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Plugged In: The Last Mile

Who will build out and pay for electric vehicle public charging infrastructure?

Deloitte Center for Energy Solutions

Deloitte's 2012 report, *Charging Ahead: The Last Mile — Is the U.S. electric infrastructure ready to support one million electric vehicles?* (*Charging Ahead*), laid out the Obama Administration's initial goal of one million electric vehicles (EVs) on U.S. roads by 2015, which corresponded with automakers' launch of new Plug-in Electric Vehicles (PEVs)[1] across the country. Based on a Deloitte survey and interviews with electric utility executives and other industry representatives, the report concluded that the utility infrastructure was prepared to meet the President's challenge.

In 2012, slightly more than 53,000 EVs were sold,[2] a figure that made it increasingly unlikely that the one million vehicle target would be reached by 2015. These sales figures likely reflect consumers' concerns regarding EV ownership, as outlined in *Unplugged: Electric vehicle realities versus consumer expectations* (*Unplugged*). The report, based on a Deloitte survey of 13,000 consumers in 17 countries, revealed that consumers have significant anxiety relative to the range, convenience (charge time and access to charging locations), price, model availability (e.g., small sedan, large sedan, SUV/crossover), and long-term residual value of EVs. These concerns, coupled with improving fuel efficiency of traditional internal combustion engine (ICE) vehicles, suggest that mass adoption of EVs in the United States may be more than a decade away. Recently, the Department of Energy (DOE) eased off the difficult-to-achieve goal of one million EVs sold by 2015 and shifted its strategy to promote advanced-drive vehicles and to lower their cost over the next nine years.[3] To accomplish this, the DOE will provide funding to lithium-ion battery makers and loans to automakers to promote EV development.

Despite the slower-than-anticipated rollout of EVs, many participants up and down the EV value chain remain steadfast in their assertions that EVs will eventually pick up speed with consumers, fueled by the introduction of new models with better range, increasingly higher gasoline prices, and national security concerns related to dependence on foreign oil imports.

While the initial *Charging Ahead* report confirmed that utilities by and large believe that the utility infrastructure is well prepared in the short term, the next questions become, "What can, or should, utilities do to prepare for the future; and what role should they play today in driving EV adoption?" This report demonstrates that despite the high likelihood of missing the President's goal of one million EVs by 2015, EV charging infrastructure can be successfully rolled out, with future earning opportunities available to utilities and other third parties willing to invest in public charging stations. The research indicates that the key to such profitability, under various pricing models, lies in the level of EV penetration. Present trends draw into serious question whether adequate levels of penetration can actually be achieved, absent subsidies, to offset infrastructure investment cost or incentives to significantly accelerate EV purchases by consumers.

Charging Ahead concluded that the utility infrastructure was prepared to meet the President's challenge.

[1] The term Plug-In Electric Vehicles (PEVs) includes three main categories: A Battery Electric Vehicle (BEV), such as the Nissan Leaf, operates solely on an electric motor and the energy stored in its rechargeable battery pack. A Plug-In Hybrid Electric Vehicle (PHEV), such as the Plug-In in Toyota Prius, uses an ICE and an electric motor and can use either (or both) for propulsion. An Extended-Range Electric Vehicle (EREV), such as Chevrolet's Volt, has an electric motor and an ICE and drives on electricity, using the ICE only as a generator to extend the total range beyond the initial battery charge. Source: The Utility Guide to Plug-in Electric Vehicle Readiness, Edison Electric Institute, November 2011

[2] http://www.hybridcars.com/december-2012-dashboard

[3] http://www.reuters.com/article/2013/01/31/us-autos-greencars-chu-idUSBRE90U1B020130131

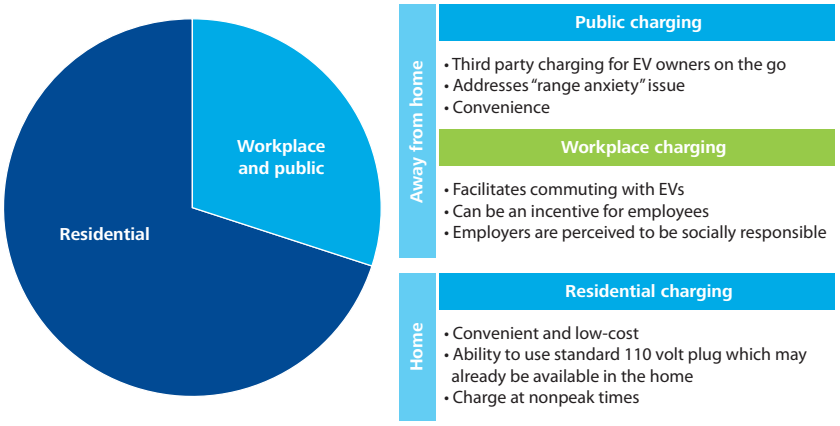
Public charging infrastructure is crucial to adoption of EVs

While the readiness of the U.S. electric power infrastructure — generation, transmission, and distribution — is critical to the rollout of EVs, the build-out of public charging stations is another element crucial to consumer adoption of EVs. This build-out is important not so much because typical EV drivers will rely on public charging stations for daily use, but rather to help allay "range anxiety" — the EV drivers' fear that the range supported by their battery's charge is inadequate to support their driving patterns. Range anxiety is of particular concern for drivers of BEVs as they do not have a back-up ICE to either charge the battery or fuel their car if they run out of power.

