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MISSOURI PUBLIC SERVICE COMMISSION

FILE NO. ET-2018-0132

DIRECT TESTIMONY

OF

PATRICK E. JUSTIS

ON

BEHALF OF

UNION ELECTRIC COMPANY

d/b/a Ameren Missouri

St. Louis, Missouri
February, 2018

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DIRECT TESTIMONY

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PATRICK E. JUSTIS

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I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Patrick E. Justis. My business address is One Ameren Plaza, 1901 Chouteau Avenue, St. Louis, Missouri 63103.

Q. By whom are you employed?

A. I am employed by Union Electric Company d/b/a Ameren Missouri ("Ameren Missouri" or "Company").

Q. What is your position with Ameren Missouri?

A. I am the Manager of Energy Services.

Q. Please describe your educational background and employment experience.

A. I received a Bachelor of Science in Mechanical Engineering from the University of Missouri-Columbia ("University of Missouri") in 1989. During that time I worked one semester as a co-op student at Union Electric's Callaway Nuclear Plant in the Systems Engineering Group. After graduating from University of Missouri, my first professional position was with a small manufacturing company in the St. Louis area, Turmatic Systems, Inc., which designs and manufactures rotary transfer machines. While working there I enrolled in graduate school to study environmental science, and graduated from Indiana University's School of Public and Environmental Affairs in Bloomington

with a Master of Science in Environmental Science and Policy in 1993. The summer between graduate school years and after graduation, I was hired by Shannon and Wilson, Inc. where I worked as an environmental consultant on a variety of remediation projects. In 1994, I was hired by the Missouri Department of Natural Resources ("MDNR") and held a few different positions over 14 years. Initially, my work at MDNR was as an Environmental Specialist with oversight responsibilities over the dioxin remediation of the Times Beach Superfund site in Eureka, Missouri. That project was completed and I moved to MDNR's St. Louis Regional Office in 1997 to work as an Environmental Engineer on Missouri's implementation of Clean Air Act section 112(r), which is essentially an extension of The Emergency Planning and Community Right-to-Know Act of 1986. In 2000, I transferred to MDNR's Outreach and Assistance Center in the City of St. Louis as an Energy Engineer where I collaborated with utilities, businesses, schools, colleges, local governments, the federal government, code officials, and the general public on energy efficiency, renewable energy, and green building projects and issues. I received my Missouri Professional Engineer license in 2007, and then joined Ameren Missouri in 2008 as a Senior Program Manager. My initial responsibilities included launching the Company's first formal portfolio of energy efficiency programs for business customers and I managed that area for six years. The next two years I focused primarily on Ameren Missouri's solar rebate program, natural gas energy efficiency program, and some limited electric vehicle ("EV") promotion. In March of 2016, my primary duties shifted to electric vehicles and I now work entirely on efficient electrification with a focus on electric transportation.

I am a founding member of the Missouri Gateway Chapter of the U.S. Green Building Council, having chaired the Chapter in 2008, and am currently the Chair of the City of St. Louis Clean Energy Development Board that has oversight responsibility for the City's Set the PACE St. Louis program.

II. PURPOSE AND SUMMARY OF TESTIMONY

Q. What is the purpose of your direct testimony in this proceeding?

A. In this testimony, I explain the rationale for the Electric Vehicle ("EV") infrastructure portion of Ameren Missouri's proposed Charge Ahead – Electric Vehicles program, the overall outline of which is addressed in the direct testimony of Ameren Missouri witness Steven M. Wills. More specifically, I describe how utility involvement in the development of EV charging infrastructure is not only appropriate but essential to accelerate the adoption of EVs. I also address the many benefits of EVs for our customers as well as Missouri communities and travelers, the current EV marketplace and barriers to consumer adoption of EVs, how our proposal seeks to reduce these barriers and accelerate EV adoption, and how other utilities and states are approaching these issues.

Q. Please summarize your key conclusions.

A. My key conclusions are:

- EVs have many benefits, and efforts to accelerate EV adoption should be supported by the Commission;
- EV adoption in Missouri will remain low unless there are significant efforts to increase consumer awareness and strategically develop charging infrastructure; and

- Utility involvement in raising awareness of the benefits of EVs and enabling a holistic charging ecosystem is essential and appropriate.

III. BENEFITS OF EVs

Q. What types of vehicles are included in your use of the term "electric vehicles"?

A. There are three primary types of passenger vehicles that utilize EV technology:

- Standard Hybrid EV – No plug, but small battery pack that allows for greater fuel efficiency than their conventional counterparts although they do not run in all-electric mode. (Examples: Toyota Prius, Ford Fusion Hybrid);
- Plug-in Hybrid EV – Similar to Standard Hybrid but with plug and larger battery pack that allows for running in all electric mode for a typical stated range of 15-50 miles, then relies on gasoline engine backup. (Examples: Toyota Prius Prime, Ford Fusion Energi, Chevy Volt);
- Battery EV – often abbreviated "BEV," plug-in EV that runs exclusively on electric energy from the grid.[1] (Examples: Nissan Leaf, Chevy Bolt EV)

These differences can be confusing to those new to EV technology and I want to make clear that when referencing the benefits of EVs in my testimony, I am intentionally focusing on the benefits derived from the EV technology inherent in both plug-in hybrid EVs and battery EVs. While some plug-in EVs utilize engines, all plug-in EVs have the capability to operate in "all electric" mode. Not surprisingly, it appears that EV owners

[1] There is an additional sub-category of battery electric vehicle that does utilize gasoline. For example, the BMW i3 is offered in an "extended range" option that has a small gasoline fueled generator to produce power and extend the range. However, this option is not intended for long range travel, but to reduce range anxiety.

prefer to drive in electric mode. In fact, Chevrolet reports that it expects Chevy Volt drivers to get 1,100 miles per tank of gasoline due to the owners' preference to drive electric whenever possible.[2] The summary of key conclusions stated in my testimony above applies to all plug-in EVs, and the benefits of EVs are available not only to battery EVs but also to plug-in hybrid EVs whenever operating in all-electric mode. Therefore, I rarely differentiate between the two in the remainder of my testimony, but generally refer to all plug-in electric vehicles as "EVs".

Q. Why should the Missouri Public Service Commission ("Commission") support and encourage Ameren Missouri's efforts to accelerate EV adoption?

A. There are three primary categories of benefits that result from EV technology compared to existing internal combustion engine technology: environmental, economic, and consumer experience. Within each of these categories there are several points worthy of consideration.

Q. Please address the benefits of EV technology.

A. Electric vehicles operate using highly efficient technology. Far simpler than its combustion engine counterpart, EV technology has inherently superior efficiency. EVs are not burdened by the complexities of high speed engines and transmissions producing and transferring power from engines to wheels. EVs also escape the thermodynamic inefficiencies associated with heat engines, especially at small scale. In fact, according to the U.S. Department of Energy ("DOE"), "EVs convert about 59%–62% of the electrical

[2] For 2016 & 2017 Chevy Volt models with all-electric range of 53 miles; http://www.chevrolet.com/electric/volt-plug-in-hybrid

energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about 17%–21% of the energy stored in gasoline to power at the wheels."[3]

Q. What are some of the environmental benefits of EVs?

A. The technology requires no petroleum fuel or lubrication[4] like that required to minimize friction in complex engines. In contrast to combustion engine vehicles, therefore, EVs reduce or eliminate the possibility of petroleum spills or leaks during fueling, operation, and even when parked.

EVs also substantially reduce emissions, and this is true even when considering the source of the electricity which energizes the grid in Missouri. Missouri's fuel mix has a variety of sources with coal the largest contributor. However, even considering this largely fossil-based source fuel mix, EVs are so efficient and utility generation emissions controls are so effective that EVs still produce almost 50% less NO_x, a precursor to ground level ozone or smog, and slightly less CO_2 than comparable combustion engine vehicles. Please see Schedule 1 attached to this testimony titled "Emissions Workbook" which is an Ameren Missouri calculation spreadsheet used for a Volkswagen settlement presentation. When considering Ameren Missouri's specific generation fleet, the NO_x reductions are even greater. Again, please see Schedule 1. Further emissions reductions will occur as Ameren Missouri adds more renewables to its mix of generation sources, such as the solar and wind sources noted in Ameren Missouri's 2017 Integrated Resource Preferred Plan. And as the grid "grows greener," EV fueling will also become greener in a directly proportional way.

