Electrify Heartland Plan

Project title: Kansas – Missouri
Community Readiness for EV and EVSE

Funded by: US DOE DE-EE0005551

By: Metropolitan Energy Center

and Kansas City Regional Clean Cities Coalition

With: Black & Veatch

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CFDA Number 81.086

Electrify Heartland Plan

Electrify Heartland Project Abstract

Electrify Heartland is an electric vehicle planning project managed by Metropolitan Energy Center. It is a product of the Greater Kansas City Plug-In Readiness Initiative, co-chaired by Kansas City Regional Clean Cities Coalition. Our goal is to produce a regional plan to prepare public resources and secure the economic and environmental benefits of plug-in vehicles within targeted metro areas with estimated 2.7M population. The targeted metro areas include Kansas City, MO & KS; Jefferson City, MO, Wichita, KS; Salina, KS; Lawrence, KS; and Topeka, KS. (14 Counties: Cass, Clay, Cole, Douglas, Jackson, Johnson, Leavenworth, Miami, Platte, Ray, Saline, Sedgwick, Shawnee, Wyandotte).

Electrify Heartland Steering Committee

Team	Organization	Name
Charging Stations	Initiatives	Troy Carlson
Charging Stations	LilyPadEV	Larry Kinder
Charging Stations	Logios	Gustavo Collantes
Government Policy	Polsinelli Shughart PC	Alan Anderson
Government Policy	Black & Veatch	Bill Roush
Project Administration	Metropolitan Energy Center	Ruth Redenbaugh
Project Administration	Metropolitan Energy Center	Kelly Gilbert
Public Education	Nation Ranch Marketing, Inc.	Bill Patterson
Training	Kansas City Kansas Community College	Bob McGowan
Training	National Electrical Contractors Association	Jim Cianciolo
Utility Grid	Black & Veatch	Sam Scupham
Vehicle & Fleet	University of Missouri at Kansas City	Henry Marsh

Exhibit i-i. Electrify Heartland Steering Committee Members

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1 Develop Electric Vehicle Planning Team

1.1 Section Introduction

1.1.1 Synopsis

This section gives a detailed description of the goals and intention of the Electrify Heartland project and what makes this plan unique. In this section we discuss how the team members that made this planning so successful were selected and how individual tasks were distributed among them. Content planning for deliverables, methods and barriers are also discussed. We provide this detail to serve as an example of one way to customize your own EV planning team. See Appendix A.

1.1.2 Author

Ruth Redenbaugh, Metropolitan Energy Center

1.2 Project history, mission and scope

Electrify Heartland imparts a "how to" approach for planning electric vehicle and charging equipment that is modular, scalable and customizable for any size business, city, county or region. We have included our teams' recommendations in developing a plan and have also made an effort to describe other options evaluated, why this alternative was selected, constraints encountered, and barriers to avoid.

Electrify Heartland is a product of the Greater Kansas City Plug-In Readiness Task Force. Our goal is to produce a regional plan to prepare public resources and secure the economic and environmental benefits of plug-in vehicles within targeted metro areas with an estimated population of 2.7 million people. Our plan will be publicly releasable and replicable for electric vehicle and charging infrastructure deployment in other regions.

The Task Force was formed in 2010 to explore benefits and learn more about the impact of electric vehicles on our area. It was chaired by Kansas City Regional Clean Cities Coalition and Mid-America Regional Council (MARC) and consisted of more than one hundred business and community leaders. The task force met many times over two years and developed the Greater Kansas City Plug-in Readiness Strategy. See Appendix B for the strategic plan including Kansas City area demographic maps and maps provided by Wichita Area Metropolitan Planning Organization (WAMPO). The Strategic plan provided the basis for our application in 2011 to further develop and implement certain planning initiatives. The proposal narrative for "Kansas-Missouri Community Readiness for Electric Vehicle (EV) and Electric Vehicle Supply Equipment (EVSE)" is attached as Appendix C.

The application resulted in US Department of Energy Award DE-EE0005551 to Metropolitan Energy Center, Inc. The project scope, by December 2012, is to produce a regional plan that can then be implemented to prepare public resources and secure the economic and environmental benefits of plug-in vehicles within the targeted metro areas of Kansas City, MO&KS; Jefferson City, MO, Wichita, KS; Salina, KS; Lawrence, KS & Topeka, KS (14 Counties: Cass, Clay, Cole, Douglas, Jackson, Johnson, Leavenworth, Miami, Platte, Ray, Saline, Sedgwick, Shawnee, Wyandotte) with an estimated 2.7M population.

Electrify Heartland is the project nickname, selected for simplicity, ease of use in social media and intended for use by jurisdictions within the region. For example, City A may use the project and team name "Electrify City A" in marketing materials and a web site that may also link to electrifyHeartland.org. Then information can be customized for City A without duplicating efforts by each jurisdiction, such as glossary, frequently asked questions, and links to DOE resources. A press release by Independence, Missouri, is included in Appendix W when Electrify Independence was announced by their Economic Development Council.

"A 'how to' approach for planning electric vehicle and charging equipment that is modular, scalable and customizable for any size business, city, county or region."

Our unique opportunity, among the sixteen US Department of Energy awards for electric vehicle planning, is including two Midwestern States with different regulatory environments, five electric service providers, two electrician unions, many educational institutions and many manufacturers of electric vehicles, batteries, components and equipment. Greater Kansas City is one of the nation's leading centers for the development of electric vehicles (EVs) and electric vehicle supply equipment (EVSE), due to efforts of Kansas City Area Development Council's (KCADC) KC Advanced Energy initiative to bring alternative and renewable energy technology companies to the area. Electrify Heartland's planning area is the home of Smith Electric Vehicles, Dow Kokam, Exergonix, Milbank Manufacturing, LilyPad EV and Mark One Electric, as well as one of the nation's first Electric Vehicle Infrastructure Training Programs (EVITP) at the Electrical Joint Apprenticeship and Training Center operated by IBEW Local 124 and the National Electrical Contractors Association (NECA). Our region is quickly becoming the center for research and development, manufacturing and deployment of electric vehicles and related technologies in the United States.

1.3 Develop project team

1.3.1 Garner expertise

The Electrify Heartland team reflects our goals to bring together all aspects of electric vehicle readiness, including municipal planning, zoning, construction, permitting, utility grid, education, and fleet policies. We are enabling communities in our region to manage the growing number of electric vehicles on our roadways well into the future. The Electrify Heartland team is an impressive group of dedicated professionals with expertise in many areas. A concerted effort was made to select individuals engaged in developing electric vehicle plans in Kansas and Missouri while not being committed to a particular city, state or brand. Leaders of each team recruited participants as needed to accomplish specific tasks on the deliverables and activities outlined in Appendix A.

Many on the EV planning team were volunteers and may have personal or professional impacts preventing planned commitments to schedules, meetings and tasks. To help reduce impacts to the team, volunteer team leads also worked with co-leads to fill in when schedules were impacted.

A variety of expertise is needed for the many aspects of EV and EVSE. To produce a stronger plan, an effort was made to include a balance of team members from both States of KS and MO, many colleges, many brands of vehicles and equipment, diverse career fields, and consumers with varying degrees of EV knowledge.

1.3.2 Attract participants

Events encouraged participation in the project, helped to rearrange priorities, generated social media connections, and developed ideas for articles. Many events were planned and delivered. Although time consuming, events were instrumental in gathering interests and concerns of the public. See Appendix V for examples of articles and publications.

The first event invited the original Task Force to learn about the grant award and resulted in developing presentations to communicate benefits of further participation in the project. Benefits include economic development, jobs for electricians and auto technicians and redirected spending potential. Appendices P and V contains sample presentations to city, county and state officials as well as complementary groups such as air quality task force, economic development councils, Missouri Solar Energy Industry Association, and Sustainable Housing Conference. While being aware of cost constraints in many municipalities, these presentations helped to gather support and focus on key planning components.

Two events in April 2012 launched the project. Insiders were invited to a public television broadcast of "Revenge of the Electric Car," a documentary directed by Chris Paine profiling the rise of Tesla Motors and renewed interest by major automakers in battery electric vehicles(PEV). The next morning a special open house was hosted featuring elected officials, announcing the project team leaders, unveiling the web site and offering joy rides and vendor displays. Press releases, photo slide show backdrop, and planning documents are provided in Appendix V-Press Kit to customize for your events.

Social media is important for gauging public awareness and gaining supporters. Supporters may then become temporary or long-term contributors to the project team. Components of Electrify Heartland communication are lapel pins, Website, Facebook, Twitter and blog. Lapel pins with the “road e” logo are provided at events to create person-to-person education, public image, citizen pride, and publicity. Website URL suffixes .com, .net and .org were purchased, and to avoid confusion all point to the ElectrifyHeartland.org site. For the initial map of the dynamic site, see Appendix M. Graphic artists and web designers were hired to present professional communications. One or more team members, including marketing specialist and interns, were assigned to monitor social media for rapid responses and frequent postings. Blog and Facebook postings provided insight into public perceptions of barriers and opportunities to address in our plan.

A contest called “Where in the Heartland is EVSE?” was conducted by a three-person team for six weeks on www.facebook.com/ElectrifyHeartland. Intentionally obvious pictures were posted four times each week for the public to guess the location. Prizes were donated relevant to charging locations in our project area. The contest increased viewers beyond the minimum requirement of twenty five to earn a Facebook URL and improved public education on the growing number of charging locations. A summary of contest results and connection analytic graphs are provided in Appendix U: Social Media. Participation was increased in consumer enthusiasts, event exhibitors, article subjects, student projects, and presentations at complementary venues.

1.4 Assign responsibilities

Responsibilities were assigned for all aspects of EV-EVSE Planning. The original Greater Kansas City Plug-in Readiness Task Force held many sessions to develop a responsibility matrix organized in categories and tasks- then assigned primary and secondary responsibilities. See the EV Readiness Index in Appendix A and note the legend provided.

The contents of this plan are organized with the same sections as the categories and tasks in the first two columns of the responsibility matrix, EV Readiness Index. The tasks were developed from the deliverables listed in the original funding opportunity outline, EV Plan

Funding Opportunity Number: DE-FOA-0000451. See the grant proposal narrative in Appendix C.

Each section includes content pertaining to each task in three subject areas: Deliverables to Address, Methods of determining above plans including other options considered, and Barriers to consider and recommended mitigation plan. The first subject, “Deliverables to address”, matches the task column in the EV Readiness Index. The second subject, “Methods of determining above plans including other options considered”, provides reasons for arriving at the plan results as well as lessons learned while developing the plan. “Barriers to consider and recommended mitigation plan” describes barriers addressed while developing the plan, possible risks to consider, and recommended methods of avoiding the barrier or risk.

A calendar of team meetings was developed to reserve time on busy schedules. The team calendar is included in Appendix A. Executive team meetings of contractual partners, Metropolitan Energy Center and Black & Veatch were scheduled monthly to review budgets and schedules. Team lead meetings were held every two weeks with standard agenda items of overall progress and the assigned section for each meeting. Assignments were made well in advance for each team to present sections of the plan and summarize findings in a standard template. Our spreadsheet used to track the document section assignments and schedule for each revision is provided on the project DVD as an example for customizing by your EV planning team.

2 Plan PEV Vehicle Deployment

2.1 Section Introduction

2.1.1 Synopsis

In this section, we describe how our team predicted the number of fleet and consumer Electric Vehicles that will be on roads in our region in 2015. We describe how the numbers were determined and what implications they have. We also discuss possible barriers to EV adoption in the region and how we have worked with consumers and business leaders to mitigate them.

2.1.2 Author

Bill Patterson, Nation Ranch

2.2 Plan PEV Vehicle Deployment

Demand for electric vehicles is increasing, with sales expected to top 62,000 units in 2012.[1]

General Motors sold more Chevy Volts in the first six months of 2012 than in all of 2011, and Nissan soon will begin manufacturing its Leaf plug-in electric vehicle at a new multi-billion-dollar facility in Tennessee.

Toyota is offering a plug-in version of its popular Prius hybrid, and Ford recently introduced an electric Ford Focus.

Year-to-date electric vehicle sales of hybrid electric vehicles are up 113.5 percent compared to 2011, and sales of plug-in electric vehicles are up 228.9 percent.[2]

Pike Research estimates the United States will reach the one million mark in the year 2018, with more than 1.7 million electric vehicles worldwide by the year 2020.[3]

1Wahlman, Anton. "2012 Electric Car Sales Forecast." *The Street*. Street Network, 6 July 2012. Web. 10 Dec. 2012. <HTTP://WWW.THESTREET.COM/STORY/11606766/1/2012-ELECTRIC-CAR-SALES-FORECAST.HTML>.
2"Vice President Biden Announces Plan to Put One Million Advanced Technology Vehicles on the Road by 2015." *Energy.gov*. US Dep of Energy, 26 Jan. 2011. Web. 10 Dec. 2012. <http://energy.gov/articles/vice-president-biden-announces-plan-put-one-million-advanced-technology-vehicles-road-2015>.
3Crowe, Philippe. "Sales of Plug-in Electric Vehicles Will Grow Strongly through 2020." hybridcars.com. HybridCars.com, 2 July 2012. Web. 10 Dec. 2012.

2.3 Deliverables to Address

2.3.1 Estimate of 2015 Registered EVs

In his 2010 State of the Union Address, President Obama set a goal to put one million electric vehicles on American roads by the year 2015.

One million electric cars is roughly equivalent to four-tenths of one percent (.4%) of all cars on American roads, which is an encouraging ratio based on 2012 sales of electric vehicles to total vehicle sales. While it remains to be seen whether or not the nation will reach the President's stated goal, if current sales trajectories hold true, sales of hybrid electric and plug-in electric vehicles will constitute just under one-half of one percent of the total U.S. car market in 2012.[4]

For planning purposes, Electrify Heartland has used a baseline projection of four-tenths of one percent (.4%) ratio to calculate the number of electric vehicles registered in the planning area by the year 2015.

According to Census data, there were 308.7 million people in the U.S. in 2010, and 246.2 million passenger cars and trucks on the road, or .7975 cars per person.

Assuming this ratio holds true for the entire planning area and its population of 2.225 million people, there are currently 1.775 million passenger cars and trucks in the planning area. This ratio was borne out in several cities and counties examined separately during the planning period.

Using the four-tenths of one percent (.4%) ratio mentioned above, Electrify Heartland calculates a total of 7,000 electric vehicles for the planning area by 2015.

"Electrify Heartland calculates a total of 7,000 electric vehicles for the planning area by 2015."

2.3.2 Analysis of EV Usage Patterns

The Mid-America Regional Council, using 2010 U.S. Census Data, calculated zip codes where electric vehicle adoption was most likely to occur, as well as likely destinations for electric vehicle owners, to develop maps indicating where the need for EVSE could be greatest in the future.

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4 Wahlman, Anton. "2012 Electric Car Sales Forecast." *The Street*. Street Network, 6 July 2012. Web. 10 Dec. 2012. <HTTP://WWW.THESTREET.COM/STORY/11606766/1/2012-ELECTRIC-CAR-SALES-FORECAST.HTML>.

As detailed in Appendix B maps, prospective electric vehicle owners tend to be clustered in affluent neighborhoods within a relatively short distance of the central city, with downtown areas and office parks fed by major Interstate highways representing likely destinations.

Similar patterns appear in a map created by the Wichita-Sedgwick County Metropolitan Area Planning Department, with clusters of likely electric vehicle owners near the central business district and on the developing east and west edges of town.

"Range anxiety and price will continue to be the biggest obstacles to widespread electric vehicle adoption."

2.4 Barriers to Consider and Recommended Mitigation Plan

Range anxiety and price will continue to be the biggest obstacles to widespread electric vehicle adoption.

Population density and misperceptions about one's own actual number of vehicle-miles traveled per day may make consumers in the Electrify Heartland planning region especially susceptible to range anxiety.

As is the case elsewhere, many of these anxieties are largely unfounded, especially when one considers that among commuters in the 67 largest U.S. cities, Kansas City workers have the 13th-shortest average commute (an average of 22.83 minutes).[5]

In an effort to enhance public communication, Electrify Heartland has created a Website, www.electrifyheartland.org, to serve as a central information resource for consumers seeking information about electric vehicles and charging infrastructure in the region.

The site contains information about the different types of electric vehicles, links to helpful resources, maps, videos, news releases and events.

The site, along with social media channels including our Facebook page (www.facebook.com/electrifyheartland), Twitter (@ElectrifyHeart) and You Tube (www.youtube.com/electrifyheartland), serve as resources for electric vehicle enthusiasts (as well as skeptics) to exchange information.

To counteract range anxiety, Electrify Heartland initiated a Facebook-based contest- Where in the Heartland is EVSE?-offering prizes to those who correctly identified the locations of

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5American City Business Journals, 25 May 2010. Web. 10 Dec. 2012
<http://www.bizjournals.com/kansascity/stories/2010/05/24/daily21.html?surround=etf&ana=E_ARTICLE

the 35 electric vehicle charging stations (EVSE) within a 50-mile radius of downtown Kansas City.

Between June 25 and August 31, photos of different charging stations were posted each Tuesday through Friday, with winning entries announced on Mondays. The contest not only reinforced the fact that ample public charging is available throughout the Electrify Heartland planning area, but also helped increase traffic to both the Electrify Heartland Facebook page and Website.

As a group, electric vehicle owners are extremely satisfied with their purchases and are highly likely to publicly express their satisfaction. Social media in particular offer those who currently own electric vehicles the opportunity to share their own personal experiences and help dispel myths about electric vehicle performance.

Electrify Heartland has forged strong relationships with citizens' groups, including the Mid-America Electric Automobile Association and KANSAS electriCITY, to enlist their support in carrying positive messages about electric vehicles to the public.

Additionally, we have engaged members of the business, labor, and academic communities to communicate the positive economic impact electric vehicles and related industry have on the region's economy.

By building a network of engaged consumers and business leaders, Electrify Heartland has enhanced its contacts database, enabling regular electronic communication with a growing audience via an electronic newsletter, which is published and distributed through the Kansas City Regional Clean Cities Coalition.

Electrify Heartland has produced and posted seven videos profiling electric vehicle owners, elected officials and representatives from local manufacturing companies, enabling these key industry advocates to share their experiences with the public.

Public events, where visitors can view, ride in and drive electric vehicles, have also been an effective way to familiarize consumers with these machines.

Electrify Heartland has also provided automobile dealerships with informational materials, such as rearview mirror "hang tags," that promote the Electrify Heartland Web and social media sites, and even enable smart phone users to access these sites using quick response (QR) code technology.

Ongoing publicity, in the form of news stories about the environmental and economic benefits of electric vehicles, including well-paying jobs in manufacturing, research and development, electrical contracting, auto repair and maintenance, etc., has also proved effective in educating the public.

The greatest barrier in the Electrify Heartland planning area, however, may in fact be vehicle *supply.* In an effort to meet demand where population is greatest and state tax incentives are the biggest, auto manufacturers have concentrated distribution in coastal areas, and some manufacturers have not yet made electric vehicles available in the planning region.

It is anticipated that vehicle production will increase beginning with the 2013 model year and more units will be available for purchase in the planning region.

3 EVSE Deployment Plan

3.1 Section Introduction

3.1.1 Synopsis

Our infrastructure (charging stations) team compiled data from many sources in order to answer questions about regional access to Electric Vehicle Supply Equipment (EVSE) at home, at work and at public locations. This section also briefly discusses how EVSE locations should be reported and mapped, how the utility grid can send and receive information regarding EVSE usage to mitigate barriers within utilities, barriers within multi-family dwellings and cost range for installation and hardware of charging stations.

3.1.2 Authors

Larry Kinder, LilyPad EV and Troy Carlson, Initiatives

3.2 Estimate consumers with access to residential EVSE and forecast trends

The question is not who has access to residential charging stations, but rather, how many of those who purchase or are considering purchasing plug in electric vehicles have access to facilities that support overnight charging?

The locations where consumer vehicles are parked overnight have a major impact on who has accesses to residential charging stations. Consumer's purchasing decision for an EV will generally consider if they have the ability to charge their vehicle where they generally park overnight.

We use the Kansas City metropolitan area (KC metro) as an example for the planning area in the following exercise.

<u>We make the following assumptions:</u>

Consumers living in a single family dwelling with a garage are likely to be able to install a charging station in that garage. Consumers living in a single-family dwelling with no garage are not likely to be able to install a charging station.

Consumers living in apartment buildings or multifamily dwellings will typically have access to charging facilities only at the discretion of the management of the facilities.

<u>We draw the following conclusions:</u>

Level 1 Charging: We believe about 68% of the consumers in the KC Metro have access to standard 110V outlets overnight for slow Level 1 charging of their vehicles. We are using the 68% (from the table below) of all consumers in the KC Metro having access to garages as a proxy for the number of people that have access to Level 1, 110V charging. We believe level one charging will be adequate for most living in single-family dwellings with a garage.

Level 2 Charging: Faster Level 2 charging requires 240V electric service. Thus those same 68% would probably have to add 240V wiring and a charging station to their garage. Cost being a deciding factor for most families, we believe most aEV consumers living in single family homes will not opt for Level 2 charging if a 240V outlet does not already exist in or near the garage. Instead, Level 2 charging will likely be the choice for multi-family dwellings. Installation may be initiated by residents or building management, but should address concerns of electrical contractors, the utility provider for the property, building management and residents

Supporting Data:

We use US government reports to estimate the number of consumers in the KC Metro with access to garages.

From a 1997 US Census Document (http://www.census.gov/prod/99pubs/ahb-9901.pdf):

> "Garages or carports are common for households living in single-detached units-just over three in four of these homes (76 percent) have a covered shelter for vehicles. Townhouses or row houses, on the other hand, include a garage or carport less than half the time (46 percent). In both mobile homes and units in multiunit buildings, the proportion is 26 percent." -1997 U.S. census data

		Total	With Garage	
table 1.6	All Housing	766	521	68%
table 3.7	owner occupied	487	417	86%
table 4.7	renter occupied	210	76	36%

Source: American Housing Survey forthe Kansas City MetropolitanArea: 2002
http://www.census.gov/prod/2003pubs/h170-02-27.pdf

Exhibit 3-1 Kansas City residents with garages

3.3 Estimate consumers with access to workplace EVSE and forecast trends

Section 3.4 below describes the total number of charging ports in our area currently and projects the number out to mid-2014. There are currently about 30 workplace charging ports, which make up about 25% of the current 119 charging ports. With a projection of 475 charging ports by mid-2014 and assuming the 25% ratio holds steady, that would mean we could expect about 118 workplace charging ports by mid-2014.

3.4 Estimate of publically available EVSE and forecast trends

As of September 17, 2012 the AFDC website shows that Kansas and Missouri (excluding the St. Louis area) have a total of 119 commercial charging ports.

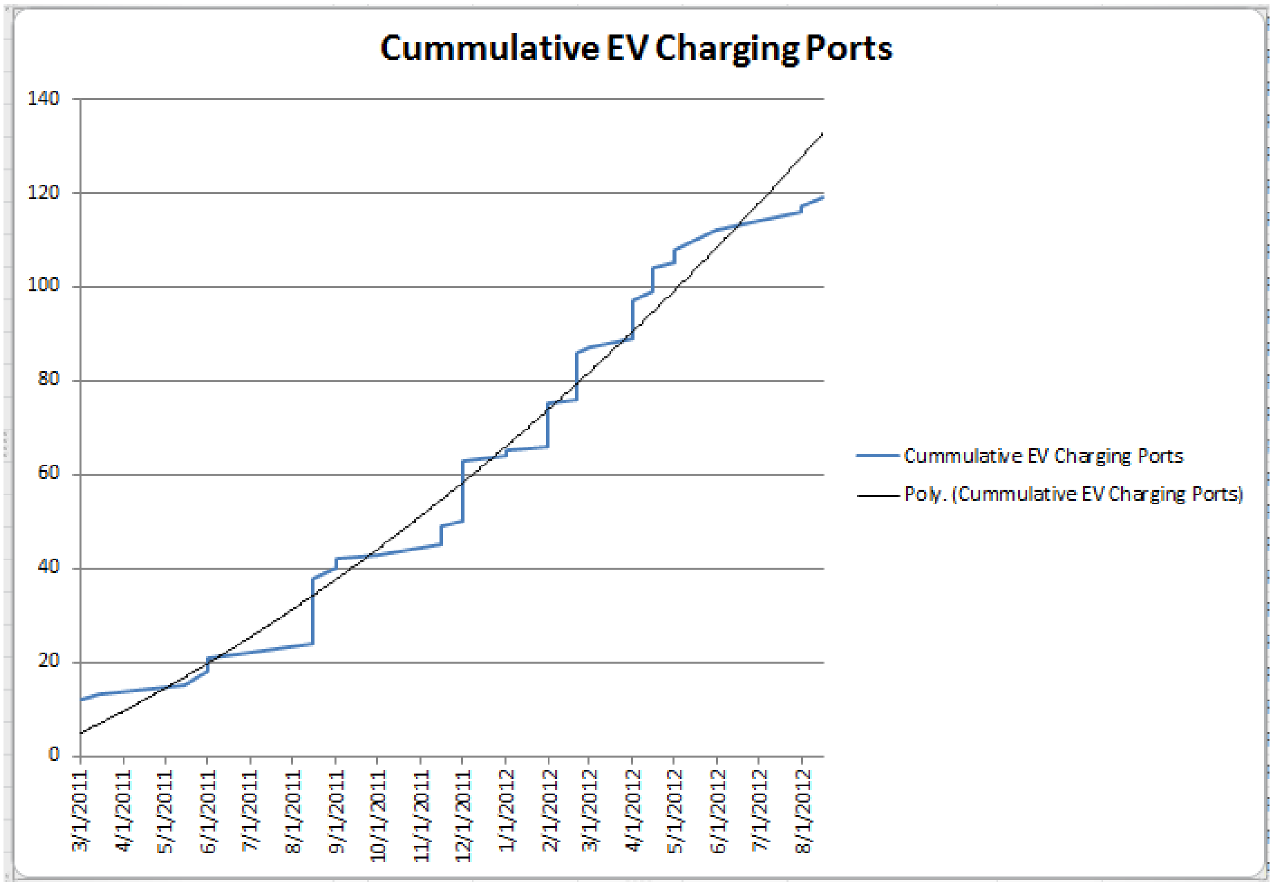


Exhibit 3-2 Number of charging station ports installed since March 2011.

The next graph shows the breakdown of currently installed charging stations by type of location:

30	Workplace
12	Gov Office
31	Auto Dealers
14	Higher Ed
4	Fleet
26	Retail
2	Demo

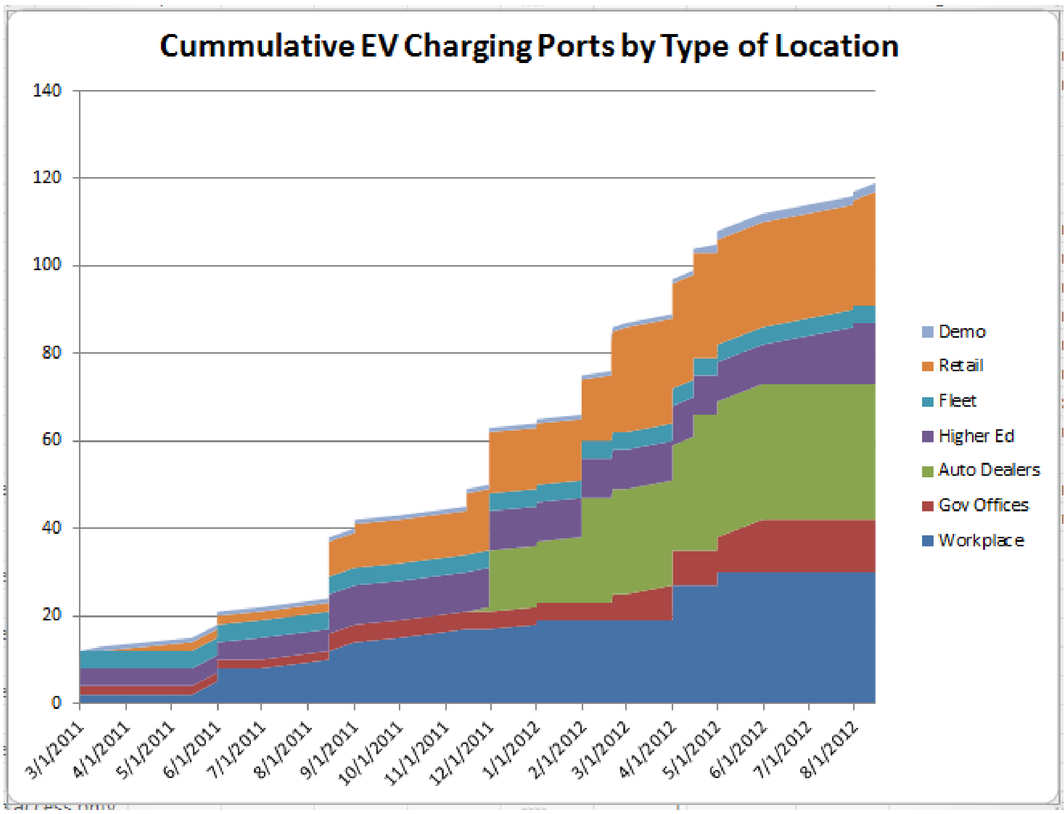


Exhibit 3-3 Number of EV charging ports shown by location type

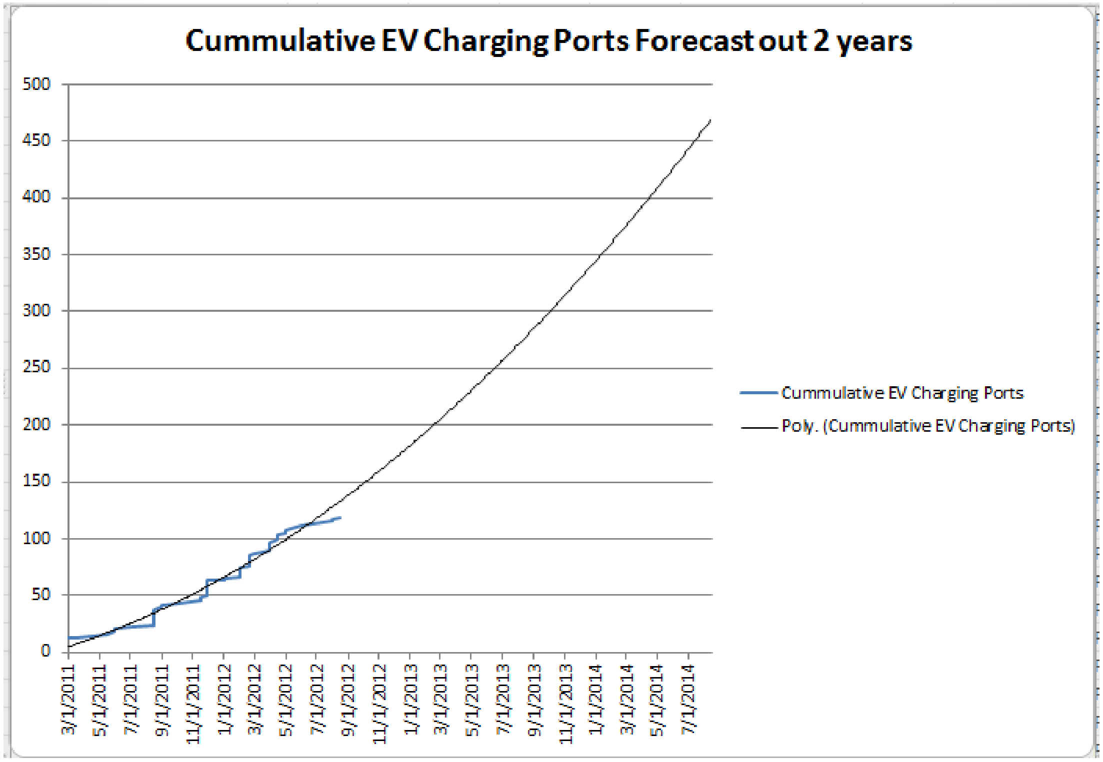


Exhibit 3-4: Projected charging ports in KS/MO (except St. Louis area) by July, 2014

3.5 Determine data flow and processes for updating maps of EVSE locations

We believe that the list of electric vehicle charging stations on the AFDC's Charging Station Locator www.afdc.energy.gov/fuels/electricity_locations.html is the most complete set of charging station locations available. We should encourage all installations of publically available commercial charging stations in the area to be reported to this database.

"…the list of electric vehicle charging stations on the AFDC's Charging Station Locator www.afdc.energy.gov/fuels/electricity_locations.html is the most complete set of charging station locations available."

After a charging station has been installed, the information about the station should be uploaded to the AFDC website. The basic flow of a project to install charging stations and upload information to the station could be described in the following steps:

1) Purchase
2) Permit
3) Installation
4) Inspection

5) Upload charging station info to AFDC's Charging Station Locator
6) AFDC Map

3.6 Analysis of EVSE/Grid send/receive information issues

Reference the City of Houston's "Recommended Electric Vehicle Charging Infrastructure Deployment Guidelines for the Greater Houston Area."[6]Please note that Kansas and Missouri are regulated states and Texas is not. However, the basic assumptions in this report remain applicable and are summarized here for information and future consideration by the regulatory bodies.

Background

Electric utilities are under significant pressure to maintain a dependable, clean, low-cost electrical supply to their customer base. In order to achieve these goals, utilities are evaluating, and in some cases implementing, smart grid technologies that allow utilities to control various electrical loads on their systems. Through these smart grid technologies, utilities can minimize new power plant and electrical distribution and transmission investment by shifting and controlling load while minimizing the impact to the customer.

Electrical transmission is the bulk transfer of electrical energy from generating power plants to substations located within populated areas. Transmission and distribution used to be owned by a single company, but numerous reforms have separated the transmission business from distribution. Power is transmitted through power lines at high voltages to reduce power loss. Energy transmission through underground means results in higher costs and causes greater operational limitations. Another limitation for distribution owners is that the energy cannot be stored, and therefore is generated on an as-needed basis.

Advanced Metering Infrastructure (AMI), also called *smart meters*, are being deployed to provide remote meter reading. Smart meters also have the ability to control various customer loads.

Electric vehicles are one of the better loads to control through smart meters, because EVs have an on-board storage system. This means that delaying the charge of the battery has no noticeable impact on the customer, unlike turning off a lighting or air-conditioning load, which can have an immediate impact on the customer.

Additionally, a neighborhood transformer may not be sized such that every EV-owning customer in an area can be charging at the same time. The ability to schedule the EV charging systems connected to a neighborhood transformer could significantly extend the

[6] City of Houston Texas, et al. "Recommended Electric Vehicle Charging Infrastructure Deployment Guidelines for the Greater Houston Area." *Green Houston TX*. Houston TX Gov, Oct. 2010. Web. 10 Dec. 2012. <http://www.greenhoustontx.gov/ev/pdf/evdeploymentguidelines.pdf>

life of that transformer, or delay and possibly eliminate the need to replace the transformer with a larger size. As the adoption of EVs increases, load control strategies for multi-family dwellings may allow the utility to control charge times to maximize the effectiveness and utilization of existing transformers.

