# ILLINOIS COMMERCE COMMISSION

# Initiative on Plug-In Electric Vehicles

# Workshop 3

## Modeling and Assessment of Potential Localized Reliability Impacts

**December 20, 2011**

# TABLE OF CONTENTS

## Introduction

In October 2011, as part of the Illinois Commerce Commission (ICC or Commission) Initiative on Plug-In Electric Vehicles (PEVs), interested parties were invited to participate in informal workshops to explore the following five issues:

1. Defining the scope of what waivers, if any, to the Integrated Distribution Company (IDC) rules would enhance the utilities' role in facilitating the adoption of PEVs and related services;
2. Developing customer education and outreach plans;
3. Modeling and assessment of potential localized reliability impacts;
4. Expanding PEV rate options in order to improve current distribution, transmission and generation asset utilization and to prevent unnecessary and duplicative investment in infrastructure for on-peak charging; and
5. Developing a petition to the Commission to clarify the legal status of public charging stations.

This report focuses specifically on issue 3, "Modeling and assessment of potential localized reliability impacts", and includes the following discussion areas:

- **PEV Industry Landscape** – Includes forecasts of electric vehicle (EV) adoption in Illinois; such forecasts reflect updates from those presented in the utilities' initial assessments of the impact of the introduction of PEVs on the distribution system.
- **Existing Load Addition Processes** – Includes a discussion of existing utility practices and policies for addressing customer load additions.

- **Potential Distribution System Impacts** – Includes a discussion of potential impacts to local distribution system assets from PEV charging.
- **Load Management Tools** – Includes a discussion of processes, policies and technologies available today to mitigate impacts of PEV charging, and those expected to become available or that may be developed in the next ten years.

## Working Group

The working group consisted of representatives from Ameren Illinois Company (Ameren Illinois), Citizens Utility Board, Commonwealth Edison Company (ComEd), DBT USA, Inc., the Staff of the ICC, MidAmerican Energy Company (MidAmerican), Northern Indiana Public Service Company, and Village of Oak Park.

## Section 1: PEV Industry Landscape

In December 2010, Ameren Illinois, ComEd and MidAmerican presented initial assessments of the impact of the introduction of PEVs on the distribution system which included projections of PEV sales in the U.S. and Illinois. At that time, it was noted that there was a significant amount of uncertainty with respect to expected adoption of PEVs by consumers and a wide variance in industry estimates of adoption rates driven by the numerous factors that affect adoption, including gasoline prices, PEV battery costs, production capacity, perceived importance of environmental issues, and availability of charging infrastructure.

While significant uncertainty remains with respect to adoption forecasts, more recent information has been obtained to further refine the outlook for PEV adoption in Illinois.

Just as it was the case in the utilities' initial assessments, it should be noted here that any projections for PEV sales and adoption included in this report are shown solely for purposes of providing a "frame of reference" for possible adoption rates, and do not represent predictions of expected PEV adoption.

In its report, "Transportation Electrification, A Technology Overview", the Electric Power Research Institute (EPRI) includes low, medium and high scenario projections of the penetration of PEVs, in terms of both the cumulative number of PEVs in the United States and as a percentage of the total vehicle fleet in the United States. [1] These projections are illustrated in Figures 1 and 2, respectively.

*Note the projection of cumulative PEVs in the U.S. included in the EPRI report is through 2015. The projection through 2030 shown in Figure 1 was obtained from EPRI by request.*

[1] *"Transportation Electrification, a Technology Overview"* EPRI, Palo Alto, CA, July 2011, 1021334, Figures 4-1, 4-3

