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Arizona Corporation Commission
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May 1, 2012

Docket Control
Arizona Corporation Commission
1200 W. Washington
Phoenix, AZ 85007

RE: Arizona Public Service Company EV-READY Study Annual Report
Docket No. E-01345A-10-0123

Pursuant to Decision No. 72582 dated September 15, 2011:

> IT IS THEREFORE ORDERED that Arizona Public Service Company shall file annual reports, beginning in May 2012, detailing the development of the EV market within Arizona Public Service Company's service territory.
>
> IT IS FURTHER ORDERED that Arizona Public Service Company shall conduct a feasibility study of offering a separately metered, non-tiered, TOU rate for EV charging with a report of the findings of this study to be included in the Company's first annual report to the Commission.

Attached please find the initial APS ev-READY Study Annual Report. The report includes the results of the Company's feasibility study on separately metered EV rates.

If you have any questions regarding this information, please contact me at (602)250-2661.

Sincerely,

Jeffrey W. Johnson

JJ/cd
Attachments

Arizona Public Service Company

ev-READY Study

Electric Vehicle Readiness Demonstration Study

ANNUAL REPORT

May 1, 2012

Docket No. E-01345A-10-0123

Table of Contents

Executive Summary

On August 8, 2011, Arizona Public Service Company (APS or the Company) filed its Electric Vehicle Readiness Demonstration Study (the ev-READY Study or the Study) with the Arizona Corporation Commission (Commission). As discussed in the Company's application, the ev-READY Study is designed to assist the Company and its customers in preparing for an increasing penetration of electric vehicles and plug-in hybrid electric vehicles (collectively referred to as EVs in this report) in the APS service territory in the next three years. APS developed the Study to provide tools to early adopters of EVs which will allow for the effective management and integration of an EV into both the customer's lifestyle and the APS distribution system.

In Decision No. 72582 (September 15, 2011), the Commission declined to approve the ev-READY Study as proposed by the Company, citing the uncertainty surrounding market penetration and customer adoption of EVs and the availability of federally-funded EV incentive programs such as the Department of Energy's *The EV Project*.[1] APS was instead directed to closely monitor EV market penetration in collaboration with industry stakeholders and report annually on the status of EV adoption within the APS service territory. This report is the initial ev-READY Study annual report.

The EV market has developed more slowly than expected. Contributing factors to the current weak market include the impact of the March 2011 Japanese tsunami on the availability of EVs, technical issues with vehicle components (most notably the battery), and the continuing depressed economy. In the Company's ev-READY Study application, APS estimated that approximately 540 EVs would be deployed in the Company's service territory by the end of 2012. To date, 171 EVs are known to have been acquired by APS customers. Likewise, the deployment of EV charging infrastructure has lagged in comparison to industry expectations.

Despite the uncertainty surrounding EV market penetration, the Commission recognized the importance of addressing expected impacts of residential EV charging behavior on the Company's distribution system as early as possible during development of the EV market by approving the ev-READY Study Experimental Rate Schedule ET-EV. Rate ET-EV is a "whole house"[2] time-of-

[1] *The EV Project* is testing deployment and utilization of charging equipment in several major cities, including Phoenix. The Project was launched in October of 2009 with the intermediate goal of installing 14,000 EV charging stations (both residential and public) in 18 major U.S. cities. The lessons learned from the initial deployment of EVs and supporting charging station infrastructure are then expected to enable the Project's ultimate goal of streamlined deployment of the next 5 million EVs.

[2] A "whole house" rate measures all energy consumption at a residence, including energy necessary to charge an EV, through a single meter. All household usage is therefore subject to pricing signals contained in the rate.

use (TOU) rate which incorporates a "super off-peak" time period designed to encourage off-peak EV charging, and will provide APS with valuable data related to delivery system performance and customer charging behavior.

Because Rate ET-EV has not yet been available during summer months when both the cost of electricity and the demand on the localized residential distribution system is at its highest, APS does not currently have sufficient data to conduct a meaningful analysis of the effectiveness of the off-peak pricing period or the impact of charging behavior on system operation. The Company will provide a detailed analysis of the relevant data in its next annual report.

In response to Commission interest, the Company also agreed to consider the feasibility of offering a separately metered TOU rate for residential EV charging in addition to Rate ET-EV. This feasibility study is presented in this report and shows that, although there are some advantages to a separately metered charging station, the current EV market penetration in the APS service territory does not support development of this option. Separately metered household EV infrastructure creates unnecessary complexity and is not cost-effective for either the utility or the customer. Therefore, APS is not proposing a separately metered rate option for residential EV infrastructure at this time.

APS will continue to monitor EV market penetration, engage industry stakeholders and other interested parties, streamline processes for data measurement and system operations, and evaluate Rate ET-EV throughout the following months.