During residential EVSE installations, the electrical contractor will evaluate the electrical service capabilities of the existing system. If inadequate power is available at the service entrance, an electrical service upgrade will be required.

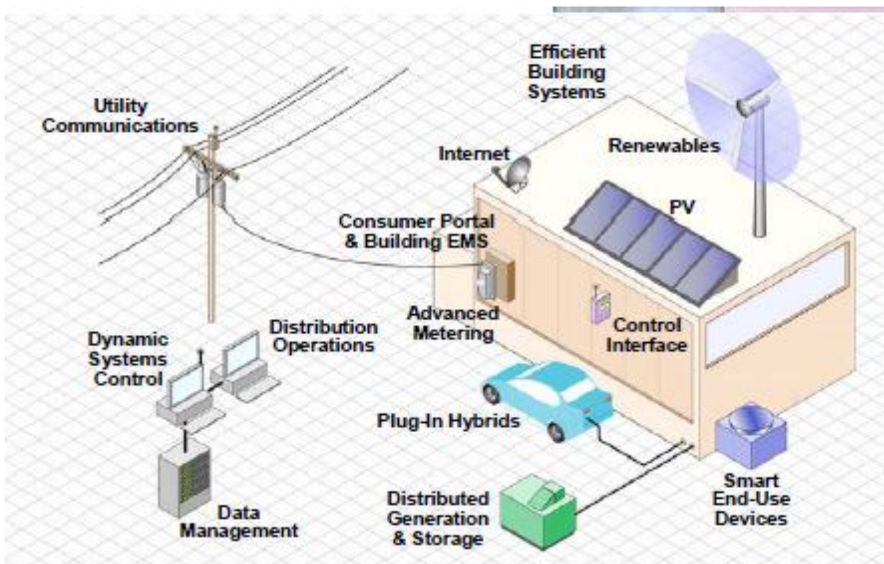


Exhibit 3-5: Smart Grid Infrastructure

Exhibit 3-5 above incorporates many design features of a smart grid/distributed energy storage system. Home use of photovoltaic or wind energy can supplement the utility power. A home area network (HAN) communicating with a smart meter can control lighting, heating, cooling, and other major appliances. Given the right incentives, a home owner may elect to have the utility control total home consumption or deliver power back to the utility through the storage capability of the EV. There are various mechanisms for utilities to control EV load, including:

Time-of-Use (TOU)

TOU is an incentive-based electrical rate that allows the EV owner to save money by charging during a designated "off-peak" timeframe established by the utility. Typically, these off-peak times are in the late evenings through early mornings and/or weekends, during a timeframe when demand on the utility electrical grid is at its lowest point. TOU is now being implemented by some utilities, but currently there is not a common approach. Discussion with local utility prior to installation of the charge station is recommended.

Dual Metering

Electric providers may provide a special rate for EV charging and require the installation of a second meter specifically for this purpose. This would require additional installation time, since the electrical contractor must install the meter before the EVSE is available for use. The use of a "revenue-grade" meter in the EVSE and a communications path to allow the utility control may obviate the need for the second meter.

Demand Response

Demand response is typically a voluntary program that allows a utility to send out a signal to customers (typically large commercial customers) to cut back on loads during times the utility is experiencing a high peak on their utility grid. These customers are compensated when they participate in this program. As deployment of smart meters becomes more prevalent, EV owners may participate in such programs. Utilities may enter into contracts with EV owners to allow the utility to maintain more control over EV charging.

Real-Time Pricing (RTP)

RTP is a concept that could be implemented in the future for EVs. In this model, pricing signals are sent to a customer through a number of communication mediums that allow the customer to charge their EV during the most cost-effective period. For example, the EVSE installed in the EV owner's garage could be pre-programmed to ensure the car is fully charged by 6:00 am, at the lowest cost possible. RTP signals from the utility would allow this to occur without customer intervention. In order to implement RTP, smart meters would need to be in place at the charging location and the technology built in to the EVSE. These programs are under development at the time of this writing.

Vehicle-to-Grid (V2G)

V2G is a concept that allows the energy storage in electric vehicles to be used to support the electrical grid during peak electrical loads, in times of emergency such as grid voltage support, or based on pricing economics. V2G could also support vehicle-to-home, where the energy stored in the vehicle battery could supplement the home's electrical requirements. V2G requires that the on-board vehicle charger is bi-directional (energy is able to flow both in and out of the system). The EVSE at the premises must also be bi-directional and able to accommodate all of the utility requirements related to flowing energy back into the electrical grid. Although there are various development efforts in V2G, for on-road EVs, this concept probably is several years away from implementation in any commercial sense.

Interconnection Requirements

Although vehicle-to-grid (V2G) connections may be in the future for most applications, some infrastructure will incorporate EVSE with solar parking structures or other renewable resources. Because these systems will connect to the local grid, it will be necessary to contact the local utility to determine whether there are any interconnection requirements. These requirements are in place to protect personnel and property while feeding electricity back into the utility grid. Most utility requirements typically are already in place for solar photovoltaic and wind systems that are grid-tied to the utility.

Commercial Electrical Supply/Metering
In the Houston area, there are typically two scenarios for connection to a commercial electrical supply. The first is utilizing the existing main service entrance section (SES) or an otherwise adequate supply panel at the commercial establishment, and the second is to obtain a new service drop from the utility.

The decision on which approach to take depends on a number of factors, including the ability to obtain permission from the property owner and/or tenant of the commercial business, and the location of the existing SES or adequate electrical supply from the proposed EV charging station site. If permission is granted by the property owner and/or tenant (as required), then a fairly simple analysis can be performed. Compare the cost of utilizing an existing supply vs. a new service drop to determine the best approach. A new utility service drop typically requires the establishment of a new customer account, which may include a credit evaluation of the entity applying for the meter, and a monthly meter charge in addition to the energy and demand charges. The local utility also may require an analysis of the anticipated energy consumption.

3.7 Analysis of barriers to EVSE for multifamily dwellings

Major Barriers Facing EVSE installations at Multi-Unit Dwellings	
Barrier	**Description**
Cost	Installation costs can range anywhere from $2,000 to $10,000. A building that has sufficient panel capacity and an existing conduit running from the panel to the PEV parking space will likely only incur charging station, permit, and electrician installation/assessment costs, resulting in a lower cost installation. On the other hand, a building with limited panel capacity, no conduit, and a parking space located a significant distance from the electrical panel, will likely incur higher installation costs.[1]
Power Supply	The charging load of PEVs range from 3.3 kW, similar to a large household appliance or Nissan LEAF, up to 6.6 kW, similar to a Ford Focus Electric. Large scale adoption of PEVs will inevitably require increases in transformer capacity. Transformers supplying multifamily buildings typically have 10% to 15% excess capacity, or overhead, which is enough to sustain a few electric vehicles. However, as PEV adoption grows and vehicles are equipped with higher charging loads, these transformers may be insufficient to handle wide scale conversion to electric vehicles.[2]
Proximity to Metering Equipment	Service panels for MUDs can be located at substantial distances from where the charging station is to be installed.[3]
High Rise Units	In downtown San Diego, meter rooms are often located on the upper floors of high rise units and conduit space is limited. Challenges are faced in installing additional conduit and/or encountering physical limitations (e.g., drilling through concrete floors).[4]

Exhibit 3-6 Findings of the San Diego Regional Electric Vehicle Infrastructure Working Group. Continued on next page.

Parking	Parking is not standard across MUD building types. In some MUDs parking is bundled into the rent or sale price of the unit. In other buildings it is unbundled or paid for separately. Unbundled parking spaces can be assigned on a first-come first-serve basis, or they can be unassigned. A charging station tied to a bundled parking space could be added value to a future tenant; however, a charging station on an unbundled or unassigned spot may pose challenges for assigning costs to individual owners. Choice of spaces also must address issues with proximity to metering equipment as addressed above.[5]
Electricity Rates and Meters for Common Areas	Parking garages/lots are typically on a common meter. This means, electricity provided in parking garages and other common areas is paid by the property manager or homeowner association (HOA) and then billed to residents through HOA fees or rent. This creates a challenge in allocating charging costs to individual owners.[6]
Homeowner Associations (HOAs)	HOAs cannot prohibit or restrict the installation of a PEV charging station. Senate Bill 880 codified this and other provisions for charging installations in common areas. However, HOA boards may still resist installations. Lack of information regarding charging station installations remain a significant barrier.

[1] Peterson, David. Addressing Challenges to Electric Vehicle Charging in Multifamily Residential Buildings June 2011, UCLA Luskin School of Public Affairs.
[2] Ibid.
[3] Bianco, James S. Power Share System for Electric Vehicle Service Equipment, 2012.
[4] Pointon, Joel, SDG&E. Clean Cities US Department of Energy, Electric Vehicle Spring 2011 Quarterly Discussion webinar presented on March 28, 2011.

Exhibit 3-7 Findings of the San Diego Regional Electric Vehicle Infrastructure Working Group. Continued from previous page.

3.8 Analysis of Regulatory Treatment of Retail EV Charging

A logical result of the wide-spread adoption of EV in Kansas and Missouri will be demand for third parties to provide quick-charging refueling services along well-traveled corridors for drivers who are not confident that there is enough charge remaining in their battery to reach their desired destination. Such businesses could provide a valuable service, especially if they are fairly common and spread throughout the region, as the perception that a refueling station is always nearby would dramatically increase drivers' range confidence.

However, this business model presents some unique regulatory challenges that will have to be addressed before these businesses can be legally pursued in Missouri. Specifically, such businesses could potentially qualify as "public utilities" under Kansas and Missouri laws. As a result, such a business would potentially have to register as a public utility and take on numerous regulatory burdens.

Under Missouri law, public utilities are regulated by the Missouri Public Service Commission ("MPSC").[7] "Public utilities," as defined by statute[8], include "electrical corporations," which own, operate, control or manage any "electric plant".[9] Unfortunately, potential retail charging stations arguably fall under this umbrella, as the definition of "electric plants" includes "all real estate, fixtures and personal property operated, controlled, owned, used or to be used for or in connection with or to facilitate the generation, transmission, distribution, sale or furnishing of electricity for light, heat or power."[10] Therefore, because retail recharging stations would own, operate, control, and manage equipment used to sell electricity for power, they would arguably be required to register as public utilities. The resulting regulatory burden would severely impair the economics of the business.

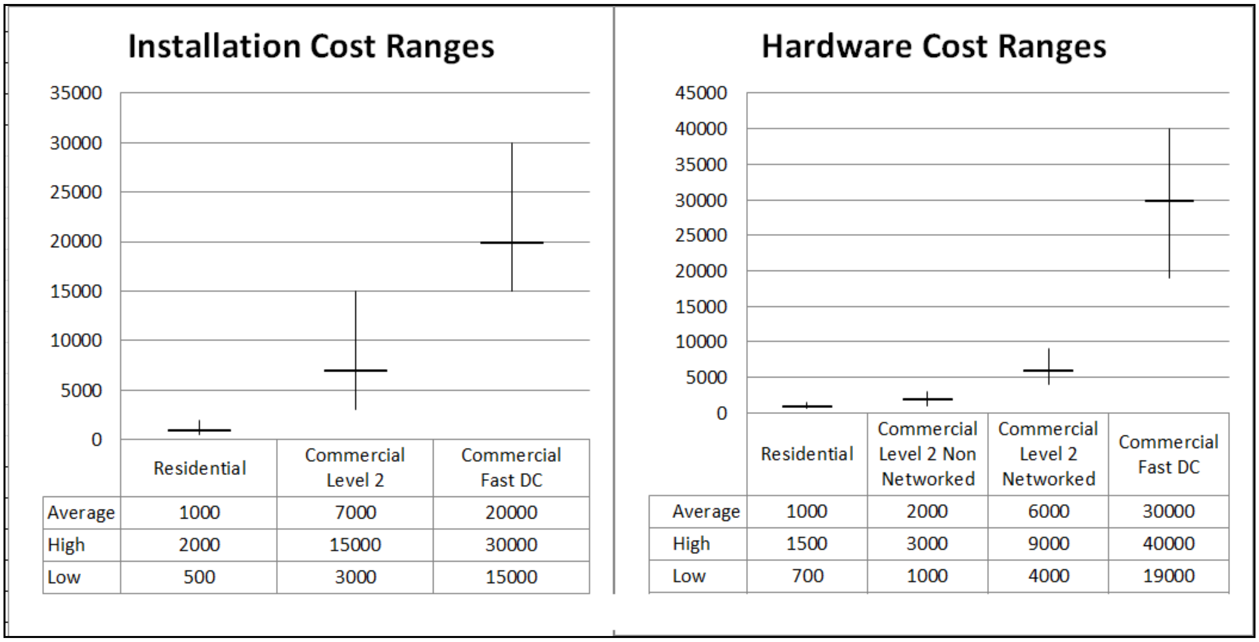
The only clear and definitive resolution of this issue would be a legislative change to the definition of a "public utility" that exempts third-party retail recharging stations. Fortunately, significant precedent for this type legislation exists in other states. For example, Maryland[11] and Virginia[12] have passed legislation exempting third-party retail charging stations from regulation as a "public utility."

3.9 Estimate of EVSE costs and potential funding

EVSE costs can range from $500 to over $30000, excluding installation. Installation can range similarly. The type of charging station and the capabilities drive the costs. It is important for the purchaser to understand the options and their charging needs before purchasing. See Exhibit 3-7 for more information.

Potential funding sources include but are not limited to: TIGER Grants, Ecotality, EV projects with the Department of Energy, Coulomb Charge Program, Stimulus and other federal grants, settlements such as State of California & Nevada Geothermal Power, U.S. military, state funds, municipal funds, venture funding and state rebates.

7Ogg v. Mediacom, L.L.C., 142 S.W.3d 801, 813 (Mo. App. W.D. 2004) (footnote omitted); see also R.S. Mo .§ 393.140.
8R.S.MO. § 386.020.
9R.S.MO. § 386.020(15).
10R.S.MO. § 386.020(14).
11"MD. Code 1-100(A) As Amended by S.B. 997." *State of Maryland*. N.p., n.d. Web. 10 Dec. 2012. <http://mlis.state.md.us/2012rs/chapters_noln/Ch_631_sb0997T.pdf>.
12Virginia Code § 56-232.2.



	Residential	Commercial Level 2	Commercial Fast DC
Average	1000	7000	20000
High	2000	15000	30000
Low	500	3000	15000

	Residential	Commercial Level 2 Non Networked	Commercial Level 2 Networked	Commercial Fast DC
Average	1000	2000	6000	30000
High	1500	3000	9000	40000
Low	700	1000	4000	19000

Exhibit 3-7 Cost ranges for Residential (Level 1), Commercial (Level 2) and Commercial Fast DC EVSE.

3.10 Fast DC Charging Standards

There are two competing fast DC charging standards. When purchasing and installing Fast DC charging stations be aware of the differences.

CHAdeMO is a Japanese standard currently used by the Nissan Leaf and the Mitsubishi MiEV. No US branded manufacturers currently support this standard.

SAE J1772 Combo Plug is a standard developed by the Society of Automotive Engineers in the US and supported by US branded auto manufactures and some European Manufacturers. No auto manufacturers are currently producing vehicles that utilize this plug.

In the US only the Leaf and the MiEV support fast DC charging and use the CHAdeMO standard. Remaining plug-in vehicles in the US have no fast charging port option on the vehicle today.

Some manufactures of CHAdeMO stations are stating that they will offer upgrades to their stations to either add an SAE port or replace the CHAdeMO port with an SAE port depending on how the market unfolds. Pricing is not known.

The dilemma is whether to install a CHAdeMO station now that can only charge a few cars or wait until a standard in the US emerges that can charge all cars.

Recommendations:

If you value providing the ability for some cars to fast charge now and can live with the uncertainty of possibly upgrading in the future, purchase/install a CHAdeMO station now. This option maximizes your community readiness efforts.

If you value certainty and ability to fast charge all vehicles rather than just a subset, then wait till a standard emerges in the US. This option minimizes your risk for upgrades, but minimizes your community readiness effort effectiveness.

4 Updated EVSE Building Code Plans

4.1 Section Introduction

4.1.1 Synopsis

This section, along with section 5 and section 6, discusses the recommendations from the Electrify Heartland Government Policy Team regarding changes that are or will be necessary in preparation and response to the deployment of electric vehicles. In particular this section discusses the need for updates to building codes to consider EVSE installations. It is necessary that these building codes not only consider installations but also ensure that the construction of new buildings will support future installation of EVSE.

4.1.2 Author

Alan Anderson, Polsinelli Shughart PC

4.2 Description of updated codes for neighborhoods, cities and counties

In order to ensure the safe and reliable installation of EVSE, it is important that the local jurisdictions within the Electrify Heartland planning area consider evaluating and potentially revising their building codes to consider the impact of installing EVSE. When considering these potential revisions, the communities should strive to incorporate as much flexibility as is practicable while still maintaining the highest level of safety at all times.

As with any electrical installation, EV charging infrastructure in Kansas and Missouri is governed by various federal and local building codes and requirements. In the Electrify Heartland planning area, the various local jurisdictions possess the ultimate authority to adopt their own building codes, and many rely upon some form of the National Electrical Code (NEC). Specifically, Article 625 of the current NEC 2011 includes best practices for wiring methods, equipment construction, control and protection, and equipment locations for automotive-type vehicle charging. The NEC in its entirety can be viewed at nfpa.org, though a subscription is required.

Because there is no state-wide authority for building codes in either Kansas or Missouri, the revisions that might be necessary to safely facilitate the current and future installation of EVSE will have to be carried out at the local level. Accordingly, Electrify Heartland recommends that all local jurisdictions within its planning area mandate that all additions and/or modifications to residential or commercial premises wiring must be performed in accordance with the practices set forth in the most recent edition of the NEC.

In addition to compliance with the most recent NEC requirements, Electrify Heartland recommends that local jurisdictions include an affirmative requirement that all new, reconstruction and renovation building codes support the future installation of EVSE. Such requirements may take a number of different forms.

First, we recommend that communities adopt a requirement that the electrical room and all conduits leading to the electrical room in new multi-unit, commercial or industrial developments must be appropriately sized to accommodate future electrical equipment necessary for electric vehicle charging stations, as well as the voltage and amperage capabilities of the accompanying infrastructure.

"Electrify Heartland recommends that all local jurisdictions within its planning area mandate that all additions and/or modifications to residential or commercial **premises wiring must be performed in accordance with the practices set forth in the most recent edition of the NEC."**

Additionally, we recommend that communities adopt a requirement that all new permitted construction or renovation projects install sufficient conduits, junction boxes, wall space, electrical panels and circuitry capacity in locations that could potentially serve EVSE sites in the future, such as garages and parking facilities. As an illustrative example, the first "Tier" of the California Green Building Standards Code, a voluntary code that is designed to be adopted by multiple communities, mandates that dwellings shall comply with the following requirements for the future installation of EVSE:[13]

One- and two-family dwellings: Install a listed raceway to accommodate a dedicated branch circuit. The raceway shall not be less than trade size 1. The raceway shall be securely fastened at the main service or subpanel and shall terminate in close proximity to the proposed location of the charging system into a listed cabinet, box or enclosure. Raceways are required to be continuous at enclosed or concealed areas and spaces. A raceway may terminate in an attic or other approved location when it can be demonstrated that the area is accessible and no removal of materials is necessary to complete the final installation.

Multi-family dwellings: At least 3 percent of the total parking spaces, but not less than one, shall be capable of supporting future electric vehicle supply equipment.

13California Green Building Standards Code (CALGreen). Section A5106.5.3. Electric Vehicle Charging.

5 Updated EVSE Permitting and Inspection Plans

5.1 Section Introduction

5.1.1 Synopsis

As adoption of electric vehicles becomes more prevalent in Kansas and Missouri, local governments will face a number of new and unique regulatory issues. The Electrify Heartland Government Policy Team has conducted a significant amount of research in the regulatory obstacles and solutions that have arisen in other communities across the nation as they have worked to design and implement the regulatory infrastructure that is needed to accommodate widespread adoption of electric vehicles, and the following section outlines our recommendations regarding permitting and inspection.

5.1.2 Author

Alan Anderson, Polsinelli Shughart PC

5.2 EVSE Charging Station Permitting

From the perspective of most municipalities across Kansas and Missouri, the primary logistical hurdle for EV adoption is the design and adoption of a permitting and inspection process for EV charging stations that will allow for safe and reliable installations. To this end, the Electrify Heartland Government Policy Team has worked closely with certified electricians and representatives from municipalities in the planning area of the project to design a model permitting process that can be seamlessly integrated into communities that are preparing for large-scale adoption of electric vehicles by their citizens.

5.3 Main Objectives for the Kansas/Missouri Model Permitting Process

Before addressing the full scope of the proposed permitting and inspection process for electric vehicle charging stations, it might be helpful to first outline the key objectives that such a regulatory system should accomplish. Based on our review of regulatory regimes across the country, we have concluded that the Electrify Heartland model permitting process should strive to accomplish the following goals:

1.) Implement a permitting and inspection process that ensures to the maximum extent possible that a safe and reliable installation has occurred.

2.) Encourage installation of charging stations by licensed and properly trained electricians.

3.) Establish confidence in safety and reliability and guard against negative events that would act as an obstacle of EV adoption.

4.) Streamline the permitting and inspection processes to an extent that is safe and practicable to minimize the permit processing and inspection time.

5.) Create clear and concise model permits and ordinances that can be easily adopted by a large number of communities in Kansas and Missouri.

6.) Minimize the administrative and logistical burden from the permitting and inspection process on electricians and communities to encourage wide-spread adoption of the model process and electric vehicles.

5.4 Encourage Adoption of 2011 National Electric Code

As a first step towards adopting a reliable and consistent model permitting and inspection process, Electrify Heartland recommends that all communities adopt the 2011 version of the National Electrical Code.

Adoption of the 2011 NEC helps to accomplish several goals. First, it creates regulatory uniformity from community to community where none currently exists. In the State of Kansas, for example, communities are free to choose the version of the NEC that will be applied. As a result, there is no uniformity and the range of applicable codes stretches from the 2011 NEC to the 1995 NEC.

Second, the 2011 NEC includes several updates that pertain specifically to the installation of electric vehicle charging stations. Especially in an industry that is developing as quickly as EVs, in order to ensure that the most current and safest industry standards and practices are utilized in every community, it is necessary that communities upgrade their electrical codes to incorporate the most recent revisions. At the very least, we recommend that communities incorporate the most recently updated versions of Article 625 of the NEC, which pertains to the installation of EV charging stations.

5.5 Overview of the Model Permitting Process

In order to assist communities with designing and implementing consistent and effective processes for regulating the installation of electric vehicle charging stations, the Electrify Heartland Government Policy Team has researched codes, ordinances, incentives, state laws, standards, white papers, and other guiding documents from other jurisdictions across the country, and adapted those that fit most appropriately in the Kansas and Missouri regulatory environments.

5.5.1 Model Permit and Inspection Process

When it comes time to design a permitting and inspections process for installations of electric vehicle charging stations, municipalities have a number of options. If no plan has been put into place prior to an application, many communities' default position is to either follow the pre-established procedure for miscellaneous electrical permits, or fail to permit the installations at all. Both scenarios present unsatisfactory results and do not take into consideration the particular complexities of installing an electric vehicle charger. This puts the public confidence in EVs and EVSE at risk unnecessarily.

Of course, communities will face a wide spectrum of potential scenarios for charging station permits, and there is no single permitting process that would be appropriate for all occasions. For example, significantly less regulatory scrutiny will be required for a homeowner that wants to have a small charging system installed in his or her garage than would be required for a large commercial entity that wants to install numerous charging stations for use by customers and employees. After reviewing the industry standards for inspection and review processes, Electrify Heartland recommends the multi-tiered process outlined below. Communities are free to draft the permits discussed below as they please, but as is explained further below, our recommendation would be that a separate permit be created for electric vehicle charger installations.

5.5.1.1 Single-Family Residential Installations

Depending upon the vehicle technology and the owner's preference, installation of a separate charger may not be required. If an electrical upgrade is not undertaken, then obviously no permit is required. However, if a dedicated 120V receptacle and circuit is needed for Level 1 charging systems, a minor electrical permit needs to be issued, though it can likely be handled under the city's existing permitting requirements.

If the residence's existing electrical panel cannot safely meet the increased electricity needs, then an additional permit to either upgrade the electrical panel or install a new panel and meter should be required. In order to facilitate gathering all of the information that might be needed to properly assess the safety of the installation, we would recommend that the municipalities adopt a stand-alone permitting form for these installations. Specifically, we would recommend that local governments consider adapting and adopting a form permit application that has been prepared by the U.S. Department of Energy's Alternative Fuels Data Center provides an excellent overview of the information that might be considered, and is therefore attached as Appendix D-EVSE Permitting..

In order to satisfy the consumers' demands for quick processing time and ease the logistical and administrative burdens on the local governments, we would recommend that the permit process be streamlined to the greatest extent possible.

For example, if the non-minor permit application has been submitted by a certified electrician that has received training in the installation of electric vehicle charging stations from an nationally-recognized training program, the local government can have some comfort that the installation was handled safely and properly and therefore can adopt less stringent inspection processes, such as inspecting one out of ten installations or foregoing inspections altogether.

"…to satisfy the consumers' demands for quick processing time and ease the logistical and administrative burdens on the local governments, we would recommend that the permit process be streamlined to the greatest extent possible"

However, in instances where the permit application was not submitted by a properly-trained electrician, then the local government should still commit to performing inspections of small single-family residential installations in a prompt manner. Many municipalities across the country have committed to conducting such inspections within 24 hours of the installation being completed.

5.5.1.2 Large Single-Family Residential, Multi-Family Residential and Commercial Installations

For charger installations that exceed the scope of the single-family residential scenarios outlined above, the same informational requirements for the permits will be required, but the local government will by necessity have to be more thorough in its inspection process. Accordingly, Electrify Heartland does not recommend that such installations be reviewed under the streamlined inspection processes outlined above.

5.5.2 Website

In order to facilitate efficient and timely review of electric permit applications by local governments, Electrify Heartland recommends that an online permit application process be utilized.

Such a website would accomplish several goals. First, it would quickly and easily disseminate all of the necessary information regarding the permitting process for electric vehicle supply equipment to consumers and certified electricians, and thus alleviate some angst about the potential regulatory treatment of such installations. Second, it would alleviate a considerable amount of the administrative burden on local governments by placing all of the necessary information out for the public. Third, it would provide an excellent opportunity for the local government to publicize itself as a progressive, forward-thinking community. Finally, our hope is that the concerted nature of the Electrify Heartland project will allow communities in Kansas and Missouri to take advantage of economies of scale and more easily facilitate the design and implementation of an online application process.

To this end, members of the Government Policy Team have entered into preliminary discussions with NIC, a web developer company that provides Government solutions for more than 3,000 federal, state, and local agencies that serve 97 million people in the United States. Though these discussions are still in the preliminary stages, our hope is that if this project enters an implementation phase that we will be able to retain NIC, or a similar company, to design an online application process that can be uniformly adopted by cities across Kansas and Missouri.

5.5.3 Public Utility Notifications

As part of the information-gathering stages of this process, members of the Electrify Heartland Steering Committee conducted several meetings with public utilities located throughout Kansas and Missouri. Throughout this process, representatives of the public utilities stressed that their load-planning activities would be considerably aided if a notification system could be built into this permitting process. Our research indicates that this is a request that is frequently raised by utilities in other jurisdictions, as utilities are seeking ways to accurately model the potential impacts on their distribution systems.

To address this concern, we would recommend two steps. First, it will be necessary for the electrical permit form to include a statement acknowledging that the system owner agrees to release limited information about the system to the applicable public utility to be used solely for the purposes of gauging the sufficiency and efficiency of the utilities generation, transmission, and distribution services. Second, if an online application process has been adopted, such process should either allow the utilities to access relevant information about the permits that have been granted, or include a notification process to send the relevant information directly to the utility. The specifics of this process are still being negotiated, and if the program moves into the implementation stages more formal procedures will be ironed out with input from the communities and the public utilities.

6 Updated EVSE Zoning and Parking Plans

6.1 Section Introduction

6.1.1 Synopsis

In this section Electrify Heartland discusses a strategic approach to signage that will accommodate widespread adoption of electric vehicles. Signage increases visibility for both plug-in electric vehicle (PEV) drivers and non-PEV drivers, increasing public awareness about charging availability. This section also discusses recommended locations for PEV charging/parking spots as incentives and associated enforcement policies.

6.1.2 Author

Alan Anderson, Polsinelli Shughart PC

6.2 Develop signage and parking markings requirements

When properly utilized street signs can serve three important functions for the adoption of EVs. First and most obviously, they direct EV drivers to the nearest public charging infrastructure locations. Second, they serve to educate non-PEV drivers about the availability of charging stations and thus decrease apprehension about range anxiety. Third, they can evidence and publicize any premium reserve parking spots, should the government choose to utilize the parking location as an incentive.

Roadway signage is regulated by the U.S. Department of Transportation, Federal Highway Administration (FHWA). Specifically, approved signage requirements are contained within the Manual of Uniform Traffic Control Devices (MUTCD), published under 23 Code of Federal Regulations (CFR) Part 655, Subpart F. The MUTCD defines the standards used to install and maintain traffic control devices including color, size, shape, letters or other symbols, as well as standards for placement of signs to ensure they are visible, legible, and enforceable.

Currently, the MUTCD does not contain any required signage for EVSE. However, there is a process by which state transportation agencies may submit a request for so-called "experimental" signage. If approved, the experimental signs may be used within the state subject to certain requirements and restrictions.

In 2011, the Departments of Transportation for the States of Washington and Oregon submitted a request for the FHWA to consider an EV Charging General Service symbol. The FHWA granted those states an interim approval, a copy of which is provided as Appendix E.

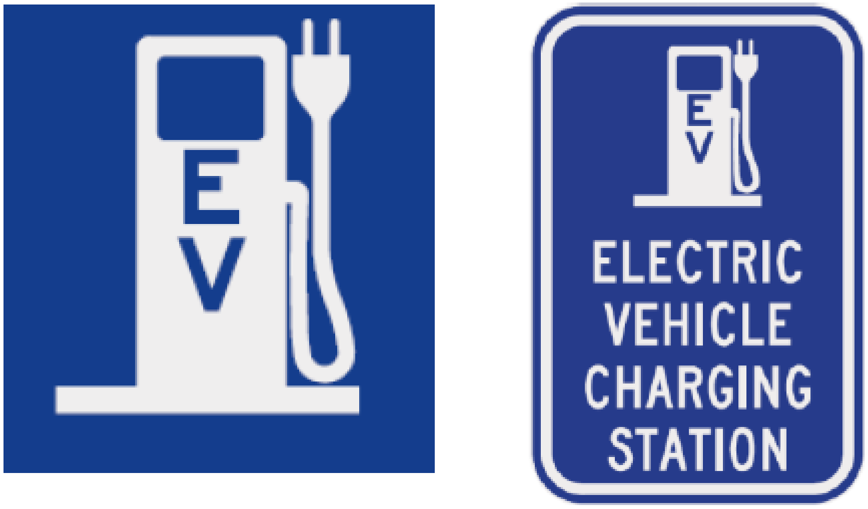


Exhibit 6-1 Recommended Signage

After evaluating a number of alternative symbols for EVSE, Electrify Heartland recommends that the local jurisdictions petition the Missouri and Kansas Departments of Transportation to submit a request and obtain approval from the FHWA to utilize the symbols proposed by the States of Washington and Oregon and approved by the FHWA. These symbols have been thoroughly evaluated by the FHWA and were found to be highly visible and comprehensible by a large segment of the population. Additionally, adopting a symbol that is being utilized in other jurisdictions across the country increases the effectiveness of the symbols by promoting uniformity and recognizability.

Additionally, while the FHWA approval process is being pursued, we recommend that this signage be presented to local businesses for adoption on private property, similar to what many businesses use currently for “Pregnant Mother” parking spaces. Of course, such signage would be unofficial and entirely without the force of law, but its adoption would signal that the business recognizes and supports the needs of its EV-driving clientele. This also serves the added function of signaling to the community that EV adoption is happening and EVSE are readily available, thus providing more important social proof to facilitate further adoption in the future.

6.3 Recommendations regarding incentives or fines to reserve public EVSE spaces for EV only or for EV charging only

As a related issue to EVSE signage, once the stations are installed and the signs are put up, public and private parking facilities owners will need to determine whether and to what extent such signs will be enforced. The enforcement of street signs on public property is currently a prerogative of the local jurisdictions, and thus each community within the

Electrify Heartland planning area will need to determine the level of enforcement that is most appropriate for its populace.

"…the Electrify Heartland recommends that local communities consider promoting the placement of EVSE in locations that are convenient and accessible, but not necessarily in the most prominent or advantageous locations."

Electrify Heartland recommends that the communities carefully weigh several competing interests when making this decision. First, it is important to note that during the early years of EV adoption, EV parking spots may be vacant for large periods of time. If these spots are located in high-traffic areas and parking by non-EVs is prohibited and heavily enforced, a negative sentiment could develop around the adoption of EVs. On the other hand, the availability of these charging locations is critically important for fostering range confidence for EV drivers, promoting the public's confidence that EV charging is readily available, and possible encouraging adoption due to parking preferences.

To successfully balance these various concerns, we recommend that local communities consider promoting the placement of EVSE in locations that are convenient and accessible, but not necessarily in the most prominent or advantageous locations. Additionally, if the community is considering adopting punitive actions for parking a non-EV in an EV spot, we recommend foregoing implementation or enforcement of those penalties until the level of EV adoption in the community is significant enough to ensure that the spots are filled for a significant period of time. Similarly, if the community is considering implementing an ordinance to penalize EVs or non-EVs that are parked in an EV charging-only spot, we recommend that the communities should be reasonably confident that the problem is widespread enough to justify the potential anxiety that might be created among EV drivers who may park in the spot without charging or continue parking in a spot after charging is complete.

7 EV and EVSE Communication, Education, and Training Plan

7.1 Section Introduction

7.1.1 Synopsis

In our preparation to ready Kansas and Missouri for electric vehicles, citizens will need to be aware of the opportunities, benefits and truths about electric vehicles.

This educational process will require different approaches for each of the identified subgroups: consumers and the general public, elected officials and civic leaders, teachers and trainers, students and youth, electricians, auto technicians, first responders, recover/salvage personnel, electric vehicle enthusiasts and electric vehicle organizations.

These subgroups were identified by examining previous educational offerings from different programs and through input from stakeholders in the region. Many organizations offer training to each group identified. A curriculum for automobile technician training is offered in Appendix G based on survey of multiple training institutions.

7.1.2 Authors

Jim Cianciolo, Kansas City Joint Apprenticeship Training Center

Robert McGowan, Kansas City Kansas Community College

Bill Patterson, Nation Ranch

7.2 Develop public education plan including methods of finding certified electricians and auto dealers

The consumer needs to understand why he or she should consider purchasing an electric car. How can they benefit from electric or plug-in vehicles and how can they become a plug-in vehicle owner? This education plan includes video presentations, computer presentations and scripts with handouts so anyone can view them.

