Discussion Paper: Charging Ahead – Options for Policymakers Regarding the Regulation of Electric Vehicle Charging Markets

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Introduction

Overview of paper

As of April 2014, almost two hundred thousand plug-in electric vehicles (PEVs) had been sold in the United States.[1] Policymakers see economic and environmental benefits to supporting further deployment of PEVs, and are beginning to examine the infrastructure required to charge the vehicles—and the role that policymakers should play in this developing market. Some states have been deeply involved in PEV policymaking for years, while others are just getting started, and some have not yet taken the issue on. This paper provides an overview of the market for electric vehicle charging services, identifies actors and actions that might warrant regulation, and poses questions for policymakers to consider in determining the role that governments should play. The section titled "Background on PEVs and charging technologies" describes the electricity charging needs for PEVs and the infrastructure options for providing this service. "Charging location options" and "Market structure options" identify considerations for regulators thinking about how to structure the market for PEV charging services and the role that existing public utilities might play. "Determining prices for PEV charging services" discusses issues relating to the pricing of electric vehicle charging services—and the barriers that existing regulatory structures might pose to pricing options—followed by "Distribution of costs," which identifies options regarding who should pay for installation of charging systems. "Other regulatory options" explores the role that nonutility regulators might play in PEV charging. Throughout the discussion, the paper identifies examples of different state approaches to these questions, and explores policy considerations of different approaches. The final section provides recommendations for state policymakers to consider.

Considerations for policymakers approaching PEV charging regulation

The first task for policymakers—both legislators and regulators—considering whether and how to regulate PEV charging is to define the goals they are trying to achieve. Some may have purely economic goals in mind, while others are trying to achieve environmental outcomes as well. A number of traditional concerns for electricity regulators are relevant to the market for electric vehicle charging. These include having prices represent the true cost of providing the service and having costs borne by the people who benefit. If a competitive market is allowed, regulators will want to assure that the competition is effective, and that it provides the information and access to allow customers to choose the provider of the service. In addition, policymakers will want to ensure that the regulatory process is equally accessible to all stakeholders—that parties with vested interests in some aspect of the market are not the only parties at the table. As is the case with other more

recently emerging topics in utility regulation (e.g., renewable energy and energy efficiency), some regulators may also be interested in—and authorized to explore—environmental goals. Different policymakers will have different priorities among these, as well as other concerns not listed here, and will appropriately consider these questions in the context of the goals that they and their jurisdictions have identified. Because many of these issues are political rather than technical, the recommendations here focus on identifying questions that policymakers should ask. The paper then suggests a process for asking those questions and for encouraging all stakeholders to play a role in answering them.

Background on PEVs and charging technologies

Plug-in electric vehicles

PEVs offer many advantages over gasoline-powered vehicles, including lower cost of ownership over the life of the vehicle,[2] reduced dependence on oil, and reduced emissions of air pollutants caused by petroleum combustion. In 2013, cumulative PEV sales surpassed 100,000 vehicles in the U.S.,[3] with 40 percent of those sales in California.[4] (In the near term, many vehicles are being delivered to California because of its Zero-Emission Vehicle (ZEV) requirement that manufacturers sell an increasing number of electric and hydrogen fuel cell vehicles in the state.)[5] In 2012, 7.2 million light-duty passenger cars were sold in the country overall,[6] so PEVs currently make up a small fraction of vehicle sales, but Navigant Research projected in 2013 that PEVs will reach over 416,000 annual sales in the United States by 2022.[7] In October 2013, governors of eight states, including California, signed a Memorandum of Understanding (MOU) establishing a goal of having at least 3.3 million ZEVs on the road in their states by 2025, which would significantly exceed the Navigant projection for PEVs.[8]

Electric vehicle supply equipment

Electric vehicle supply equipment (EVSE) is categorized according to its "level," which describes the voltage and power at which it charges a plug-in electric vehicle. The level, combined with characteristics of the vehicle, determines how long it takes the vehicle to charge. The level also reflects widely differing costs to install the equipment. Because of these differences, policymakers may want to distinguish between EVSE levels in the design of policies regarding cost recovery, rate structures, grid impacts, and other issues. Key characteristics of EVSE levels relevant to policy design are discussed here.

