16th Joint Agencies workshop.
[17] SMUD opening comments at p.3, Mitsubishi opening comments at p. 3, and BP America opening comments at p.6.

Allow for flexibility for metering requirements. Almost half of the parties that filed comments to the OIR encouraged the Commission to allow flexibility in the metering options that would be made available to PEV users. San Diego Gas and Electric (SDG&E), Sacramento Municipal Utility District (SMUD), Interstate Renewable Energy Council (IREC), AeroVironment, Environmental Coalition, Better Place and the University of Delaware all suggested that the market is at such an early stage of its development that narrow metering requirements might be quickly outmoded by new technologies or market challenges.[18] Coulomb and The Utility Reform Network (TURN) both thought that different customer types could benefit from different metering arrangements, requesting the Commission accept multiple metering arrangements for PEVs.[19] Pacific Gas and Electric (PG&E) and Tesla suggested that the Commission should allow for flexibility within defined technological and communication constraints.[20] One party, Southern California Edison (SCE), indicated that the current practices regarding meter investments are appropriate to facilitate early market adoption.[21]

1.5 Metering Requirements

In order to understand what metering functionality might be required for PEV meters, it is useful to review the metering requirements that the CPUC has used in other customer or technology contexts. Metering arrangement issues have been addressed by prior Commission decisions in the four contexts discussed below.

Advanced Meter Initiative (AMI). The May 18, 2005 Assigned Commissioner Ruling in the AMI proceeding established six broad functional requirements for smart meters:

- Support price responsive tariffs;
- Collect hourly usage data;
- Allow customer access to data;
- Be compatible with customer education, energy management, customized billing and complaint resolution applications; and
- Be compatible with utility system applications that promote and enhance system operating efficiency and improve service reliability.[22]

The AMI meters being deployed by each IOU meet or exceed each of these requirements.

California Solar Initiative. The CSI program uses different metering requirements depending on the incentive requirement used. For photovoltaic (PV) systems receiving a performance-based incentive, CSI requires that a 2% accuracy meter be used. For systems receiving a capacity-based incentive, the CSI program requires that a 5% meter

[18] SDG&E Opening Comments at p. 7, SMUD opening comments at p. 2, IREC reply comments at pp. 2-3, AeroVironment opening comments at p. 2. Environmental Coalition opening comments at p.16, University of Delaware opening comments at p.2, Better Place opening comments at p.2, Division of Ratepayer Advocates (DRA) opening comments at p. 7, Tesla opening comments at p. 2.
[19] Coulomb opening comments at p.4 and TURN opening comments at p. 4.
[20] PG&E opening comments at p. 4 and Tesla opening comments at p. 2.
[21] SCE opening comments at p. 9.
[22] CPUC Decision 05-09-044.

be used. In California and most other states, PV programs require that performance-based incentives have metering that is equal to or better than what is required of capacity-based incentives.[23] Meters are not required to communicate wirelessly. Metering service organizations are required to submit metering data to the utility; however, they are allowed to use whatever remote or manual data collection method they choose.

Direct Access. Direct Access customers are not required to have a utility-owned meter. Instead, the service provider or the customer can provide the meter used for billing. This meter, though not provided by the utility, is used by the utility to calculate transmission and distribution charges, while the energy provider uses the meter to calculate generation charges. The Commission recognizes that third party intermediaries for DA customers may install and operate metering equipment, provided that it meets utility standards.[24] For instance, the meters must measure load on hourly intervals and store 12 months of load data. In addition, the utility can inspect the meter if they suspect that it is faulty.[25]

Self-Generation Incentive Program (SGIP). SGIP provides financial incentives to customers that install on-site distribution generation. To receive a production incentive, customers are required to use meters with 2% accuracy or better.

1.6 Meters and Smart Grid Communication Functions

Some parties implied that PEV electricity usage needs to be measured separately by an AMI enabled meter. While the meter can play a role in facilitating smart grid communication, a smart meter is not essential to enable a PEV or a customer-owned EVSE to participate in smart grid communications.

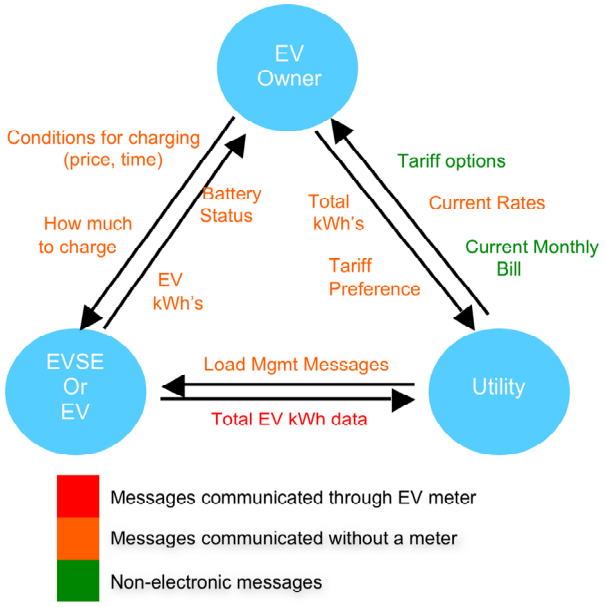

Figure 1. Messages Needed for PEV Charging

The following are examples of data and information exchanged between entities involved in the PEV charging process:

- PEV load
- Unique tariffs and billing arrangements for PEVs

[23] Ibid.
[24] CPUC Decision 95-12-063.
[25] PG&E Tariff Rule 22. SCE Tariff Rule 22 and SDG&E Tariff Rule 25.

- Remote management/control of PEV charging
- Smart vehicle charging communication

Metering communication is a subset of the broader communication that occurs between the utility, the customer and the electric vehicle. Figure 1 is a simplified representation of the information exchanged between these entities.

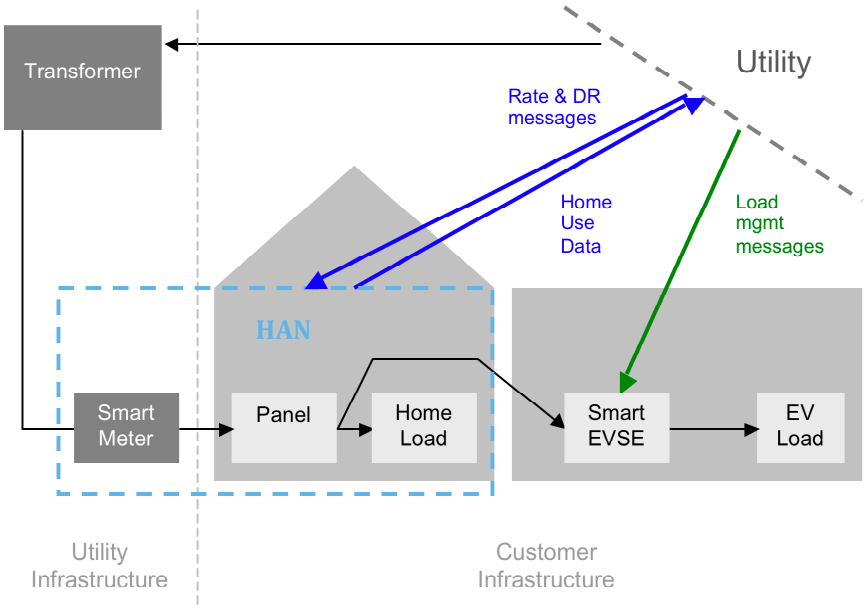

Figure 2. Smart Grid Communication without Separate PEV Metering

It is not necessary to have a second AMI meter coordinate all of the communication functions for a PEV identified above. The PEV meter need only communicate the electricity usage. Other types of remote control devices in the HAN, EVSE or even the PEV can accomplish many or all of the load management control and smart charging communication functions.

Figure 2 shows how these messages are communicated within a residential house using whole house metering. In this figure, the EVSE is responsible for receiving any demand response (DR) messages. All other communications functions can be achieved with out the need for an AMI compatible meter, if the EVSE is AMI-enabled.

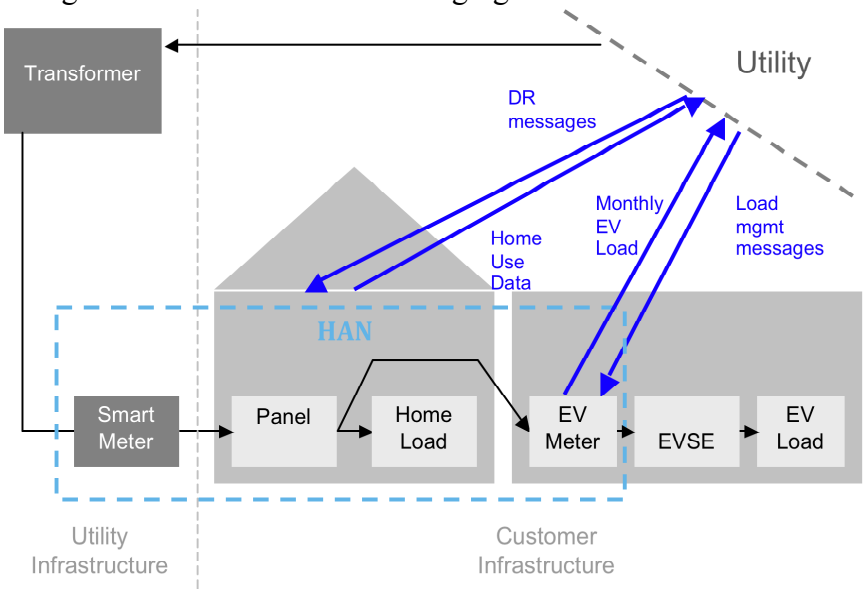

Figure 3. Smart Grid Communications with Separate PEV Metering

Figure 3 shows what communication functions could work when a second meter is AMI compatible. In this example, the PEV meter is assumed to be a submeter of the primary meter. This submeter is responsible for communicating PEV usage data to the utility and receiving load management messages.