Consumer information is intended for all audiences and should offer answers from a quick read with links for further information and greater detail. Much of this material is already available from different resources and will be included in our presentations.

The Electrify Heartland program has already created and is actively promoting a website, www.ElectrifyHeartland.org, that serves as a central reference point for consumers seeking information related to electric vehicles, electric vehicle service equipment (EVSE), qualified electricians who can safely handle EVSE installations, as well as the names and locations of auto dealers offering electric vehicles for purchase.

Additionally, the site contains links to government resources, such as the Department of Energy's Alternative Fuels Data Center (AFDC).

7.3 Develop training for EVSE installers

The electrician needs to understand the specifications and technical information regarding charging stations and their effect on the power delivery systems to the home or business, and within the home or business.

This technical training requires certified instructors with expertise in the specific methods of preparing the home or business for the installation of the charging unit.

Some homes will require electrical service upgrades to safely deal with the additional load that an electric car puts on their power systems and electricians need specific information to enable them to do their job. This will be technical training aimed at specific professionals in an advanced level delivery.

Kansas City is home to one of the nation's first five Electric Vehicle Infrastructure Training Programs (EVITP). EVITP is recognized as a training partner by the Department of Energy's Clean Cities Initiative and offers a comprehensive 24-hour course for licensed electricians across North America. The training includes instruction in electrical codes, safety and other building regulations and standards; renewable energy and electric vehicles, EVSE installations; and customer relations. The course work also includes training for code officials and inspectors, first responders, a field installation practicum and written examinations.

"Kansas City is home to one of the nation's first five Electric Vehicle Infrastructure Training Programs (EVITP)."

Developed in collaboration with automakers, utility companies, EVSE manufacturers and key stakeholders such as the International Association of Electrical Inspectors (IAEI), the National Fire Protection Agency (NFPA) and the National Electrical Contractors Association (NECA), the EVITP has certified more than 220 instructors and 800 electricians through the program and has representation in 35 states.

In addition to EVITP, regional career and technical colleges, junior colleges and four-year universities are developing curricula for training electricians, engineers and construction managers to address the specific needs of electric vehicles and EVSE installations in residential, commercial and industrial properties.

An informal advisory board, representing schools including the University of Kansas, Pittsburg State University, Johnson County Community College, Kansas City Kansas

Community College, Metropolitan Community Colleges and Olathe Public Schools, has formed to share knowledge and develop in-classroom and hands-on programs to ensure a more skilled workforce serving the EV and EVSE industries.

7.4 Develop training for EV techs and dealers

Automotive and truck technicians need to understand how to repair electric vehicles.

Technicians are aware of electrified vehicles but few have received training in this new technology. This training will be at an advanced level offered by certified personnel. These training sessions will need to be added to current programs and offered as updates for working technicians.

Currently there are no real standards for certification by the Automotive Service Excellence (ASE) or any other service authority. This problem should be addressed quickly to assure clients and employers that technicians received quality training and are capable of safe repair and maintenance. Current vehicle trainers will need to be updated to understand this technology as a new specialty. Students need to have the ability to certify in electrified vehicles so they can present themselves as a specialist.

An accreditation development team will begin with meetings between schools that have training in electrified vehicles and ASE to complete educational standards with a standard for curriculum and list of learning outcomes. This will enable stakeholders to have a standard to begin offering training in a complete and consistent manor. The content must be inclusive of all vehicles that use electric propulsion.

The automotive technician is responsible for service to everything on the vehicle side of the plug and its related elements. When the Electrify Heartland plan is engaged, the Midwest region will begin to work on this standard by inviting service stakeholders to a meeting to launch the effort. Until such time, service training will be offered through many organizations, institutions and dealerships.

Safety is the key element in service of electric vehicles. No person should attempt service of any electrical components without adequate training or proof of competency in dealing with high voltage. These vehicles have been designed with many safety features for the service technician; however, accessing certain areas in the car could result in injury or death.

Automobile technicians have indicated a strong desire to learn about electric vehicles and will like to attend training updates and/or earn a credential. The greatest interest will be in the form of evening classes, one or two nights a week and occasional service updates.

Automotive technician resources include sample content and links to consultants, established school programs, sample presentations, photos, books and other related resource material for the working technician.

7.4.1 Vehicle recovery and salvage

People that are towing a vehicle or salvaging its components need knowledge of how to safely disable and disassemble electrified vehicles. Many of these procedures are outlined by the vehicle manufacturer. Tow truck operators must be aware of contact points that must be avoided and how to safely disable the electric storage devices of these vehicles.

Salvage of vehicles must be done in accordance with outlines that enable the safe recovery of components and proper disposal of batteries and hazardous components. Research of recycling centers that accept batteries needs to include review of certifications such as e-stewards and R2 - Responsible Recycling to ensure that toxic material streams are managed safely, responsibly, and legally by downstream vendors – all the way to final disposal. Salvage and insurance claims are excellent source of materials needed for hand on training of technicians.

7.5 Develop training plan for first responders

First responders need to understand how to deal with electrified vehicles in the case of an accident, an extraction or fire in or around the vehicle. Training needs to be specific for concerns that are common to all battery electric vehicles and vehicle-specific concerns for locations of shutoffs and cut points. Different battery types may affect strategies to properly deal with different events.

Training from colleges and other sources is available. The municipality can find lists of opportunities for training on our first response resources link. Two organizations that have nationwide safety training programs are National Fire Protection Agency (NFPA) and National Alternative Fuels Training Consortium (NAFTC). Also listed is specific information from each vehicle manufacturer about dealing with emergency situations.

7.6 Develop public communications materials

Many cities have electric vehicle clubs and organizations that meet regularly and have an abundance of expertise in the specifics of building and converting vehicles. Some active EV organizations in the Kansas City area are Mid-America Electric Automobile Association, who have chapters nationwide, Kansas ElectriCity has organized several events that feature EV, Kosher Fest emphasizes healthy, sustainable living, and Kansas City Advance Energy a group dedicated to advancing the capacity and capabilities in the Kansas City area for designing, engineering, commercializing, and manufacturing **advanced** energy systems including wind, solar, fuel cells, high energy battery, and advanced bio-fuels.

These organizations have been invited to public events to share their knowledge and enthusiasm with the public. School programs can also benefit from these organizations as they build electric vehicles as school projects. Many schools and individuals have chosen to build or should consider building an electric car to motivate students, enhance learning and shape character. Club members support these student efforts with their experience and advice.

7.7 Design presentations, webinars, web and social media campaigns for each audience

7.7.1 Teachers and Trainers

Instructors of any form should be able to gather material from our Website that includes presentations and scripts to promote a common message to as many consumers as possible. These presenter resources are readily available for download to anyone who wishes to obtain them.

7.7.2 Student and Youth Resources

Student resources are available for youth and adult education. Many primary school students need information for research when preparing papers and homework on this subject.

Electrify Heartland’s student resources will offer people a place to gather scholarly information with sources and links enabling them to create papers and presentations, which can and should be adapted for younger students, who will grow up in a world where electric vehicles have always been an option and will therefore be more comfortable with electric vehicle technology.

Internet based and electronic communications are a youth-friendly environment enabling students with a path to simplify their work. Vehicle electrification is a common subject of discussion in our schools and this will be a great way for students and teachers to obtain quality information.

This education plan could include presentations on the history and future of oil and gasoline consumption and pricing, reasons for driving an electric car, electric vehicle safety, the history of hybrid and electric vehicles, reasons for industry purchase of electric cars and trucks and how to install a charger at home.

When the Electrify Heartland plan is implemented, videos will be produced on these and other related subjects for release to the public in many forms including presentations, YouTube and free download from our website.

7.7.3 Electric vehicles as a platform for math and science education

Electric vehicle training is beginning to appear as a component of auto technology classes, electric vehicle clubs or class projects in secondary institutions. In an effort to promote and enable students' safety, some basic standards need to be established.

Instructors and schools implement programs, projects or instruction using the electric vehicles to enhance understanding in science and engineering. Without basic training and curriculum standardization, building a class or program represents a challenge. While instructor training and curriculum is available, it is inconsistent and needs some organization.

It will be beneficial to identify suitable components that can be embedded into existing course curricula. The development of basic components of training for electric vehicles should be established by an institution such as the National Automotive Technicians Education Foundation (NATEF) or other entity with experience in automotive education.

No secondary student should ever be allowed access to live high voltage circuits under any circumstances. It is vital that all lab experiments remain at a safe power level. Lower voltage vehicles will be best so that the student could be more involved in the electrical work and remain safe. The principles involved in low voltage are the same as high voltage and of equal value at this level of learning.

Beyond the classroom, Electrify Heartland actively supports education programs such as Kansas City based MindDrive, which serves at-risk youth from the inner city, and has used electric vehicle technology to inspire young people to achieve inside and outside the classroom, while teaching practical, hands-on math and science skills at the same time.

In summer 2011, MindDrive students and their adult mentors drove an electric car that they designed and built themselves on a cross-country trip from San Diego to Jacksonville. Along the way, MindDrive students met with young people to talk about their program, their career aspirations and electric vehicle technology.

7.7.4 Electric vehicle training for post-secondary institutions

The value of learning and understanding the complexities of electric vehicles not only supports the goals of getting electric vehicles on the road but also supports the practice of higher-level understanding of scientific and engineering principles.

Basic standardization of curriculum offers the benefit of helping institutions start new programs and builds consistency of the subject matter. It is recommended that an existing group such as NATEF undertake this effort, or that a group be created from existing programs and stakeholders to build electric vehicle training program standards and optional accreditation. This will not be a governing agency but an asset to aid in the development of a program with an optional qualification for all parties to recognize. Students, faculty, schools, employers and government are all stakeholders that need a standard for building and maintaining electric vehicle programs.

At the college and technical school level, it becomes necessary for students to work around high voltage components, requiring a higher level of safety. A qualification standard should be established to ensure that students have a level of competency in electricity to allow them to work around high voltage components.

While it is assumed that each institution has some way to determine who is able to work around high voltage, it will be of value to all stakeholders in education to have a suggested standard and qualification that can be offered to the institution to evaluate each participant. This could be adopted from an OEM, established training school or developed by conference utilizing NATEF.

8 EV Benefits and Incentives Promotion Plan

8.1 Section Introduction

8.1.1 Synopsis

In order to make Electric Vehicle adoption more realistic there have been federal incentives developed for consumers to promote purchase. Another means of promotion, which is discussed in this section is education. Through both testimony and savings calculations cost can become an incentive instead of a barrier. This section discusses what actions have been taken throughout the run of this project- developing a website, running a promotional contest, posting videos, forming partnerships with utilities and meeting with elected officials, representatives of city government and concerned citizens.

8.1.2 Author

Bill Patterson, Nation Ranch

8.2 Deliverables to address for incentive and promotion planning

Purchase price and range anxiety are anticipated to be the largest obstacles to widespread electric vehicle adoption for the foreseeable future.

To address these concerns, the Federal government has developed incentive programs to make electric vehicles more cost-competitive with their internal combustion engine competitors, and has joined forces with local governments and the private sector to promote installation of electric vehicle supply equipment (EVSE).

Neither Kansas nor Missouri currently offers tax incentives or rebates over and above the Federal $7,500 tax credit for those purchasing electric vehicles, nor are there any state incentives for companies that purchase electric fleet vehicles.

There currently is no evidence to suggest that either state will implement incentive programs in the foreseeable future, although many states, including Colorado, are offering tax rebate incentives for the purchase of electric vehicles over and above those offered by the Federal government, which could lead other states, including Kansas and Missouri, to follow suit.

"..our recommendations for electric vehicle promotion center on public education through the first-hand experiences of early adopters who have realized significant benefits from owning and operating electric vehicles."

On the other hand, we anticipate greater consumer and fleet demand for electric vehicles as additional electric vehicle options become available and as vehicle and battery manufacturers achieve the economies of scale necessary to reduce electric vehicle prices.

Additionally, evidence suggests that the more consumers know about the benefits of driving and owning electric vehicles and how electric vehicles are congruent with their existing driving habits, the more likely they are to consider purchasing and owning an electric vehicle.

For these reasons, our recommendations for electric vehicle promotion center on public education through the first-hand experiences of early adopters who have realized significant benefits from owning and operating electric vehicles.

8.3 Consider audiences for incentive and promotion planning

Primary audiences for incentives and promotion planning include the following:

- Fleet operators
- Automobile dealerships and sales representatives
- Members of the news media
- Consumers

While tax credits and other incentives have spurred adoption of electric vehicles by fleet owners and consumers alike, the larger business case in favor of electric vehicles over their internal combustion engine counterparts continually comes into clearer focus.

As more real-world information about the cost benefits of replacing gasoline and diesel vehicles with electric is analyzed, our ability to successfully promote and leverage existing incentives for electric vehicles will increase accordingly.

Major fleet operators, such as Pacific Gas & Electric and FedEx Corporation, have embarked on major campaigns to test the viability of alternative fuel vehicles in real-world applications, and have become willing to share their findings with other fleet operators. See sample fleet business cases in Appendix J.

On the consumer side, electric vehicle owners are tremendous evangelists for the performance and cost-savings associated with EV ownership, and their testimonials continually make their way into the public domain via social and mainstream media, thereby generating incremental interest among the general public.

8.4 Develop education plan for fuel cost savings

The Department of Energy's Alternative Fuels and Data Center (AFDC) already offers a fuel savings calculator on its Website, www.afdc.energy.gov/calc/, which enables consumers to determine the return on the higher cost of an electric vehicle compared to a traditional internal combustion engine vehicle.

Electrify Heartland recommends adapting this calculator and incorporating this technology on the Electrify Heartland Website, www.electrifyheartland.org, to enable consumers in the planning region to conduct their own calculations based on the price of gasoline in their neighborhood, as well as prevailing rates for electricity from their local utility.

Cost savings in the Electrify Heartland planning area will likely be significantly higher than in other parts of the country due to the relatively low rates most consumers pay for electricity, thereby reducing the time required for an electric vehicle owner to realize operating savings that offset the extra costs of the vehicle.

As stated in the previous section, as additional real-world cost savings data become available, the ability to leverage these case studies to promote electric vehicle adoption by both fleet operators and individuals will increase.

8.5 Develop environmental/greenhouse gas/energy security benefit education

Electric vehicles eliminate emissions that contribute to ground level ozone in metropolitan areas where air quality increasingly violates Clean Air Act standards, particularly in the hot summer months.

Although concerns remain about the use of coal to produce electricity in the Electrify Heartland planning region (the so-called "long tailpipe" argument), annual CO_2 emissions from electric vehicles are significantly lower than their gasoline-burning counterparts, a fact that one can easily discern using the AFDC's vehicle cost calculator.

In rural areas especially, energy security is a major selling point for electric vehicles compared to their gasoline-burning competitors. The electricity used to power these vehicles is produced in Kansas and Missouri, using fuels that that are sourced in the United States.

Additionally, Kansas now ranks third nationally in wind energy, and "Kansas also has more wind energy construction projects underway than any other state, with at least 663 new turbines set to be installed and nearly $3 billion of new investment from 2011 to the end of 2012"[14].

BP Wind Energy currently is building the state's largest wind farm, an $800 million investment that will include 300 wind turbines capable of powering about 125,000 homes across the country[15].

8.6 Develop maintenance/parking benefits

Electric vehicles owners not only save money by not purchasing gasoline, they also get savings due to sharply lower maintenance costs.

As outlined above, educational videos and the AFDC's vehicle cost calculator should be used to enhance awareness for the money electric vehicle owners save on maintenance.

As outlined in Section 6.3 of this plan, Electrify Heartland recommends that local communities consider promoting the placement of EVSE in locations that are convenient and accessible, but not necessarily in the most prominent or advantageous locations.

Preferred parking for electric vehicles can be a double-edged sword for property owners and the electric vehicle industry alike, as prominently placed and little-used "EV only" parking spaces could spark a consumer backlash.

8.7 Promote incentives for EV and EVSE

Electrify Heartland in summer of 2012 sponsored a Facebook promotion, "Where in the Heartland is EVSE?" designed to heighten the public's awareness about the number and location of electric vehicle charging stations in the planning region.

The contest featured photographs of nearly three dozen charging stations, and donated prizes, such as Kansas City Royals baseball tickets and AMC Theatres movie passes, to those who correctly guessed the location of each charging station.

In doing so, Electrify Heartland accomplished three major goals:

- Enhanced awareness among consumers in the planning area for the growing number of publicly available charging stations to serve electric vehicle owners.

14 Brownback, Sam. "Governor Brownback Addresses WINDPOWER 2012 Conf." *Kansas: Office of the Governor*. Kansas Sam Brownback, 4 June 2012. Web. 10 Dec. 2012. <http://governor.ks.gov/MEDIA-ROOM/MEDIA-RELEASES/2012/06/04/GOVERNOR-BROWNBACK-ADDRESSES-WINDPOWER-2012-CONFERENCE>.
15Ellis, Blake. "Farmer Cashes in on Wind and Oil Royalties." *CNN Money*. Cable News Network, 6 June 2012. Web. 10 Dec. 2012. <http://money.cnn.com/video/news/2012/06/01/n-farmer-wind-oil-royalties.cnnmoney/>.

- “Rewarded” private businesses, such as Walgreen’s and area auto dealerships, by showcasing their EVSE installations.
- Increased the level of consumer engagement with the Electrify Heartland program via Facebook and the Electrify Heartland Website.

Additionally, Electrify Heartland is working in partnership with utility partners, such as Westar Energy, to promote their efforts to install EVSE in cities and towns throughout the planning area.

8.8 Develop webinars for EV and EVSE audiences

Perhaps the most powerful way to convey key messages about the benefits of electric vehicles is through Web-based video, which allows stakeholders to “show” as well as “tell” the EV story.

We recommend developing a series of webinars, which could include content as simple as narrated Power Point presentations or as complex as professionally produced videos, to quickly provide news and information about electric vehicles and EVSE to key audiences including:

- Business and property owners considering EVSE installation
- Elected officials and civic leaders
- Auto dealers and sales representatives
- Members of the news media
- Consumers

8.9 Educate public officials on EV benefits and challenges

The Electrify Heartland team has held public meetings with elected officials, representatives of city government and concerned citizens in the following Kansas communities in the planning area, with additional “road show” meetings scheduled in the future:

- Lawrence
- Topeka
- Manhattan
- Salina
- Wichita

Additionally, as outlined in Appendix O, Electrify Heartland has created an EV Ready Communities award, to help cities identify and implement best practices to support electric vehicles and related infrastructure.

Similar to Leadership in Energy and Environmental Design (LEED) Certification, EV Ready Communities uses a series of criteria that municipalities can use to earn a one-, two-, or three-star designation, based on the number of criteria met.

8.10 Develop requirements for Website with benefits, EVSE locations and EV options, webinar promotion

Electrify Heartland has created a comprehensive website, www.ElectrifyHeartland.org, to provide the public with news and information on all aspects of EV and EVSE development in the planning region.

The steering committee developed a flowchart and built the website using a Wordpress platform, enabling any member of the team to add pages and/or update content with minimal programming or training.

As of this writing, the website contains the following elements:

- About EVs (including vehicle descriptions, a glossary of terms and the Department of Energy's electric vehicle consumer handbook in downloadable PDF form)
- Event Calendar
- Links to other helpful online resources
- News releases, photos and videos
- Planning maps
- "Where is EVSE?" contest page (as outlined in this section)
- Password-protected Workspace page, where Steering Committee members can share and access planning documents and other resources

Additionally, Electrify Heartland has created social media pages on Facebook and YouTube, and maintains a Twitter account (@ElectrifyHeart) that currently has more than 140 "followers."

9 Utility Grid

9.1 Section Introduction

9.1.1 Synopsis

Electrify Heartland proposed to identify and analyze barriers to the implementation of plug-in electric vehicles (EV) and infrastructure in the proposed area and discuss steps to reduce or eliminate the identified barriers.

The Utility Sub Team identified several potential barriers to increased EV penetration in the region:

- EV impacts on the area electrical distribution system.
- EV/electric vehicle supply equipment (EVSE)/grid communications.
- Area utility rates for EVSE.
- Net metering plan and EVSE.
- EV road tax issues.
- Utility smart grid plans.
- Cost recovery allowed to utilities for EVSE.

In examining these potential barriers to EV development in the region, the Utility Sub Team (UST) found some areas for development, but no insurmountable barriers.

9.1.2 Authors and Contributors

Chad Mazurek, Lucas Oehlerking, Bill Roush, and Sam Scupham, Black & Veatch

9.2 EV impacts on the area electrical distribution system

Three representative electric utility distribution feeders were examined: a likely-adopter residential, a mixed use residential and commercial, and an industrial fleet area.

The study findings indicate that for the probable level of electric vehicle deployment within a reasonable utility planning time horizon, there is little concern regarding electrical distribution impacts. This level of vehicle market penetration is far less than 1 percent of current gasoline fueled vehicles. A “one percent case” of EV penetration was modeled and no impact was found on the distribution grid parameters examined. The Black & Veatch distribution study analyzed much higher levels of EV penetration (20 to 100 percent) and was intended to indicate which components of the distribution grid might benefit from additional planning studies if EV penetration were to reach higher percentages.

Even under the most optimistic forecasts for EV market penetration, converting significant portions of the vehicle fleet to EVs would take years. There are currently more than 230 million light duty vehicles in the U.S.[16] This planning effort focuses on deployment of 1 million U.S. EVs by 2015. This utility distribution study considered penetration levels of 20 percent and higher, which equates to 50 million or more EVs in the U.S. These penetration levels were used to provide perspective on the utility planning horizon, rather than to focus on short-term needs. Annual sales of new passenger vehicles are approximately 10 million per year,[17] so it would take years or even decades of high EV sales levels to reach 20 percent or higher penetrations.

Little EV impact is expected on the distribution system in the near future. If mainstream levels of 20 to 100 percent of EV penetration should occur, the highest reliability risk would be to the primarily residential feeders. The residential feeders would most likely have the largest amount of constant EV load (i.e., daily chargers), especially during the work week. In addition, as the system exists today, residential load is typically smaller than that of commercial and industrial establishments. Consequently, the equipment on the residential feeders has lower ratings than that of mixed residential and commercial or industrial feeders.

9.2.1 Residential Area Concerns

The main concerns for residential areas with increased EV use include the following:

- Potential phase imbalances where this problem already exists.
- Over and under voltages.
- Transformer overloads.
- Main feeder thermal overloads.

These areas of concern may appear at levels of EV penetration far higher than what is seen today. Black & Veatch's study reviewed various scenarios with penetrations of 20, 40, 60 and higher percents. The study goal was to determine what areas need to be monitored first so that planning could be focused in those areas.

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[16] U.S. BUREAU OF TRANSPORTATION STATISTICS FOR 2010. "Table 1-11: Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances." *Bureau of Tranportation Statistics*. Research and Innovative Technology Administration (RITA) • U.S. Department of Transportation (US DOT), n.d. Web. 10 Dec. 2012. <http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html>.

17U.S. BUREAU OF TRANSPORTATION STATISTICS FOR 2010. "National Transportation Statistics." *Bureau of Tranportation Statistics*. Research and Innovative Technology Administration (RITA) • U.S. Department of Transportation (US DOT), n.d. Web. 10 Dec. 2012. <http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf>.

9.2.2 Mixed Residential and Commercial

In the mixed residential and commercial scenario, minimal impacts were identified on the commercial side for public charging stations sized for up to 100 EVs. Most of the impacts were isolated to the residential portion of the feeder at very high penetration levels.

9.2.3 Industrial Fleet

No reliability impacts were identified for the fleet scenario.

9.2.4 EV/EVSE/GRID Communications

The advanced batteries in electric cars have charging procedures that need to be followed to maintain longevity, safety, and warranties. This is especially true when charging rates increase. In addition, the Society of Automotive Engineers (SAE) defines different levels of charging with varying rates. (Refer to Section 9.4.3, Current Standards.)

Communications between the EVSE and the battery pack in the vehicle regarding data on such things as battery temperature, ambient temperature, state of charge, and charge rate are needed to ensure rapid, safe, and reliable charging and battery condition. Communications and standards issues relating to "overnight" duration charging are largely settled and are not a problem in planning for higher EV penetration levels.

The situation regarding "fast charging," the kind of "15 minute or less" charging that can enable long trips with daytime on-the-road recharging, is not a settled matter. There are multiple potential standards and compatibility issues that, if not resolved, could hamper EV adoption in areas of the country where long trips are common and range anxiety is a concern for EV owners. Making sure that these public, fast charging EVSE can "talk" to the EVs that drive up to them is important for long-term EV adoption.

At lower levels of penetration, when the EVs purchased are self-selected for commuting and are charged at home at night and/or in an employee parking lot, the fast-charging standards are less important.

9.2.5 Area utility rates for EVSE

Some concepts for rate structures for EV charging can involve high rates at certain times and, perhaps more importantly, require the vehicle owner to install expensive equipment. These types of rate structures could create a barrier to EV penetration if they are perceived by the public to remove the economic advantages of EV ownership or to create an installation inconvenience.

Currently, neither Missouri nor Kansas has a utility rate structure that would create a barrier to the adoption of EVs. See Section 3.6 for discussion of rate structures being used elsewhere in the U.S. and Section 9.5 for a more complete discussion of rates in Kansas and Missouri. There is some consideration by utility regulatory staff of possible studies or pilot programs that could involve higher rates in peak demand times. These studies may lead to increased management of EV charging times, but do not, in the near term, seem likely to create a barrier to EV adoption.

9.2.6 Net metering rules in Missouri and Kansas for EVSE

Net metering is one method of allowing and setting the value of electricity sold by a customer-producer to the utility. Usually this occurs when a customer-producer generates electricity from an on-site solar array, wind generator, or other distributed generation device. In the case of an EV, the customer controls electricity stored in a battery in a vehicle which could, theoretically, be sold to a utility. Net metering rules become important to EV penetration only when there are vehicles and EVSE capable of vehicle-to-grid (V2G) charging and selling of electricity to and from the grid. For the most part, neither EVSE nor EVs are now capable of this kind of two-way transaction, in large part because communication and related standards have not been set for such activity.

Currently, neither Missouri nor Kansas net metering laws directly address sales of electricity from an EV to a utility. This absence of metering rules does not create a direct barrier to EV penetration, nor does it create a clear legal path for such transactions.

9.2.7 EV Road Taxes Issues

Several states have proposed methods to replace road tax revenue that is not paid by vehicles using alternative fuels. While some states are further along in pursuing a legislative remedy for this matter, and there is no consensus solution, there is, however, a focus on a fee per miles driven.

In Kansas, a complex proposal specifically aimed at EVs was introduced, but was delayed for further study. Missouri is actually ahead of other states and has already enacted a $75 annual fee on "alternative fueled vehicles," including EVs.

While state road taxes have come largely from gas taxes, local streets are largely paid for by local communities with other local taxes. The local taxes in place now include utility franchise taxes that are paid on a per kilowatt-hour (kWh) basis by electricity users, including EV owners.

While action regarding these tax issues in the Kansas legislature bears watching, currently there are no significant tax barriers to higher penetrations of EVs in the two-state region.

9.2.8 Utility Smart Grid Plans

There has been much discussion and effort put into making the U.S. utility grid smarter, which generally means adding controls and communication aspects at various points in the transmission and distribution system. If these controls and communication protocols conflict with EVSE, causing malfunctions or poor operation, it may create a barrier to EV penetration.

Both Westar Energy (Westar) and Kansas City Power & Light (KCP&L) have smart grid demonstration projects. Westar's SmartStar program covers 39,000 residential meters and 4,000 commercial meters in Lawrence, KS. KCP&L's project in what is called the Green Impact Zone in central Kansas City, MO, includes 14,000 commercial and residential customers. Neither project has an exceptionally large EV charging component. Both smart grid projects allow for and have encouraged EV participation.

9.2.9 PV and EVSE for daytime charging

The potential for daytime EV charging raised initial concern that, in general, adding to peak utility demand could cause cost or reliability issues and create a barrier to increased levels of EV penetration. This study investigated levels of EV penetration that are far lower than 1 percent of load. While adding to peak demand at the expected levels of EVs (approximately 7,000 vehicles by 2015) in the study region will not create grid reliability issues, there was an interest in exploring solar photo voltaic (PV) as an option for serving a part of the peak.

Black & Veatch's study team did not do a technical study of the potential for PV to shave peak or allow for increased EV charging. However, the team did survey commercial efforts to combine daytime generated solar power with EV charging. Black & Veatch's survey of activities in this area found several national and regional examples of businesses active in some aspect of combining EV charging with solar power. PV used in a duel role as covered parking and power producer was a common way to make the solar and EV charging connection. University research efforts are being pursued in the region to study other managing elements such as energy storage and power electronics. See section 11 for a longer discussion of PV.

9.2.10 Cost Recovery Allowed to Utilities for EVSE

The Kansas Corporation Commission (KCC) has not issued any rulings directly relating to cost recovery for EV programs by utilities. One method they could use to give guidance in this area would be through a predetermination docket.[18] The KCC did commission a study, *Electric Vehicle Rate Issues*, issued in April 2012 which addresses topics like the key

[18] Fry, Andrew. 8 Oct. 2012. E-mail.

ratemaking issues related to EVs, an overview of current utility EV ratemaking practice (from other states), and some observations about EV activity in Kansas.

9.3 Electric Vehicle Impacts on the Area Electricity Distribution System

This section of the report outlines the Edison Electric Institute (EEI) guide to EV readiness, previous EV grid impact studies, and the Black & Veatch study assessing potential EV impacts on the electricity grid in the study area.

9.3.1 Introduction

According to a report issued by the Union of Concerned Scientists (UCS), regardless of where EVs are charged, the greenhouse gases (GHGs) associated with using EVs are less than those emitted by vehicles powered by internal combustion engines. In the Kansas City area, the emissions associated with EV charging, according to the recent generation profile data used in the study, are similar to the most efficient conventional vehicles and some hybrid electric vehicles.[19] For example, EV emissions in Kansas City are estimated to be equivalent to a car getting 35 miles per gallon (mpg), which is above the compact vehicle national average of 27 mpg.

The UCS report was based on power plant production and emissions data for the region in 2009. It is important to note that a utility generation profile changes over time and that some utilities in the region have lower GHG emissions than the average. For instance, Westar Energy submitted a greenhouse report and control plan to the Kansas Department of Health and Environment in April 2009 that shows their CO2 emissions to be lower than the regional profile used by UCS.[20]

Regardless, according to the UCS report, almost half of all Americans live in areas where the GHGs associated with driving EVs are less than the most efficient hybrids available today.

Additionally, depending on the cost of electricity in a particular region of the United States, EV use could result in fuel savings of up to $1,200 per year over a gasoline powered car.[21]

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[19] Anair, Don, and Amine Mahmassani. "State of CHARGE:Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States." *Union of Concerned Scientists and Citizens for Environmental Solutions*. Union of Concerned Scientists, June 2012. Web. 10 Dec. 2012. <http://www.ucsusa.org/assets/documents/clean_vehicles/electric-car-global-warming-emissions-report.pdf>.
[20] Kansas Department of Health and Environment. "KDHE Greenhouse Gas Report." *Westar Energy*. Westar Energy, n.d. 10. Web. 10 Dec. 2012. <http://www.westarenergy.com/WCM.NSF/CONTENT/KDHE%20GHG%20REPORT>.
[21] Ibid

With these environmental and operation cost benefits, some predict EVs will gain higher levels of market penetration. A 2011 study by the Center for Automotive Research estimated that U.S. sales for electric vehicles will increase to 140,000 vehicles sold in 2015. The study takes into consideration such factors as previous nationwide hybrid registrations and forecasts by J.D. Power.[22] The predictions of EV penetration vary widely; a report issued by the Electric Power Research Institute (EPRI) assumed 100 million EVs by 2030 when analyzing the possible emissions reductions from EV adoption.[23] While the estimates of future EV deployment vary from source to source, President Obama's administration is helping drive these projected EV levels by setting a goal of 1 million EVs on the road by 2015.[24]

9.3.1.1 Edison Electric Institute

To help utilities get ready for these levels of deployment, the EEI produced "The Utility Guide to Plug-In Electric Vehicle Readiness." The EEI is "the association of U.S. shareholder-owned electric companies," according to the EEI Plug-In Readiness Guide.[25] The guide references a study that EEI conducted in 2010. According to the study:

> "… almost three in four (71 percent) residential customers feel that electric utilities should [be] working and investing now to assure that proper infrastructure [is] in place for convenient recharging of electric vehicles. Furthermore, almost two-thirds (61 percent) wanted their utility [to] take a leadership role in encouraging a shift toward electric transportation."[26]

The guide breaks down preparing for EVs into the following four areas:

Getting Your Company Up to Speed
Topics to consider when preparing various departments within a utility for EV deployment.

Enhancing the Customer Experience

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[22] Center for Automotive Research (CAR). "Deployment Rollout Estimate of Electric Vehicles 2011-2015." *Car Group*. N.p., Jan. 2011. Web. 10 Dec. 2012. <http://www.cargroup.org/assets/files/deployment.pdf>.

[23] Electric Power Research Institute. "2009 Portfolio: Electric Transportation - Program Overview." *Electric Power Research Institute*. N.p., 2009. Web. 10 Dec. 2012. <http://mydocs.epri.com/docs/Portfolio/PDF/2009_P018.pdf>.

[24] "Vice President Biden Announces Plan to Put One Million Advanced Technology Vehicles on the Road by 2015." *Energy.gov*. US Dep of Energy, 26 Jan. 2011. Web. 10 Dec. 2012. <http://energy.gov/articles/vice-president-biden-announces-plan-put-one-million-advanced-technology-vehicles-road-2015>.

[25] Edison Electric Institute, and Electric Drive Transportation Association. "The Utility Guide to Plug-In Electric Vehicle Readiness." *Edison Electric Institute*. N.p., Nov. 2011. Web. 10 Dec. 2012. <http://www.eei.org/ourissues/EnergyEfficiency/Documents/EVReadinessGuide_web_final.pdf>.

[26] Edison Electric Institute, and Electric Drive Transportation Association. "Power Poll, Quarter 4, 2010." *Edison Electric Institute*. Web. 10 Dec. 2012.

Making sure customers have a positive experience with EV deployment where "education and outreach will be essential."

VIPs (Very Important Passengers) to Include
Engaging other groups and stakeholders when utilities develop EV plans.

Plugging into the Grid
Items to consider for distribution system impacts.

According to the guide, various utilities are already showing substantial progress toward EV readiness. Southern California Edison has a mature plug-in EV (PEV) Readiness Program with 25 full-time employees working in "four parallel workstreams: Operations, Infrastructure, Customer Education & Outreach, and External Engagement." Other utilities that are also showing significant EV activity include DTE Energy, Hawaiian Electric Company (HECO), Indianapolis Power & Light (IPL), San Diego Gas & Electric (SDG&E) and Southern Company. Some of the items being addressed include the following:

- Modeling PEV loads on their distribution system.
- Conducting surveys to monitor penetration rates.
- Conducting processes for PEV use notifications.
- Conducting employee training and preparedness.