I. Development of the Electric Vehicle Market

The ev-READY study is designed to assist the Company and its customers in preparing for the expected increase in market penetration of EVs in the near term. In the Company's ev-READY Study application, APS noted that uncertainty existed as to the percentage of vehicle sales that would be comprised of EVs over the next decade. However, the Company also noted that the DOE-funded *The EV Project*, which is supporting the development of the EV market by installing EV charging stations in eighteen major cities across the United States, has included the Phoenix and Tucson areas within the project. APS expected that, as a result of *The EV Project*, a relatively higher percentage of APS customers would be among the early adopters of EVs. In turn, expected early adoption of EVs in the APS service territory increases the importance of developing and implementing a plan to seamlessly integrate EVs into the Company's distribution system.

The EV Project targeted the deployment of approximately 900 EVs in the Phoenix and Tucson areas by the end of 2012, of which 350 to 500 were expected to be located in the Company's service territory. As of March 31 of this year, only 171 EVs are known to have been purchased by customers living in the APS service territory, some of which are not affiliated with the DOE-funded *The EV Project*. While deployment of vehicles and charging stations through the project has not yet met expectations, *The EV Project* continues to be a viable program and public charging stations are being installed at an increasing rate today.

There is no doubt that the EV market has developed more slowly than expected; therefore, the high degree of uncertainty surrounding market penetration and customer adoption of EVs continues today. Additionally, consumer concerns regarding the availability of EV charging stations in areas outside the home remain, as vehicle and infrastructure manufacturers have not yet been able to adequately address the consumer's fear of being stranded away from home while driving an EV, with no options to recharge the battery and return home.

However, an increasing number of auto manufacturers are introducing EV models (see Table 1). Battery research continues in an attempt to address limited vehicle range. Federal tax credits are still available for up to $7,500 toward the purchase of an EV, dependent upon the battery capacity and gross total weight of the vehicle.[3] This continuing support, along with other advances in technology, keeps industry observer expectations of increased deployment of EVs high.

[3] Internal Revenue Code (IRC) 30 (Plug-in Electric Vehicles) and IRC 30D (Qualified Plug-in Electric Drive Motor Vehicles).

APS is working with EV infrastructure contractors to monitor the EV market, both in Arizona as a whole and specifically in the Company's service territory.[4] The Company participates in the EVAZ Stakeholder Group, a group of EV infrastructure manufacturers, auto dealerships, government organizations, utilities, and other industry observers based in Arizona. Meetings of the group are held regularly and participants share information on EV-related programs, successes and challenges. The group is also developing policies that are intended to advance the adoption of EVs within the state.

Company personnel monitor industry activity and network with other utilities, infrastructure developers, and auto manufacturers to maintain a high level of awareness of industry trends and to build a network of information specialists. In addition, the Company is currently working with Ecotality, the program manager and installation partner for *The EV Project*, on development of an integrated charging infrastructure which would include battery storage and photovoltaic systems.

A. Availability of Electric Vehicles

The first widely available EVs were deployed in the United States to participants in *The EV Project* in the latter part of 2010 and into 2011. Adoption of these vehicles by consumers during this period was lower than expected amid delays in vehicle availability, the largest of which was the impact of the Tohoku earthquake and tsunami in Japan in March of 2011 on the ability of Japanese car manufacturers to ship product to the United States. Other delays in EV availability included technical difficulties such as software glitches and vehicle component breakdowns, including battery fires.

1. Market Participants

In 2011, consumers were able to purchase their choice of three main brands of EVs, each with differing attributes and price points.

The Nissan LEAF (Leading Environmentally-friendly Affordable Family car) is an all-electric vehicle with an estimated range of 100 miles. Deliveries to United States consumers that had pre-ordered vehicles began in December of 2010. By the end of 2011, Nissan had sold more than 9,600 cars in the United States; however, this amount fell short of the forecasted 20,000 cars by that date. The LEAF is currently priced at approximately $35,000.

[4] "IT IS FURTHER ORDERED that Arizona Public Service Company shall work cooperatively with the federally-funded EV infrastructure contractors for the first year of the proposed Study." *Decision No 72582, page 15 lines 5-6.*

In contrast, the Chevrolet Volt is advertised as an extended-range EV with an initial range on an electric charge of approximately 40 miles. Once the car battery is depleted, a gasoline engine powers an electric generator to extend the car's range. The Volt became widely available in the United States by June of 2010, and by the end of 2011 Chevy had sold approximately 7,700 vehicles (short of the planned sales levels of 10,000 cars by that date). The Volt is currently priced at approximately $40,000.

The high-end Tesla Roadster was also available; however, Tesla is not a partner in *The EV Project*. The Roadster is an all-electric vehicle using a lithium-ion battery, which has an advertised range of approximately 200 miles. It was the first highway-capable EV in production and available in the United States, although with a price of over $110,000, the Roadster was not planned as a mass-produced vehicle. Tesla sold approximately 2,100 vehicles through the end of 2011, but its production has since been halted in favor of Tesla's next generation EVs.