Level 1 alternating current (AC) chargers operate at 120 volts (V), and take approximately 10-20 hours to fully charge a completely depleted PEV, depending on other factors, including the size of the vehicle's battery.[9] 120-V outlets are the U.S. standard and are available in all U.S. homes, so PEV drivers can plug their PEVs directly into any wall outlet, as long as it is on a circuit rated to carry enough current. A cable provided by the vehicle dealer connects the vehicle to the outlet, and no special equipment is required to charge at Level 1.[10]

Level 2 AC chargers operate at 240 V, and can charge a vehicle in 3-7 hours, depending on the size of the battery and the maximum rate at which the vehicle's battery is able to charge.[11] 240-V outlets are used to power clothes dryers and other powerful household equipment. These outlets are sometimes found in homes, and PEVs could charge at Level 2

by plugging directly into these outlets. Various independent do-it-yourself guides and after-market cord products are available online, without official government or automobile supplier endorsement. However, because of the higher voltage, manufacturers and regulators recommend that PEV drivers install special Level 2 charging equipment at the charging site if they wish to charge at the faster rate.[12] For example, the voluntary National Electric Code (NEC) allows 120-V charging equipment to be connected by only a cord or plug, but requires all other EVSE to be "permanently connected and fastened in place," suggesting some kind of wall-mounted equipment.[13]

Many of these Level 2 charging stations are also "smart," meaning they perform various functions in addition to providing electricity. For instance, a PEV driver might use a smartphone to tell a smart charger when to start charging the PEV.[14] Level 2 charging stations typically cost around $1,000-$2,000,[15] although in May 2013, one manufacturer made news by announcing a Level 2 charger for sale for $450.[16] Many jurisdictions also require permits for Level 2 stations, and require electricians to install the equipment.[17]

DC fast chargers operate at 480 V, and can charge a vehicle's battery to 80 percent capacity in less than half an hour.[18] DC fast chargers provide direct (rather than alternating) current, and are significantly more expensive than Level 2 chargers, with costs in the range of $10,000-$20,000 (not including installation costs).[19] There are currently two DC charging standards: CHAdeMO and the SAE J1772 Combo.[20] Both of these standards operate at 480 V; the differences are in the connector that is used to plug the car into the charging station. A third DC fast charger has been developed by Tesla, and is being installed across the U.S. by the company,[21] but is only compatible with Tesla PEVs.

Charging location options

In addition to the level of charger involved, the appropriate regulatory treatment of EVSE may also vary depending on the identity of the customer and the charging location. Relevant considerations regarding the placement and use of the equipment are discussed here.

Since sales of modern PEVs began in the U.S. in 2011, a variety of approaches to vehicle charging have emerged. These can best be grouped into three categories of customer and location: residential charging, workplace charging, and publicly available charging.

Residential charging is the most common form of PEV charging.[22] PEV drivers plug in at home because it is convenient, cars spend significant amounts of time parked at home, and drivers (or their property managers) have control over the charging equipment. Typically charging happens overnight because this is when cars sit for many hours unused, but this arrangement is also advantageous from an electricity grid standpoint, as overnight hours are off-peak hours when grid demand and generation costs are lower than other times of day. With residential charging, the electricity transaction takes place between the electricity customer (homeowner or renter) and the retail utility. The utility may or may not be involved in installing or inspecting a residential Level 2 charging station, and may or may not be informed that residential PEV charging is occurring, particularly if only Level 1 charging is in use.[23]

Despite the ease of residential charging, it cannot serve all charging needs. The typical range for a PEV is 60-100 miles,[24] which means that round trips longer than that distance require an additional charge before returning home, and longer one-way trips require an additional charge along the way.

Workplace charging provides one solution for drivers with long round-trip commutes. Many employers are opting to provide access to Level 1 stations, because of the low cost and because a 120-V charge over the course of a work day is enough to fully recharge many PEV drivers' batteries.[25] The cost to an employer to offer this service can be minimal, although circuits may have to be upgraded to handle the power needs of vehicle charging.[26] In addition, the cost of electricity to recharge the vehicles from standard outlets is likely small relative to the employer's overall electricity bill. Installing Level 2 charging equipment can present higher up-front costs to employers, especially if the building is not pre-wired for EVSE, but may be viewed as worth the investment. Many employers see access to PEV charging as an employee benefit[27] or as a demonstration of corporate environmental values. With workplace charging, the electricity transaction occurs between the employer and its utility, with the employer determining whether or not to pass the cost along to the employee.