The EEI guide also includes an easy to review checklist that can aid a utility in understanding where it is in the process of becoming "EV Ready" and what some of the next steps might be. The checklist offers many suggestions for actions that can be scaled to any size utility.

9.3.1.2 Past EV Grid-Impact Studies

Studies predicting the impacts of a significant number of EVs charging on the electricity grid have been around for some time. This subsection does not contain a complete list of the plug-in hybrid EV (PHEV) grid-impact studies, but it outlines the evolution of the previous studies and provides a background for the Black & Veatch modeling methodology.

Lemoine, Kammen, and Farrell (2006) studied the projected impact of 1, 5, and 10 million PHEVs on an area served by the California Independent System Operator (CAISO) with three charging scenarios: optimal charging (from a grid-operator standpoint), evening charging, and twice per day charging. The study showed that 1 million EVs probably do not produce a significant problem for any charging scenario, but system generation capacity upgrades in the CAISO area may be necessary if large PHEV fleets (several million) were allowed to charge during peak times.[27]

In 2007, Kintner-Meyer, Schneider, and Pratt at Pacific Northwest National Laboratory (PNNL Generation) and Parks, Denholm, and Markel at the National Renewable Energy Laboratory (NREL) were also studying EV grid impacts at about the same time as Lemoine et al. The PNNL generation study showed that the national grid could support the changing energy requirements of up to 73 percent of the U.S. light-duty vehicle (LDV) fleet, although this percentage varies by region of interest. This would require many power plants to operate at near capacity during most of the day.[28]

NREL studied an Excel Energy Colorado service territory using public and "proprietary system data." The study looked at summer and winter load impacts and used four charging scenarios: (1) uncontrolled charging, (2) delayed charging, (3) off-peak charging, and (4) continuous charging. Continuous charging, where the vehicle charges wherever it is parked continuously throughout the day, resulted in the worst-case scenario and increased the load total and peak demand. However, most load impacts were minimal, and even problems with high penetration rates could be avoided by charging constraints such as delayed charging mechanisms.[29]

9.3.1.3 Recent EV Grid Impact Studies

Among the more recent studies is a study by Letendre and Watts[30] and a study by Sioshansi, Fagiani and Marano.[31] Letendre et al. reported on the impacts of PHEVs on the Vermont power system. They report that even a small amount (50,000) of uncontrolled charging PHEV penetration could increase peak demand. Delayed night-time charging could allow

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[27]Lemoine, Derek, Daniel M. Kammen, and Alexander E. Farrell. "Effects of Plug-In Hybrid Electric Vehicles in California Energy Markets." University of Vermont. N.p., 15 Nov. 2006. Web. 10 Dec. 2012. <http://www.uvm.edu/~transctr/pdf/email/LemoineArticle.pdf>.

[28]Kintner-Meyer, Michael, Kevine Schneider, and Robert Pratt. "IMPACTS ASSESSMENT OF PLUG-IN HYBRID VEHICLES ON ELECTRIC UTILITIES AND REGIONAL U.S. POWER GRIDS PART 1: TECHNICAL ANALYSIS." *Federal Energy Regulatory Comission*. N.p., 24 May 2007. Web. 10 Dec. 2012. <http://www.ferc.gov/ABOUT/COM-MEM/WELLINGHOFF/5-24-07-TECHNICAL-ANALY-WELLINGHOFF.PDF>.

[29]Parks, K., P. Denholm, and T. Markel. "Costs and Emissions Associated with Plug-In Hybrid Electric Vehicle Charging in the Xcel Energy Colorado

[30]Letendre, Steven. "Effects of Plug-In Hybrid Electric Vehicles on the Vermont Electric Transmission System." *University of Vermont*. N.p., n.d. Web. 10 Dec. 2012. <http://www.uvm.edu/~transctr/trbpapers/Effects_of_PHEVs_on_the_Vermont_Electric_Transmission_System.pdf>.

[31] Sioshansi, Ramteen, Riccardo Fagiani, and Vincenzo Marano. "Cost and Emissions Impacts of Plug-In Hybrid Vehicles on the Ohio Power System." *Ohio State University*. N.p., 7 July 2010. Web. 10 Dec. 2012. <http://www.ise.osu.edu/ISEFaculty/sioshansi/papers/PHEV_ohio.pdf>.

more than 100,000 PHEVs without adding to peak demand, and complete utility control could enable about one-third (200,000) of Vermont's LDVs to charge on the grid without adding to peak electricity demands. Sioshansi et al. reported that a 5 percent penetration level on the Ohio power grid has a "negligible impact;" however, 30 percent LDVs with uncontrolled charging could result in a summer peak load increase of over 3 percent.

9.3.1.3.1 2010 PNNL Distribution System Analysis

Gerkensmeyer, Kintner-Meyer, and DeSteese (PNNL Distribution) published a detailed report, "Technical Challenges of Plug-In Hybrid Electric Vehicles and Impacts to the US Power System: Distribution System Analysis," that studied PHEV impacts on the residential distribution systems of three utilities: Franklin Public Utility District (PUD), Snohomish PUD, and Puget Sound Energy (PSE). The study focuses on the impacts to the entire distribution system as well as the impacts on transformers serving each load. The charging cases include Level 1 and 50/50 mix of Level 1 and Level 2 charging. These different charging levels were coupled with different charge times to make up six different charge cases. Given the lack of information about work charging, the work charging was modified to include only the home charging component (Case 2M and 5M). The charge scenarios are as follows:

- Case 1 – 120 V charging at home.
- Case 2M – 120 V charging at home and work – home only.
- Case 3 – 120 V charging at home delayed until after 10 p.m.
- Case 4 – 50/50 120 V/ 240 V charging at home.
- Case 5M – 50/50 120 V/ 240 V charging at home and work – home only.
- Case 6 – 50/50 120 V/ 240 V charging at home delayed until after 10 p.m.

The number of feeders studied varied from eight for Snohomish PUD and PSE to 34 for Franklin PUD. The feeders were composed of various amounts of residential, commercial, and industrial loads. The load curves for Franklin PUD and Snohomish PUD were verified by engineers at both utilities and were exported using SynerGEE Electric 2009 (SynerGEE). The levels of penetration considered were 50 percent and 100 percent. A penetration of 100 percent means that each residential customer owns one PHEV. The study evenly distributed these PHEVs throughout the residential-only distribution system. Each residential customer was allotted 7.5 kilovolt-ampere (kVA) and, given the transformer capacity, the number of customers on each transformer was calculated. Analyses were performed in 1 hour increments throughout the day for each of the six charge cases using two levels of penetration (50 percent and 100 percent).[32]

For Franklin PUD, charge Case 3 resulted in all 34 feeders being able to handle even 100 percent (one car per house) PHEV penetration. However, Case 6 resulted in only 19 feeders that could tolerate 100 percent PHEV penetration. Equipment failure for Case 6 included fuses, lines, and switches. The worst case scenario for PSE feeders appears to include Case 6 as well (Cases 4 through 6 were the same), with four feeders' fuses being affected at 100 percent penetration. A 50 percent penetration would cause failures on at least one feeder for all cases. For Snohomish PUD, Case 6 was again the worst, with six feeders showing some kind of failure; 100 percent penetration did not affect Cases 1 through 3. The equipment failing in Case 6 were lines and regulators.[33]

Fast charging was considered for each of the utility's systems as well. This new scenario consisted of three hours of nominal (3.5 kW) charging, from 5 p.m. to 8 p.m. For Franklin PUD, 100 percent penetration caused failures on more than 20 feeders, which included fuses, lines, switches, and reclosers. Fuses were the primary mode of failure for 100 percent penetration for both PSE and Snohomish PUD, with four and seven feeders showing failures at 100 percent penetration, respectively.[34]

Finally, the 2010 PNNL Distribution study analyzed secondary transformer impacts for each utility for each of the six charge cases. The study presented the number of transformers that were at various levels of capacity for each scenario. For Franklin PUD, charge Case 6 produced a significant number of transformers operating with 70 percent to 100 percent of capacity. For example, the number of transformers operating at 70 percent capacity went up from less than 500 for Case 5 to more than 1,500 for Case 6 at 100 percent penetration. PSE showed many transformers already operating above 100 percent capacity, and this number appeared to increase in the worst Case 6. Snohomish PUD did not show any transformers operating above 100 percent, even for 100 percent PHEV penetration.[35]

In summary, Level 1 charging is generally not a concern to the distribution system but could cause fuses to fail at high levels of PHEV penetration. However, if Level 2 charging is used, fuses, lines, switches, and reclosers can fail at higher levels of PHEV penetration. Making

[32] Gerkensmeyer, C., MCW Kintner-Meyer, and JG DeSteese. Technical Challenges of Plug-In Hybrid electric Vehicles and Impacts to the US Power System: Distribution System Analysis. Rept. no. PNNL-19165. N.p.: PACIFIC NORTHWEST NATIONAL LABORATORY, 2010. SmartGrid. Web. 10 Dec. 2012. <http://www.smartgrid.gov/sites/default/files/resources/phev_distribution.pdf>
[33] Ibid.
[34] Ibid.
[35] Ibid.

matters worse in this study is delaying the charging until 10 p.m., since the charging is allowed to naturally distribute over several hours. According to the study, of particular concern are older residential transformers that are already operating above their nameplate capacity and have been in use for quite some time.[36]

9.3.1.3.2 2010 ISO/RTO Report

The grid impact section of a report, "Assessment of Plug-In Electric Vehicle Integration with ISO/RTO Systems," by the Independent Systems Operator and Regional Transmission Organizations (ISO/RTO) Council and DNV KEMA Energy & Sustainability (KEMA) projected PEV penetration rates in regions of the North American ISOs and RTOs. Each region gets its share of the Obama administration's goal of 1 million PEVs. A "fast" scenario would achieve this goal by 2015, while a "target" penetration would achieve this by 2017. Finally, a "slow" case would not hit this level of penetration until 2019. The study covered other aspects associated with PEV deployment, but the PEV grid impact is of interest to this report.[37]

Two charging scenarios were examined: charging in a 12-hour time frame and charging in an 8-hour time frame. Also, as a worst case scenario, charging happening in a 1-hour time frame was considered. The report assumed that advantages to Level 2 charging would likely result in 80 percent of the overall charging, leaving Level 1 charging to cover the remaining 20 percent of PEVs.

The report predicted that Los Angeles will have the most PEVs of the target 1 million, resulting in 119,069 PEVs. San Francisco is close behind at 91,005 PEVs, while the Kansas City metro area comes in at 5,000 PEVs. The report predicted the load "based on the portion of the load within their primary ISO/RTO." The load produced in Los Angeles and San Francisco if everyone charged in the same 1-hour window would be 658 megawatts (MW) and 503 MW, respectively. Scaling this load according to the number of PEVs in the Kansas City metro area, the metro area would see an increase in load of about 27.5 MW.

In summary, PEV adoption modeled after Prius adoption profiles in this report will most likely be focused in the West Coast and Northeast regions.

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[36] Ibid.

[37] Fell, Ken, et al. "Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems." *ISO/RTO Council*. N.p., Mar. 2010. Web. 10 Dec. 2012. <http://www.isorto.org/ATF/CF/%7B5B4E85C6-7EAC-40A0-8DC3003829518EBD%7D/IRC_REPORT_ASSESSMENT_OF_PLUGIN_ELECTRIC_VEHICLE_INTEGRATION_WITH_ISO-RTO_SYSTEMS_03232010.PDF>.

9.3.1.3.3 2011 Janigian Study

A detailed analysis of a specific residential feeder in California was outlined by Darren Janigian at California Polytechnic State University in 2011. The study, “Plug-In Hybrid Electric Vehicle Impacts on a Central California Residential Distribution Circuit,” created a generalized model in Electronic Transmitter Analyzer Program (ETAP) for an actual system in central California and considered only residential components. The study assumed a Chevy Volt battery and included both Level 1 and Level 2 charging. The study examined PHEV levels of deployment from 0 percent (baseline) to 100 percent in 20 percent increments. 100 percent penetration means one PHEV per household.[38]

The study loaded the PHEVs on the feeder in a way to emphasize sequential end-of-line to substation (EOL-sub) loading, sub-EOL loading, and “cluster” loading. EOL-sub loading means that EVs were added near the end of the feeder first. The analysis looked at voltage levels on the main bus, as well as overall feeder load for peak and off-peak times.

The worst-case charging scenario was charging during peak hours of operation with Level 2 charging. The loading arrangement that puts the most stress on the system is EOL-sub PHEV deployment. At 15.3 percent penetration, or 264 of the 1,722 possible total PHEVs, a 64 percent circuit breaker will trip, followed by an 80 percent circuit breaker trip at 33.2 percent penetration. The main 12 kV overhead feeder overload occurs at 37.6 percent, and the final circuit breaker will trip at 54.8 percent penetration. For reference, switching to off-peak charging for this scenario allows for 50 percent penetration before the 64 percent circuit breaker trips.

Full capacitor support was required because of sagging voltages at 60 percent penetration for Level 2 charging. For 100 percent penetration, the voltage dropped to 96.5 percent at the end of the distribution line. Increased wear on service transformers could cause a drop below 95 percent. At 100 percent penetration and Level 2 charging, all transformers will be overloaded beyond the 130 percent.

The first circuit breaker trip will only require “switching operations” to be changed, and no equipment will be damaged. However, the report stated that details on circuit breaker settings were beyond the scope of the study.

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[38] Janigian, Darren. "Plug-In Hybrid Electric Vehicle Impacts on a Central California Residential Distribution Circuit." Caly Poly San Luis Obispo. California Polytechnic State University, June 2011. Web. 10 Dec. 2012. <http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1543&context=theses>.

9.3.2 Black & Veatch Distribution Planning Study

For the EV impact modeling study, Black & Veatch used a distribution planning software called SynerGEE Electric.

9.3.2.1 Distribution Impact Modeling

Black & Veatch developed a framework for modeling EV grid impacts that was based on past EV grid-impact studies and modified to fit regions in the Kansas City metropolitan area.

To gain insights into EV use demographics and transportation-based information, Black & Veatch collaborated with the Mid-America Regional Council (MARC). MARC assessed extensive EV user demographics in the Kansas City metropolitan area in the past for the Greater Kansas City Plug-In Readiness Initiative.[39] These demographics were updated for this study to validate the characteristics of feeders to be modeled in the study. Discussions with the participating utilities also validated the selection of feeders to be studied. Details about the feeder selection and how they relate to Black & Veatch's modeling efforts are discussed in the following sections.

The intent of this study is to explore the limits of the distribution system to see what, if any, impacts would arise from higher penetrations of EVs into the Kansas City metropolitan area. With that in mind, Black & Veatch looked at three scenarios: a residential scenario, a mixed use residential and commercial scenario, and an industrial fleet scenario. Each of these scenarios was then divided into different EV penetration scenarios to explore unique loading schemes relevant to EV impacts on the distribution grid. The scenarios and assumptions for each are described in detail in the following sections.

9.3.2.2 Selecting Feeders of Interest

To further refine which areas within the utility service area would be relevant to EV penetration; Black & Veatch collaborated with MARC to update EV user demographics from MARC's previous work on the Greater Kansas City Plug-In Readiness Initiative. The EV user demographics that are used to validate feeder selection for this EV grid-impact study include an Electric Vehicle Driver Residence Analysis and an Electric Vehicle Driver Destination Analysis that were initially created by MARC. These analyses were updated with more current American Community Survey (ACS) census data that are a 5-year average from 2005 to 2009.

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[39] Greater Kansas City Plug-in Readiness Iniative, Mid-America Regional Council, and Kansas City Regional Clean Cities. "Greater Kansas City Plug-in Readiness Strategy." *Mid-America Regional Council*. N.p., 16 Feb. 2011. Web. 10 Dec. 2012. <http://www.marc.org/assets/GreaterKansasCityPlug-InReadinessStrategy.pdf>.

The residence analysis uses ACS census data to predict the most likely areas of high EV concentrations in the Kansas City metro. Multiple ACS census datasets and an anonymous EV-owner hand-raisers dataset were weighted together to form the residence analysis. The methodology that MARC used in this analysis was similar to other studies around the nation. According to the Greater Kansas City Plug-In Readiness Strategy, census datasets were selected to meet the following criteria: households with higher income, households with higher education, older population (likely disposable income), and households with 2 or more vehicles. The updated residence analysis created by MARC is shown on Exhibit 9-1.

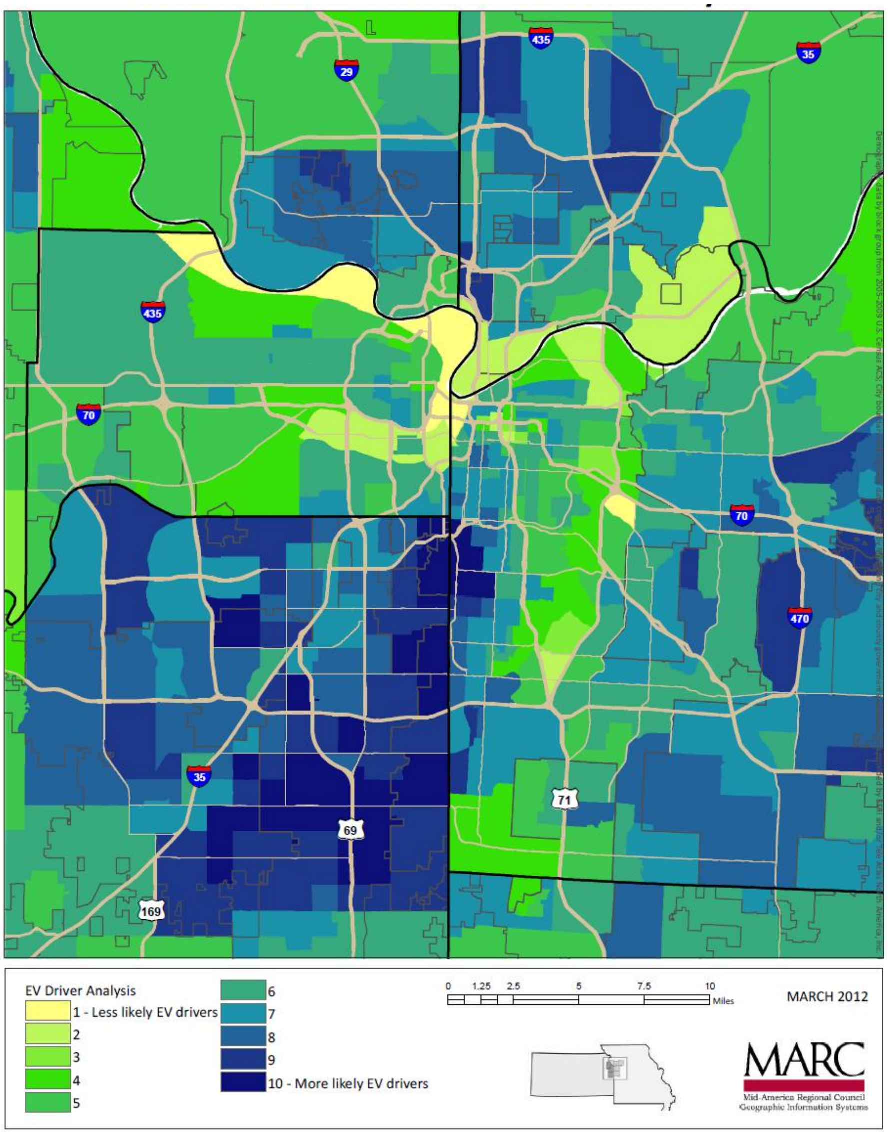

Exhibit 9-1 Electric Vehicle Driver Residence Analysis

The destination analysis estimates the destination of EV drivers with trips originating from the most likely regions of high EV concentration from the residence analysis. In addition to factoring in the residence analysis as areas of origin, the destination analysis also takes into consideration census employment data such as density of high income workers by workplace and information about planned and current activity and employment centers. The destination analysis created by MARC is shown on Exhibit 9-2.

Similar to statements found in other EV grid-impact studies outlined in previous sections, participating utility professionals believe that as issues arise with EV adoption, they are likely to occur in feeders in older, more established residential neighborhoods. Correspondingly, the residential feeder for the study was an older, established

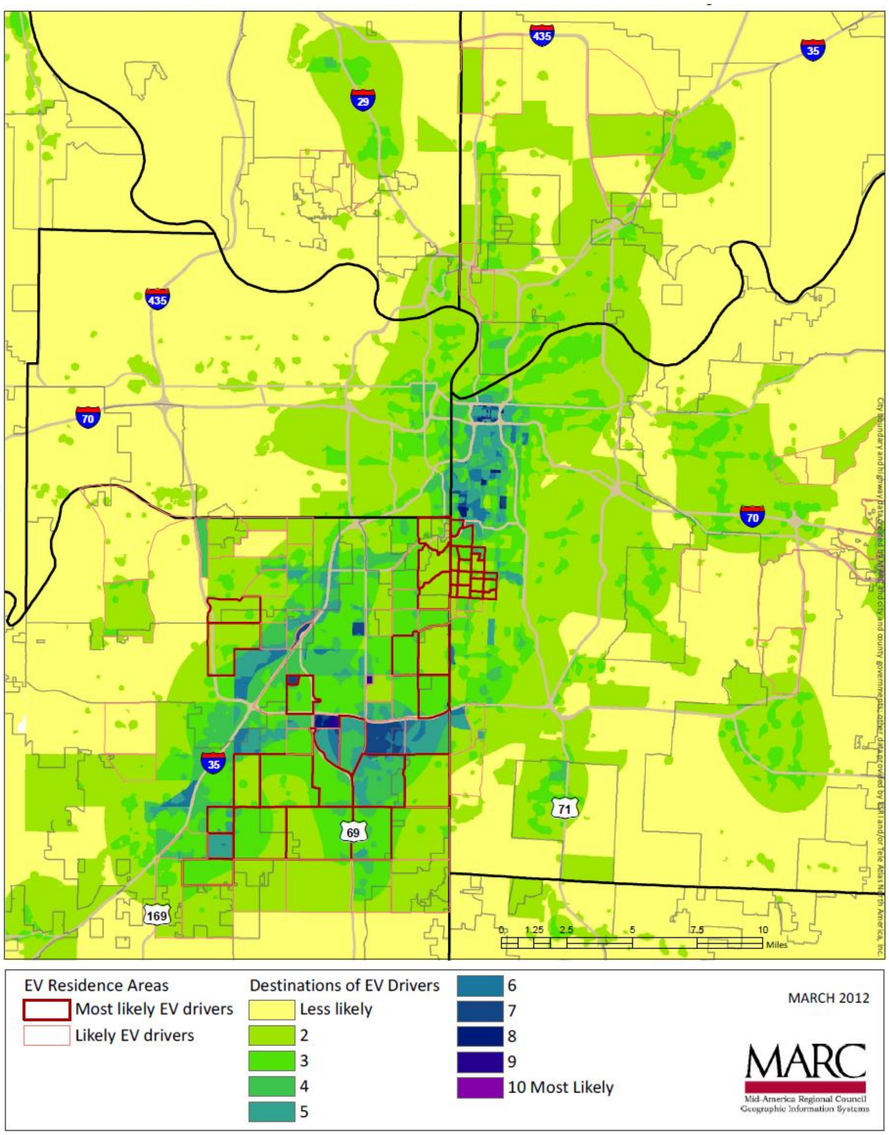

Exhibit 9-2 Electric Vehicle Driver Destination Analysis

neighborhood selected from the most likely regions of EV driver residence from the residence analysis.

Additionally, the destination analysis was used to validate selecting a feeder to explore the effects on the distribution system of EV penetration in a region with mixed commercial and residential loads. The destination analysis was used to select a feeder in a region of most likely EV driver destinations. This destination region was called mixed-use. Finally, the selection of a feeder to be used for modeling the fleet scenario was based on the location of existing distribution centers such as a delivery fleet distribution center.

9.3.2.3 Modeling Methodology and Assumptions

To assess the steady-state reliability impacts on the local distribution system from increased EV penetration, Black & Veatch performed a distribution planning study of three unique distribution feeders. Those feeders included (1) a typical residential feeder, (2) a mixed residential/ commercial feeder, and (3) an industrial feeder where an EV delivery fleet might be feasible. The study consisted of three separate analyses:

- Residential Feeder Analysis:
    - Balanced Penetration: Assumes EVs are distributed evenly across all distribution customers (i.e., no particular distribution customer is more likely to purchase an EV than another customer).
    - Front-of-Line Penetration (FOL): Assumes more EVs tend to congregate on the feeder sections closest to the distribution substation. Load pockets can lead to significant voltage sags. Since distribution feeders are typically operated in radial patterns, a considerable voltage drop near the source (distribution substation) would mean the voltage sags would only get worse further from the substation because of conductor voltage drop (losses) and downstream loads.
    - End-of-Line Penetration (EOL): Assumes more EVs tend to congregate on the feeder sections farthest from the distribution substation. Higher concentration of load can lead to significant voltage sags and thermal overloads, especially if the system is operated in radial patterns and there is a large load pocket downstream.
    - Phase-Imbalanced Penetration: Assumes EVs tend to congregate more to a particular phase than others, creating a load imbalance. This is perhaps one of the most realistic scenarios that could create impacts; despite distribution

planning engineers' best efforts, phase imbalances do exist on the system. It is common for much of a neighborhood to be served on a particular phase; therefore, it is not unreasonable to predict that increased EV penetration in such neighborhoods could lead to phase imbalances.

- Mixed Residential/Commercial Analysis
    - Assesses the impact of public charging stations at commercial establishments coupled with residential EV penetration on a feeder with roughly even distribution of residential and commercial load.
- Industrial Fleet Analysis
    - Addresses the impact of a large industrial, manufacturing, or shipping center adopting an appreciably sized EV fleet for delivery vehicles (such as a FedEx, Frito-Lay, or UPS).

The study was performed using the steady-state power flow analysis feature of SynerGEE 4.0.1, a distribution system engineering software suite used by many utilities to design and plan their distribution system. Black & Veatch obtained base case models for each of the three aforementioned types of feeders from an existing utility system. Black & Veatch modified those models to create the following study models based on references to similar studies and good engineering judgment. However, the identities of those feeders were kept confidential, and results are presented as representative of systems throughout the planning area.

SynerGEE models loads on the primary side of the service transformer as distributed loads on the circuits themselves. The service transformers are not modeled. SynerGEE uses two methods for modeling loads:

- Distributed Loads on Feeder Section
    - The entire load on a particular feeder section is distributed uniformly throughout the section. This method is preferred by distribution planners and is defined by the following parameters:
        - kW Demand
        - Kilovar (kvar) Demand
        - Connected kVA – Total kVA capacity available on transformers on each phase for the section, excluding spot loads.
        - Connected kWh – Total peak-month kWh energy usage in each phase of the section.

  - Customers – Number of customers per phase of the section.
  - Capacity Factor
  - Load Composition – The user must specify what percentage of the load is constant current (%I), constant impedance (%Z), and constant megavolt-ampere (MVA) (%PQ). This defines not only the behavior of the load, but also the boundary conditions used in the power flow solution.

- Spot Loads on Feeder Section

  - All of the load is concentrated either at the beginning, middle, or end of the section. This method is defined by the following parameters:
    - kW Demand
    - kVAR Demand
    - Connected kVA – Total kVA capacity available on transformers on each phase for the section, excluding spot loads.
    - Customers – Number of customers per phase of the section.
    - Capacity Factor
    - Load Composition – The user must specify what percentage of the load is constant current (%I), constant impedance (%Z), and constant MVA (%PQ). This defines not only the behavior of the load, but also the boundary conditions used in the power flow solution.
  - Capable of using "time-of-day analysis" with the use of "customer class" curves.
  - Not included in SynerGEE's load-balancing functions.

A customer class can have up to 72 individual load curves associated with it, including peak day, weekday, and weekend curves for each month for both kW and kVAR. An alternative to defining kVAR curves is to define a constant power factor for each of the 36 respective kW curves. Refer to Exhibit 9-3 for a visual representation for a customer class curve.

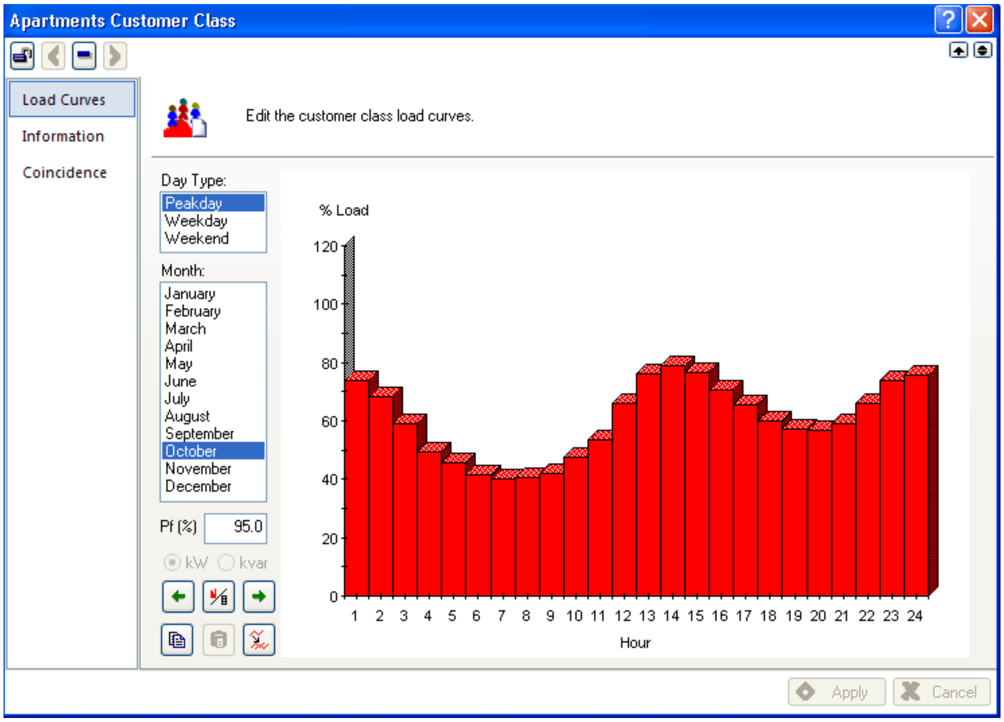

Exhibit 9-3 Customer Class Curves in SynerGEE

The user can set up several customer classes to represent different load types in the model; Exhibit 9-3 is an example of apartment load. After the users have set up various customer classes, they must then define a "customer zone." Customer zones are essentially a mixture of up to three customer classes in specified proportions that determine how much a feeder section's spot and/or distributed load pertains to each class.

Customer zones serve as the intermediary between the raw load data and the model. This intermediate step is necessary to avoid detailed and granular curve data at the section level (models can easily have thousands of sections, even for a small system). It is not feasible to apply customer classes and percentages at the section level for an entire model, because that would require section-specific curves, depending on the load composition. The basic assumption of customer zones is that all loads within a specific zone behave the same way (i.e., have the same composition).

After careful review of the merits of both types of modeling techniques, Black & Veatch determined that the best approach for this study was to model all of the EVs as separate spot loads. Spot loads are simple to implement in SynerGEE and are decoupled from the distributed loads. They can have different load compositions, customer numbers, demand, customer zones, etc., than the distributed loads. This allows the EV loads to have their own separate set of customer zone curves that could be used for all EV loads, eliminating the need to create a composite customer zone curve. Lastly, all customer zones have an assumed load composition (percent constant current, impedance, and MVA) associated with them. EV loads most generally behave as constant impedance loads To obtain the correct power flow on the feeders with EV loads, it is important to ensure that the constant impedance nature of the EV loads is realized in the models; otherwise, the boundary condition used to determine the power flow will be incorrect and could provide misleading results.

9.3.2.3.1 Residential Scenario Modeling

The residential feeder provided by the participating utility was divided into four sections (north, south, east, and west) because the feeder embodied a fairly symmetrical shape, and customer distribution was fairly uniform across each section.

The following sections describe how each sub scenario was modeled on the basis of the physical characteristics of the feeder provided.

9.3.2.3.1.1 Balanced Scenario

The balanced scenario studied up to 100 percent EV penetration in 20 percent increments. The EV placement for this scenario is straightforward. The number of EVs added is a result of the product of the penetration level and the existing customer number as shown below:

$$\boldsymbol{EV\ Load} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)$$

Each distributed load has a defined customer number. This number is understood to present single households. The above calculation assumes two vehicles per household. There is no weighted placement for this scenario; it is strictly driven by the number and location of existing customers. This scenario was also used to benchmark the remaining residential scenarios to ensure that generally the same amount of load was being added at each penetration level to avoid biased results.

9.3.2.3.1.2 End-of-Line Scenario

The end-of-line (EOL) scenario studied up to 60 percent EV penetration in 20 percent increments. The source (distribution substation) is located on the north section of the feeder. Therefore, the south section was selected for the EOL scenario. The equation used in Subsection 9.3.2.3.1.1 for the balanced scenario was modified for the south section, and for the north, east, and west sections as the following equations:

$$\boldsymbol{EV\ Load_S} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)(\boldsymbol{2})$$

$$\boldsymbol{EV\ Load_{N,E,W}} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)(\boldsymbol{0.5})$$

This provided a total EV load similar to the balanced scenario, but with the higher concentration desired on the south section.

9.3.2.3.1.3 Front-of-Line Scenario

The front-of-line (FOL) scenario studied up to 60 percent EV penetration in 20 percent increments. Similarly, as the north section is the closest to the distribution substation, it was selected for the FOL scenario. The equation used in Subsection 9.3.2.3.1.1 for the balanced scenario was modified for the north section, and for the south, east, and west sections as the following equations:

$$\boldsymbol{EV\ Load_{N}} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)(\boldsymbol{2})$$

$$\boldsymbol{EV\ Load_{S,E,W}} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)(\boldsymbol{0.5})$$

This provided a total EV load similar to the balanced scenario, but with the higher concentration desired on the north section.

9.3.2.3.1.4 Phase Imbalance Scenario

The phase imbalance scenario studied up to 60 percent EV penetration in 20 percent increments. The particular feeder modeled has a partial phase imbalance on the C phase. To be conservative, this was the phase chosen for the phase imbalance scenario. The equation in Subsection 9.3.2.3.1.1 for the balanced scenario was modified for the three phases of the alternating current known as A, B, and C in the following equations:

$$[1].\ \boldsymbol{EV\ Load_{C}} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)(\boldsymbol{1.5})$$

$$[2].\ \boldsymbol{EV\ Load_{A,B}} = \left(\frac{\boldsymbol{Customers}}{\boldsymbol{Section}}\right)\left(\frac{\boldsymbol{Vehicles}}{\boldsymbol{Customer}}\right)(\%\ \boldsymbol{Penetration})\left(\frac{\boldsymbol{6.6\ kW}}{\boldsymbol{Vehicle}}\right)(\boldsymbol{0.5})$$

This provided a total EV load similar to the balanced scenario, but with the higher concentration desired on the C phase. Per equation [1], all EV loads were assumed to have a power factor of 99 percent. The residential and commercial EVs assumed the charging characteristics of the 2012 Ford Focus EV.