In its metering report for CSI, KEMA addressed the need for CSI meters to be AMI compatible. KEMA evaluated three options for CSI participants: no AMI integration, AMI compatible meters owned by the customers, and AMI meters owned by the utility. KEMA found that requiring AMI meters for PV systems would result in increased costs for PV owners but would allow for consistent record keeping.[26] KEMA also found that allowing customer owned meters to connect to AMI would allow customers to take advantage of technology changes. However, KEMA noted that third party electric vehicle service providers (EVSPs) could leave the market, raising subsequent maintenance issues for the AMI-compatible meters that the third party EVSPs installed.[27]

1.7 PEV Metering Requirements under the LCFS and Other Regulations

Parties identified the need for two possible regulatory requirements that may require direct metering of PEVs: LCFS credits and electricity fuel excise taxes. No excise taxes that apply to electricity currently exist in California. However, Executive Order S-01-07 directed the California Air Resources Board (ARB) to establish the LCFS regulation by 2011. The LCFS requires fuel deliverers (at specified points of regulation) to reduce the carbon intensity of fuels used in California by 10% from a baseline applicable to reformulated gasoline and diesel fuels.[28] Currently, alternative fuels below the established baseline carbon intensity may generate surplus LCFS credits. These credits may be traded at a price determined by the supply and demand for the credits. The regulation will go into effect in 2011.

ARB's regulation assigns LCFS credits to a third party provider, where applicable. If there is not a third party provider, the load serving entity that provided the fuel is assigned the LCFS credit. Customers can set up contractual agreements that require the third party EVSP or the utility to turn over the LCFS credits to the customer.[29]

In its Final LCFS Regulation Order, ARB required that electricity fuels used for transportation can only receive LCFS credits if they are "direct metered." Prior to 2015, ARB will allow regulated entities to claim LCFS credit provided they demonstrate that they have a credible alternative to direct metering. After 2015, all credits for residential charging, public access charging, and fleet charging require some form of direct metering (although ARB has not specified how this will be achieved).[30] ARB's regulation does not specify the metering frequently or level of accuracy required for LCFS credits.

[26] KEMA, 2009. Final Report for the CSI Meter and Market Assessment Project.
[27] Ibid.
[28] Air Resources Board, 2010. Low Carbon Fuel Standard Program Background.
[29] Air Resources Board, 2010. Final Regulation Order.
[30] Ibid.

Section 2: Identified Approaches to Metering PEV Load in Single Family Homes

This section addresses PEV metering options for single family homes. Generally, PEV charging is expected to occur predominantly at the customer's home. Three metering options are described in this section, and they are evaluated against four criteria (installation impacts cost impacts, communication functionality, and billing flexibility).

2.1 PEV Metering Options

Three general approaches have been identified that can be used for metering PEV load in a single family residence: single metering, submetering, or separate metering. Each of these approaches can be used by each customer type, though unique customer contexts may require additional specifications. In its presentation at the March 16th Joint Agencies workshop, PG&E identified three similar metering options.[31] (Except for a handful of submetering exceptions described in Section 4.1, California's IOUs currently offer PEV customers the choice of either using a single or separate metering arrangement.)

Single Metering. All PEV load is counted as part of the total house load, and is not separately measured. This approach (which is used for virtually any other new appliance purchased by a household) is sometimes referred to as 'whole house' metering.

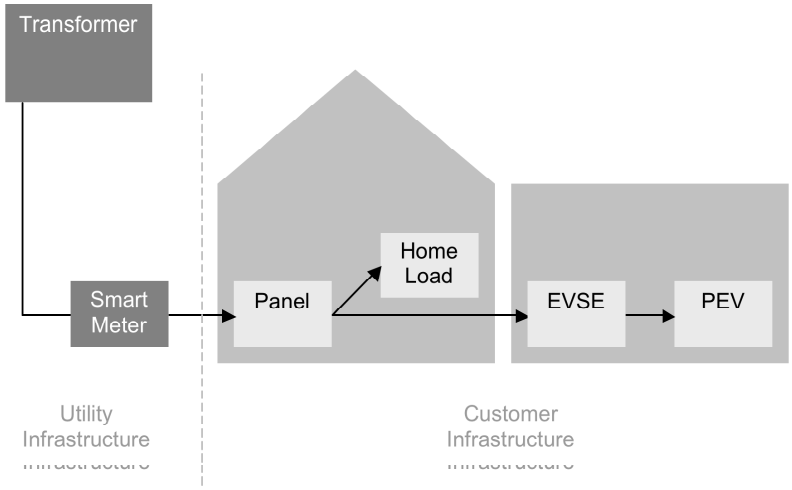

Figure 4. Single Metering for a Residential Home with PEV

Separate Metering. PEV load is measured and billed separately from the rest of the customer load, using a dedicated revenue grade meter. The PEV load is essentially charged to a separate account from the rest of the customer's load, though the accounts can be aggregated onto one bill. Separate metering is sometimes referred to as 'parallel metering.'

[31] PG&E Presentation, March 16th Joint Agencies EV Workshop.

During the 1990s, separate metering was often accomplished using a dual meter adapter. The dual meter adapter reduced the number of utility visits during the installation process and avoided the need for some panel upgrades.[32] However, staff understands that SCE will no longer support dual meter adapter installations, because the dual meter adapter is not United Laboratories (UL) approved.

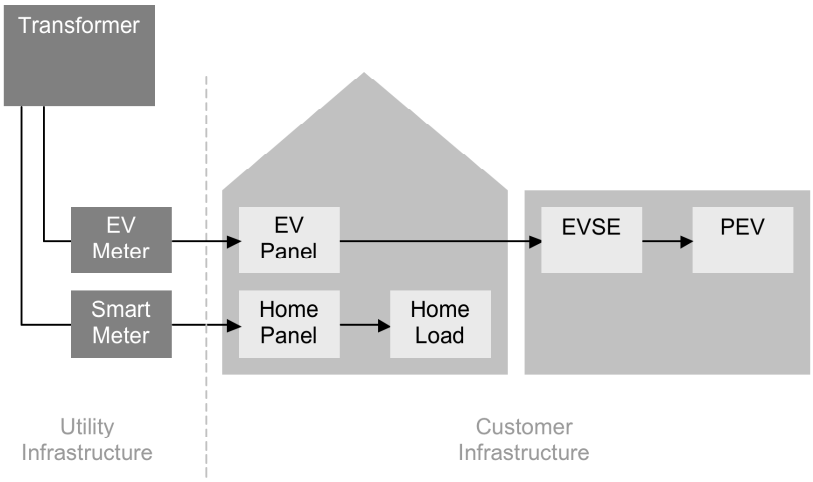

Figure 5. Separate Metering for a Residential Home with an PEV

Submetering. PEV load is measured by a meter installed between the main meter and the EVSE that acts as a submeter for the PEV load. This meter measures PEV load as a subset of the entire load, while the original customer meter measures the entire customer load. For billing purposes, the PEV meter load needs to be subtracted from the main meter load to avoid double-counting the PEV kWhs. Submetering is sometimes referred to as 'subtractive metering' or 'series metering.'[33]

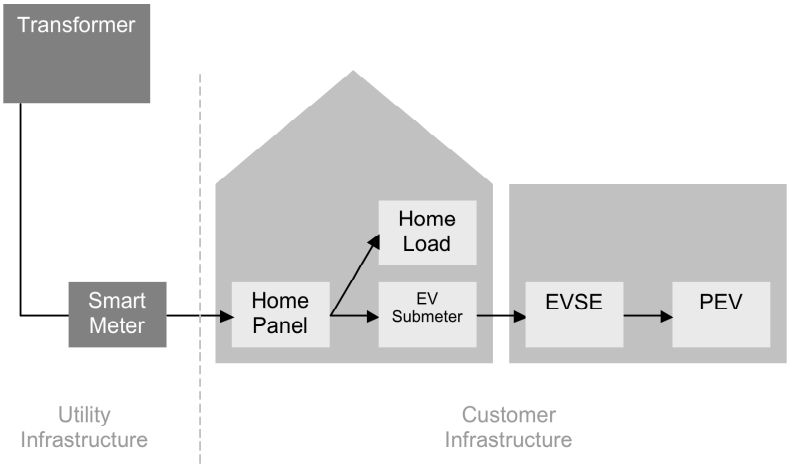

Figure 6. Submetering for a Residential Home with an PEV

These criteria are explored in the following three subsections, evaluating the metering options from the perspective of a single family house.

2.2 PEV Metering Arrangement Criteria

PEV metering arrangements can be evaluated based on the four criteria described below.

[32] Verbal communication from Enid Joffe (CEO, Clean Fuels Connection) on August 26, 2010.
[33] The term 'series metering' may be considered misleading because the meter is not in series per the electrical definition of the term.