Beyond the fact that overall emissions are lower, EVs produce zero emissions at ground level close to where people live. Most pedestrians, bicyclists, neighborhoods and

[3] http://www.fueleconomy.gov/feg/evtech.shtml
[4] http://knowhow.napaonline.com/electric-car-maintenance-need-know/

businesses adjacent to roadways, and drivers exposed to traffic have experienced the nuisance of noxious tailpipe fumes. These fumes come especially during engine warm-up as well as from diesel engines and gasoline engines that are older or in poor condition. Displacing combustion engine vehicles with EVs will result in less of these unhealthy and nuisance emissions and, ultimately, eliminate them.

A smaller but not insignificant environmental benefit of EVs is that they produce less noise pollution. The U.S. EPA recognizes the potentially negative health impacts of community noise pollution under Title IV of the 1990 Clean Air Act Amendments.[5] Proliferation of EVs would significantly reduce noise pollution due to vehicular traffic because EVs virtually eliminate noise, other than that resulting from wind resistance and tires.

Q. You mentioned economic benefits of EVs. Please elaborate.

A. While the initial purchase price of an EV today is higher than a similarly equipped combustion engine vehicle, the economics are improving rapidly due to battery advances and cost advantages of scaling up production. However, even today there are economic advantages to EVs. Due to their simplicity, EVs have many fewer parts that require maintenance and that can fail and, as a result, have lower maintenance costs. As an example, General Motors states that the first major maintenance interval for its 2017 Chevy Bolt EV, an all-electric vehicle with 238 miles of range, is 150,000 miles.[6] Imagine no oil changes, transmission fluid, spark plugs, timing belts, or other typical combustion engine maintenance items for 10 years. Fueling an EV also has a cost advantage over combustion

[5] https://www.epa.gov/clean-air-act-overview/clean-air-act-title-iv-noise-pollution
[6] https://my.chevrolet.com/content/dam/gmownercenter/gmna/dynamic/manuals/2017/Chevrolet/BOLT%20EV/Maintenance%20Schedule.pdf

engine vehicles. Assuming a retail rate of $0.10 per kilowatt-hour ("kWh"),[7] an EV costs roughly half as much to fuel as vehicles using gasoline at $2.25 per gallon. According to a comparison calculator on DOE's fueleconomy.gov website, a 2017 Chevy Bolt EV saves $800 annually in fuel costs compared to a similar sized gasoline vehicle, a 2017 Chevy Trax.[8] Additional economic benefits accrue to all utility customers due to the majority of EV charging occurring off peak and causing downward rate pressure, as described in Mr. Wills' direct testimony. Better utilization of the existing grid is helpful to all electric utility customers.

Q. What consumer-centered performance benefits do EVs provide?

A. Consumer Reports® lists the owner satisfaction for new EVs as very high. In fact, for all 14 EVs listed as available today, seven rate "excellent," four rate "above average," two rate "average," and only one rates "below average."[9] Consumers testing EVs quickly realize that electric drives are simply a better way to move a car. Electric drives offer 100% torque from a stop, so they are very quick in response, and quite powerful, offering impressive 0-60 mph statistics. For example, the Chevy Bolt EV boasts 200 horsepower and can deliver 0-60 mph in 6.8 seconds. Electric vehicle owners also appreciate the quiet and smooth acceleration EVs provide, without the traditional rumble, vibration, and shifting of an engine and associated transmission. In this age of electronics and mobile devices, EVs typically have an associated mobile application ("app") that allows the owner to view logged energy use, miles driven, and fuel efficiency data on a computer or smartphone. The apps also allow a user to start or stop battery charging

[7] Ameren Missouri's average residential rate per kWh is $.0927.
[8] http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=38187&id=37946
[9] https://www.consumerreports.org/cars/types/new/hybrids-evs/ratings?categoryName=Electric%20cars/Plug-in%20hybrids

remotely, and this capability may someday support a cost-effective utility-sponsored demand response program. Another seemingly small but valued feature of most EVs is the ability to preheat or precool the interior prior to entry. What makes this especially helpful is that preconditioning can occur inside a closed garage, even when attached to a home or business, which is not safely done with combustion engine vehicles. This is possible because EVs have zero emissions. Further, if plugged in, an EV can use grid energy for preconditioning and save battery energy to extend its range.

The environmental benefits of EVs are significant, and current owners of EVs are clearly well-satisfied with the performance benefits of EVs. Widespread enthusiasm and adoption will occur when the barriers of low awareness, high initial price, and insufficient charging infrastructure have been sufficiently lowered.

Q. Does the State recognize these many benefits of EVs?

A. Yes. Missouri has already indicated its support for EVs and associated charging infrastructure in the Department of Economic Development - Division of Energy's Missouri Comprehensive State Energy Plan,[10] published in October 2015, which states, "Using electricity to power vehicles can have significant energy security and emissions benefits." In terms of utility involvement in helping to establish charging infrastructure the same plan states, "Electric vehicle charging stations need access to the electric grid and will likely impact the design, operation and cost of the grid. Due to this interrelation, electric utilities are uniquely positioned to help support electric vehicle infrastructure and charging station networks." [11]

[10] https://energy.mo.gov/sites/energy/files/MCSEP.pdf, p.10
[11] Ibid, p.104

I agree. Because there are so many benefits for consumers, electric customers, and our shared environment, the Commission should support and encourage efforts to lower these barriers and stimulate the EV marketplace in Missouri. As discussed further below, electric utilities in Missouri have an essential and appropriate role to play in these efforts.

IV. CURRENT EV MARKETPLACE

Q. How do EV sales in Missouri compare to EV sales across the country?

A. Missouri's sales are relatively low, ranking 34 of the 50 states plus the District of Columbia, with 3,524 cumulative EVs and 0.29% of new vehicle sales comprised of EVs. Total cumulative sales of EVs in the United States through December 2016, including both plug-in hybrid EVs and battery EVs, are as shown in Table 1 below and ranked by EV percent market share of new vehicle sales in that state:[12]

Table 1

Rank	State	Total Registered Vehicles 2016	Cumulative# of EVs through 2016	Total EV Sales 2016	Total Vehicle Sales 2016	EV % of Market 2016
1	**CA**	**30,280,165**	**261,506**	**73,482**	**2,086,880**	**3.52**
2	**OR**	**3,510,389**	**11,910**	**3,475**	**185,258**	**1.87**
3	WA	6,356,986	22,206	5,345	302,601	1.76
4	HI	1,155,823	5,455	1,246	89,160	1.39
5	**VT**	**558,127**	**1,485**	**496**	**42,697**	**1.16**
6	DC	323,295	1,047	406	38,900	1.04

[12] https://autoalliance.org/resource-center/, Auto Industry Fact Sheets, data through Dec 2016.