9.3.2.3.2 Mixed Residential and Commercial Scenario Modeling

The mixed residential and commercial feeder represents a feeder with approximately 50/50 distribution of commercial and residential load. This scenario embodies the same practices adopted for the balanced residential scenario with the addition of a public charging station, for example, a parking garage with multiple charging ports. On the basis of the location of the various commercial establishments, Black & Veatch developed five cases. The following is a more detailed description of how each subscenario was modeled on the basis of the physical characteristics of the feeder provided:

1. 20 EV public charging station, 20 percent balanced EV penetrations for residential loads.
2. 40 EV public charging station, 40 percent balanced EV penetration for residential loads.
3. 60 EV public charging station, 60 percent balanced EV penetration for residential loads.
4. 80 EV public charging station, 80 percent balanced EV penetration for residential loads.
5. 100 EV public charging station, 100 percent balanced EV penetration for residential loads.

All EV loads were assumed to have a power factor of 99 percent in accordance with equation [1]. The residential and commercial EVs assumed the charging characteristics of the 2012 Ford Focus EV.

9.3.2.3.3 Fleet Scenario Modeling

The fleet EVs assumed the charging characteristics of the Smith Electric Vehicles Newton EV equipped 120 kWh battery modules. The following equation defines the EV load per vehicle:

$$\boldsymbol{P = \sqrt{3}(21.5\,A)(208\,V)(3)\cos(.098) = 23.233\,kW}$$
$$\boldsymbol{Q = \sqrt{3}(21.5\,A)(208\,V)(3)\sin(.098) = 0.397\,kVAR}$$

Black & Veatch chose one location and studied 20, 40, and 60 percent EV penetration at that location.

9.3.2.3.4 Reliability Criteria

The models used are non-coincident peak models that assume all distribution load peaks at once; this is a conservative industry standard used in distribution and transmission planning. Reliability impacts were assessed in accordance with utility distribution planning criteria.

Voltage Criteria

No load voltages shall exceed 126 V (105 percent of nominal) or fall below 114 V (95 percent) of nominal during system intact conditions.

Thermal Overload Criteria

All conductors and protection equipment (fuses, switches, etc.) shall not be loaded more than 100 percent of their nameplate rating.

Transformer Overloads Criteria

Transformers will be allowed to exceed 140 percent of their nameplate rating for no longer than 24 hours.

9.3.2.4 Comparison of 2010 PNNL Distribution Study to Black & Veatch Study

Black & Veatch reviewed several published studies on the impact of EVs on the distribution system. As previously described, Black & Veatch's methodology and assumptions were based both on previous studies and good engineering judgment. Of all the studies reviewed by Black & Veatch, the study that is the most similar to its study was the 2010 "Technical Challenges of Plug-In Hybrid Electric Vehicles and Impacts to the U.S. Power System: Distribution System Analysis," performed by PNNL. The table in Exhibit 9-4 shows a comparison of the two. The Black & Veatch study examined, among other issues, where the stress points might be in older feeders that are presumably susceptible to failure.

STUDY ASPECTS	BLACK & VEATCH	PNNL
SynerGEE Electric	Yes	Yes
Steady-State Power Flow Analysis	Yes	Yes
Residential Analysis	Yes	Yes
Mixed Residential and Commercial Analysis	Yes	No
Industrial Fleet Analysis	Yes	No
Time-of-Day Analysis	No (non-coincident peak)	Yes
Mixture of Level 1 and Level 2 Charging	No (assumed all Level 2)	Yes
Balanced EV Penetration Scenario	Yes	Yes
End-of-Line Penetration Scenario	Yes	No
Front-of-Line Penetration Scenario	Yes	No
Phase Imbalance Scenario	Yes	No
Studied Equipment Loading (Lines, Transformers, Fuses, Switches)	Yes	Yes
Multiple Charging Scenarios (charging at home, work, delayed charging, etc).	No	Yes
Effects of Quick Charging	No	Yes

Exhibit 9-4 Comparison of Black & Veatch Study to 2010 PNNL Distribution Study

9.3.2.5 Study Results and Discussion

The Black & Veatch study addressed the following three aspects of reliability with regard to increased EV penetration against the aforementioned criteria:

1. Voltage Criteria – Monitored load side voltages to over and under voltages.
2. Thermal Criteria – Monitored conductor and transformer loadings.
3. Protection Criteria – Monitored the loading of switches, fuses, and fuse pickups settings.

Study results are reported in the following subsections. The residential and mixed use (residential and commercial) feeders are discussed in separate subsections. Because such limited impacts were identified in the industrial/fleet scenario, those results are discussed in the conclusions and outlook sections 9.3.2.6 and 9.3.2.7.

9.3.2.5.1 Residential Scenario Results

While the purpose of the modeling study was to determine stress points in the distribution system due to high levels of EV penetration, these levels of penetration are not expected for several years. Our guidelines for the Electrify Heartland planning effort were to plan for our share of EVs in 2015 based on national EVs sales cumulatively totaling to 1,000,000 vehicles by that time. As stated elsewhere in this report, that level of EV use would result in approximately 7,000 EVs in the Electrify Heartland study area. That number of EVs is much, much lower than the 20 percent and higher cases that were used in the modeling effort to learn what parts of the distribution system might experience stress at high levels of EV penetration.

9.3.2.5.1.1 Residential One Percent Case

As part of our distribution modeling study we ran a "base case" using one percent penetration of EVs. Our planning effort used 1,774,575 as the total number of vehicles in the Greater Kansas City (GKC) study area.[40] One percent of that number of vehicles would be 17,746 EVs in GKC, which is approximately 2 ½ times the 7,000 EVs we were to plan for by 2015.

[40] WHY EV & EVSE, RUTH REDENBAUGH, 12/2011

Exhibit 9-5, below shows that there are no impacts on either the feeder line or the distribution lines regarding voltage at the one percent level of EV penetration on a phase-balanced feeder.

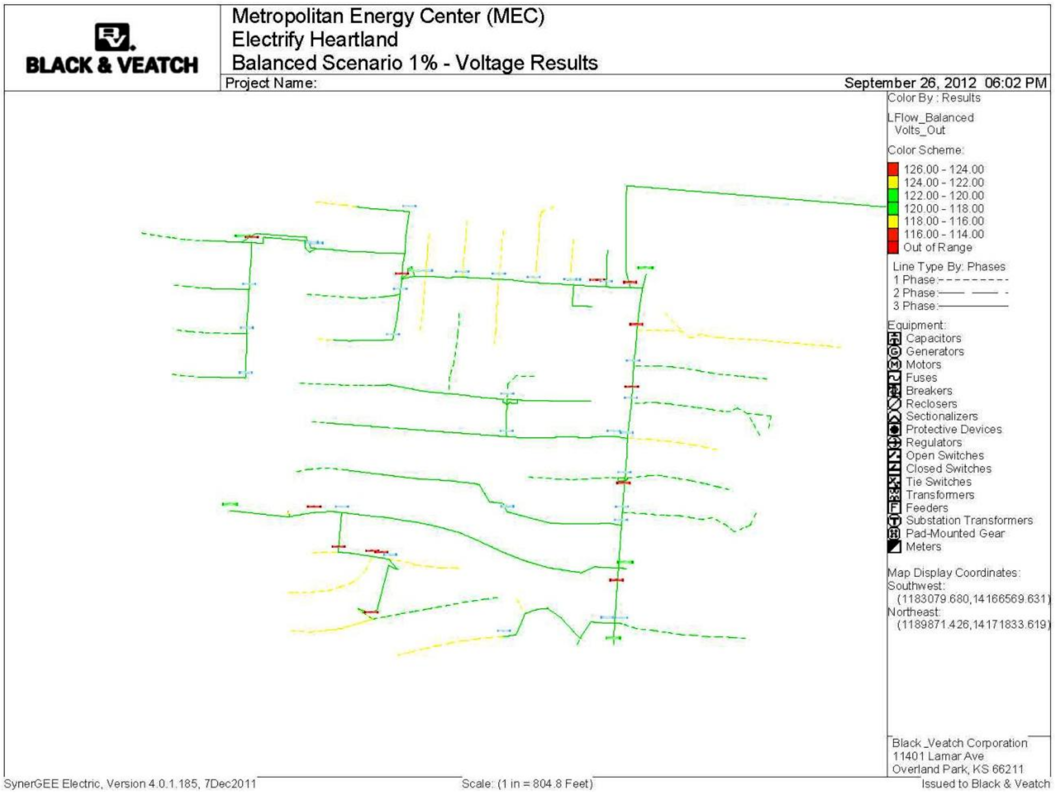

Exhibit 9-5 Balanced Scenario One Percent EV Penetration – Voltage Results

Exhibit 9-6 below shows that there are no impacts on either the feeder line or the distribution lines regarding thermal overloading at the one percent level of EV penetration on a phase-balanced feeder.

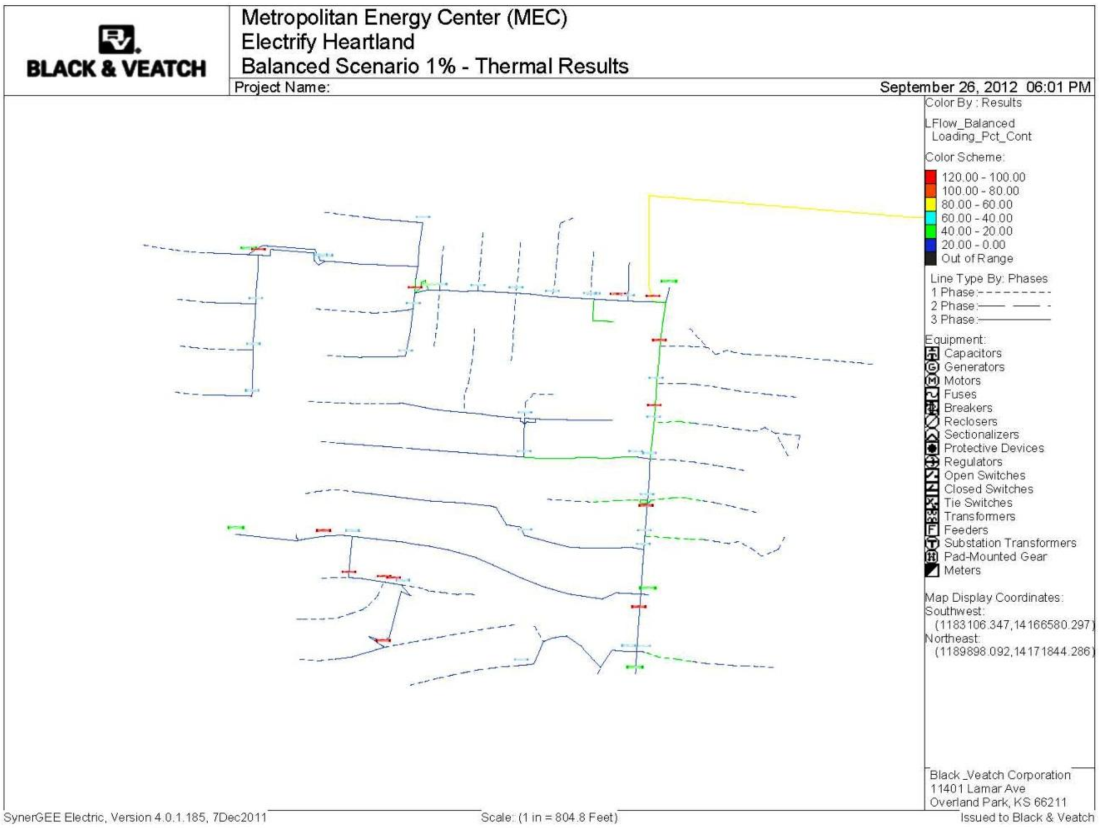

Exhibit 9-6 Balanced Scenario One Percent EV Penetration – Thermal Results

Exhibit 9-7 below shows that there are no impacts on either the feeder line or the distribution lines regarding thermal overloading at the one percent level of EV penetration on a phase-imbalanced feeder.

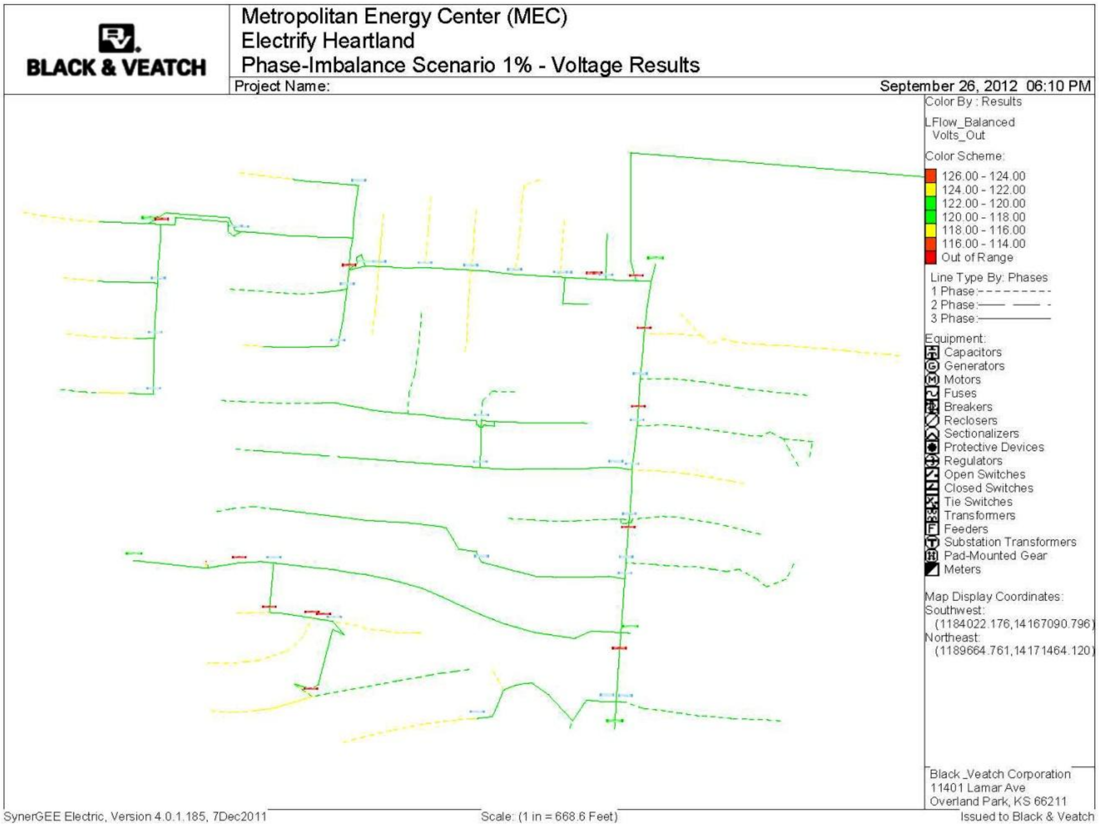

Exhibit 9-7 Phase Imbalanced Scenario at one percent EV penetration – Voltage Results

Exhibit 9-8 below shows that there are no impacts on either the feeder line or the distribution lines regarding thermal overloading at the one percent level of EV penetration on a phase-imbalanced feeder.

For this case of one percent EV penetration, which is more than two times the EV penetration levels planned for in the study, we found no impact on the older, residential distribution feeder modeled. The current distribution system in our area appears to be able to handle EV penetration levels far above the levels expected in the planning study, even using assumptions of charging at relatively high levels at peak times.

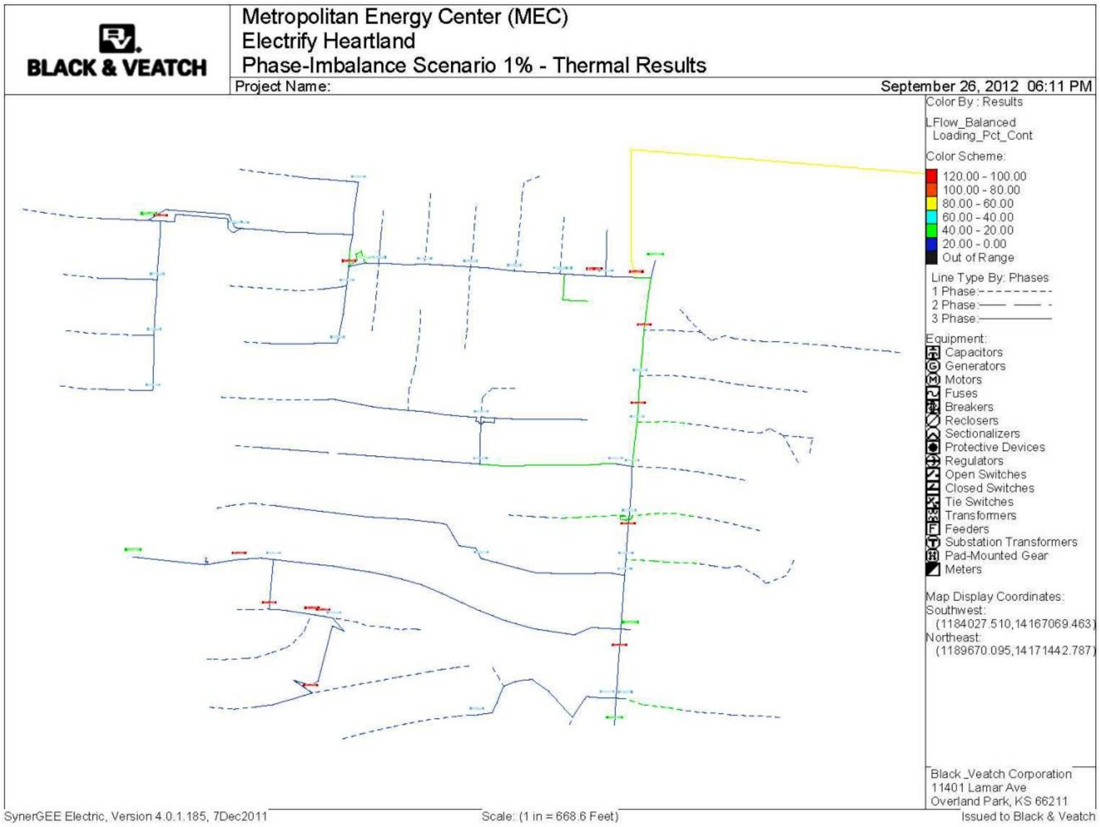

Exhibit 9-8 Phase Imbalanced Scenario at one percent EV penetration – Thermal Results

9.3.2.5.1.2 Higher Levels of EV Penetration

At higher levels of EV penetration, primarily, all of the feeder overloads were limited to the main feed from the distribution substation. This particular feeder under study indicated thermal overloads with EV penetration at 20 percent, with the majority of the overloads present at a 40 percent penetration. While the number of unique overloads did increase slightly as EV penetration increased, most of the overloads were triggered at the lower penetration scenarios. This indicates that a majority of the distribution line upgrades would be prompted by an EV penetration of 40 percent for this particular feeder, as shown on Exhibit 9-9.

Thermal overloads were observed at 20 percent EV penetration, although they were isolated to the main feeder section from the distribution substation. This trend continued as the penetration level was increased up to 100 percent, as shown on Exhibit 9-10.

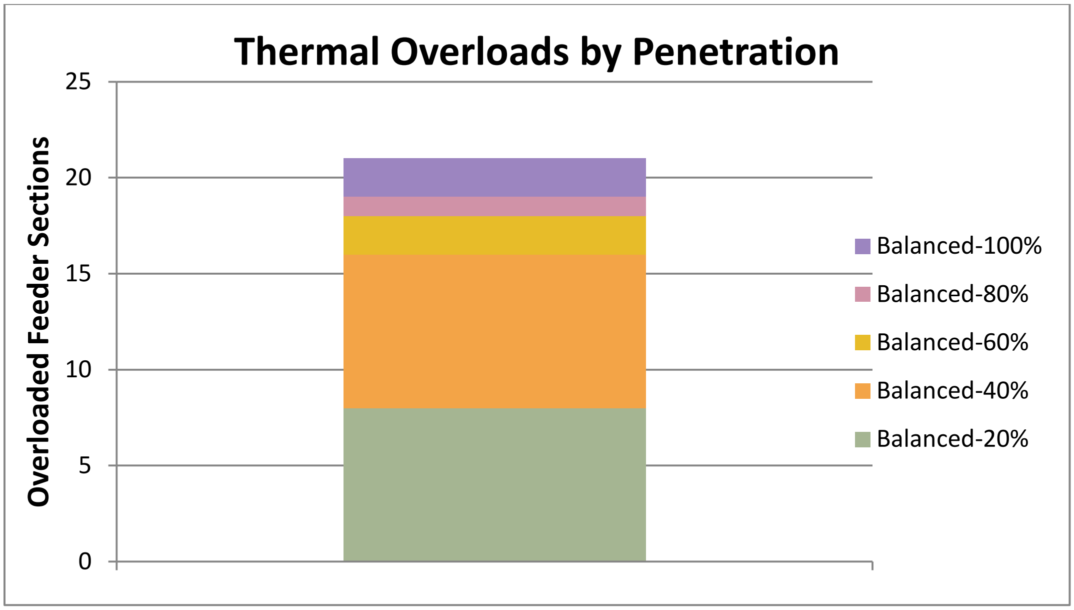

Exhibit 9-9 Balanced Scenario – Conductor Loading

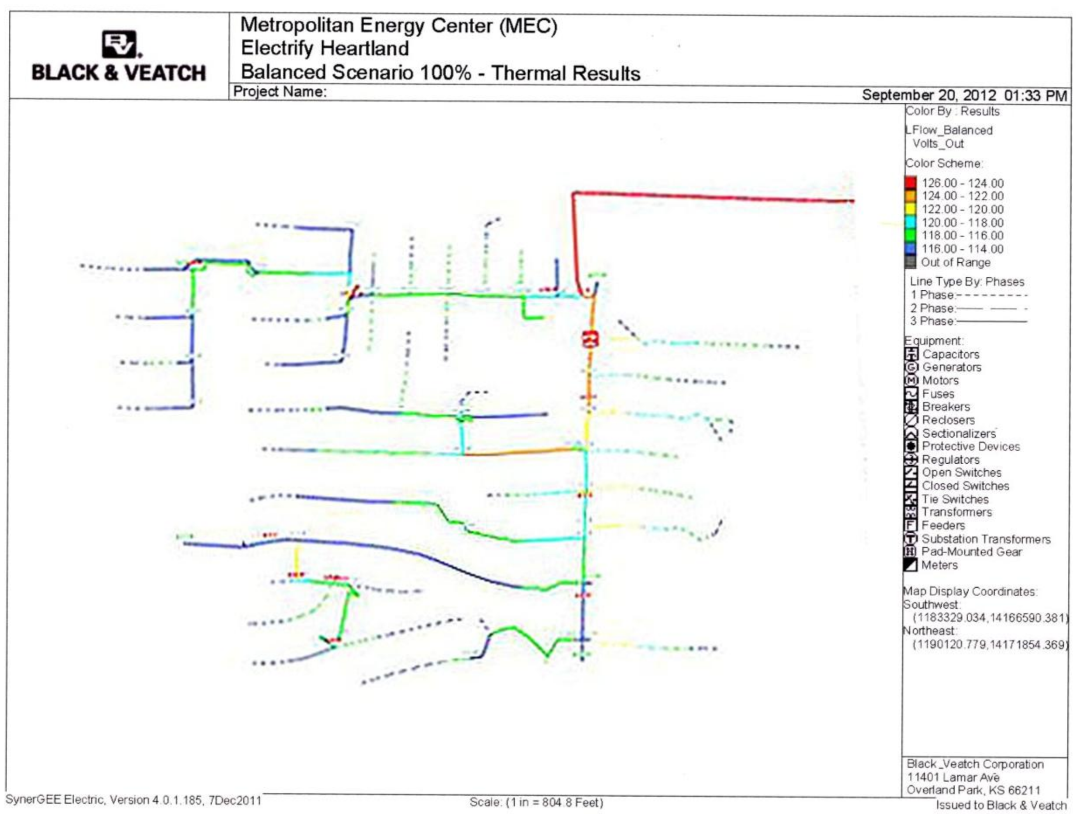

Exhibit 9-10 Balanced EV Scenario 100 Percent - Thermal Results

The number of overloaded feeder sections remained relatively constant at 60 percent and above, with the previous overloads getting worse as more and more EVs were added to the system.

There were minimal voltage violations observed under the balanced scenario. Steady voltage sag was observed as EV penetration was increased, as expected, although no under voltages were observed until the 100 percent scenario, shown on Exhibit 9-11.

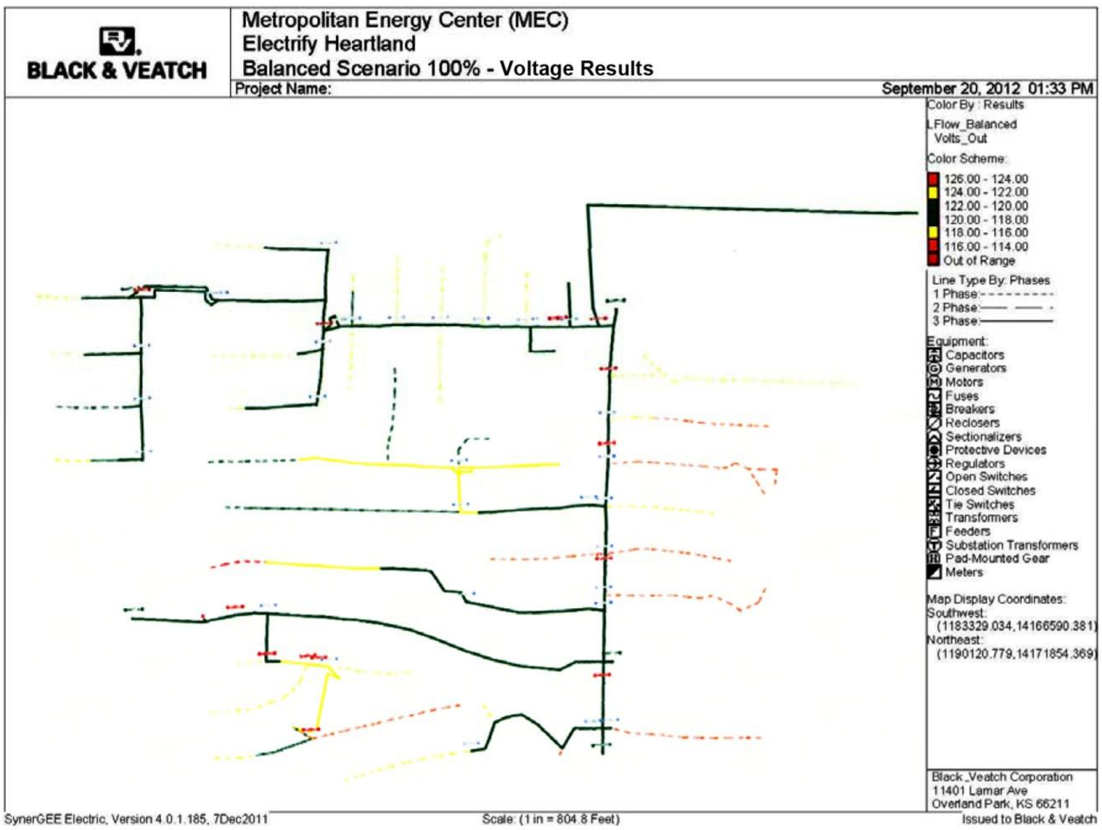

Exhibit 9-11 Balanced EV Scenario 100 Percent - Voltage Results

Distribution transformer overloading was by far the most prominent issue observed under this scenario. Any transformer overloads that existed in the base case condition were omitted from the results because they are not caused by increased EV penetration. There were several distribution transformer overloads observed at 20 percent EV penetration, with the number of transformers overloaded remaining fairly constant throughout the analysis. The number of new and cumulative distribution transformer overloads is shown on Exhibit 9-12.

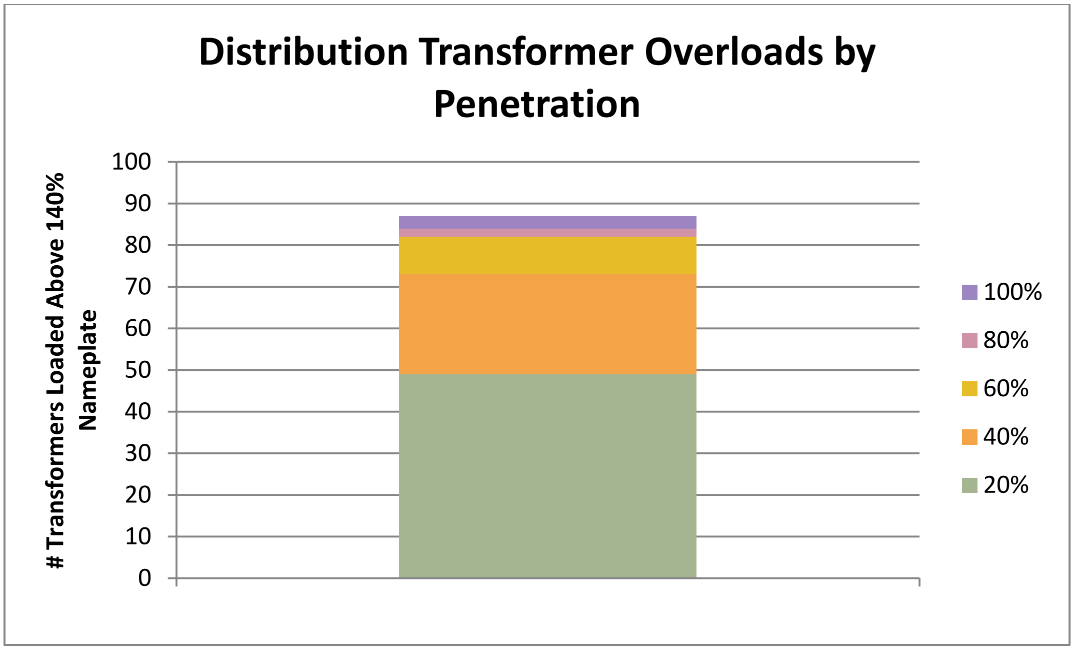

Exhibit 9-12 Balanced Scenario – Transformer Loading

This particular feeder under study indicated thermal overloads with EV penetration at 20 percent, with the majority of the overloads present at a 40 percent penetration. While the number of unique overloads did increase slightly as EV penetration increased, most of the overloads were from the lower penetration scenarios. This indicates that a majority of the distribution transformer upgrades would be prompted by an EV penetration of 40 percent for this particular feeder.

Lastly, the analysis considered the impacts of increased EV penetration on the system protection elements, specifically focusing on switches, fuses, and their associated pickup settings. Although some overloads were observed, they were minor, given the amount of load added to the system. A few switch overloads were observed, as well as some fuse overloads. It can be rationalized that increased EV penetration will require close observance to the loading of system protection elements and protection settings to prevent failures or tripping on load.

Compared to the balanced scenario results, the phase imbalance scenario proved to be much more problematic from a reliability standpoint.

Thermal overloads were observed at 20 percent EV penetration, although they were isolated to the main feeder section from the distribution substation.

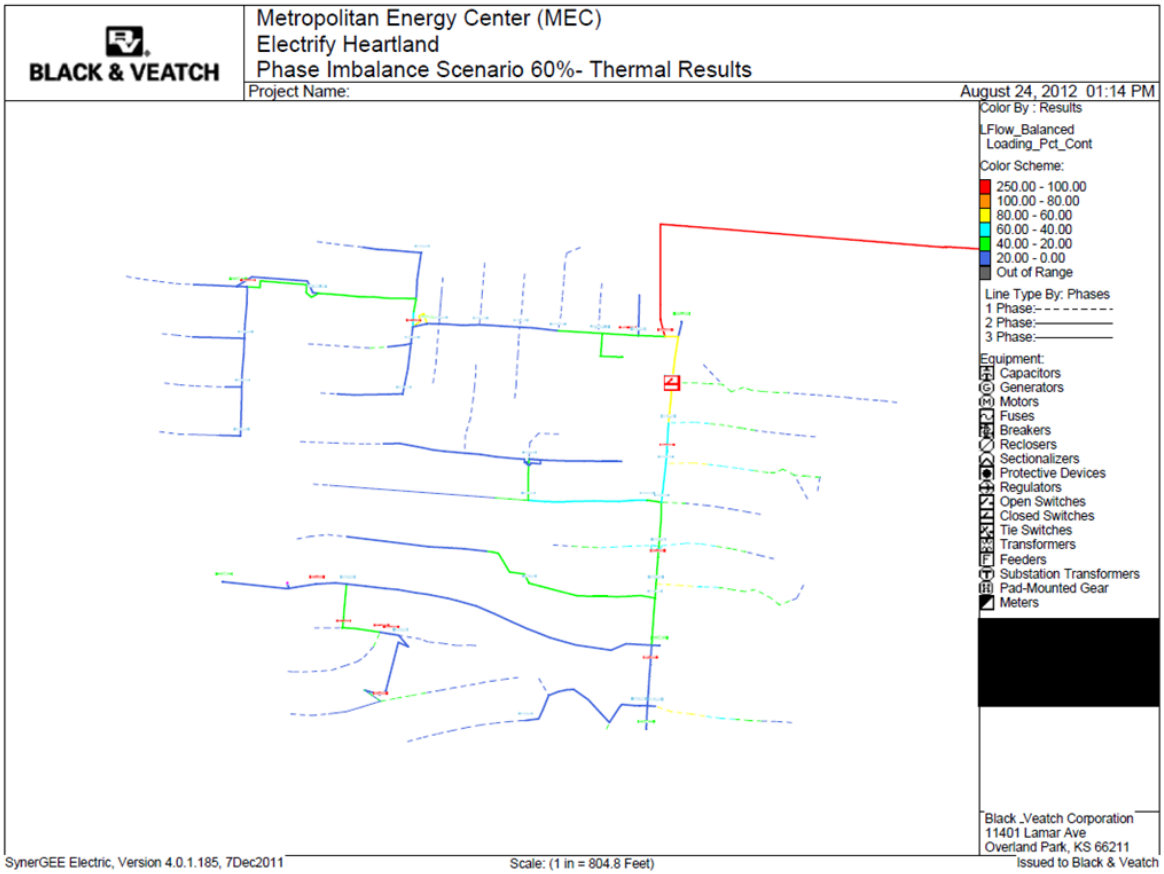

Exhibit 9-13 Phase Imbalance EV Scenario 60 Percent - Thermal Results

This trend continued as the penetration level was increased to 60 percent. The conductor overloads in this scenario continually increased with EV penetration and did not taper off as they did in the balanced scenario. This is shown on Exhibit 9-14.