Publicly available charging refers to EVSE locations that are open to the general public (and that may or may not be provided by a government entity using public funds). There is a temptation to think of public charging as a "gas station" for PEVs, but there are key differences in these two models. Most importantly, while a gasoline tank takes only a few minutes to fill, PEV charging can take hours. Even with a DC fast charger, recharging a battery from empty to 80 percent capacity can take 20 minutes.[28] Because of the length of time needed to recharge at Level 1 and 2 stations, the expense of DC fast charge stations, and the only recently resolved debates about DC fast charge standards,[29] many public stations consist of Level 2 charging equipment installed at hotels, restaurants, retail stores, tourist destinations, entertainment venues, and other locations where drivers are likely to have other reasons to spend time.

As with employer charging, the electricity transaction for public stations occurs between the utility and the charging station provider, and the costs may or may not be passed on to the driver. This decision is made by the station provider, but substantially guided by the rules regarding retail electricity sales in each state, as discussed in the next section. In many cases, private businesses install charging stations and make them available to their customers as amenities. While revenue generation is often an important consideration, many businesses with other revenue sources choose to make stations free to use and publicly available. This is in part due to the low cost of electricity, as well as the qualitative benefits provided by a charging station, including customer attraction and retention, and corporate branding opportunities.

Market structure options

The emerging market for PEV charging services raises several questions about the structure of this market—who may provide the service, how will they be regulated, and by whom? Key considerations are discussed below, and Table 1 illustrates the variety of market structure options.

Defining the product: Charging service is more than just electrons

Electric vehicle charging is not necessarily a single product market. While one might think of the product simply as electricity, the charging service (the ability to plug in and receive the electricity) could be thought of as a second product, and characteristics of that product could factor into upfront costs, levels of supply and demand, and the appropriateness of regulation. For example, a charging station in a remote location might be more expensive to install and more valuable to a PEV driver than one in an area with multiple other charging options. (It would likely also face lesser competition from other EVSE providers.) Likewise, the service provided by a DC fast charge station might be more valuable per kilowatt-hour (kWh) delivered than that provided by a station that charged at a slower rate. While the two products (electricity and charging service) are bundled at the point of sale, they come from two different providers (the electric utility and the EVSE owner, which may or may not be the same entity).

Identifying the relevant buyers and sellers in the PEV charging market

PEV drivers have two broad options: charging at home, or using a system provided by another entity, which the driver may or may not have to pay to use. The latter option is provided by a host who transacts directly with a utility, buys wholesale power, or generates electricity itself, and the host may be working with a third-party charging provider to manage the station. It may be helpful to compare EVSE to vending machines, for which the owners or managers of the equipment, the owners of the property on which it sits, and the suppliers of the product being sold are typically all different entities.

Multiple businesses and services have been created around the sale and use of EVSE equipment. The equipment itself is manufactured by large technology companies like Eaton and ABB, as well as more specialized companies like AeroVironment. Another set of companies installs and manages the stations (although generally doesn't own them once installed). For example, ChargePoint, founded in 2007, operates more than 14,000 charging stations in 14 countries.[30] The company sells charging stations to other entities that offer charging (either for free or for a fee), and then manages the network of stations, including payment collection and data collection about station usage.[31] NRG's eVgo program offers a similar service, but is based on a monthly subscription model (much like a cell phone payment plan), with different charging costs based on the customer's plan.[32] As the PEV and EVSE markets are still relatively new, participants are still exploring business models for EVSE installation, financing, and customer fees, and it is not yet clear which approaches might ultimately be successful.[33] Once the system is installed, EVSE charging services are provided by a diverse mix of parties with different business models, as the following section will illustrate.

Table 1. EVSE Market Options

Charging location	Residential Charging	Workplace or Public Charging
Products	Electricity	Electricity Charging service at a particular speed, location
Station owner	Residential property owner/renter	Property owner Third-party charging provider Retail electric utility
Provider of electricity	Retail electric utility (Less likely: residence generates its own electricity)	Retail electric utility Wholesale power market Host generates electricity
Buyer of electricity	Residential owner/renter	Host, providing free electricity to driver Host, passing on a cost to driver Driver, direct from utility
Driver pays for charging service in addition to or instead of electricity cost?	Probably not	Maybe

Monopoly or competitive market: Deciding who may provide PEV charging

A number of market structure options are possible for PEV charging services, although most states are settling on a market with multiple nonutility entrants. Nevertheless, the various options are discussed here.

