Emerging Customer Technology:

Plug-In Electric Vehicles

AMEREN'S PROPOSAL IN SUPPORT OF PLUG-IN ELECTRIC VEHICLES - MARCH 2011

SCHEDULE MJN-4

Acknowledgments

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Glossary of Acronyms

A Ampere
AC Alternating Current
ARRA American Recovery and Reinvestment Act

BGS Basic Generation Service

CAFE Corporate Average Fuel Economy
CAIR Clean Air Interstate Rule
CARB California Air Resources Board
CPP Critical Peak Pricing
CO_2 Carbon Dioxide
CV Conventional Vehicle

DA Day Ahead
DC Direct Current
DEW Distribution Engineering Workstation

EAA Electric Automobile Association
EEI Edison Electric Institute
EIA U.S. Energy Information Administration
EPRI Electric Power Research Institute
EVs Electric-only Vehicles
EVSE Electric Vehicle Supply Equipment

FERC Federal Energy Regulatory Commission

GHG Greenhouse Gas
GREET Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model
G2V Grid-to-Vehicle

HEV Hybrid Electric Vehicle
Hz Hertz

IBC Illinois Business Consulting
ICC Illinois Commerce Commission
ICE Internal Combustion Engine
IEEE Institute of Electrical and Electronic Engineers
IRS Internal Revenue Service
ISO/RTO Independent System Operator/Regional Transmission Organization

kW kilowatt
kWh kilowatt-hour

LMP Locational Marginal Pricing

MISO Midwest Independent Transmission System Operator
MPG Miles per Gallon
MSRP Manufacturer's Suggested Retail Price
MWh Megawatt-hour
MW Megawatt
MY Model Year

NEC National Electric Code
NHTSA National Highway Traffic Safety Administration
NPV Net Present Value
NO_x Nitrogen Oxides

O_3 Ozone
OEM Original Equipment Manufacturer
O&M Operations and Maintenance
ORNL Oak Ridge National Laboratory

PEV Plug-in Electric Vehicle
PHEV Plug-in Hybrid Electric Vehicle
PM10 Particulate Matter (size 10 microns or less)
PSC Public Service Commission

RCGA St. Louis Regional Chamber and Growth Association
R&D Research and Development
RTP Real Time Pricing

SAE Society of Automotive Engineers
SIP State Implementation Plan
SLADA St. Louis Auto Dealers Association
SO_2 Sulfur Dioxide
SUV Sport Utility Vehicle

TEPCO Tokyo Electric Power Company
TOG Total Organic Gases
TOU Time of Use

UL Underwriters Laboratories
U.S. United States
USDOE United States Department of Energy
USDOT United States Department of Transportation
USEPA United States Environmental Protection Agency

V Volt
VAC Volts – Alternating Current
V2G Vehicle-to-Grid

ZEV Zero Emission Vehicle

¢/kWh Cents per kilowatt-hour

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Executive Summary

Approximately 95 percent of America's cars, trucks, planes and locomotives are fueled by oil-derived products. The U.S. is the largest oil consumer and importer in the world and relies on imports for more than half of its oil consumption. Dependence on oil may be an energy security threat and increases U.S. economic vulnerability. In addition, the environmental impact of petroleum-powered vehicles is a rising concern.

The Obama Administration is investing in a broad portfolio of advanced vehicle technologies. The American Recovery and Reinvestment Act of 2009 allocated over $5 billion to the plug-in electric vehicle (PEV) industry for demonstration programs, U.S. Department of Energy loan guarantees for manufacturers, infrastructure development programs, and the manufacture of advanced battery systems and drive components. These investments will contribute to meeting President Obama's pledge for one million plug-in hybrids on U.S. roads by 2015.

The federal government's intervention and broader environmental interests are creating increased consumer awareness of PEVs. In fact, several customer and societal benefits are routinely associated with this emerging technology:

- **Foreign Oil Independence** – PEV technology is expected to help usher in an era of greater energy independence. While the oil our nation's gas and diesel-powered vehicles use is a mix of domestic and imported products, the electricity required by PEVs would be produced almost exclusively in the U.S.
- **Positive Environmental Impact** – PEV technology also ushers in an era of clean transportation. Even in areas of the U.S. dominated by fossil-fueled electric power suppliers, new PEV owners will have a net positive impact on the environment by virtue of reduced tailpipe emissions.
- **Lower Maintenance & Fuel Costs** – While the purchase cost of a PEV is higher than that of a conventional vehicle, significantly lower PEV maintenance and fueling costs over its operating life make the "total cost" of ownership attractive for periods spanning several years.
- **Vehicle Incentives** – Governments at the state and federal levels offer various purchase incentives for prospective PEV owners to consider, taking the form of tax credits, deductions, exemptions, and other creative offers.

Ameren believes one of the keys to the success of the PEV market and the realization of its associated benefits is the utility's ability to continue to provide safe and reliable electric power. Customers will expect Ameren to be able to provide service to adequately charge their vehicles, and we want to actively contribute to a positive ownership experience for all of those who choose to adopt.

PEVs represent the potential for a brand new, and in some cases, significant load on the delivery system. Ameren expects to begin seeing PEVs in its service territory in late 2011. The PEV market will take time to develop in Ameren's service area, but in the mean time we are preparing for what we believe could be a transformation in the auto industry.

In March 2010 Ameren created a team to explore the potential impacts and opportunities that the developing PEV industry introduces to our business and customers. Building on the success of an Ameren Missouri study performed in August 2009, the team comprehensively re-examined all aspects of the current PEV industry, market, and technology in order to arrive at a proposal for Ameren's involvement and strategic stance going forward.

This proposal contains the following information:

- **Background and Industry Overview** – the current state of electric vehicle, vehicle battery and vehicle charging technologies in the industry, their value proposition to customers and society (including a total cost of ownership analysis comparing PEVs to gas-fueled vehicles), and other considerations such as forecasted market penetrations and federal policies and incentives.
- **Electric Vehicles and Ameren** – the impact on our distribution system, potential rate options for new vehicle owners, charging station infrastructure issues, recent customer survey results, and other community PEV advocates in the service territory.
- **Strategy Development and Recommendations** – how Ameren's support of PEVs aligns with stakeholder concerns and our corporate mission, the expectations key market players are placing on utilities, and how these considerations led to the team's strategy proposal.

The following elements emerged that were deemed fundamental to an Ameren PEV strategy, aligning both with the corporate vision of "leading the way to a secure energy future" and our intent to earn our customers' trust as an "energy advisor:"

Educate Ourselves

- Purchase PEVs and charging stations internally in order to study their operational characteristics and better understand potential impacts on the distribution system. Ameren is making arrangements with Nissan to acquire up to four of its all-electric LEAF sedans and has made arrangements with Mitsubishi for a month-long test drive of its all-electric i-MiEV sedan in 2011. In addition, Ameren is purchasing and installing vehicle charging stations for several of our office and operating center locations in Missouri and Illinois.
- Participate in Electric Power Research Institute (EPRI) demonstrations and research regarding PEVs as appropriate. To date Ameren has made plans to acquire our first eight plug-in hybrid electric buckets trucks and lease our first two Chevrolet Volt sedans in 2011, all part of industry research demonstrations. The charging stations above will also support these vehicles.
- Develop methods and processes by which Ameren can share information with and transfer acquired knowledge directly to customers and employees in response to their inquiries.

Educate and Support Our Customers

- Investigate various modes of providing communication, education and assistance to both our customers and employees, including on line resources, "specialty-skilled" call takers, bill inserts, and in-person community involvement.
- Investigate various types of support to help ensure a positive PEV ownership experience for our customers, including providing free service capacity assessments and field upgrades. This also assumes a degree of public outreach, such as asking interested customers to check with us before buying an electric vehicle and arranging with auto dealers to make the same recommendation (as well as providing other information) to customers at the point of sale.
- Provide information to our customers and employees regarding PEV technology. This includes encouraging others to consider their own plans for plug-in readiness at the home or workplace and using our experience to provide assistance and support as they consider installing their own charging stations.

Engage Our Regulators and Other Community Partners

- Proactively reach out to our regulators to discuss our strategic stance and obtain feedback on action plans as they are developed.
- Explore the possibilities of alternative rate designs as appropriate for both Ameren Missouri and Ameren Illinois, and investigate possible incentive programs around customer charging station installations.
- Develop local partnerships and alliances in order to support and grow into the technology with the rest of the region. This includes working with a range of organizations to make sure the communities we serve are ready for widespread adoption of electric vehicles. Ameren is currently participating in the St. Louis Clean Cities Plug-In Readiness Task Force to help develop conceptual plans for a public charging station infrastructure and to encourage others to consider various measures for plug-in readiness.

Ultimately, preparation for PEVs is considered critical for Ameren not only from system and stakeholder standpoints, but in order to assume our desired "energy advisor" role with our customers. The Ameren PEV Team recommends adopting a supporting role in preparation for commercial PEV availability in the Ameren service territory beginning in late 2011. Such a role represents a proactive stance that in addition to acknowledging the emergence of PEVs, actively promotes the technology in the community, takes direct actions to educate stakeholders, and seeks out partnership opportunities intended to encourage greater PEV acceptance.

Next steps for the Ameren PEV Team include developing a detailed PEV implementation plan, participating in and monitoring the execution of this plan, identifying future risks and opportunities associated with the PEV market, and recommending adjustments to Ameren's strategic position as appropriate.

1.0 - Introduction

Approximately 95 percent of America's cars, trucks, planes and locomotives are fueled by oil-derived products. The United States (U.S.) is the largest oil consumer and importer in the world and relies on imports for more than half of its oil consumption. Dependence on oil may be an energy security threat and increases U.S. economic vulnerability. In addition, the environmental impact of petroleum-powered vehicles is a rising concern (USDOE, 2010). Expectations are that hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEVs) and electric-only vehicles (EVs) will help modernize the transportation sector and our nation, allowing us to enter an era of clean transportation and greater energy independence.

In general, there are three types of electricity-powered vehicles – hybrids that run on both electricity and another fuel, but cannot be externally recharged; hybrids that can be charged by connecting to an external power source; and vehicles that run on electricity only. Below are the basic vehicle descriptions.

Hybrid Electric Vehicle (HEV): *A HEV typically combines an electric propulsion system with a conventional internal combustion engine (ICE) propulsion system. In addition, technologies such as Regenerative Braking and Automatic Start/Shutoff for the combustion engine are employed with a HEV. Examples: Toyota Prius, Honda Accord Hybrid, and Ford Escape Hybrid.*

Plug-In Hybrid Electric Vehicle (PHEV): *A PHEV is similar to a conventional hybrid; however, PHEV batteries can be charged by either connecting a plug to an external power source for electricity, by using power generated by the vehicle's ICE, or by using regenerative braking power. Some PHEVs can use a combination of electricity and gasoline for propulsion ("parallel" drive), while others operate as electric vehicles ("series" drive). These vehicles typically have an "electric only" driving range varying from 10 to 60 miles and then rely on the ICE for either propulsion or range extension once the battery depletes to a particular level. Example: PHEV modified Toyota Prius and Chevrolet Volt.*

HEV: Toyota Prius

Electric Vehicle (EV): *An EV is similar to a PHEV in that it is a plug-in vehicle; however EVs are powered exclusively by electricity. Ranges vary from 40 to more than 200 miles. Examples: Nissan Leaf, BMW Mini E, Mitsubishi iMiEV and Tesla Motors Roadster.*

PHEV: Chevrolet Volt

The Obama Administration envisions one million plug-in hybrids on U.S. roads by 2015 (USAToday, 2010). The federal government is investing billions of dollars in the plug-in electric vehicle (PEV) industry through the American Recovery and Reinvestment Act of 2009 (ARRA). The ARRA allocated over $5 billion to the PEV industry for demonstration programs, U.S. Department of Energy (USDOE) loan guarantees for manufacturers, infrastructure development programs, and the manufacture of advanced battery systems and drive components. In addition, other countries like China, Japan, Germany, and Israel are investing billions of dollars in the PEV industry.

EV: Nissan LEAF

Ameren believes one of the keys to the success of the emerging PEV market and the realization of its associated energy benefits is the utility's ability to continue to provide safe and reliable electric power. Customers will expect Ameren to be able to provide service sufficient to adequately charge their vehicles. Utilities in general recognize that PEVs represent the potential for a brand new, and in some cases, significant load on the delivery system. The PEV market will take time to develop in Ameren's service area. While PEVs will not be available outside of targeted launch cities until late 2011 or early 2012, Ameren expects to begin seeing PEVs in its service territory during this period. In the mean time, we are preparing for what we believe could be a transformation in the auto industry.

The federal government's intervention and broader environmental interests are creating increased consumer awareness of PEVs. This report explores the potential impacts and opportunities that the development of the PEV industry introduces to the utility business and its customers. In it, the Ameren PEV Team researches a variety of issues such as environmental benefits, the value proposition to customers, PEV penetration rates forecasted in Ameren's service territory, the impacts on our distribution system, and potential rate structures that would encourage off-peak charging of vehicles. In addition, the team evaluates the appropriate level of Ameren engagement to ensure alignment not only with our corporate vision, mission and values, but with our stakeholders' interests (those of our customers, shareholders, employees and communities) as well. Education and outreach efforts are also considered to support Ameren's intended role as a trusted energy advisor to customers.

This PEV Report summarizes information the PEV Team gathered and includes a number of recommendations for Ameren.

2.0 - Background and Industry Overview

2.1 - History of Electric Vehicles

Electricity was first used to power vehicles over 100 years ago. The first electric vehicles were developed in France and England in the late 1800s. By the early 1900s, there were more electricity-powered vehicles on the road than there were gasoline-powered vehicles. However, EV production stopped in the 1920s because gasoline-powered vehicles proved to be more functional, offering increased range at a lower cost. In the 1970s, interest in EVs developed again, mainly due to the oil crisis. Subsequently, investments were made in research and development (R&D) to improve EV technology. However these did not create enough interest to gain mass market acceptance (Research Reports International, 2010).

In the 1990s, regulatory and legislative actions prompted a renewed interest in EV technology. The 1990 Clean Air Act Amendment and the 1992 Energy Policy Act caused automakers to invest in cleaner vehicles. The California Air Resources Board (CARB) issued regulations restricting greenhouse gas (GHG) emissions from vehicles. The California Zero Emission Vehicles (ZEV) mandate, requiring 2% of the state's vehicles to have no emissions by 1998 (10% by 2003), ultimately forced manufacturers to build EVs.

From 1997 to 2002, a few thousand all-electric cars (e.g., Honda EV Plus, GM EV1, Nissan Altra EV, and the Toyota RAV4 EV) were produced by major automakers, but most were available for lease only. All major automakers discontinued advanced EV production programs by the early 2000s. In 2002, GM, DaimlerChrysler and the Bush Administration sued the CARB to repeal the ZEV mandate. In 2003, GM announced that it would not renew leases on the EV1 because the carmaker would no longer supply parts to repair the vehicles. In 2005, GM reclaimed all of the EV1s that were leased and demolished the vehicles in California (Research Reports International, 2010). This series of events caused a setback for the EV industry. **Appendix A** contains a timeline of EV development. **Table 1** summarizes many of the differences between today's EV movement and that of the 1990s.

2.2 - Current State of the Electric Vehicle Industry

PEV technology represents an opportunity for the nation to transition from an oil-based transportation system to one based on a more stable, dependable source of fuel – electricity (in particular, electricity produced from domestic resources such as uranium, natural gas, and coal, as well as from renewable resources, like wind and solar). The Ameren PEV Team recognized that PEVs will arrive soon in our service territory and explored the potential benefits of PEVs for our customers. This section describes the current technology, customer value proposition, environmental benefits, R&D efforts, and regulatory policy that are helping bring EV technology to the mass market.

Table 1 - What is Different Now Compared to the 1990s?

1990s	2010
■ The EV movement was forced by the California ZEV mandate	■ The EV movement is supported by the Federal government with ARRA funds (bipartisan support) and consumer interest
■ Automakers produced only 3,000 to 5,000 EVs	■ Automakers are planning to rollout between 25,000 – 50,000 vehicles/year for the next few years
■ Gasoline = $1.16/Gallon	■ Gasoline = $2.69/Gallon (Recently, as high as $4/Gallon)
■ The EVs and Infrastructure were given away for free (non-sustainable business model)	■ Increased awareness of Energy Independence/National Security
	■ Significant impact to increase regional economies (e.g. more jobs and increased household incomes)
	■ Technology has improved (e.g. batteries, regenerative breaking and materials)
	■ Environmental benefits: ■ Less CO_2/smog/VOCs/Ozone/NOx ■ PEVs provide environmental benefit even with Ameren's fuel mix of 80% coal-fired power

*Reference: http://www.1990sflashback.com/1990/economy.asp

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2.2.1 - Electric Vehicles and Vehicle Batteries

According to the U.S. Department of Transportation (USDOT), more than 75% of all commuters travel 40 miles or less per day (USDOT, 2003). As a result, the current state of EV technology can support the needs of the majority of U.S. commuters.

2.2.1.1 - Electric Vehicles

Currently, no mass market for PHEVs exists in the U.S.; however, Nissan and Chevrolet will roll out EVs and PHEVs in limited markets in late 2010 with a nationwide rollout by late 2011. The Nissan LEAF (Leading, Environmentally friendly, Affordable, Family car) is an EV with a range of up to 100 miles on a fully charged battery. The Nissan LEAF has a manufacturer's suggested retail price (MSRP) of $32,780; however, it will cost about $25,000 after the $7,500 federal tax incentive. It will take approximately eight hours to fully charge the LEAF when utilizing a Level 2 (240 volt) charging station.

The Chevrolet Volt is a PHEV with a range-extending gas generator that produces enough energy to power it for hundreds of miles on a single tank of gas. It has a range of up to 40 miles under electric battery power only, after which the gas engine kicks in automatically. The Chevrolet Volt has a MSRP of $41,000; however, it will cost about $33,500 after the $7,500 federal tax incentive. It will take approximately three to four hours to fully charge the Volt utilizing a Level 2 charging station. **Table 2** presents market entry product highlights for the Nissan LEAF and Chevrolet Volt.

Table 2 - Product Highlights: Nissan LEAF and Chevrolet Volt

Item	**Nissan LEAF** NissanUSA.com	**Chevrolet Volt** Chevrolet.com
Price	$32,780 (MSRP) **$25,280** (after $7,500 Federal Tax Credit)	$41,000 (MSRP) **$33,500** (after $7,500 Federal Tax Credit)
Size	4-door compact hatchback (5 adults)	4-door sedan (5 adults)
Range	Up to 100 miles (all electric)	Up to 40 miles (electric) Range-extending gas generator produces enough energy to power it for hundreds of miles on a single tank of gas
Top Speed	90 mph	Over 90 mph
Battery	Laminated Lithium-ion (8-yr/100,000 mile warranty)	Lithium-ion (8-yr/100,000 mile warranty)
Capacity/Power	24 kWh/over 90 kW	16 kWh/Over 111 kW
IT System	Integrated communication system	On-star
Charging Requirements	Level 1–120V, Level 2–240V, and DC Fast Charging	Level 1–120V, Level 2–240V, and DC Fast Charging

Over 30 automakers worldwide are planning to introduce PEVs to the market within the next few years, including Ford, Toyota, BMW, Mitsubishi, Audi, and Honda. **Table 3** presents the initial target markets for Nissan and Chevrolet. **Table 4** presents the projected target markets for other manufacturers within the next few years.