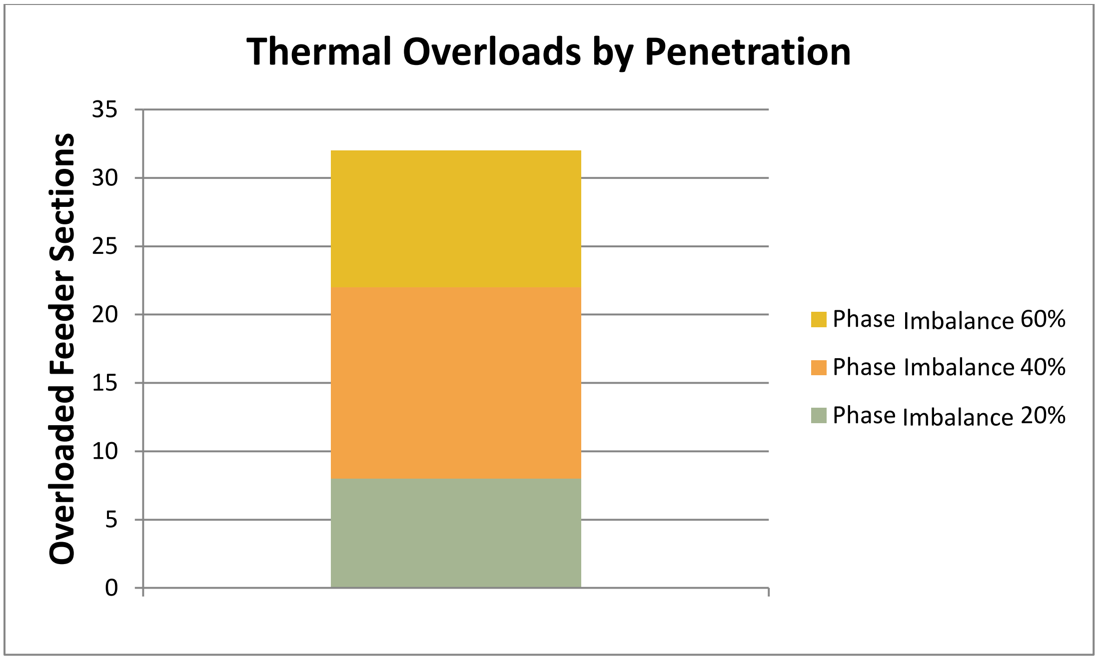

Exhibit 9-14 Phase-Imbalance Conductor Loading

Unlike the balanced scenario, where voltage violations were minimal, significant phase voltage violations were observed in this scenario. Severe under voltages were observed on several C phase sections because of the unbalanced placement of EV load. The voltage sag was large enough in some cases that it resulted in over voltages on the A and B phases. Phase imbalance at the 60 percent penetration level is shown on Exhibit 9-15.

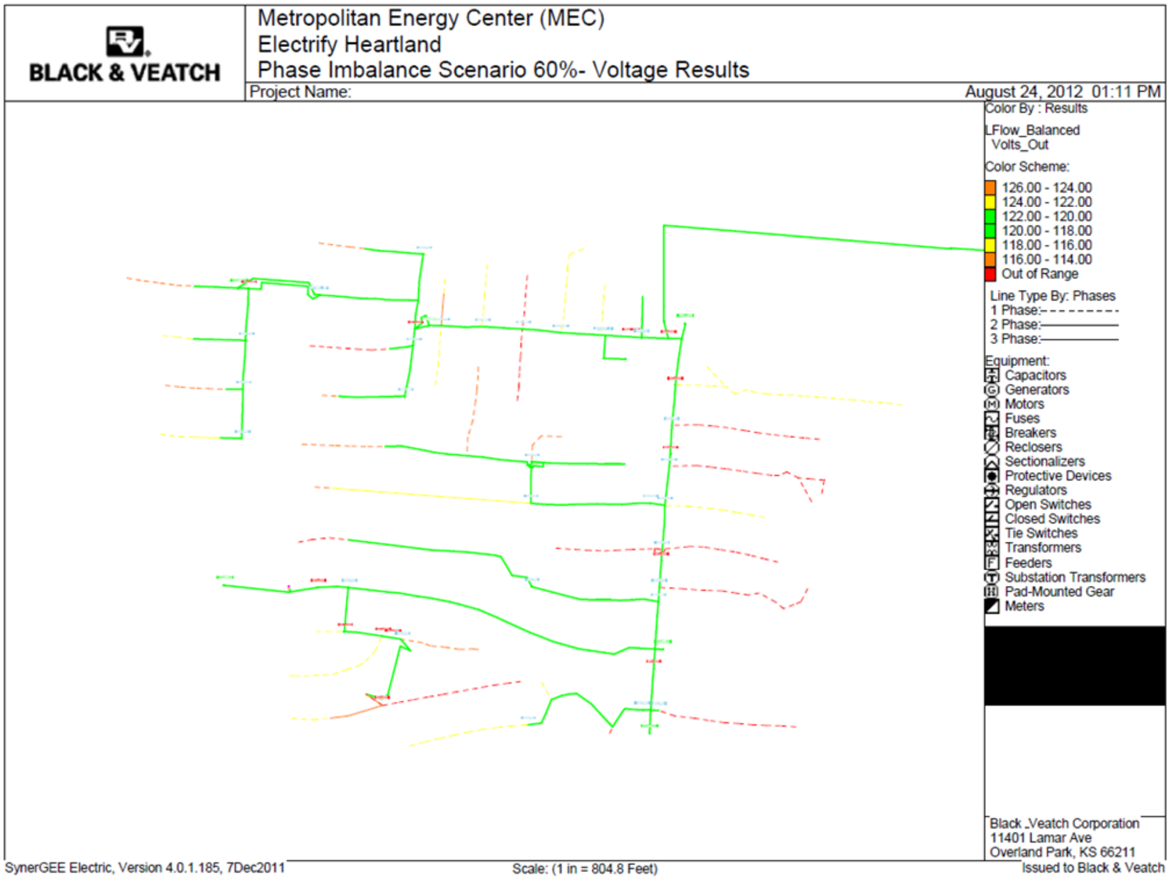

Exhibit 9-15 Residential Scenario, Phase Imbalance Summary 60 Percent, Voltage Results

For the specific feeder under study, a 40 percent penetration with a phase imbalance proved to be the point where the system started to suffer severe voltage sags. Unlike the thermal overloads where the problems leveled out, as EV penetration increases, the issues became much worse, as shown on Exhibit 9-16.

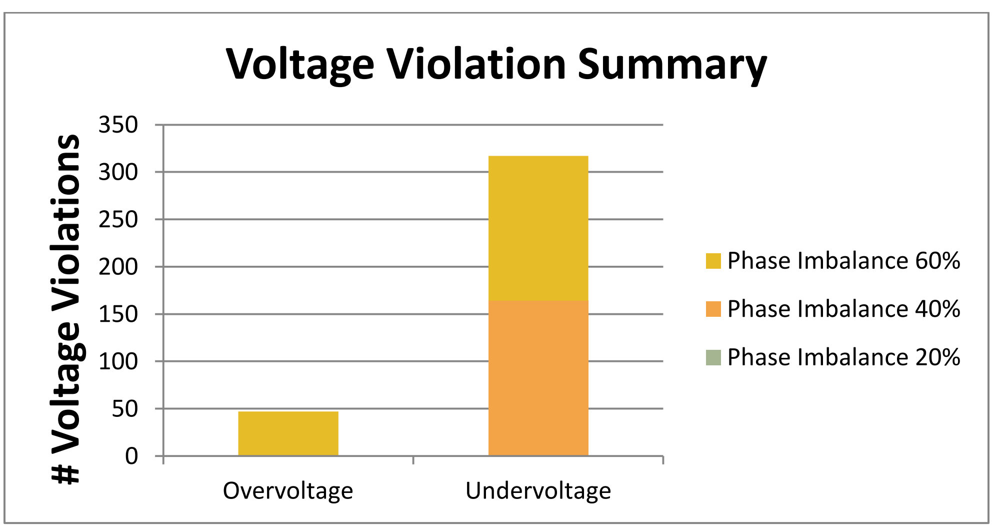

Exhibit 9-16 Phase-Imbalance Voltage Violation Summary

There were several distribution transformer overloads observed at 20 percent EV penetration, with the number of transformers overloaded remaining fairly constant throughout the analysis. Any transformer overloads that existed in the base case condition were omitted from the results because they are not caused by increased EV penetration.

The transformer overloads in this scenario, shown on Exhibit 9-17, continually increased with EV penetration and did not taper off as much as they did in the balanced scenario.

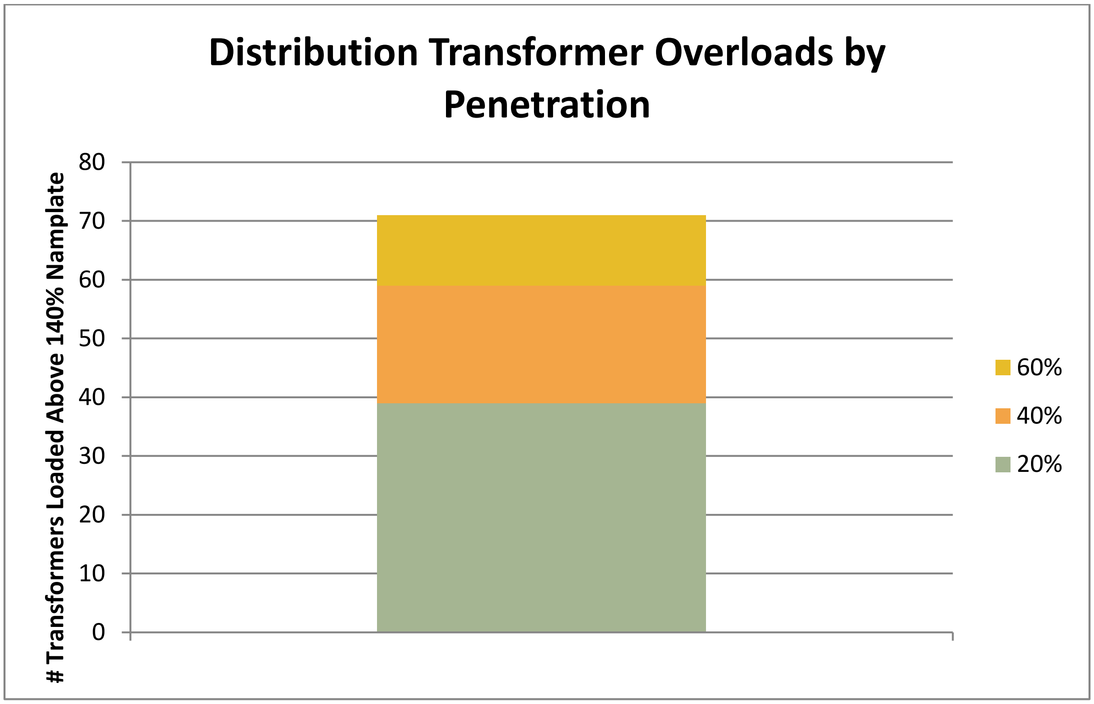

Exhibit 9-17 Phase-Imbalance Distribution Transformer Overloads

Lastly, the analysis considered the impacts of increased EV penetration on the system protection elements, specifically focusing on switches, fuses, and their associated pickup settings. Although there were some overloads observed, they were minor, given the amount of load added to the system. A few switch overloads were observed, as well as some fuse overloads. It can be rationalized that increased EV penetration will require close observance to the loading of system protection elements and protection settings to prevent failures or tripping on load.

9.3.2.5.2 Mixed Residential and Commercial Scenario Results

No switch overloads were identified for this scenario.

Results of the mixed residential and commercial scenario proved to be quite favorable from a reliability standpoint.

A minimal number of thermal overloads were observed, and those were present only in the 100 percent case (100 EV public charging station and 100 percent balanced residential penetration). The thermal overloads were limited to the residential portions of the feeder. These 100 percent penetration level thermal overloads are shown on Exhibit 9-18.

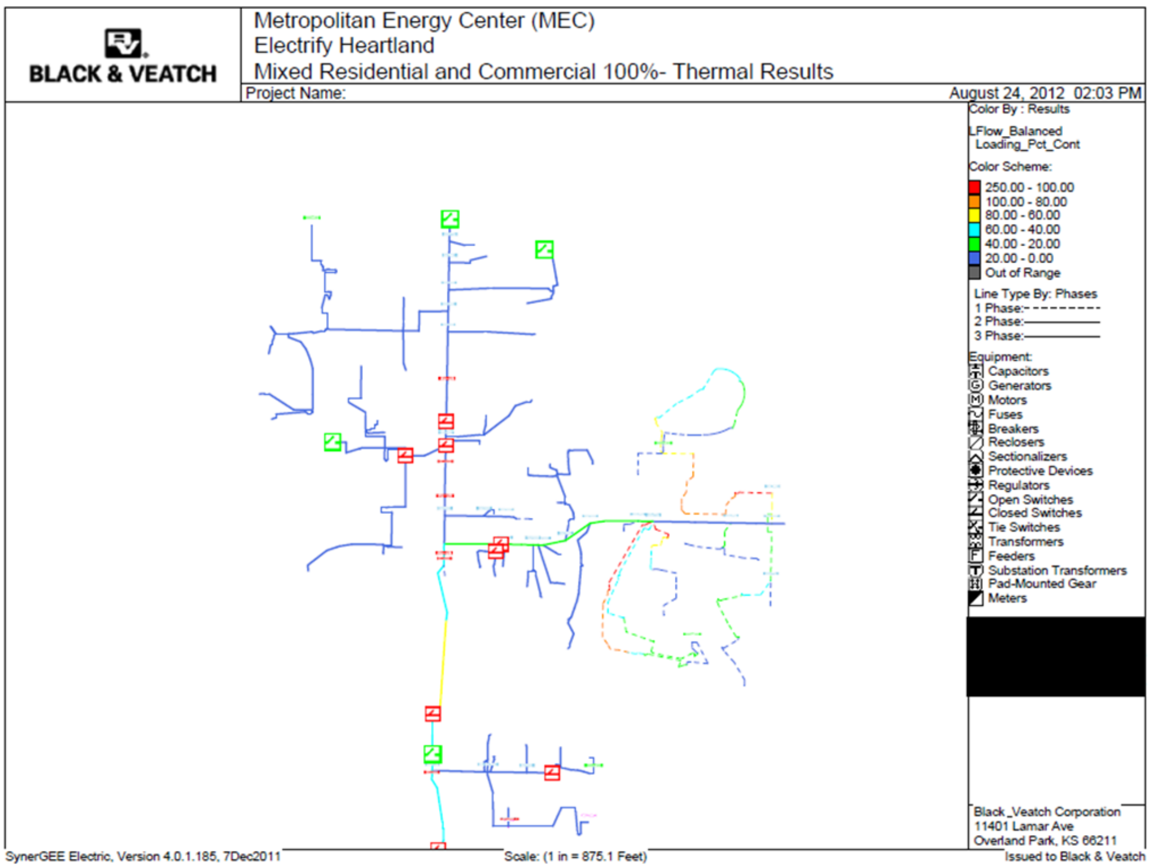

Exhibit 9-18 Mixed Residential and Commercial Balanced EV Scenario 100 Percent - Thermal Results

There were several over voltages observed in this scenario, although they were minimal and could most likely be mitigated by adjusting distribution transformer tap settings. The over voltages were isolated primarily to the A phase because of high voltage sag on the B phase. It is evident that load balancing is just as important for this scenario as it was for the residential scenario. These voltage results are shown on Exhibit 9-19.

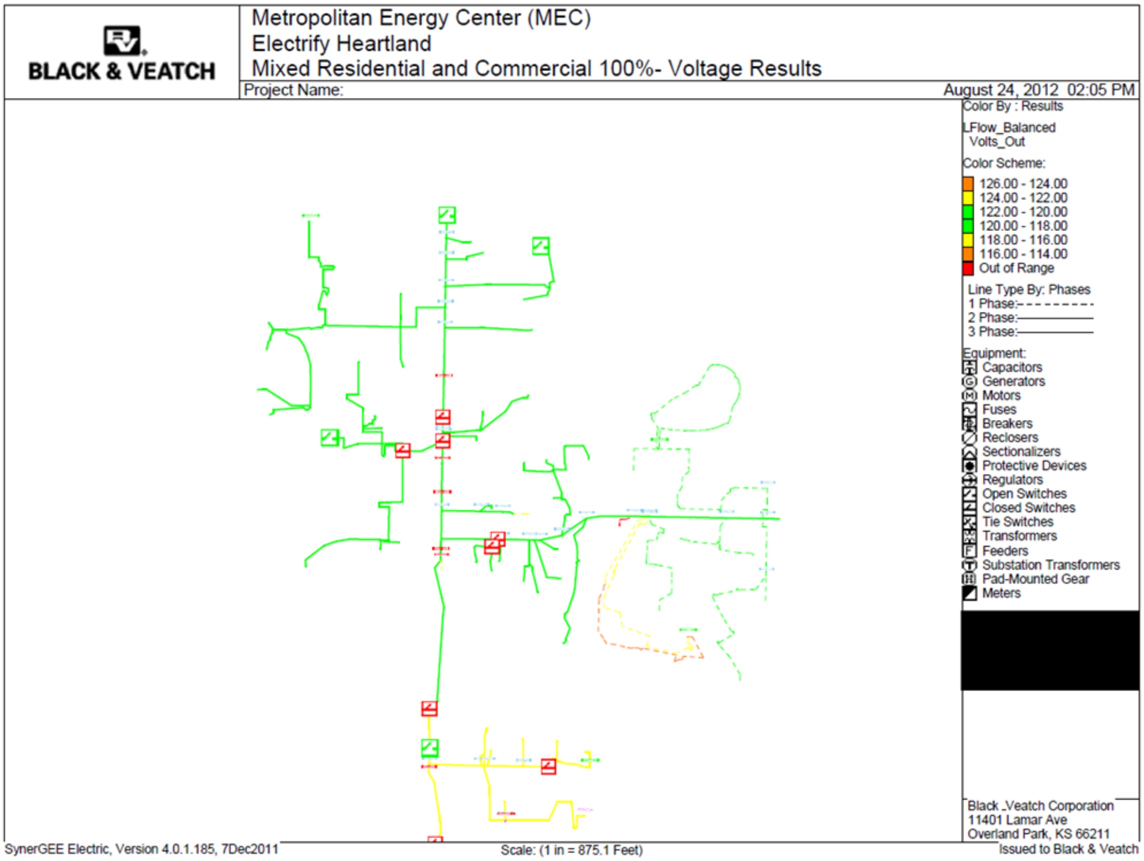

Exhibit 9-19 Balanced EV Scenario 100 Percent - Voltage Results

There were several distribution transformer overloads observed, although not nearly as many as in the residential scenarios. Any transformer overloads that existed in the zero-EV case condition were omitted from the results because they are not caused by increased EV penetration. Distribution transformer overloads by penetration in the mixed-use area are shown on Exhibit 9-20.

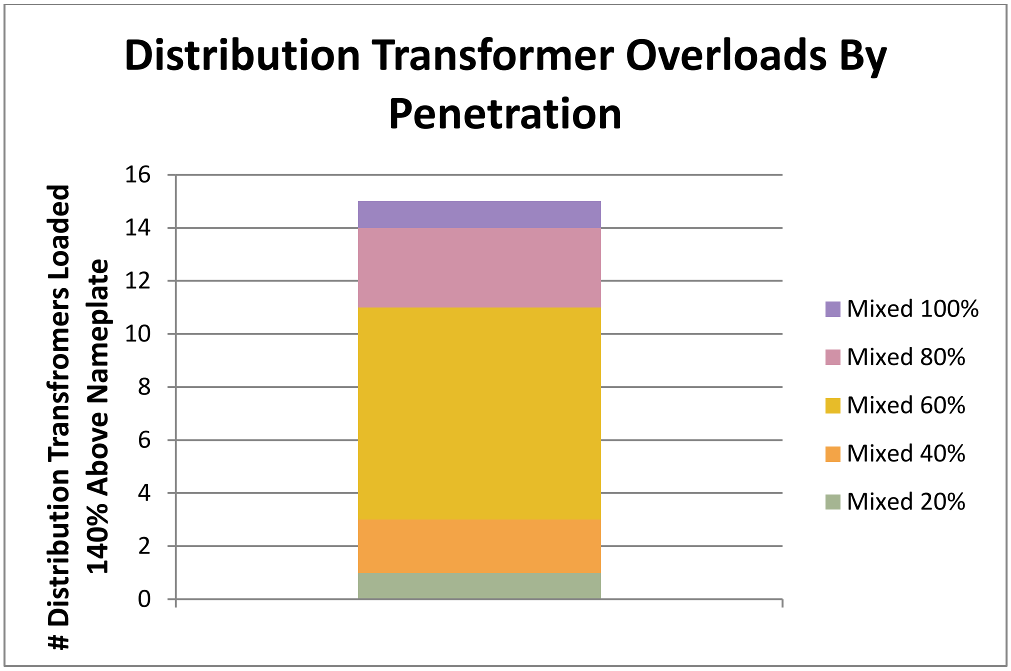

Exhibit 9-20 Mixed Scenario – Distribution Transformer Overloads

Lastly, the analysis considered the impacts of increased EV penetration on the system protection elements, specifically focusing on switches, fuses, and their associated pickup settings. Although some overloads were observed, they were minor, given the amount of load added to the system. No switch overloads were observed. It can be rationalized that increased EV penetration will require close observance to the loading of system protection elements and protection settings to prevent failures or tripping on load.

9.3.2.6 Overall Distribution Level Planning Study Conclusions

Each of the scenarios studied provided valuable insight into the potential reliability impacts on the distribution system associated with increased EV penetration. The following summarizes the above findings and discusses how these impacts will potentially affect the distribution system as a whole for the study area.

The study findings indicate that mainstream EV penetration poses the highest reliability risk to the primarily residential feeders. The residential feeders will most likely have the largest amount of constant EV load (i.e., daily chargers), especially during the work week. In addition, as the system exists today, residential load is typically smaller than that of commercial and industrial establishments. Consequently, the equipment on the residential feeders has lower ratings than that of a mixed residential and commercial or industrial feeder.

Specifically with regard to the residential feeders, the largest reliability implications appear to be caused by potential phase imbalances. The most prominent issues were over- and under-voltage and distribution transformer overloads. For the feeders provided by the utility, the feeder conductors for the most part appear to have adequate thermal capacity to serve this extra load, although there were overloads observed on the main feeder section from the distribution substation. This implies that as significant EV penetrations come to fruition, there may be some upgrades required for the main feeder sections, although this will depend on the feeder and how dense the EV load is.

The issues for the EOL and FOL scenarios were minimal compared to the balanced and phase imbalance scenarios and, therefore, were not covered in this report.

The mixed residential and commercial scenario indicated minimal impacts on the commercial side for public charging stations sized for up to 100 EVs. Most of the impacts were isolated to the residential portion of the feeder.

The fleet scenario indicated no reliability impacts. The feeder provided by the utility for this analysis was a robust feeder with a large amount of industrial load. There are several existing loads that were larger than the total EV load even in the 60 EVs case. EVs also have a high power factor that is important for industrial applications.

It is important to note that this study was performed on a non-coincident peak basis. Therefore, the impacts observed may be more severe than they would be under typical peak loading conditions. The study also assumed that all residential and commercial EVs utilized Level 2 charging. In addition, the results of this study are limited to the steady-state time frame. This study does not assess the impacts with regard to transient stability.

9.3.2.7 Outlook for the Study Area

The most limiting factor to high EV penetration for the study area lies with the residential feeders, because they appear to be more susceptible to reliability impacts. This study presented an aggressive approach to EV penetration in an attempt to bring to light the worst-case barrier to high EV penetration. That being said, the following types of issues were observed and can potentially come to fruition, depending on the location and density of the EV load(s):

- Distribution transformer overloads.
- Conductor overloads.
- Voltage violations.
- Minimal system protection equipment overloads.

The conductor overloads appear to be mostly isolated to the main feed from the distribution substation. Voltage violations are largely dependent on the location of the EV load pockets. Careful consideration should be given to system phase loadings as more EVs come to market. Distribution transformer overloads were one of the most constant violations witnessed across all residential scenarios and one of the most costly, although they were mostly prominent at higher penetration levels.

The use of public charging stations appears to be feasible in centralized locations. Keep in mind that even though this study analyzed a public charging station with up to 100 EVs, only one station at a centralized location was studied. The impacts of multiple 100 unit, or similar, charging locations have yet to be seen.

The use of EVs in industrial applications looks promising based on the results of this study, keeping in mind that only one feeder was studied. Industrial feeders are typically much more robust than a typical residential feeder because of the amount of load being served and the sensitivity of those loads, with some demanding a high degree of reliability to function properly. EVs also have a high power factor, which is particularly important because they do not add to power factor issues caused by motor startup, which is common in industrial areas.

As previously noted, this study does not assess the impacts with regard to transient stability. There are many aspects of reliability that steady-state analysis cannot answer and that can only be addressed by further studies.

9.4 EV/EVSE/Grid Communications

9.4.1 Introduction

Various types of communication are available with EVSE. At an advanced level, sophisticated communications may be possible for power-use monitoring and control, financial transactions, and marketing statistics on vehicle use. There are several parties, perhaps with varied interests, that could be potentially involved in EVSE communications. The parties involved could include the vehicle owner, the vehicle manufacturer, the EVSE owner, a third-party financial transaction manager, the electric utility, and/or a third-party demand side management aggregator. The type of communication system involved can determine how and what data flows to whom and who is in control of the EVSE power. If prospective PEV buyers do not see EVSE that match the cars they are considering, it could be a barrier to EV adoption. Electric vehicles without an EVSE infrastructure have a limited value for purchase and resale. Electric vehicles that "can be plugged in anywhere" have more utility and value. Standards tend to lower costs of manufactured goods such as EVSE by creating a competitive marketplace of suppliers. Standards also can make manufacturing decisions easier and cheaper as suppliers vie for that segment of the auto supply chain market.

Utilities would like to know how much power is being used for EV charging and where those vehicles are charging.

9.4.2 Background

9.4.2.1 Standards History

Several international standards and industry organizations are involved in EVSE communications. In the U.S. market, principal among these are the SAE, the Institute of Electrical and Electronics Engineers (IEEE), and EPRI. Consideration of standards for EVSE communications began many years ago, but standard setting is still ongoing. For instance, SAE recently moved to focus Level 1 and Level 2 charging on the European-based ISO/International Electro technical Commission (IEC) 15118 standard. Chinese interests have limited activity in the American standard setting discussions.[41]

9.4.2.2 Utility Communication Standard

EPRI is working toward a common standard for utility communications and is involved in setting standards, along with IEEE and SAE. EPRI established an Infrastructure Working Council to provide a forum for utilities, automotive manufacturers, suppliers, and other stakeholders to address issues regarding electric infrastructure for PHEVs and EVs.[42]

9.4.3 Current Standards

The anticipated increase in electric-powered vehicles has prompted many efforts, both domestic and international, to standardize aspects of the industry. One useful and widely used model is the Open System Interconnection (OSI) model (ISO/IEC 7498-1), which defines the following seven layers of a communication system: [43]

1. Physical
2. Data link
3. Network
4. Transport
5. Session

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[41] Lawler, Tim. EPRI. Interview by Bill Roush. 26 Mar. 2012.

[42] Electric Power Research Institute. "2009 Portfolio: Electric Transportation - Program Overview." *Electric Power Research Institute*. N.p., 2009. Web. 10 Dec. 2012. <http://mydocs.epri.com/docs/Portfolio/PDF/2009_P018.pdf

[43] SAE International. "Charging – What Can Be More Simple?" *SAE International*. N.p., n.d. Web. 28 Sept. 2012. <http://www.sae.org/smartgrid/chargingprimer.pdf>.

6. Presentation
7. Application

SAE standards have been developed to address some of the layers defined in the OSI model: SAE 2931 (OSI link layer) establishes the type of technology used, and SAE 2847 (OSI application layer) establishes how data are presented.

The SAE standard J1772 defines two levels of EV power charging:

- Level 1—120 V AC charging from standard 15 or 20 amp NEMA outlet, on-board vehicle charger (approximately 1.9 kW).
- Level 2—208–240 V AC charging up to 80 amps, on-board vehicle charger (approximately 19 kW).

~A definition for DC charging levels (fast charging) is currently under development.[44]

Other organizations and companies are collaborating to find workable standards for the industry. One such group, the Smart Energy Initiative, which consists of American Electric Power, Consumers Energy, Pacific Gas and Electric Company, Reliant Energy, Sempra, and Southern California Edison and ZigBee and HomePlug alliances, is working on advanced metering infrastructure (AMI) and home area networks (HANs). EPRI is also collaborating to standardize communications and certification processes to improve the efficiency of the smart grid.

9.4.3.1 Establishing a DC Fast Charging Standard

Currently, there is no single “breakout” vehicle with enough sales to drive the development of standards. Absent international standards from traditional organizations, Nissan is actively working with a Japanese group called CHAdeMO[45] (which stands for charge and move) for its DC fast charging equipment. The Nissan Leaf uses a CHAdeMO plug and is a leading production non-hybrid EV. The DC fast charging system is optional on the Leaf (50 kW), so only a limited number of Leafs have the feature. The system is used in Japan, Norway, and parts of the United States. ABB is currently introducing Terra Smart Connect in Europe using CHAdeMO connectors. The Chinese are not participating fully with either the CHAdeMO or SAE/European Automobile Manufacturers’ Association (EU ACEA) international standard setting group.

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[44] *MindDrive*. Tangient, n.d. Web. 10 Dec. 2012. <http://minddrive.wikispaces.com/EPK>. This is a wikispace that contains information about the MindDrive project objectives, educational objectives,mentor educational process and project bios.

[45] "Hydro-Quebec Joins CHAdeMO Association." *CHAdeMO*. N.p., n.d. Web. 10 Dec. 2012. <http://www.chademo.com/pdf/pressrelease.pdf>.

NRG Energy and the California Public Utilities Commission have entered into an agreement that includes deploying a minimum of 200 DC fast charging EVSE sites in the state. The agreement was part of a settlement stemming from the legal actions taken as a result of the 2001 California energy crisis. NRG's subsidiary produces eVgo charge stations that convert 480 V AC to DC. Past NRG DC charging projects have used a CHAdeMO-compliant charger, but it is unclear what the plans are for these new California DC chargers.

9.4.4 Recent Standards Developments

There is progress from conventional standard setting organizations in establishing standards for EVSE fast charging and communications. SAE narrowed Levels 1 and 2 charging to ISO/IEC 15118 in late March 2012.[46] This decision anticipated fast DC charging, but did not set a standard.

The International SAE has chosen the "combined charging system," as has the ACEA, the European association of vehicle manufacturers. This is an AC/DC system that builds on the SAE J1772–type connectors. It includes single and faster three-phase AC charging, DC charging at home, and ultra-fast public DC charging.[47] For this combined charging system agreed to by SAE and ACEA, member vehicle manufacturers Audi, General Motors, BMW, Chrysler, Daimler, Ford, Porsche, and Volkswagen are set to have vehicles fully using the system by 2017.

9.4.5 Alternative Communications and Control Methods

In addition to the EVSE through network via smart grid communications discussed here, there are other communications avenues to control charge patterns that may help address EV adoption barriers. These forms of communication may also be used to help address the multiple issues of safe battery charging, cost allocation and efficient infrastructure use.

For example, a utility could potentially communicate with the EV, rather than the EVSE, through onboard telematics, such as GM OnStar®, to control charging. A signal sent directly to the EV from the utility could allow the car to accept or decline charging.

Also, utilities can already communicate directly with ratepayers to convey information regarding the costs and benefits of various charging scenarios. This communication could be targeted to EV owners. It could come in the forms of informational campaigns such as fact sheets, information tied to billing (via paper or on the Web), and special EV rate structures.

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[46] Lawler, Tim. EPRI. Interview by Bill Roush. 26 Mar. 2012

[47] REVE. "Universal Charger for Electric Vehicles." *REVE*. N.p., 5 July 2012. Web. 7 May 2012 <http://www.evwind.es/2012/05/07/universal-charger-for-electric-vehicles/18350/>.

9.4.6 EVSE Communications and Smart Grids

Because EVSE communications would interface with smart grid communications planned by many utilities, there is an effort to coordinate these systems. Smart Energy Profile 2.0 is being moved forward by the ZigBee® Alliance (a group of vendors using the proprietary Zigbee low-power wireless sensor and control networks) and includes the following development partners.[48]

- HomeGrid
- HomePlug Powerline Alliance
- SAE International
- IPSO (Internet Protocol Smart Object) Alliance
- SunSpec Alliance
- Wi-Fi Alliance

Smart Energy Profile 2.0, which includes EVSE EV communications, is not universally agreed upon but is in the process of developing standards. The capabilities of this communication could include commands to provide information such as location, battery capacity, charge cycles, and how much energy an EV could use versus how much it is actually using. At this point, this Smart Energy area is limited to proprietary services. In this scenario, ZigBee would be the link layer, and on top, visible to the end user, would be an EV energy management and control application layer.

Smart Energy Profile 2.0 is intended to address such topics as sub-metering, special EV tariffs, demand response, off-peak charging, mitigation of local EV hotspots at distribution transformer level, vehicle to grid, energy storage for grid arbitrage and ancillary services, micro-grid and uninterruptible power supply (UPS) and renewable energy integration (green renewable energy credit [REC] sales, etc.).

9.4.7 Conclusion

While there is considerable progress being made in Level 1 and Level 2 charging standards, there is no universally agreed-upon standard for DC fast charging. This is a barrier to EV adoption because travel by EVs over long distances or extended or unplanned excursions, even close to home, becomes more difficult if "15 minute" recharging is not available for the vehicle model in use.

Fast charging requires powerful electrical infrastructure, possibly in a somewhat remote location, such as a refueling station in a rural area of a heavily traveled interstate or state

[48]ZigBee Alliance. "Smart Energy Profile 2.0 Documents." *ZigBee Alliance*. N.p., 30 Mar. 2012. Web. 10 Dec. 2012. <http://www.zigbee.org/Standards/ZigBeeSmartEnergy/Version20Documents.aspx>.

highway. Demand for EVSE stations like this may require planning by electric utilities; such planning is complicated when EVSE fast charging standards are not set. Further, some of these locations may be in the service territory of smaller electric utilities, rural electric cooperatives, or municipal utilities who have not previously planned for high EV penetration levels. The transient nature of the EV fast charging load may be of concern to utilities.

Communications with EVSE can aid utilities in managing EV charging load to off-peak times, lessening the impact on stressed distribution infrastructure. This communication can come in forms such as onboard telemetric (GM OnStar), networked EVSE, and direct smart metering to vehicle communication.

9.5 Kansas and Missouri Utility Rates for EVSE

9.5.1 Kansas and Missouri Public Utility Commission Activity

It is possible that the Kansas Corporation Commission (KCC) and Missouri Public Service Commission (MPSC) could incorporate rate tariffs that would affect EV use and development. However, there is currently little activity at the KCC or MPSC that could be construed as a barrier to EV development. The current activities being pursued by the two commissions are summarized in the following subsections.