Installation Impacts. Metering requirements may add additional steps to the EVSE installation process. Several parties thought that utilities should use PEV metering arrangements that minimize the installation requirements for EVSE. General Motors expressed the concern that metering arrangements should introduce "neither an inconvenience nor a cost to residential customers and that the installation should be integrated with the EVSE installation."[34] The installation process has already been identified by stakeholders as a potential obstacle to PEV adoption. In the March 16th Joint CEC and CPUC workshop on EVSE installation, several parties (including PG&E and Clean Fuel Connection) identified 'hand-offs,' or transitions/sign-offs between parties, as the primary source of installation delays, rather than the actual labor time associated with the installation.[35] According to Clean Fuels Connection, the average installation took 35-45 days, while the actual work to install the equipment took only about 4 hours.[36] PEV installations that require new meters or changes to the existing meter will require a visit from utility personnel, adding additional 'hand-offs' to the EVSE installation process. Panel upgrades are the source of several additional hand-offs and considered by Clean Fuel Connections to be the biggest driver of installation costs.[37]

Cost. Different meter arrangements require different equipment and total labor time. SMUD argued that the "financial interests of customers" must be factored into the PEV metering requirements in order to avoid stifling adoption.[38] A major source of time and labor costs for EVSE installation is the need to upgrade the panel size. According to Clean Fuel Connection, the average cost of an installation – excluding the charging station and service upgrades expenses - in 2009 was $1,671, and the median cost was $1,494.[39]

EVSE installation may require distribution system upgrades under high PEV penetration rates. However, these costs do not appear to be linked to the metering arrangement. Distribution upgrades are dependent on the customer's panel size and their neighborhood transformer load. Although single metering does not change the 'nameplate' amperage demanded by a household, it can increase the coincident demand on a transformer, impacting the quality of power for customers on that transformer. So although PEV load will be the same regardless of how it is metered, single metering and submetering may not signal to the utility the need for an upgrade evaluation the way that the permitting and installation of separate meter may.

Communication Functionality. The metering arrangement will impact the PEV load information available and the control utilities and customer have over that load. Metering arrangements with fewer communication functions do not necessary prevent the use of remote load management functions. As stated previously, the lack of a unique PEV meter does not preclude a PEV or an EVSE from participating in DR or other load management

[34] General Motors opening comments (p.2).
[35] PG&E and Clean Fuels presentations, March 16th Joint Agencies EV Workshop
[36] Clean Fuel Connection Presentation, March 16th Joint Agencies EV Workshop.
[37] Clean Fuel Connection Presentation, March 16th Joint Agencies EV Workshop.
[38] SMUD opening comments (p. 3).
[39] Clean Fuel Connection Presentation, March 16th Joint Agencies Workshop.

programs. However, meters that lack these functions will require additional equipment components to participate in DR programs.

Billing Flexibility. A separate meter enables a PEV to be separately billed from the rest of the customer's load. Separate billing allows customers to choose the tariff schedule for their PEV usage separate from the tariff schedule used for their home usage, though it is not a requirement that PEV load be separately billed (each of the IOUs currently has a 'single meter' rate available to its PEV customers).

2.3 Single Metering

Under this arrangement, PEV usage is billed to the house meter. Both the home usage and PEV usage are billed at the same tariff rate.

Total Installation Hand-offs. Minimum of 4. This arrangement requires the fewest hand-offs and results in the fewest installation delays because it does not require changes to the meter. PG&E believes that single metering results in the simplest installation process.[40]

Cost. No additional meter is needed, though it may be necessary to equip the EVSE or vehicle with a communication device to receive load management and other smart grid messages.

Billing Flexibility. No billing flexibility – all PEV load must be billed at the same rate as the rest of the customer's load. This avoids the opportunity to shift usage between two meters to reduce cost ("load arbitrage").

Communication Functionality. Without additional communication devices in the EVSE or PEV, this meter arrangement does not provide any direct communication with the utility or the HAN network. Additional communication devices would need to be included in the EVSE or PEVs to allow vehicle charging to automatically respond to load management messages.

Other Issues. Under a single tariff for both home and EV usage, customers currently on tiered rates could find themselves paying very high rates for PEV charging if they do not switch to a TOU rate. PEV charging would lift their rates into upper tiers, resulting in a very high marginal rate (over $.35/kkWh) for their PEV charging.

Party Comments. SCE commented that whole house metering would meet user needs during the early market stage.[41] PG&E commented that this installation approach results in the simplest back office integration.[42]

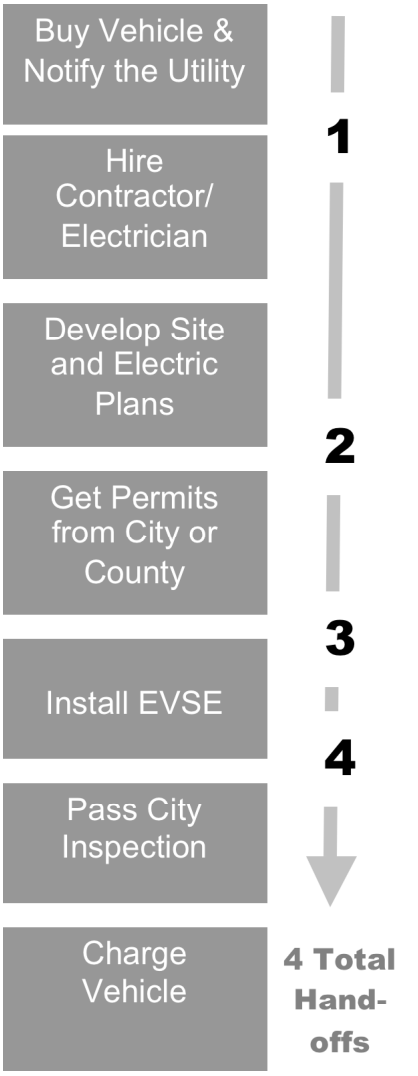

Figure 7. EVSE INSTALLATION STEPS for SINGLE TARIFF METER. **Assumes PEV load is served by AC Level 2 EVSE and metered as part of the total residential load. Assumes no panel upgrade or distribution system upgrades are needed.**

[40] PG&E presentation, March 16th Joint Agencies Workshop.
[41] SCE opening comments at p.11.
[42] PG&E presentation, March 16th Joint Agencies Workshop.

2.4 Separate Metering

The PEV is assigned its own revenue-grade meter, and PEV usage is measured and billed separately from the rest of the house usage. This meter will likely be served by a separate service line, connecting to the transformer, though dual meter adapters that use the same service line have been used in the past.

Total Installation Hand-offs. Minimum of Six. The utility will need to install and seal the meter once the contractor has completed the EVSE installation and other upgrades. According to PG&E, parallel metering results in the most complicated installation.

Cost. This meter arrangement requires a second meter and a dedicated panel for the EVSE.[43] The utility may need to upgrade the service line from the transformer to the customer to serve the new meter and panel.

Billing Flexibility. Maximum flexibility. Customer can use any tariff they want for their PEV, while still separately billing their home load. Separate billing also introduces the opportunity for billing arbitrage.

Communication Functionality. If the PEV meter is AMI compatible, the PEV would appear as an AMI node. As an AMI node, the meter could directly participate in utility demand response and load management programs. Additional communication functions may be needed to enable the customer to connect to the HAN network. Connecting with the HAN could allow customers to control charging, though the user could communicate directly to their vehicle or using a smart grid-enabled EVSE.

Party Comments. IREC commented that separate metering would increase the cost of EVSE equipment and would result in installation delays.[44] SMUD shared this concern regarding installation delays, stating that utilities are not equipped to handle a significant increase in meter installations and inspections. This would only be an added cost of submetering if utilities owned and installed the submeter.

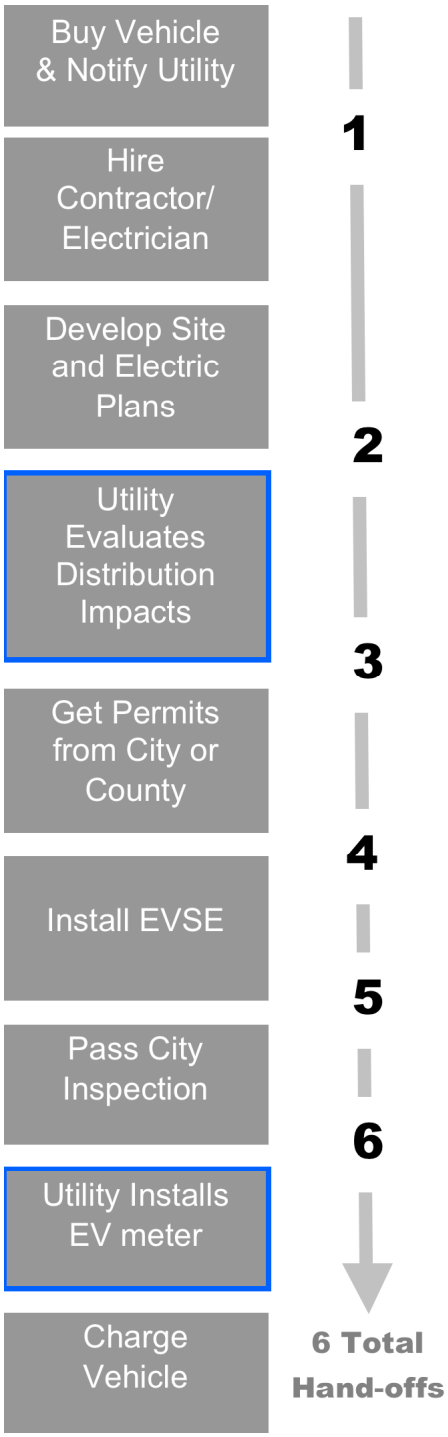

Figure 8. EVSE INSTALLATION STEPS with SEPARATE METERS. **Assumes PEV load is served by AC Level 2 EVSE and metered by a separate, utility-owned meter and does not account for panel or distribution upgrades.**

[43] It is possible that the EVSE could contain the panel and/or circuit breakers.
[44] IREC reply comments at p. 5.