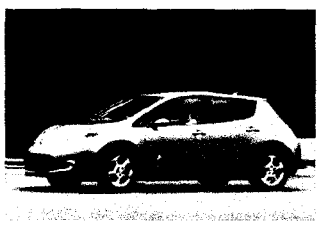


Figure 1. Nissan LEAF

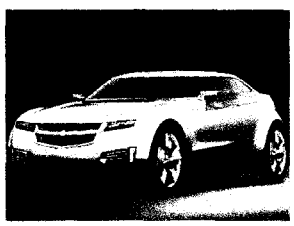


Figure 2. Chevy Volt

Figure 3. Tesla Roadster

By the end of 2011, several other EV models were available for purchase, including the Daimler Smart Electric Drive (Smart ED), the Mini-E, and the Fisker Karma. None of these EVs were widely available. However, the EV models planned for deployment in the coming years have grown significantly, creating higher expectations of EV market penetration growth in the upcoming years.

Table 1. Planned Electric Vehicle Models through 2015

	Planned Release Year			
Vehicle Brand	**2012**	**2013**	**2014**	**2015**
Audi	R8 - BEV		A4 - PHEV	
BMW	Active E - BEV	i3 MCV - BEV i8 - PHEV		
Bugatti	16C Galibier - PHEV			
BYD	e6 - BEV F3DM - PHEV			
Cadillac			ELR - PHEV	
Coda	All Electric Car - BEV			
Chrysler		200C - PHEV		
Fisker	Karma S - PHEV Surf - PHEV	Nina - PHEV		
Ford	C-Max Energi - PHEV Focus E - BEV	F-Series Super Duty - PHEV		
GM		Minivan - PHEV		
Honda	Accord - PHEV	Fit - BEV		
Hyundai	Blue-Will - PHEV			
Jaguar				C-X75 - PHEV
Mercedes		S500 - PHEV		
Mitsubishi		SUV - PHEV		
Porsche		918 Spyder - PHEV		
Scion	iQ - BEV			
Smart	ForTwo Electric - BEV			
Toyota	Prius - PHEV			
Volkswagen	RAV4 - BEV	Up! - BEV		

BEV = Battery Electric Vehicle
PHEV = Plug-in Hybrid Electric Vehicle

2. Electric Vehicles in the APS Service Territory

As of March 31, 2012, APS has identified 171 electric vehicles that are being charged regularly at residential sites throughout the Company's service territory. The vast majority of these EVs are either Chevy Volts or Nissan LEAFs; however, APS is aware of six Tesla Roadsters, one Fisker Karma, and one Smart ED that have been purchased by APS customers.

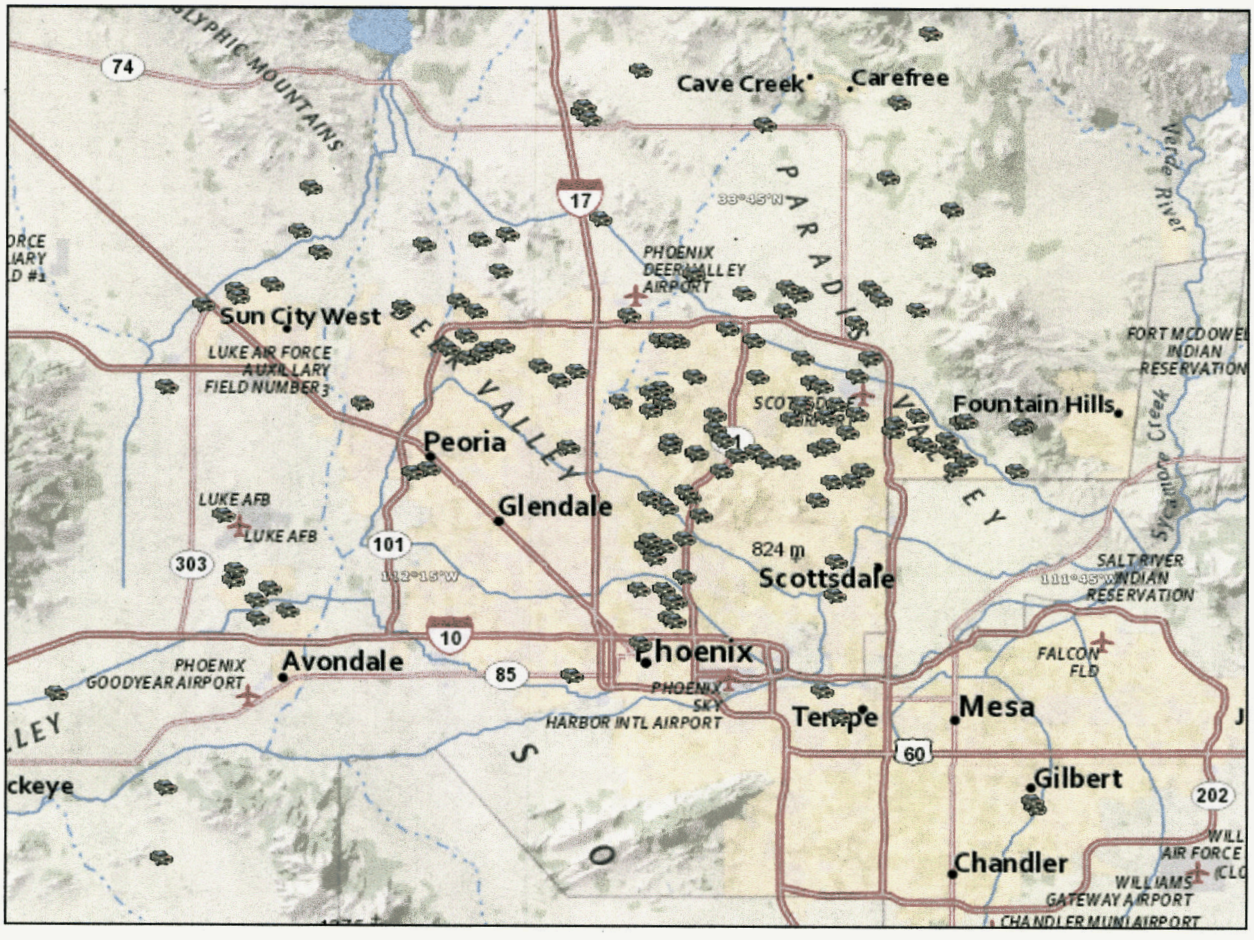
APS customers self-identify as EV purchasers. The Company learns of the individual EV purchaser either through customer phone calls to learn about services or other rate options available to EV owners, or from EV manufacturers and dealerships who are tracking EV deployment (such as through *The EV Project*). At the time of purchase, an individual is told that purchase information will be shared with the electric utility serving the customer unless that customer chooses not to provide the data. Purchase statistics based on dealership records show that only about 10% of EV purchasers choose not to share information with their Arizona electric utility.