***Figure 1: Cumulative PEVs in the U.S.***

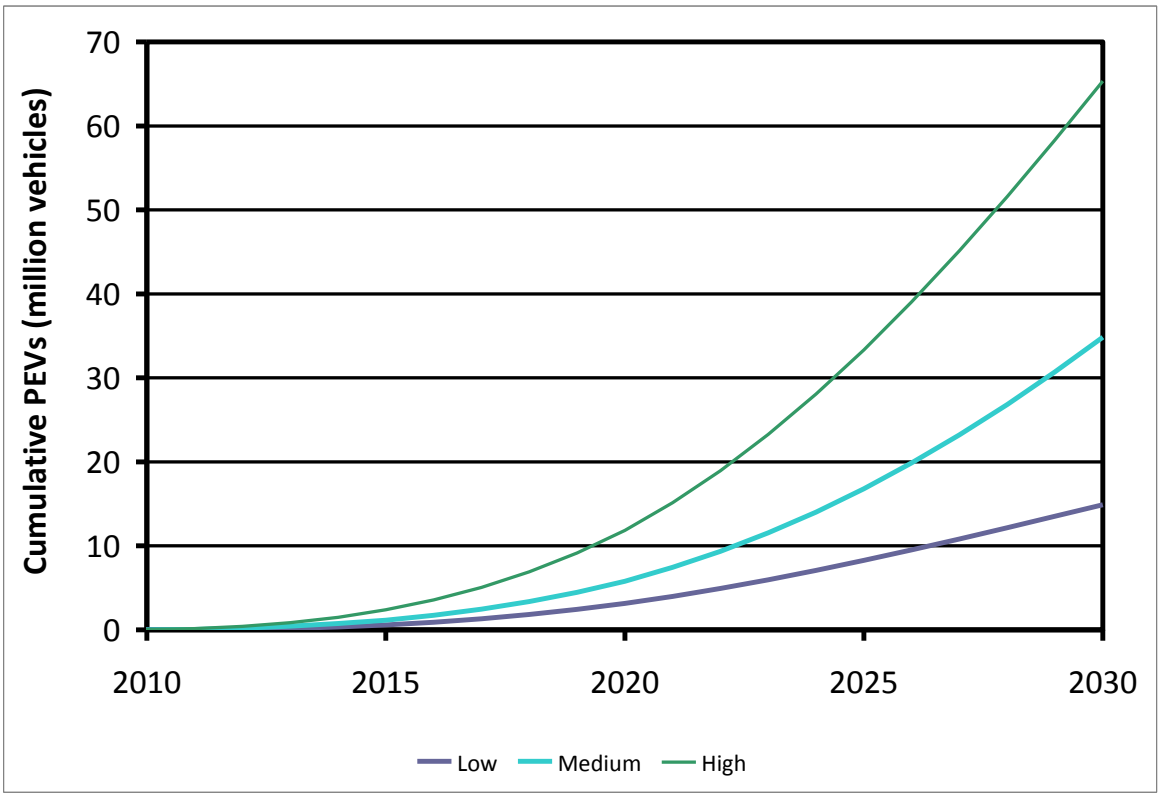
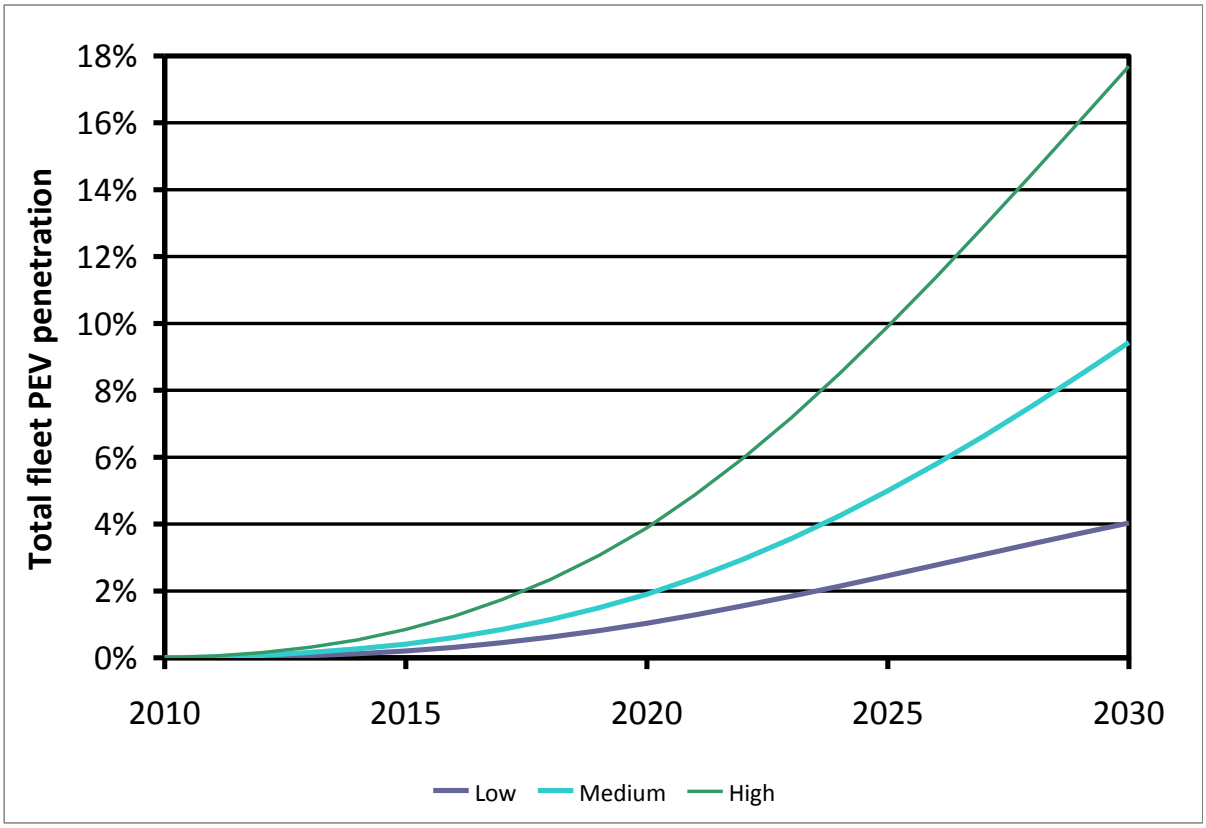


