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Serving Multi-Family Residential and Commercial Electric Vehicle Customers

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Abstract

After much anticipation, numerous auto manufacturers have started launching Electric Vehicles (EVs) since the end of 2010. The spectrum of issues utilities have to deal with to support their PEV customers is broad, including customer education and outreach, rate design, internal operations streamlining and collaboration with numerous external stakeholders. While the initial focus of utilities has been on their single family residential customers, utilities are increasingly addressing the needs of their multi-family residential and commercial customers as well. Serving multi-family residential and commercial customers tends to be far more complex than serving single-family customers due to the large number of ways their electrical systems and properties are configured. For these customers, there is no such thing as a standard solution. Our solutions must be designed to meet each customer's unique situation. Southern California Edison started focusing on these more complex customer segments in2010. The objective of the presentation is share the findings regarding the special circumstances, needs and best practices required to serve multi-family residential and commercial customers, including educational materials, rate analyzes, and fleet conversion tools.

Keywords: commercial charging, decision tools, infrastructure, multi-family dwelling, process, residential charging

1 Introduction

The purpose of this paper is to provide an overview of challenges related to serving Electric Vehicle (EV) customers living in Multi-Family Dwellings (MFD), share potential solutions to address these challenges, and to share best practices identified by Southern California Edison (SCE). SCE is one of the nation's largest investor owned utilities, currently serving 5 million customer accounts and 14 million people in a 50,000 square mile territory. SCE is the leading purchaser of renewable energy in the U.S.

SCE has been an industry leader with Plug-in Electric Vehicles (PEVs) since 1988:

- Operating the nation's largest fleet of battery electric PEVs (Toyota RAV4s), which have traveled more than 20 million all-electric miles
- Evaluating the nation's first Plug-In Hybrid Electric Vehicles (PHEV) fleet vans (DaimlerChrysler) and acquiring the first PHEV medium duty utility bucket truck (Ford, Eaton, EPRI)
- Working with Ford to evaluate complete energy system impacts of PHEVs on the utility grid
- Collaborating with Toyota and the University of California–Irvine to evaluate the technology and system impacts of PHEVs

2 Anticipating PEV Charging

2.1 Overview

Approximately 10% of U.S. hybrid vehicles sales are registered in SCE's service territory [1]. Consequently, Southern California is expected to be a hot spot for PEV sales, with vocal early adopters wanting to charge at home, work, and public locations. At this juncture, SCE has forecast approximately 400,000 PEVs in its service territory by 2020.

SCE and many utilities nationwide are working with automakers, businesses, cities, individuals and other stakeholders to prepare by:

- Evaluating and upgrading grid infrastructure as necessary
- Streamlining the home charging installation process
- Collaborating on education and outreach
- Helping businesses develop fleet, workplace and customer charging
- Developing public charging infrastructure plans

2.2 SCE's PEV Readiness Activities

For the past two years SCE's PEV Readiness Program has undertaken a comprehensive effort to prepare the utility and its customers for the arrival of PEVs. Multiple teams were established to:

- Build market adoption assumptions and quantify incremental utility infrastructure and operating costs in order to assure utility readiness
- Assess the impact of PEV charging on distribution infrastructure, update transformer standards for PEV Load, and implement an equipment upgrade strategy
- Implement new and streamline existing end-to-end customer processes affecting utility customer service, electrical service planning, meter, and billing organizations (see section 3.2)
- Develop and implement education and communication efforts via the Internet, direct mail, auto shows, and other means to prepare customers, electricians, local inspection authorities, and other stakeholders on how to most efficiently and effectively prepare for electric vehicle charging
- Directly engage automakers, Electric Vehicle Service Equipment (EVSE) manufacturers, and Electric Vehicle Service Providers (EVSP); local inspection authorities and other city, state, and federal agencies; and PEV and environmentally-oriented non-governmental organizations (NGOs) via regular meetings, public presentations, and training to assure understanding of PEV readiness processes and the roles and responsibilities played by each stakeholder
- Plan and prepare for all regulatory requirements and milestones in connection with PEV readiness, which has included California Public Utilities Commission (CPUC) decisions regarding facilitating PEV adoption; assessing notification options to track the location and re-location of PEVs; developing methods to assure the privacy and security of PEV customer information; and other rulings related to smart grid deployment, load research, cost allocation and tracking, rate design, education and outreach, and the submetering of PEV load