As discussed in the Company's ev-READY Study, APS utilizes this information on EV purchases to determine the ability of existing transformers to absorb

the additional electric load of EVs being charged within a specific neighborhood. As part of the ev-READY Study, the Company has developed processes and procedures to ensure safe and reliable integration of EVs into the local distribution system, including the mapping of known EVs.

Figure 4. Known EVs in APS Service Territory throughout Arizona

Figure 5. Distribution of Known EVs in Metro Phoenix APS Service Territory



As explained in the Company's ev-READY Study, it is unlikely that a single vehicle charging during peak demand hours will create reliability issues on the distribution system.[5] However, in a situation in which several EVs are clustered within a neighborhood, the probability of reliability issues increases.

Clustering refers to the adoption of EVs by additional homeowners in areas where one or more than one household has already adopted an EV, resulting in the potential for overload and failure of transformers. This phenomenon is also referred to as geographic clustering, which can occur long before EV market penetration matures. There is evidence to suggest that EVs will experience the same geographic clustering experienced with the adoption of hybrid vehicles.

[5] The timing of EV charging is a key determining factor of possible grid impacts in neighborhoods. For residential customers, it is likely that an EV will begin charging as soon as it reaches home absent an incentive to charge at a later time.

To date, APS has not encountered clustering of EVs. The Company is aware of only two neighborhood transformers that are carrying electric load for more than one EV – each in cases where a single household has purchased two EVs. In those instances, existing transformers are able to absorb the additional load created by both EVs. As the EV market matures, however, and more vehicle models are released, the Company expects to encounter greater concerns with geographical clustering.

B. Availability of Public EV Charging Stations

Just as deployment of EVs has lagged, the Arizona market has seen a slower than expected deployment of related public charging infrastructure as well. Through *The EV Project*, approximately 920 publicly available charging stations were estimated to be installed in the state as of the end of 2012; however, as of the end of 2011 only 280 of these had been deployed. These stations are being installed in the metropolitan areas of Phoenix and Tucson, Arizona and the Interstate 10 corridor between the two cities.

Ecotality, the program manager and installation partner for *The EV Project*, has installed 103 Level 2 chargers at residential and public sites in the APS service territory as of December 31, 2011.[6] This network of charging stations, known as the Blink Network, is the largest deployment of EV infrastructure in the state.

Table 2. Blink Chargers Deployed in Arizona as of 12/31/2011

	Residential Level 2	**Public Level 2**	**Total**
APS Service Territory	61	42	103
Metro Phoenix (other than APS)	105	12	117
Tucson	49	11	60
Total Arizona Deployment	215	65	280

To date, in the Metro Phoenix area, Blink public charging stations have been installed largely at government or business properties. For example, several Blink Network stations are available in downtown Phoenix at the Burton Barr Library, the Phoenix City Hall garage, the downtown campus of Rio Salado College, the Two Renaissance office building, and the Arizona Department of Environmental Quality office.[7]

[6] Level 2 chargers are the primary EV chargers for residential applications and the majority of commercial applications, as this infrastructure is typically capable of fully charging an EV in approximately four to six hours.

[7] A map of existing Blink Network public charging stations throughout the United States can be found at www.blinknetwork.com/locator.html. The map is notable because the number of stations at each installation site is provided, along with real-time usage information to allow consumers to both find a station and know in advance if that station is available for immediate use.

Additional public EV infrastructure has been installed in the state by Coulomb Technologies. Coulomb is the sponsor of the national EV infrastructure program *ChargePoint America*, which provides host families and businesses with charging stations at no cost and is funded through the American Recovery and Reinvestment Act (ARRA). However, the charging stations installed in Arizona by Coulomb are not part of either *ChargePoint America* or *The EV Project*.