***Figure 2: PEV Percentage of Total U.S. Vehicle Fleet***




Similar projections specific to the State of Illinois were also obtained from EPRI. Figure 3 shows a projection of the cumulative number of PEVs in Illinois through 2030 and Figure 4 shows a projection of PEVs as a percentage of the total vehicle fleet in Illinois through 2030.

As these figures illustrate, EPRI projects Illinois PEV adoption to range between about 110,000 and 415,000 vehicles (1% and 3.6% of total Illinois vehicles, respectively) by 2020; and between 537,000 and 2,400,000 vehicles (3.9% and 17% of total Illinois vehicles, respectively) by 2030.

***Figure 3: Cumulative PEVs in Illinois***

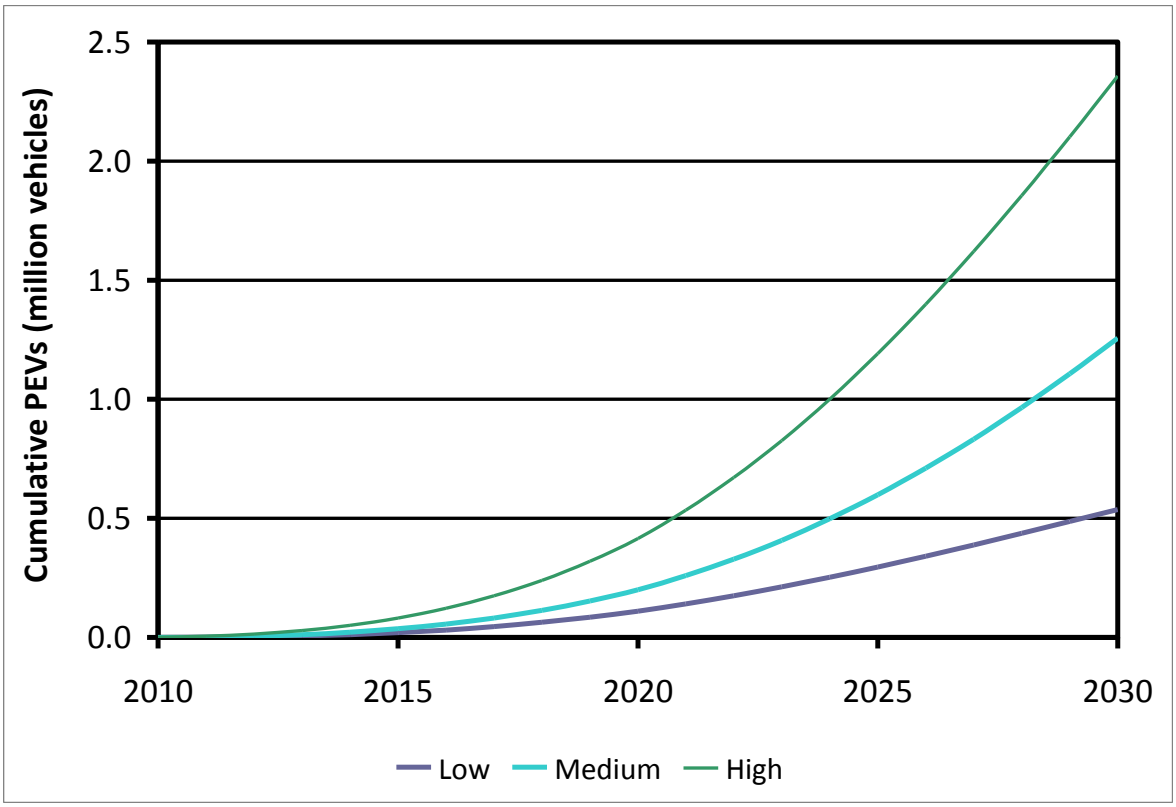


***Figure 4: PEV Percentage of Total Illinois Vehicle Fleet***

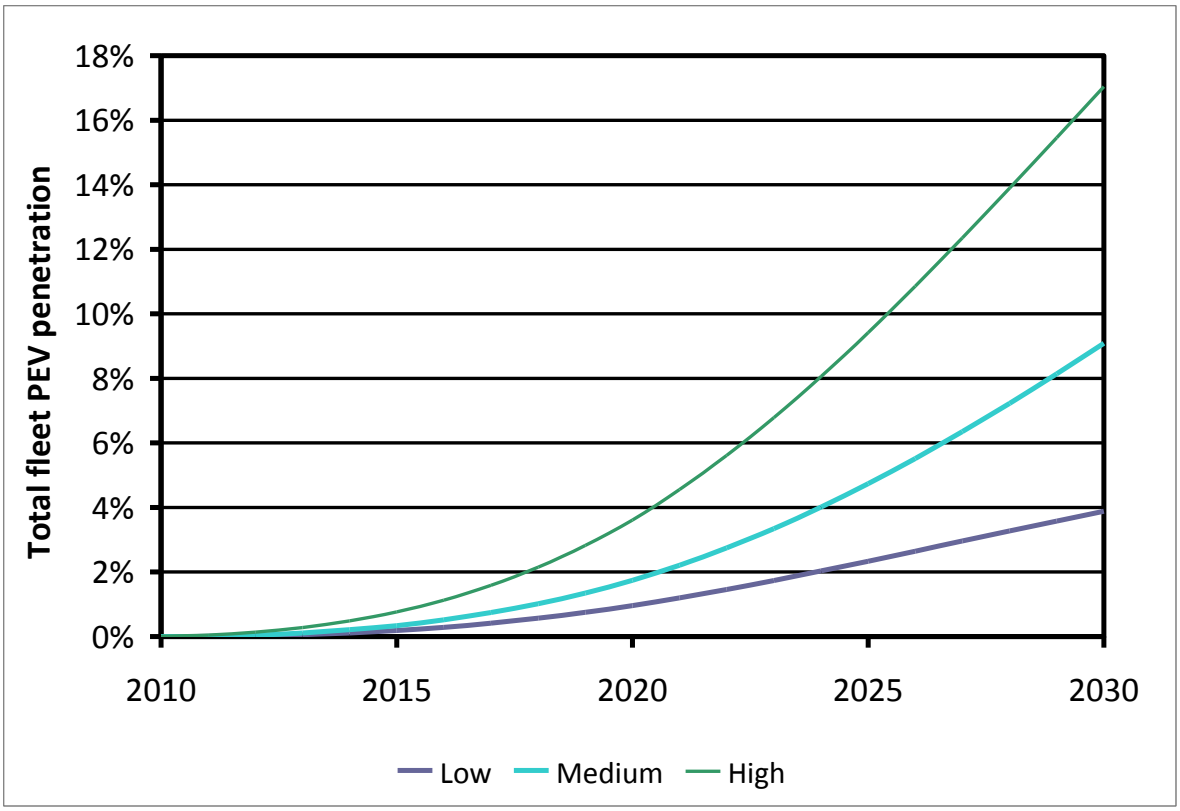
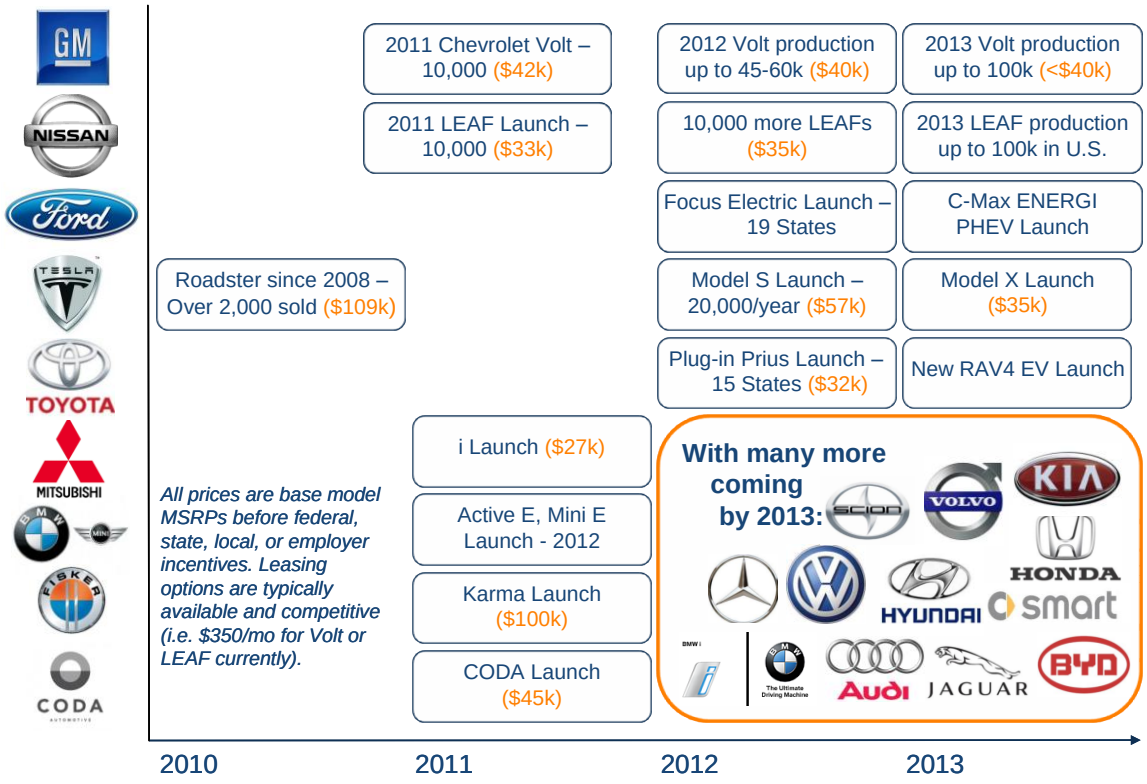