Although Deloitte's *Unplugged* report reveals nearly 60 percent of consumers in the United States expect an EV to fully recharge in two hours or less, the Electric Power Research Institute (EPRI) projects that the majority of EV drivers will charge their vehicles at home overnight, similar to a cell phone, and will not require further charging on a typical day of driving. Actual results from the EV Project, a national pilot to collect data on EV driving and charging patterns, have so far validated this projection, reporting that the majority, more than 70 percent, of charging took place at residential locations.[4] This data was supported by additional utilities and stakeholders interviewed. To encourage residential charging, 39 percent of utilities[5] had plans to implement programs such as time-of-use (TOU) rates.

In addition to residential charging, many EV drivers will plug in their vehicles at work and charge throughout the day. The DOE's "Workplace Charging Challenge"[6] aims to motivate 500 employers to offer workplace charging over the next five years.[7] Workplace charging typically differs from public charging since chargers are for the benefit of the employees only, while public charging is available to all. The 2013 Deloitte reSources Study found that almost one-quarter of employers surveyed now have EV charging available at their locations. However, over 80 percent of these stations are available for use for the general public and not just for employees. Of the chargers available to the public, 60 percent of employers reported not charging a fee. Drivers will likely use "public" charging stations (i.e., those supplied by retailers, municipal governments, and others) only to top off their batteries or fulfill a short-term charging need. The relative usage of each type of charging facility would be similar to that shown in Figure 1.

Figure 1: EV charging patterns



[4] http://www.theevproject.com/downloads/documents/Q3%202012%20EVP%20Report.pdf
[5] *Charging Ahead: The Last Mile*
[6] http://www.reuters.com/article/2013/01/31/us-autos-greencars-chu-idUSBRE90U1B020130131

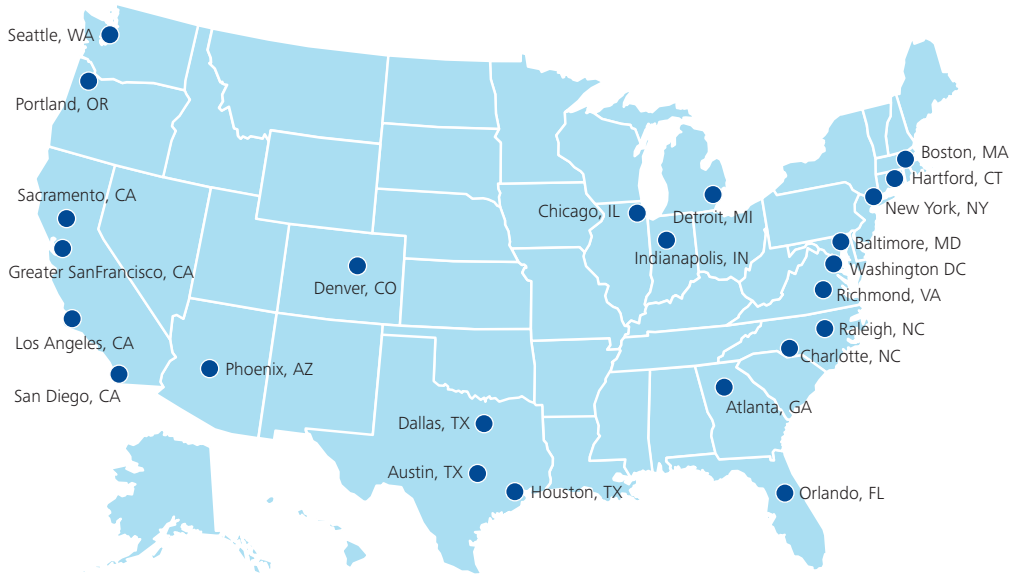
While the "public" charging infrastructure may be used the least in terms of kilowatt-hours (kWh) of charge, it is critical to the adoption of EVs because until battery capacities are significantly enhanced, consumers will require it for "peace of mind." Again, *Unplugged* revealed only 44 percent of United States consumers would be satisfied with an EV driving range of 200 miles on a full charge. Yet, this range is considerably more than the 50 miles that 77 percent of U.S. respondents indicated they drive on average per day during the week (Monday through Friday)[7] and is also more than the 38 to 100 mile, gasoline-free range offered by most of the EVs currently in the market.[8]

With this in mind, this report, the second in *The Last Mile* series, focuses on the build-out of public charging infrastructure and who will pay for it.

The public charging infrastructure today: Who has been footing the bill so far?

For the purposes of this study, public charging infrastructure is defined as charging stations outside of the home or workplace that are accessible to all EV drivers, presumably for a fee. It includes charging stations owned by retailers, real estate investment trusts, EV supply equipment (EVSE) companies, utilities, and other commercial interests, as well as those installed by governments and municipalities. To date, the vast majority of the public charging infrastructure in the United States has been installed in projected high EV adoption cities, which are detailed in Figure 2. Many of these were target launch cities for the three major EV manufacturers, Ford, GM, and Nissan, in 2011. Several of these cities were also identified by the United States DOE as having the potential for high EV adoption due to socioeconomic factors, such as a large number of hybrid-electric vehicle (HEV) early adopters, high population density, and a large percentage of high-income consumers. Automakers have since expanded the availability of initial models across the United States, and the public charging infrastructure, as one might expect, is beginning to expand along with it, with more than 5,000 publically accessible EV charging stations across the country.[9]

Figure 2: Projected high adoption cities for EVs[10,11,12]



[7] *Unplugged: Electric vehicle realities versus consumer expectations*
[8] Deloitte analysis, includes Ford Focus, Chevy Volt, and Nissan Leaf
[9] http://www.afdc.energy.gov/fuels/electricity_stations.html
[10] Department of Energy – www.doe.gov
[11] Automotive OEM websites
[12] Deloitte analysis