3 PEV Owners = Shared Customers

3.1 Overview

PEVs create a new automobile sales model with multiple stakeholders not traditionally involved in vehicle acquisition or fueling. Auto manufacturers, dealerships, and customers are joined in the PEV purchase and charging preparation process by:

- Charging equipment manufacturers and service providers
- Electrical contractors
- Utilities
- Local governments and communities

SCE and many other utilities have determined that maintaining grid reliability and optimum safety conditions requires an increased effort to facilitate the customer charge-readiness process.

3.2 The Single-Family Residential Charge-Readiness Process

The basic process—which SCE developed in conjunction with automakers, EVSPs, and local inspection authorities—consists of the following basic steps:

1. The customer chooses a vehicle and determines the likely charging level (Level I 120-volt standard charge or the faster Level II 240-volt) for that vehicle.
2. Customers then contact their utility to understand rate options. This choice is somewhat complex due to the unique characteristics of the available rates.
    - Certain PEV electrical rates require a second meter to separately track PEV charging usage. The associated cost of installing a second panel to house the meter may be significant depending on the unique configuration of each home. Alternatively, customers choosing to remain on a standard or combined time-of-use home and electric vehicle rate may cost more per kWh but typically does not require the same level of electrical infrastructure expenses. Added to these factors is how much electricity the customer tends to use, and when it is used.
    - A customer selecting a time-of-use combined home and electric vehicle rate benefits from lower cost power during off-peak night time hours, but power used during day time on-peak hours can cost more than remaining on a standard residential rate.
    - A customer choosing to charge a PEV under the utility's' standard rate which is tiered-that is, the more power you use the more you pay per kWh-will experience an increase in monthly electric cost.

    Because of these complexities, SCE and other utilities offer customers a free rate analysis to understand the impact of PEV charging in various rate scenarios.
3. Armed with the cost of the various rate options, the PEV customer should then have an EVSP or electrical contractor provide estimates for the electrical work required to accommodate both Level I and Level II charging at the various rate options.
4. Once the charging level and rate options are determined, customers can inform both the utility and EVSP or electrical contractor of their final decision.
5. SCE will at this point have an electrical service planner evaluate utility infrastructure in the customer's neighborhood to assure that it is sufficient to safely and reliably provide the additional load needed to charge the PEV. If any parts of the infrastructure including the secondary lines, transformers and or service lines to the residence are not adequate, SCE will replace that equipment.
6. When the customer has been informed by the utility it is safe to charge a PEV, he or she can direct the electrician to install the charging equipment and add or upgrade the service panel, as needed.
7. The local city or county Authority Having Jurisdiction for inspecting electrical work completes the inspection and informs the customer and utility when the electrical work has been approved.
8. And, finally, the utility will change or add a meter, as required, because of rate choice. The customer is now ready to charge the PEV.

SCE's strategy for making this process as transparent and efficient as possible has been to focus on the hand-offs between the customer, utility, EVSPs/electrical contractors, and local inspection authorities.

3.2 PEV Customer Segments

SCE views its PEV customers in two main categories: Residential and Commercial (Figure 1). Multi-Family Dwelling (MFD) charging can be

treated as either residential or commercial depending on situation.