Figure 5, included in a recent publication from the Edison Electric institute (EEI), "The Utility Guide to Plug-In Electric Vehicle Readiness", illustrates the anticipated launches of commercial passenger PEVs in the United States.[2]

[2] *"The Utility Guide to Plug-In Electric Vehicle Readiness"*, EEI, Washington, D.C., November 2011. p 13

***Figure 5: Anticipated U.S. Commercial Passenger PEV Launches***




Currently, there are two levels of EV charging available that meet national Society of Automobile Engineers (SAE) standards.

**Level 1:** This charging level requires access to a standard, grounded, three-prong 120-volt outlet with a ground fault circuit interrupter, or installation of electric vehicle supply equipment (EVSE) with a standard, grounded, three-prong 120-volt outlet by a qualified electrician. This level of charging can take 8-12 hours to fully charge a PEV. A comparable electric load is a hand-held hair dryer.

**Level 2:** This charging level requires installation of a 240-volt charging station by a qualified electrician. PEV manufacturers have different capabilities for Level 2 charging. For example, the Mitsubishi i-MiEV and the Nissan Leaf can charge at a rate of about 15 amps (or 3.2 kW) where the Ford Focus PEV will be capable of charging at 27.5 amps (or 6.6 kW). This load is comparable to that of a residential central air

conditioner. Level 2 charging will typically charge a PEV in half the time it takes to charge at Level 1.

**Level 3 or Fast-Charging**: Manufacturers are developing United States (U.S.) standards for fast-charging technologies (commonly known as DC fast-charging) for commercial or public use that can recharge certain types of PEVs in 30 minutes or less. There are currently Japanese and European standards for fast-charging equipment, but no U.S. standard currently exists. As a result, only a limited number of PEV types will initially be able to utilize fast charging. However, there are proposed Level 3 charging stations planned for installation in the near term utilizing the Japanese standard.

This fast-charging equipment can charge a PEV battery to 80% capacity and the typical supply voltage is 480 volts three phase. There are some manufacturers that have plans to introduce a 208 volt three phase supplied charging station which can be installed in commercial district locations where 208 volt service is commonly available.

## Section 2: Existing Load Addition Processes

Ameren Illinois, ComEd and MidAmerican each have a process for customers to notify the serving utility of significant load additions and electric service upgrades. Each of these utilities has engineering representatives who are available either via telephone or in person to discuss any service capacity or service upgrades that are needed by the customer.