Utility-only providers – Policymakers could limit PEV charging services to incumbent electric utilities only. The physical equipment would be owned by (or contracted to) the local utility, which would be responsible for providing the charging service, and with rates that would be determined by a regulatory process. This could involve cost-based, rate-of-return regulation, or policymakers and regulators could devise another method for determining compensation for the charging service that is different from the method used for the electricity itself. No state is currently limiting the provision of PEV charging to regulated utilities.[34]

A single new entity – One alternative would be to create a single new entity to provide these same charging services from a single commercial point of contact that is different from the utility. No state has taken this approach either.[35]

Multiple non-utility entrants, in addition to utility participation – Rather than opt for a single provider, most states that have considered this question have encouraged multiple entities in addition to electric utilities to enter the PEV charging market. This raises a variety of questions for regulators. If new entrants are sharing the market with a regulated utility, regulators will want to consider whether the utility might advantageously price electricity for PEV charging at utility-owned stations over other charging providers, use the overall rate base to supplement the cost of installing the charging equipment, use rate-payer-funded resources to perform the installation, or otherwise leverage existing relationships to an unfair advantage.[36] In addition, customers' familiarity with the utility's name might offer an unfair advantage. On the other hand, the New York State Energy Research and Development Authority (NYSERDA) describes a number of advantages to allowing utilities into the PEV charging market, including the ability to make sure the EVSE operates efficiently on the grid, the ability to make sure that the EVSE does not disrupt the local grid, the ability to charge a fee based on the amount of electricity consumed (which most states do not allow non-utilities to do, see discussion below), the ability to bill PEV charging to a user's home utility account, and the ability to serve less profitable locations that a third party might avoid. Many of these advantages can also be addressed through the treatment of the third-party entrants in the market, so regulators will want to think carefully not just about who enters the market, but how to ensure that the market operates efficiently and effectively.

Utilities prevented from owning EVSE – A few jurisdictions have taken the competitive approach a step further, and prevented the local electric utility from owning EVSE. For example, expressing concerns about limiting competition and customer choices, the California Public Utilities Commission (CPUC) has prevented utilities from owning EVSE, although the regulators have reserved the right to revisit the issue if the prohibition results in underserved markets or market failures.[37] Likewise, the Arizona Corporation Commission determined that its utility must work cooperatively with federally funded EVSE contractors for the first year of a proposed PEV readiness demonstration project rather than deploy its own utility-owned EVSE, although the utility has an opportunity to request a public point-of-sale rate if it identifies specific gaps or deficiencies in EVSE deployment.[38] In contrast, Oregon regulators determined that they did not see any indication that utility participation in the charging market was limiting competition, so they have allowed utilities to own and operate EVSE as a nonregulated, nonrate-based activity. They also allow an Oregon utility to request rate recovery for EVSE investment if it makes a compelling case that it will benefit ratepayers (rather than just the general public).[39]

Making competition effective: Determining whether and how to regulate providers of PEV charging services

Just because regulators opt for a competitive market for PEV charging doesn't mean that the regulators should not play a role in that market. "Authorizing competition does not promise effective competition."[40] To ensure that a market for PEV charging is effectively competitive, regulators must ensure that rules applying to EVSE are integrated thoughtfully into the existing framework for electricity regulation, which has developed over many decades of experience with entities that often look nothing like the parties providing PEV charging.

To date, much of the work of utility commissions relating to PEV charging has been around the question of whether PEV charging providers are "public utilities." This relates closely to the question of whether EVSE providers can and should charge a fee for the electricity (or charging service) provided, and if so, on what basis. In most states, only entities that are classified as public utilities or otherwise registered with the utility commission can resell electricity.[41] Many states are explicitly exempting PEV charging providers from the obligations imposed on sellers of retail electricity, through a variety of mechanisms. California first exempted EVSE providers from public utility regulation through a CPUC decision and later through legislation. Florida, Hawaii, Illinois, Maryland, and Minnesota have done so through legislation; Oregon has done so through its Commission's interpretation of existing law.[42] In November 2013, New York's Public Service Commission declared that it does not have jurisdiction over publicly available charging stations.[43] Virginia and Colorado have taken more complex approaches. Virginia passed legislation exempting charging service providers as long as all of the electricity is provided by the local electric utility.[44] Colorado's legislation also exempts EVSE providing public utility-supplied electricity, as well as EVSE providers that generate the electricity from a renewable resource on the property.[45] (The latter creates an incentive for charging stations to make use of distributed renewable power opportunities.) There is a precedent for this approach in other alternative-energy vehicle fueling markets: many states have already excluded entities that sell compressed natural gas (CNG) for vehicle fueling from being classified as a gas corporation.[46]

In states that have not exempted charging service providers from regulation as a public utility, some EVSE owners are basing fees on time spent charging instead of kWh delivered, which avoids the limitation on reselling electricity.[47] However, because different vehicles draw electricity at different rates, an hourly price does not reflect the amount of energy consumed. This means that fast-charging cars (generally the more expensive PEVs) could get more "fuel" for their money than cars that charge more slowly, which makes it difficult for the provider to determine an appropriate per-hour fee and to accurately bill customers for the service provided.[48] (Note that the charging service product—as opposed to the electricity itself—might appropriately be sold for a flat fee or by the hour. This suggests that a hybrid fee structure that combined a use fee with a fee reflecting the cost of the electricity might be appropriate. Even so, the per-kWh component requires the utility regulation exemption discussed above.)