Table 3 - Initial PEV Target Markets for Nissan and Chevrolet

Nissan LEAF		Chevrolet Volt	
Late 2010	California, Oregon, Washington, Arizona and Tennessee (Production 25,000)	**Late 2010**	California, New York, Michigan, Connecticut, Texas, New Jersey and District of Columbia (Production 10,000)
2011 Jan April Fall	 Texas and Hawaii North Carolina, Florida, District of Columbia, Virginia, Maryland and Georgia Nationwide	**Late 2011**	Nationwide (Production 10,000)
		2012	Nationwide (Production 45,000)

Table 4 - Initial PEV Market Launches

Make	Model	Type	US Market Release Date	Status
Tesla Motors	Roadster	EV	Current	Approximately 1,000 built. High cost vehicle. Production volumes expected to remain low (700 - 1,000 units per year).
BMW	MINI E	EV	Current	Lease trial has been extended to June 2011. No plan announced for mass production.
Th!nk	City	EV	2010	Plans to sell in NY and other select cities. Company plans to begin building the Think City in Elkhart IN, beginning in 2011 with 2,500 vehicles. 20,000 units planned for 2012 and 2013. Annual capacity of the plant is 60,000.
Ford	Transit Connect	EV	Summer 2010	The target customer is a commercial fleet operator with a central recharging facility, preferably with short-range routes featuring frequent stops and lots of stop-and-go driving.
Detroit Electric	e63	EV	2010	First year production approximated at 40,000 units.
Coda	CODA Sedan	EV	2010	First year production approximated at 14,000 units.
BYD	e6	EV	2010	
BYD	F3DM	PHEV	2010	
GM Chevy	Volt	PHEV	2010 - November	First year production 7,000 - 10,000 units (launching in CA and MI). Widespread distribution set for 2012.
Nissan	Leaf	EV	2010 - December	Aiming for 25,000 orders in 2010 to be distributed in 20 of the largest states. Will be widely available late 2011/2012. Through April approximately 115,000 registrations have been received for first priority.
Mitsubishi	i-MiEV	EV	2011	Total production of 9,000 units in 2010. World-wide distribution plans still being determined. Production of 18,000 planned for 2011 and 30,000 by 2013.
Ford	Focus EV	EV	Late 2011	Initial production of 10,000 Cars
Fiskar	Karma	PHEV	2011	Customer deliveries expected early 2011. Initial production of 7,500 to ramp up to 15,000 in 2011. Base price to be $87,000, but a more affordable option targeted for 2013.
Audi	1 Sportback	PHEV	2011	
Tesla Motors	Model S	EV	2011	To begin 2011 with 2,000 cars, followed by 12,000 in 2012, and 20,000 by 2013.
Ford	Escape	PHEV	2012	
Toyota	Prius	PHEV	2012	

2.2.1.2 - Vehicle Batteries

Battery technology and the lack of affordable, highly functional battery packs is a potential barrier to widespread consumer adoption of PEVs. Lithium-ion battery technology is the energy storage solution currently being developed for PEVs. According to a new White House report, "The Recovery Act: Transforming the American Economy through Innovation," the ARRA investment shows that the U.S. is on-track to realize a major innovation breakthrough in cutting the cost of electric batteries by 70 percent between 2009 and 2015. According to the White House report, in 2009 the U.S. had only two factories manufacturing advanced batteries, and the U.S. produced less than two percent of the world's advanced batteries. The ARRA is investing over $2 billion in advanced battery and electric drive component manufacturing. By 2012, it's anticipated the U.S. will have 30 manufacturing facilities producing advanced batteries, accounting for an estimated 20% of the world's advanced battery production and potentially creating tens of thousands of U.S. jobs. Bringing battery costs down, making them lighter and longer lasting, and managing their disposal are important factors in making the PEVs more affordable and competitive with conventional vehicles.

Affordability

According to the USDOE, a battery for a PEV with a 100-mile range cost more than $33,000 in 2009. The ARRA investments are forecasted to drive the cost of the PEV batteries down. By the end of 2015, Recovery Act investments are anticipated to help lower the cost of 100-mile range batteries to approximately $10,000. **Figure 1** presents the forecasted costs of a typical EV battery (USDOE, 2010).

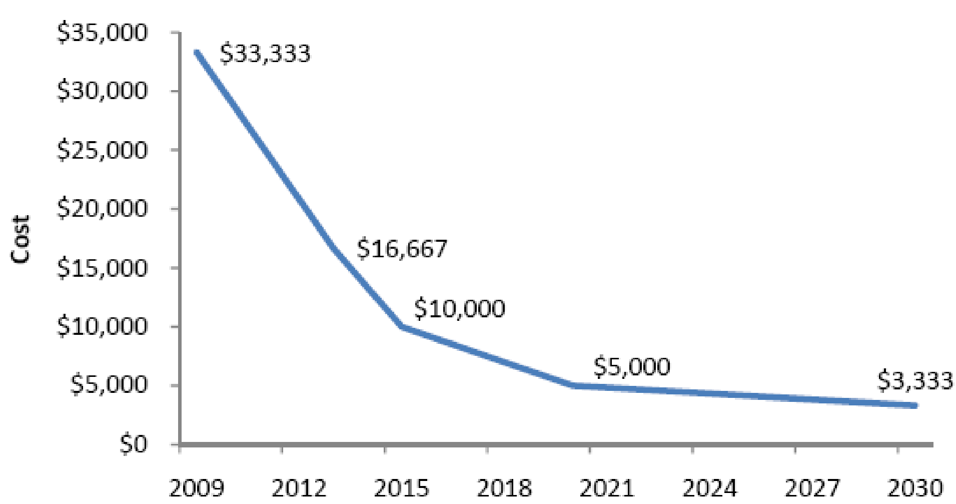
The same cost improvement applies to batteries for PHEVs – cars that can travel up to 40 miles on electricity before the gasoline engine is utilized. The cost of a 40-mile range battery is anticipated to fall as well. In 2009, PHEV 40-mile range battery cost $13,000. Recovery Act investments could lower the PHEV 40-mile range battery costs to approximately $6,700 by the end of 2013 and $4,000 by the end of 2015 (USDOE, 2010).

It is important to note however that despite the USDOE's current optimism, the prospect of deep cuts in battery costs over time is debatable. Lithium-ion technology currently makes use of a large array of precious metals in order to produce EV and PHEV batteries. If EV penetrations in the U.S. begin approaching optimistic forecast levels, the demand for these metals will increase, with the potential of driving battery costs up dramatically. Whether battery production efficiencies gained over time would be able to sufficiently offset these rising material costs is uncertain.

Lighter Weight

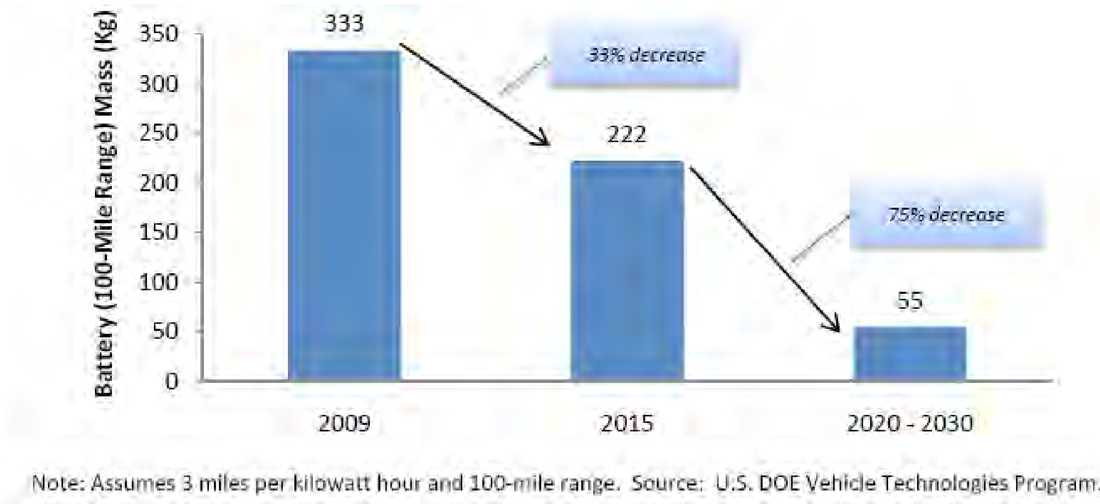
Heavier, low energy density batteries significantly limit vehicle range and acceleration. Recovery Act investments are supporting innovations to reduce battery weight and increase the energy density, allowing them to store more energy in smaller, lighter packages. These higher density batteries will pack more power, performance, and range. Increases in energy density could potentially reduce the typical weight of an EV battery by 33% between 2009 and 2015. **Figure 2** presents the forecasted weight of a typical EV battery (USDOE, 2010).

Figure 1 - Forecasted Cost of a Typical Electric Vehicle Battery (USDOE, 2010)



Note: Assumes 3 miles per kilowatt hour and 100-mile range. Source: U.S. DOE Vehicle Technologies Program.

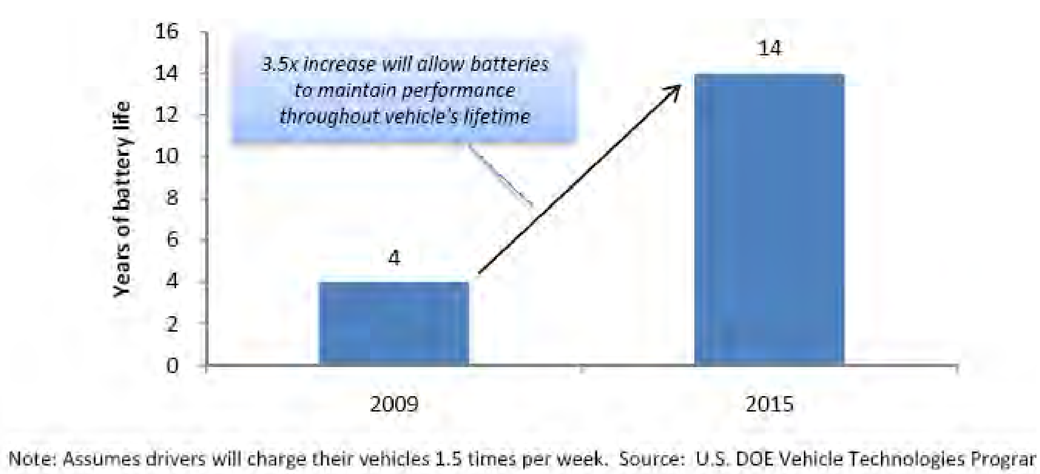
Figure 2 - Forecasted Weight of a Typical Electric Vehicle Battery (USDOE, 2010)



Longer Life

In the near future, domestic battery manufacturers could potentially produce batteries with operating lives of up to 14 years. This should give consumers confidence that the electric vehicle batteries will last the full life of the vehicle. **Figure 3** presents the forecasted lifetime of a typical EV battery (USDOE, 2010).

Figure 3 - Forecasted Lifetime of a Typical Electric Vehicle Battery (USDOE, 2010)



Battery Disposal

While the toxicity of lead acid batteries in a conventional vehicle requires tight regulations when it comes to disposal, these laws and regulations do not apply to lithium-ion batteries. Once a lithium-ion battery reaches its end of life, it can either be recycled or re-used in other applications. The metals and compounds of the batteries can be resold, while the lithium can be recycled back to battery manufacturers or disposed of as non-hazardous material. Even when lithium-ion batteries lose their ability to carry a sufficient charge for vehicle applications, the residual capacity can be re-used in less intensive applications, such as back-up energy storage or load leveling for the electric grid. Secondary life applications are currently being studied by auto manufacturers. Additionally, the lower cost of recycled units should improve the current value proposition for any electric utility considering energy storage as part of its distributed resource strategy.

2.2.2 - Electric Vehicle Value Proposition

From early on in its study, the Ameren PEV Team cited a number of customer and societal benefits associated with this emerging technology, including the following:

- **Foreign Oil Independence** – PEV technology will help usher in an era characterized by greater energy independence. While the oil our nation's gas and diesel-powered vehicles use is a mix of domestic and imported products, the electricity required by PEV's would be produced almost exclusively in the U.S.
- **Lower Maintenance & Fuel Costs** – While the up-front purchase cost of a PEV is higher than that of a conventional vehicle, significantly lower PEV maintenance and fueling costs over its operating life make the "total cost" of ownership very attractive for ownership periods exceeding roughly seven years.
- **Vehicle Purchase Incentives** – As a means of supporting this emerging technology, governments at the state and federal levels have formulated various purchase incentives for prospective PEV owners to consider, taking the form of tax credits, deductions, and exemptions. Some states also offer access to carpooling lanes and other incentives associated with vehicle charging station purchase and installation.
- **Positive Environmental Impact** – PEV technology will also help usher in an era of clean transportation. Even in areas of the country dominated by fossil-fueled electric power suppliers, new PEV owners will have a net positive impact on the environment through a reduced combination of air-borne power plant and tailpipe emissions.

The PEV Team looked at a number of these customer and societal benefits in greater detail, especially in those cases where factors germane to Ameren and its service territory had a bearing on the impact of those benefits to customers. These additional considerations are discussed below.

2.2.2.1 - Total Cost of Ownership

The PEV Team analyzed the life-cycle costs for an EV (2011 Nissan LEAF) compared to a conventional vehicle (2011 Nissan Versa) for both Ameren Missouri and Ameren Illinois (IP) residential customers. **Appendix B** contains the analysis and assumptions. **Tables 5 and 6** present the fuel cost per mile and life cycle costs for Ameren Missouri and Ameren Illinois respectively.

Table 5 - Ameren Missouri: Fuel Cost per Mile and Life Cycle Costs

Vehicle	7-YR Economic Life		10-YR Economic Life	
	Fuel Cost Per Mile ($/mile)	Life Cycle Cost (NPV@3%)	Fuel Cost Per Mile ($/mile)	Life Cycle Cost (NPV@3%)
EV - 2011 Nissan LEAF (Standard Rate, OFF-PEAK: 10 PM to 4 AM)	**$0.020**	**($34,203)**	**$0.021**	**($36,575)**
EV - 2011 Nissan LEAF (Time of Day Rate, OFF-PEAK: 10 PM to 4 AM)	**$0.012**	**($33,482)**	**$0.013**	**($35,531)**
CV - 2011 Nissan Versa (Gasoline Vehicle, 30 mpg)	**$0.117**	**($32,506)**	**$0.131**	**($39,600)**

Notes:
1. EV – Electric Vehicle, CV – Conventional Vehicle, NPV – Net Present Value.
2. Federal tax incentives are included. State tax incentives are not included.
3. Climate change legislation is not included.
4. Ameren Missouri rates increase over periods shown based on projected rate increases.
5. Life cycle costs include vehicle cost, fuel, maintenance, and charging station (EV only).
6. Gasoline prices based on EIA forecast ($2.70/gallon in 2010 increasing to $5.55/gallon in 2020).

Table 6 - Ameren Illinois (IP): Fuel Cost per Mile and Life Cycle Costs

AmerenIP	7-YR Economic Life		10-YR Economic Life	
	Cost Per Mile ($/mile)	Life Cycle Cost (NPV@3%)	Cost Per Mile ($/mile)	Life Cycle Cost (NPV@3%)
EV - 2011 Nissan LEAF (Standard Rate, OFF-PEAK: 10 PM to 4 AM)	**$0.027**	**($34,867)**	**$0.029**	**($37,585)**
EV - 2011 Nissan LEAF (Time of Day Rate, OFF-PEAK: 10 PM to 4 AM)	**$0.017**	**($33,915)**	**$0.018**	**($36,190)**
CV - 2011 Nissan Versa (Gasoline Vehicle, 30 mpg)	**$0.117**	**($32,506)**	**$0.131**	**($39,600)**

Notes:
1. EV – Electric Vehicle, CV – Conventional Vehicle, NPV – Net Present Value.
2. Federal tax incentives are included. State tax incentives are not included.
3. Climate change legislation is not included.
4. Time-of-day rates: MISO 2008 Day Ahead Rates, increasing over life.
5. IP rates increase over periods shown based on projected rate increases.
6. Life cycle costs include vehicle cost, fuel, maintenance, and charging station (EV only)
7. Gasoline prices based on EIA forecast ($2.70/gallon in 2010 increasing to $5.55/gallon in 2020).

Based on the Ameren Missouri and Ameren Illinois analyses, a conventional vehicle is slightly more cost-effective than an EV over a 7-year economic life; however, the EV is more cost-effective over a 10-year economic life. In general, while an EV is more expensive than a conventional vehicle up front, it is cheaper to fuel and maintain than a conventional vehicle over the course of its operating life. It is also important to note that the total costs of ownership for a conventional vehicle and EV are not substantially different overall, due primarily to the $7,500 EV federal tax incentive that is currently offered.

2.2.2.2 - Vehicle Incentives

Several government incentives have been established to further promote PEVs. In 2006, the Bush Administration developed the U.S. Advanced Energy Initiative to help make the U.S. energy supply more economical, secure, and reliable through advances in technology. The initiative included a goal to create a PHEV that could drive up to 40 miles on electricity with a single charge. The “PHEV-40” technology was envisioned to reduce average gasoline consumption by 50% or more (Research Reports International, 2010).

Federal Incentives

In February 2008, the ARRA was passed by Congress and signed into law. ARRA provides a tax credit for PEVs of $2,500 plus $417 for each kWh of battery capacity greater than 4 kWh. The maximum credit of $7,500 per vehicle applies to at least 200,000 units per auto manufacturer before it phases out (Plug In America).

In December 2010, an earlier Internal Revenue Service (IRS) charging station tax credit was extended and modified to cover 30% of the purchase and installation costs of the charging equipment, up to $1,000 for individuals and $30,000 for businesses. The new charging equipment tax credit expires on December 31, 2011 (Plug In Cars, 2010).

State Incentives

Currently, PEV incentives are available in 17 states with more pending. While PEV incentives are available in Illinois, they’re not available in Missouri at this time. **Table 7** presents a summary of PEV state incentives (Plug In America).

The Illinois Alternate Fuel Rebate Program provides rebates for 80% of the incremental cost of either purchasing an alternative fuel vehicle or converting a vehicle to operate on alternative fuel. The maximum amount of each rebate is $4,000. The rebate program is available to all Illinois residents, businesses, government units (except for the federal government), and organizations located in Illinois. Eligible vehicles include those powered by natural gas, propane, and electricity. Gasoline-electric hybrid vehicles (e.g., the Chevrolet Volt) are not eligible (Hybridcars.com).

Table 7 - Summary of State PEV Incentives

LEGEND: ✓ In Place ◆ In Progress

State	Incentive Amount or Rate	Income Tax Credit or Deduction	State Tax Exemption	Conversions Included	Carpool Lane Access?	Infastructure Incentives	Other*
Arizona					✓		✓
California	up to $5,000	✓			✓	✓	✓
Colorado	up to $6,000	✓					
Connecticut			◆				
District of Colombia		✓					✓
Florida				✓	✓		✓
Georgia	up to $5,000	✓			✓		
Hawaii	20%	✓			◆	✓	
Illinois	up to $4,000	✓		✓		✓	
Louisiana	up to $3,000	✓		✓		✓	
Massachusetts			◆		◆		◆
Montana	up to $500			✓			
Nebraska							✓
New Jersey	up to $4,000		✓		✓		
New York			◆		◆		◆
Oklahoma	50%	✓		✓		✓	
Oregon	up to $5,000	✓		✓			
Pennsylvania			◆				
South Carolina	up to $1,500	✓					
Tennessee		✓					
Texas		◆	◆				
Utah	up to $2,500	✓		✓	✓		
Washington			✓			✓	

Note: 1. * Other includes incentives include lowering licensing fees for BEVs, reduced registration fees, exemption from insurance surcharges, or special interest rate for PEVs.