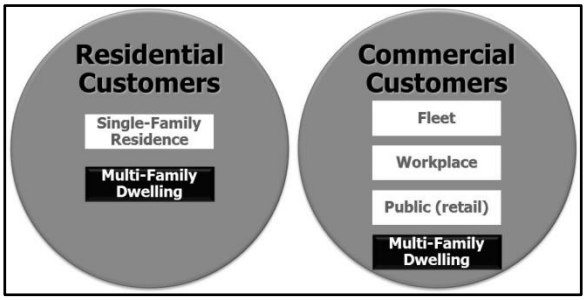

Figure 1: SCE's PEV Customer Segments

For example, let's look at two customers residing in virtually identical 24-unit condominium buildings. In the first building, the resident has an assigned parking space with a dedicated electrical outlet linked to the customer's meter. This resident would be treated as a residential customer of the utility using the process described in section 3.2 because the customer's meter can track PEV charging usage. In the second building there is no electrical outlet in the parking space. In this situation the resident must get the homeowner's association (HOA) permission to install a dedicated circuit to the resident's parking space. The HOA can decide to approve the resident's request. In this case, the resident pays for all the electrical work and can be served as a residential customer. If the HOA declines the resident's request but instead elects to install PEV charging in a common area available to all residents, the HOA is the utility's customer and has a choice of charging the PEVs on its current rate or selecting a commercial PEV rate.

5 PEV Charging in Multi-Family Dwellings

5.1 Overview

SCE's key objective is to ensure safe, reliable and cost-effective charging for MFD residents' electric vehicles.

5.2 The Multi-Family Dwelling Charge-Readiness Process

The basic MFD process is similar to the Single-Family Residence process described in Section 3.2; however, residents—whether owners or renters—of multi-family buildings wishing to charge an PEV will take different courses of action based on their parking situations. We will now discuss four basic parking/meter situations where the resident and building owner/homeowners association (HOA) may respond differently in each situation.

5.2.1 Resident Charging PEV at LI (120 volts) in Dedicated Parking Space Using Outlet Serving Only That Resident

In this situation, the resident may already be equipped to charge a PEV at Level I (120 volts) with minimal additional effort. The resident should consult with a qualified electrician to ensure the existing circuit and outlet can handle PEV charging and ask the property owner, management company or HOA, as necessary, for permission to proceed.

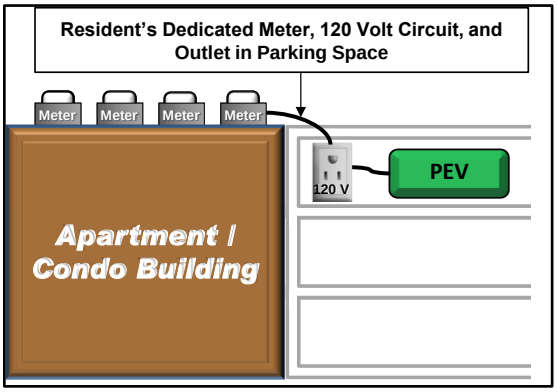

Figure 2: Top View of Resident Charging PEV at LI (120 volts) in Dedicated Parking Space Using Outlet Serving Only That Resident

In most instances this situation is handled entirely by the resident, and only involves a residential rate discussion and possible rate change with the utility's customer service organization, unless the building owner/HOA has placed restrictions on how parking area outlets are to be used.

5.2.2 Resident Wants to Charge a PEV at LII (240 volts) in Dedicated Parking Space Using Existing Outlet Serving Only That Resident

In this scenario, building owner/HOA approval will likely be required for potential panel and wiring work and charging equipment installation, while the resident contacts the utility for residential rate information and a possible rate change.