EVSE providers argue that there are additional reasons to exclude them from public utility regulation (including the comprehensive regulations and obligations described above), and the fact that the provider could be a landlord or employer who is incapable of managing

these obligations.[49] On the other hand, there may be reasons not to offer this blanket exemption; for example, utilities have argued that some level of regulation is required to ensure that vehicle charging is consistent with safety and grid reliability.[50] In this context, it will also be important to consider the role of the grid operator and the grid planning process. As electric vehicle penetration increases, the effect of PEVs on the electricity grid will increase as well, and system operators may need to become involved in planning for the siting of charging stations. As EVSE becomes more integrated into the grid planning process, it will be important for policymakers to ask what type of regulation is needed (of which parties and by which regulators) rather than simply deciding whether or not to regulate.

There are good reasons for utility regulators to play a role in overseeing PEV charging—even if EVSE providers are not treated as a generic seller of electricity. Policymakers can define the role that utility commissions should play in this market more explicitly, and this role need not be limited to applying or not applying the existing definitions and rules. For example: Should EVSE providers have an obligation to serve PEV drivers similar to the obligation that regulated utilities have to serve any electricity customer? Should the local utility have to provide adequate electricity infrastructure (e.g., transmission lines to remote locations) to support charging station installations? There are a number of aspects of PEV charging in which public utility regulators may legitimately seek to remain involved, even if the EVSE provider itself is not considered a public utility.

Determining prices for PEV charging services

If utility regulators play a role in the market for charging services (in addition to the role they play in the market for the electricity itself), they will consider whether rate structures are "just and reasonable" and do not grant any "undue preference or advantage,"[51] as well as whether the rate structures help the market operate more efficiently. Even if public EVSE is not regulated by public utility commissions (PUCs), commissions are still likely to be involved in the rate structures that the electricity customer hosting the charging station pays.[52] There are many more considerations regarding rate setting than can be explored in this paper, but some of the issues particular to PEV charging are identified here.

Rate structures for residential charging

For residential stations, there are a number of rate options for the electricity being supplied. Many states have explored the use of time-of-use (TOU) rates or other structures that provide incentives to draw electricity at off-peak times in order to better match prices to the cost of generation and to minimize the need for costly investment in peak capacity.[53] The "controlled charging" that TOU rates enable has been shown to dramatically reduce peak charging impacts and the need for distribution system upgrades, even at relatively high levels of PEV penetration.[54] TOU rates can be especially effective at shifting use of residential charging installations, where the electricity customer is also the PEV driver, and where drivers have flexibility regarding when to charge. Many states are exploring TOU rates specifically for PEV charging. For example, Oregon has directed its utilities to offer all PEV customers the choice of a TOU rate.[55] A TOU rate could be applied to the entire home electricity bill, or a separate meter could be dedicated to PEV charging, which would allow the residence to stay on a traditional rate structure or to pay a different TOU rate than is paid for vehicle charging.

Rate structures for workplace and publicly available EVSE

EVSE rates paid by PEV drivers – As discussed in the section on market structure above, most states have placed legal limitations on entities' ability to sell electricity to consumers without being registered with the state utility commission, causing for-profit providers to seek some other payment model, and causing many states to exempt these entities from PUC authority in order to allow kWh-based fees. The question therefore arises whether states want to maintain some control over the rates that EVSE providers bill customers for the electricity (or the time spent charging). Policymakers should consider whether EVSE rates differ in character from other electricity rates such that regulation is not needed, or whether states should play a role in determining appropriate rates to be charged by EVSE providers to their customers. The answer will likely depend on all of the factors discussed in the charging location and market structure sections above, as well as other considerations like number of market participants. (For example, regulators may want to minimize barriers to entry early in the market's development, but may also be concerned that a market with few entrants will not have competitive markets without rate regulation.) Pilot projects provide one way for regulators to explore the role that regulation should play before making long-term decisions. For example, in July 2013, the Hawaii Public Utilities Commission established a pilot Commercial Public Electric Vehicle Charging Service rate that allows Hawaiian electric utilities to operate up to 25 publicly accessible DC fast charge stations and assess a per-session fee.[56]