2.2.2.3 - Environmental Impact

The transportation sector is a large emitter of GHGs associated with climate change (excluding international bunker fuels), accounting for approximately 32% of carbon dioxide (CO_2) emissions from fossil fuel combustion in 2008. Approximately 53% of the emissions resulted from gasoline consumption for personal vehicle use. The remaining emissions came from other transportation activities, including the combustion of diesel fuel in heavy-duty vehicles and jet fuel in aircraft.

PEVs will help reduce GHG emissions in two ways – by using gasoline more efficiently than traditional ICE vehicles and by using electricity that is produced with fewer GHG emissions relative to gasoline emissions. PEVs would likely help with ambient air quality issues. Currently, St. Louis is classified as a non-attainment zone because the ambient air quality exceeds the United States Environmental Protection Agency (USEPA) standards for ozone (O_3) and particulate matter (PM10). PEVs, compared to conventional gasoline vehicles, have reduced CO_2, O_3, carbon monoxide (CO), nitrogen oxides (NOx), and PM10 emissions.

Appendix C contains an analysis that forecasts the estimated environmental impact of PEVs on Ameren's emissions in terms of NO_x, sulfur dioxide (SO_2), PM10, total organic gases (TOG), mercury (Hg), and CO_2 in 2030. The analysis assumed that approximately 900,000 PEVs would be in the Ameren service territory in 2030. Based on the analysis, Ameren could see a reduction in NO_x emission of 1.57% (approximately 2,690 short tons of NO_x) and a reduction in SO_2 emission of 0.39% (approximately 718 short tons of SO_2) by 2030. Ameren's service area would have a potential reduction of 43% of overall vehicle CO_2 emissions by 2030, assuming no change in the existing Ameren generation mix.

The PEV Team calculated the annual CO_2 emissions for an EV and a conventional gasoline vehicle that each travel 14,600 miles per year. The EV has less CO_2 emissions compared to a conventional gasoline vehicle, assuming that the production of 1 megawatt hour (MWh) generates 0.75 metric tons of CO_2. **Table 8** presents the CO_2 emissions for an EV compared to a conventional gasoline vehicle.

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Table 8 - CO_2 Emissions: EV vs. Conventional Gasoline Vehicle (CV)

Vehicle	CO_2 Emissions (metric tons/year)
EV – 2011 Nissan LEAF	2.48*
CV – 2011 Nissan Versa	4.28

Note: 1. *Ameren Service Territory: 1 MWh = 0.75 metric tons of CO_2

In addition, PEVs would be beneficial to human health because conventional gasoline vehicles produce tailpipe emissions that are in the breathing zone, while PEVs produce no tailpipe emissions. Although coal-fired and natural gas-fired power plants could produce more CO_2 emissions in coming years due to rising demand for power (due in part to greater use of PEVs), the overall CO_2 emissions generated from all sources will still be reduced.

2.2.3 - Charging Station Technologies and Standards

Charging stations, otherwise known in the industry as Electric Vehicle Supply Equipment (EVSE), manage the flow of electricity for recharging PEVs. Although most PEVs can be recharged from a standard wall receptacle, many can or will support faster charging at higher voltages and currents that require dedicated equipment with a special connector or interface. Three charging levels (Levels 1-3) were defined by the Electric Power Research Institute (EPRI, the utility industry's research arm) and codified in the National Electric Code (NEC), along with corresponding functionality and safety requirements. Standards have been developed by the Society of Automotive Engineers (SAE) for Level 1 and 2 charging. A discussion of the charging levels and associated standards follows:

2.2.3.1 - Charging Levels and Battery Swapping

Charging Levels

Level 1 charging uses a 20-amp (A) branch circuit at 120 volts alternating current (VAC) – the lowest common voltage level found in both residential and commercial buildings in the U.S. Level 1 charging equipment is typically installed on the vehicle and the 120 VAC is brought to the vehicle through a plug and cord set. Level 1 provides the smallest amount of power and can result in prolonged charge times depending on the size of the battery being charged and its initial charge state. The ability to charge at Level 1 from a standard 120 VAC wall socket is deemed important due to widespread availability in emergency situations, even if it means waiting several hours to obtain a charge.

Level 2 charging is generally considered the primary, or preferred, method for EVSEs for both private and public facilities, and most commonly specifies a single phase 240 VAC 40A branch circuit. Larger charging currents than this are possible, and Level 2 charging can also be done from a two-phase 120/208 VAC power source. Level 2 charging employs special equipment (including a standard plug-in connector) to provide the level of safety required by the NEC and may require customers to upgrade their electric service.

Level 3 charging or "Fast Charging" is intended for commercial and public applications and represents a means of electric "refueling" most analogous to a commercial gasoline service station. Level 3 typically uses an off-board charging system serviced by a three-phase 480 VAC or 200-600 VDC circuit. Level 3 EVSEs vary in size from 60 to 240 kilowatts (kW), allowing PEVs a 50% charge in as little as 10 to 15 minutes. To date, a standard has not been established for Level 3 charging.

Level 2 Plug-In Connector

Coulomb Level 2 EVSE

It is unlikely that Level 3 EVSEs will gain acceptance in residential settings due to the voltage incompatibility at 480 VAC. **Table 9** presents a summary of the charging levels and system requirements. **Table 10** presents a summary of PEV charging times for the Nissan LEAF and Chevrolet Volt at these different levels.

Table 9 - Summary of Charging Levels

Level	Estimated Cost (USDOE, 2010b)	AC	DC
1	$0 (Residential wall socket)	120VAC, 1.2-2.0 kW, Single Phase	200-450VDC, ≤ 19.2 kW, ≤ 80 A
2	$2,000-$9,000 (Residential)	240VAC, 2.8-15 kW, Single Phase	200-450VDC, ≤ 90 kW, ≤ 200 A
3	$25,000-$75,000 (Commercial/Public)	To Be Determined 480VAC, ≤ 140 kW, Three Phase	To Be Determined 200-600VDC, ≤ 240 kW, ≤ 400 A

Table 10 - Summary of Charging Times (Based on zero to full charge)

Level	Nissan LEAF	Chevrolet Volt
1 (AC)	20 Hrs @ 120VAC/12 A	8-9 Hrs @ 120VAC/12 A
2 (AC)	8 Hrs @ 240VAC/15A-40 A	3 Hrs @ 240VAC/15 A
3 (DC)	3 Hrs @ DC Fast Charging (Available for select models only)	Currently, Level 3 charging is not available.

Battery Swapping

There is a business model being considered in the industry that presents an alternative to recharging. It involves the physical exchange of drained or nearly drained batteries with fully charged batteries, otherwise known as "battery swapping." Automated facilities have been developed that can swap a battery in less than one minute.

Project Better Place, a California-based private company involved in developing EV charging system infrastructures, is the driving force behind the battery swapping initiative. They envision battery swapping in specific geographic areas and are currently building systems in Hawaii and Israel (Motor Trend, 2008). Their greatest challenge is developing a standard that facilitates battery swapping. Currently the only manufacturers adopting a standard platform are Renault (Megane and Kangoo) and Nissan (Rogues) (WARDSAUTO.com, 2009).

Battery swapping provides a quick and reliable method for extending the range of a PEV. However, there are several challenges that have kept it from becoming a viable solution:

- Original Equipment Manufacturers (OEMs) would have to adopt a single battery standard (size, capacity and configuration). It is unlikely that automakers would standardize on such a critical selling feature (mileage, charge speed, size, shape, relative cost of vehicle model).
- Designs would have to allow for batteries to be accessible and easily removable.
- Consumers would have to be comfortable and willing to swap batteries with limited knowledge of the replacement battery's condition and previous consumption (diminishing storage capacity).
- Cost to support the labor and infrastructure of battery swapping could be prohibitive relative to charging.
- Advancements in battery technology that extend the range of PEVs may quickly render the swapping concept obsolete.

2.2.3.2 - Standards

Various organizations and standards-making bodies, including the SAE, the Institute of Electrical and Electronic Engineers (IEEE), Underwriters Laboratories (UL), NEC, and EPRI have been collaborating to develop PEV-related technical standards and codes since the 1990s. Although many standards presently exist, these organizations and standards groups have continued to develop new standards and update existing ones to ensure electric grid compatibility as the manufacturers announce production schedules for such vehicles as the Chevrolet Volt and the Nissan LEAF. The automotive manufacturers, infrastructure equipment manufacturers, utilities and various other groups have recognized the need for electric vehicle and utility grid interface standards to achieve cost effective and reliable PEV designs and avoid roadblocks to PEV adoption. Coordination and technical compatibility is needed among the various system and equipment standards and building codes.

Standards related to the battery charger and the physical connectivity between the electric vehicle and the charging station and between the charging station and the electric grid have received the most attention and are the most advanced. The EPRI report *Plug-in Electric Vehicle to Grid Interface Requirements* (EPRI, Palo Alto, CA: 2009.1017674 published December 2009) provides a thorough overview and update on these and other standards related to PEVs and future challenges.

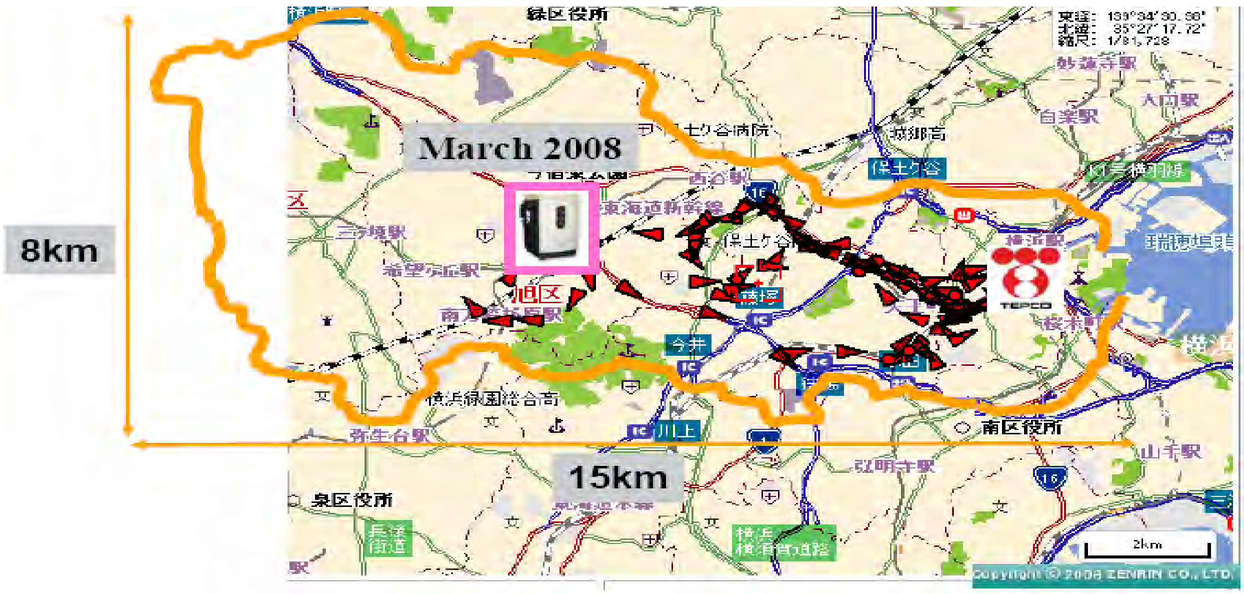
Appendix D also contains a list of applicable PEV standards and a brief description and status of each.

2.2.3.3 - Range Anxiety

Range anxiety is the fear that an EV will run out of battery power and leave its driver stranded. Although the majority of PEV charging will occur in residential areas, other charging stations will need to be installed to overcome range anxiety issues. Installation of Level 2 and Level 3 charging stations in public areas are anticipated to relieve range anxiety pressures and promote adoption of PEVs.

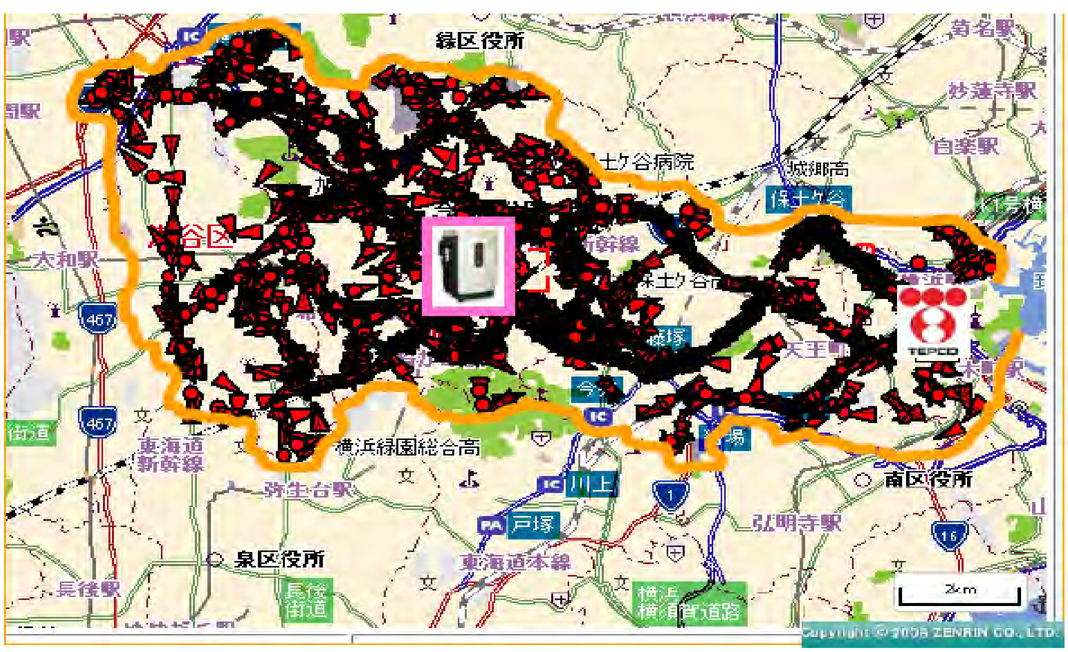
Tokyo Electric Power Company (TEPCO) evaluated the impact of a public charging station on the consumers' driving ranges between 2007 and 2008. In 2007, TEPCO educated customers on EV driving range performance, and drivers understood that they could cover a certain range on a full charge. Despite this, TEPCO noticed that drivers were only willing to travel a short distance initially. Then in 2008, TEPCO installed a quick charging station, after which the EV drivers significantly increased their mileage (PGE, 2010). **Figures 4 and 5** show the driving ranges before and after the installation of a quick charging station, respectively.

Figure 4 - Driving Range before the Quick Charger Installation (PGE, 2010)



**LEGEND: Orange Line – Boundary of Study. Red Arrows – Driving Patterns.

Figure 5 - Driving Range after the Quick Charger Installation (PGE, 2010)



**LEGEND: Orange Line – Boundary of Study. Red Arrows – Driving Patterns.

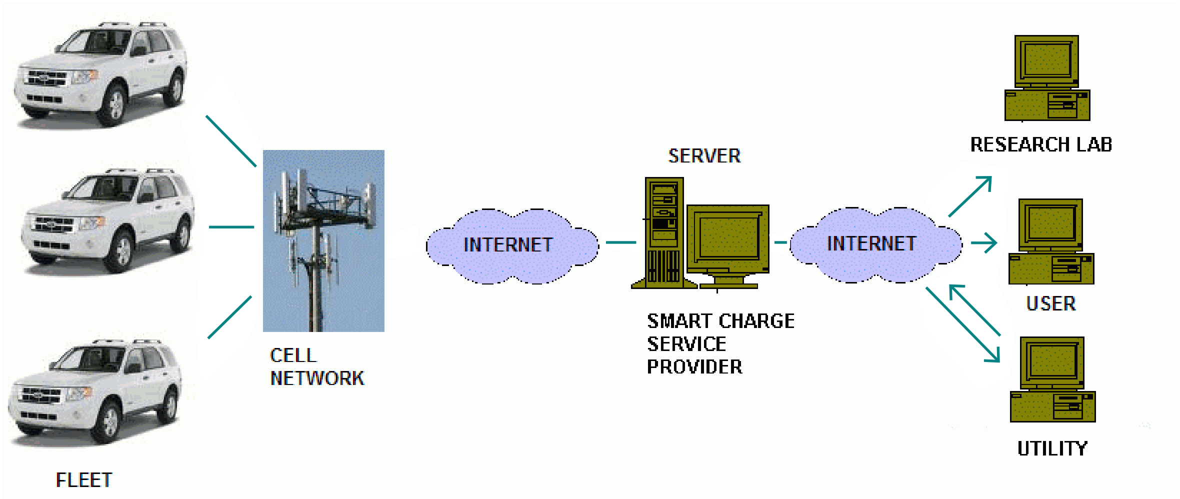
2.2.3.4 - Controlled Charging and Discharging

Controlled charging [i.e. Grid-to-Vehicle (G2V)] generally refers to the pursuit of moving PEV charging times to off-peak hours when possible and practical. Utilities need to minimize the impact of large vehicle penetrations on the distribution system by leveraging off-peak infrastructure capacity. This effort could be as simple as using timers; however, it is likely that charge controllers will involve some kind of communication with the utility provider, inferring the utility will have a stake in how such charging is conducted. This is also referred to as "smart charging," and it implies only one direction of power flow, from the power grid to the vehicle.

Electric-drive vehicles, whether powered by batteries, fuel cells, or gasoline hybrids, also have the potential to produce the same 60-Hertz (Hz) electricity that powers our homes and offices. Controlled discharging [i.e., Vehicle-to-Grid (V2G)] refers to the possibility that electricity flow is also permitted in the non-conventional second direction, from the vehicle to the power grid. The motivation driving V2G can be either the utility's (e.g. demand response) or the customer's (e.g. lower cost). Many technical, marketing and sociological considerations need vetting before V2G would ever become commonplace.

With either type of control, a fleet of plug-in vehicles is outfitted with "smart charging" (and optionally, V2G) hardware. The charging control hardware is connected to the servers of the controlling company, perhaps via public carrier and/or Internet communications. The owners, the utilities, and/or research organizations have access to data from each plug-in vehicle and have control over charging times and charging diversity. The utility could conceivably disable or limit charging in response to emergencies, high demand periods, or other contingencies, in addition to issuing requests for V2G discharging. **Figure 6** presents a typical charge control system diagram (Ameren Missouri, 2009).

Figure 6 - Typical Charge Control System Diagram (Ameren Missouri, 2009)



2.2.3.5 - Wireless Vehicle Charging

Researchers today are also developing a wireless charging solution for consumer use, involving no plugs or charging cords. Drivers would simply park their EV over a wireless energy source that sits on the garage floor or is embedded in a paved parking spot. The system would automatically transfer power to the battery charger on the vehicle (Delphi, 2010).