Thus far, the question of who will finance and invest in this build-out has largely been answered by federal, state, and local grant money, with some assistance from the automakers. In addition, employers have built out some of this infrastructure with 62 percent of the EV chargers located at workplaces owned by the company.[13] For instance, in August 2009, ECOtality Inc., a San Francisco-based EVSE, was awarded a cost reimbursement grant of $99.8 million from the DOE as part of the American Recovery and Reinvestment Act (ARRA). This grant supported ECOtality Inc. in undertaking the largest deployment of EV charging infrastructure in U.S. history. This effort, now known as the EV Project, was granted an additional $15 million by the DOE in June 2010. With partner matches from automakers, the total value of the EV Project is now approximately $230 million.[14] Similarly, Coulomb Technologies Inc., which is based in Campbell, California, and operates the ChargePoint EV charging network, received a $15 million DOE grant, also provided through the ARRA. This grant partially funded its $37 million ChargePoint America program, which offered no-cost home and public charging stations in nine United States regions.[15] In addition to building out the EV infrastructure, collection of data indicating consumer-charging patterns is also a major objective for both of these projects. This information will be important to utility load planning as EV adoption grows.

The DOE funded other EV infrastructure related efforts in 2011 through its $8.5 million Clean Cities Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure awards. These grants, which were designed to encourage local public-private partnerships in developing EV deployment strategies, were given to awardees ranging from localities with extensive EV planning experience to those that were eager to begin but did not have the resources to do so previously. According to the DOE, Clean Cities activities may include updating permitting processes, revising codes, training emergency personnel, educating the public, and developing incentives.[16] In *Charging Ahead*, 85 percent of utility respondents said they were working with some form of public partner, including Clean Cities and universities, although the extent to which these partnerships are involved in building public charging stations is unknown. In addition to grants provided by the government, automakers such as Nissan are also installing charging stations. Nissan plans to install up to 500 direct current (DC) fast-charging stations over the next 18 months, in addition to the 160 chargers the company currently operates in the United States.[17]

The availability of grants and seed money has increased the number of installed chargers in recent years. However, as these funds are slated to run out in 2013, it is now time to address the question of whether there is enough incentive for private sector participants to keep expanding and maintaining charging stations in the absence of government grants. Will the reduction in public funding leave early EV adopters unplugged? A breakeven analysis for commercial chargers developed by Deloitte suggests that third parties, including utilities, should have the motivation to continue to charge ahead.

Charge-for-Charge: What is in it for me?

In an effort to assess the economic feasibility of building out charging infrastructure without government support, Deloitte's Center for Energy Solutions (the Center) developed a scenario modeling system called Charge-for-Charge, to analyze the viability of owning and operating commercial chargers without government subsidies. This analysis examined two common pricing models in use today: charging for the amount of electricity consumed (commodity-based pricing, i.e., the actual cost of the kWh consumed, plus a markup to cover costs such as maintenance and installation) versus charging for the amount of time a vehicle is plugged in at a charging station (i.e., a flat fee per hour). Each of the pricing models also considered utilization (the percentage of time that the charger would need to be in use in order to break even) and if the number of customers using the charging station affected the breakeven point.

[13] *2013 Deloitte reSources Study*
[14] http://www.ecotality.com/featured/ev-project/
[15] http://chargepointamerica.com/pr/pr-20100602-a.php
[16] http://www1.eere.energy.gov/cleancities/news_detail.html?news_id=17724
[17] http://www.yomiuri.co.jp/dy/business/T130201004075.htm

The breakeven analysis was calculated using the installation and recurring costs associated with owning and maintaining a common 240-volt, Level 2 charger, which is capable of fully charging most car models in three to eight hours.[18] A cost of $4,000 was assumed for installation, including the cost of the charger, as $4,000 represents the approximate midpoint of the average cost of installation in two separate studies.[19,20] However, the cost of commercial installation varies greatly, with estimates ranging from as little as $500[21] to as much as $18,000[22] with a more elaborate arrangement. In addition, the cost of the charging equipment varies greatly depending upon the sophistication of the equipment, although these costs are trending downward.[23] Profit was calculated separately, so the analysis could be used in various scenarios. For the breakeven analysis, Charge-for-Charge analyzed the revenue required based on total hours of utilization over a payback period of three years.

The analysis shows both pricing models can break even in a relatively short period depending on hours of charger utilization and the number of customers. The cost of charger installation is the single most important factor influencing the amount of revenue required for payback. For every additional $1,000 spent on installation, the revenue required to break even increases by approximately 20 percent. While the analysis found various breakeven points, including as little as 438 hours per year or about 1.2 hours per day, the per hour rate charged to the customer to attain this breakeven could be greater than $5 per hour depending on installation costs. As Figure 1 illustrated, the majority of EVs will be charged at residential locations, not public charging stations. Therefore, even though payback within three years is possible under the right utilization conditions, these conditions will be met only if EV sales continue to grow. The analysis also highlights that investors in EV infrastructure should focus on the location of the charging station, demographics of the population of EV owners, and understanding the customer's purpose for stopping at the charger location when determining which pricing model would be most profitable at the specific location.

Commodity-based pricing

Consumers are familiar with commodity-based pricing, which is similar to gasoline purchases. Gasoline prices fluctuate based on the cost of the underlying commodity plus a markup to allow for profit, and required federal, state, and local taxes. Using the breakeven assumptions outlined in the base case above, the model calculated that revenue of $0.95 per hour is required in addition to electricity costs and any taxes to recover the cost of installation in three years with 2,000 hours of use each year (about 46 percent utilization based on 12 hours per day). However, utilization is a significant factor in this model. In reality, using this pricing model, owners of EV charging infrastructure are generally looking to maximize time spent at a charger. This pricing model reduces risks to the charger owner, as electricity prices are flowed through to the EV owner at the time the charging station is used. Risks of high electricity prices or increased draw due to larger batteries are passed directly to the consumer. Charging station owners using this pricing model may believe each customer will be using the charging station for a relatively long period, thereby increasing utilization.