Table 1						
Rank	**State**	**Total Registered Vehicles 2016**	**Cumulative# of EVs through 2016**	**Total EV Sales 2016**	**Total Vehicle Sales 2016**	**EV % of Market 2016**
7	CO	4,882,258	8,873	2,724	276,921	0.98
8	MI	8,325,386	13,833	5,377	645,029	0.83
9	UT	2,427,093	4,033	1,137	138,834	0.82
10	**CT**	**2,971,572**	**4,633**	**1,450**	**180,518**	**0.81**
11	**MA**	**5,128,971**	**10,219**	**2,806**	**369,021**	**0.76**
12	WI	5,126,449	4,861	1,773	256,298	0.69
13	NV	2,213,097	3,683	950	145,918	0.65
14	**NJ**	**7,077,772**	**11,092**	3,915	**605,570**	**0.64**
15	**MD**	**4,612,232**	**7,926**	**2,145**	**343,233**	**0.62**
16	DE	821,276	918	329	52,741	0.62
17	AZ	5,698,022	11,396	2,307	387,866	0.59
18	**NY**	**11,448,368**	**19,954**	**5,909**	**1,047,317**	**0.56**
19	**RI**	**831,847**	**808**	**284**	**52,146**	**0.54**
20	VA	7,270,919	7,514	2,128	404,104	0.52
21	NH	1,244,800	1,427	472	98,307	0.49
22	GA	8,555,387	22,598	2,573	528,990	0.48
23	FL	16,050,134	23,376	6,451	1,352,271	0.48
24	**ME**	**1,203,053**	**1,216**	**287**	**65,123**	**0.44**
25	PA	11,545,745	9,100	2,990	677,143	0.44
26	MN	4856561	4,315	1,081	262,481	0.42

Table 1						
Rank	**State**	**Total Registered Vehicles 2016**	**Cumulative# of EVs through 2016**	**Total EV Sales 2016**	**Total Vehicle Sales 2016**	**EV % of Market 2016**
27	IL	10,316,936	11,829	2,733	674,154	0.40
28	TN	5,773,154	4,593	1,175	293,133	0.40
29	NC	8,516,942	7,075	1,697	456,444	0.38
30	KS	2,656,883	1,616	411	109,884	0.37
31	ID	1,587,698	1,064	213	62,048	0.34
32	AK	641,727	409	96	28,406	0.34
33	TX	21,599,174	19,281	4,612	1,551,868	0.30
34	**MO**	**5,460,015**	**3,524**	**890**	**308,843**	**0.29**
35	NM	1,783,423	1,255	263	95,478	0.28
36	IN	5,707,801	3,791	674	251,219	0.27
37	OH	10,328,138	7,633	1,660	627,756	0.27
38	NE	1,886,437	924	207	91,461	0.22
39	SC	4,619,623	2,144	479	229,760	0.21
40	IA	2,980,447	1,610	275	136,691	0.20
41	KY	3,834,722	1,421	283	154,827	0.18
42	WY	599,231	171	42	23,607	0.18
43	MT	1,224,850	486	114	69,031	0.16
44	AL	4,614,792	1,574	349	219,225	0.15
45	LA	3,705,520	1,125	288	223,092	0.13
46	ND	748,296	236	39	36,151	0.11

Table 1						
Rank	**State**	**Total Registered Vehicles 2016**	**Cumulative# of EVs through 2016**	**Total EV Sales 2016**	**Total Vehicle Sales 2016**	**EV % of Market 2016**
47	SD	888,661	314	37	37,497	0.10
48	AR	2,517,624	642	139	142,427	0.10
49	MS	2,546,454	445	91	107,287	0.09
50	WV	1,519,052	419	72	84,585	0.08
51	OK	4,218,121	1,575	270	777,864	0.03

Q. What insights do you gather from the data in Table 1?

A. Clearly, sales of EVs and EV market share vary considerably by state due to the variety of different state policies and incentives in the United States. States listed in bold type (with the exception of Missouri) are those states that have signed onto the 2013 State Zero-Emission Vehicle ("ZEV") Programs Memorandum of Understanding ("MOU")[13] and have committed to policies that are expected to cause a collective 3.3 million EVs in member states by 2025. These states have agreed to a sales goal of 15% EV market share for new vehicles sold by 2025. (Note that Maine and New Jersey have committed only to the new vehicle sales goal of 15%). Not surprisingly, these 10 "ZEV states" claim 61% of all new EV sales in the U.S., though they only comprise 29% of the new sales market. Please see Schedule 2 attached to my testimony, "Auto Alliance Manufacturing Data set December 2016." The overall average state EV sales as a percent of total sales is 0.85%, while the ZEV states average is more than double the national average, having 1.8% of all vehicles sales as EVs. The eight ZEV states which signed the

[13] https://arb.ca.gov/newsrel/2013/8s_zev_mou.pdf

MOU have formed the "Multi-State ZEV Program Implementation Taskforce" and developed the 2014 "Multi-State ZEV Action Plan."[14] Notable in the action plan overview is the recognition that states have a role, but the plan also calls out a wide variety of market players that are necessary to accelerate EV adoption, including "electricity providers":

> The Governors' MOU acknowledges the key role states will play in promoting ZEV market preparation and growth, and this plan identifies specific actions to help achieve those goals. However, states must rely on the automobile manufacturers, car dealers, the electric vehicle supply equipment industry, electricity providers, and others to: (1) produce, market, and sell desirable vehicles; (2) identify the right business model(s) and build out a viable fueling infrastructure; and (3) ensure that competitively priced fuels are available for ZEVs. Therefore, this plan identifies a series of partnership opportunities among states and key stakeholders that are critical to market acceleration.[15]

The task force lays out 11 "Key Actions" to comprehensively address the barriers to EV adoption. The task force also outlines a pathway for state government to play a dominant role in providing leadership by performing outreach, program and policy development, and by establishing incentives.

There is a clear correlation between states that have embraced the merits of EVs and established policies that encourage both the EV market players and consumers, and the market share EVs hold in those states. For Missouri, which tends to tread lightly in terms of providing financial incentives, it seems appropriate that electric utilities would play a much larger role in accelerating adoption of EVs if that involvement can be done in a way that provides significant benefits to all electric customers and Missouri as a whole.

[14] https://www.zevstates.us/about-us/
[15] Id.

V. UTILITY ACTIVITY AND COMMISSION POLICY IN OTHER STATES

Q. Are there examples of utilities that have similarly determined utility involvement is essential to accelerating the adoption of EVs?

A. Yes, there are many utilities that are taking a similar approach by offering, or proposing to offer, incentives for customers to install EV charging stations. Table 2 below is a summary table showing the various incentives these companies have proposed. The amount and type of incentive varies depending upon the category of charging and whether ownership is public, private sector, or utility, but these examples have some similarity to what Ameren Missouri is proposing.

Table 2

Utility Name / State	EV Program Description	Public	Multi-family	Workplace	Corridor	Total Budget	Proposed	Settlement	Pending	Approved
Rocky Mountain Power - UT	Approved incentives for customers to install Level 2 and fast-charging stations that will be customer owned and operated. Maximum incentive levels: Level 2: 75% of cost up to $7K Fast-charging: 5% of cost up to $63K	X	X	X	X	$10M		X		
AEP - OH	Settlement pending; includes incentives for customers to install a total of 300 Level 2 and 75 fast-charging stations that will be customer owned and operated. Maximum incentive levels: Level 2: 50-100%* of cost up to $5K Fast-charging: 80-100%* of cost up to $100K *100% applies to public/gov't customers	X	X	X	X	$10M		X	X	

Table 2										
Utility Name / State	**EV Program Description**	**Public**	**Multi-family**	**Workplace**	**Corridor**	**Total Budget**	**Proposed**	**Settlement**	**Pending**	**Approved**
National Grid - MA	Proposed incentives include 100% of line extension costs and make ready costs plus incentives for about 600 Level 2 and 80 fast-charging stations. Maximum incentive levels: none stated but use of pre-approved list of contractors required.	X	X	X	X	$25M	X			
Eversource - MA	Approved incentives include 100% of line extension costs and make ready costs for about 4,100 Level 2 and 66 fast-charging stations. Maximum incentive levels: none stated but use of pre-approved list of contractors required.	X	X	X	X	$45M				X
Southern Cal Edison - CA	Approved line extension, make ready, and equipment incentives for customers to install 1,500 Level 1 and Level 2 charging stations that will be owned and operated by the customer. Maximum incentive levels: none stated but use of pre-approved list of contractors required and 25-50% rebate on equipment provided.	X	X	X		$22M				X
Pacific Gas & Electric - CA	Approved line extension, make ready, and equipment incentives for customers and utility to install 1,500 Level 1 and Level 2 charging stations that will be owned and operated by the customer and also by PG&E. Maximum incentive levels: none stated but use of pre-approved list of contractors required and tiered rebate on equipment provided.	X	X	X		$130M				X

Table 2										
Utility Name / State	**EV Program Description**	**Public**	**Multi-family**	**Workplace**	**Corridor**	**Total Budget**	**Proposed**	**Settlement**	**Pending**	**Approved**
San Diego Gas & Electric - CA	Approved program for customers only to host and utility to install and own 3,500 Level 1 and Level 2 charging stations that will be owned and operated by SG&E. Participation fee to site host. Maximum incentive levels: none stated but use of pre-approved list of contractors required and tiered rebate on equipment provided.		X	X		$45M				X
Ameren Missouri	Proposed incentives for customers to install Level 2 and fast-charging stations that will be customer owned and operated. Maximum incentive levels: Level 2: 50% of cost up to $5K Fast-charging: 50% of cost up to $25K Fast-charging for Corridor: Reverse-auction RFP process with incentives up to $360,000 per site having 2 each of fast-charging and Level 2 ports.	X	X	X	X	$10.5	X			

Q. Are there examples of other utility commissions that have determined utilities are an essential participant in stimulating the EV marketplace?