Recently, Delphi Automotive reached an agreement with WiTricity Corp., a wireless energy transfer technology provider, to develop automatic wireless charging products for hybrid and electric vehicles (Delphi, 2010). In addition, the Oak Ridge National Laboratory (ORNL) is developing a system that magnetically couples an electric source with a car battery. The technology allegedly offers a charge efficiency of 90 percent or more, depending on how far the car battery is situated above the flush-mounted charging station. This is an efficiency that rivals that of plugging the car directly into an outlet, without requiring cumbersome add-on technology for the car or much "precision" on the part of the driver. Among the biggest potential selling points of this technology is the simplification of "opportunity charging." In the long term, ORNL believes the device has the potential to electrify highway systems, even allowing continuous charging while driving full-speed (Knoxville News, 2010).

2.2.4 - U.S. Regulatory Policy

The automotive sector is affected by a number of major federal statutes and regulations designed to protect the environment. The fuel economy standards established a regulatory policy to encourage auto manufacturers to create more fuel efficient vehicles, like PEVs. A summary of the fuel economy standards and the potential impact on road taxes follows:

Fuel Economy Standards

The Energy Policy Conservation Act of 1975 established the Corporate Average Fuel Economy (CAFE) standards for passenger cars and light trucks. The original goal of the CAFE standard was to double the 1974 passenger fuel economy average by model year (MY) 1985 to 27.5 miles per gallon (MPG). After 1985, Congress provided for the continued application of the 27.5 MPG standard for passenger cars, but gave the USDOT the authority to set higher or lower standards. From MY 1986 through 1989, the passenger car standards were lowered. In MY 1990, the passenger car standard was amended to 27.5 MPG where it has remained.

In May 2009, the Obama Administration announced a new national policy and set new CAFE standards for all new cars and trucks sold in the U.S. beginning in 2012. Starting with MY 2012, the CAFE standards will require automakers to improve fleet-wide fuel economy and reduce fleet-wide GHG emissions by approximately five percent every year. The National Highway Traffic Safety Administration (NHTSA) established fuel economy standards that strengthen each year reaching an estimated 34.1 MPG for the combined industry-wide fleet for MY 2016. The United States Environmental Protection Agency (USEPA) standards require that manufacturers achieve an equivalent of 35.5 MPG by MY 2016. The USEPA standard can be met with air-conditioning improvements, while the NHTSA standard cannot. Essentially, the CAFE standards put pressure on automobile manufacturers to create more efficient vehicles (Research Reports International, 2010).

Road Taxes

Road taxes are currently a component of fuel prices and are collected when fueling at the pump. Since PEVs are not fueled exclusively at the pump like conventional vehicles, PEV users are not paying the same level of road taxes as drivers of conventional vehicles. This exemption is currently being treated as an incentive for PEVs. As more PEVs replace conventional vehicles and revenues from fuel taxes decrease, government entities will likely develop new tax models (e.g., “wheel” taxes) for generating revenues.

2.3 - PEV Market Penetration

There is a tremendous amount of uncertainty around forecasting market penetration of PEVs, since the technology is in the very early stages of market rollout in the U.S. The Obama Administration envisions one million plug-in hybrid vehicles on U.S. roads by 2015 (USAToday, 2010). Recent government incentives and stimulus investments designed to accelerate market acceptance, including grants and loans to manufacturers and tax credits to consumers, indicate movement toward this goal. A summary of three PEV market penetration and load forecasts follows:

- Nationwide Forecast – KEMA, Inc. *Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems* (March 2010)
- Nationwide Forecast – IDC Energy Insights (IDC Energy). *Business Strategy: The Coming Plug-In Electric Vehicle Rollout-Forecasting the Market* (September 2010)
- Ameren Forecast – Corporate Planning (April 2010)

2.3.1 - Nationwide Forecast – KEMA, Inc.

The Independent System Operator/Regional Transmission Organization (ISO/RTO) Council commissioned KEMA, Inc. to develop a PEV market penetration forecast. The key from the ISO/RTO perspective was to locate the concentrations of PEVs that can provide significant impact for demand response resources. The KEMA PEV market projections were based on historical Prius adoption rates. The Prius adoption rates were used to model PEV penetration rates to meet the goal of 1 million PEVs by 2015 (fast scenario), 2017 (target scenario), and 2019 (slow scenario). The KEMA projections assume a smooth transition in market growth. In addition, the KEMA projections are based on extrapolations of first-generation vehicles; however, it is important to note that “game-changers” in cost and power density can have dramatic impacts on the PEV market penetration rates. KEMA forecasted a potential range of 250,000 to one million PEVs in the U.S. by 2015. **Figure 7** presents Forecasted Cumulative U.S. PEV Sales from 2009-2020 (KEMA, 2010).

Figure 7 - Forecasted Cumulative U.S. PEV Sales from 2009-2020 (KEMA, 2010)

Assuming that historical Toyota Prius adoption rates are a good proxy for estimating regional PEV penetration, KEMA estimates that PEVs will be distributed more densely on the West Coast and Northeast than in the Midwest and Southeast, and that metropolitan areas will have higher concentrations than rural areas.

According to the KEMA analysis, Los Angeles was ranked 1st out of the top 20 most populous metropolitan areas in the U.S. in terms of PEV adoption by 2015; St. Louis was ranked 20th. **Table 11** presents the projected distribution of consumer, fleet, and total PEVs in the top 20 most populous metropolitan areas to meet the goal of 1 million PEVs by 2015 (KEMA, 2010).

Table 11 - Projected Distribution of PEVs in the Top Twenty Most Populous Metropolitan Areas by 2015 (KEMA, 2010)

City	Consumer PEVs	Fleet PEVs	Total PEVs
New York	40,000	14,069	54,069
Los Angeles	105,000	14,069	119,069
Chicago	20,000	7,892	27,892
Washington, DC	31,000	6,520	37,520
San Francisco	85,000	6,005	91,005
Philadelphia	13,000	5,319	18,319
Boston	27,000	4,976	31,976
Detroit-Ann Arbor	6,000	4,718	10,718
Dallas-Fort Worth	6,500	4,461	10,961
Houston	8,000	4,032	12,032
Atlanta	4,500	3,517	8,017
Miami	8,000	3,346	11,346
Seattle-Tacoma	23,000	3,088	26,088
Phoenix	13,000	2,831	15,831
Minneapolis	8,000	2,574	10,574
Cleveland-Akron	6,000	2,574	8,574
San Diego	20,000	2,445	22,445
St. Louis	3,500	2,230	5,730
Denver-Boulder	9,000	2,230	11,230
Tampa-St. Pete	7,000	2,059	9,059

Note: Metro areas located within the ISO/RTO study are **bold**; other metro areas are in gray

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KEMA also developed load and charging projections for these same twenty metropolitan areas. KEMA assumed that 80 to 90% of the charging would occur in the evening or overnight; 10% of charging time would occur during the day. The study also assumed that 20% of the vehicles would be charged at Level 1, and 80% would be charged at Level 2. KEMA forecasted load projections based on the following charging scenarios: concurrent charging for at least one hour, staged charging over eight hours, and staged charging over twelve hours. **Table 12** presents the load and charging projections for the top 20 most populous metropolitan areas (KEMA, 2010).

Table 12 - Load and Charging Projections for the Top Twenty Most Populous Metropolitan Areas (KEMA, 2010)

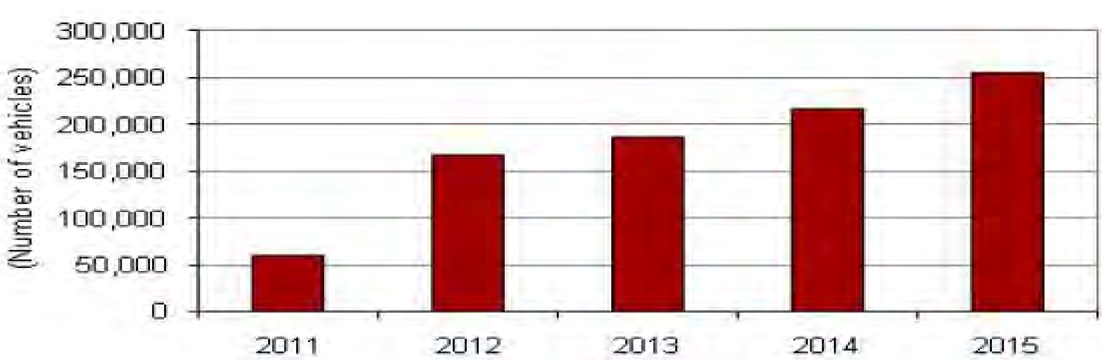
City Metro Area	Total PEVs	Load if everyone charged at the same time (MW)	Load if charging is staged over 8 hours (MW)	Load if charging is staged over 12 hours (MW)
New York	**54,069**	**299**	**33**	**22**
Los Angeles	**119,069**	**658**	**147**	**98**
Chicago	**27,892**	**154**	**34**	**23**
Washington, DC	**37,520**	**207**	**46**	**31**
San Francisco	**91,005**	**503**	**112**	**75**
Philadelphia	**18,319**	**101**	**23**	**15**
Boston	**31,976**	**177**	**40**	**26**
Detroit-Ann Arbor	**10,718**	**59**	**13**	**9**
Dallas-Fort Worth	**10,961**	**61**	**14**	**9**
Houston	**12,032**	**67**	**15**	**10**
Atlanta	8,017	44	10	7
Miami	11,346	63	14	9
Seattle-Tacoma	26,088	144	32	21
Phoenix	15,831	88	20	13
Minneapolis	**10,574**	**58**	**13**	**9**
Cleveland-Akron	**8,574**	**47**	**11**	**7**
San Diego	**22,445**	**124**	**28**	**18**
St. Louis	**5,730**	**32**	**7**	**5**
Denver-Boulder	11,230	62	14	9
Tampa-St. Pete	9,059	50	11	7

Note: Metro areas located within the ISO/RTO study are **bold**; other metro areas are in gray

2.3.2 - Nationwide Forecast – IDC Energy Insights

IDC Energy Insights developed a U.S. PEV forecast from 2011-2020. According to the IDC Energy forecast, the U.S. market could have 885,346 PEVs by 2015 (falling short of the Obama Administration's goal of one million PEVs). **Figure 8** presents Forecasted Annual U.S. PEV Sales from 2011-2015 (IDC Energy, 2010).

Figure 8 - Forecasted Annual U.S. PEV Sales from 2011-2015 (IDC Energy, 2010)

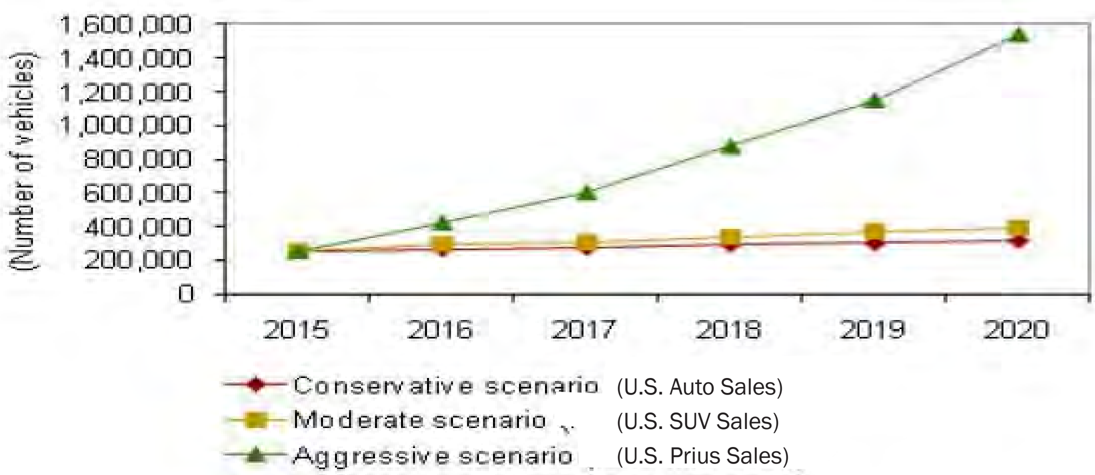


IDC Energy indicates that it is much more difficult to forecast what happens after 2015, due to PEV prices being considerably lower and mainstream consumers being the primary purchasers. IDC Energy developed a U.S. PEV forecast between 2015 and 2020 based on three scenarios:

- The "conservative" scenario follows the regular trends of car sales in the U.S. between 2002 and 2007. This was a period of steady growth in the automotive market. The conservative scenario results in a less than 1% penetration rate of PEVs by 2020.
- The "moderate" scenario follows the trend of sport utility vehicles (SUVs) during the second half of the 1990s. SUVs were very popular during that era and represented a relatively new product transitioning from an initial consumer interest phase into one of high growth. The moderate scenario also results in a 1% penetration rate of PEVs by 2020.
- The "aggressive" scenario follows the sales trend of the Toyota Prius from 2002 to 2007 (which begins five years after it was first introduced). The aggressive scenario results in a rapid adoption rate and a PEV penetration rate of almost 4% by 2020.

Figure 9 presents Forecasted Annual U.S. PEV Sales from 2015-2020 (IDC Energy, 2010).

Figure 9 - Forecasted Annual U.S. PEV Sales from 2015-2020 (IDC Energy, 2010)



2.3.3 - Ameren Forecast

Ameren developed a PEV forecast for the Ameren service territory from 2012-2020. The Ameren PEV market projections were based on some assumed market penetration rates PEVs and historical Prius adoption rates applicable to the Ameren service territory relative to the rest of the U.S. The forecast assumed that 15% of new car sales would be PEVs by 2015 and increase to 25% by 2025.

The Ameren service territory consists of approximately 1.8% of the nation's households. A simple view would be to assume that 0.9% of the PEVs sold would occur in each of the Ameren Missouri and Ameren Illinois territories; however, the adoption rate of HEVs shows that Missouri lagged the national average adoption rate. Subsequently, the Ameren territory PEV forecast was based on two scenarios:

- The "follower" scenario assumes an adoption rate in the Ameren service territory equal to 66% of the national average of historical Prius adoption rates.
- The "aggressive" scenario assumes an adoption rate in the Ameren service territory equal to 100% of the national average of historical Prius adoption rates.

The Ameren Missouri PEV analysis forecasted an adoption rate ranging from 156,215 to 236,690 PEVs by 2020. Ameren assumed the same adoption rate for Ameren Illinois in the same period. **Table 13** presents the estimated range of PEVs for each company (i.e. Ameren Missouri and Ameren Illinois).

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Table 13 - Forecasted PEV Adoption Rate for Each Company – Ameren Missouri and Ameren Illinois

YEAR	Estimated Range of Cumulative Total PEVs
2012	4,387 - 6,647
2013	13,054 - 19,779
2014	25,974 - 39,355
2015	42,326 - 64,130
2016	61,084 - 92,552
2017	82,177 - 124,510
2018	105,758 - 160,239
2019	131,881 - 199,820
2020	156,215 - 236,690

An electric load forecast for Ameren Missouri from 2012-2020 based on the PEV adoption rates presented on **Table 13** was developed, also. Again, the results in the Missouri and Illinois service territories are assumed to be identical. The electric load forecast made the following aggressive assumptions:

- PEV batteries have an average of 15 kilowatt-hours (kWh) of capacity and require a daily recharge of 75% of that capacity.
- Charging occurs at an average demand of 1.8 kW per vehicle over a 6.25-hour period daily.
- All charging occurs simultaneously. [Note this is an extremely conservative assumption. In a study performed since this analysis, EPRI determined that relative to the standard 3.3 kW on-board charger for passenger vehicles, the cumulative effects of different home arrival times, plug-in times, and initial battery states combine for an aggregate charging demand of only 0.8 kW per vehicle (Chartwell Webinar, 2010).]
- PEVs have an operating life of eight years.

Table 14 presents the forecasted load (MWh) and peak demand (Megawatt, MW) impacts from PEVs for each company.

Table 14 - Forecasted Load (MWh) and Peak Demand (MW) Impacts from PEVs for Each Company – Ameren Missouri and Ameren Illinois

YEAR	Estimated Range of MWh Impact	Estimated Range of Peak MW Impact
2012	18,014 - 27,294	8 - 12
2013	53,603 - 81,217	23 - 36
2014	106,658 - 161,603	47 - 71
2015	173,799 - 263,332	76 - 115
2016	250,827 - 380,041	110 - 167
2017	337,438 - 511,270	148 - 224
2018	434,267 - 657,980	190 - 288
2019	541,536 - 820,509	237 - 360
2020	641,459 - 971,907	281 - 426

2.3.4 - Forecast Summary

Many inconsistent PEV adoption rate forecasts exist. At this point, it is difficult to forecast how quickly the market will adopt PEVs; regardless, Ameren needs to be prepared. Below is a summary of the various forecasts.

Nationwide Forecasts

- According to the KEMA analysis, the U.S. PEV market could range from 250,000 to 1 million PEVs by 2015.
- According to the IDC Energy forecast, the U.S. market could have 885,346 PEVs by 2015.

Ameren Service Territory Forecasts

- According to the KEMA analysis, Los Angeles ranked first out of the top 20 most populous metropolitan areas in the U.S. in terms of PEV adoption by 2015 (119,069 vehicles), while St. Louis ranked 20th (5,730 vehicles). The associated peak demand in St. Louis could range from 7 to 32 MW depending on the degree of charging diversity.
- A more aggressive Corporate Planning analysis has the Ameren Missouri and Ameren Illinois service territories each reaching a potential 42,326 to 64,130 PEVs by 2015. The energy from charging these vehicles ranges from 173,799 to 263,332 MWh, with peak demands ranging from 76 to 115 MW in each state.

3.0 - Plug-In Electric Vehicles and Ameren

This section of the report discusses a number of areas the PEV Team identified in which Ameren could be affected by the introduction of PEVs. The team analyzed the potential impact of vehicle charging on the distribution system, considered various rate and revenue implications associated with PEVs within the confines of the regulatory structures in Missouri and Illinois, and studied options for the development of charging station infrastructure in the service territory. In addition, the results of an Ameren PEV telephone survey designed to provide an understanding of PEV interest and awareness among Missouri and Illinois residential customers are presented. Finally, this section identifies various PEV advocates in Ameren's service territory and their activities to date.

3.1 - Electric System Impacts

The impact that PEV charging load will have on the electric system depends on many variables such as the total number of vehicles, their locations on the system, charging levels (120 VAC vs. 240 VAC or higher), vehicle charger sizes, charging frequencies and times of day, and initial battery charge states. The addition of PEV charging load could advance the need for system upgrades, particularly in areas where facilities are already heavily loaded or constrained. The most likely impact will be at the lower voltage distribution system level in areas of high penetration or where "clusters" of charging stations exist. "Clustering" occurs when a concentrated number of charging stations are installed in one area (e.g., an apartment building, a neighborhood, a parking garage, or place of business). PEV "clusters" are likely to require minor upgrades (e.g., services, secondary spans, or distribution transformers) to avoid equipment overloads and/or low end-use voltages.

An analysis was conducted to determine the electric system impact of PEVs on the Ameren service territory. Based on Corporate Planning's projected PEV penetrations in the Ameren service territory, as discussed in Section 2.3.3, the estimated additional peak loading at the distribution substation level over the next ten years is 4.6% to 6.9%. This is based on two aggressive assumptions – all vehicle charging overlaps during on-peak hours (10 AM to 10 PM) and exhibits an average coincident demand of 1.8 kW per PEV. On this basis, it is certain Ameren will have enough capacity to meet the load requirements for PEVs in the near term. In isolated cases, Ameren may need to upgrade the distribution system (e.g., in 4 kV distribution areas) due to the "clustering" phenomenon.