An important consideration is that for EVSE companies to be successful, they will have to bill customers enough to recoup not just the cost of the electricity consumed but also of the charging equipment and installation. Fees that are higher than (or in addition to) typical retail or commercial electricity rates may be justified, as consumers will have access to standard-priced electricity for their vehicles at home and may be willing to pay more for the convenience and speed of public charging (the charging service product, distinct from the electricity product). However, the option raises several questions: Should there be a limit to the fees assessed? Should the market be allowed to determine what prices customers will bear? Should EVSE providers have to make their product available to all drivers, or may they allow access only to members of a network they have defined? Should EVSE providers be allowed to give electricity away for free, or does this unfairly advantage providers with alternative sources of revenue and encourage inefficient consumption of electricity? Should state or local government entities providing EVSE be allowed to provide the service for free, since only some members of the public will benefit? Should they be *required* to provide the service for free, since they're providing a public service available to all? EVSE providers are exploring rate structures (including monthly subscription models)[57] that provide a viable business model while also attracting customers to their stations. The question for state legislators and regulators will be the extent to which they want to be involved in these considerations, given potentially competing public policy goals to encourage PEV adoption and to protect consumers, and how the need for regulation might change over time, as PEVs and EVSE become more prevalent.

Electricity rates paid by EVSE providers – The fact that PEV charging stations are being installed by commercial entities that are themselves electricity customers raises some interesting questions for the rates that these entities pay their own electricity providers.

Commercial electricity users generally face a different rate structure from residential users, and often face a "demand charge" as part of this arrangement, based on the peak demand at the facility.[58] For a retail store, these demand charges are probably fairly predictable and consistent over time; however, these same entities might be surprised by unexpectedly high use of a free EVSE installation in the parking lot, or even by minimal use of a DC fast charge station. An analysis by an ECOtality engineer of some relatively high demand charges levied by California utilities found that meters supporting only DC fast charge stations could see demand charges making up over 80 percent of the monthly bill.[59] This could be a strong disincentive to these entities to provide free EVSE to their customers. On the other hand, the demand charge provides an important signal regarding the cost of maintaining sufficient capacity to handle peak electricity demand. For the electricity retailers serving these facilities, the demand charge makes sense—they have to be prepared to serve that load. However, policymakers will have to consider potentially conflicting goals of promoting public charging station installation and accurately pricing electricity consumption.

As discussed above, commercial establishments are well suited to publicly available EVSE—they are places where drivers are already spending a significant amount of time and won't mind waiting for a vehicle to charge. It may, therefore, be valuable for policymakers to work with electricity retailers to develop rate structures that allow commercial retailers to meet their customers' PEV demand without substantially increasing the businesses' own electricity costs through demand charges. This could involve a separate meter for the EVSE, exempted from the demand charge calculation. For example, Portland General Electric in Oregon adapted an existing rate for high occasional demand for use with DC fast charge stations. The rate allows the utility to charge the facility more per kWh than other facilities but without the demand charge.[60] Likewise, in July 2013, Hawaii adopted pilot rates that include PEV time-of-use rates for commercial customers without a demand charge.[61] Another alternative might be to eliminate the demand charge and keep the same rate, but with the utility not responsible for providing the same guaranteed service to the EVSE (perhaps analogous to demand response programs, which provide an incentive for customers to adjust the amount or timing of electricity consumption based on market prices or system reliability concerns). Yet another option might be for the commercial establishment to charge users TOU rates for EVSE (and to pay a demand charge), but for policymakers to provide a rebate to commercial establishments hurt by this cost. Technical solutions are available as well, including on-site electricity generation or backup storage. With any of these options, policymakers will also have to consider who should pay the cost of maintaining adequate capacity, if not the commercial electricity customer (EVSE provider). Electricity providers and utility commissions can likely devise any number of solutions that are workable for the parties involved; the issue is merely one more question for policymakers to consider.

Distribution of costs

Beyond the question of how PEV drivers pay for the electricity to charge their vehicles, there is the question of who pays to install the charging equipment and any transmission or distribution upgrades required to support the EVSE. This section identifies options and considerations in determining which entities should bear the cost of EVSE installations themselves. Allocation of responsibility for the cost of upgrades to the grid required by EVSE installations will likely be handled in much the same way that upgrades to accommodate other high-power equipment (e.g., air conditioning) have been handled in the past. Typically, utilities spread the cost of these upgrades across all customers rather than billing individual installers of the equipment, on the grounds that utilities do not distinguish between types of customer uses.[62] Nonetheless, equity concerns regarding transmission and distribution costs should be considered.