Table 3. Coulomb Chargers Deployed in Arizona

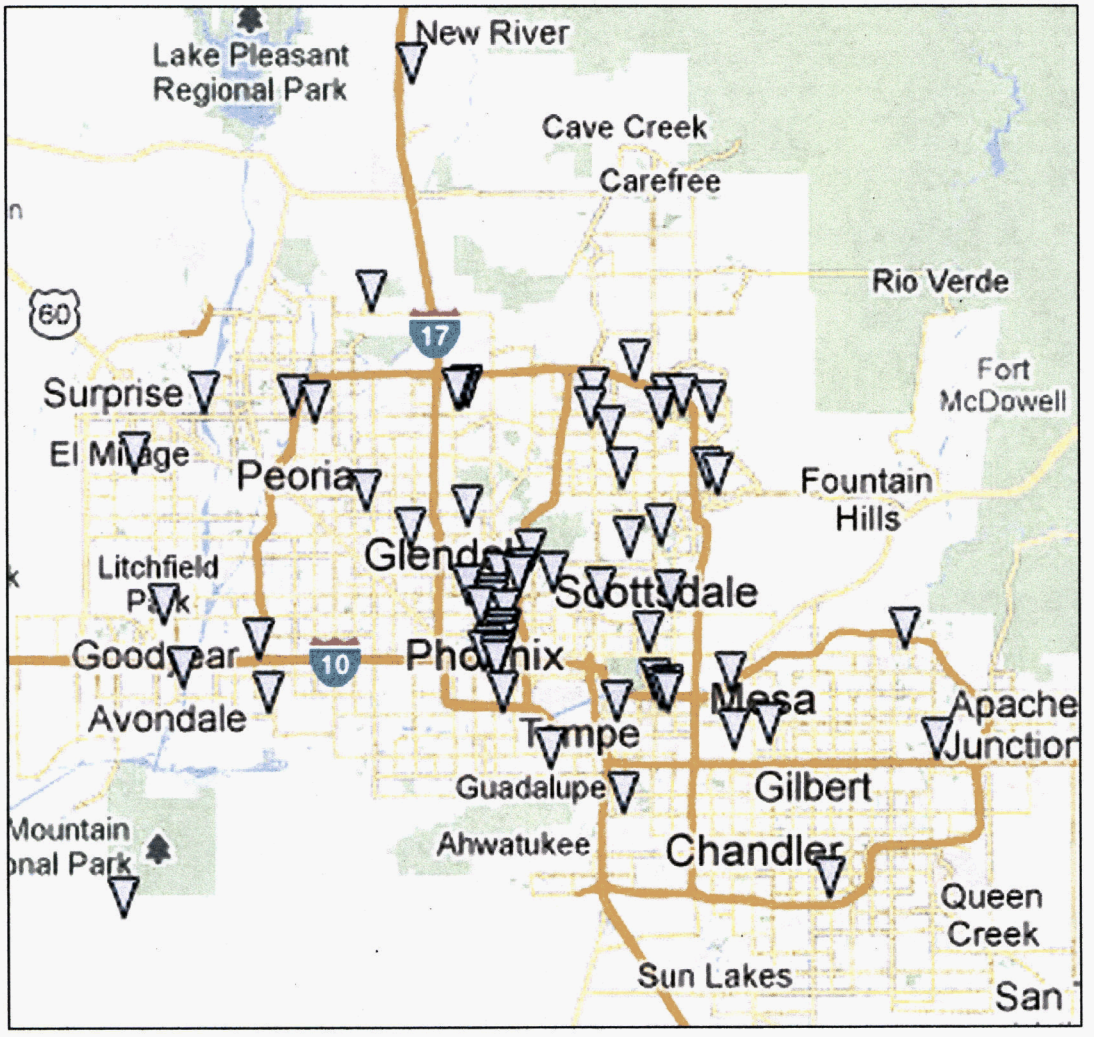
	Public Level 2
Metro Phoenix	5
Tucson	3
Total Arizona Deployment	8

Other national electric vehicle infrastructure networks that have installed EV charging stations include the Better Place network (currently deployed in Hawaii) and the eVgo network (a subsidiary of NRG Energy, with charging stations deployed in metropolitan areas in Texas). The eVgo program provides residential and business EV owners with a choice of monthly payment plans for purchase, installation, and maintenance of charging infrastructure.[8] To date, APS is not aware of an Arizona presence for either of these networks.

A map of EV charging stations in the Metro Phoenix area as produced by the Department of Energy's Alternative Fuels and Advanced Vehicles Data Center is provided in Figure 6. Public EV charging infrastructure continues to be deployed almost exclusively near highly traveled roadways and freeways or near government buildings.

[8] In California, a landmark settlement agreement was signed by the Public Utilities Commission in March of 2012 in which NRG Energy has agreed to install more than 10,000 publicly available EV charging stations across California to settle claims relating to market manipulation during the 2001 California energy crisis. Installation of these stations is expected to be complete by the end of 2015.