The system impacts can be minimized for the foreseeable future to the extent that PEV charging can be shifted to off-peak hours. The system could potentially handle charging up to a 100,000 PEVs or more during off-peak periods without requiring significant system upgrades at the distribution substation level or above. It is generally acknowledged in the industry that the increased off-peak load could diminish the transformer and circuit reserve capacity available on the system, reducing the options for transferring load to restore power during outage events or to perform system maintenance. Of particular concern are the potential restrictions on distribution transformer ratings, given the reductions in the cooling cycles of these units during off-peak hours.

In order to minimize and better analyze the electric system impacts of PEV charging loads, the following items should be considered:

- Options such as time-of-day rates (see Section 3.2) and "smart" charging (see Section 2.2.3.4) should be investigated to maximize off-peak charging.
- A process for providing division engineering with a notification that a customer has purchased a PEV will be extremely helpful. Such a notification will prompt a division review of the capacity of Ameren's service to the customer premise for possible upgrade. This ensures both the operating integrity of the distribution system and a positive PEV purchase experience for the customer.
- Division Engineering presently relies on the EPRI Distribution Engineering Workstation (DEW) to identify 12 kV and 4 kV feeder overloads and voltage problems. A more detailed modeling of customer loads in DEW will also be helpful in order to determine the coincident peak contribution of PEV charging load at different delivery points on the distribution system.

3.2 - Rate Designs

Electric rates are based on cost of service principles and attempt to ensure a utility an opportunity to earn a fair rate of return. Sound rates also attempt to encourage the efficient use of the electric infrastructure.

By their nature, electric rates undergo a degree of public acceptance. For example, while time-of-use (TOU) rates encourage more efficient use of the electric system, residential customers have been slow to adopt them over the fixed cents per kilowatt hour (¢/kWh) rates that are familiar to them. Customers may perceive a small benefit under TOU, but such benefits do not outweigh the simple convenience of the standard rate. Historically, utilities may have been reluctant to promote TOU rates as well, due to revenue uncertainty associated with customers changing pricing structures.

Today, several utilities are offering various rate plans exclusively for charging electric vehicles. Below is a brief summary of some of these plans currently being offered by other utilities (WSJ, 2010a):

- **DTE Energy** – In August 2010, DTE Energy (formerly Detroit Edison) became the first utility in the U.S. to offer a flat monthly rate for charging, $40 per PEV. This is a test rate and was designed to gauge customer response.
- **Consumers Energy** – Consumers Energy (Lansing, MI) is offering a rate plan of $35 a month for 300 kWh of electricity, provided it is used exclusively for charging PEVs. Customers using more than 300 kWh per month would pay 7.8 ¢/kWh from October through May and 12.5 ¢/kWh from June through September.
- **Southern California Edison** – SCE has three new rate plans, including one that has lower rates from 9 PM until noon and much higher rates during the afternoon. In addition, SCE provides a web-based tool to help determine which rate plan is the cheapest option for each customer.
- **Sempra Energy** – San Diego Gas & Electric Co. (a Sempra Energy company) plans to randomly assign purchasers of the Nissan LEAF who participate in a federally funded project one of three rate plans. In two of the plans, the home charging station is metered separately under its own pricing plan. In the third plan, the entire house (including the charging station) is billed under a single TOU rate.

The challenges and perceptions of various rate design concepts will likely carry forward for the near term as the PEV market continues to emerge. However, acceptance of time-differentiated rates could increase with customer education and demonstrated benefits to both the utility and the consumer. A TOU rate structure that (1) customers can easily understand and opt into, (2) allows the utility a fair rate of return, and (3) encourages efficient use of the system, should be designed and implemented. The design of such a TOU rate must have significant input from regulators and other stakeholders.

3.2.1 - Regulatory Structures

The regulatory structure in Illinois and Missouri differs significantly. Ameren Illinois operates as a delivery-only company and owns no generation, while Ameren Missouri operates as a fully integrated company providing delivery, transmission, and generation.

Ameren Illinois procures generation resources from the marketplace under the provisions of the Illinois Power Agency Act. Ameren owns merchant generation that submits competitive bids to provide power to Ameren Illinois. Transmission service is charged to customers at FERC-approved rates as a pass through. Delivery service for non-FERC regulated assets falls under the jurisdiction of the Illinois Commerce Commission (ICC). Illinois state law mandates that all customers, including residential customers, have the option to take hourly power service at market-based rates (i.e., real time pricing). Unlike Ameren Missouri customers, Ameren Illinois customers with demands over 400 kW are "competitive," and as such, do not have a fixed price option available to them. Instead, only hourly priced energy supply service is available.

Regulated rules or statutes in both Illinois and Missouri require utilities to offer non-discriminatory rates, meaning that prices offered to one must be offered to all similarly situated customers. End use rates can be developed with sufficient cost-based justification. For example, Ameren Illinois has had residential space-heat rates to encourage customers to use electricity in the non-summer period as a means of encouraging greater utilization of fixed generation and distribution assets.

Both end use and other rate offerings have always been optional, empowering customers to make a choice. Customers have the ability to take service under the otherwise applicable "standard" tariff offering. Thus, any tariff targeting PEV charging should assume customers will have a choice between continuing on the standard rate and taking advantage of whatever the new tariff offers, whether it be a special PEV end-use rate or an off-peak rate that is available to all.

For purposes of this discussion, the residential "standard" rate is expressed in cents per kWh (¢/kWh) and is seasonally differentiated, with a possible energy usage block. Non-residential customers may have such a rate or a demand-based rate (typical for customers with demands over 150 kW and 100 kW in Ameren Illinois and Ameren Missouri, respectively).

3.2.2 - Residential Rate Options

As discussed above, regulated electric rates are based on cost of service principles, both ensuring utilities have an opportunity to earn a fair rate of return and encouraging the efficient use of the electric infrastructure. **Table 15** outlines existing rate structures and basic frameworks for alternative rate structures that could be branded as "PEV Rates."

Table 15 - PEV Rate Options

Existing Rate Options	Ameren Illinois	Ameren Missouri
Fixed ¢/kWh Rates-Status Quo	■ ICC regulated Delivery rate, seasonally differentiated ¢/kWh ■ Separate Rider for Transmission service ¢/kWh rate ■ Fixed price ¢/kWh power rate (Basic Generation Service – BGS), seasonally differentiated	■ PSC regulated ¢/kWh rate, fully integrated service
RTP Option – Status Quo	■ Same as Status Quo, except: ■ Incremental $5/month for interval meter ($2.25 if on PSP) ■ Hourly prices for energy equal to MISO DA LMP ■ Transmission billed as $/kW value	■ Not available
TOU Option – Status Quo	■ Not available	■ Larger Customer Charge for TOU meter ■ Seasonal on/off peak period ¢/kWh differentiated pricing
Other Options to Consider		
TOU DS (non-demand) with RTP	■ Illinois only ■ Additional incentive to shift to off-peak (and/or "super-off peak") ■ Requires further analysis	■ NA
TOU – with Demand based rates	■ Would be difficult to gain widespread customer acceptance and, also, require additional investment in metering	
TOU with Critical Peak Pricing component (Paired with technology most effective, per EEI literature)	■ Operates like standard TOU, except limited number of times per year utility allowed assess much higher prices during "CPP" events ■ Requires metering capable of recording daily TOU and hourly events ■ Prices during non-CPP events lower than otherwise applicable TOU prices to encourage participation, achieve overall revenue neutrality ■ Still must overcome customer acceptance of TOU	

Any changes to rates inevitably raise revenue stability concerns. An off-peak rate open to all customers may invite non-PEV customers to participate, potentially eroding existing rate revenue. Potential revenue erosion concerns could be mitigated by offering a PEV rate pilot program. A pilot program offers the benefits of a targeted study on the end use group, while minimizing exposure to revenue erosion from non-PEV customers. The pilot objectives could analyze the importance of electric pricing to customers through their charging decisions as well as track the customer response to two or three alternative pricing models.

3.2.3 - Other Rate and Revenue Considerations

PEVs are anticipated to use an average 2,500 to 3,000 kWh of energy annually per vehicle, assuming charging on a daily basis. This and the prospect of thousands of vehicles between the Missouri and Illinois service territories over the long term combine for the potential of generating measurable additional revenues annually. Additionally, alternative rate offerings and other methods of controlled or "smart" charging add to the value proposition by ensuring that most of this energy is used during off-peak hours. This yields a minimal system impact and in turn reduces the capital expenditures required for infrastructure improvements in order to deal with this emerging technology.

It is important to acknowledge that the effects of this kind of revenue growth would, in a sense, be "normalized" at the time of the next rate case filing, whenever that would occur. The additional revenues from electric vehicle charging, having become part of the new revenue base, would have a diluting effect on the new rates emerging from the case. In the end, the greater the rate of PEV adoption combined with effective charging control, and the longer the period of time between rate cases during these growth periods, the better the impact for Ameren as a result of PEV technology. Despite the "normalizing" effect of rate cases, any degree of revenue growth due to charging electric vehicles may offset other costs over those periods in which this kind of growth occurs.

Rate design could influence customer behavior to minimize incremental investment in the electric system, producing benefits to shareholders (higher margin), participating customers (lower overall rate), and ultimately non-participating customers (lower average rate). Investments in infrastructure and the cost of operations and maintenance (O&M) to support PEVs, which occur between rate cases, serve to offset margin. If the cost of these investments is greater than the incremental revenue, Ameren encounters "regulatory lag." If such investments are ultimately included in regulated rates in the future, this lag is effectively reset. Proper rate design can help minimize regulatory lag by encouraging off-peak use, which in turn helps minimize incremental investment. An off-peak or PEV rate will likely undergo several iterations as the market evolves and additional data is gathered, and will need to be developed with stakeholder input from the respective state jurisdictions.

3.3 - Charging Station Infrastructure

Longer drives between cities and towns require a network of public charging stations or other technologies (i.e. charging infrastructure) that extend the ranges of electric vehicles beyond normal daily commutes. Ultimately, PEVs will be charged in a combination of residential, workplace, and public locations. EPRI predicts approximately 80% of charging will occur in residential areas (apartments and single or multi-family homes), approximately 15% of charging will occur at the workplace, and approximately 5% will occur at public locations such as hospitals, shopping malls, universities, interstate rest areas, and train stations (EPRI, 2010). Several issues continue to exist regarding charging infrastructure, including infrastructure development and metering and billing options.

3.3.1 - Infrastructure Development

Residential consumers of PEVs are ultimately responsible for the cost of getting their homes ready for charging their vehicles. Consumers can work through auto dealerships, charging station manufacturers, or local contractors to have certified personnel install EVSEs in their homes.

Building a public charging system outside of the residential arena is an entirely different matter and can require a large outlay of capital. Further complicating the issue today are open questions as to how much charging infrastructure is required for a given area's PEV penetration, where charging stations should be located relative to area driving patterns, who should own and maintain them, and how the public charging "service" should be billed to consumers, if at all. On the positive side with regard to Ameren's service territory, General Electric recently identified the top ten American cities that are best set up for PEV adoption by virtue of the number of commuters living within a 50-mile radius of the city center combined with the percentage of those commuters who drive to work. St. Louis ranked fourth on the list (GE Reports, 2010).

Another challenge with public infrastructure is the level of consumer demand; an isolated charging station along a busy interstate may see hundreds of customers per hour if every passing electric vehicle has to stop there to complete the trip. There is no one party generally considered "responsible" for developing and building out public charging infrastructure to support PEVs. In communities where public charging infrastructure is being developed, local governments (municipalities), businesses and utilities have partnered to varying degrees to take on this responsibility.

PEV manufacturers have indicated that the demonstrated support of charging infrastructure development by the local utility is vital to their consideration of any area as a "launch market" for their product. Such utility support does not necessarily take the form of building infrastructure outright; it can also take the form of customer education, employee incentives, partnering with corporate "neighbors," communicating with building code authorities to support charging infrastructure growth, and working with local inspection authorities to ensure a smooth permit process for home charging station installations.

3.3.2 - Metering and Billing Options

Currently, a national standard does not exist regarding metering and billing options for charging stations, and many states are developing their own structures. As discussed in Section 3.2.2, there are various residential rate options possible, and ultimately residential customers will pay for the energy used at their homes. However, there are several issues regarding who pays for the electricity usage at the workplace and at public charging stations, and how the billing is conducted. For instance, Ameren operating company tariffs prohibit the direct resale of electricity to end users. While this indicates that billing a public charging station user by the kWh is off limits, there are other billing methods possible, like charging by the hour or charging a fixed price for each "session" regardless of duration.

EPRI has developed a matrix that identifies possible PEV metering and billing options in the future. **Table 16** provides a summary of possible PEV metering and billing options (EPRI, 2010).

3.4 - Customer Survey Results

In July 2010, the Ameren Missouri Customer Satisfaction and Business Optimization Department conducted a telephone survey to determine the current level of PEV awareness and interest among Ameren's residential customer base. One thousand customers (500 residential customers in each of Ameren Missouri and Ameren Illinois) were contacted. **Appendix E** contains the introductory script, three PEV questions that were included as part of an energy efficiency telephone survey, and a detailed summary of the results of the July 2010 Survey.

Based on the results of the July 2010 Residential PEV Survey, the following key observations were identified:

- **Awareness of PEVs** – Approximately 44% of Ameren Missouri residential customers are very aware of PEVs, while approximately 38% of Ameren Illinois residential customers are very aware of PEVs. Respondents between the ages of 55 and 64 and 65+ have the greatest awareness. Those with incomes of $75,000 to $100,000/year and greater than $100,000/year have a higher awareness.
- **Purchase Consideration Likelihood** – Approximately 35% of residential customers are either very likely or somewhat likely to consider purchasing a PEV in the Ameren Missouri service area. Approximately 27% of residential customers are either very likely or somewhat likely to consider purchasing a PEV in the Ameren Illinois service area. Those with incomes of less than $35,000/year were the least likely to consider a PEV in Ameren Missouri. In Ameren Illinois, the majority of customers at all income levels were not very likely or not at all likely to consider purchasing a PEV.
- **Purchase Consideration Influences** – Residential customers in Ameren Missouri and Ameren Illinois indicated that the biggest items influencing the purchase of a PEV included (1) an initial cost that was less than comparable gasoline vehicles and (2) its positive impact on the environment. These items of influence are the same for both states regardless of the respondent's location – whether in an urban or rural area. In addition, these factors were more important among the female respondents.

Table 16 - Summary of Possible PEV Metering and Billing Options (EPRI, 2010)

Billing/Metering Options		
Near-Term	**Mid-Term**	**Long-Term**
Residential: Single Family Dwelling		
Three approaches: 1. Do Nothing - premise being metered as a whole and consumer pays the bill on a premise-level with no special provision for PEV charging energy 2. Premise-based metering and off-peak rates regardless of PEV adoption-single meter on house 3. Sub-meter to measure and incentivize PEV-only charging consumption	Sub-meter to measure and incentivize PEV-only charging consumption-likely to become more prevalent as PEVs become a significant portion of the overall load. Consumer gets one bill but with PEV-only consumption separated out for informational purposes.	Sub-meter for EV charging, added with roaming capability afforded by the standards (SAE J2836/J2847 Smart Energy 2.0) can allow individual car owner to be billed directly for their energy consumption and the time of use
Residential: Multi-Family Dwelling		
Two approaches: 1. Proportioning of the bill similar to what is being done today by multi-unit landlords 2. Sub-meter on every electric outlet tied to individual customer account	Sub-meter on every electric charging outlet tied to individual customer account	Sub-meter for PEV charging, added with roaming capability afforded by the standards (SAE J2836/J2847 Smart Energy 2.0) can allow individual car owner to be billed directly for their energy consumption and the time of use
Workplace		
Two approaches: 1. Workplace owners (employers) are likely to be billed as a commercial & industrial (C&I) customer, with no costs passed to employees (“free” workplace charging) 2. A fixed charge similar to any other facility usage charge (lunch, cell phones, etc) for every employee	Same as near-term	Sub-meter for PEV charging, added with roaming capability afforded by the standards (SAE J2836/J2847 Smart Energy 2.0) can allow individual car owner to be billed directly for their energy consumption and the time of use
Public Charging		
Driven by charging infrastructure suppliers. Three dominant models: 1. Credit Card Based Model – Any customer can charge. The charging fee includes energy consumption bill, which the premise owner pays as a C&I customer. The car owner pays an agreed-upon rate. 2. Subscription-Based Model – The “in-network” customer pays a subscription per month and has access to all charging stations of the operator everywhere. 3. Free Model – Operated by public utilities or business owners, similar to ‘free WiFi’ model. Premise owners get billed as C&I customers.	#1 and #3 of the near-term have more chance of success, particularly #3, with the premise-owner treating this as a customer acquisition/retention cost (marketing)-at least initially. The long-term outlook depends on how inexpensive the charging infrastructure becomes in time and over volume, plus how the standards evolve.	Direct relationship between utility and customer. Pricing and billing information communicated to the utility by identifying the vehicle and owner regardless of the location and billing the customer as a part of the monthly bill (cellular phone roaming model).

3.5 - PEV Advocates in Ameren's Service Territory

Several environmental, civic and corporate organizations within Ameren's service territory currently advocate for or represent an interest in PEVs. Below is a preliminary list of regional advocates the PEV Team compiled:

- **Electric Vehicle Manufacturers** – Ameren participated in discussions with several PEV manufacturers (Nissan, General Motors, Smith Electric, Eaton, and Mitsubishi Motors) to obtain information on their offerings and commercial availability in the Ameren service territory. Many of these discussions are driven by Ameren's intended participation in EPRI demonstration projects.
- **Charging Station Vendors** – Ameren participated in discussions with several charging station vendors (Clipper Creek, Coulomb Technologies, GE/PlugSmart, Leviton Manufacturing, and Eaton) to obtain information on their offerings and commercial availability in the Ameren service territory. The charging station manufacturers have partnerships with local distributors and electrical contractors for installations in the Ameren service territory.
- **Normal, Illinois** – The Town of Normal received a $488,500 Energy Efficiency and Conservation Block Grant that was part of the 2009 federal stimulus package. The town plans to use a portion of these funds for charging station deployment throughout the community. Normal expects to install multiple Level 1 (120 VAC) charging stations along the street in its Central Business District as well as several Level 2 (240 VAC) charging stations in parking decks and other public locations. A community initiative will focus on consumer education, charging station deployment, and development of electric vehicle-related local incentives. Through this developing initiative, Normal hopes to emerge as a model electric vehicle community.
- **Lewis & Clark Community College (Godfrey, IL)** – Lewis & Clark is doing its part by developing a number of green initiatives and educating its student body and the rest of the community about sustainability solutions. They are planning to install two charging stations on campus in 2011 in addition to converting two conventional vehicles to electric. In addition, regional community colleges and technical schools are developing curricula for future electric vehicle mechanics on the maintenance and repair of these types of vehicles.
- **St. Louis Clean Cities' Plug-In Readiness Task Force** – St. Louis Clean Cities is a voluntary initiative, sponsored by the USDOE, to expand the commercial use of vehicles that operate with fuels other than gasoline and diesel. An EV Task Force (including participants from Missouri and southern Illinois) has been formed to get local and regional businesses, educational institutions, and governments ready for plug-in hybrid vehicles and establishing electric charging stations in the area. Members include the East-West Gateway Council of Governments, Ameren, the State of Missouri, the Gateway Electric Vehicle Club, Microgrid Energy, French Gerleman, St. Louis Community College, Lewis & Clark Community College, and Ranken Technical College.
- **Gateway Electric Vehicle Club** – The Gateway EV Club, a registered chapter of the Electric Automobile Association (EAA), includes individuals living in the St. Louis area who believe EVs are an important part of the solution to our global energy crisis. The group's main goal is to raise awareness of EV benefits. The club does this by attending community events, converting and helping others convert their cars into EVs, conducting their own meetings, and providing EV information to interested parties.
- **AT&T** – AT&T Fleet operations are based in St. Louis. AT&T purchased two of the first all-electric versions of the 2010 Ford Transit Connect vans. In addition, Kansas City-based Smith Electric delivered an all-electric Smith Newton cargo truck to AT&T (St. Louis Business Journal, 2010). Until recently, AT&T's alternative fuel focus had been restricted to compressed natural gas vehicles.
- **Enterprise Holdings Inc.** – Enterprise Rent-A-Car (headquartered in St. Louis) announced that it is buying 500 Nissan LEAFs beginning in January 2011. Enterprise will put the vehicles in its rental fleets in eight cities: Seattle, Portland, Los Angeles, San Diego, Phoenix, Tucson, Nashville and Knoxville. It will also add vehicle charging stations to some of its locations in 30 U.S. cities and pledged to buy PEVs from other manufacturers as they become available (WSJ, 2010b).