At this time, 10 states[24] allow third parties to resell electricity to consumers at a markup. This will continue to increase as state laws catch up with the relatively new concept of mobile electricity customers.

[18] *Unplugged: Electric vehicle realities versus consumer expectations*
[19] *2011 EPRI Transportation Electrification Study*
[20] *Plugging In: A Stakeholder Investment Guide for Public Electric-Vehicle Charging Infrastructure, Rocky Mountain Institute* (2009) – http://www.rmi.orgContent/Files/Plugging%20In%20-%20A%20Stakeholder%20Investment%20Guide.pdf
[21] Ibid.
[22] *Plug-In Electric Vehicle Handbook for Public Charging Station Hosts*, April 2012 – http://www.afdc.energy.gov/pdfs/51227.pdf
[23] Ibid.
[24] http://www.theevproject.com/cms-assets/documents/103425-835189.ri-2.pdf

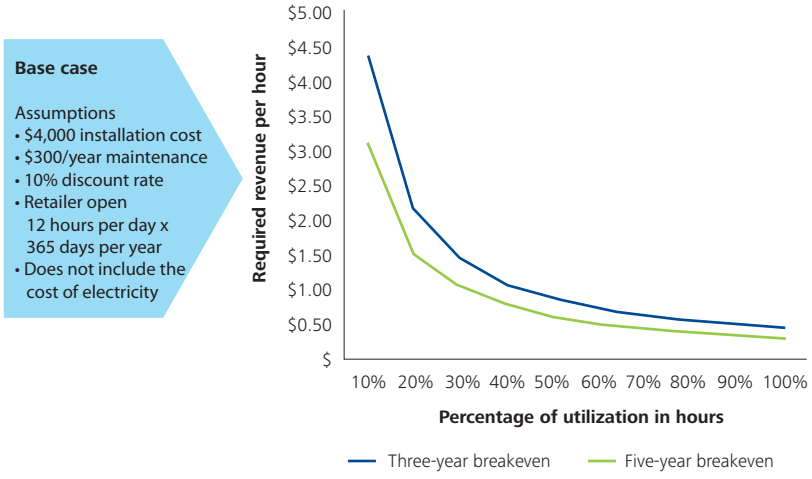
Flat fee pricing

The flat fee pricing model analysis calculated the price required per customer visit or per hour. Using this model, profitability depends on the number of customers and the length of time a customer stays at each charging station. For example, using the assumptions outlined in Figure 3, breakeven is possible on 2,000 hours of charging per year if the charging station owner can earn at least $1.25 per hour, including electricity costs assumed to be $0.103 per kWh.[25] This revenue could be earned by either charging $1.25 per hour or by setting minimum charges for smaller increments of time, for example, $0.50 for 20 minutes of charging. The flat fee pricing model is more sensitive to fluctuations in the price of electricity than the commodity-based model as the actual cost of electricity is not passed on to the EV owner. This, however, can be mitigated if EV charging station owners set prices leaving enough room for fluctuations in the price of electricity and try to increase the number of customer visits by installing chargers in locations that may attract quick top-offs, such as fast-food restaurants. Changes in the underlying commodity price may require adjustments to the fee charged. Infrastructure owners can also mitigate price risk through hedging strategies and power purchase agreements or they could set minimum fee requirements per charge to establish a minimum revenue level per customer. EV charging station owners may also set maximum time limits for charging to try to increase the number of customers at each location.

At this time, most EVSEs are using the flat fee model. In the short term, commercial EVSE owners have created networks to increase utilization by making it easy for the EV owner to charge in network. Out-of-network customers are charged higher prices. In addition, an analysis of network pricing shows that EVSE providers are using a variety of pricing structures ranging from free to as much as $2.50 per hour at chargers located as close to each other as a mile.

The analysis found that the pricing model used depends on the location of the charger, demographics of the EV owner, and the length of time the customer is expected to park in that type of establishment. For example, in longer-term charging locations, such as movie theaters or shopping malls, a commodity fee structure may collect more revenue as the charger may be plugged in for a few hours at a time — thereby increasing utilization. In quick turnaround locations, such as pharmacies or fast-food restaurants, a flat fee pricing structure may be beneficial as there might be two or three EVs plugging in during a single hour, making this pricing model more dependent on the number of customers each day. In some cases, the cost of installation and electricity may be "subsidized" in order to encourage customer visits.

Figure 3: Revenue and hours required to break even on public EV charging stations



[25] Using EIA U.S. National Commercial average – http://www.eia.gov/forecasts/steo/tables/?tableNumber=21#

Retailer motives

The Center's research found retailers were initially building out the public charging infrastructure because it was a low-cost investment due to the availability of stimulus funds and revenue-sharing arrangements with their EVSE partners made it easy and potentially profitable to do so. Yet, even as government funding runs out, Deloitte's Charge-for-Charge model suggests there is some incentive for companies to invest in commercial EV charging infrastructure as long as the number of EV sales increases significantly.

Discussions with representatives from a major pharmacy chain, a big-box retailer, a popular restaurant chain, and a charger installation company revealed several qualitative and quantitative factors motivating these organizations to make EV chargers available to the public, often providing space in their parking lots to do so. Qualitatively, study participants named customer goodwill and positive public relations as motivating factors, with some pointing to the fact that EVs and other green efforts are in line with their organization's values and corporate sustainability goals. Nonetheless, their motives for installing chargers do not appear to be purely related to brand image and community relations.