Figure 6. Metro Phoenix Area EV Charging Station Deployment as mapped by the Department of Energy[9]



The Company's ev-READY Study included a proposal to deploy APS-owned public EV charging stations throughout the APS service territory. This portion of the Study was designed to complement *The EV Project* by placing charging stations in locations where the project did not have plans to install EV infrastructure (to fill in gaps within cities and more evenly distribute availability of charging stations, and to place in APS service territory outside of the metropolitan Phoenix area). The proposed public charging station acquisition and deployment timeline was based on a forecast of EV sales in the Company's service territory. The Commission declined to approve this portion of the ev-READY Study, citing the uncertainty surrounding market penetration and customer adoption of EVs.

[9] For this and similar maps, please see www.afdc.energy.gov/afdc/locator/stations.

APS continues to believe utility-owned public charging stations may be appropriate in future years of the ev-READY Study to complement *The EV Project* infrastructure deployment; however, at this time the Company does not intend to install Company-owned public charging stations nor request approval of a point-of-sale pricing methodology for energy usage at these stations.[10] The Company will continue to monitor deployment of *The EV Project* and the number of EV sales in the APS service territory and may request a similar charging station deployment program in the future.

C. Customer Education and Outreach

APS has developed several methods of communication in order to reach and inform customers regarding the availability of EVs and their contribution to a cleaner environment, the various types of charging stations and under what circumstances a residential customer may wish to install a station at home, and the impacts EV ownership may have on individual electricity usage and neighborhood distribution systems.

APS maintains a robust website (www.aps.com/ev) which provides information about EVs, EV charging, and other basic information regarding EV ownership including customer rate options appropriate for the EV owner. A dedicated e-mail account, electricvehicles@aps.com, is available for EV owners to ask specific questions regarding their EV and their APS account. The Company has also partnered with leading automobile makers, other utilities, and battery and charging station manufacturers to establish a website to educate consumers, policymakers, and key industry sectors on the benefits of EVs. This website (www.GoElectricDrive.com) contains comprehensive information about owning and operating an EV, including available federal and state incentives and other EV benefits.

APS personnel also attend public events with Company-owned EVs to broaden public awareness of available vehicles, answer questions, and demonstrate the benefits of EVs.

[10] "Should APS identify a gap in charging infrastructure deployment, or other deficiency in the federally-funded EV infrastructure efforts, APS may request approval of a public point-of-sale rate in APS' first annual report of Study findings to the Commission." *Decision No. 72582, page 15, lines 7-9.*

II. Feasibility of Separately Metered EV TOU Rate

It is well understood that EVs represent a significant addition to individual residential energy requirements. The possibility of existing transformer failure and other distribution system impacts due to geographic clustering of EVs (as described earlier in this report) has persuaded utilities to focus on strategies designed to encourage customers to charge EVs during off-peak hours. As the smart grid platform becomes more prevalent, automatic metering infrastructure is enabling utilities to develop TOU rates for a variety of purposes, including EV charging.

Utilities in most regions of the country are just beginning to implement and market TOU rates. APS customers, however, are very familiar with these rates as the Company has successfully offered a family of TOU rate structures for many years. APS customers choosing to purchase an EV are expected to easily adapt to TOU rates for EVs.[11]

As part of developing effective TOU rates, utilities are independently determining whether residential EV load should be separately metered or viewed simply as an additional customer-owned end-use appliance. A few utilities have opted to separately meter EV load and offer targeted pilot TOU rates. The Company developed a whole-house residential TOU rate for EV load as part of the ev-READY Study (Experimental Rate Schedule ET-EV) rather than separately meter residential EV load.

In Decision No. 72582, APS was ordered to study the feasibility of offering a separately metered TOU rate for residential EV charging in addition to Rate ET-EV.[12] The Company has considered the feasibility of three differing methods of separately measuring EV load: the addition of a second meter, with its own dedicated circuit, installed parallel to the existing residential meter; the addition of a sub-meter "behind" the primary residential billing meter; and the integration of an internal meter into the EV charging station itself.

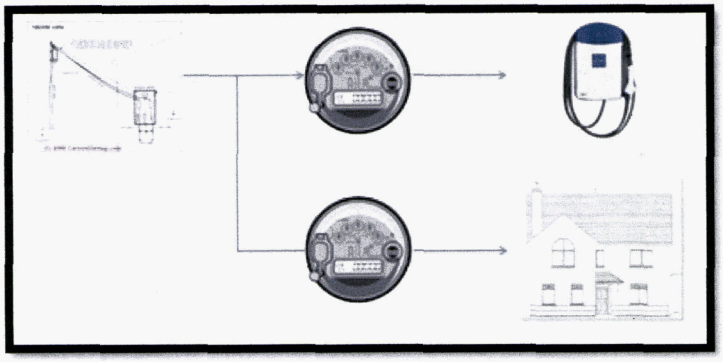
A. Separate Circuit Metering

One method of separately measuring residential EV load is to install an additional meter in parallel to the existing meter, dedicated strictly to the EV charging equipment.

[11] APS implemented its initial experimental TOU rate in April of 1976. Today, over 50% of the Company's residential customers subscribe to a TOU rate, making APS the leading time-differentiated pricing provider in the United States.