2.5 Submetering

All usage is first measured through the primary meter, while the PEV usage is also measured by a dedicated submeter. The PEV usage can be subtracted from the primary meter to separately bill the house and PEV consumption. This "subtractive billing" is accomplished by back office billing software that links the meter data from the two meters and separately calculates the charges.

Total Installation Hand-offs. Minimum of five.

Cost. This meter arrangement requires a second to serve as the submeter. Additionally, this metering arrangement may require additional utility back office costs to integrate meter data into billing information.

Billing Flexibility. Maximum flexibility, but may require back office utility upgrades.

Communication Functionality. High functionality can be achieved with an AMI-compatible submeter, which would serve as a node on the AMI network and could also be a part of the HAN. Equivalent functionality can be achieved by installing these features in the vehicle or the EVSE.

Other Issues. The submeter could be owned by the utility, the customer, or an energy service provider (ESP). Section 4 discusses the impact of the customer/utility boundary.

Party Comments: Better Place commented that submetering was "an important step to ensuring that independent providers can participate in the market."[45] AeroVironment expressed concern that requiring submetering for customers during the early market phase would be costly and increase installation time.[46] PG&E expressed concerned that submetering could result in increased costs, especially to integrate data for bill calculation.[47] SMUD commented that the submeter would facilitate future metering options – such as including the meter in the EVSE – which may be beneficial to customers in the long run.[48]

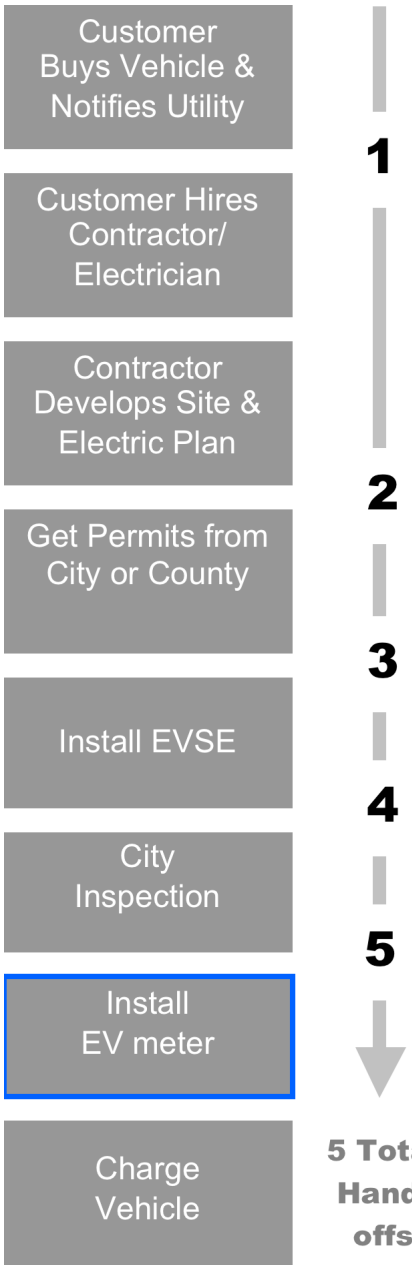

Figure 9. EVSE INSTALLATION STEPS for SERIES METERING. **Assumes all PEV load is served by AC Level 2 EVSE and metered by a PEV meter connected to primary meter on the customer side. Assumes no panel or distribution upgrades are needed.**

[45] Better Place opening comments at p.6.
[46] AeroVironment opening comments at p. 4.
[47] PG&E reply comments at p.8.
[48] SMUD presentation, March 16th Joint Agencies EV Workshop.

2.6 Safety Issues

Separate metering can trigger safety issues, depending on the installation plan. Emergency responders need to be able to cut off electricity when they respond to fires and other emergencies. Separate metering can create a safety problem if the service line is located far from the main service or if it the service panel is not easily identifiable. Emergency responders would prefer to have a single circuit breaker location. Single metering and submetering do not require a second service line, eliminating this risk to emergency responders.[49] Separate metering can minimize this risk to emergency responders by co-locating the PEV and house panels. A less effective option would be to include maps or signage at the main panel that indicate the existence and location of the EVSE panel.

2.7 Installation Complexity Comparison

The table below compares installation "complexity" based on the estimated number of visits from contractors, utility representatives and inspectors for each metering option, both with and without a panel upgrade.

Table 1. Installation Visits for Each Proposed Metering Arrangement Scheme

	Without Panel Upgrade				With Panel Upgrade			
	Single House Meter	Separate Meter	Submeter (utility-owned meter)	Submeter (Customer-owned meter)	Single House Meter	Separate Meter	Submeter (utility-owned meter)	Submeter (Customer-owned meter)
Contractor Visits	2	2	2	2	2	2	2 or 3	2 or 3
City Permit Visits[50]	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2	1 or 2
Utility Visits	0	2	2	1 or 2	2	2	2	2
Minimum Visits	**3-4**	**5-6**	**5-6**	**4-6**	**5-6**	**5-6**	**5-7**	**5-7**

2.8 Criteria Matrix

The following table compares each of the metering options based on the criteria listed in subsection 2.2. Submetering is broken into two categories to show the impact of customer-owned submeters versus utility-owned submeters. As PG&E stated in its March 16th workshop presentation, each of the three metering categories optimizes different criteria. Single metering optimizes installation time and cost, but provides no billing flexibility. Separate metering optimizes billing flexibility, but does not minimize costs or installation time. Submetering moderates the impact of some criteria (customer cost, and billing flexibility) relative to the other metering arrangements, but results in additional back office costs for the utility.

[49] Verbal communication from Kevin Reinertson, California Office of the State Fire Marshall on August 26, 2010.

[50] This counts the trip an electrician makes to the county permit office to get permits as a 'city permit visit.' In some municipalities, electricians can electronically file for permits.

Table 2. Criteria Matrix for Proposed Metering Arrangement Options

Criteria	Single Metering	Separate Metering	Submetering (Customer Owned)	Submetering (Utility Owned)
Minimum Installation 'Hand-offs'	**4**	**5**	**5**	**6**
Additional Costs (beyond EVSE installation costs)	Minimal, assuming no panel upgrade required	Separate meter + meter installation + dual meter adapter + panel cost	Submeter	Separate AMI meter + meter installation + dual meter adaptor
Communication Functions	Requires additional communication devices in the EVSE or PEV	Full functionality of AMI meter	Varies depending on meter type. May require additional communication functions in EVSE or PEV	Full functionality of AMI meter
Billing Flexibility	None. Must be billed the same as the home usage	Full Flexibility	Uncertain	Full Flexibility
Other Issues	Need a submeter for LCFS credit tracking.	Introduces electricity rate arbitrage opportunity	Introduces electricity rate arbitrage opportunity	Introduces electricity rate arbitrage opportunity

2.9 Additional Issues for Residential CSI Customers

Parties did not raise any unique metering issues for customers with existing or considering the option of installing solar PV panels and use a PEV. Any of the three metering options discussed could be utilized by CSI customers who own PEVs. Additional analysis will be necessary to determine if there are tariff or other limitations / requirements that suggest a preferential (or prohibitive) metering arrangement for customers who combine the use of solar panels and PEVs.

2.10 Metering Requirements for LCFS

ARB has yet to determine specific metering requirements for measuring LCFS credits, so the metering requirements for LCFS credits could be lower than those for utility revenue grade meters. As discussed in Section 1.5, most CPUC incentive programs set lower technical meter requirements for metering incentive activity as a means of reducing costs for participants. The use of lower cost meters would likely reduce the accuracy of electricity measurements, increasing inaccuracy from 1-5%.

Presumably, the separate and submetering options can be aligned with the LCFS credit program once ARB sets specific requirements; however, the single metering option does not appear to be compatible with the LCFS credit program, since the PEV load is not isolated. In this case, some form of secondary metering will be required to conform with the LCFS credit program.

ARB may want to consider allowing LCFS meters to be located in vehicles. ARB has the authority to set requirements for vehicles that qualify in its ZEV program, and could require that all ZEV vehicles include a meter that meets LCFS specifications. This requirement may increase vehicle costs, but may decrease overall costs for customers under single metering, by reducing their need to purchase an additional meter solely for LCFS credits. ARB would need to determine how this meter would communicate PEV usage to the utility. Additional communication functions would be needed to assign credits between PEV electricity provided by the utility and third party EVSPs.

Section 3: PEV Metering for Other Customer Types

Although the majority of PEV charging is expected to take place at single family residences, PEV charging will need to be made available in other residential and non-residential settings. This section explores metering issues for the following customer types, locations and arrangements: multiple dwelling units, workplace charging, third party public charging, and future metering possibilities.[51]

Charging in other locations will often involve an intermediary between the actual PEV owner and the utility. The metering arrangements described in this section refer to the utility metering arrangement with the account holder. This metering arrangement does not necessarily reflect the billing and meter arrangement experienced by the PEV owner.