4.0 - Ameren Strategy Development and Recommendations

It is difficult to forecast a market penetration rate of PEVs in Ameren's service territory, much less identify a potential impact on revenues. Regardless, the Ameren PEV Team recognized that electric vehicles will be arriving in auto dealer showrooms in late 2011 or early 2012 in our service territory and that a corporate strategy is needed to prepare for the launch of this technology.

This section describes the various considerations that ultimately went into the formation of Ameren's PEV strategy. Among these were an introspective look at our corporate mission, vision and values statements, an examination of the ways in which PEVs could be important to stakeholders, and a review of the expectations that PEV industry players have of utilities. Finally, the alignment of all these considerations rendered a list of factors the Ameren PEV Team deemed critical to the formation of a corporate strategy.

4.1 - Corporate Vision and Alignment with Stakeholders

The PEV Team examined how our support of PEV technology and the emerging local market would align with Ameren's corporate mission, vision, and values:

VISION *Leading the way to a secure energy future.*

MISSION *To meet our customers' energy needs in a safe, reliable, efficient and environmentally responsible manner.*

VALUES *Our values – the way we do business – include integrity, respect, accountability, stewardship, teamwork and commitment to excellence.*

Our vision – leading the way to a secure energy future – reflects how we approach change – by remaining forward-looking and working proactively for solutions that meet the changing energy needs of our customers. The Ameren mission supports this vision and further emphasizes our continued focus on safety, service reliability, and environmental stewardship throughout, regardless of what lies ahead. The Ameren values reflect our daily priorities and guide our conduct – with customers and all stakeholders. Ameren's mission, vision and values compel us to embrace our energy future with excitement and confidence, actively supporting emerging technologies and the customers who choose to adopt them.

To get a better handle on the form this kind of support would take for Ameren, the PEV Team compiled a list of stakeholders and the reasons each would consider PEVs important. **Table 17** presents the list of those stakeholders and the nature of their vested interests in the technology and its success.

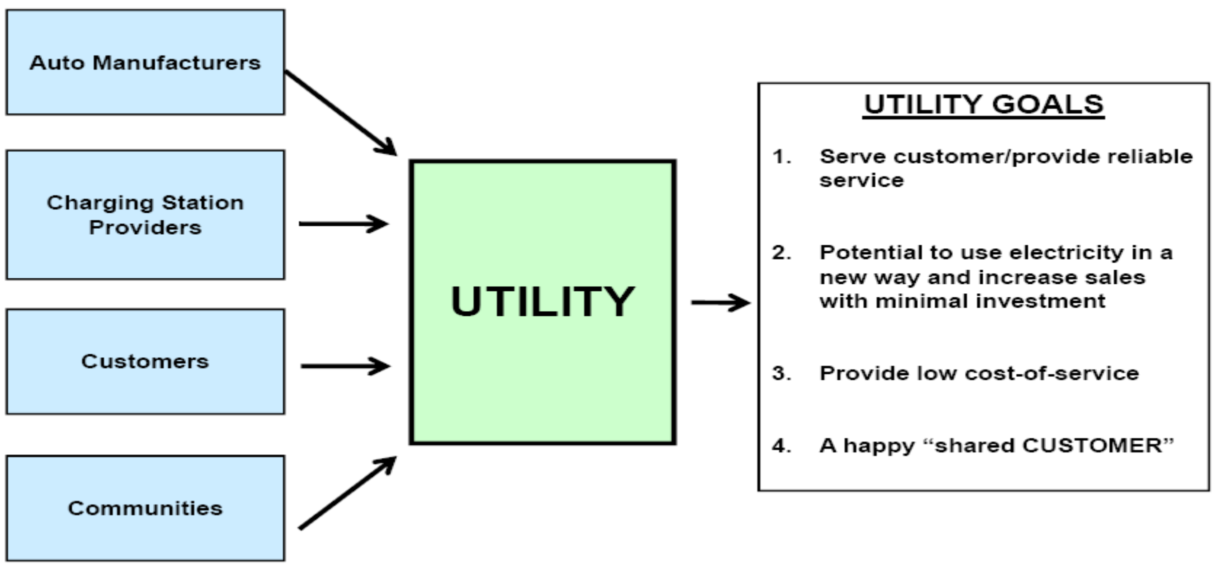
Table 17- Ameren Stakeholders and Reasons PEVs are Important to Them

AMEREN STAKEHOLDER	WHY PEVs ARE OF IMPORTANCE
Customer	■ Utility's role as a trusted energy advisor ■ Environmental Stewardship (improvement of air quality/non-attainment issues) ■ Energy Independence/Economic Resurgence/National Security
Communities	■ Promote a desirable place to live/do business/work ■ Potential job opportunities ■ Sustainability is important
Employees	■ Promote new growth opportunity ■ Potential job opportunities ■ Sustainability is important
Operations	■ Promote new technology opportunities (e.g. smart grid) ■ Promote improved generation/equipment efficiency due to potential for high off-peak loads
Shareholders	■ New opportunity for electric market (growth) ■ Create new streams of revenue ■ Electric sales ■ Investments/capital/infrastructure ■ Image/leaders/sustainability/corporate responsibility
Commissions	■ Growing public support ■ Growing consumer interest ■ Need to understand customer behaviors/choice ■ Environmental policy ■ Need to understand impact of PEVs on system ■ Potential for new rate schemes/rate design

4.2 - The Role of the Utility

The Ameren PEV Team identified various key players involved in and critical to the advancement of the PEV market – auto manufacturers and their dealership partners, charging station manufacturers and their distributors, customers, community leaders, and the local electric utility. **Figure 10** depicts the central role of the utility in fulfilling its responsibilities as an electric service provider.

Figure 10 - Role of the Utility – "Shared Customer" Satisfaction is Key



Each of the key players in Figure 10 has a different role and will ultimately interact with the utility in a different manner to ensure the new PEV ownership experience is as positive as it can be for the consumer, our "shared customer." The PEV Team's discussions with many of these key players brought to light the nature of their expectations for the utility and how they view the utility's "support" of technology and the emerging market:

- **Auto Manufacturers** – OEMs want assurance that the local utility supports PEV technology enough to warrant the launch of their product in the utility's service territory. This includes offering alternative rates, supporting deployment of charging infrastructure, and engaging with local authorities to help ensure a smooth hassle-free inspection process for customers installing home charging stations.
- **Charging Station Providers** – Manufacturers and their distributors are interested in knowing that the local utility is participating in a regional planning effort for charging station deployment. This includes outreach efforts to educate customers on PEV technology and requirements, support for corporations interested in becoming "plug-in ready" for their own employees, and partnerships with local contractors to provide an efficient process for completing service upgrades.
- **Customers** – New PEV owners will want to be confident that their local utility has the system capacity to handle electrical vehicle charging, regardless of when they choose to buy. They will expect to be able to trust their electric service provider as an "energy advisor" in PEV-related matters, not only answering questions they have regarding electric vehicles and charging stations but also offering cost-saving advice and support with regard to their charging new vehicles at home.
- **Communities** – Governments, institutions, and corporations with fleets of their own will not only look for advice from the local utility on how they can best prepare for the emergence of this new technology, they will expect the utility to be an able and creative partner as they move beyond the formative planning stages.

Ultimately, all of the PEV key players above need to work together to make sure that the new PEV owner, their "shared customer," has the most positive ownership experience possible.

4.3 - Key Strategic Elements

The Ameren PEV Team identified how the support of PEVs as an emerging technology aligns with our corporate mission statement, vision, values, and customer service goals. The team considered the utility's role in general as well as Ameren's connections and interactions with key players in the industry and the community. What emerged from these considerations were the following elements the PEV Team deemed fundamental to an Ameren PEV strategy, aligning both with the corporate vision of "leading the way" and our intent to earn our customers' trust as an "energy advisor:"

Educate Ourselves

- Purchase PEVs and charging stations internally to study their operational characteristics and better understand potential impacts on the distribution system.
- Participate in EPRI demonstrations and research on PEVs, as appropriate.
- Develop methods and processes by which Ameren can transfer acquired knowledge directly to customers and employees in response to their inquiries.

Educate and Support Our Customers

- Investigate various modes of communication and outreach with both customers and employees, including web pages, "specialty-skilled" call takers, bill inserts, and in-person community involvement.
- Provide information to our customers and employees on PEV technology and items to consider prior to the installation of charging stations at the home or workplace.
- Investigate various types of support to help ensure a positive PEV ownership experience for our customers, including providing service capacity reviews and upgrades, and offering information through local PEV dealers at point-of-sale.

Engage Our Regulators and Other Community Partners

- Proactively reach out to our regulators to discuss our strategic stance and obtain feedback on action plans as they are developed.
- Explore the possibilities of alternative rate designs as appropriate for both Ameren Missouri and Ameren Illinois.
- Investigate possible incentive programs around customer charging station installations.
- Develop local partnerships and alliances (e.g., St. Louis Auto Dealers Association, St. Louis Regional Chamber and Growth Association, St. Louis Clean Cities' Plug-In Readiness Task Force, electrical contractors and distributors, etc.) to support and develop greater understanding of the technology, along with the rest of the community.

4.4 - Potential Strategies

Three potential strategies were developed by the Ameren PEV Team representing varying degrees of Ameren support for PEVs as they emerge in the local marketplace and incorporating the strategic elements identified in Section 4.3. Each strategy involves a three-year plan (2011-2013) with specific goals and activities for both Ameren Missouri and Ameren Illinois. The following three strategies were identified:

- **Participating Role (Following the Market)** – This role represents a largely reactive stance that acknowledges the emergence of PEVs and commits to providing the appropriate level of customer service to new PEV owners. However, it does relatively little to promote the technology in the community beyond the service territory's early adopters.
- **Supporting Role (Raising Awareness and Supporting Customers)** – This role represents a more proactive stance that, in addition to acknowledging the emergence of PEVs, calls for Ameren to more actively promote the technology in the community, educate stakeholders, and seek out partnership opportunities to encourage greater acceptance and adoption of PEVs. The Supporting Role includes all the activities in the Participating Role; however additional goals and activities were added to increase community support.
- **Promoting Role (Aggressively Influencing Market Adoption)** – This role represents an aggressive stance that in addition to participating in and supporting the technology, is further distinguished by an intent to explore options for directly influencing market penetration, industry research and public policy around PEVs. The Promoting Role includes all the activities in the Participating and Supporting Roles; however, more aggressive goals and activities were added to increase its scope and market reach.

4.5 - Strategy Recommendation and Next Steps

Ultimately, some degree of preparation for PEVs is considered critical for Ameren not only from system and stakeholder standpoints, but to assume our desired "energy advisor" role with our customers. The Ameren PEV Team recommends the corporation adopt a Supporting Role strategy at this time, since PEVs are expected to be available in the Ameren service territory by the end of 2011 or early 2012. However, the Ameren PEV Team will continue to monitor the PEV market and revise the strategy as necessary. **Table 18** presents a summary of the three strategies and some of their associated activities.

Table 18 - Proposed Ameren PEV Strategies: Summary and Recommendation

RECOMMENDATION

ITEM	Participating Role	Supporting Role	Promoting Role
I. Partnership Opportunities			
Clean Cities - Plug-in Readiness Task Force	X	X	X
St. Louis Auto Show Sponsorship (St. Louis Auto Dealers Association)			
II. EPRI			
Programs			
EPRI Program 18A - PHEV Development	X	X (2011)	X
EPRI Program 18D - Advanced Infrastructure for PHEVs		X (2012 and 2013)	X
Demonstration Projects			
EPRI/GM Smart Charging Demonstrations			
Level 3 - Access to GM EREV smart-charging technology (3-YR Program)			X
EPRI/GM Vehicle Demonstration - One Vehicle			X
Utility-Specific Projects			
EPRI Customer Expectations Survey			X
III. EV & Charging Stations for Ameren			
Purchase EVs and charging stations for Ameren	X	X	X
IV. Regulatory and Identifying Funding Activities			
Develop alternative rate design for PSC/ICC		X	X
Conduct research for grant opportunities/Apply for grants			
V. Training and Education			
Customer Education Campaign [Limited to: website, video, direct mail (brochures) and outreach efforts]	X	X	X
Employee Education - Outreach	X	X	X
Internal Data Collection and Analysis --- Report	X	X	X
VI. Partnership/Research and Incentive Program			
***Charging Station Installation Program:** Offer incentives to various customers in Ameren Missouri and Ameren Illinois. (i.e. Various customer types: Corporate, Govt, Universities, and Residential Customers)		X	X
***Charging Station Build Out Program:** Partner with businesses to install Charging Stations		X	X

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The Ameren PEV Team believes it is necessary to continue monitoring the PEV market and customer interest level. At the same time, consistent with the Supporting Role being proposed, it is equally important to begin taking active steps now to research associated technologies, and to both share and promote this information with stakeholders. This includes preparing Ameren employees and work locations for PEVs. It includes preparing both our customers and our grid for the emergence of these vehicles. And it includes partnering with the community to likewise prepare the region.

There are several departments within Ameren that will continue to monitor the emerging PEV market and technology. In addition, the Ameren PEV Team will assume the following responsibilities for the future:

- Develop a detailed implementation plan for the Supporting Role strategy.
- Participate in, and monitor, the progress of PEV sub-teams as they formulate and execute on specific action plans in areas such as community partnerships, stakeholder education and communication, Ameren-owned vehicles and charging stations, EPRI demonstrations, regulatory affairs, and PEV load research.
- Update the PEV analysis and associated action plans on a periodic basis.
- Continue to monitor the local PEV market, identify future risks and opportunities, and recommend adjustments to Ameren's strategic position as appropriate.

4.6 - Forward-Looking Statement Disclaimer

This document includes forward-looking statements regarding future events and the future development of technology, and also includes information, studies and assumptions of third parties, including but not limited to the Electric Power Research Institute ("EPRI") and the Edison Electric Institute ("EEI"). These forward-looking statements are only predictions and are subject to risks, uncertainties, and assumptions that are difficult to predict because they relate to events and depend on circumstances that will occur in the future. The actual future developments related to Plug-in Electric Vehicles ("PEV") may differ materially and adversely from those opinions expressed or implied in any forward-looking statements. Factors that might contribute to such differences include, but are not limited to: economic conditions nationally and globally, the impact of competition, political and economic developments, and legal and regulatory changes. Any forward-looking statement contained herein made by or on behalf of Ameren speak only as of the date they are made. Ameren disclaims any intention or obligation to update forward-looking statements to reflect any changes in Ameren's expectations with regard thereto or any changes in events, conditions or circumstances on which any such statement is based.

5.0 - References

Ameren Missouri, 2009. *Plug-In Hybrid Vehicles (PHEVs)*. August 24.

Chartwell Webinar, 2010. *Planning at Nashville Electric Service for Plug-in Electric Vehicles*. October 6.

Delphi, 2010. *Press Release: Delphi Working to Make Electric Vehicle Wireless Charging a Reality*. September 29.

Electric Power Research Institute (EPRI), 2007. *Environmental Assessment of Plug-In Hybrid Electric Vehicles, Volume 2: United States Air Quality Analysis*. July.

EPRI, 2008. *Capital Projects for Efficiency Improvements*. Report Number: 1015735. Technical Update, December.

EPRI, 2009. *Plug-in Electric Vehicle to Grid Interface Requirements* (EPRI, Palo Alto, CA: 2009.1017674) December.

EPRI, 2010. *PHEVs in Automated Metering Infrastructure Presentation*.

General Electric Reports (GE Reports), 2010. *The 10 Best Cities for Electric Cars*. November 1.

Greencar.com, 2008. *20 Truths about the GM EV 1 Electric Car.* May 26.

Hybrid Cars website: http://www.hybridcars.com/local-incentives/region-by-region.html

IDC Energy Insights (IDC Energy), 2010a. *Business Strategy: The Coming Plug-In Electric Vehicle Rollout-Forecasting the Market.* September.

IDC Energy, 2010b. *Business Strategy: The Coming Plug-In Electric Vehicle Rollout Part 2-Challenges and Opportunities for Electric Utilities.* September.

KEMA, Inc. (KEMA), 2010. *Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems.* March.

Knoxville News, 2010. *Larisa Brass: Wireless Charging in Development*. November 2.

Motor Trend, 2008. *Hawaii Joins Project Better Place Initiative, EV Battery Stations Due By 2012.* December 4.

Plug In America website: http://www.pluginamerica.org/incentives.shtm

Plug in Cars, 2010. *BREAKING: Electric Car Charging Station Tax Credit Extended, but at Lower 30% Pre-Stimulus Levels*. December 17.

Portland General Electric (PGE), 2010. *Presentation: EV Update-Last 6 Months*. July 21.

PBS, 2009. *Timeline: History of the Electric Car*. Week of October 30.

Research Reports International, 2010. *The Impact of Plug-In Hybrid Electric Vehicles on the Electric Industry*, 3rd Edition. May.

St. Louis Business Journal, 2010. *AT&T Adds Electric Vehicle to St. Louis Fleet* . March 11.

WARDSAUTO.com, 2009. *EV Makers Debate Quick-Charge vs. Quick-Change Batteries*. May 13.

The Wall Street Journal (WSJ), 2010a. *Charge That Car-for Less*. October 18.

WSJ, 2010b. *Rent a Leaf: Enterprise Buys a Fleet*, July 27.

USAToday, 2010. *Obama Pushes Electric Cars, Battery Power This Week*, July.

United States Department of Energy (USDOE), 2010a. *The Recovery Act: Transforming America's Transportation Sector, Batteries and Electric Vehicles*. July 14.

USDOE, 2010b. U.S. Dept of Energy's *EECBG/SEP Technical Assistance Program Webinar-Preparing for the Arrival of Electric Vehicles*. November 3.

United States Department of Transportation, Bureau of Transportation Statistics, 2003. *Omnibus Household Survey---Volume 03, Issue 04.* October.

United States Whitehouse-Executive Office of the President of the United States, 2010. *The Recovery Act: Transforming the American Economy through Innovation.* August.