[12] "IT IS FURTHER ORDERED that Arizona Public Service Company shall conduct a feasibility study of offering a separately metered, non-tiered, TOU rate for EV charging with a report of the findings of this study to be included in the Company's first annual report to the Commission." *Decision No. 72582, page 15, line 1-4.*

Figure 7. Configuration of a Separate EV Circuit



The primary advantage of a separate circuit for EV load is that both the customer and the utility can determine precisely how much electricity the vehicle requires for charging. The utility can gather this information from its EV customers to assist in the determination and mitigation of neighborhood distribution system impacts. The customer can track energy usage more accurately to allow for planning and budgeting for the significant increase in energy usage caused by EV charging.

Another advantage of a separately metered circuit for EV charging is the ability for the utility to develop separate rates designed specifically for the unique characteristics of EV charging. Rates can be designed to send price signals to encourage off-peak charging, which is also beneficial to both the utility and the customer.

Conversely, the major disadvantage to the installation of a second meter dedicated solely to the measurement of EV load is that this configuration requires significant additional electrical equipment at significant additional cost. In addition to the meter itself, a separate circuit requires a secondary meter panel and a meter panel main breaker. Wiring from the second meter panel main breaker to the neighborhood transformer would be required. Conduit and trenching to place the additional wiring would also be required. The additional cost of this equipment and electrical work would be borne by the customer in accordance with the Company's Service Schedule 3.

Additionally, each residence would need to be independently evaluated to determine if the existing transformer serving the neighborhood has the necessary physical space to host a new service line. If new or additional transformers were deemed necessary, these costs would also be charged to the customer.

The actual cost of a separate circuit under these circumstances is highly dependent upon the configuration of the existing residential load and the neighborhood distribution transformer configuration. As an example, in the case of a residential customer whose home is 300 feet away from the

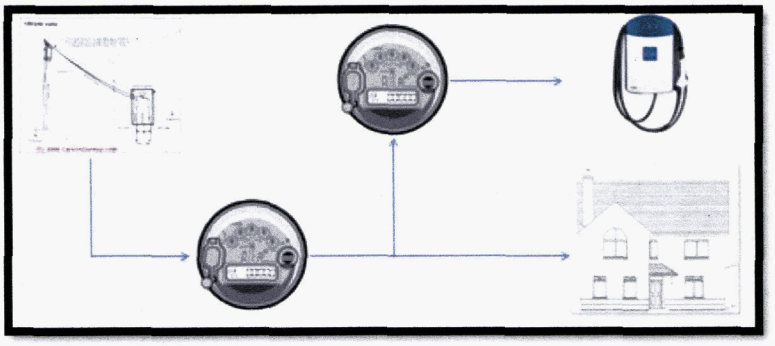
neighborhood transformer, the wiring alone would cost $837 (300 ft. x $2.79 per underground circuit foot as stated in the Company's currently effective Service Schedule 3). If the transformer does not have the space to accommodate an additional service drop, the cost of a larger transformer would be a minimum of approximately $3,400 (also as provided for in Service Schedule 3).

Several utilities have developed rates for separately metered EV load, including Detroit Edison, Hawaiian Electric Company, Los Angeles Department of Water and Power (LADWP), Pacific Gas and Electric (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE). Each of these utilities require the customer to pay the majority, if not all, of the costs of providing a separate circuit (although a few also offer rebates or incentives to customers choosing to provide a separate circuit[13]). These rates are offered in addition to a whole-house EV rate similar to the Company's Rate ET-EV.

B. Sub-Metering

The second method of separately metering residential EV load that APS reviewed is the addition of a sub-meter "behind" the primary residential billing meter.

Figure 8. Configuration of Sub-metered EV Load



The advantage of separately metering EV load through a sub-meter is similar to that of a separate circuit meter; namely, the load attributable specifically to the EV can be precisely measured, providing benefits to both customers

[13] For example, Detroit Edison is offering a $2,500 rebate to the first 2,500 customers owning an electric vehicle that switch to its EV TOU rate. The rebate can be applied to the cost of the charging station installation, the charging infrastructure itself, or the wiring for the separate circuit meter. LADWP offers a $2,000 rebate to those customers who choose to install a separate meter for EV charging load.

and the utility as noted earlier. However, the cost profile of a sub-meter is less than that of a separate circuit.

A sub-meter would still require the installation of a secondary meter panel with separate wiring to the existing meter panel main breaker at the customer's expense, but an additional meter panel main breaker is unnecessary. Likewise, additional wiring to the neighborhood transformer and the related conduit and trenching would not be required.