Quantitatively, retailers stressed they are not taking ownership of EV charging stations; they have not been paying for charger installation and maintenance, nor are they interested in doing so in the future. Instead, they are partnering with major EVSE companies, who pay for, own, and manage charger installation and maintenance, as well as the transactions with consumers. In exchange for the "prime" parking lot space, the EVSE companies share a portion of the revenue collected with the retailers. This is directly contrary with workplace EV charging stations where EVSE companies only own nine percent of charging locations.[26] Retailers benefit from gaining new revenue streams. Not only do they share in the revenues collected from the charging station, but they can also increase their revenues by selling their products — from aspirin to french fries — without spending capital or incurring additional overhead costs.

A push/pull strategy appears to be at work in forming these partnerships, both with EVSEs approaching retailers and restaurants in prime locations and retailers and restaurants approaching EVSE companies to "get in on the ground floor" of the EV movement. The impetus to get involved early appears to be strong regardless of the motive. Field research revealed that some retailers and EVSEs are providing EV drivers the chance to plug in for free, at least for now. While exact motivations for this generosity are deemed proprietary, retail and EVSE participants indicated that absorbing some of these installation, maintenance, and electricity costs would strengthen their network synergies, build their brands, or benefit the retailers' customers in certain strategic locations.

Figure 4: Comparison of costs to drive 100 miles

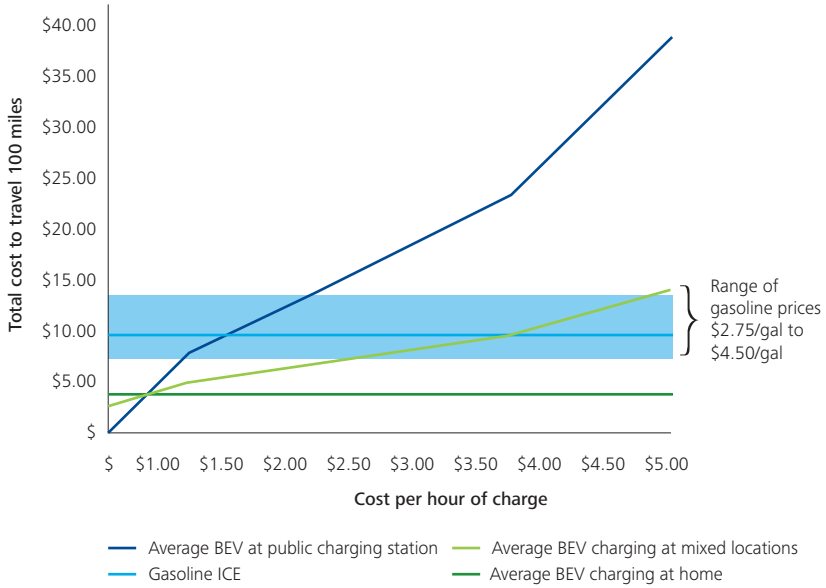


Figure 4 assumes the following:

- Average ICE mileage of 35.2 mpg[27]
- Average cost of electricity at home $0.12 kWh[28]
- Average cost for gallon of gasoline $3.23[29]
- Range and battery information from the vehicle automotive websites

[26] *2013 Deloitte reSources Study*

[27] http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013ER&subject=15-AEO2013ER&table=50-AEO2013ER&region=0-0&cases=early2013-d102312a

[28] http://www.eia.gov/forecasts/steo/report/electricity.cfm

[29] http://fuelgaugereport.aaa.com/?redirectto=http://fuelgaugereport.opisnet.com/index.asp as of 12/19/12

In addition to creating the Charge-for-Charge model, the Center performed a breakeven analysis to examine if using a public charging station was reasonable when compared to filling a gasoline-fueled vehicle. The Center assessed the cost of driving 100 miles in an EV versus a car with a traditional gasoline ICE. The Center found that utilizing only public charging stations to drive 100 miles is in almost all cases more expensive than driving the equivalent distance in a gasoline vehicle, with the exception of an EV with a very large battery size. This held true even for charging rates as low as $1 per hour. However, when the traditional EV charging pattern of 70 percent residential and 30 percent public/workplace charging was analyzed, Center research found that even if EV drivers pay a premium over household electricity rates for public charging, they will still pay less than an equivalent gasoline driver would pay overall.

The Center's analysis found that until public charging prices rise to about $1.82 per hour for Volt[30] owners, $2.17 per hour for Leaf owners, and $6.19 per hour for Tesla Model S owners, EV owners can incorporate public charging into their routine without paying a premium over gasoline drivers.

However, what does this mean for EVSE companies and pricing? If consumers wish to pay a price equal to or less than the equivalent amount for gasoline, they would be willing to pay a maximum of only about $2 per hour at a public charging station (see Figure 4). EVSE companies would need to consider this "price ceiling" when setting prices at public charging stations and calculating the payback period.

The California experience

As home to four high-adoption EV areas and aggressive environmental policies, California is leading the nation in building out the public EV infrastructure. According to the DOE's Alternative Fuels Data Center, about 20 percent of all public EV chargers are located in California. As such, California provides an excellent case study to explore the business models being deployed and the challenges that need to be addressed as the EV infrastructure expands throughout the nation. To that end, the Center analyzed California's progress in building out its EV infrastructure across three dimensions: network accessibility and pricing, information collection and consolidation, and the role of utilities in the public EV charging space.