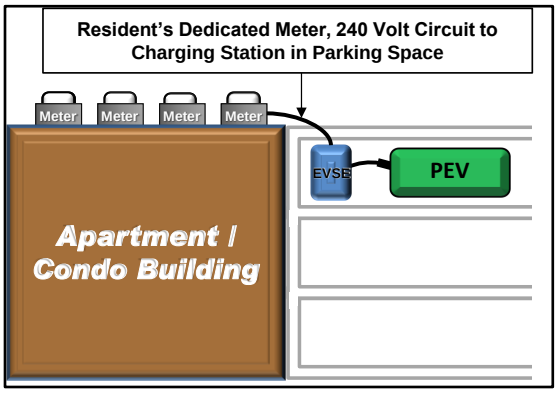

Figure 3: Top View of Resident Charging PEV at LII (240 volts) in Dedicated Parking Space Adjacent to Resident Meter

Once the resident obtains the Building owner/HOA approval to upgrade the circuit and outlet and to install a charging station, this situation is typically handled and paid for entirely by the resident, and only involves a residential rate discussion and possible rate change with the utility's customer service organization.

5.2.3 Resident Wants to Charge a PEV at LII (240 volts) in Dedicated Parking Area without a Dedicated Outlet

Building owner/HOA approval will likely be required for the potential installation of new circuits, panel, wiring and charging equipment. This will often require extensive installation work including trenching for the new circuit at significant expense to the resident.

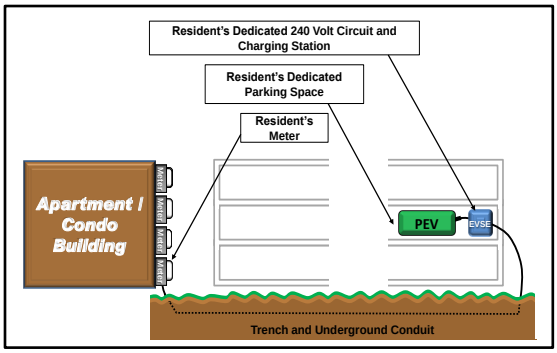

Figure 4: Top View of Resident Charging PEV at L2 (240 volts) in Dedicated Parking Area Not Adjacent to Resident Meter

Once the resident obtains the Building owner/HOA approval for the new circuit and outlet and to install a charging station, this situation is typically handled and paid for entirely by the resident, and only involves a residential rate discussion and possible rate change with the utility's customer service organization

5.2.4 Property Owner/HOA Installs Dedicated L2 (240 volts) Charging Station for Use by Specific Resident

In this situation, the building owner/HOA approval will be required for any panel and wiring work and/or charging equipment installation. The building owner/HOA must decide who pays for the electrical work (panel or charging equipment installation), who is responsible for maintaining the equipment, and who keeps the equipment, if the resident moves.

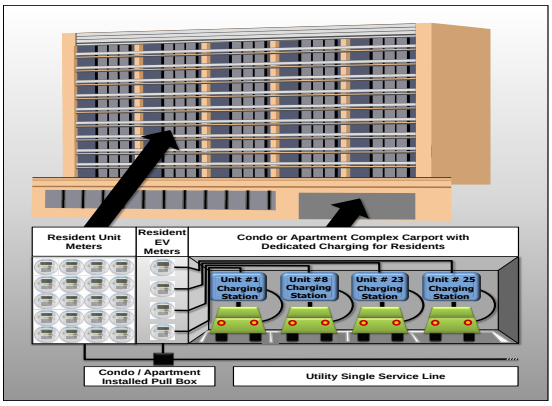

Figure 5: Property Owner/HOA Installs Dedicated L2 (240 volts) Chargers for Use by Specific Resident

5.3 Sample MFD Charge-Readiness Scenario

The examples of MFD PEV charging in this section do not represent *all* possible multi-family dwelling PEV charging configurations. In fact, each situation must be assessed to determine the appropriate steps to follow.

5.3.2 The 32-Unit Apartment Building

For example, let's consider a 32-unit apartment building (Figure 6) with a driveway and tenant parking below the building and the electrical panel at one end of the parking area.

Figure 6: 32-Unit Apartment Building

Challenges in this scenario include determining:

- Whether to provide charging to individual tenants with PEVs or to build a "common area" charging station for use by multiple residents
- How to get power to individual parking spaces in a common area charging location
- How to recoup the expense of a service provided to a minority of tenants

Taking a closer look at the electrical panel and metering configuration (Figure 7), we see that there is no space to easily add another panel or even a circuit breaker to support an EVSE.