9.5.1.1 Kansas Corporation Commission Electric Vehicle Activity

A pilot program for real-time electricity pricing filed by Westar Energy in January 2009 (effective February 2010) could affect EV development in Westar's North Rate Area (roughly northeast Kansas). It was a small pilot program, limited to five customers. While the tariff structure is complex, the "Energywise Adjustment" is essentially weighted by the customer's actual kWh energy metered, minus the customer's baseline load (CBL).[49] This adjustment could effectively increase or reduce the customer's bill, depending on how much the customer's usage differs from the customer's CBL. The results of this study are not currently available.

In the spring of 2012, the KCC approved a pilot program for up to 1,000 Westar customers, anywhere on the system, to opt for a time-of-use rate program.[50]

[49] *Westar Energy*. Ed. Westar Energy and State Corporation Commission of Kansas. N.p., 2009. Web. 10 Dec. 2012.<http://www.westarenergy.com/wcm.nsf/publishedtariffs/57B82FE1CAD08EFA8625770C0067622C/$file/EHLF-RTP.pdf>.

[50] Lehrman, Matt. Interview by Bill Roush. 26 Apr. 2012. Regarding Westar SmartStar Program.

Additionally, Kansas City Power & Light (KCP&L) has suggested a series of informal collaborative workshops to discuss rate design issues with broad implications, such as exploration of the best method to encourage off-peak charging of PHEVs.[51]

9.5.1.2 Missouri Public Service Commission Electric Vehicle Activity

The MPSC was awarded an American Recovery and Reinvestment Act (ARRA) grant of $900,000. The goal of the project, as stated in the MPSC 2010 Report[52], is as follows:

> The Commission applied for and was awarded an ARRA grant of $900,000 to be spent over a four year period to help facilitate timely consideration of dockets, demand-side management tariff filings, notices of inquiry, integrated resource plans, rulemakings and other regulatory actions pertaining to the ARRA electricity-related topical areas of: renewable energy, energy efficiency, demand response, energy storage, Smart Grid, plug-in hybrid electric vehicles, coal and carbon capture and storage, transmission and distribution.

As the grant indicates, this money is to be allocated, in part, for topics relating to PHEVs. The MPSC has hired an engineer and a policy analyst to work on this project full-time. A 2010 Missouri Department of Economic Development ARRA Dashboard Report indicated that there will be future work targeted at streamlining policy decisions related to “modernizing” and maintaining Missouri’s “electric system.”[53]

The MPSC also received a real-time electricity pricing program filing from KCP&L. This filing, which applies to industrial and commercial customers, was effective May 14, 2006, and may be relevant to EV development in the area.[54]

9.5.2 **Resale of Electricity through EVSE**

Kansas and Missouri laws prohibit the resale of electricity to a consumer via a third party. Laws similar to ones in Kansas and Missouri are common in the United States. However,

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[51]"KCC Docket No. 09-GIME-360-GIE (27 June 2009 Order, ¶127)," *Kansas Corporation Commission*. N.p., n.d. Web. 10 Dec. 2012. <http://estar.kcc.ks.gov/estar/ViewFile.aspx/20090727082750.pdf?Id=3ed8929d-f080-4577-9041-9317d657dd09>.

[52]"Missouri Public Service Commission 2011 Annual Report." *Missouri Public Service Commission*. N.p., 2011. Web. 10 Dec. 2012. <http://psc.mo.gov/CMSInternetData/Annual%20Reports/PSC%20Annual%20Reports/2011%20Annual%20Report.pdf>.

[53]*Transportation*. N.p., 14 Apr. 2010. Web. 10 Dec. 2012. <http://library.modot.mo.gov/RDT/ARRA/TEMP/DED%20ARRA%20DASHBOARD,%20APRIL%205,%202010.PDF>.

[54]"KCP&L Real Time Pricing." *Kansas City Power & Light*. N.p., 13 Apr. 2006. Web. 10 Dec. 2012. <http://www.kcpl.com/ABOUT/MORATES/SCHED26.PDF>.

several states are considering allowing resale of electricity through EVSE. Colorado passed a law that, effective August 2012, would allow the resale of electricity through EVSE.[55]

9.5.3 Conclusion

Policy and infrastructure will evolve in the coming years to adapt to increased EV market penetration. For example, to handle possible increased peaks on local grids, utility companies could request the implementation of EV-targeted tariffs. Potentially, these changes could serve as barriers to EV deployment. To the extent that those legislative or regulatory actions seek to add additional costs to or restrictions on EVSE service to EVs, such as requiring separate customer-purchased meters, prohibiting charging at certain times of the day, or prohibiting third-party resale of electricity through EVSE, those actions could dampen EV market penetration.

Currently in Missouri and Kansas, utility regulators have not systematically addressed EV issues or created new barriers to EVSE adoption. However, both states do have regulations and utility tariffs that prohibit the resale of electricity by a third-party, which effectively prevents the development of third-party EVSE deployment in both states.

9.6 Net Metering Plan and Electric Vehicles

9.6.1 Kansas and Missouri Net Metering Laws

In Kansas, net metering is limited to 200 kW for nonresidential utility customers and 25 kW for utility customers. The rule applies only to investor-owned utilities. Meter aggregation and V2G issues are not specifically addressed. A bidirectional meter must be supplied at no cost to the customer. There is a capacity limit to net metering set at 1 percent of a utility's retail peak demand for the previous year.[56] A bill was introduced in the Kansas Senate that could raise the 200 kW nonresidential limit to 3 MW; but as of November 2012, no further action had been taken.[57]

In Missouri, net metering has a system capacity limit of 100 kW and an aggregate cap of 5 percent of the utility's single-hour peak load. The rule applies to all utilities in Missouri.

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[55] Finley, Bruce. "Electric-Vehicle Drivers in Colorado to Get a Charge Out of New Law." *Denver Post*. N.p., 24 June 2012. Web. 10 Dec. 2012. <http://www.denverpost.com/recommended/ci_20926269>.

[56] "Kansas Incentives/Policies for Solar." *Database of State Incentives for Renewables & Efficiency*. North Carolina State University, 28 June 2012. Web. 10 Dec. 2012. <http://www.dsireusa.org/SOLAR/INCENTIVES/INCENTIVE.CFM?INCENTIVE_CODE=KS08R&RE=1&EE=1>.

[57] "Senate Bill No. 383 by Committee on Utilities." *Kansas Legislature*. N.p., 1 June 2012. Web. 10 Apr. 2012. <http://www.kslegislature.org/li/b2011_12/measures/sb383/>.

REC ownership, V2G, and meter aggregation issues are not addressed. The customer must pay for any additional metering hardware required.[58]

9.6.2 Regulatory Status of EV Charging/Discharging into Grid

This issue does not appear to be addressed in either Missouri or Kansas.

9.7 Electric Vehicle Tax Legislation

EVs are becoming increasingly available as an option for transportation. However, the EV market is still relatively small. According to the 2011 U.S. Energy Information Outlook, only about 20,000 electric cars existed in 2011 compared to more than 225 million total vehicles on the road in the U.S.[59] This number will likely increase with President Obama's goal of 1 million EVs nationwide by the year 2015 and the administration's 2012 budget that proposes increasing the existing EV tax credit from $7,500 to $10,000.[60] When broken down into a local 14 county region, this 2015 goal would result in about 7,000 EVs on the road in Kansas and Missouri (exclusive of the St. Louis and Cape Girardeau metros).

With this background in mind, this section examines potential legislative and regulatory barriers to achieving the EV adoption rates described above. If the current fuel tax policy remains as these electric vehicles enter the market, state fuel tax revenues will be affected. It is possible that state legislators will respond to this potential impact on revenue by enacting EV use taxes. If implemented, such taxes could serve as a barrier to EV deployment.

9.7.1 Potential Electric Vehicle Use Tax Issues

Currently, both Kansas and Missouri use fuel tax revenues for maintaining and constructing highways and roads. A substantial growth in EV use could slow the growth of or reduce federal and state fuel tax revenues, and this is a concern as governments consider changes to infrastructure and policy to allow for EV deployment.

Several states have proposed plans to resolve this decrease in fuel tax revenue and to ensure that EV owners pay a fair share of transportation costs. The Washington State Senate

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[58] "Kansas Incentives/Policies for Solar." *Database of State Incentives for Renewables & Efficiency*. North Carolina State University, 28 June 2012. Web. 10 Dec. 2012. <http://www.dsireusa.org/SOLAR/INCENTIVES/INCENTIVE.CFM?INCENTIVE_CODE=KS08R&RE=1&EE=1>.

[59] Energy Information Administration. "Light Duty Vehicle Stock by Technology Type, Reference Case." *US Energy Information Administration*. US Department of Energy, n.d. Web. <http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=49-AEO2011®ion=0-0&cases=ref2011-d020911a>.

[60] Voelcker, John. "Obama 2012 Budget Proposes Higher Tax Credit For Plug-In Cars." *The Washington Post*. N.p., 15 Feb. 2012. Web. 10 Dec. 2012. <http://www.washingtonpost.com/cars/obama-2012-budget-proposes-higher-tax-credit-for-plug-in-cars/2012/02/15/gIQAPuKgFR_story.html>.

recently passed legislation that requires owners of electric vehicles to pay a $100 fee when they register their cars each year in order to make up for lost gas tax revenue.[61] Similar legislation currently being considered in Oregon would charge registered owners or lessees of electric vehicles 1.43 cents per mile.[62] In both bills, revenues would be distributed to state and local transportation projects in a similar way to fuel tax revenues.

Legislative efforts of this type are not new occurrences. Over the past few years, Arizona, California, Colorado, Mississippi, Texas, and Utah have all either unsuccessfully introduced legislation or had indications that this type of legislation may be proposed.

In early 2012, legislation was introduced in Kansas that proposed taxing the amount of electricity used to charge EVs.[63] Although it was recently heavily modified and tabled, as proposed, the legislation would have required EV owners to maintain two electricity meters: one to record traditional power consumption, and one to record EV power consumption. Electricity used to charge EVs would then have been taxed at a higher rate by the utility companies, with the proceeds passed back to the state.

Missouri has imposed an annual fee on "alternative fueled vehicles," including EVs. The Missouri fee imposes an "alternative fuel decal fee in lieu of tax" on "vehicles powered by alternative fuel."[64] For passenger motor vehicles, the decal fee is $75 per year. The Missouri Department of Revenue says the Chevy Volt does not need a decal because it also uses gasoline, but the (all-electric) Nissan Leaf does require one.[65]

In addition to the gas tax substitute issues described above, another tax issue that factors into EV adoption is a utility franchise tax. A utility franchise tax is a tax that cities impose on utilities providing service within the city limits. This tax is important because it shows consumers that the city has a revenue stream directly from their use of electricity for EV charging as well as other uses. Additional information regarding the electric utility franchise tax for Kansas City, Missouri; Overland Park, Kansas; and Lawrence, Kansas, is provided in a following section.

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[61] Haugen, et al. "Senate Bill 5251." *Washington State Legislature*. N.p., 19 Jan. 2011. Web. 10 Dec. 2012. <http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/Senate%20Bills/5251.pdf>.

[62] "House Bill 2328." *The Oregonian*. N.p., n.d. Web. 10 Dec. 2012. <http://gov.oregonlive.com/BILL/2011/HB2328/>.

[63] Committee on Energy and Utilities. "House Bill No. 2455." *Kansas Legislature*. N.p., 2012. Web. 10 Dec. 2012. <http://www.kslegislature.org/li/b2011_12/measures/documents/hb2455_00_0000.pdf>. Session of 2012.

[64] "Missouri Revised Statutes." *Missouri General Assembly*. 2012 Committee on Legislative Research, 28 Aug. 2012. Web. 10 Dec. 2012. <http://www.moga.mo.gov/STATUTES/C100-199/1420000869.HTM>.

[65] Russel, Linda. "Missouri's alternative fuel fee surprises electric car driver." *KY3 Article Collections*. KY3-TV, 23 Feb. 2011. Web. 10 Dec. 2012. <HTTP://ARTICLES.KY3.COM/2011-02-23/ELECTRIC-CAR_28623140>.

9.7.2 Electric Vehicle Tax Legislation at the State Level

Recently, the U.S. Congressional Budget Office (CBO) released a report stating that "a consensus view of many transportation experts and economists is that a system of taxes on vehicle-miles traveled should be viewed as the leading alternative to fuel taxes as a source of funding for highways."[66]

Oregon, Washington, and Kansas are among the states that have recently attempted to proactively address this revenue replacement issue through proposed legislation aimed at generating revenue from EV use. The bills are designed to either accrue on a per-mile basis or collect a fee at the time of the yearly vehicle registration. The legislation considered in Kansas proposed to tax the amount of electricity used in charging at a level similar to a per-mile basis on gas taxes. Additional information about state-level initiatives to address the gas tax issue is provided in the following subsections.

9.7.2.1 Oregon Legislation

In 2006, Oregon Department of Transportation (ODOT) carried out an extensive pilot program that showed promising enough results to warrant state legislation.[67] Specifically, ODOT launched a pilot program in the Portland area that addressed an EV "mileage fee" and possible issues surrounding its implementation. The study found that the concept was a viable alternative to the gas tax in Oregon.[68]

The pilot program findings materialized in early 2011 as House Bill 2328.[69] The legislation was introduced to the House of Representatives on January 11, 2011, and passed the Transportation and Economic Development Committee as well as the Revenue Committee.[70]

The fee is now called a "vehicle road usage charge" in House Bill 2328. The bill applies to "electric motor vehicles," or EVs, and "plug-in hybrid electric motor vehicles," or PHEVs. A transition fee of $0.0085/ mile would be in effect on July 1, 2015, as this bill currently stands.

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[66] The Congress of the United States. "Alternative Approaches to Funding Highways." *The Hill*. Capitol Hill, Mar. 2011. Web. 10 Dec. 2012. <http://thehill.com/images/stories/blogs/flooraction/Jan2011/cboreport.pdf>.

[67]Whitty, James M. *Oregon's Mileage Fee Concept and Road User Fee Pilot Program*. Salem: Oregon Department of Transportation, 2007. *State of Oregon*. Web. 10 Dec. 2012. <http://www.oregon.gov/ODOT/HWY/RUFPP/DOCS/RUFPP_FINALREPORT.PDF?GA=T>

[68] IBID.

[69]"B-Engrossed House Bill 2328." *Oregon State Legislature*. N.p., 16 May 2011. Web. 10 Dec. 2012.<http://www.leg.state.or.us/11reg/measpdf/hb2300.dir/hb2328.b.pdf>. 76th OREGONLEGISLATIVE ASSEMBLY--2011 Regular Session.

[70] "House Bill 2328." *The Oregonian*. N.p., n.d. Web. 10 Dec. 2012. <http://gov.oregonlive.com/BILL/2011/HB2328/>.

During this transition rate period, a driver can opt to pay a yearly $300 fee. On July 1, 2018, a rate of $0.0156/ mile would be charged to all EV and PHEV users.

The mileage reporting method is yet to be determined by this legislation. Electronic location technology could be one of the methods used for reporting miles traveled, but an alternative to location technology could also be made available.

Should it be enacted, the revenues generated from this legislation are predicted to range from $300,000 in 2016 to $12 million in 2021[71]. According to House Bill 2328, the revenue generated is to be distributed as follows:

- 50 percent to the Department of Transportation.
- 30 percent to counties for distribution as provided in ORS 366.762.
- 20 percent to cities for distribution as provided in ORS 366.800.

9.7.2.2 Washington Legislation

Washington's Senate Bill 5251 passed the Senate on April 27, 2011, and again this year on February 11, 2012.[72] The bill targets EVs only and implements a $100 yearly fee due at the time of vehicle registration. As this bill currently stands, the fee will be assessed to registration renewals due on or later than February 1, 2013[73].

If the legislation passes, generated revenues are predicted to range from $56 thousand in FY 2012 to $1.55 million in FY 2021.[74] The revenue generated will go to the Motor Vehicle Fund for "highway purposes" and will be dispersed as follows after the fund reaches $1 million:

- 70 percent to the motor vehicle account.
- 15 percent to the transportation improvement account.
- 15 percent to the rural arterial preservation account.

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[71] "B-Engrossed House Bill 2328." *Oregon State Legislature*. N.p., 16 May 2011. Web. 10 Dec. 2012.<http://www.leg.state.or.us/11reg/measpdf/hb2300.dir/hb2328.b.pdf>. 76th OREGONLEGISLATIVE ASSEMBLY--2011 Regular Session.

[72] Senate Committee on Transportation. "Senate Bill Report 2SSB 5251." *Washington State Legislature*. N.p., 2012. Web. 10 Dec. 2012. <http://apps.leg.wa.gov/DOCUMENTS/BILLDOCS/2011-12/PDF/BILL%20REPORTS/SENATE/5251-S2%20SBR%20APS%2012.PDF>. As Passed Senate, February 11, 2012.

[73] Senate Transportation. Second Engrossed Substitute Senate Bill 5251. *Washington State Legislature*. N.p., 2011. Web. 10 Dec. 2012. <http://apps.leg.wa.gov/DOCUMENTS/BILLDOCS/2011-12/PDF/BILLS/SENATE%20BILLS/5251-S.E2.PDF>. 2011 first special session.

[74] Transportation Committee. "Washington State Senate." *Washington State Legislature*. N.p., 24 Jan. 2012. Web. 10 Dec. 2012. <http://apps.leg.wa.gov/CMD/default.aspx?AID=17686>.

9.7.2.3 Kansas Legislation

Kansas House Bill 2455 was introduced to the House on January 17, 2012, and, as introduced, proposed imposing a fee on the amount of electricity used when recharging either EVs or PHEVs.[75] However, recently the Kansas Committee on Energy and Utilities adopted a substitute version of the bill that dramatically reduced the potential impact.

As originally proposed, the fee was to be set by the Kansas Department of Transportation and approved by the KCC. The fee was intended to be "comparable to the motor fuel tax established in K.S.A. 79-3401 *et. seq.*, and amendments thereto." Residential charge stations were to be required to have a separate meter to record the amount of electricity being used. This would present significant technical challenges, as well as piracy and privacy concerns in that Level 1 charging can be done at any standard 120 volt power outlet. The fee was to be collected by the utility providing the electricity. Any other public or private recharge station would also have been required to pay a fee to the utility providing the electricity, which would then be collected by the Kansas Department of Revenue and distributed as follows:

- The Motor-Vehicle Fuel Tax Refund Fund for fuel tax refunds.
- The State Highway Fund.
- The Special City and County Highway Fund.
- The Kansas Qualified Agricultural Ethyl Alcohol Producer Incentive Fund.

However, as noted above, the original bill was debated before the Kansas House Committee on Energy and Utilities, and on February 20, 2012; that committee passed a substitute bill which dramatically reduced the impact of the legislation. Specifically, all of the provisions discussed above were deleted from the text of the bill and were replaced, in pertinent part, with the following:

> The Department of Transportation is directed to organize a discussion with the public and all interested stakeholders about the long term feasibility of relying on the motor fuel tax as the primary mechanism of funding the state's highway maintenance and construction program and as the major contributor of state aid to local government transportation budgets. The department is to report its findings and policy recommendations to the governor and the legislature by 1 January 2014.[76]

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[75] Committee on Energy and Utilities. "House Bill No. 2455." *Kansas Legislature*. N.p., 2012. Web. 10 Dec. 2012. <http://www.kslegislature.org/li/b2011_12/measures/documents/hb2455_00_0000.pdf>. Session of 2012.

[76] Committee on Energy and Utilities. "Substitute for House Bill No. 2455." *Kansas Legislature*. N.p.,2012. Web. 10 Dec. 2012. <http://kslegislature.org/li/b2011_12/measures/documents/hb2455_01_0000.pdf>. session of 2012.

9.7.2.4 Mississippi Legislation

House Bill 796 died in a committee on February 23, 2011, but the bill proposed a $0.005 per mile tax on miles traveled in the previous year for electric vehicles.[77] The Department of Revenue eventually would have obtained the revenue, which then would have been allocated similar to state fuel taxes.

9.7.2.5 Arizona Legislation

In Arizona, House Bill 2257 was proposed on January 17, 2012.[78] This bill proposed to tax EVs $0.01 per mile. However, in recognition of the fact that this area of lawmaking is quite young, it requires the state to "adopt rules necessary to implement this article."

9.7.2.6 California, Colorado, Texas, and Utah Activity

California Assembly member Bonnie Lowenthal authored a resolution recommending that the president and the U.S. Congress study a VMT tax as an acceptable form of transportation revenue.[79] Assembly Joint Resolution 5 (AJR 5) "urges the federal government to study the feasibility of collecting transportation revenues based on vehicle miles traveled (VMT) to create a reliable and steady transportation revenue source." This became law (chaptered) on June 8, 2011.[80]

Colorado plans to run an "electric/alternative fuel vehicle user-based fee program in 2012," according to legislative liaison, Melissa Nelson-Osse.[81]

Texas proposed legislation, HB 1669, aimed at setting up a pilot program to study a VMT tax in Texas. The pilot would include electric, hybrid, and "liquefied fuel" (for example operating on liquefied natural gas or propane) vehicles. It was introduced to the House of Representatives on March 3, 2011.[82]

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[77] Ellington. "HOUSE BILL NO. 796." *Mississippi State Legislature*. N.p., 2011. Web. 10 Dec. 2012. <http://billstatus.ls.state.ms.us/documents/2011/pdf/HB/0700-0799/HB0796IN.pdf>. Regular Session.

[78] Farley. "Vehicle Mileage Tax; Electric Vehicles." *Arizona State Legislature*. N.p.,2012. Web. 10 Dec. 2012. <http://www.azleg.gov/legtext/50leg/2r/bills/hb2257p.pdf>.

[79] *Official California Legislative Information*. California State Legislature, n.d. Web. 10 Dec. 2012.<HTTP://WWW.LEGINFO.CA.GOV/PUB/11-12/BILL/ASM/AB_0001-0050/AJR_5_CFA_20110505_105552_SEN_COMM.HTML>.

[80] Lowenthal, Bonnie. "Relative to Transportation." *MapLight*. N.p., 8 June 2011. Web. 10 Dec. 2012.<http://maplight.org/california/bill/2011-ajr-5/985345/history>.

[81] Shepherd, Todd. "CDOT exploring tax on electric vehicles, raising gas tax." *Independence Institute*. Independence Investigates, 11 Sept. 2011. Web. 10 Dec. 2012. <HTTP://INVESTIGATES.I2I.ORG/2011/09/11/CDOT-EXPLORING-TAX-ON-ELECTRIC-VEHICLES-RAISING-GAS-TAX/>.

[82] Harper-Brown. "A Bill to Be Entitle an Act." *Open Government*. N.p., May 2011. Web. 10 Dec. 2012. <http://tx.opengovernment.org/system/bill_documents/001/241/873/original/HB01669H.htm?1310512458>.

Finally, the Salt Lake *Tribune* reports Utah has considered an electric vehicle tax, but no bill was found to actually pursue this.[83]

9.7.3 Local Distribution of Kansas and Missouri Fuel Taxes and Utility Franchise Taxes

9.7.3.1 Kansas and Missouri Fuel Taxes

The federal government imposes a tax of $0.184 per gallon for gasoline and $0.244 per gallon for diesel.[84] Additionally, Kansas has a $0.24 per gallon gasoline fuel tax and a $0.26 per gallon diesel fuel tax,[85] and Missouri has a fuel tax of $0.17 per gallon for both gasoline and diesel.[86]

About 7 percent of both Kansas and Missouri's total tax revenues come from motor fuel taxes. This amounts to about $425 million generated from fuel taxes in Kansas[87] and about $722 million in Missouri during fiscal year 2010.[88] This compares equivalently with Oregon's and Washington's fuel tax revenues, which during fiscal year 2010 were about 6 percent or $403 million[89] and about 7 percent or $1.2 billion[90], respectively.

Kansas allocates fuel tax revenues as follows:[91]

- 66.37 percent to the State Highway Fund.
- 33.63 percent to the Special City and County Highway Fund.

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[83] Gehrke, Robert. "Legislator's plan: Fee for owners of hybrid, electric cars." The Salt Lake Tribune. N.p., 29 Apr. 2011. Web. 10 Dec. 2012. <http://www.sltrib.com/politics/51715747-90/CARS-ELECTRIC-GAS-HYBRID.HTML.CSP>.

[84] Weingroff, Richard. "Highway History." *U.S. Department of Transportation- Federal Highway Administration*. N.p., 7 Apr. 2011. Web. 10 Dec. 2012. <http://www.fhwa.dot.gov/INFRASTRUCTURE/GASTAX.CFM>

[85] "Memorandum- Tax Rates." *Kansas Department of Revenue*. N.p., 16 Aug. 2010. Web. 10 Dec. 2012. <http://rvpolicy.kdor.ks.gov/Pilots/Ntrntpil/IPILv1x0.NSF/ae2ee39f7748055f8625655b004e9335/fa9f71af6ca0cf5786256528006f7006?OpenDocument>.

[86] "Motor Fuel Tax: Frequently Asked Questions." *Missouri Department of Revenue*. N.p., n.d. Web. 10 Dec. 2012. <http://dor.mo.gov/faq/business/fuel.php#q9>.

[87] "State Government Tax Collections." *United States Census Bureau*. N.p., 15 Mar. 2010. Web. 10 Dec. 2012. <http://www.census.gov/govs/statetax/1017ksstax.html>.

[88] "State Government Tax Collections." *United States Census Bureau*. N.p., 15 Mar. 2011. Web. 10 Dec. 2012. <http://www.census.gov/govs/statetax/1026mostax.html>.

[89] "State Government Finances." *United States Census Bureau*. N.p., 14 Dec. 2011. Web. 10 Dec. 2012. <http://www.census.gov/govs/state/1038orst.html>.

[90] http://www.census.gov/govs/statetax/1048wastax.html

[91] Kansas Legislative Research Department. "Transportation and Motor Vehicles." *Kansas Legislative Research Department*. Skyways, 2012. Web. 10 Dec. 2012. <http://skyways.lib.ks.us/KSLEG/KLRD/PUBLICATIONS/2012BRIEFS/Z-1-STATEFUNDINGFORTRANSPORTATION.PDF>.a service of the state library of Kansas.

Missouri allocates fuel tax revenues as follows:[92]

- 10 percent to County Aid Road Trust Fund.
- 15 percent to cities, towns, and villages.
- The remaining revenue goes to "the state road fund" and is to be "expended and used solely as provided in subsection 1 of section 30(b) of Article IV of this Constitution."

9.7.3.2 Kansas and Missouri Utility Franchise Taxes

Another type of tax that exists at the city level that could affect EV development is a utility franchise tax or fee. Cities in both Kansas and Missouri collect utility franchise fees from utilities for doing business within city limits. Functionally, EV owners can view these fees as taxes, as the utilities directly pass the franchise fees collected from their customers to the cities in question.

Kansas City, Missouri, has an electric utility franchise fee of 6 percent. An emergency tax of an additional 4 percent also exists, but it applies only to commercial and industrial customers[93].

Cities in Kansas also charge a utility franchise fee to utilities operating within their city limits. Lawrence, Kansas, has a franchise rate of 5 percent,[94] which in fiscal year 2009 brought in about $5.78 million in revenue.[95] Overland Park, Kansas, has a franchise rate of 3 percent,[96] which in fiscal year 2010 brought in about $9.95 million in revenue.[97]

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[92]Article IV. Mo. Rev. Stat. Sec. 30. 1962 and Supp. 2012. *Missouri General Assembly*. Web. 10 Dec. 2012. <http://www.moga.mo.gov/const/A04030a.HTM>.

[93]Finace Department. "Utilities Licence Tax." *City of Kansas City Missouri*. N.p., Sept. 2009. Web. 10 Dec. 2012. <http://kcmo.org/idc/groups/finance/documents/finance/rd-util.pdf>.

[94] Wheeler, Toni Ramirez. "Draft Ordinance Amending Provision Related to Franchise Fee." Letter. 20 Nov. 2006. *City of Lawrence Kansas*. Web. 10 Dec. 2012. <http://www.lawrenceks.org/assets/agendas/cc/2006/12-05-06/12-05-06h/cm_report_franchise_fee_kawvalley_letter.html>.

[95]Department of Finance, comp. *Comprehensive Annual Financial Report*. N.p.: n.p., 2009. *City of Lawrence Kansas*. Web. 10 Dec. 2012. <HTTP://WWW.LAWRENCEKS.ORG/FINANCE/SYSTEM/FILES/ CITY+OF+LAWRENCE+CAFR+09.PDF>.

[96]*Adopted 2009 Annual Budget*. Overland Park, Ks.: n.p., n.d. *The City of Overland Park Kansas*. Web. 10 Dec. 2012. <http://www.opkansas.org/wp-content/uploads/downloads/2009-city-budget.pdf?&redir=1>.

[97]Scott, David M. *City of Overland Park, Kansas: Comprehensive Annual Financial Report*. Overland Park,Ks.: n.p., 2010. Print. Financial Report.

9.8 Westar and KCP&L Smart Grid Plans

9.8.1 Westar Energy SmartStar Lawrence Project

The Westar SmartStar project involves 39,000 residential and 4,000 commercial meters in Lawrence, Kansas. The total budget is approximately $40 million. The project goes beyond automated meter reading to include a meter communications network and backhaul communications for a meter data management system (MDMS), enabling improved billing, outage management, and load research. Customers can call Westar and have service started or restored minutes after payment with no expensive or time consuming "truck roll" of Westar service crews.[98] In addition, 15 out of 1,338 distribution circuits received automation equipment.[99]

9.8.2 Kansas City Power & Light Green Impact Zone SmartGrid Demonstration

KCP&L is implementing an end-to-end smart grid demonstration in an older neighborhood of Kansas City, Missouri, as part of a larger project known as the Green Impact Zone. The KCP&L SmartGrid program is an end-to-end demonstration area involving 1 substation, 10 circuits, and 14,000 residential and commercial customers. The full cost of the program is approximately $50 million.[100]

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[98] Lerhman, Matt. Westar SmartStar Program Analyst. Interview by Bill Roush. 26 Apr. 2012.
[99] U. S. Department of Energy, Office of Electricity Delivery and Energy Reliability, http://www.smartgrid.gov/sites/default/files/09-0249-westar-energy-project-description-06-13-2012.pdf, July 2011, Accessed April 2012.
[100] "Kansas City Power and Light Green Impact Zone SmartGrid Demonstration." Smart Grid. US Department of Energy, n.d. Web. Apr. 2012. <http://www.smartgrid.gov/project/kansas_city_power_and_light_green_impact_zone_smartgrid_demonstration>.

10 Develop Corridors

10.1 Section Introduction

10.1.1 Synopsis

This section addresses the very important step of developing electric vehicle travel corridors. Within our planning area there are many stretches of highway between major cities that exceed the limitations of a plug-in electric vehicle. In order to pave the way for electric vehicles to become more than just commuter vehicles we must develop these strategic corridors. This section discusses how we can approach this barrier to adoption.

10.1.2 Authors

Troy Carlson, Initiatives and Larry Kinder, LilyPad EV

10.2 Identify corridors for recommending number and locations of future EVSE installations

Information in this section is distilled from experiences of Washington State's EV corridor development. Western Washington Clean Cities had some exposure to the West Coast Green Highway, stretching between Washington, Oregon, California and British Columbia. They worked with the Washington Department of Transportation and did not go about telling them how to establish the highway. The only highway project where this was done was I-5 in California and Mexico.

The proper spacing of stations so that they are close enough for first generation vehicles like the Nissan Leaf is approximately 40 to 60 miles distance.

Their metropolitan planning organization did a study with Department of Registration and mined data to see where Prius owners lived via registrations. Prius owners have a high correlation with future battery or plug-in ownership.

They queried where the Prius vehicles were located in their region and tied in other data points. They also asked, "Where do they travel?" and "How long do they stay there?" People typically travel the longest for entertainment (ball games, theater, etc.). Based on this information they prioritized locations on presumed early adopters and where they would travel the farthest for entertainment.

They ran into a federal statue citation 230.5.c that cannot establish private businesses at rest stops. There were concerns that the state was not the right entity to operate EVSE. When they looked for private entities to host the stations, locations were also changed. Strategy changed when some installed level II and some installed DC fast chargers to eliminate longer Level II charging times at rest stops.

The following is a link to the presentation that describes how they chose charging station sites in the Puget Sound Region http://psrc.org/assets/4144/Station_siting_July2010.pdf

Using similar principles, Electrify Heartland conducted a travel corridor study in Kansas provided as Appendix Q. Travel corridors to be studied were chosen during discussions with Kansas Department of Transportation and anchor cities. The study considers travel between Kansas City and Topeka and between Topeka and Wichita. Major travel corridors are I-70 and I-35. It concludes that Level 2 charging is adequate between Kansas City and Topeka, assuming an all-day commuter trip, and recommends DC fast charging between Topeka and Wichita.

10.3 Recommended EVSE Locations

Extrapolating from these travel corridor studies and best practices, Electrify Heartland recommends EVSE installations at the following locations along interstate highways.

"What you want are EVSEs where people spend time."

Travel between Kansas City and Wichita, KS (Northeast to Southwest on I-35):

- Olathe Exit 215
- Ottawa
- Beto Junction
- Emporia
- Matfield Green
- El Dorado
- Wichita K-96 Exit

Travel between Kansas City and Salina, KS (East to West on I-70):

- Legends in KCK
- Lawrence
- Topeka Wanamaker Exit
- I-40 Wamego Exit
- Junction City
- Abilene
- Salina (135/I-35 Interchange)

Travel between Kansas City and Columbia, MO (West to East on I-70):

- Independence
- Warrensburg Exit
- Marshall/Sedalia Exit
- Boonville Exit

In addition, Mid-America Regional Council (MARC) updated the likely destination maps provided in the Greater Kansas City Plug-in Readiness Strategy. Destination analysis updates based on the latest census are provided in Exhibit 9-2. These maps help to identify recommended EVSE location in the Greater Kansas City metropolitan planning area.

10.4 Identify possible partners and owners of future EVSE

A tremendous amount of groundwork has already been laid with potential partners across the United States. Examples include ChargePoint America, NRG and Ecotality. In addition there is tremendous opportunity with businesses that want to attract new traffic, such as shopping malls, theaters, bowling alleys, merchants, and retailers. Look at www.Ecotality.com and their partners (Macy's, Best Buy, IKEA, Kohl's, ABB). Another important group of public EVSE owners is municipalities

There are three general categories of public charging stations:

1) Networks
2) Retailers
3) Public

What you want are EVSEs where people spend time (retail, sports, entertainment, etc). In addition to those locations you want them installed at parking garages, airports, train stations, city parking facilities, and parking lots, primarily public and some private. On street parking is considered a more difficult market to target.

10.5 Identify needed signage

The signs in Exhibit 10-2 were shown to workshop participants and their feedback solicited. The left sign is from the U.S. Department of Transportation's (DOT) Manual on Uniform Traffic Control Devices. As described in Section 6.2, U.S. DOT gave interim approval to this sign on April 1, 2011. The middle sign is similar to the U.S. DOT 10.03b Sub Title B but also contains the charging levels supported at the charging station. The right sign is an adaptation of the U.S. DOT sign intended to resemble a parking sign for the disabled.

Workshop participant's remarks

- It is odd for the sign to resemble a gasoline pump.
- Providing the charging levels would be helpful.