3.1 Multiple-Dwelling Units (MDUs)

In the majority of MDUs, tenants in individual units are metered directly by the utility. Decision 05-05-026 determined that the building owner is required to separately bill each tenant using a utility-owned revenue grade meter in all buildings built after 1982.[52]

For the MDUs that are individually metered by utility, all three metering options appear to be feasible. Whole house metering (in this case, billing all the PEV and household load for each tenant under one rate and meter) would appear to be the easiest to implement. Separate metering could face space constraints, which might in turn increase total installation time and cost, as all the building's meters are grouped in one area. Submetering might also generate space constraints, though it might allow for more flexibility in meter location than separate metering would.

Table 3. PEV Metering in Utility-metered MDUs (w/o third party EVSPs)

	Single Meter	Submeter	Separate Meter
Description	Each tenant's overall usage is billed directly to her/his individual meter.	Each tenant's PEV usage is tracked by a submeter and subtracted from their primary meter	Each tenant has a separate meter for PEV usage.
Issues	How are LCFS credits tracked? Does the building owner or tenant receive LCFS credits?	Is there space to add a submeter behind the customer's utility meter?	Is there space to add a separate meter / service line next to the existing service (need to be co-located for first responder safety.

[51] According to PG&E's presentation at the March 16th Joint Agencies EV Workshop, the same general metering arrangements used for residential customers also apply to other customer types.
[52] CPUC Decision 05-05-026 found that landlords could administer submetering through their own meters.

Submetered MDUs with third party EVSPs. An MDU owner may choose to allow a third party EVSP to provide charging services to its tenants. Under this situation, the building owner and the EVSP would need to develop a system for recovering costs. If the EVSP is operating under the building owner's account, the EVSP would need to compensate the building owner for the electricity used, or provide a system for allowing the PEV user to directly pay the building owner for this usage. A building owner would also theoretically have the option of not billing tenants for this usage.

PEV Metering in pre-1982 Apartments (Master-metered MDUs). Owners of MDUs (or mobile/manufactured homes) built during or prior to 1982 can choose to allow the utility to individually meter tenants or use one primary utility meter for the entire building ('master metering'). In the master metered arrangement, the building owner can either embed the cost of electricity into the rent charged or bill each unit separately for their usage with submeters that are owned, maintained, and monitored by the building owner. CPUC Decision 05-05-026 allows building owners to purchase CEC-approved submeters to use in determining the electricity costs of each of their tenants. The building owner is ultimately responsible for paying the utility for the entire facility amount of electricity on the property's master meter. For these accounts, the electricity rates are adjusted to account for the building owner's cost in purchasing and managing the submeters. In 2004, the Commission estimated that less than 40,000 MDUs are currently master-metered.[53]

If a third party EVSP owned and operated EVSE in a master metered MDU, the EVSP would have two choices for getting its electricity: through the owner's master meter or through a separate service. There are no MDU-specific complexities associated with the scenario in which the EVSP obtains its electricity through a separate service. However, if the EVSP received its electricity through the building owner's account, and the EVSP could require that tenants pay for usage directly for their usage directly at the charging station. However, Electric Rule 22 may bar the use of an EVSP in an MDU if the EVSP is determined to be an ESP, per Tariff Rule 22.

[53] CPUC Decision 05-05-026.

Table 4. PEV Metering in Master-metered MDUs

	Single Meter	Submeter	Separate Meter
Description	Tenant usage is billed directly to building owners account.	Tenant PEV usage is tracked by a submeter.	Tenant has a separate meter for PEV usage.
Issues	Building Owner pays the entire bill and passes cost onto tenants How are LCFS credits tracked? Can the building owner or tenant get them?	Building owners of master-metered MDUs are already allowed to submeter their tenants. Building owners can only recoup their cost if they do this, they cannot profit. Is there space to attach a submeter to the customer utility meter?	Building owner sets up a separate account to separately meter PEV usage. Requires new panel and new meter. Separate meter and service line needs to be next to existing service to avoid problems with first responder issues.

Other Metering-Related Issues for MDUs. Determining who pays the costs related to EVSE installation further complicates the installation process. Building owners would benefit from owning the EVSE if it helps attract tenants, but they risk not finding tenants that will compensate them for the EVSE expense. Tenants may be reluctant to buy the EVSE if it is burdensome or costly to remove and reinstall it when they move. Additionally, it is unclear who should be responsible if the PEV installation triggers a panel upgrade. While the building owner would normally be responsible for these costs, it is not clear that they would be willing to bear this cost if only specific customers created and benefited from them.

3.2 Workplace metering issues

The key factors impacting metering arrangements for workplace charging appear to be the need to track LCFS credits and the ability to bill PEV owners directly for their workplace consumption.

LCFS credits. Tracking LCFS credits for workplace charging would require at a minimum some form of monthly kWh load total for commercial facility charging.

User Charges. Workplace charging can facilitate PEV adoption, but also could create special challenges for load management. In its presentation at the March 16th workshop, Clipper Creek explained how PEV users in a pilot test conducted at Georgia Power would charge at work rather than at home, despite the fact that they each had EVSE installed at their homes. Presumably, these customers realized the cost advantage of charging at work, where they did not pay for electricity.[54] The availability of subsidized workplace

[54] Clipper Creek presentation. March 16th Joint Agencies EV Workshop.

charging could encourage daytime charging, reducing the load benefits of nighttime charging at home.

User payment for workplace charging can reduce the incentive to charge during the day. Price signals are ineffective at influencing charging behavior if the user does not experience them. Alternatively, submeters could be billed directly to a customer credit card or billed directly to their home account. Submeters would need to be AMI compatible to communicate billing messages with the utility and the primary meter. However, as in the case of residential charging, submetering may require significant back office costs for utilities.

Table 5.PEV Metering Arrangements for Workplace Charging

	Single Metering	Separate Metering	Submeter
Without Third Party Providers	Simple installation Low cost Difficult to track LCFS credits Need a way for employees to measure usage and reimburse employer	Complex installation High cost Easy to track LCFS credits Need a way for employees to reimburse employer	Medium installation Moderate cost Easy to track LCFS credits Need a way for employees to reimburse employer.
Issues with Third Party Providers	Requires a way for third party charger to measure usage and reimburse employer for electricity cost	Allows third party provider to set up its own utility electricity account. Easy for employer to measure third party provider usage. May need method for third party provider to reimburse employer.	Allows third party providers to provide submeter integrated with the EVSE Need method to reimburse host for electricity cost.
Ideal Applications	Using charging as an employee benefit/incentive	Best for coordinating with third party provider.	Supports flexible billing (between third party, employer and employees) and allows flexible charging arrangements

While businesses would have to pay the cost for EVSE and metering equipment and any electricity they provide, it is not clear that this expense is enough to incent these businesses to bill their workers or customers. It may be possible for workplaces and commercial entities to allow a third party to establish its own electricity account with the utility, thereby eliminating a need for a workplace or commercial entity to collect revenue from the user or the third party EVSP.

3.3 Metering for Third Party EVSP Public Charging Stations

The billing issues in public charging are the same as workplace charging, in terms of metering arrangement options and their respective advantages. Public charging will also raises the same issues in regard to direct billing and LCFS credits.

3.4 Future Metering Possibilities

As SCE pointed out in their opening comments, the technology used in PEVs is rapidly developing, but current technologies limit metering arrangements.[55] Several parties asked the Commission to provide sufficient flexibility to accommodate the various possible directions that the market may move over time. Three possible metering technology changes could impact the Commission's policies: meters embedded in the EVSE, meters incorporated into vehicles, and AMI changes that allow submetering within one meter.

Meter embedded in the EVSE. In the future, EVSE manufacturers could include a meter inside the charging station equipment. Including the meter in the charging equipment would simplify the installation process for submetering, by eliminating the need for a separate installation of the meter. A meter in the EVSE would need to meet utility requirements for communication, data storage, and accuracy. This approach would raise utility-customer boundary issues, which are addressed in Section 4.

Meter Incorporated in the Vehicle. Manufacturers of PEVs are not currently including meters in their vehicles. However, the complex battery charging data tracked by the vehicle's onboard computer is able to provide metering functions at minimal additional cost, which are addressed in Section 4. A meter in the vehicle raises similar utility boundary and specification issues as a meter in the EVSE. A meter in the vehicle may also add complexity to LCFS credit assignment. ARB is currently considering assigning LCFS to the entity that provides the charging service – either the utility or the third party charge provider. For LCFS purposes, a vehicle meter would need to track charge location in addition to total kWhs.

Future AMI Developments. AMI meter technology is expected to evolve as meter communication technology improves and communication protocols are defined. In the future, existing AMI meters may be able to track a subload by communicating with a second meter. If a meter has a communication channel dedicated to communicating with a PEV submeter, existing AMI meters could accommodate separate billing. It is unclear if this functionality will require hardware changes in addition to software changes.

[55] SCE opening comments at p.11.

Section 4: Utility Role in PEV Charging

All parties agreed that utilities will play an important role in PEV adoption. Based on party comments, this section examines the utility role in five areas: the utility-customer service boundary, EVSE cost, EVSE installation, LCFS credits, and vehicle roaming. Some issues related to the utility role will not be addressed in this paper. In addition, issues related to ratemaking and direct charging management will be addressed in future white papers.