1990s Flashback Website: http://www.1990sflashback.com/1990/economy.asp

TIMELINE OF EV DEVELOPMENT

Appendix A

Timeline of EV Development

Thomas Edison and an electric car.

1832-1839	Scottish inventor Robert Anderson invents the first crude electric carriage by non-rechargeable primary cells.
Early 1900s	There are more electric powered vehicles on the road than there are gasoline powered cars.
1909	Ameren Missouri enters the automobile business – selling electric cars. The Company becomes the St. Louis agent for Studebaker and Rauch & Lang autos.
1920s	The electric car ceases to be a viable commercial product. Downfall is attributed to desire for longer range, lack of horsepower, and the ready availability of gasoline.
1968	Long an advocate of electric vehicles, CIPS (AmerenCIPS) purchases a Mars II electric car for operations and sales promotions. CIPS' Ice Division operates a number of Walker Electric trucks.
1970s	Concerns about the soaring price of oil (Arab Oil Embargo 1973) and growing environmental movement result in renewed interest in EVs from consumers and manufacturers.
1990	California passes a Zero Emission Vehicle (ZEV) Mandate, which requires 2% of the state's vehicles to have no emissions by 1998 and 10% by 2003.
1997-2000	A few thousand all-electric cars (e.g., Honda EV Plus, GM EV1, Nissan Altra EV, and Toyota RAV4 EV) are produced by major automakers, but most are available for lease only. All major automakers discontinue advanced EV production programs by the early 2000s.

GM EV1 released in 1996.

2002	GM and DaimlerChrysler sue the California Air Resources Board (CARB) to repeal the ZEV mandate. The Bush Administration joins the lawsuit.
2003	GM announces that it will not renew leases on the EV1 because they will no longer supply parts to repair the vehicles. GM announced its plans to reclaim the EV1s by 2004.
2005	GM demolishes all the EV1s in California.
2006	Tesla Motors unveils the Tesla Roadster. The first production Roadsters are scheduled to be sold in 2008 with a base price listing of $98,500.
2009	The American Recovery and Reinvestment Act (ARRA) allocates approximately $14 billion for EV development.
	President Obama announces a new gas mileage policy that requires automakers to meet a minimum fuel-efficiency standard of 35.5 miles/gallon by 2016.
	Nissan unveils the LEAF (Leading, Environmentally friendly, Affordable, Family car).
2010	The first production Nissan LEAFs and Chevrolet Volts are scheduled for limited US release in the fall.

Sources: PBS and Greencar.com

TOTAL COST OF OWNERSHIP:
EV VS. CONVENTIONAL VEHICLE

Appendix B

SCHEDULE MJN-4

Total Cost of Ownership: EV vs. Conventional Vehicle

Introduction
An analysis was conducted to determine the life-cycle costs for an electric vehicle (2011 Nissan LEAF) compared to a conventional vehicle (2011 Nissan Versa). The analysis was conducted for both Ameren Missouri and Ameren Illinois (IP) residential customers.

The 2011 Nissan LEAF and 2011 Nissan Versa were selected for the analysis because the vehicles are similar in size. The 2011 Nissan LEAF is a five-passenger four-door hatchback electric vehicle (EV) that has a 24 kWh battery that can travel up to 100 miles on a full charge. The 2011 Nissan Versa is available as a five-passenger four-door hatchback conventional vehicle (CV) – 1.8 liter 4 cylinder Continuously Variable Transmission – that gets approximately 30 miles per gallon.

Scenarios
Residential customers have an option to choose electricity rates based on a standard rate structure or a time-of-day rate structure in Missouri and Illinois. In Missouri, the standard rate structure has one summer (June to September) rate ($/kWh) and one winter (January to May and October to December) rate; the time-of-day rate structure incorporates different rates that vary due to on-peak (10 AM to 10 PM) and off-peak (10 PM to 10 AM) usage. The on-peak time-of-day rates are typically higher than the off-peak rates. In Illinois, the standard rate structure has one summer rate ($/kWh) and one winter rate for the first 800 kWh and a lower winter rate for consumption above 800 kWh; the time-of-day rate structure incorporate different rates that vary due to the Midwest Independent Transmission System Operator (MISO) day-ahead prices.

The following scenarios were analyzed for both Ameren Missouri and Ameren Illinois (IP) residential customers:

1. EV Standard Rates On-Peak (4 PM to 10 PM)
2. EV Standard Rates Off-Peak (10 PM to 4 AM)
3. EV Time-of-Day Rates On-Peak (4 PM to 10 PM)
4. EV Time-of-Day Rates Off-Peak (10 PM to 4 AM)
5. CV – Gasoline (unleaded regular gasoline)

Assumptions

EV - 2011 NISSAN LEAF

- $32,780.00 = 2011 Nissan LEAF
- $7,500.00 = Federal EV Tax Credit
- $2,200.00 = 220-Volt Charging Station with Installation
- $1,100.00 = Federal Tax Credit for Charging Station
- 24 kWh Lithium-Manganese Battery
- 8 hr Battery Recharge
- 100 miles – Distance traveled per charge
- Forecasted rate increases (Appendix A)
- CO_2 Emissions = 0.73 metric tons/1 MWh (Ameren Missouri) and 0.75 metric tons/1 MWh (Ameren Illinois)
- 14,600 miles – Distance traveled/YR
- 6% Loan Interest Rate
- 3% Discount Rate
- $566 Maintenance Cost/Year
- 2.59% Escalation Rate
- Economic Life: 7-YR and 10-YR
- UE and IP Rates (Appendix A)

Charge Assumptions

- 40 miles/day = Average Residential Commute/Travel
- 6 hr = Charge Required at Home (240-volt charging station)
- 182.5 days = # of charges/YR (Assume charge required every other day)

CV - 2011 NISSAN VERSA

- $16,780.00 = 2010 Nissan Versa
- 30 miles per gallon
- 487 gallons of unleaded gasoline/YR
- $566 Maintenance Cost/Year
- Economic Life: 7-YR and 10-YR
- Fuel based on 2008 EIA Motor Gasoline Forecast
- CO_2 emissions from a gallon of gasoline = 19.4 lbs/gallon
- 14,600 miles – Distance traveled/YR
- 6% Loan Interest Rate
- 3% Discount Rate
- 2.59% Escalation Rate

Sensitivities

The EV scenarios were evaluated with and without federal incentives. In addition, all scenarios were evaluated with and without a carbon tax. The carbon tax was based on the 2010 Kerry/Lieberman Bill that assumes a carbon price of $20/ton in 2013 that escalates at 4%+Inflation each year after 2013.

Results

Results provided on the tables below are based on a net present value (NPV) analysis. NPV is an indicator of how much value an investment adds and is a standard method for using the time value of money to appraise long-term projects. The results from the analysis present negative NPVs that represent the cost to the customer for each scenario over the specified economic life.

Ameren Missouri 7-YR Economic Life

	WITHOUT CARBON TAX		WITH CARBON TAX*		
UE	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	CO2 Emissions (metric tons/yr)
STANDARD RATES					
Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($34,203)	($43,553)	($34,382)	($43,732)	2.39
Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($34,203)	($43,553)	($34,382)	($43,732)	2.39
TIME-OF-DAY RATES					
Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($33,482)	($42,832)	($33,661)	($43,011)	2.39
Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($34,296)	($43,646)	($34,475)	($43,825)	2.39
CONVENTIONAL VEHICLE					
Nissan Versa (CV - Gasoline)	($32,506)	($32,506)	($32,826)	($32,826)	4.28

Ameren Missouri 10-YR Economic Life

	WITHOUT CARBON TAX		WITH CARBON TAX*		
UE	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	CO2 Emissions (metric tons/yr)
STANDARD RATES					
Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($36,575)	($45,925)	($36,905)	($46,255)	2.39
Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($36,575)	($45,925)	($36,905)	($46,255)	2.39
TIME-OF-DAY RATES					
Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($35,531)	($44,881)	($35,861)	($45,211)	2.39
Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($36,709)	($46,059)	($37,039)	($46,389)	2.39
CONVENTIONAL VEHICLE					
Nissan Versa (CV - Gasoline)	($39,600)	($39,600)	($40,192)	($40,192)	4.28

Results (continued)

Ameren Illinois (IP) 7-YR Economic Life

	WITHOUT CARBON TAX		WITH CARBON TAX*		
IP	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	CO2 Emissions (metric tons/yr)
STANDARD RATES					
2011 Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($37,585)	($46,935)	($37,927)	($47,277)	2.48
2011 Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($37,737)	($47,087)	($38,079)	($47,429)	2.48
TIME-OF-DAY RATES					
2011 Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($36,190)	($45,540)	($36,532)	($45,882)	2.48
2011 Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($37,548)	($46,898)	($37,890)	($47,240)	2.48
CONVENTIONAL VEHICLE					
2011 Nissan Versa (CV - Gasoline)	($39,600)	($39,600)	($40,192)	($40,192)	4.28

Ameren Illinois (IP) 10-YR Economic Life

	WITHOUT CARBON TAX		WITH CARBON TAX*		
IP	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	NPV @ 3% (with incentives)	NPV @ 3% (without incentives)	CO2 Emissions (metric tons/yr)
STANDARD RATES					
2011 Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($34,867)	($44,217)	($35,053)	($44,403)	2.48
2011 Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($34,971)	($44,321)	($35,156)	($44,506)	2.48
TIME-OF-DAY RATES					
2011 Nissan Leaf (OFF-PEAK: 10 PM to 4 AM)	($33,915)	($43,265)	($34,101)	($43,451)	2.48
2011 Nissan Leaf (ON-PEAK: 4 PM to 10 PM)	($34,839)	($44,189)	($35,024)	($44,374)	2.48
CONVENTIONAL VEHICLE					
2011 Nissan Versa (CV - Gasoline)	($32,506)	($32,506)	($32,826)	($32,826)	4.28

General Observations

- CV is the lowest cost option assuming a 7-YR economic life.
- EV/Time-Of-Day Rates/With and Without Carbon Tax/ With Federal Incentives are the lowest cost options assuming a 10-YR economic life.
- EV/Standard and Time-of-Day Rates/ With and Without Carbon Tax/With Federal Incentives are cheaper than a conventional vehicle assuming a 10-YR economic life.
- CO_2 emissions are lower for an EV.

ENVIRONMENTAL BENEFITS OF PEVS *Appendix C*

Environmental Benefits of PEVs

High Level Summary
The overall estimated impact of PEVs in 2030 using current CO_2 intensities, when contrasted to a 2030 base case without PEVs, is shown in the table below:

Change in Tons of Emission per Year

Area	NO_x	SO_x	PM_{10}	TOG	Hg	†CO_2
Illinois	-4,355	6,738	2,595	-1,814	0.13	-3,580,561
Missouri	-6,188	-6,615	1,015	-2,106	-0.02	-2,638,103
Ameren Illinois	-741	1,146	441	-1,814	0.0221	-608,820
Ameren Missouri	-1,676	-1,792	275	-2,106	-0.0054	-714,629
Ameren	-2,417	-646	716	-3,920	0.0167	-1,323,449

†The Reduction of CO_2 is based on EPRI estimated exhaust CO_2 reductions with replacement by electric miles at current Ameren CO_2 intensities. The intensities used were UE at 0.80 short tons per MWH generated and AIU at 0.83 short tons per MWH purchased (MISO).

Corporate Planning developed two vehicle adoption projections, "Follower" and "Aggressive" through 2020 for Ameren Missouri. These projections have been extended through 2030 and also developed for Ameren Illinois.

The "Follower" vehicle population projections are at a level equivalent to 52% of the EPRI PHEV projection. The "Aggressive" vehicle population projections are at a level equivalent to 79% of the EPRI PHEV projection.

However, the level of energy consumption (kWh/PHEV/day) estimated in this projection was 17% higher than what was used for results in the Ameren analysis. This is due to the aggressive charging assumptions discussed in Section 2.3.3. Using this information, the projected emission level in 2030 from the "Follower" projection is 61% of the EPRI CO_2 emission projection. Likewise, the projected emission level in 2030 from the "Aggressive" projection is 92% of the EPRI CO_2 emission projection.

In summary, the "Aggressive" projection is aligned with the projections from the EPRI study. Sensitivities to the impact of CO_2 intensity (all coal versus current intensity) of the fuel used to charge the vehicles were also performed in this analysis using PHEV projection data. For Ameren Illinois, the increase results in an increase of 20% CO_2 emissions for the power used to charge the vehicles. For Ameren Missouri, the increase results in an increase of 25% CO_2 emissions for the power used to charge the vehicles.

There is a net result of the increase CO_2 emissions from generating plants; however, the overall regional CO_2 emissions would be reduced by approximately 43%. Therefore, there is a reduction in GHG emissions from PEVs compared to conventional vehicles.

Development of the Analysis
Information in this area is still being developed as the industry is still in its infancy. This summary represents information that was readily available to date.

The table below summarizes the CO_2 emission levels per mile for solo driver vehicle operations. According to the Sightline Institute, total CO_2 emission levels per mile are due to in part to the estimated emissions resulting from extracting, transporting, and refining crude oil. For this reason, the values for pounds of CO_2 per mile in the following table are higher than those obtained from a standard conversion of gallons of gas to CO_2.

Vehicle Description	Pounds CO_2 per mile
Sport Utility Vehicle (15 mpg) – Solo Driver	1.57
Average car (21.5 mpg) – Solo Driver	1.10
Economy Car (40-mpg) – Solo Driver	0.59
Prius (~42 mpg) – Solo Driver	0.56

Sightline Institute:
http://www.sightline.org/maps/charts/pollu_co2transp_ooh

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Nissan's specifications for the 2011 LEAF indicate the battery has a 24 kWh capacity and a 100-mile range. This would equate to 6 kWh for 25 miles (typical mpg rating for internal combustion engine vehicles is currently 25 mpg, but this is due to increase to 35 mpg).

Using the information above, and estimates of the current CO_2 intensities for the Ameren Missouri and Ameren Illinois service territories (CO_2 emission intensity factors could be dramatically different by 2030 if climate legislation were to be enacted), the following table was developed:

Description	Average MPG	lbs CO_2/25 miles	lbs CO_2/mile
SUV/4 wheel drive	15	39.25	1.57
Average/medium car	21.5	27.50	1.10
Typical Average MPG	25	23.50	0.94
Small Car	40	14.75	0.59
Prius	42	14.00	0.56
Nissan LEAF EV based on Ameren Missouri Generation	N/A	9.60	0.38
Nissan LEAF EV based on MISO Generation	N/A	9.96	0.40

Note that the CO_2 intensities used for Ameren Missouri and MISO are 0.80 and 0.83 short tons of CO_2/MWH

For purposes of a CO_2 emission benefit assessment, the Nissan LEAF should be compared to a small car for benefits. If the average car is driven 40 miles/day (14,600 miles annually), then the average annual CO_2 emission benefit of converting a typical small car to an electric vehicle similar to the Nissan LEAF would be a reduction of 1.50 or 1.40 short tons in annual CO_2 emissions with power provided by Ameren Missouri or Ameren Illinois respectively.

The EPRI environmental impact information is sourced from the report:

Environmental Assessment of Plug-In Hybrid Electric Vehicles

Volume 2: United States Air Quality Analysis
Based on AEO-2006 Assumptions for 2030

The report is dated July 2007 and it described an environmental assessment of anticipated 2030 PEV market penetration. It does not include any climate change policies or greenhouse gas emissions constraints. The report is based on the U.S. Department of Energy's 2006 Annual Electric Outlook. An inquiry was placed with EPRI to obtain updated information related to PEV environmental impact/benefits, and EPRI indicated that work on this was underway for Ameren specific impact information (90% complete) and would be available at a later date. In addition, they indicated that the PEV estimates within the 2007 report are meant to be 'bounding' scenarios, not predictions of actual growth.

Using the information from the 2007 report, estimates were presented indicating the impact of the introduction of PEV on vehicle emissions in 2030. The specific vehicle emissions investigated included:

- **TOG** – Total Organic Gases (hydrocarbons)
- **CO** – Carbon Monoxide
- **NO_x** – Nitrogen Oxides ($NO + NO_2$)
- **PM_{10}** – Particulate Matter with an Aerodynamic Diameter less than 10 micrometers (Coarse and Fine Particulate Matter)
- **$PM_{2.5}$** – Particulate Matter with an Aerodynamic Diameter less than 2.5 micrometers (Fine Particulate Matter)
- **SO_2** – Sulfur Dioxide
- **NH_3** – Ammonia
- **CO_2** – Carbon Dioxide

Reductions in vehicle pollutants were estimated in the 2030 timeframe and were stated in the form of multipliers for each of the vehicle pollutants. The modeling that was performed, using the NEEM model (developed by CRA), incorporated the following regulations and the impacts that these regulations would have on the makeup of the generation fleet into the future:

- Title IV/Clean Air Interstate Rule (CAIR) for SO_2
- SIP Call/CAIR Ozone Season NO_x
- CAIR Annual NO_x
- Clean Air Mercury Rule (CAMR)

APPENDIX C

No CO_2 Policy was included in the analysis. A table representing the percent reduction in vehicle-generated pollutants (i.e., from the tail pipe) in 2030 for the states served by Ameren – Illinois and Missouri – follows:

EPRI Assessment of Vehicle Emission Impacts by State

State	TOG	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	NH_3	CO_2	VMT
Illinois	-9.60%	-19.30%	-15.70%	-3.00%	-6.10%	-17.90%	-19.50%	-15.90%	-18.50%
Missouri	-10.20%	-19.30%	-15.80%	-2.90%	-5.90%	-17.70%	-19.50%	-15.50%	-18.30%

In addition, EPRI estimated the number of vehicle miles that would be travelled within each state. Below is a table that represents a conversion of these miles to vehicle quantity, based on average annual vehicle mileage of 14,600, for the states of Illinois and Missouri.

Estimate of Vehicles by State in 2030
Assumes Annual Vehicle Mileage of 14,600

State	Number of Vehicles
Illinois	12,411,918
Missouri	8,017,808

Ameren internal forecasts of residential customer levels, along with an estimate of an average of 1.8 vehicles per residential customer, were used to develop the Ameren service territory specific vehicle quantities in the table below:

Ameren Illinois and Ameren Missouri
Vehicle Populations
Based on 1.8 vehicles per Res Customer in 2030

Service Territory	Quantity
Ameren Illinois	2,110,457
Ameren Missouri	2,171,924

Using this information, a set of ratios (below) were developed that can be used to estimate Ameren service territory specific environmental impacts when applied to the EPRI state specific data.

Ratios to use when Assessing "Absolute" Impacts by Utilities

Service Territory	Ratio
Ameren Illinois	0.170035
Ameren Missouri	0.270887

In the tables below, EPRI estimated the impact of PEV introduction on a number of "Source Categories" for the 2030 timeframe. A description of each source category follows:

- **Area Sources (Non-Point Stationary Sources)** - This category comprises stationary sources that are not identified as individual points and so are treated as being spread over a spatial extent (usually a county). Examples of stationary area sources include (but are not limited to) residential emissions, fires, oil and gas wells, fugitive dust, and road dust.
- **On-road Mobile Sources** - This category comprises vehicular sources that operate on roadways, such as light-duty gasoline vehicles and heavy-duty diesel vehicles.
- **Off-road Mobile Sources** - For example, railroad locomotives, aircraft, commercial marine vessels, farm equipment, recreational boating, and lawn and garden equipment.
- **EGU Sources** – Electrical Generating Units
- **Non-EGU Sources** - Such as refineries.
- **Biogenic Sources** - Biogenic emissions are a function of vegetation type and meteorological conditions.
- **Dust Sources** – Wind blown dust

EPRI developed tables indicating the impact of PEV on the level of annual emissions for:

- **NO_x** (Nitrogen Oxides) emissions
- **SO_x** (Sulfur Oxides) emissions;
- **PM_{10}** (Particulate Matter less than 10 micrometers in size) emissions
- **TOG** (Total Organic Gases) emissions
- **Mercury** (Hg) emissions

Note: Values in black have been estimated by EPRI, values in red are by Ameren.