**Ameren Illinois –** Ameren Illinois's current processes for receiving and evaluating proposed customer load additions are based on its Standards and Qualifications for Electric Service which are on file with the Commission and state (in part):

*"In applying for electric service from Company, and receiving such service thereafter, Customer shall: 1. Inform Company as to the size and characteristics of the load that is*

*to be initially and thereafter served, the location of the Premises, the date Customer anticipates the need for said service and any special circumstances or conditions affecting the supply of electric service by Company."* The Illinois Construction Engineering (ICE) Team is the normal point of contact for all Ameren Illinois engineering and capacity requests. If a customer is installing a Level 1 charger, Ameren Illinois requires no further information. If a customer is installing a Level 2 charger, Ameren Illinois informs the customer to consult with a qualified electrician because a permit may be required by the local inspection agency for the installation of the circuit to the garage and any necessary upgrade to the customer's electric panel. The ICE Team also reviews the load on the transformer, and if necessary, advises the customer that work may be required by Ameren Illinois to serve this additional load. An Ameren Illinois representative investigates the situation and contacts the customer. At this point, the project follows the normal Ameren Illinois process for any electric service upgrade. For larger load additions, which may include Level 3 chargers, an Ameren Illinois electrical engineer responsible for distribution planning will review the circuit for any system impacts the resulting new load might create.

**ComEd –** ComEd's current processes for evaluating system component loading and for receiving and evaluating proposed customer load additions are stated in its Terms and Conditions, on file with the Commission:

"*The Company has representatives that can meet with the retail customer or applicant and discuss issues that arise concerning the provision of electric service at the premises. It is recommended that the retail customer or applicant consult with such representatives well in advance of an anticipated service commencement date or change in electric service requirements. It is the retail customer's or applicant's responsibility to secure information from the Company pertaining to the distribution*

*system facilities available at the premises, and it is the retail customer's or applicant's responsibility to obtain such information in a timely manner prior to the purchase or lease of equipment or the completion of design plans that pertain to the provision of electric service.*" Additionally stated is "*For a situation in which a retail customer anticipates the need for an alteration to or a change in the distribution facilities provided by the Company for such retail customer, it is the retail customer's responsibility to notify the Company as far in advance of the need for the change as possible so that arrangements can be made to facilitate any necessary changes to the Company's distribution facilities*."

Customers adding load can notify ComEd by calling ComEd's New Business organization at 866-NEW-ELEC (866-639-3532) and selecting Option 2. This will help to ensure that the ComEd equipment connected to customers' homes is capable of serving the additional load. ComEd expects that any customer that is adding enough load that it could impact the utility system will likely be using a qualified electrician. ComEd also expects the electrician will be familiar with ComEd's processes for load additions and the need to contact to ensure adequate distribution facilities.

**MidAmerican –** MidAmerican's current process for electric load additions is described below.

The flow of the process is as follows:

1. Customers adding load can notify MidAmerican by calling into the general call center phone number. A call center representative will route them to the appropriate engineering technician for that customer's area.
2. The engineering technician or engineer meets with the customer and determines the amount and characteristics of the load to be added.

3. Engineering conducts an evaluation of the load requested and the adequacy of current facilities to serve it or if upgraded facilities will be required. This evaluation would include determining upstream impacts. Electric System Planning would be involved, if needed, on larger electric system impacts.
4. If contributions would be required from the customer in accordance with our tariffs, a proposal would be presented to the customer. Once a signed agreement with the customer was received, proceed to step 6.
5. If customer contributions are not required, proceed to step 6.
6. Engineering would prepare a work order that would be sent to the field operations group.
7. The field operations group would complete work and close out the work order.

To summarize, Ameren Illinois, ComEd and MidAmerican each have existing processes for managing customer load additions that are applicable to customer installations of PEV charging facilities. However, given that many residential customers may not be familiar with these processes, the utilities can raise consumer awareness by providing such information (including contact information for the respective utility) on company websites, printed brochures or other materials developed for purposes of educating consumers about PEV adoption.