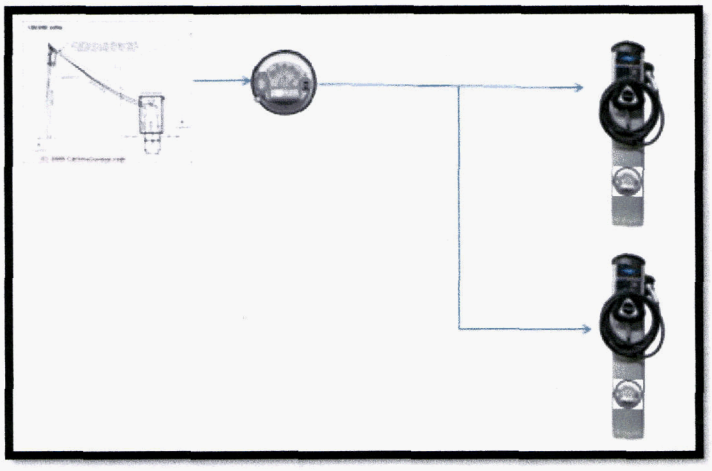
The utility would incur the cost of upgrades to the customer information and billing system to ensure the data is captured for billing purposes, for analysis of the EV load, and to provide the customer with usage statistics.

Utilities offering rates based on sub-metered EV load include Consumers Energy and Sacramento Municipal Utility District (SMUD). At each of these utilities, the customer is responsible for the additional cost of equipment required to sub-meter the EV load. Both utilities also offer a whole-house EV rate similar to the Company's Rate ET-EV.

C. Internal EV Charging Station Metering

Finally, APS reviewed the feasibility of utilizing meters incorporated internally in EV charging infrastructure. These meters would function in a similar fashion as a sub-meter, and would be included in charging stations by the infrastructure manufacturer.

Figure 9. Configuration of Internal EV Charging Station Metering



The advantage of separately metering EV load through internal charging station metering is similar to that of both separate circuit metering and sub-

metering; namely, the load attributable specifically to the EV can be precisely measured, providing benefits to both customers and the utility. Another significant advantage of internal charging station metering in contrast to either separate circuit metering or sub-metering is that the customer would bear no additional cost to allow for separately metered EV load other than the cost of the charging station itself and its installation by a licensed electrician.

However, at the present time there are significant barriers to the utility to use these internal charging station meters as billing meters. For example, based on the Company's discussion with various charging station manufacturers, the internal meters available today are either still under development or do not meet the American National Standards Institute (ANSI) standards required for a meter to be considered adequate for utility billing purposes. Additionally, it is unclear how an internal meter can be tested for accuracy by the utility and be reasonably tamper-proof.

Several dozen independent charging station manufacturers have entered the electric vehicle market in recent months. If each manufacturer incorporates differing meters into their charging stations, these meters may have significantly different configurations and technical specifications. Each manufacturer's internal meter would need to be individually certified and reliable communications links with a utility's metering and customer information system infrastructure would need to be established at significant cost.

APS participates in industry working groups on this topic and is aware that utilities across the nation are working on solutions to the many issues surrounding internal charging station metering, including the lack of industry standards for internal metering and the integration of various types of metering with various types of utility AMI systems. APS is not aware of any utilities to date that have developed the infrastructure required to support internal EV charging station metering.

D. Summary of Findings

Table 4 below summarizes the Company's findings regarding the feasibility of offering a separately metered TOU rate for residential EV charging.

Table 4. Summary of Feasibility of Offering a Separately Metered EV Rate

	Advantages	**Disadvantages**
Separate Circuit Metering	• Precise EV load measurement • Greater understanding of cost to charge EV (customer)	• Cost to customer (separate secondary meter panel and meter panel main breaker, wiring, conduit and trenching, possible transformer upgrades) • Cost to utility (separate meter, meter reading)
Sub-Metering	• Precise EV load measurement • Greater understanding of cost to charge EV (customer)	• Cost to customer (separate secondary meter panel and wiring) • Cost to utility (separate meter, upgrades to billing and customer information system, meter reading)
Internal EV Charging Station Metering	• Precise EV load measurement • Greater understanding of cost to charge EV (customer) • No additional cost to customer	• Lack of industry standards • Current meters do not meet ANSI standards • Difficulty of testing for accuracy • Higher risk of tampering • Development of communications protocol with utility billing infrastructure

Although there are some advantages to separately metered residential EV load, the significant costs and technical concerns attributable to each of the separate metering options do not support development of any of the three metering options today, especially as the market penetration of EVs in the APS service territory remains lower than expected. Separately metered household EV infrastructure creates unnecessary complexity and is not cost-effective for either the utility or the customer. APS believes the Company's Experimental Rate Schedule ET-EV sends appropriate and effective price signals to customers to encourage EV charging during off-peak hours without the additional complexity and cost of separate metering. Therefore, APS is not proposing a separately metered rate option for residential EV infrastructure at this time.

III. Conclusion

The high degree of uncertainty surrounding EV market penetration persists. Although deployment of electric vehicles and their attendant charging infrastructure through the DOE-funded *The EV Project* has been slower than planned, recent increased activity within EV markets, including the advent of additional EV models within the next three years, is keeping industry expectations high for a surge in EV market penetration in the near future.

Through the ev-READY Study, the Company is well situated to manage any level of EV market penetration in the APS service territory. APS has developed processes and procedures to ensure safe and reliable integration of EVs into the local distribution system. APS will continue to monitor EV market penetration, engage industry stakeholders and other interested parties, streamline processes for data measurement and system operations, and evaluate Rate ET-EV throughout the following months.