Figure 7: Electrical Panel in 32-Unit Apartment Building

So the owner of this building would be required to make some difficult decisions about providing charging for electric vehicles. In fact, providing electric vehicle charging in any MFD—whether apartment, townhome, or condominium—is generally a challenging proposition for any MFD owner:

- Configuration options for positioning one or more PEV charging stations are generally limited, based on CC&Rs, local building codes, and the availability of space and power for charging equipment
- Rate options must be considered because in some cases a residential rate is acceptable and in others a commercial rate will be required
- Multiple stakeholders—customer, building owner or HOA, utility, electrical contractor, local inspection authority—require coordination and someone to act as project manager
- A method of cost recovery must be identified, implemented, and explained to residents
- And depending on the work required, costs can be significant

Fortunately, many utility customers residing in a MFD, will be able to leverage the single-family residential approach (as described in Section 5.2.1) to charge their vehicles. Those customers, or building owners, whose charging needs call for a commercial approach can avail themselves of the support teams most utilities offer their business customers.

5.3.2 Main Questions for Property Owners or HOAs to Consider When Making PEV-charging Decisions

The following checklist can help MFD property owners and HOAs think through the main issues to be considered prior to working with residents, EVSPs, electricians, utilities, and local inspection authorities:

- Do existing rental agreements and/or covenants, conditions and restrictions (CC&Rs) need to be updated to reflect PEV-charging policies?
- Will you provide (or allow residents to install) Level I (120-volt) and/or Level II (240-volt) charging stations?

- What is the approval process for Level I installations as opposed to that for Level II?
- Who hires and manages contractors for any electrical or other construction work required for charging-station installations?
- Who pays for charging equipment, installation and ongoing maintenance costs, which may include electric panel and/or circuit upgrades, and any additional insurance required?
- Who is responsible for the cost of electricity associated with PEV charging?

6. Serving Other Commercial & Industrial PEV Customers

6.1 Overview

In certain situations, the commercial/industrial (C/I) business owner may decide to install PEV charging to service its fleet of electric vehicles or provide PEV charging for its employees and/or customers. Examples of commercial industrial businesses include retail stores, fleet operators, manufacturing companies and related service providers. In these instances, the business owner is SCE's customer, not the employee or customer.

The approach to serve this customers is similar to the one described for the MFD property owner/HOA customers. The key message is that it is critical for business owners to contact SCE to discuss SCE's commercial PEV rates to determine what rate will best fit their situation. The business owner is encouraged to hire a qualified electrician to provide an assessment of the premise's readiness to charge PEVs. This assessment can potentially be very complex, owing to the numerous choices facing the customer, such as:

- Is there a need or desire to track PEV usage separately from your other electrical usage?
- Level I – 120volt or Level II – 240 volt charging or a mixture of both?
- For Level II, which make and type of charging station best fits the location's needs?
- How many charging stations should be installed?
- Who is responsible for the cost of electricity associated with PEV charging for employees and/or customers?
- Does the business owner install the entire PEV charging infrastructure now or in phases?
- Who will own the charging station? (e.g. business owner? 3rd party provider? Tenant?)
- Who will maintain the charging stations? (e.g. business owner? 3rd party provider?)

Based on the response to these and other related questions, the electrician of the C/I customer will provide the customer with a plan, schedule and estimate to complete the installation.

Given the potential size and complexity of these scenarios, business owners are encouraged to work closely with their electrician, Local Authority Having Jurisdiction and with SCE, particularly if they select PEV charging solution requiring installation of a separate, dedicated meter to track PEV charging usage which will require SCE's approval of the electrician's plan.