4.1 Utility "Boundary" Background

In general, the Commission has defined the utility-customer boundary relative to what is called the "service point." The service point is the point on a customer's property where the utility delivers electricity via a service wire from the transformer. Customers are responsible for the installation and maintenance of wiring used to deliver electricity from the service point to other parts of their property. An important exception to this rule is the fact that the meter is usually located on the "customer side" of the service point, despite the fact that the meter is usually owned and maintained by the utility. In some cases, the service point is located on the second story, where a meter could not be easily accessed by the utility. The wiring used between the service point and the meter is owned and maintained by the customer. Figure 11 illustrates how the utility-customer ownership boundary is defined for most customers. [56]

It is important to note that the ownership determination does not always determine what entity is responsible for paying for the purchase, installation or maintenance of infrastructure or equipment. In some cases, customers are responsible for paying for upgrades to infrastructure that will ultimately be owned by the utility.

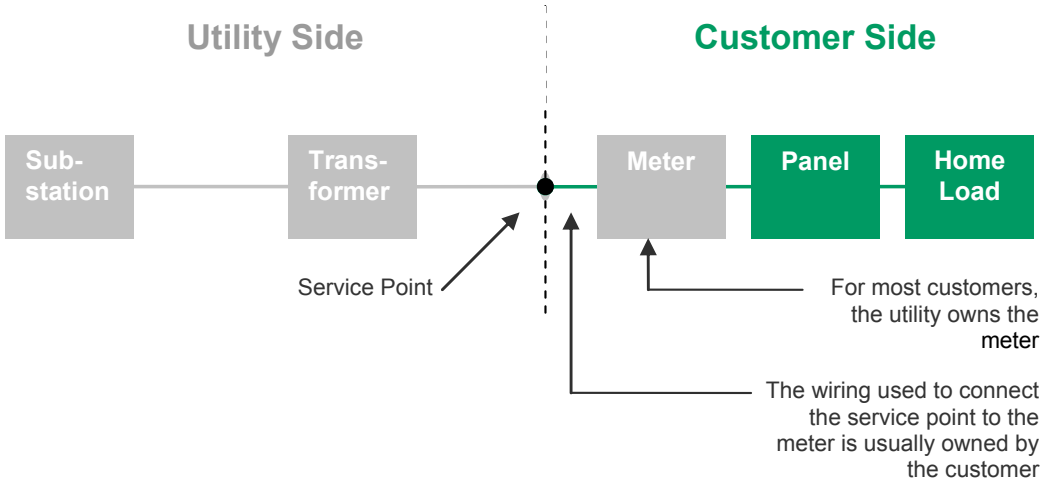

Figure 10. Utility-Customer Infrastructure Boundary.

[56] Electric rules can be found on each of the utilities websites: PG&E (http://www.pge.com/tariffs/ER.SHTML#ER), SCE (http://www.sce.com/AboutSCE/Regulatory/tariffbooks/rules.htm), and SDG&E (http://www.sdge.com/regulatory/elec_rules.shtml).

Meter Ownership. Generally, the utility owns the meter that is used by customers to measure their billable load. However, there are cases where the utility does not own the submeter that is used for billing purposes:

- 'Grandfathered' apartments that use submetering furnished by the apartment owner to bill customers off of a utility-owned master meter;[57]
- Mobile home parks or manufactured housing developments where the developer is allowed to use submeters and bill customers the utility rate;[58]
- RV parks where the park owner does not absorb the energy cost through rent, but instead uses a submeter to calculate the direct electricity costs for each tenant;[59]
- Multi-tenant commercial buildings where the owner is allowed to submeter tenants with customer-owned meters;[60]
- Marina or harbor operators that opt to submeter individual berths or slips with customer-owned meters;[61] and
- Direct Access customers or their energy provider may opt to own their own meter.[62]

The Commission sets the performance requirements for meters owned by Direct Access customers (see Section 1.5).

In the case of net energy metering, the customer is permitted to own the meter that is used for subtractive metering under a multiple tariff account. Net generation metering customers that have multiple generators receiving different rate treatment are eligible to own their own net generation output meter.[63] The utility must read these meters to determine the generation amounts that are attributable to different generators in order to accurately calculate the total net meter compensation.[64] The utility retains ownership of the primary meter, which measures the aggregate load from which the PEV usage is subtracted. Standby charges and other tariff requirements may also require the use of meters that may be owned by customers.

Rules for Capacity Upgrades to Existing Service. Changes in customer electricity usage (home additions, new appliances, etc.) can necessitate upgrades to customer panels, meters, service lines or other components of the utility's distribution system. Customers requiring service upgrades usually cover the cost of these upgrades, though cost allowances are granted by the utility, if additional load supports the cost.[65] The cost assignment of these upgrades does not change the ownership of these components. For customer owned infrastructure that requires upgrades, the customer must hire a contractor and is responsible for these costs. Any changes made to utility-owned meters must be

[57] PG&E Tariff Rule 18C-1, SCE Tariff Rule 18, SDG&E Tariff Rule 19.
[58] Ibid.
[59] Ibid.
[60] PG&E Tariff Rule 18C-2, SCE Tariff Rule 18, SDG&E Tariff Rule 19.
[61] Ibid.
[62] PG&E Tariff Rule 22, SCE Tariff Rule 22, and SDG&E Tariff Rule 25.
[63] Non-emitting generation receives a net metering amount, while some emitting distributive generation is refunded at the wholesale rate
[64] PG&E Tariff Rule 22-F (3), SCE website (http://www.sce.com/customergeneration/net-energy-faqs), and SDG&E website (http://www.sdge.com/nem/interconnectionRequirements.shtml).
[65] See PG&E Tariff Rule 15, SCE Tariff Rule 15, and SDG&E Tariff Rule 15.

done by the utility and the utility is responsible for "re-sealing" the meter after modifications are complete.

In some cases, changes to a utility's infrastructure may necessitate changes to a customer's service. In cases where service modifications are driven by utility convenience, the utility bears the cost of these modifications.[66] Although these modifications may impact customer-owned infrastructure (such as panels), they do not impact the utility-customer boundary.

Current Boundary Issues for PEVs. Under existing utility tariffs, the utility owns the meter used by PEV owners who separately meter their PEV load. In the PEV context, several key questions emerge related to the utility-customer boundary. The boundary issue appears to be a foundational PEV policy issue, as it impacts the EVSE installation process, utility cost assignment, and utility rate policies.

4.2 PEV Boundary Issues in Single Family Residences

Section 2 discussed three types of metering arrangements available to residential customers – single metering, submetering, and separate metering. The ownership boundary issue is important to each of these metering arrangements to determine who will bear the cost of what infrastructure.

Single Meter Arrangement. Under a single meter arrangement, no additional panels or meters are added to the customer side of the meter, though a panel upgrade may be necessary. The customer boundary is not changed with regard to the panel or the meter.

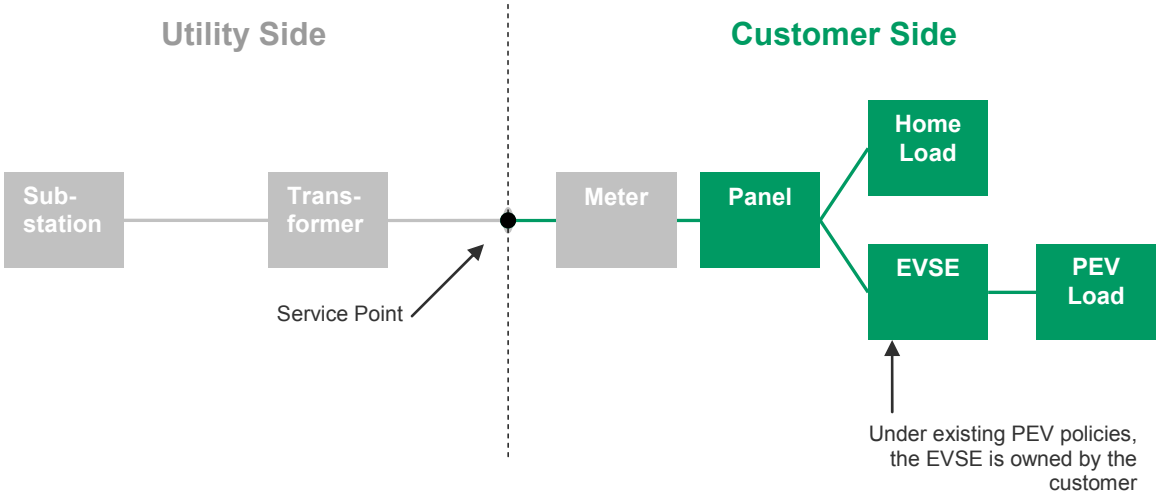

Figure 11. Utility-Customer Boundary under a Single Meter Arrangement.

[66] Ibid.

Submetering Under submetering, a separate meter is connected downstream of the primary meter to allow for separate billing of PEV load. Under this meter arrangement, the utility-customer boundary will need to be determined in regard to the second meter. The meter is on the customer side of the primary meter and would appear to be customer-owned equipment. However, the utility usually assumes ownership of the meter unless an exception is made in the utility tariff rules.