A. I'll provide three examples of utility commissions that have determined that utility engagement in proactively supporting the development of EV charging infrastructure is essential to accelerating the adoption of EVs and energizing the overall EV competitive marketplace. The examples include the statements of the California Public Utilities Commission ("CPUC"), the Massachusetts Department of Public Utilities ("MDPU"), and the Washington Utilities and Transportation Commission ("WUTC").

The situation in California may be the most telling example due to the reversal of an earlier CPUC decision. Even in California, where there have been strong incentives to encourage consumers to purchase EVs. Yet even where there is the highest level of sales and number of EVs, there is still a lack of sufficient EV charging infrastructure. In Decision 14-12-079, the CPUC overturned its 2011 prohibition against electric company-owned EV charging infrastructure and allowed an expanded role for utilities. In fact, in the decision, CPUC stated:

> The Scoping Ruling in this proceeding asked parties to consider whether there should be an increased role for the utilities in development of EV infrastructure. The parties' comments represent near unanimity that the utilities should have an expanded role in EV infrastructure support and development in order to realize the potential benefits of widespread EV adoption. There was disagreement in the appropriate degree of increased utility participation, with some parties advocating for limited utility activity, with stringent criteria applied to approval of utility program proposals, while others strongly promoted a swift and aggressive turn to utility participation and funding.
>
> We agree with the majority of comments received, and endorse an expanded role for utility activity in developing and supporting PEV charging infrastructure. However, in doing so, we decline to prescriptively determine the appropriate level of utility activity at this time. Instead, we will evaluate utility proposals on a case-specific basis. [16]

Another example is the Eversource-Massachusetts Case 17-05, in which the MDPU concluded that utility involvement was in the public interest, that the utility was needed to fill a gap that the private EV market was unlikely to fill, and utility involvement would not be anti-competitive.

> …the Companies proposed EV infrastructure program meets the standards laid out in D.P.U. 13-182-A as it: (1) is in the public interest; (2) meets a need regarding the advancement of EVs in the Commonwealth that is not likely to be met by the competitive EV market; and (3) does not hinder the

[16] http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M143/K682/143682372.PDF, pp. 4-5 [Footnotes omitted.]

> development of the competitive EV charging market. Further, the Department finds that the Companies have demonstrated that their proposed expenditures of $45 million on the EV infrastructure program are reasonable in relation to the likely benefits to be achieved. [17]

In a very strong statement of policy, the WUTC indicated that as utilities enter the EV market, its role in regulating utilities remained unchanged with regard to ensuring fair rates of return, consumer protection, and a competitive marketplace, and that it is appropriate for utilities to operate in the EV market. The following reflect many of the WUTC's key points in support of its conclusions:

- There is no clear demarcation line at the customer's meter, but each proposed utility service should be judged by whether it serves an appropriate public service;
- Public purpose is apparent for utility pursuit of electrification of transportation, and the WUTC's general powers and duties direct it to determine how to regulate;
- WUTC has adopted "a policy supporting transformation of the EV market through utility provision of a portfolio of regulated EV charging services that maximize the benefits of EVs to the electric system and allow a competitive market for EV charging services to continue to develop."
- It is appropriate for utilities to support "make ready" components of EV charging station installations.
- "Charging availability and consumer awareness, in particular, are barriers that electric utilities are naturally positioned to address."
- "Accordingly, we adopt a policy supporting a 'portfolio approach' to electric vehicle charging services, similar to the approach used in utility conservation programs. Rather than a single 'measure' or program offering, utilities should provide customers with multiple options for EV charging services, designed to serve a range of customer types, target multiple market segments, and evolve as technology changes." [18]

These three examples make a strong case for utility involvement in the manner the Company has proposed: to accelerate adoption of EVs and the many benefits of EVs by

[17] http://170.63.40.34/DPU/FileRoomAPI/api/Attachments/Get/?path=17-05%2f1705_Final_Order_Revenue_Requi.pdf, p. 501.
[18] https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=147&year=2016&docketNumber=160799, pp. 23-33.

raising consumer awareness of EV options and benefits, and providing incentives that will stimulate the market to establish a sufficient amount of EV charging.

VI. BARRIERS TO CONSUMERS CHOOSING EVs

Q. You previously mention "barriers to EV adoption." Please explain what these barriers are in more detail.

A. Given all the benefits of EVs, one might think that these vehicles would automatically capture a relatively high market share. However, three key barriers prevent consumers from purchasing EVs, despite the benefits: lack of consumer awareness of EVs and their performance, initial cost, and most relevant to my testimony, a real lack of sufficient and suitable charging infrastructure.

A 2013 survey by the Union of Concerned Scientists found that 70% of drivers travel less than 60 miles per weekday.[19] Therefore, a majority of drivers could utilize an EV, even an all-electric BEV, for most of their daily driving needs if they had sufficient access to charging at home, work, or around town. However, another 2016 survey of households in California and nine Northeast states by the Union of Concerned Scientists and Consumers Union found that the biggest concern about owning an EV was that, "There are too few, if any, public charging stations where I travel."[20] This indicates that even though today's all-electric BEVs can meet most drivers' daily needs, the lack of sufficient EV charging stations is a significant barrier in the minds of consumers. The Company's proposed program will contribute to removing that barrier, thus promoting EV adoption by customers, which will in turn enable the benefits of EVs I discuss in my testimony.

[19] http://www.ucsusa.org/news/press_release/ev-survey-0384.html#.WjgSG9KnG5s
[20] https://www.ucsusa.org/sites/default/files/attach/2016/05/Electric-Vehicle-Survey-Methodology.pdf, p. 5.

Awareness is another significant barrier recognized by the EV marketplace. A 2016 survey of 2,500 consumers conducted by Altman Vilandrie & Company and reported by *The Business Wire* indicated that 60% of American drivers were unaware of EVs and 80% had not driven or ridden in an EV:

> [The] survey shows that a perceived lack of charging stations (85%), high costs (83%) and uncertainty over duration of charge (74%) were the top reasons consumers did not want to purchase an EV. Three percent of survey respondents said they currently own an EV, while 10 percent said they planned to buy an EV as their next car. Sixty percent of consumers who have experienced an EV say they 'enjoyed' the experience, while only eight percent reported not enjoying it. [21]

As mentioned previously in my testimony, EV owner satisfaction is high but, as shown by this survey, there is a need to increase consumer awareness of EVs, their benefits, and their compatibility with current driving habits for many. Raising awareness and deploying charging infrastructure will have a great positive impact on Missouri's EV adoption rates and both activities fit well into the Company's customer programs.

Q. What about EV availability and cost? Are these barriers to EV adoption?

A. Yes. There is currently an incremental cost to owning an EV, though the federal tax credit that is still available and lower fuel and maintenance costs help to significantly narrow the overall cost of ownership. It is expected that with advancements in battery technology and efficiencies of scale in production worldwide that EVs will not only reach price parity with combustion engine vehicles in the next decade, but will be lower in price. Bloomberg New Energy Finance studied the issue and reports that it expects

[21] https://www.businesswire.com/news/home/20161208005809/en/High-Costs-Lack-Awareness-Threaten-Short-Electric

parity for some EVs to begin in 2025.[22] Although utilities could justifiably play a role in reducing the incremental EV cost to consumers through incentives, Ameren Missouri believes raising consumer awareness and enabling EV charging infrastructure are more appropriate and effective focuses for utility activities.