6.2 Examples for commercial/industrial business solutions

Similarly to residential customers, SCE offers special time-of-use (TOU) PEV rates to commercial/industrial customers. Depending on the individual situation and objectives of the customers, there are multiple scenarios and solutions to enable commercial/industrial customers to charge their PEVs. We will now review two potential scenarios as examples of commercial/industrial PEV charging solutions.

6.2.1 PEV Charging Not Requiring Separate Metering of PEV Charging

In this scenario, the commercial/industrial customer does not want to track PEV charging usage separately from its other electrical usage for items such as property lighting, heating, ventilation and air conditioning. The customer wants to install a number of PEV charging stations for the use of its fleet, employees or customers. This scenario will use the existing premises meter to track PEV usage and not require installation of a separate, dedicated electric panel and meter.

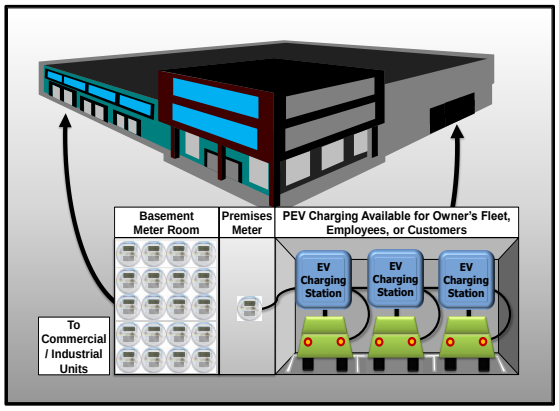

Figure 8: Commercial/Industrial PEV Charging Configuration

Depending on the volume of PEV charging, SCE and other utilities offer different general and PEV specific rates (i.e., rates for facilities drawing load less than 20kW, rates for loads greater than 20kW but less than 500 kW, and rates for facilities drawing more than 500 kW.)

Charging PEVs on the existing premises meter can often be the easiest choice to make when commercial/industrial customers decide to charge electric vehicles at their facility. However, depending on the physical configuration of the building and capacity of the existing panels, it can limit future expansion capacity. Therefore, SCE encourages facility owners and managers to select a qualified electrician to help customers plan and estimate the infrastructure installation and review the plan with your utility and Local Authority Having Jurisdiction (LAHJ) to be sure it complies with current requirements.

In this situation, customers will not be able to identify the amount of electricity used to charge PEVs on their monthly utility bill because the circuit and premises meter used are not dedicated to PEV charging and therefore track other electric usage such as property lighting, heating, ventilation and air conditioning, etc., along with PEV load.

Alternatively, some of the special time of use (TOU) PEV rate options for commercial/business customers require a second, dedicated meter to measure PEV charging usage and can potentially be more complex and costly to install.

6.2.2 EV Charging Requiring Separate Metering of EV Charging

In this scenario, the commercial/industrial customers want to track EV charging usage separately from other electrical usage items such as property lighting, heating, ventilation and air conditioning. They want to install a number of EV charging stations for the use of their fleet, employees or customers. Their electricians help them determine the exact number of charging stations they will need and estimate the electric demand for EV charging. As described in Section 6.2.1, SCE offers multiple rate options depending on the volume of the electricity usage (i.e., rates for facilities drawing load less than 20kW, rates for loads 20kW and 500 kW, and rates for facilities drawing more than 500 kW), and in this scenario some specific EV time of use (TOU) rates require installation of a separate, dedicated electric panel and meter (Figure 9). These commercial/industrial EV TOU rates offer reduced cost per kWh for charging an EV during off-peak hours.