NO_x Tons per year

	Base Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	55,739	130,134	55,166	115,822	102,275	39,970	0	499,106
MO	36,238	35,621	33,326	42,912	71,053	34,325	0	253,475
	PHEV Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	55,396	130,134	46,647	115,050	107,554	39,970	0	494,751
MO	35,304	35,621	28,110	42,890	71,037	34,325	0	247,287

	Change Assessment	
State	Delta	% Chg
IL	-4,355	-0.87%
MO	-6,188	-2.44%

SO_x Tons per year

	Base Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	15,881	10,690	1,609	144,050	335,957	0	0	508,187
MO	41,866	1,504	901	72,373	183,212	0	0	299,856
	PHEV Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	15,881	10,690	1,324	143,458	343,572	0	0	514,925
MO	41,866	1,504	743	72,370	176,758	0	0	293,241

	Change Assessment	
State	Delta	% Chg
IL	6,738	1.33%
MO	-6,615	-2.21%

PM_{10} Tons per year

	Base Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	20,360	9,305	5,179	37,063	26,028	0	403489	501,424
MO	49,806	7,678	2,788	19,060	13,482	0	522299	615,113
	PHEV Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	20,318	9,305	4,950	36,965	28,992	0	403489	504,019
MO	49,747	7,678	2,667	19,059	14,678	0	522299	616,128

	Change Assessment	
State	Delta	% Chg
IL	2,595	0.52%
MO	1,015	0.17%

TOG Tons per year

	Base Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	215,751	62,310	73,568	71,757	0	570,230	0	993,616
MO	239,648	70,743	42,355	40,648	0	1,371,797	0	1,765,191
	PHEV Case 2030							
State	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
IL	214,865	62,310	64,712	70,833	0	570,230	0	982,950
MO	237,667	70,743	37,070	40,138	0	1,371,797	0	1,757,415

	Change Assessment	
State	Delta	% Chg
IL	-10,666	-1.07%
MO	-7,776	-0.44%

Hg Tons per year

	Base Case 2030			
State	EGU	Biogenic	Others	TOTAL
IL	0.89	0.87	3.58	5.34
MO	0.34	1.10	0.19	1.63
	PHEV Case 2030			
State	EGU	Biogenic	Others	TOTAL
IL	1.02	0.87	3.58	5.47
MO	0.32	1.10	0.19	1.61

	Change Assessment	
State	Delta	% Chg
IL	0.13	2.43%
MO	-0.02	-1.23%

The vehicle ratios can be applied to the EPRI provided state level “Base Case 2030” and “PHEV Case 2030” emission levels to arrive at estimates of Ameren service territory specific emission impacts due to PEV introduction. It should be noted that the Ameren service territory specific impacts may be revised by the work being performed by EPRI to provide updates specific to Ameren.

Tables that are Ameren service territory specific are shown below:

NO_x Tons per year

	Base Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	10,531	24,586	10,422	21,882	19,323	7,551	0	94,295
Ameren Missouri	10,907	10,721	10,031	12,916	21,386	10,331	0	76,292
	PHEV Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	10,466	24,586	8,813	21,736	20,320	7,551	0	93,472
Ameren Missouri	10,626	10,721	8,461	12,909	21,381	10,331	0	74,430

	Change Assessment	
Territory	Delta	% Chg
Ameren Illinois	-823	-0.87%
Ameren Missouri	-1,863	-2.44%

SO_x Tons per year

	Base Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	3,000	2,020	304	27,215	63,472	0	0	96,010
Ameren Missouri	12,601	453	271	21,783	55,144	0	0	90,252
	PHEV Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	3,000	2,020	250	27,103	64,910	0	0	97,283
Ameren Missouri	12,601	453	224	21,782	53,202	0	0	88,261

	Change Assessment	
Territory	Delta	% Chg
Ameren Illinois	1,273	1.33%
Ameren Missouri	-1,991	-2.21%

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PM$_{10}$ Tons per year

	Base Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	3,847	1,758	978	7,002	4,917	0	76230.16	94,733
Ameren Missouri	14,991	2,311	839	5,737	4,058	0	157204.7	185,140
	PHEV Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	3,839	1,758	935	6,984	5,477	0	76230.16	95,223
Ameren Missouri	14,973	2,311	803	5,736	4,418	0	157204.7	185,446

	Change Assessment	
Territory	Delta	% Chg
Ameren Illinois	490	0.52%
Ameren Missouri	306	0.17%

TOG Tons per year

	Base Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	40,761	11,772	13,899	13,557	0	107,732	0	187,721
Ameren Missouri	72,131	21,293	12,748	12,234	0	412,892	0	531,298
	PHEV Case 2030							
Territory	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren Illinois	40,594	11,772	12,226	13,382	0	107,732	0	185,706
Ameren Missouri	71,534	21,293	11,158	12,081	0	412,892	0	528,957

	Change Assessment	
Territory	Delta	% Chg
Ameren Illinois	-2,015	-1.07%
Ameren Missouri	-2,340	-0.44%

Hg Tons per year

	Base Case 2030			
Territory	EGU	Biogenic	Others	TOTAL
Ameren Illinois	0.1681	0.1644	0.6764	1.0089
Ameren Missouri	0.1023	0.3311	0.0572	0.4906
	PHEV Case 2030			
Territory	EGU	Biogenic	Others	TOTAL
Ameren Illinois	0.1927	0.1644	0.6764	1.0334
Ameren Missouri	0.0963	0.3311	0.0572	0.4846

	Change Assessment	
Territory	Delta	% Chg
Ameren Illinois	0.0246	2.43%
Ameren Missouri	-0.0060	-1.23%

Combining the impacts to both the Ameren Missouri and Ameren Illinois service territories yields the tables shown below.

NO_x Tons per year

	Base Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	21,438	35,307	20,453	34,798	40,709	17,883	0	170,587
	PHEV Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	21,092	35,307	17,274	34,645	41,701	17,883	0	167,902

	Change Assessment	
	Delta	% Chg
Ameren	-2,685	-1.57%

SO_x Tons per year

	Base Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	15,601	2,472	575	48,998	118,616	0	0	186,263
	PHEV Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	15,601	2,472	474	48,886	118,112	0	0	185,545

	Change Assessment	
	Delta	% Chg
Ameren	-718	-0.39%

PM_{10} Tons per year

	Base Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	18,837	4,069	1,818	12,739	8,975	0	233434.9	279,873
	PHEV Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	18,812	4,069	1,738	12,720	9,895	0	233434.9	280,669

	Change Assessment	
	Delta	% Chg
Ameren	796	0.28%

APPENDIX C

TOG Tons per year

	Base Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	112,892	33,065	26,647	25,791	0	520,624	0	719,019
	PHEV Case 2030							
	Area	Off-road	On-road	Non-EGU	EGU	Biogenic	Dust	TOTAL
Ameren	112,128	33,065	23,383	25,463	0	520,624	0	714,664
	Change Assessment							
	Delta	% Chg						
Ameren	-4,356	-0.61%						

Hg Tons per year

	Base Case 2030			
	EGU	Biogenic	Others	TOTAL
Ameren	0.2705	0.4955	0.7335	1.4995
	PHEV Case 2030			
	EGU	Biogenic	Others	TOTAL
Ameren	0.2890	0.4955	0.7335	1.5180
	Change Assessment			
	Delta	% Chg		
Ameren	0.0185	1.24%		

Below is a summary of the overall impact on emissions that could be anticipated with the introduction of PEVs. Note that the EPRI study assumptions do not include any greenhouse gas policy or emission constraints. In addition, all Ameren Illinois intensities assume that the generation mix that currently exists will continue to exist in 2030.

Change in Tons of Emission per Year

Area	NO_x	SO_x	PM_{10}	TOG	Hg	†CO_2
Illinois	-4,355	6,738	2,595	-1,814	0.13	-3,580,561
Missouri	-6,188	-6,615	1,015	-2,106	-0.02	-2,638,103
Ameren Illinois	-741	1,146	441	-1,814	0.0221	-608,820
Ameren Missouri	-1,676	-1,792	275	-2,106	-0.0054	-714,629
Ameren	-2,417	-646	716	-3,920	0.0167	-1,323,449

†The Reduction of CO_2 is based on EPRI estimated exhaust CO_2 reductions with replacement by electric miles at current Ameren CO_2 intensities

Attempts are underway to assess the overall "Well to Wheel" impact of PEV introduction. The Argonne National Laboratory is making use of the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model in their assessment of "Well to Wheel" impact of the PEV and other vehicle technologies. These studies show similar results to the EPRI study. However, the studies do not include the introduction of battery recycling technologies.

It should also be noted that the recycling industry will evolve in a similar manner as the Lead-Acid battery recycling industry has evolved. The materials contained within the current battery technology of choice for PEVs (Lithium Ion) do not contain hazardous materials.

RELEVANT STANDARDS AND CODES FOR PEVS

Appendix D

Relevant Standards and Codes for PEVs

Many entities are already involved and collaborating on the development of PEV-related technical standards and codes. Coordination and technical compatibility is needed among the various system and equipment standards and building codes.

SAE (Society of Automotive Engineers) J1772 – Electric Vehicle Conductive Charge Coupler

- Published 1/15/2010
- Interface standard for AC Level 1 & 2 charging
- AC level 1 charging: 120 VAC, 15 or 20 amp outlet, on-board vehicle charger
- AC level 2 charging: 208 - 240 VAC, up to 80 amps, on-board vehicle charger
- SAE is working on fast charging standard (DC fast charging system standard already exists in Japan)

SAE J1773 – Electric Vehicle Inductively Coupled Charging

- In progress

SAE J2847/2836/2931 – Communications for PEV

- Communication between plug-in vehicle and the utility grid
- Communication between plug-in vehicle and off-board charger
- Communication between plug-in vehicle and utility grid for reverse power flow
- Power line carrier communications for plug-in electric vehicles

SAE J2894 – Power Quality Requirements for Plug-In Vehicle Chargers

- Based on EPRI TR109023
- Includes guidelines for power factor, total harmonic current distortion, and charger restart after loss of AC power

Institute of Electrical and Electronic Engineers (IEEE) P1809 – Guide to Electric-Sourced Transportation Infrastructure

- Working Group kickoff meeting was 2/18/2010
- Scope is to provide guidelines that can be used by utilities, manufacturers, transportation providers, infrastructure developers and end users of electric-sourced vehicles and related support infrastructure in addressing applications for road-based personal and mass transportation.
- Transportation load characteristics
- Electric grid requirements to support the transportation loads
- Roadmap to identify what utilities need to do to prepare for loads and by when

IEEE 1901 – Draft Standard for Broadband over Power Line Networks

- Includes HomePlug AV technology as a key element.
- Designed to accommodate Smart Grid applications as well as next generation of broadband solutions.

IEEE P2030 – Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System, and End-Use Applications and Loads

- Provide guidance to permit two-way power flow with communication and control

IEEE 1547 – Standard for Interconnecting Distributed Resources with Electric Power Systems

- Applies if PHEV/EV used to supply power to electric grid

National Electric Code (NEC) 625 – EV Charging Systems

- Covers wiring methods and ventilation requirements

Underwriters Laboratories (UL) 2202 – EV Charging System Equipment

- Charging Station Safety
- Covers conductive and inductive charging system equipment supplied at 600 VAC or less

UL 2231 – Personnel Protection Systems for Electric Vehicle Supply Circuits

- Grounding and fault protection

UL 2251 – Plugs, Receptacles and Couplers for Electric Vehicles

UL 2594 – Electric Vehicle Supply Equipment

- Covers electric vehicle supply equipment rated at maximum of 250 VAC and intended to provide power to an electric vehicle with an on-board charging unit.

Standards and Codes under Development

The SAE is still working on the development of a Level 3 "fast charging" standard. Level 3 charging is expected to provide a full battery charge in 30 minutes or less and will likely require a three-phase 480 VAC electric supply.

SAE J2847 and J3836 establish the fundamental communication protocol between electric vehicles, the electric supply equipment and the electric power grid. Development of the communication standards and a framework for Smart Grid interoperability continues to be one of the primary areas of focus for EPRI and others to facilitate optimized operation of the interconnected electric system.

The SAE J2894 working group was initiated in March of 2009 to establish power quality requirements for plug-in vehicle chargers. A draft document dated August 2009 recommends a minimum power factor of 95% and maximum limits for total harmonic distortion of 10%.

IEEE Standard 1547 and UL 1741 establish requirements for interconnection of distributed resources with the electric power system. As the penetration of PEVs increases, it may be possible to use the energy stored in the batteries as sources of distributed generation. IEEE 1547 and UL 1741 provide the starting points from which to develop future standards for facilitating safe and reliable transfers of power from vehicle-to-grid and vehicle-to-home.

An IEEE working group (P1809) has begun to develop a guide to electric-sourced transportation infrastructure. The scope of this working group is to provide guidelines that can be used by utilities, manufacturers, transportation providers, infrastructure developers, and end users for addressing applications for road-based personal PEVs and electrically powered mass transportation.

SCHEDULE MJN-4

AMEREN CUSTOMER SURVEY:
PEV AWARENESS AND INTEREST

Appendix E

Ameren Customer Survey: PEV Awarness and Interest

July 2010 Telephone Survey: Introductory Script and Questions

Major automobile manufacturers are currently introducing plug-in vehicles into the marketplace. Plug-in vehicles are powered by electricity or a combination of electricity and gasoline. These plug-in vehicles differ from hybrid electric vehicles, such as the Toyota Prius, because they can be recharged by plugging them into an electrical outlet or recharging station.

Q1 How aware were you that plug-in vehicles are being introduced by major auto makers?

4 Very aware
3 Somewhat aware
2 Not very aware
1 Not at all aware

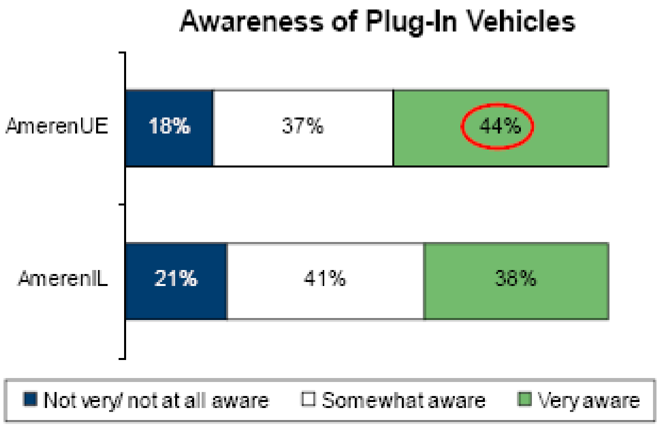
Q2 If you were in the market to purchase a vehicle, how likely would you be to consider purchasing a plug-in vehicle?

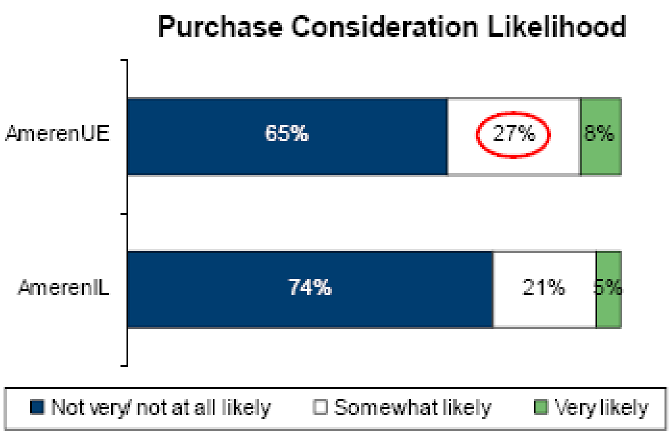
4 Very aware
3 Somewhat aware
2 Not very aware
1 Not at all aware

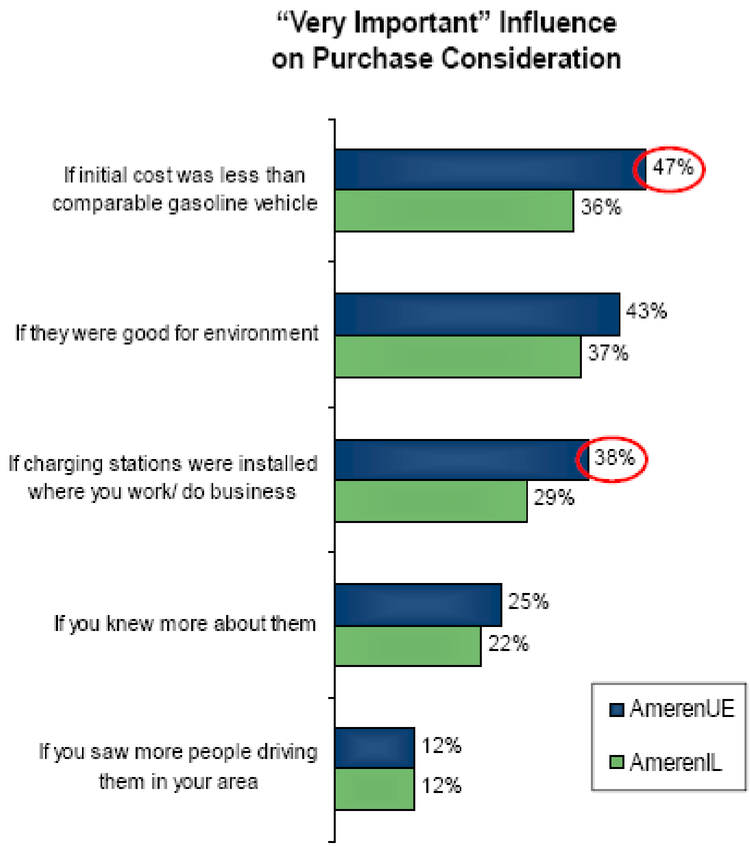
Q3 To what degree are the following items likely to influence your decision to consider purchasing a plug-in vehicle? Please use a 1 to 4 scale where 1 means the item is "not at all important," 2 means "not very important," 3 means "somewhat important," and 4 means "very important."

Items:

1 If you knew more about plug-in vehicles
2 If the initial cost of the plug-in vehicle was less than a comparable gasoline vehicle
3 If plug-in vehicles were good for the environment
4 If electric charging stations were installed where you work and do business
5 If you saw more people driving plug-in vehicles in your area







Notes:

1. Q1 – How aware were you that plug-in vehicles are being introduced by major auto makers?
2. Q2 – If you were in the market to purchase a vehicle, how likely would you be to consider purchasing a plug-in vehicle?
3. Q3 – To what degree are the following items likely to influence your decision to consider purchasing a plug-in vehicle?
4. Base: Total (Ameren Missouri = 500, Ameren Illinois = 500)
5. Residential Telephone Survey conducted July 2010
6. ⬭ indicates a statistically significant increase over IL customers at a 95% confidence level

SCHEDULE MJN-4