With regard to EV choices in the marketplace, there are currently about 40 EV models available today, 14 of which are all-electric BEVs.[23] However, automakers worldwide have been stating their bold plans to add many new models over the next few years:

- Ford announced it is planning for 40 EVs in its worldwide offerings by 2022, 16 of which will be all-electric BEVs;[24]
- General Motors is planning to offer at least 20 new all-electric BEVs by 2023;[25]
- Daimler is planning for 10 all-electric BEVs by 2022;[26]
- Hyundai is planning for 8 all-electric BEVs by 2020;[27]
- Toyota is planning for 10 new all-electric BEVs by early 2020's.[28]

These are a handful of examples, though the majority of automakers, and even some electric-only startups, are planning for new models of EVs and consumers will have many choices in the near future. Automakers are clearly doing their part in developing new EV options in the marketplace. Given that all utility customers will benefit from the proliferation of EV adoption, it is up to utilities to do our part in supporting and encouraging deployment of charging infrastructure. And, given what we know about the

[22] https://about.bnef.com/blog/electric-cars-reach-price-parity-2025/
[23] http://www.plugincars.com/, go to "Cars" link.
[24] https://www.reuters.com/article/us-autoshow-detroit-ford-motor/ford-plans-11-billion-investment-40-electrified-vehicles-by-2022-idUSKBN1F30YZ
[25] http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2017/oct/1002-electric.html
[26] http://media.daimler.com/marsMediaSite/en/instance/ko/Plans-for-more-than-ten-different-all-electric-vehicles-by-2022-All-systems-are-go.xhtml?oid=29779739
[27] https://www.reuters.com/article/us-hyundai-motor-electric-vehicle/hyundai-plans-long-range-premium-electric-car-in-strategic-shift-idUSKCN1AX039
[28] https://www.reuters.com/article/us-toyota-electric-vehicle/toyota-to-market-over-10-battery-ev-models-in-early-2020s-idUSKBN1EC0EB

need for charging, the Commission should encourage Ameren Missouri to help overcome the charging infrastructure barrier so that our customers and those who regularly travel in Missouri are enabled to participate in the EV marketplace and enjoy the benefits of these new EVs as a practical choice.

VII. CHARGING EQUIPMENT TYPES, CATEGORIES OF USE, AND IMPORTANCE

Q. What are the different types of charging equipment?

A. There are three basic levels of electric vehicle service equipment, commonly called "charging stations" or "chargers": Level 1, Level 2, and Level 3 DC fast charging ("fast charging"). Note there are some additional variations within Level 3:

Level	Power	Range added /hour
1 AC	1.5 kW	Up to 5 miles
2 AC	7 kW	Up to 25 miles
3 DCFC	50 kW	Up to 150 miles
	150 kW	Up to 450 miles

Power levels for fast chargers are rising to reduce EV driver charging times, but 50 kW is the most common fast charger power rating for Level 3 chargers today. Higher power fast charging, from 100kW – 150kW will be available in the very near future, probably this year, and even higher levels such as 350kW within the next few years. All of these higher levels will be designed to accommodate today's EVs.

Q. How important is charging capability to widespread EV adoption?

A. Having a sufficient quantity of EV chargers is critically important to enable widespread EV adoption. It is important to understand that there are four broad categories of charging needed to support a holistic charging ecosystem and the need for each depends on the EV owner's situation. The four categories of charging are home (including single and multi-family), workplace, public around town, and long distance corridor.

The ability to conveniently charge at home and skip the gas station is one of the benefits of EVs. Home charging can typically be accomplished using the manufacturer-supplied charger provided with the EV purchase that plugs into a typical 120V receptacle found in homes. This type of charger, commonly known as "Level 1," provides about 5 miles of range per hour of charging time. Strictly within the narrow need of consumers that commute the relatively short average commute in St. Louis or Kansas City of about 20 miles round trip,[29] this type of charging is completely adequate. The Missouri average daily commute of approximately 40 miles is a bit higher than the average for the largest cities, but Level 1 charging still provides appropriate and adequate charging for this limited category of use. For homeowners that have the option to extend a 240V/40 amp circuit to their garage or parking area, installing Level 2 charging will provide about 25 miles of range per hour of charging and allows the convenience of "topping off" to extend range for multiple trips in a day.

However, for many homeowners, and particularly for the vast majority of multifamily renters, a dedicated 120V receptacle may not be available, much less a 240V Level 2 option. For this reason, the multi-family home end use is one category of chargers that is necessary for these consumers to consider EVs a practical option.

Another category of EV charging is workplace. Workplace charging is provided by employers as an amenity for employees and/or visitors, and is a way for employers to demonstrate their commitment to sustainability, innovation and technology to employees, customers and new recruits. When provided for employees, there is evidence that workplace charging brings attention to EVs, thereby raising awareness and causing a higher

[29] https://www.marketwatch.com/story/here-are-the-typical-commutes-for-every-big-metro-area-2015-03-25

rate of adoption. According to the 2014 DOE Workplace Charging Challenge survey, drivers at Workplace Challenge employers were six times more likely to drive an EV than the national average worker.[30] These Workplace Challenge employers typically develop programs to promote EVs, raise awareness of the available charging, and reduce range anxiety. Level 1 and Level 2 chargers are most suitable for workplace charging where vehicles have long dwell times. Level 2 has the advantage that more than one vehicle can be charged in a typical 8-9 hour work day if employees are required to move cars or connectors. Also, because most commercial equipment with communication networking capability is commonly Level 2, it is the preferred option for workplaces that want to monitor, restrict use, or receive payment from users.

Public charging "around town" can reduce drivers' range anxiety when traveling around town, and also provide "full charge" when available as fast charging. Examples of this type of charging include Level 2 at local retailers, restaurants, hospitals and clinics, and other local destinations, and are offered as an amenity to customers, typically without charge for the service. Much of today's fast charging is primarily located at auto dealerships and is not considered truly public. Examples of public fast charging include 14 locations in Kansas City Power & Light Company's ("KCP&L's") "Clean Charge Network" surrounding Kansas City, and Nissan's "No Charge to Charge Program" charging stations situated at 12 Commerce Bank locations circling St. Louis. Unlike the less costly Level 2 charging, public fast charging usually requires a membership or credit card payment for the service due to the equipment cost and the significant amount of energy that can be dispensed in a relatively short time. And the cost tends to be higher than the residential

[30] https://www.afdc.energy.gov/uploads/publication/wpcc_mid-program_review.pdf

retail rate of energy at home. It is possible for adventurous drivers without access to home or workplace charging to utilize public fast charging as their sole source of charging, but this is not common because it is rather inconvenient for routine charging. More typically, local networks of fast chargers such as those in St. Louis and Kansas City serve to help prospective customers feel less range anxiety when making the decision to purchase an EV but are infrequently utilized once the EV purchase has been made. As EVs grow in battery capacity and associated range, drivers will have less range anxiety and public around town charging may become a less important part of the charging ecosystem.

Long distance corridor charging is also critical to fully establish the holistic charging ecosystem. Tesla Motors understood that to sell its long-range (300+ miles) EVs, it was necessary to solve the long-distance charging problem. So Tesla Motors established a private, nationwide network of fast charging stations.[31] Some automakers have declared that there will be new models of all-electric EVs in the next few years expected to have ranges exceeding 300 miles. Even the existing Chevy Bolt EV, with 238 miles of range, has the potential for practical long-distance travel, but is currently unable to travel across Missouri and return in a timely manner because there is insufficient fast charging available. In fact, between the Kansas City and St. Louis metro areas,[32] and between Kirksville and Springfield, there are **zero** non-Tesla fast chargers available for general public use. There are available Level 2 chargers, but that is not a practical option given the 25 miles/hour rate of charging. Fast charging is the only practical option for long-distance charging, and a practical network is necessary to enable consumers to seriously consider the longer range

[31] Unfortunately, Tesla Motors' charging stations use a proprietary plug that is not typically usable by other EVs.
[32] "Specifically, between Blue Springs and Wentzville."