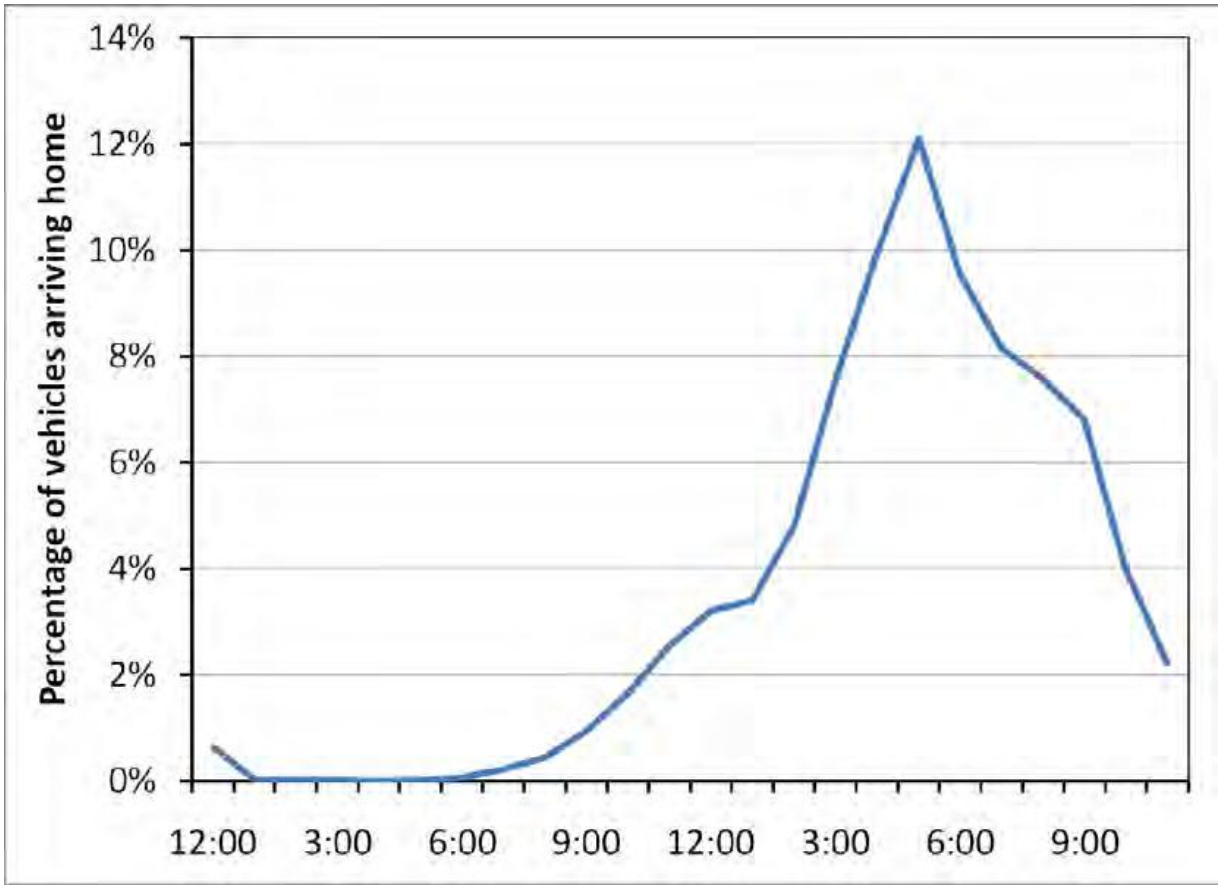
## Section 3: Potential Distribution System Impacts

Given the projections for PEV adoption shown in Section 1, PEV charging is not expected to have widespread impacts to the distribution system. Also, EPRI studies indicate that diversity in home arrival times facilitates relatively well distributed PEV

charging load on a system-wide basis. [3] Figure 6 illustrates such a distribution of home arrival times from EPRI.

[3] *"Transportation Electrification, a Technology Overview"* EPRI, Palo Alto, CA, July 2011, 1021334, Figure 5-1

***Figure 6: Home Arrival Time Distribution***




However, since PEV adoption is likely to be "clustered" by geographic area and subsequently by distribution system components, local distribution assets could be impacted if PEV charging at Level 2 (240 volt, 30 amps) or greater is not appropriately managed. Level 1 charging (120 volt, 15-20 amps) poses minimal threat to the distribution system. The Impact Study[4] that ComEd conducted with EPRI identified service transformers as particularly vulnerable to impacts of Level 2 charging.

The penetration level at which PEV charging would impact local distribution equipment is dependent on a number of factors, including the existing size and available capacity of equipment (e.g., service transformers), the number of customers served by the

[4] Commonwealth Edison PEV Distribution Impact Study, EPRI, November 2010 ("Impact Study")

equipment, and other loads being added by customers served by the equipment. Because of this variability, effective load management tools will be important to mitigate impacts of EV charging not only to the PEV owner, but to other customers served by the same distribution equipment. Such tools are discussed in Section 4 of this document.

## Section 4: Load Management Tools

*Current Tools*

The use of currently available time-variable rates, such as ComEd's Rate BESH, Ameren Illinois's Rider PSP – Power Smart Pricing, Rider RTP – Real Time Pricing or Rider HSS – Hourly Supply Service, and MidAmerican's Optional Time-of-Day Residence Electric Service, Optional Commercial Time-of-Day Service or Non-Residential Real Time Pricing, could largely mitigate impacts of PEV charging by providing incentives for PEV owners to charge their vehicles at night, shifting the associated load to off-peak periods. Similarly, advance notification to the utility prior to installing PEV charging rated at Level 2 or greater enables the utility to proactively assess the electrical capacity of local distribution equipment to serve the additional PEV charging load. Such notification is consistent with existing utility practices for managing customer load additions and should be encouraged through effective consumer outreach and education, utilizing various communications channels and media.