Network accessibility and pricing

Four major commercial charging networks, which are owned and operated by EVSEs, are active in California: Blink (owned by ECOtality Inc.), ChargePoint (owned by Coulomb Technologies Inc.), SemaCharge, and Shorepower. They account for about half of the 1,000+ public chargers that are currently available in the state.[31] The remaining half is offered by independent commercial entities and municipalities. One additional network, eVgo (owned by NRG Energy) is in the process of entering the California market with plans to open numerous charging stations in the near term. As part of a settlement with California regarding energy prices, one energy company will provide $120 million for the installation of at least 200 public fast-charging stations and another 10,000 plug-in units at 1,000 locations across the state.[32]

The most common pricing model across all of these networks combines a monthly or yearly membership fee with a flat hourly rate at the charging stations, although there are many variations on this basic concept, with some networks bundling mobile charging access with home charger installation. One network, ChargePoint, does not require a membership fee, but does ask consumers to obtain a free ChargePoint membership card. Of note, the published flat hourly fees of these networks ranged from $0.85–$4.00/hour, which is in line with the aforementioned one- to three-year profitability projections of the Deloitte Charge-for-Charge model.

[30] Although the Chevrolet Volt is an EREV, for the purposes of this comparison, we utilized the battery only range
[31] http://www.afdc.energy.gov/fuels/electricity_locations.html
[32] Governor Brown Announces $120 Million Settlement to Fund Electric Car Charging Stations Across California - http://gov.ca.gov/news.php?id=17463

Overall, Center research found these charging networks provide near universal access to EV drivers, but typically at a premium: five of them allow nonmembers to charge at their stations, but they do assess a premium over the rates offered to members. The one exception is eVgo, which does not allow nonmembers to charge. An additional finding was that all of the above-mentioned charging networks have been at least partially funded by the State of California or federal grants. Given the state and federal budget pressures, it is unlikely that the current rate of charging infrastructure expansion in California will continue.

Data collection and consolidation

With more than 1,000 public charging stations already available and that number growing, California is poised to soon surpass an important milestone in the minds of consumers: Chargers will be available to EV drivers every 10–30 miles, which is well within the range of most EVs. On the one hand, this will likely go a long way toward removing "range anxiety" as a barrier to purchase. On the other, it could raise new concerns among utilities, as it is critical to know where and when EVs will be charging and how much electricity they will consume in order to forecast

Highway taxes for EVs?

Coincidentally with the rollout of EVs across the nation, federal and state governments are taking note that tax revenue for highway infrastructure is slowly diminishing. Since 1993, the federal government has administered a $0.184/gallon tax on gasoline to be used for road development and maintenance.[33] State and local governments also add taxes to gasoline to maintain road infrastructure. Given that EVs are less reliant on traditional fossil fuels, there is a clear disconnect in the current mechanism for collecting taxes based on road usage.

To overcome this issue and protect a vital revenue stream, state governments, including Washington, Oregon, Virginia, and Texas, have been proactively exploring options for adjusting the traditional collection model. Three proposals for collecting revenue to support road infrastructure from EVs are collecting a flat annual fee per vehicle, taxing by vehicle miles traveled (VMT), or charging a tax on the electricity used to charge an EV. While an annual fee would be simple from an administrative standpoint, it would clearly not be the most equitable approach to accounting for the amount consumers use public roadways. Conversely, VMT would address the equity issue but at the same time create additional challenges such as determining the appropriate accounting method. Consumers have expressed distaste for the government tracking their mileage using technology like global positioning systems, but experts say there are ways to address privacy issues. Pennsylvania is an example of a state using an alternative fuel tax to collect revenue on nontraditional vehicles. The regulation stipulates that a tax of $0.0093/kWh[34] be collected, but currently the collection of this tax is limited since EV charging is not distinguishable from other energy usage without the use of separate meters.

Policymakers will need to consider a redesigned tax structure that accounts for evolving technology. A number of variables will need to be considered, including vehicle weight and type. Vehicle weight, in addition to VMT, is a critical variable when determining the amount of wear and tear a vehicle inflicts on the roads. In general, heavier vehicles consume more gasoline, resulting in higher taxes paid. Another consideration is the type of vehicle. Since PHEVs can use both an ICE and an electric motor, double taxation could occur. Whatever the fuel for passenger cars may be in the future, developing a taxation scheme under which all vehicles pay their fair share for road development and maintenance is the desired outcome.

[33] http://www.fhwa.dot.gov/reports/fifahiwy/fifahi05.htm
[34] http://www.portal.state.pa.us/portal/server.pt/community/alternative_fuels_tax/14435/tax_rates/593722

load and plan any necessary upgrades to ensure reliability. Utilities' "need to know" becomes magnified even further when it comes to public charging stations as most of this charging is expected to occur during peak daytime hours and in clusters where heavy commercial use already exists. In California, as in much of the nation, this data is difficult to track. Some information regarding the size and scope of the charging networks active in California is available via the DOE's Alternative Fuels Data Center. Since this data is self-reported, it may not always represent the most accurate or up-to-date information available. Other data is available through the networks themselves, many of which offer mobile phone apps that allow EV owners to locate the nearest charging stations. Piecing together information from many sources, however, is cumbersome and imperfect, which underscores the potential opportunity for utilities to consolidate this data.

On the consumer side, notification to utilities of EV purchases is also inconsistent. In the Center's first report, *Charging Ahead*, 50 percent of utilities nationally responded that they are not notified when someone in their service territory purchases an EV and 11 percent are notified occasionally. Sometimes this notification comes from the permitting process. Interviews also indicated that some manufacturers of EVs in the United States have programs to notify utilities of EV purchases, but these programs are frequently inconsistent between manufacturers. In addition, original equipment manufacturers often base notifications on sales location data, not on where the EV will actually reside and charge, which makes it difficult for utilities to monitor clustering and potential load on transformers. To help remedy this information gap, the California Department of Motor Vehicles can now share information on EV registrations with utilities.[35]

Utilities' role

At present, investor-owned utilities in the United States are not active in the funding of public EV charging infrastructure. Only 19 percent of respondents to Deloitte's *Charging Ahead* survey said they were partnering with third parties to build EV charging stations. However, utilities will likely play a critical role in building and maintaining the distribution infrastructure needed to supply electricity to these stations, whether public or residential. As highlighted in *Charging Ahead*, utility respondents overwhelmingly indicated that the generation, transmission, and distribution infrastructure in the United States is ready to serve electricity demand from one million EVs by 2015, a penetration rate well under one percent of the total U.S. passenger fleet. However, California may be the exception.