EVs as a viable alternative to the traditional combustion engine vehicle. Imagine a consumer learning about EVs in the dealer showroom or even online. They may love the car and all of its benefits, but when the discussion turns to charging options for a long-distance trip across Missouri and there are no practical options, the long-range EV is no longer a viable purchase. When long distance trips are necessary or desired, it is critical that fast charging is available. Like public around town charging, long distance corridor charging will not get significant use from any given consumer; when it *is* needed, however, it will be essential. And when strategically placed in or near communities, fast charging can serve additionally as public around town charging and raise awareness of EVs as a practical option. For this reason, establishing a minimum practical network of corridor fast charging should also be a priority focus in developing charging infrastructure in Missouri.

VIII. MARKET INTELLIGENCE

Q. What does "holistic charging ecosystem" mean and how do you know that is important?

A. Over the past 18 months or so, through development of our previous EV proposal, (File No. ET-2016-0246), and through the Commission dockets on electric vehicle charging facilities (File No. EW-2016-0123) and Emerging Issues (File No. EW-2017-0245), Ameren Missouri has been exploring options to support the development of charging infrastructure. Given the Commission order in File No. ET-2016-0246, the Company has put more focus on the question of how to effectively engage the private sector in owning and operating EV charging infrastructure. Seeking more market intelligence about the costs and challenges for the private sector to establish long distance corridor charging, the Company engaged multiple charging equipment developers through a

Request for Information ("RFI") titled, "Development of Missouri Highway Corridor DC-Fast Charging" to learn:

> ….how Ameren Missouri should stimulate the EV marketplace to establish a minimum practical network of privately managed public long-distance DC Fast Charging (DCFC) stations along Missouri's highways. Through this RFI solicitation, Ameren Missouri intends to engage private sector charging station developer/operator partnerships for the purpose of getting market intelligence that will inform utility development of tariffs and/or incentives related to EV line extensions, DC service, billing rates, and/or other development aspects needed to stimulate private marketplace investment that will establish a minimum practical network of DCFC along Missouri's highway corridors.

After holding conversations with the various respondents, the Company captured five key takeaways:

1) While Ameren Missouri's vision of a minimum practical network of corridor charging is generally realistic and was confirmed to be important, the amount of support required to stimulate the private sector to set up corridor islands along Missouri highways is substantial and a **holistic charging ecosystem** approach that includes some local types of charging is needed.
2) With regard to corridor charging, our conversations suggest that Ameren Missouri focus initially on interstate highways and add multi-lane highways outside of interstates as a second phase.
3) Our conversations suggest that Ameren Missouri should include reliability performance requirements in 5-10 year contracts that include financial penalties for under performance.
4) While 50kW fast charging would be utilized for 10 years, developers recommended that Ameren Missouri work to deploy higher power levels initially given the fact that automakers will soon - and are already - deploying cars capable of higher charging power levels.
5) While there is no current market for utility-supplied DC fast charging service, 2 of 5 developers are excited about the possibility and the associated battery storage opportunity to reduce demand charges.

Note the use of the term "holistic charging ecosystem" in the first listed key takeaway. The Company heard this term, or phrasing with the same meaning, during all of the conversations and it was the common response when developers were asked what category of EV charging was most important to stimulate the EV marketplace. A holistic charging ecosystem provides for all four categories of EV charging so that all EV drivers or

prospective EV buyers have confidence in the availability of charging in all of their refueling need scenarios

Q. In the first takeaway, what do you mean by "…the amount of support required to stimulate the private sector to set up corridor islands along Missouri highways is substantial…"?

A. In exploring utility options for stimulating the private sector to serve Missouri's corridors with fast charging stations, the Company identified various costs associated with establishing and operating charging stations. The costs include line extensions, charging hardware, networking software, site selection, design, development (concrete pads, conduit, protective bollards, etc.), maintenance costs, energy and demand charges, and customer service (transactions and responding to customer inquiries). From the RFI responses as well through our own discussion of a stand-alone charging station business, we have concluded that without utility engagement, public fast charging along Missouri corridors is not feasible and is unlikely to be feasible any time soon. The issues are high initial capital cost and ongoing operational costs relative to the low revenue stream attributable to the few currently existing EVs in Missouri. Further, even in the future when Missouri can boast a larger number of EVs, these stations are likely to remain a challenging prospect for the private sector without utility or other support. Given that 95% or more of charging will likely occur at or near the home with associated revenues flowing to a local utility, utilities are the logical source for market support. It is possible to provide the necessary market support to stimulate interest among competitors while holding the private sector accountable to utility customers who, ultimately, expect high quality service and reliability from their utilities.

What we understood about the EV charging marketplace, and have confirmed, is also reflected in the dissenting opinion from Commissioner Rupp taken from our previous proposal:

> The order that passed, of which I opposed, was predicated on the belief that a market for EVCS currently exists in Missouri. It states that a utility must find a third party partner who will pay the costs to install and maintain a charging station. To put real numbers to this situation, according to the evidence in the record charging equipment costs $60,000, plus another $20,000 for construction/installation, and several thousand per year of maintenance. In other words, $80,000 upfront costs plus several thousand per year in maintenance. That is a massive capital cost in hopes of making a small margin on the price of electricity, on a minuscule volume of customers, even if those customers patronized your business while their car was charging.[33]

The figures Commissioner Rupp has provided are accurate for our previous proposal (File No. ET-2016-0246). Importantly, through engagement with the marketplace, we have determined that those costs underestimate the total cost for the proposed corridor charging islands, thereby reinforcing the "substantial" support needed to stimulate the private sector to develop corridor charging infrastructure.

Q. Are you stating that without utility engagement in supporting development of EV charging infrastructure that the overall EV marketplace in Missouri will continue to be sluggish?

A. Absolutely, that is what I believe. Based on multiple utility filings as well as executive, legislative, and regulatory policies in other states, the EV marketplace has also come to this to conclusion. Especially in states like Missouri, that lack clear executive or legislative policy directives that support EVs, it is paramount and appropriate that utilities step up and engage the marketplace. Without a concerted effort by those whose

[33] Dissent, April 26, 2017, File No. ET-2016-0246, p. 2.

customers will benefit most, such as utilities, Missouri will continue to lag in EV adoption and its associated benefits.

Q. Is there any data to support Ameren Missouri's premise that building EV charging infrastructure results in higher EV adoption?

A. Earlier in this testimony, I provided statistics connecting supportive policies and incentives found in ZEV states to the high proportion of EV sales in ZEV states. Another example that provides evidence for a holistic charging ecosystem approach and demonstrating how the widespread availability of charging infrastructure increases EV adoption is the KCP&L Clean Charge Network. This network of over 2,000 charging ports throughout the Kansas City Metro Area has had impressive impacts to the growth rate of EVs in the area. According to KCP&L statistics, the Kansas City area has had the highest growth rate of EVs in the U.S. for 2016-Q4 and 2017-Q1 at 78%. And earlier in 2016, Kansas City was in the top two or three cities nationwide.

IX. AMEREN MISSOURI'S PROGRAM PROPOSAL

Q. How is Ameren Missouri proposing to help establish a "holistic charging ecosystem?"

A. Through the proposed Charge Ahead – Electric Vehicles program outlined in the tariff sheets filed concurrently with this testimony, the Company will offer financial incentives to customers to own and operate charging equipment in each of the four categories previously discussed (multifamily, workplace, public around town, and long distance corridor), thereby stimulating the private market to establish a holistic charging ecosystem throughout the Company's service territory.

Q. Please describe Ameren Missouri's vision for a minimum practical network of corridor DC fast charging mentioned previously in your testimony.