**Ameren Illinois –** Today, Ameren Illinois uses a program titled Transformer Load Management (TLM) to monitor loading on distribution transformers. TLM uses an algorithm (based upon kilowatt hours consumed) to calculate individual customer demand and coincident peak demand on single phase and three phase transformer stations. Upon notification that a customer has purchased an EV and plans to add a charging station, an Ameren Illinois engineering representative will review TLM data to

ensure an existing transformer has adequate capacity to serve the increased load. In addition to the ability to research loading on individual transformers, an Ameren Illinois engineer is able to generate a report of all transformers that are overloaded by a specified percentage. The report can be generated for overloaded transformers in a particular district, substation, or circuit.

Finally, a report of overloaded transformers is generated from a program titled System Load Snapshot (SLS). This report is only available in areas that have Automated Meter Reading (AMR) capability and is distributed to Division Supervising Engineers. SLS data is gathered on peak days in winter and summer. The report lists pole-mounted transformers that are loaded to at least 140% and pad-mounted transformers that are loaded to at least 100%.

In all cases, it is incumbent on the engineer to analyze the data and ensure a transformer is actually overloaded (the overload is not the result of faulty data such as customers assigned to an incorrect transformer). Ameren Illinois has a standard covering the upgrade of transformers or splitting of loads once a specific loading is reached that is higher than the load data threshold limits used in the report.

In addition, Ameren Illinois's Business Center takes any general customer inquiry calls on electric vehicles. The customer is informed of resources available at http://www.ameren.com/Environment/ElectricVehicles/Pages/ElectricVehicles.aspx.

Note: Ameren Illinois currently informs customers of the potential to choose an electric supplier; however, Ameren Illinois can not market or promote specific electric supply rates. For Distribution Delivery Service customers, excluding those taking service under DS-5 Lighting Service, time-variable rates are included as options for supplying energy to customers that charge EV's.

**ComEd –** One example of an outreach effort is ComEd's recently launched EV web page (www.ComEd.com/EV), which includes information for consumers regarding the need to notify ComEd if Level 2 or greater PEV charging is anticipated, and provides opportunities for both residential and commercial customers to electronically send such information to ComEd so the appropriate actions can be taken to proactively accommodate the customer's additional charging load.

**MidAmerican –** MidAmerican is in the process of developing electric vehicle information to be included on its corporate website.

*Potential Future Tools*

Improvements in both smart grid and customer-side technology will enable more seamless, automated management of a variety of customer loads, including PEV charging. In order to leverage these advancements in technology, charging stations must be made "smart grid enabled". That is, they must be capable of two-way communications with the smart grid and be able to accept both control signals and provide load information back to the grid.

For example, load control technology, such as that used by many utilities for managing residential air conditioner load, can be easily adapted to PEV charging. This may include simple "on/off" remote control of charging equipment, or more advanced "throttling" of the charging level based on local distribution system loading.

An Advanced Metering Infrastructure (AMI) such as that which ComEd is deploying and which Ameren Illinois intends to deploy, with its two-way communications, can in the future facilitate the effective management of PEV charging load in the following ways:

- Time variable rates coupled with AMI and in-home devices can provide real-time electric pricing information to consumers that give them greater control over their electric usage, while minimizing the grid impacts of PEV charging.
- The two-way communications of an AMI network can support intelligent charging stations that allow consumers to automatically set PEV charging based on electricity price signals.
- AMI can provide real-time information about loading on the electric distribution system and automatic notification to utilities when the load on local distribution system equipment, such as service transformers, reaches a level that requires attention. This automatic notification allows overloaded equipment to be upgraded before it fails, benefitting both PEV owners and their neighbors.

## Conclusion

Given the projections for PEV adoption discussed in this document, PEV charging is not expected to have widespread distribution system impacts for Ameren Illinois, ComEd, or MidAmerican. The utilities have existing load addition processes in place to manage the addition of charging facilities that may occur in the near term; and they continue to investigate new technologies and tools that may facilitate more automated and seamless integration of PEV charging with the grid as PEV adoption becomes more widespread in the future. Additionally, time-variable rates play an important role in encouraging customers to move PEV charging and other loads to off-peak periods, which benefits both consumers and the electric grid.