In California, where 32 percent of all new EVs sold in the United States in 2012 were registered,[36] utilities and other stakeholders are already raising the critical question of who should pay for running new power lines, upgrading transformers, and other activities that may be needed to accommodate additional load from EVs. At present, the California Public Utility Commission (CPUC) has ruled that utilities can recover some costs for necessary infrastructure build-outs and upgrades, such as new transformers, due to EV charging.[37] What has yet to be determined, however, is how to recover these costs in an equitable way. For example, if an EVSE installs a cluster of charging stations in a high-traffic area that already has high industrial electricity consumption; should the utilities' business customers or only the EVSE be responsible for paying for the higher-capacity transformers needed to accommodate the extra load?

[35] http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0851-0900/sb_859_bill_20110218_introduced.html
[36] http://www.edmunds.com/about/press/california-buying-hybrid-and-electric-cars-at-supercharged-rate-reports-edmundscom.html
[37] http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0851-0900/sb_859_bill_20110218_introduced.html p. 39

Rate design and metering are also being discussed in California. One way utilities plan to limit the impact of EV demand on distribution systems is to influence charging behavior through TOU rates or flat EV rates for customers with separate meters. In the initial *Charging Ahead* report, one-third of utility respondents said they are already employing discounts for off-peak charging, while 44 percent have not yet decided whether they will employ specific EV rates. Nonetheless, 61 percent of utility respondents stated they would not install separate meters to track EV charging, indicating that they are too expensive. A few interviewees said their organizations plan to install meters on a small scale as a data collection measure even though they are not cost-effective as stand-alone devices. This data collection effort is important to utilities to understand the actual impacts of EV charging behavior to transmission and distribution infrastructure, load planning, maintenance, and pricing, etc., are understood related to charging behavior.

California, where tiered rates are the norm, offers an exception to this approach. The CPUC directed the three largest utilities to develop sub-metering protocols in 2013.[38] A sub-meter is a device that allows utilities to monitor electricity use for a specific location or for specific equipment on a property past the main meter. For example, in an apartment building, a landlord may be billed for the electricity usage for the entire building but then have sub-meters located in each apartment to determine individual tenant electricity usage. The utilities' sub-metering protocols will provide direction to the CPUC for how sub-meters should be paid for and deployed. Will demand-based, tiered rates deter adoption of EVs? Is sub-metering the answer?

These questions currently raised in California also become topics raised with greater frequency throughout the nation leading up to 2015 and beyond as EV penetration increases and EV infrastructure expands. Furthermore, utilities will likely need to be involved to a greater extent in order to maintain the integrity of their systems and to capitalize on any new business opportunities afforded by expanding use of EVs.

[38] http://docs.cpuc.ca.gov/published/Final_decision/139969-05.htm

The study shows it is feasible for a commercial entity to be profitable with a variety of pricing models as long as there is a significant increase in EV penetration in the future.

Utilities and the EV business

If utilities in general believe their infrastructure is prepared to handle the growing penetration of EVs — and they do, as reported in the *Charging Ahead* study — should they be more involved in the business of building out the public charging infrastructure? Or should utilities avoid investment in public charging stations in cases where few of their regulated customers own EVs, because it could be considered unfair for all customers to pay for infrastructure that benefits only a few? Of those utilities in high adoption areas, 40 percent indicated that they have a strategy in place for handling EVs' impact to the infrastructure. Based on the findings of this paper, utilities in high EV adoption areas may consider investing in EV charging infrastructure as a way to expand their business in an environment of relatively flat U.S. electricity demand. Through greater participation in the charging infrastructure, utilities would also improve their understanding of customer charging behavior, which would help with future load planning as EV adoption increases. In addition, utilities could have a greater impact on policy decisions affecting charging infrastructure growth, cost allocation, and recovery.

Austin Energy offers an example of a utility that is actively exploring the business of EVs. It has developed a network of 103 public charging stations called the Plug-in EVerywhere network.[39] This build-out fulfilled Austin Energy's commitment to the ChargePoint America program, funded by federal stimulus grants, which selected the city as one of only nine metropolitan regions in the country to participate in the program. The stations are geographically dispersed in diverse locations, such as restaurants; hotels; medical facilities; educational institutions; retail stores; and public facilities, including libraries and recreation centers. Austin Energy offered rebates of up to $2,500 per charging station to the private, public, and nonprofit sectors to help defray the costs of installing the charging stations offered by the utility through the ChargePoint America program. Anyone with an EV can use the stations. The utility offers a $25 six-month subscription swipe card for unlimited charging at any network location, or alternatively, consumers can use a credit card for $2 per hour of charging. According to a company press release, the Plug-In EVerywhere network will enable Austin Energy to gather data regarding when the charging stations are used, how much energy is consumed, and will help the utility research and plan for how PEVs will help shape the electric and transportation sectors in the years to come.[40]

Motivation for the last mile

Utility infrastructure is ready to supply the electricity needed to support the build-out of U.S. EV infrastructure at penetration rates far higher than the President's one million EV goal. While grant money has seeded the initial build-out of EV infrastructure, what should be the next step for utilities, EVSEs, retailers, municipalities, and other stakeholders as this funding expires?