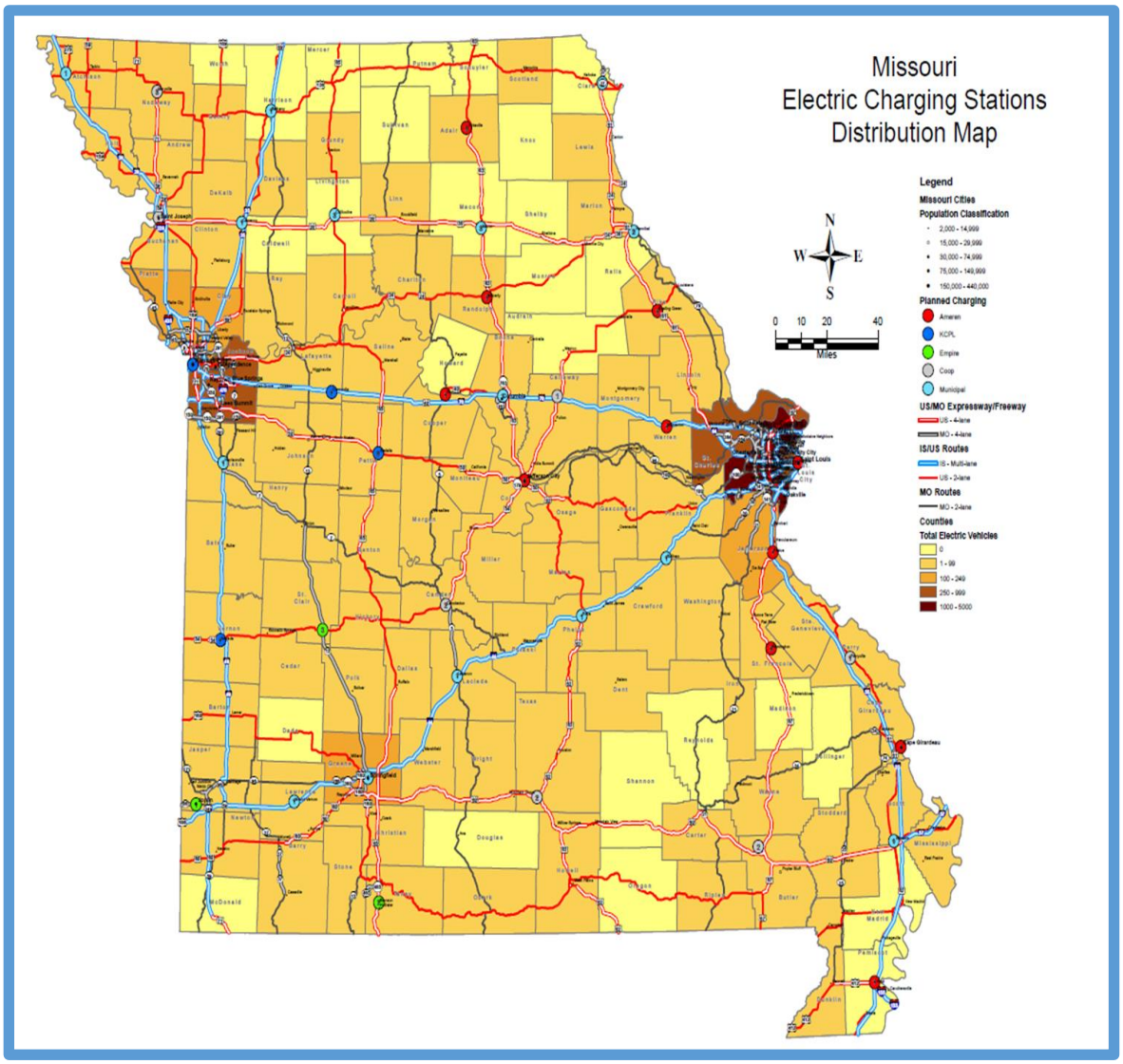
A. Ameren Missouri has been helping lead an informal group of Missouri utilities and environmental organizations, the Missouri EV Collaborative ("EV Collaborative"), to explore the benefits of efficient electrification with a focus on electric vehicles. The origin of this EV Collaborative was an EV Peer Exchange meeting held at KCP&L late in 2016 where there was some urgency around the topic of the Volkswagen Environmental Mitigation Trust funding. This is funding that will come to Missouri as a result of the U.S. EPA's settlement with Volkswagen related to Clean Air Act violations. Missouri will receive approximately $41.6 million through a trust managed by MDNR. Under the Volkswagen Environmental Mitigation Trust rules, up to 15% of this fund can be utilized for "light duty zero emission vehicle supply equipment," and this can include any public EV charging.

The EV Collaborative's view, contained in its letter which is attached as Schedule 3 to my testimony, is that development of a minimum practical network of fast charging along Missouri’s highways requires not just financial support but also coordinated statewide planning to cost-effectively ensure a sufficient number and appropriate placement of charging stations occurs rather than only having fast charging near higher population urban areas. This vision for a minimum practical network for corridor fast charging in Missouri is a public network that makes long-distance EV travel across Missouri not only possible but practical, for EVs having a nominal range of 100 miles or greater. The following specifications include important requirements to achieve the "minimum practical network" goal:

- Minimum of two fast chargers having the following capability:
  - 150kW charging rate, but minimum of 50 kW, DC output
  - Can connect to all fast charging-compatible EVs
- Minimum of two Level 2 ports having ~7kW AC output
- Credit card capability
- Spacing of islands no less than 25 miles and no more than 75 miles apart
- Located in communities within approx. 3 miles of interstates or multi-lanes
- Located on real estate having a "no cost easement"
- Located within walking distance of amenities
- High reliability/availability

The EV Collaborative outlined a high level plan for establishing a minimum practical network of corridor fast charging throughout Missouri. Please see Schedule 4 to my testimony, EV Collaborative's Proposal for Development of Missouri Statewide Highway Corridor DC-Fast Charging, submitted to the MDNR on December 6, 2017. Map 1 below depicts the network of 40 fast charging "islands" as dots having color based on the utility serving that location. Each utility will have to determine how to enable development of the fast chargers to be located within its service areas. The 10 red dots are in areas served by Ameren Missouri.