Charging stations at residential and business locations are often paid for by the homeowner or business owner. Many of these purchases, however, are supported by federal and state grants and other incentives for EVSE installation.[63] Level 2 charging stations are relatively inexpensive (although still potentially thousands of dollars), but DC fast charging stations can cost as much as $45,000-100,000 by the time permitting and other installation issues are addressed.[64] Who should bear these costs?

The obvious direct beneficiaries of an EVSE installation are the drivers who will be able to use the station to charge electric vehicles. There is value to the driver in the electricity provided, as well as in the location, speed, and availability of the service. A PEV driver might be expected to pay for each of these aspects of EVSE infrastructure in some way, and fees will likely have to evolve to be able to incorporate a number of these aspects into the pricing of the service. If the driver were the only beneficiary of the charging infrastructure, it would be difficult to make a case for extensive public funding for building out that infrastructure. On the other hand, multiple benefits of expanded access to PEV charging accrue to the general public as well as to the individual using the service.

A 2011 study by the Center for Automotive Research projected that 469,000 electric vehicles would be sold in the U.S. from 2012-2015.[65] A subsequent analysis by Environment America estimated that this level of national PEV deployment by 2015 would reduce oil consumption in the country by 2.6 million barrels of oil per year.[66] Likewise, a transition from gasoline-fueled vehicles to PEVs can greatly reduce the air emissions resulting from fuel combustion. A 2007 report by the Electric Power Research Institution and Natural Resources Defense Council found that "the overwhelming majority of the population and land area of the United States experience [air quality] benefits due to the penetration of the PHEVs in the vehicle fleet."[67] Studies are also being done to explore the extent to which PEVs could provide benefits to the reliability and stability of the electric grid, by smoothing electricity demand peaks due to off-peak charging and by providing distributed electricity storage in vehicle batteries.[68]

These societal benefits provide an argument for a public contribution to greater PEV deployment, and in fact, the public sector has played a significant early role in putting EVSE infrastructure in place. In addition to substantial private investment, the U.S. government contributed over $100 million to EVSE provider ECOtality to install a network of publicly

available charging stations across the United States.[69] Several states provide additional grants or incentives for EVSE installation, including grants to municipalities to install stations locally.[70]

Public policy will determine the extent to which each state chooses to support EVSE installation through public funding, as well as the extent to which state regulators will allow electric utilities to pass the costs of EVSE installation along to utility customers broadly, rather than just EVSE customers. Maine's Public Utilities Commission has recently considered this question in the form of a series of pilot projects to be conducted by the Central Maine Power Company (CMP), a Maine-based transmission and distribution company. In August 2013, the Commission approved a Stipulation by CMP, three environmental groups, and two renewable energy companies proposing three PEV pilot projects.[71] In doing so, the Commission approved a $105,000 incentive grant program for the purchase or lease of PEVs and purchase and installation of charging stations, with none of these costs to be included in rates. It also approved a second $125,000 incentive grant program specifically for the Portland area, for the same purposes, with CMP initially providing the funding but authorized to defer the costs for future rate recovery. Two of three commissioners voted in favor of the Stipulation with one commissioner dissenting on the grounds that it did not constitute a sufficiently broad spectrum of interests and that the Stipulation represented an inappropriate use of ratepayer funds for promotional purposes. This is precisely the debate that will take place about the next stages of EVSE infrastructure build-out, and opinions will likely vary about whether the costs are best borne by PEV drivers (through payments to private EVSE providers), taxpayers (through publicly funded stations), or ratepayers (through utilities making use of rate recovery). Pilot projects like Maine's (and Hawaii's, discussed in the "determining prices" section above) offer opportunities to explore these issues and the associated benefits at a small scale before committing to a large-scale investment in the infrastructure.

Other regulatory options

State public utility regulation is not the only relevant area of regulation: aspects of charging stations not regulated by the utility commission could instead by regulated by the state agency that regulates Weights and Measures. The National Institute of Standards and Technology has formed a National Workgroup on Measuring Systems for Electric Vehicle Fueling and Submetering to develop proposed requirements for commercial electrical energy-measuring devices for electric vehicle charging.[72] If adopted by the National Conference on Weights and Measures, which addresses concerns like the proper units of measurement to be used in the sale of commodities, these standards would be incorporated into national standards that could then be adopted by states.[73] The proposed standards address issues like EVSE labeling, street signs and other advertisements, and allowable units/methods of retail sale, but would not address grid integration issues, nor would they consider whether rates charged to drivers are appropriate.