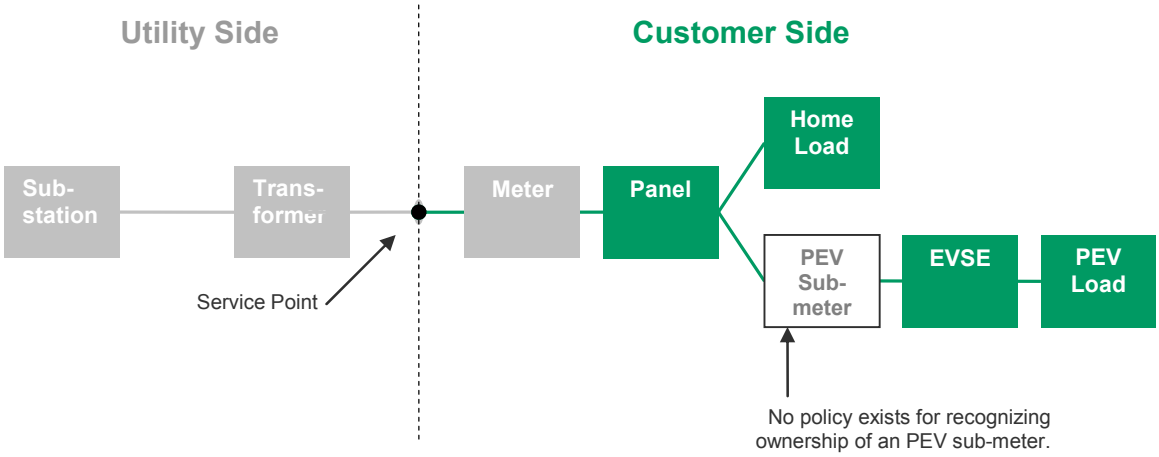

Figure 12. Utility-Customer Boundary under a Submetering Arrangement.

Better Place indicated third parties should be able to own submeters used for PEVs, and that these meters should be allowed to connect to a third party data management system and not be required to communicate through utility smart grid networks. PG&E agreed that third party ownership of submeters should be considered by the Commission, but that the costs and other impacts should be evaluated by the Commission in making this decision.[67] PG&E contends that if submeters are allowed to be owned by third parties, utilities will require detailed specifications regarding meter performance and integration with utility smart grid networks.[68]

Customer ownership of PEV submeters provides the following advantages:

- Allows customers to respond to changes in technology over time. Allowing customers to own a PEV submeter used for billing may allow the market to develop new metering approaches that provide customers with cost or functional advantages. KEMA identified a similar benefit to allowing customer-owned meters to connect to the AMI network.[69]
- Allows customers to benefit from a competitive market that could reduce total metering costs for customers.

Customer ownership of PEV submeters also raises the following issues:

[67] PG&E reply comments at p. 8.
[68] Ibid.
[69] KEMA, 2009.

- If meters are not owned by the utility, the utility's role in calibrating and inspecting them will need to be clarified.[70] Security requirements would also need to be developed to prevent tampering with meter data or introducing new opportunities for cyber attacks against the utility network.
- Utility ownership of submeters may introduce economies of scale that reduce customer costs for submeters. Customer-owned submeters may be more costly that utility-owned submeters if a competitive market for submeters does not reduce costs compared to the purchase power of the utilities.

Separate Metering. Under separate metering, a separate meter is connected upstream of the primary meter to separately measure the PEV usage. This meter will likely be served by a separate service line, connecting to the transformer, though dual meter adapters have been used in the past. As a separately metered load, the PEV load will be treated like a separate utility account, though this account can be aggregated on a single customer bill.

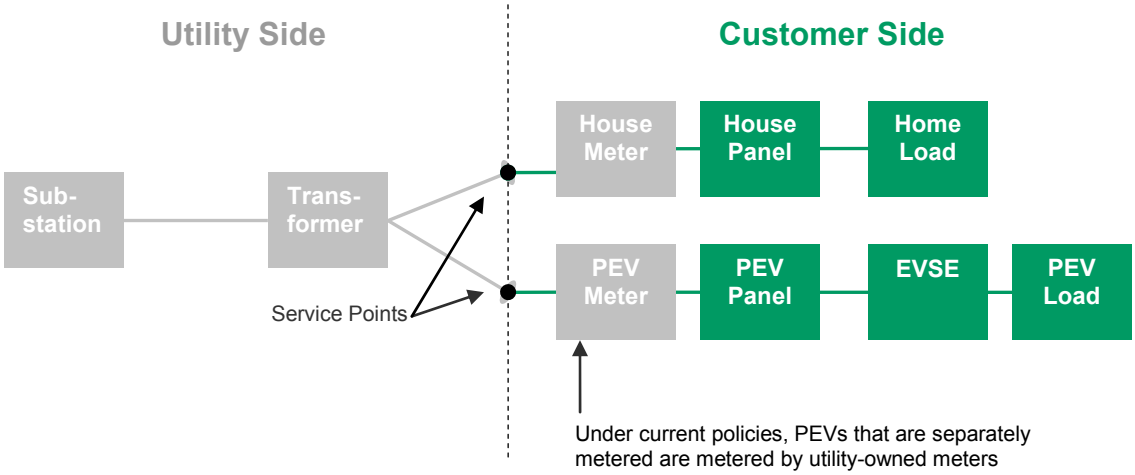

Figure 13.Utility Customer Boundary under a Dual Meter Arrangement.

Some current PEV customers use separate metering for PEV load. In these cases, the meter is owned by the utility, consistent with utility tariff rules.

Customer ownership of the meter under separate metering provides the same benefits as customer ownership of submeters, but introduces similar to those risks (load manipulation, tampering, etc.) for DA customers that have a customer-owned meter.

4.3 Boundary Issues in Other Customer categories

MDUs, workplace charging and public charging face similar boundary issues as single family residences. In each of these charging situations, single metering and separate metering follow well-established boundary rules, while submetering introduces the issue of meter ownership. For workplace charging and public charging stations, rules governing ownership of the submeter may impact their approach to PEV metering, as discussed in Section 3. In master metered complexes, the owners have the authority to submeter their tenants, which would seem to also apply to PEV usage.

[70] SMUD presentation, March 16th Joint Agencies EV Workshop.

4.4 Other Boundary Issues

The technology advances identified in Section 3.5 could raise new metering issues in the future.

Meters in the EVSE. Meters in the EVSE would raise new boundary issues between the utility and the customers for series billing. If the customer is required to use a utility meter for billing, then the EVSE (or, at least, the meter within it) would need to be owned by the utility in order to serve as a submeter in a series metering arrangement. This would represent a significant change in the customer-utility boundary, as the EVSE is currently regarded as customer-owned equipment on the customer side of the meter. However, a vehicle in the EVSE would not necessarily need to be owned by the utility – such a meter could be treated the same as a customer-owned submeter.

Meters in the Vehicle. Vehicle meters used for billing would raise the same boundary issues as EVSE meters. Requiring utility-owned meters in the vehicle would likely form a significant barrier to vehicle-based meters, as vehicle manufacturers would have to meet vehicle meters with the requirements of hundreds of US utilities. Similar to above, a meter in the vehicle would not necessarily need to be owned by the utility.

4.5 Utility Role in EVSE Deployment

Party comments suggested that the utility role in relationship to EVSE raised two issues: utility ownership of EVSE and utility subsidization of EVSE material and installation costs.

Utility Ownership of EVSE. Under existing PEV policies, the EVSE is not owned by the utility because it is located on the customer-side of the meter. Utility ownership of the EVSE would represent a significant change in the existing customer-utility boundary. While utility subsidization of the meter could impact PEV adoption and infrastructure development, it is not clear that utility ownership of the EVSE is also needed to achieve this effect.

Cost subsidization. GM estimates that customers are willing to pay $500-1000 for EVSE purchase and installation - significantly below the current cost estimates for EVSE purchase and installation at a single family residence.[71] Currently, state and federal subsidies are available for customers that install EVSE equipment. A federal subsidy provides a tax credit equal to 50% of the cost of the EVSE, with a maximum of $2,000 available per household.[72] The city of Los Angeles is proposing a $2,000 tax credit to the first 5,000 EVSE installations in the city.[73]

In their opening comments, some parties suggested that the EVSE could be included in the utility ratebase. Utility involvement in EVSE installation and purchase may reduce

[71] GM presentation. March 16th Joint Agencies EV Workshop.
[72] California Energy Commission, 2010. 2010-2011 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program.
[73] LADWP presentation, March 16th Join Agencies EV Workshop.

the cost – Clipper Creek believes this was the case in the Georgia Southern pilot project, which reduced installation and material costs through bulk purchases.[74]

It is unclear what business models for EVSE distribution will be supported by the market. Some automakers may distribute EVSE with their vehicles or customers may buy their own EVSE at retail stores.[75] 'Ratebasing' of EVSE by the utilities could create an "unlevel playing field" on which independent EVSE providers would need to compete.

Beside ratebasing, additional options for financing EVSE could be made available. The City and County of San Francisco suggested that local governments or utilities could finance infrastructure through taxes or utility bills, respectively.[76]

4.6 Utility Role in EVSE Installation

Utilities expressed a need for a notification system that would alert them when a customer purchased a PEV. PG&E states that purchase notification is an important aspect of the utilities role in the installation process.[77] Upfront data on who purchases a PEV is important to start distribution impact analyses and avoid customer service interrupts or future EVSE installation delays. While customers are required to notify the utility whenever they increase their load, however this requirement does not define what constitutes a load increase. Electricians generally define a load increase as anything requires a change to the service panel.[78] If utilities received notice whenever there was a panel upgrade, they would only be receiving notice during the installation process and would not receive notice about the PEV installations that do not regard a panel upgrade. Even if a PEVE installation does not require a panel upgrade, it may still trigger upstream distribution upgrades for the transformer.