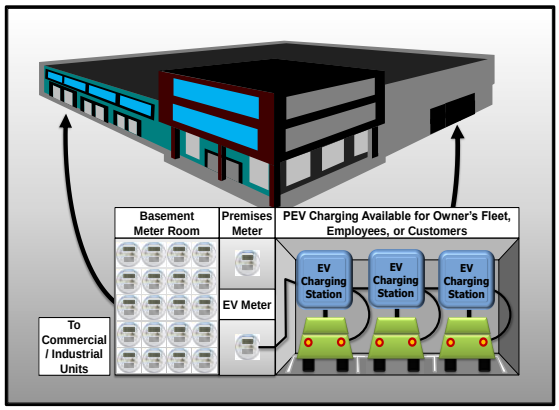

Figure 9: Commercial/Industrial PEV Charging Configuration Metering PEV Charging Separately

In this situation, customers are able to identify the amount and cost of electricity used to charge EVs because the circuit and meter used is dedicated to EV charging. This approach facilitates recovering EV charging costs. This solution requires facility owners or managers to install a new panel or meter socket box to house the separate, dedicated EV meter.

When working with their electricians to plan the installation, commercial/industrial customers may

want to consider developing a flexible approach enabling them to add EV charging infrastructure incrementally based on their expected demand growth vs. installing all charging units at once.

6.3 SCE's Analytical Tools to Support its Non-residential Customers

SCE offers various interactive decision tools to its non-residential customers to make educated decisions concerning their PEV charging needs. These interactive tools include a rate analysis and fleet conversion tools designed specifically to serve non-residential customers.

Similarly to a rate analysis tool developed for residential customers, non-residential customers can request a free, customized PEV rate analysis, which uses the customer's historical energy usage and planned plug-in electric vehicle charging information to provide side-by-side comparisons of annual electricity costs on each of the available rate options.

This customized rate analysis, combined with a quote from an electrician for any necessary electrical system upgrades, provides customers the information they need to make informed decisions about how to most efficiently and cost-effectively charge their PEVs.

Non-residential customers can also use SCE's PEV Fleet Conversion Tool (Figure 10) to quickly model fueling cost comparisons between fleets of conventional and plug-in electric vehicles. The Fleet Conversion Tool is easy to use and flexible, providing commercial/industrial customers a fairly simple way to determine the potential costs and benefits of replacing gasoline-powered vehicles with plug-in electric vehicles.

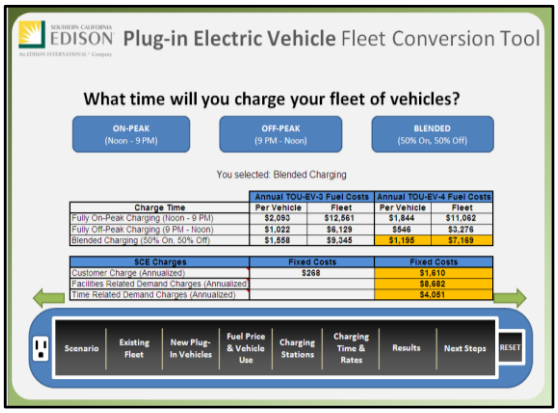

Figure 10: SCE's PEV Fleet Conversion Tool

7 Conclusions

Just as it does for its residential PEV customers, SCE provides a wide range of support services to non-residential PEV customers, including:

- Comprehensive customer outreach and educational materials
- Special TOU PEV rates
- Process support as customers work with permitting agencies, electricians automakers, inspectors, and other parties
- Dedicated customer service representatives
- Interactive web seminars
- Interactive decision tools enabling customers to make educated decisions regarding their PEVs

Unlike the single-family residential PEV customer segment, however, there are few if any standard approaches or solutions for serving commercial and industrial PEV customers. This is especially true for residents and owners of multi-family dwellings.

Each MFD has its own set of unique layout, parking, and meter location configurations which will require unique approaches to providing PEV charging in such a facility. New construction can benefit from planning for PEV charging in the design stage.

One of the main considerations for utility customers in a MFD setting is that individual customers need to engage with all relevant parties involved in the management of their MFD. MFD management

should carefully craft plans based on a defined charging policy.

Finally, all customers should involve their utility and inquire about PEV rates and metering implications to ensure safe, reliable and cost-effective PEV charging.

Acknowledgments

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