In addition, many of the regulations currently applied to charging stations are put in place at the local level and are focused on the safe installation and connection of the equipment to the electrical supply.[74] Should any of these issues be addressed at the state (or federal) level instead? State legislators may want to consider other aspects of EVSE markets that warrant

government intervention. For example, provisions could be put in place to notify the utility of the proposed charging station so that the utility can ensure that the local distribution grid is adequate to serve the load. Several states have also taken steps to ensure that consumers have access to home charging by enacting legislation that bars homeowners associations from inhibiting the installation of EVSE or by modifying the building code to require new multi-unit buildings to be PEV-ready.[75] Policymakers may wish to tie EVSE policies to other infrastructure improvements (e.g., requiring residential charging stations to be paired with smart meters to take advantage of special rates). Even if the state utility commission is not the primary regulator for these policies, commissioners may have insights to share on these topics.

Recommendations for policymakers

Policymakers' opinions and priorities on these issues will vary, but some lessons can be learned regarding the role they might play and a process that would encourage all stakeholders to play a role in finding the answers.

Clearly define the EVSE market

First, some action will be needed on the part of state legislators and regulators to identify the extent to which EVSE fits into existing rules. Most owners and installers of EVSE are not traditional utilities and many of the obligations imposed on regulated utilities are not appropriate to apply to retail businesses or employers. The manufacturers and providers of charging equipment generally do not own the equipment once installed, and do not fit well into traditional definitions of electricity sellers either. However, that does not mean that there aren't important regulatory questions and potentially important roles for regulators to play. Legislation and regulations should include clear definitions of parties included or excluded from existing rules regarding electricity sales, as well as from any new rules developed explicitly to handle PEV charging. For example, residential charging might be treated as any other residential use, employee charging as any other commercial use, and public charging for profit as a distinct use with its own set of rules regarding participants and rates. Legislation should also be clear about the authority and discretion given to utility commissions and other regulators in overseeing the EVSE market.

Make the policy process transparent

Policymakers should ensure that a wide range of parties and interests are heard in the policymaking process. Electric vehicles are not a primary concern for most members of the public, but they raise issues that could affect taxpayers and electricity ratepayers broadly. In addition, many of the key concerns involve new technologies that may not be familiar to policymakers. Even without a rate case brought before it, a public utility commission could hold a public hearing to proactively assess the role it might plan in PEV charging. This would allow the commission to gather information from a broad policymaking—rather than adjudicatory—perspective, and to raise issues for the public as well. Similarly, legislators could also hold hearings on these topics. Through these processes, policymakers could hear from utilities and charging station providers regarding technical and business concerns, from PEV drivers and other utility customers regarding customer experience and rate concerns, and from law and policy analysts regarding relevant research. It would also be valuable to

invite policymakers from other states to share their experiences, as many states have already asked themselves some of these questions (and occasionally come to different conclusions regarding policy design, as in the examples noted throughout this paper). On topics where additional information could be helpful, pilot projects can be used to gather data and explore models for more extensive programs.

Collaborate with other states

Finally, policymakers should consider whether these questions are best answered on an individual state-by-state basis, or whether there is value in coordinating across state borders. Neither electricity nor vehicle drivers remain within state boundaries—for the sake of consistency of rules for EVSE providers, technical realities of the electricity grid, and ease of use for drivers, there may be good reason for states to collaborate with each other. In fact, many states have already started to collaborate to address PEV and EVSE concerns, including the Transportation and Climate Initiative (facilitated by the Georgetown Climate Center) in the northeast and mid-Atlantic[76] and the West Coast Green Highway in the west.[77] States are not yet formally collaborating on the utility regulation issues discussed in this paper, but perhaps these regional processes could provide a forum for states to consider these topics in a more coordinated way. In addition, professional associations of regulators, e.g., the National Association of Regulatory Utility Commissioners or similar regional associations, and research institutions like the National Regulatory Research Institute could provide venues for discussion, information sharing, and analytical work in this area.

By approaching the lawmaking process thoughtfully and publicly, and by learning from the hard work already being done by the public and private sectors across the country, policymakers can tailor EVSE rules to achieve the goals and priorities their own states and communities have identified. In the process, they can make best use of each party's expertise and perspective, and gain buy-in from the public along the way.

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