Voluntary notification is necessary to avoid privacy issues.[79] Currently, there is no communication program between utilities and customers or car dealers, but utilities are currently exploring agreements with auto manufacturers to establish a system that would provide utilities with notice when a customer in their service territory purchases a PEV.

4.7 Utility Role in LCFS Credits

Most parties agreed that the use of LCFS credits given to investor-owned utilities should be determined by the CPUC. Parties' proposals for the use of this revenue are summarized below.

- *Return value to PEV customers.* DRA, PG&E and SCE all suggested that the Commission return the value to PEV customers.[80] GM made a similar argument, suggesting that this value could be used to reduce costs for customer EVSE and to

[74] Clipper Creek presentation, March 16th Joint Agencies EV Workshop.
[75] GM Presentation at the March 16th Joint Agencies EV Workshop.
[76] City of San Francisco presentation, March 16th Joint Agencies EV Workshop.
[77] PG&E presentation, March 16th Joint Agencies EV Workshop.
[78] Verbal communication with Enid Joffe, CEO of Clean Fuel Connections, on Aug. 26, 2010.
[79] SG&E presentation, March 16th Joint Agencies EV Workshop.
[80] DRA opening comments at p.18, PG&E opening comments at p.30, and SCE opening comments at p. 49.

provide incentives to customers who purchase PEVs.[81] If LCFS value were returned to customers on a per unit basis, staff argues that customers would have a greater incentive to use their PEVs. However, staff also thinks this subsidy could also reduce price signals during peak hours, which could increase the incentive to charge during peak hours.

- *Return the value to all ratepayers.* PG&E suggested LCFS value should be returned to all customers.[82] PG&E argued that PEV electricity demand could increase electricity costs for all electricity customers. LCFS value could be returned to all customers to offset this cost increase. Under this approach, LCFS credits would not serve as an incentive to the PEV users who generate the credits. SCE, the Environmental Coalition and Coulumb suggested that LCFS value be used for infrastructure investments.[83] SCE, SDG&E, SMUD and the Environmental Coalition suggested that the Commission use LCFS value to reduce the cost of AB 32 mitigation efforts and RPS costs.[84]

4.8 Utility Role in 'Vehicle Roaming'

Some parties commented that utilities should facilitate charging in other territories by providing a billing system that would allow billing to be made directly to a PEV owners account when they travel to other territories.

While this would encourage PEV use and could simplify the user experience when charging away from home, the costs of developing and operating such a system appear to be significant. Utilities would have to develop a 'clearinghouse' that would allow them to exchange information about charging costs to one another and 'true-up' revenue. It is not clear that these costs are justified. The ability to travel long distances will primarily be a factor of the availability of charge stations and less a function of the payment method. Charge stations can easily be equipped with payment methods at the service point, eliminating the need for a costly data/revenue exchange between utilities.

Without a 'roaming' program, LCFS credits generated from sales of electricity would accrue to the third party EVSP or utility that provides the vehicle electricity, rather than the customer or their home utility. More compelling justifications for a 'roaming and true up' billing system could emerge if non-residential charging proves to be a widespread practice and is subject to unfair pricing practices, or if new metering arrangements that facilitate roaming (such as vehicle-based metering) become commonplace.

[81] GM opening comments at p. 23.
[82] PG&E opening comments at p. 30.
[83] SCE opening comments at p. 49, the Environmental Coalition opening comments at p.53, Coulumb opening comments at p. 13.
[84] SCE opening comments at p.49, SDG&E opening comments at p. 33, SMUD comments at p. 16, Environmental Coalition opening comments at p.53.

Section 5 Conclusions, Recommendations and Questions

This section summarizes the conclusions drawn from party comments on the OIR and the information and analysis provided in this paper. Based on these conclusions, staff proposes several policy recommendations regarding PEV metering arrangements and other related policy issues. The paper concludes with several questions staff has identified for further stakeholder input.

5.1 Conclusions

- Metering is a critical policy issue for PEV adoption. Three main themes emerge from the comments received in response to the OIR: the Commission should allow flexibility in metering arrangements available to customers, various options exist for the functionality that should be included in PEV metering requirements, and some form of segregation of PEV load that is deemed adequate by ARB is needed to measure LCFS credits.
- A dedicated meter for a PEV is not necessary to enable communication functionality needed to participate in load management, demand response, or 'smart charging' programs. PEV meters may not need "smart" capabilities if communication functions are included in the EVSE or PEV.
- Metering arrangements will impact total installation cost, installation time, and billing flexibility.
- 'Single metering' results in minimal installation hand-offs, likely reducing the total installation time for customers, and minimize installation costs, but would still likely require a submeter to measure PEV load for LCFS credits and may require smart communication functions embedded in the PEV or the EVSE in order to enable automatic load management control.
- Billing flexibility, where the customer can choose independent rates for their PEV and house usage, can only be achieved under a submeter or separate meter arrangement.
- Different metering arrangements may be attractive to different customer types. Each of the metering arrangements offers different attributes which may be attractive to different customers and customer types. While residential customers may be attracted to single metering for its simplicity and low cost, commercial and workplace chargers might be attracted to separate metering for its billing flexibility.
- Submetering requires that the Commission determine who should own the second (PEV) meter. Meters are usually owned by the utility, though there are examples of the utility using customer owned meters for billing purposes.
- Allowing utility billing from non-utility owned meters would allow flexibility to adopt to future market conditions, including meters located in EVSE or the vehicle itself. This flexibility could reduce costs for consumers and all the market to respond to changing technologies and business models within the PEV and EVSE industry, but may necessitate additional utility back office changes and costs.
- Although LCFS metering requirements have not been recommended by ARB, minimal functionality might be able to meet their requirements.

- Under current IOU rules, the submeter and the EVSE both fall on the customer-side of the meter and would be owned by the customer.

5.2 Proposed Recommendations

Based on its analysis on metering issues to date, staff proposes the following recommendations related to metering arrangements and the utility role in vehicle charging.

Near-term Recommendations (12-36 months)

Until all PEV metering and data requirements are better understood, utilities should encourage single family residential customers to use a single meter arrangement for PEVs to avoid stranded costs. This arrangement minimizes installation delays, avoids possible safety issues, and is adaptable to new metering technologies and metering business models that may emerge for vehicle charging in the future. Each utility should continue to facilitate the use of separate or submeter PEV configurations by customers.

Utilities should establish an installation notification protocol to help understand and prepare for local distribution impacts. These protocols should establish a system that informs the utility of when a customer purchases a PEV without violating personal privacy issues.

Long-term Recommendations (36+ months)

The utilities should propose tariffs that support all three meter arrangements. The three primary meter arrangements should be available to customers, and utilities should design tariff and billing systems to support each type. Given the nascent stage of the PEV market, the Commission should allow as much choice and flexibility as possible.

The CPUC and utilities should establish minimum metering requirements for each of the three potential metering options.

Table 6. Recommended Minimum Meter Functionality for Each Proposed Metering Arrangement

	Single Metering[85]	Submetering	Separate Metering
PEV Metering Accuracy and Functionality	N/A	Greater accuracy of the submeter is achieved at a higher cost to customers.	Require the same accuracy requirements as AMI meters. Require AMI compatibility[86]
Minimum load data granularity	N/A	Multiple time intervals consistent with the number of intervals in the utility PEV tariff structure	Multiple time intervals consistent with the number of intervals in the utility PEV tariff structure
Minimum Communication Functionality for the meter	N/A	Daily reporting will be necessary to enable consumers to track online billing information.[87]	Same as AMI primary meter
Minimum Meter Data Storage Functionality	N/A	TOU data storage	Same as AMI meter
Boundary Definition	EVSE should be owned by customers	PEV meter and EVSE should be owned by customer	PEV meter should be owned by utility, EVSE should be owned by the customer
Who owns for the meter?	Utility owns primary meter used to measure all usage	Customer	Utility

The CPUC and utilities should actively monitor PEV and metering technology to identify new metering options or challenges in the future. Commission metering requirements should avoid proscribing alternative metrologies that may emerge as the market matures.

ARB should evaluate the use of on-vehicle usage tracking to meet LCFS credit tracking and consider other alternative metering configurations. Through its ZEV program, ARB has the ability to establish requirements for vehicles meeting the ZEV requirements. ARB should evaluate the cost and effectiveness of tracking LCFS credits through on-board metering devices. If other load management and communication requirements can be accomplished with other devices than a second meter, this may

[85] In order to receive LCFS credit beginning in 2015, customers that use Single Metering may need to incorporate a secondary meter to track the PEV usage. Flexible accuracy requirements (1-5% accuracy) for this secondary meter could allow customers to reduce the purchase cost of this meter.
[86] HAN communication functionality should be an optional component left to the discretion of the EVSE owner.
[87] Communication with the HAN could also serve this function.

ultimately be the least costly approach to tracking PEV-eligible LCFS credits (i.e., rather than installing a second meter solely for LCFS purposes).

5.3 Questions for Parties

Parties should address the following questions in comments on this paper.

- Are there additional meter arrangements that the utilities should consider beyond those identified in this paper?
- Do some metering arrangements better encourage (or discourage) future technology changes or market developments relative to other arrangements?
- What factors should the Commission consider in determining the utility-customer boundary in regards to submeters and EVSE?
- What utility role issues should be prioritized by the Commission in order to facilitate PEV adoption beginning in Winter 2010?
- What back office communication functions are necessary to allow utilities to process submeter data?
- What metering arrangements should be used for residential homes with PV panels?
- How does the issue of roaming impact metering requirements?

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(END OF ATTACHMENT A)