The Deloitte Center for Energy Solution's Charge-for-Charge model demonstrated that there is a business case to be made for investing in public charging stations if there is sufficient penetration of EVs in the marketplace. The study shows it is feasible for a commercial entity to be profitable with a variety of pricing models as long as there is a significant increase in EV penetration in the future. However, based upon the analysis performed, it would appear that only in California, where more EVs are sold than elsewhere in the nation, would there potentially be sufficient EV penetration rates to reach the public charger breakeven utilization of 2,000 hours in the next three to five years.

"It would appear that EV drivers are becoming more comfortable with charging in public locations" according to the most recent report from the EV Project showing increased usage of public chargers.[41] However, with less than 30 percent of charging occurring at workplace and public charging stations, the payback period is currently unknown. Therefore, it could take a number of years to reach the 2,000 hours of utilization needed to reach the breakeven point. In fact, based on the current rate of EV sales, the payback period simply may not be sufficient for the EVSE companies to maintain their current business

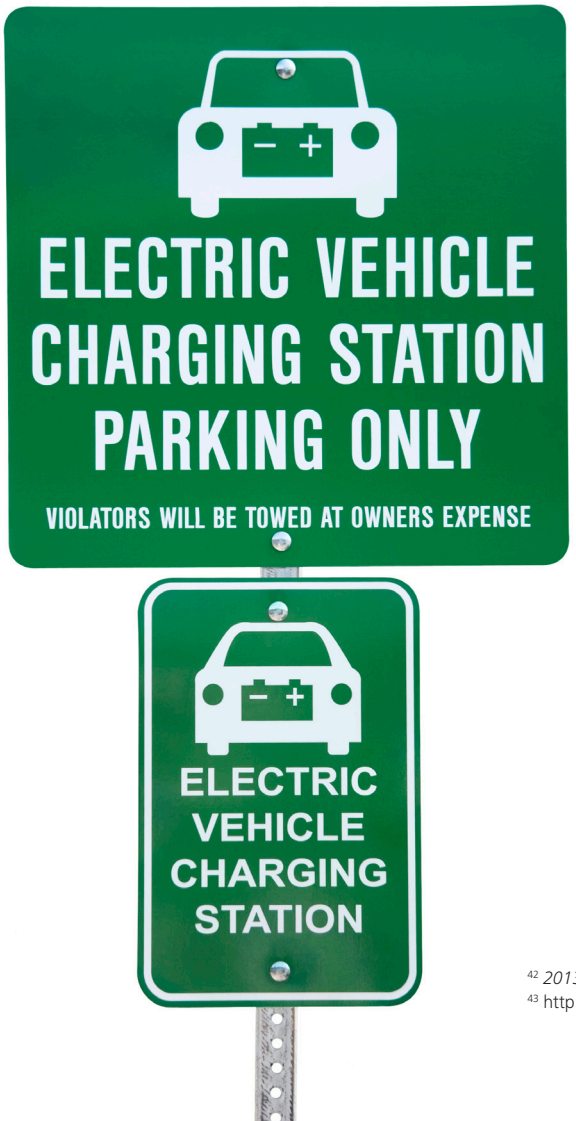
[39] http://www.austinenergy.com/About%20Us/Newsroom/Press%20Releases/Press%20Release%20Archive/2011/chargingStations.html
[40] Ibid.
[41] http://www.theevproject.com/downloads/documents/Q3%202012%20EVP%20Report.pdf, pg. 4

model. The expiration of tax credits for EVs could further depress sales figures. At the same time, however, improvements in battery and charging station technologies could decrease the amount of utilization hours necessary to break even in the future. In addition, if employers continue to offer charging available to the general public and in many cases for free,[42] this could further erode the timeline to breakeven.

Utilities and other stakeholders in the EV ecosystem will need to keep an eye on changing technology as it could potentially accelerate the penetration of EVs and increase load on transmission and distribution systems, and also could affect the profitability of public charging stations. For example, increases in battery capacity may increase load and, therefore, the number of kWh sold, but may not affect the profitability of EV infrastructure depending on the type of pricing model used and the amount of time the new technology can carry a charge, since higher-capacity batteries may not need to top off as often. However, if the larger batteries are topped off during peak hours, then it could potentially affect the utility's ability to offer reliable electricity. With the DOE looking to increase competition in the battery market and lower the cost per kWh,[43] this is a very real possibility.

There are a number of good business reasons to charge ahead in completing the last mile of EV charging infrastructure, and utilities would do well to take notice. The investments and decisions being made by the private sector and municipalities in building out this infrastructure will someday affect utilities' systems. Alternatively, they could be missing out on opportunities to grow their businesses and diversify their revenue streams as more EVs are sold in the U.S. passenger fleet.

To gain additional perspectives on the readiness of the electric grid and the development of the public charging infrastructure, please visit **www.deloitte.com/us/chargingahead**. To read Deloitte's EV consumer research, please visit **www.deloitte.com/us/electricvehicles**.



[42] *2013 Deloitte reSources study*
[43] http://www.reuters.com/article/2013/01/31/us-autos-greencars-chu-idUSBRE90U1B020130131

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Study methodology

Plugged In: The Last Mile and Charging Ahead: The Last Mile (*the study*) consisted of primary interviews as well as an online survey targeted at utilities regarding their preparations for EVs. More than 70 entities, including utilities, retail businesses, EVSEs, state and local government agencies, and trade associations, participated in the overall study. The study was supplemented with secondary research, including academic studies and publications. The study follows a report Deloitte published in Fall 2011 on consumers' attitude toward EVs and their likelihood of purchasing them, titled *Unplugged: Electric vehicle realities versus consumer expectations.*

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