- Some kind of tow warning to conventional vehicles should also be included.
- Consistency is important, though it is difficult to achieve consistency at the local level.
- The color blue indicates it is a special parking spot.
- Mass-produced signs can be less expensive.
- The sign can act as an advertisement for an EV community.
- Using an image of a car with a plug might be better (similar to the logo at www.pluginamerica.org).
- Friendly signs can work better. Portland, Oregon has signs that say “thank you for saving this space for an EV to recharge.”
- Signage helps locate charging stations. Errors in data exist including where EVSE are located, when they are available, and what kind of charging level they support. Existing mobile and web-based apps are insufficient.
- Regarding changing the sign with U.S. DOT, it took 17 years to get the sign so it may be prudent to avoid trying to change it. [101]

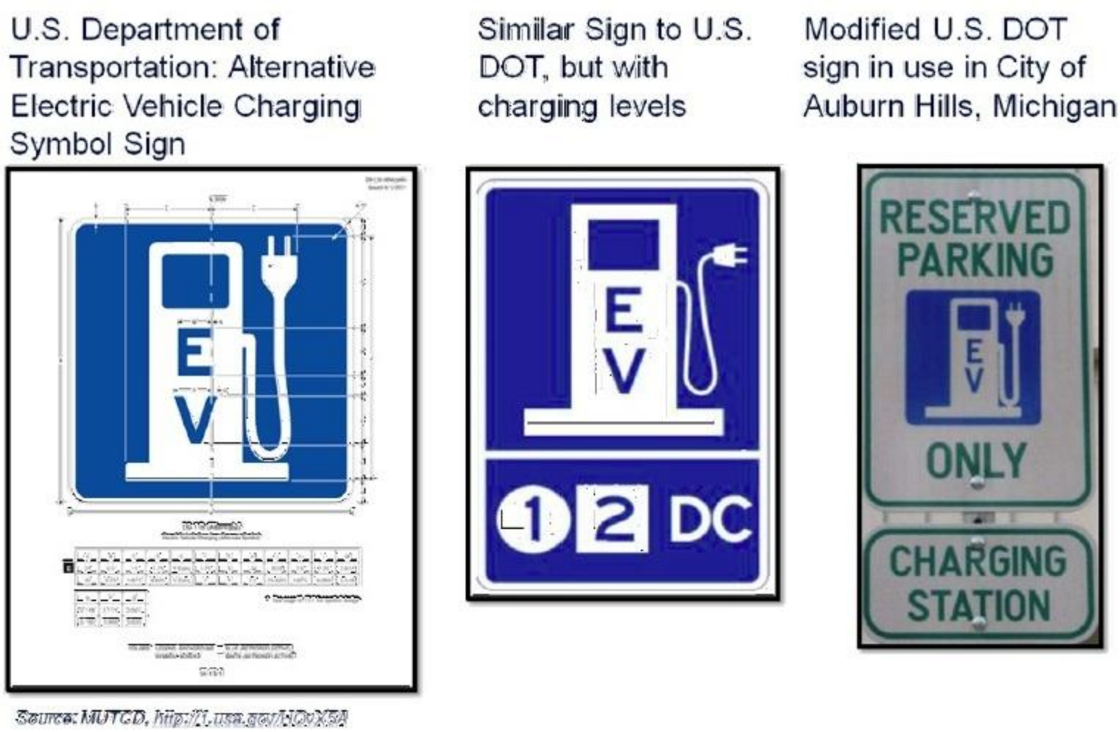

Exhibit 10-1 Three different U.S. DOT signs

[101]Nigro, Nick, comp. *Summary Report: Clean Cities Plug-in Electric Vehicle Community Readiness Partners Discussion Group*. Los Angeles, CA: Center for Climate and Energy Solutions, 2012.Print.

10.6 Identify Signage Barriers

The following is an excerpt from "Get Ready Central Florida (GRCF)"[102]:

"Currently, the generic sign used to identify Electric Vehicle Service Equipment (EVSE), otherwise known as Public Charging Stations, is green with white letters, typically found at area sign shops. Unfortunately EVSE signage can vary from state to state. GRCF would like to see a national sign developed by the Department of Transportation, the agency responsible for designing national street signs. We plan to work with Project Get Ready and the Department of Transportation to develop a national EVSE sign. This would help EV drivers that live and visit Florida easily identifies public charging stations. We also plan to work with transportation planners to have highway exits marked with signs directing drivers to the nearest public charging stations."

[102] "Future Projects." *Get Ready Central Florida*. N.p., n.d. Web. 10 Dec. 2012. <HTTP://WWW.PLUGANDGONOW.COM/WHAT-WERE-DOING/FUTURE-PROJECTS/>.

11 Emerging Technologies

11.1 Section Introduction

11.1.1 Synopsis

Advanced technology vehicles, including electric vehicles, are in themselves emerging technologies and are continually changing as adoption increases worldwide. This section includes information about advances within the Electrify Heartland project planning area with solar energy, wind energy, and wireless charging of vehicle batteries as related to EV and EVSE.

11.1.2 Authors

William Roush, Black & Veatch and Sebastian Ramos, Metropolitan Energy Center

11.2 Solar Photovoltaic (PV) and EVSE

11.2.1 Area Survey of PV installers

Electrify Heartland utility sub team asked members of the Heartland Solar Energy Industries Association about their experience regarding solar PV tied to electric vehicle charging. Information obtained indicted the following activities:

- Creighton University in Omaha, Nebraska, has 85 kW of covered parking spaces using PVs in its Cuming Street parking lot.[103]
- SWT Energy of Lincoln, Nebraska, has relationships with suppliers of pre-engineered hardware for PV covered parking and EVSE.[104]
- Solar Design Studio in Prairie Village, Kansas, has developed designs for PV covered parking with EV charging.[105]
- Cromwell Environmental, Lawrence, Kansas, has worked with a carport manufacturer in the Kansas City area on three projects totaling about 30 kW of covered PV parking.[106]

[103] Byrnes, Robert. 9 Mar. 2012. E-mail.
[104] Schantell, Randy. 9 Mar. 2012. e-mail.
[105] Solger, Bob. 9 Mar. 2012. e-mail.
[106] Rogge, Chris. 9 Mar. 2012. E-mail.

11.2.2 Solar Carport and EV Charging Products

In the U.S., several companies are addressing the PV carport market, which is a market that could become tied to the EV charging market.

- Schletter, a larger company involved in many kinds of PV racking, is promoting Park@Sol©, an engineered solar carport product with a variety of foundation options and scalability from one unit to many much larger areas. They emphasize streamlined manufacturing and fast installation with no welding required.
- SunDurance Energy and Solaire Generation offer a solar parking lot canopy for installations like the 120kW system installed at the New Jersey Meadowlands Commission headquarters in Lyndhurst, NJ.

"Several Midwestern companies are addressing the photovoltaic carport market which is building strong ties to the EV charging market."

- Baja Construction, Inc., with several U.S. locations, has become somewhat specialized in offering Solar Carports, Solar EV Charging Stations, Solar Truck Bays and Solar RV/boat storage. Baja suggests that solar carports in paid parking lots, such as sports venues, have a potential for an additional revenue stream, charging a premium for shade and snow shelter.
- Chevron Energy Solutions offers to run empty conduit underground from AC switchgear to the base of carport columns, allowing easier retrofit of EV chargers at a later date.
- For EPRI, John Hallihan manages a solar carport and EV charging project in Tennessee and notes that this type of EV charging aligns well with workplace charging.
- Demand Energy, Liberty Lake, WA, has parking lot installations of EV charging combined with about 30 kW of PV and 100 kW of energy storage.
- Inovateus Solar, South Bend, IN, has several vendor partnerships to build solar carports with EV charging stations and are active in the Midwest.[107]
- Evergo/Merit Charge, a division of a large metal building company that is very active in the solar industry, has an operational PV/EVSE carport at their headquarters. Their EVSE system allows for credit card transactions on site rather than through a phone call or proprietary network[108].

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[107] Matz, Michael. "Parking Lots and PV." *Photon Magazine* 2012: 41. Print.

[108] Lehrman, Matt 15 Oct. 2012. E-mail.

- On September 24, 2012, Tesla Motors announced an EV charging system called Supercharger. The first six California locations feature a solar canopy generating power to offset electricity used for automotive fuel. The charging system is being done in cooperation with SolarCity, a leading installer of home and commercial PV systems. The charging stations offer recharges at no cost. The Supercharger system is not compatible with other EV charging systems.
- While the company has not tied it directly to EVSE support, Petra Solar has a utility-owned, utility pole-mounted solar offering that has some smart grid capability. Their SunWave solar product of single modules on single utility poles uses ZigBee wireless supported by either cellular, Ethernet, or WiMax backhaul networks. When installed throughout a neighborhood (with heavy EV and EVSE penetration, for instance) it could give a utility the potential to leverage future applications such as smart grid management solutions at the distribution level combined with a level of solar support including reactive power (VAR) and some mitigation of power factor instability[109].
- Kansas City, MO based Premier Carports offers pre-engineered carports that include solar.[110]
- Also in Kansas City, Milbank Manufacturing, long active in electrical metering systems, is now manufacturing and marketing EVSE and solar equipment.

11.2.3 EV Charging Efforts in Education

At the University of Kansas, the KU EcoHawks have built a solar energy station on campus consisting of six 180 W solar panels that allowed recharging the car batteries of an electric vehicle. Kansas State University (K-State) is moving toward a study of solar charging of electric vehicles in a micro-grid using innovative power electronics design. The K-State effort hopes to include cooperation through its Industry/University Cooperative Research Centers Program (I/UCRC) with the University of Texas at Austin and Texas A&M University National Science Foundation – supported program (EV-TEC I/UCRC), which conducts research on the role of electric vehicles in the convergence of transportation and electric power infrastructures.

Kansas City Joint Apprenticeship Training Center built a solar canopy adjacent to their Level 2 EVSE. The solar panel was built as a part of a session of the Electric Vehicle Infrastructure Training Program (EVITP).

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[109] "SunWave Pole-Mount Solutions." *Petra Solar*. N.p., n.d. Web. 10 Dec. 2012. <http://www.petrasolar.com/products/sunwave-smart-solar-energy-solutions/sunwave-pole-mount-solutions>.
[110] "Solar Infrastructure." *Premier Carports*. N.p., n.d. Web. 10 Dec. 2012. <http://www.premiercarports.com/SOLAR.HTML>.

"Solar carports and EV Charging Efforts featured at University of Kansas, Kansas State University and Kansas City Joint Apprenticeship Training Center."

11.2.4 Solar Incentives and EV Charging

Because solar equipment is eligible for a 30 percent Federal Investment Tax Credit (ITC), and this credit includes racking systems, there is an issue of whether the carport structure is eligible for the solar tax credit. The solar ITC expires December 31, 2016. The Solar Electric Power Association 2012 Tax Manual includes this statement on solar carport tax treatment:

> *Credits can be claimed only on equipment as opposed to buildings. Not all structures are considered buildings for tax purposes. In general, a structure that is little more than a shell to house equipment is considered part of the equipment. However, if the structure includes office space or a control room, then it is usually considered a building.*

Interested parties should consult with tax advisors to determine whether the carport structure in a specific installation is eligible for the 30 percent ITC.

11.3 Wind Energy

11.3.1 Wind Speed and Strength in the Planning Area

Wind power is an emerging energy source that could potentially provide the planning area with an enormous amount of energy. Being in the Great Plains Wind Corridor, the planning area receives a fair amount of wind, which further enhances its capability to support wind energy.

"Wind energy produces about 1 percent of the energy in the US, at roughly 25 billion kWh."

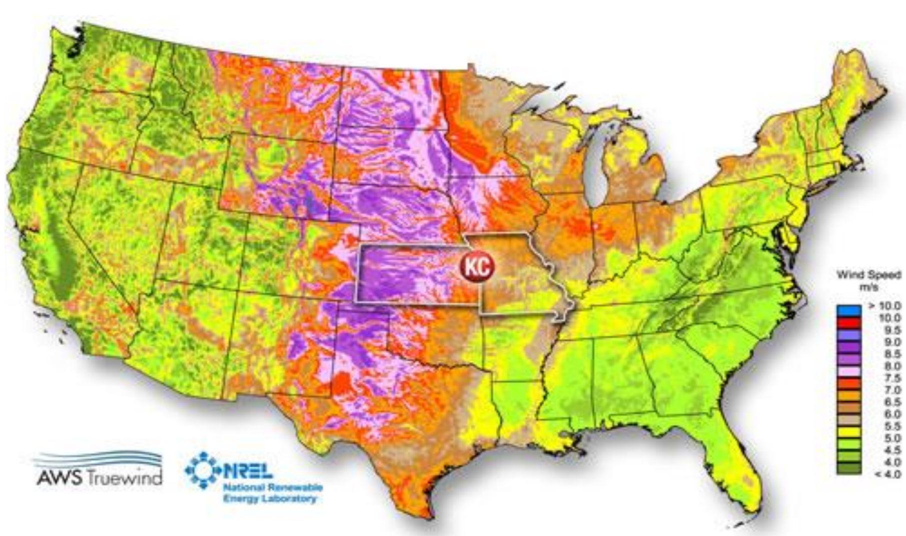

Exhibit 11-1 Wind Speed in the United States

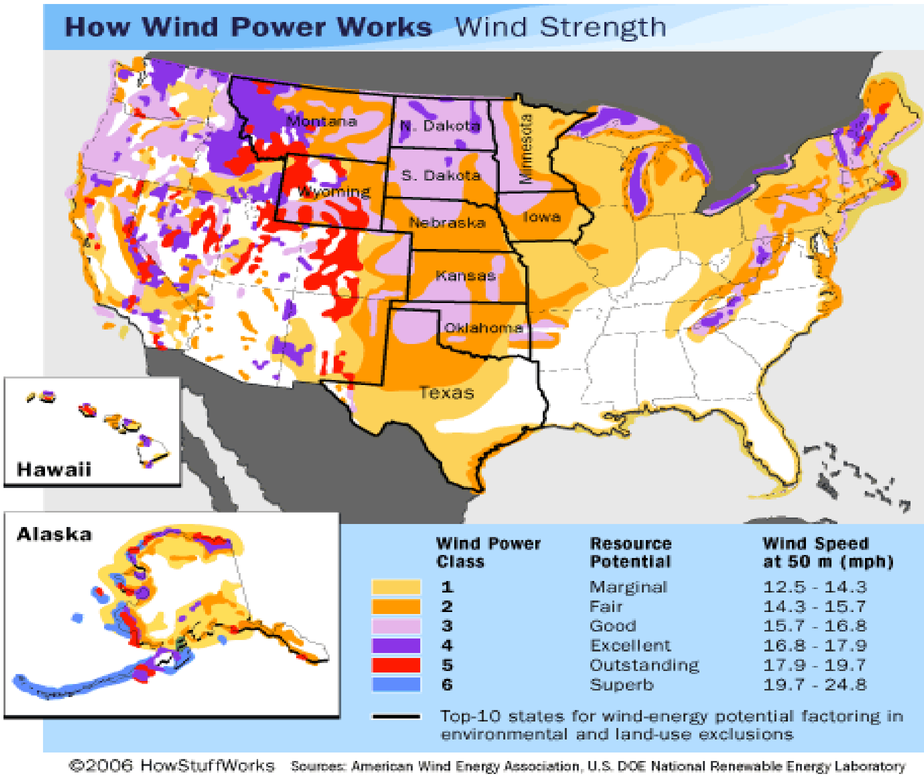

Exhibit 11-2 Wind Strength in the United States

Currently, wind energy produces about 1 percent of the energy in the US, at roughly 25 billion kWh. However, there is potential for far more. The total electricity generation in America is 3.6 trillion kWh, but the estimated potential amount of wind energy is over 10 trillion in the US. In order to produce this energy, all of the smaller windmills would need around 9 mph winds and larger ones would require 13 mph, all quite common in the US and especially Kansas. In addition to this, wind energy increases exponentially in accordance with its speed, meaning higher wind speeds produce far more energy at a quick rate. The pricing estimates of using wind power vary. For the east coast it was estimated to be about 93 billion, which is a fraction of the cost of the savings to be had from using it. As the Midwest has more wind than other parts of the nation, much of the wind energy will need to be transmitted to clear up congestion in our area and transmit it to other places with less wind.

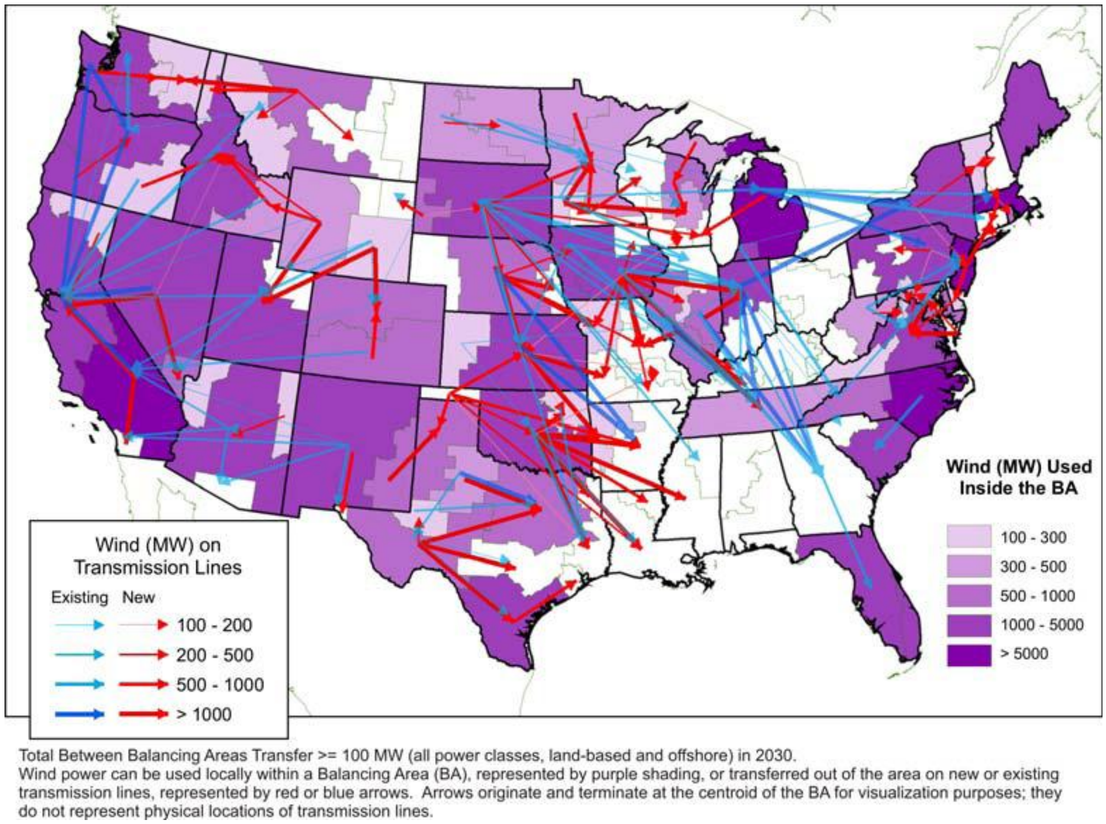

Exhibit 11-3 Wind Energy Transmission in the United States

The actual cost of wind energy is quite cheap, however. In recent years, cost of wind power has been rated at 5 to 6 cents per kilowatt-hour, which is about 2 cents cheaper than coal. The price of coal can also fluctuate quite a bit, and if you factor in things such as the health costs associated with coal, it actually costs around 9 to 27 cents per kilowatt-hour. Natural gas isn't much better; however, there haven't been many accounts of the energy costs of it, as its still being developed. Beyond the actual cost savings of wind energy, there exist other benefits. It is a clean energy source that leaves behind no pollution or damage to the environment.

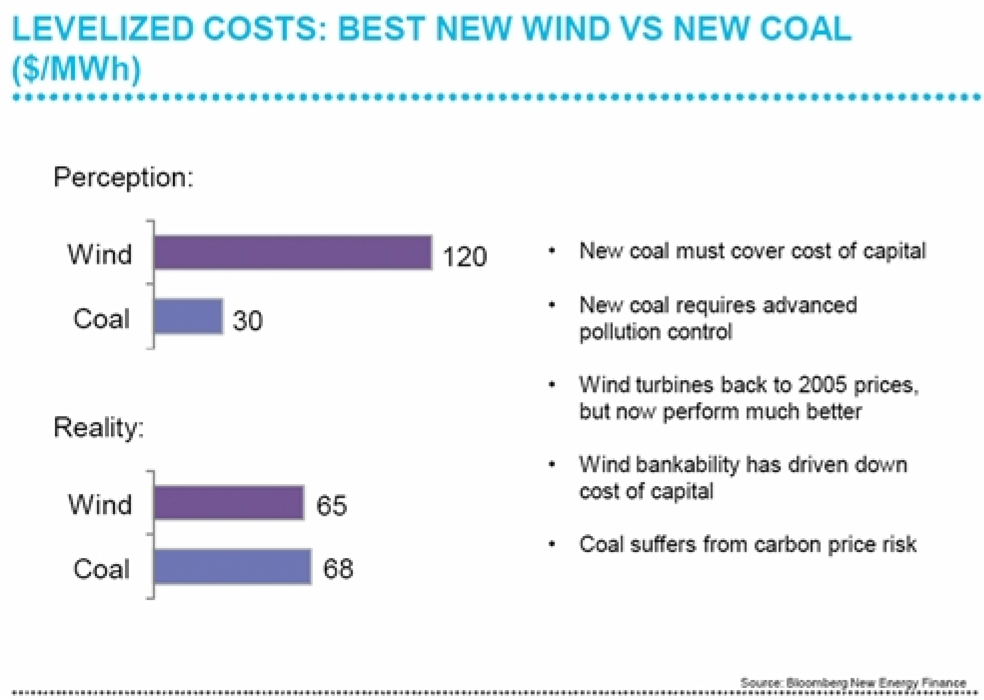

Exhibit 11-4 Cost comparisons between best new wind and new coal: perception and reality

A common complaint lodged at electric cars is that they still get their power from the electric grid, that is, coal and other fossil energy sources. Also, an increased amount of them could overburden the electric grid in some parts of the country. Wind energy could help alleviate that problem by providing an additional, clean energy alternative. However, wind energy is not always stable. While the Midwest may have a fair amount of wind, fluctuations may lead to shortages if sufficient wind is not available. Of course, other energy sources could also be used to fill these gaps, such as solar power. Researchers at Princeton University are experimenting over whether wind energy could be stored in batteries to be used later, during these lulls in wind. If wind energy cannot be sufficiently stored, excess energy could also be used to further power EVs, as they could basically be batteries on wheels. Spain has already acted on this idea and made a functional wind-powered EV charging station in Barcelona. New York has followed with their own 4 kW sky pump that provides energy for electric vehicles.

Wind energy will also revitalize rural areas by adding a new source of property taxes as well as more industry. Wind turbines also don't interfere with agriculture and can be set amidst fields with little problem. A farm sized turbine can even produce excess energy for farmer-owners, allowing them to feed extra energy to the grid. Wind energy can also support local communities by being run by businesses in the area. This leads to money recirculation through the community.

11.4 Wireless Charging

Wireless energy has been around since the time of Nikola Tesla, however only recently has it been considered as a viable option. Wireless energy is based on the concept of magnetic resonance coupling. This relies on two coils of the same frequency being a few feet from one another, with one receiving an electric current. Because of their being on the same frequency, the magnetic current results in a transfer of electric energy from the one receiving the current to another. While there are no current cost estimates of wireless energy, it is known that energy efficiency runs at about 40 percent or more, however this is sure to rise as technology improves. Currently, this technology is primarily emphasized on smaller devices such phones, laptops, controllers, and so on, but the possibilities for larger machines is open. Current experiments show energy can be transferred through walls and obstacles, and have no harmful effects to anyone or anything around.

Wireless EV charging could provide another option. While companies such as Evatran in the US have piloted EV wireless charging, and the major car manufacturers are interested in future development, wide spread adoption will be in the future. Currently, electric vehicles batteries have a charge that lasts for about 100 miles and takes several hours to recharge, making it quite inconvenient. An experiment by Stanford proposes lining highways with the coils that would provide energy to the battery of electric vehicles as they drive on the highways. The coils provide about 10 kilowatts of energy at 6.5 feet, which is about 97% efficiency. Wireless energy could provide a comprehensive solution to the current complaints of electric vehicles, if implemented properly.

Sources for research on Wireless Charging include:

http://news.stanford.edu/news/2012/february/wireless-vehicle-charge-020112.html

http://www.qualcomm.com/solutions/wireless-charging/wipower

http://suite101.com/article/the-future-of-wireless-energy-transfer-a207875

12 Other considerations

12.1 Section Introduction

12.1.1 Synopsis

This section discusses other considerations for EV and EVSE development, which include transit and student programs. The Electrify Heartland planning area has a unique transit history. We briefly discuss this history as well as the possibilities for streetcar development in the near future. This section also recognizes a uniquely innovative student program in the area known as MindDrive and work of students at University of Kansas in the EcoHawks program.

12.1.2 Author

Crista Childers, Metropolitan Energy Center

12.2 Transit

Electric mass transit is important to urban areas due to its accessibility by all income classes, ability to improve air quality, and potential to increase revenue through ease of access to entertainment areas.

12.2.1 History

Kansas City has a unique history when it comes to electric transportation. Franks Sprauge's electric street car made its debut in 1889, allowing for a wide expansion of the rail lines, and by the 1920's 375,000 passengers got around by using the rail system every day. Due to either increased popularity of the car or new conveniences and attractions of the suburban dwelling (or perhaps these two are interrelated) the electric street car (and most public transit for that matter) completely vanished by 1959. [111]

12.2.2 Reasons for Consideration

According to an article in the October 22, 2012 Kansas City *Star* a 2-mile starter streetcar line in the heart of the city has been approved. The line, which may open as early as 2015, is estimated to attract about 2,700 riders daily. The leading argument for this new development, according to Kansas City Mayor, Sly James, "is that we're going to have millennial, those people who believe that having an internet connection is much more important than having a car." The new streetcar will ideally also appeal to business men and women who "simply don't care about the car culture."

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[111] Sherwood, Kyle P. "Kansas City Streetcar Experience." *College of Architecture Planning and Design: Kansas State University*. N.p., n.d. Web. 10 Dec. 2012. <http://capd.ksu.edu/media/pdfs/kcdc-streetcars-by-kyle-sherwood.pdf>.

There is a business case for the development. Modeled after Portland, where a 55 million dollar investment resulted in 3.5 billion dollars in private sector investment over 11 years, primarily in retail and housing, Kansas City could similarly attract a predicted 500 million dollars in added development through 2025.[112] If we don't reverse the pattern of urban sprawl that has been taking place over the past 60 years, the City will spend somewhere around 8 billion dollars over the next 30 years in infrastructure and other public service extensions, according to the Transportation Outlook 2040 baseline scenario by Mid-America Regional Council. [113]

According to the American Public Transportation Association, "Every $10 million of capital investment in public transportation yields $30 million of increased sales."

Another important consideration of electric mass transit is the air quality benefits. For details about air quality impact of transportation options, see Appendix N.

12.2.3 New Developments

In October of 2012 the Federal Transit Administration issued a Finding of No Significant Impact (FONSI) to the planned Kansas City Streetcar Project after a report was submitted for an environmental assessment of the project in late September.[114]

Effective November 20, 2012, the referendum passed by citizens living in the Transportation Development District in downtown Kansas City Missouri to fund the mechanism to build and operate today's Modern Streetcar. It could be operational as soon as 2015 offering another electric transportation option to Kansas City. The Urban Rail Project has been a long journey succeeding primarily through the efforts of Kansas City Regional Transit Alliance (KCRTA). Major obstacles are being addressed including state statues, largest systems of highways at 33,681 miles, lowest fuel tax of seventeen cents, and historically low funding. Missouri is one of only eight states that restrict state road funds to highways thus excluding transit options. Reference Missouri Constitution article IV Section 30 (b). Low annual funding is evidenced by Missouri spending at $119,000, ranking 45th in the nation, yet there are more than 55,000 transit riders per day. See a presentation by the Kansas city Missouri

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[112] Horsley, Lynn. "KC Streetcar Plan: Pricey Transit or Economic Magnet?" *The Kansas City Star. Midwest Democracy*. N.p., 30 Oct. 2012. Web. 10 Dec.2012. <http://midwestdemocracy.com/articles/kc-streetcar-plan-pricey-transit-or-economic-magnet/#storylink=misearch>.

[113] "Growth Scenarios: Visualizing the Future." *Transportation Outlook 2040*. Mid-America Regional Council, n.d. Web. 10 Dec. 2012. <http://www.marc.org/2040/LAND-USE_DIRECTION/DEVELOPING_A_FORECAST/GROWTH_SCENARIOS/INDEX.ASPX>.

[114] *Kansas City Streetcar Project: Finding of No Significant Impact*. N.p.: Federal Tranist Administration, 2012. *City of Kansas City Mo.* Web. 10 Dec. 2012. <http://www.kcmo.org/idc/groups/capitalprojects/documents/publicworks/ocs879231-103299.pdf>.

Councilman and the KCRTA Board on December 18, 2012 http://kcrta.org/images/RTA.pdf for details[115].

12.3 Student Education Programs

Innovative programs involving high school and college students are important to the future of electric vehicle adoption because they are the potential EV owners of the future. As students learn about advanced technology vehicles, interest is sparked in math, science and engineering careers as well as the next big idea for improving efficiency and reducing environmental impacts of transportation.

12.3.1 MindDrive

Briefly mentioned in Section 7.7.3 MindDrive, a Kansas City-based non-profit, grew out of a project at the DeLaSalle Education Center. Students, primarily from Kansas City's urban core, work with mentors on projects that are current and relate to the environment. One of those projects was the design and construction of an electric vehicle[116]. Subsequent projects have also been design and build of EVs with a view toward marketing and communications.

Steve Rees, the founder and CEO of MindDrive has described the mission statement as "to inspire students to want to learn, not just the stuff that we are teaching in our class but also the core elements that make up education."

MindDrive students in 2012 come from the following urban high schools: Alta Vista Charter High School, DeLaSalle Charter High School, Center High School, University Academy Charter High School, and Shawnee Mission East High School.

The 2000 Lola Indy car shown below in Exhibit 12-1 is extremely innovative and may even be the most efficient car in the world. The school has allegedly applied to the Guinness Book of Records. The car was tested at Bridgestone's Texas Proving Ground and found to achieve 307 miles per gallon equivalent.[117]

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[115] Johnson, Russ. "Kansas City Regional Transit Alliance December 2012 Holiday Luncheon." *Kansas City Regional Transit Alliance*. N.p., Dec. 2012. Web. 20 Dec. 2012. <http://kcrta.org/images/RTA.pdf>.

[116] *MindDrive*. Tangient, n.d. Web. 10 Dec. 2012. <http://minddrive.wikispaces.com/EPK>. This is a wikispace that contains information about the MindDrive project objectives, educational objectives,mentor educational process and project bios.

[117] Yoney, Domenick. "DeLaSalle School Students Build Super-Efficient Electric Car That Gets 307 MPG." *Auto Blog Green*. AOL, 19 Aug. 2012. Web. 10 Dec. 2012. <http://green.autoblog.com/2010/08/19/delasalle-school-students-build-super-efficient-electric-car-tha/>.

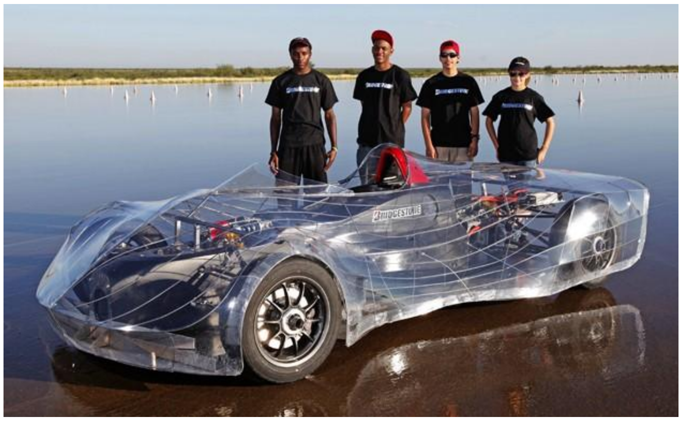

Exhibit 12-1 The 2000 Lola Indy

Project information and updates can be found on their website www.minddrive.org or at http://minddrive.wikispaces.com/Project+Updates.

12.3.1.1 EcoHawks

With recognition from local and national news EcoHawks, an innovative University of Kansas student program, has been making a difference for the past four years and showing the way for others to do the same.

Their Mission statement reads:

> "A Sustainable Approach to Automobiles and Energy Infrastructure "
> The students provide the following definition of Sustainability:
> "The application of engineering principles to solving a real-world problem by focusing upon the connection between the *environment*, *energy*, *economy*, *education* and *ethics*[118]"

From 2008 to 2012, KU EcoHawks have been working on many projects, including electric vehicle conversions and smart-grid innovations. From 2008 to 2009, they converted a 1974 VW Beetle into a series hybrid electric vehicle (HEV) that was fueled by electricity and biodiesel. In the 2009-2010 school years, they converted the vehicle to a hybrid electric vehicle and built a solar-powered charge station capable of charging the VW Beetle in half a day. In 2010-2011, using funds from an EPA grant, the students built a small scale electric and wind smart grid. They later were recognized by the EPA with an honorable mention at the People, Prosperity and the Planet Student Design Competition for Sustainability in 2011. In the 2011-2012 school year students have worked on an electric conversion of an SUV to be

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[118]Depcik, Christopher. "KU Feedstock to Tailpipe Initiative." *Kansas Commerce*. N.p., n.d. Web. 10 Dec. 2012. <http://www.kansascommerce.com/DocumentView.aspx?DID=804>

used as a delivery vehicle. They have also designed a genset trailer that is intended to run on biobutanol created from biomass in order to extend the range of the vehicle.

KU EcoHawks is sparking interest in K-16 students through KU's engineering Expo. In 2013 this two-day event will host over 1,000 students from elementary through high school as they participate in design competitions, examine engineering organization displays, listen to industry professionals speak about real-world engineering and see interactive demonstrations.[119] EcoHawks partnered with OPTIMA batteries in a project called "K-16 Parallel Hybrid Go Kart" and is creating a go-kart sized hybrid vehicle that will be donated to a local high school for the intention of educating and inspiring younger generations[120]. In a less tangible way this involvement can inspire students to explore their abilities and spark interest in alternative energy technologies.

119 *KU School of* Engineering. KU Engineering Student Council, n.d. Web. 6 Dec. 2012.<http://groups.ku.edu/~kuesc/cgi-bin/EXPO/generalInfo.php>.

120 "Optima",Jim. "Helping the Next Generation." *Optima* *Batteries*. Johnson Controls, Inc., 6 Feb. 2012. Web. 1 Dec. 2012.<http://www.optimabatteries.com/us/en/experience/power-source/helping-the-next-generation/>.