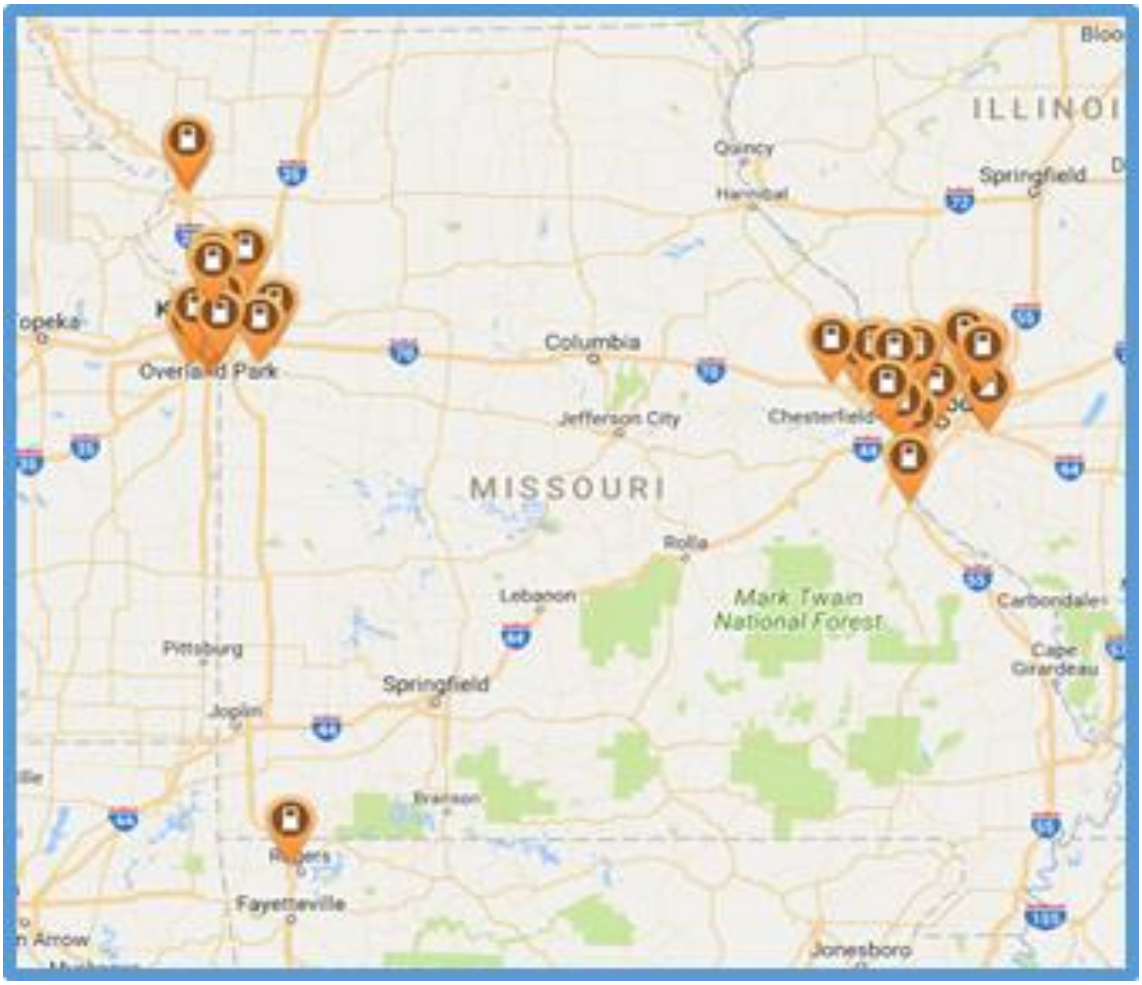
Map 1



Q. How much public fast charging exists in Missouri today?

A. Except for limited and proprietary Tesla charging, none exists outside the metropolitan areas of Missouri's two largest cities. As shown in Map 2 below, non-Tesla public fast charging exists only near the St. Louis and Kansas City areas. Importantly, many of these fast chargers are at car dealerships rather than truly public locations, and therefore cannot be considered reliable locations for public charging.

Map 2



Q. How does the Volkswagen Mitigation Trust affect Ameren Missouri's proposed program?

A. Ameren Missouri's proposed Charge Ahead – Electric Vehicles program stands alone on its merits for the reasons outlined in Mr. Wills' direct testimony. However, it is important for the Commission to know that the Company is not planning this undertaking without full knowledge and engagement in related matters such as the Volkswagen Mitigation Trust and coordination with other utilities as necessary to develop the minimum practical network of corridor fast charging. Should the EV Collaborative be awarded some of the Volkswagen Mitigation Trust funding, the portion of that award

reserved for sites located in Ameren Missouri territory would reduce the costs of long-distance corridor incentives that Ameren Missouri would offer through its program, to the benefit of Ameren Missouri customers.

Q. What are the specific incentives you propose to offer?

A. As described in the program tariff, proposed incentives are as follows:

Charging Category	Incentive Amount	Estimated Total Incentives	Number of Ports Expected
Multifamily	$ 5,000 per L2 port	$4M	800
Workplace	$ 5,000 per L2 port	$1M	120
	$25,000 per L3 ≥50kW		16
Public Around Town	$ 5,000 per L2 port	$1M	120
	$25,000 per L3 ≥50kW		16
Long Distance Corridor	TBD thru RFP Reverse Auction Process	$4M	10-12
Except for Long Distance Corridor, all incentives are capped at 50% of project cost.			

Q. How would Ameren Missouri use the long distance corridor incentives to pursue development of the minimum practical network of corridor fast charging islands located in the Company's territory?

A. The long distance corridor incentives differ significantly from the other EV charging infrastructure incentives because corridor incentives cannot achieve the intended purpose of a minimum practical network through a first-come, first-served application process that does not ensure chargers at specific, needed locations. In designing the fast charging network, draft community locations along all major and some minor highways have been selected based on the needs of the EV drivers traveling long distances across Missouri. Without a planned network, the result could be redundancy in one area and lack

of options in other areas. Therefore, Ameren Missouri will develop a set of minimum configuration and performance requirements for fast charging islands in designated communities (as shown in the bulleted list in an earlier answer on pages 32-33.) In a "reverse auction" request for proposal, bidders will be asked to detail their plan to design, build, own and operate the fast charging islands and declare the level of utility incentive they will require to successfully establish this charging as a stand-alone private sector business or as an addition to or partnership with another business. The rubric for both quantitative and qualitative scoring of a proposal would include how much incentive the bidder requires. Bids with the least incentive required would be favored on the cost aspect of scoring.

This approach to engaging the private marketplace balances utility involvement and private sector competition. Given that the incentives would ultimately be supported by Ameren Missouri customers, the Company will require a contract stipulating operational requirements.

Q. How would you administer Charge Ahead – Electric Vehicles?

A. Ameren Missouri has extensive experience in administering large customer-facing energy efficiency incentive and solar rebate programs. As a new program in the Company's portfolio of customer offerings, Charge Ahead – Electric Vehicles would be managed in much the same way by an "Electric Vehicle" Team ("EV Team") of employees. The EV Team would have responsibility for development and operation of the program including detailed planning, internal and external communications and coordination, marketing, customer service, incentive processing, and tracking and reporting.

Q. How would the Company promote the Charge Ahead – Electric Vehicles incentives?

A. Ameren Missouri would promote charging equipment incentives through marketing channels such as the Company's website, bill messages, social media, live events, dealerships, trade allies and word of mouth from employees. The program will encourage the installation of charging equipment through financial incentives for business customers and make it easier for all customers to install charging equipment and support EVs. A big part of making it easy for customers is to make sure there are plenty of contractors that understand the numerous considerations that go into a well-planned charging network and offer competent solutions for charging station installation and management. The EV Team would establish and nurture an EV trade ally network. Existing electrical suppliers and contractors are a natural fit for helping customers with charging station installation. However, because charging stations are not yet a commonly installed device in Missouri, Charge Ahead – Electric Vehicles may need to offer charging station installation training to help grow the number of trained professionals that can advise and serve customers. Once charging station incentives are available in the Company's territory, manufacturers of charging equipment will likely have increased motivation to market their products to customers, suppliers and contractors and they will enhance the trade ally network. Ultimately, the trade ally network would be a resource to customers for help with consulting, equipment selection, site planning, installation and maintenance.

In addition to promoting incentives for charging infrastructure, the Company will also work to promote greater awareness about the benefits of EVs to consumers. This will include information about the consumer centric benefits mentioned earlier in my testimony

as well as the grid benefits and how to maximize both. For example, the Company can make customers aware of how easy it is to set the automatic charging timer integrated into most EVs so that charging occurs well off-peak.

Q. Please summarize your recommendations.

A. Considering the broad and significant benefits to both customers and the environment resulting from consumer adoption of EVs, and the data that reveal Missouri's low number of EVs relative to other states, the Commission should encourage Missouri utilities to stimulate the EV marketplace. Ameren Missouri's proposal has been thoughtfully developed after review of Commission proceedings in Missouri and other states as well as direct market intelligence. Through Charge Ahead - Electric Vehicles, Ameren Missouri would be able to stimulate the private sector to develop a holistic charging ecosystem while also educating customers on the benefits of EVs. The resulting boost to consumer awareness coupled with strategically placed charging infrastructure and a knowledgeable trade ally network would make it both practical and easy to choose an EV in Missouri. Consequently, the Commission should approve Ameren Missouri's Charge Ahead - Electric Vehicles proposal.

Q. Does this conclude your direct testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Approval of Efficient Electrification Program.	))))	File No. ET-2018-0132

AFFIDAVIT OF PATRICK E. JUSTIS

STATE OF MISSOURI)
) **ss**
CITY OF ST. LOUIS)

Patrick E. Justis, being first duly sworn on his oath, states:

1. My name is Patrick E. Justis. I work in the City of St. Louis, Missouri, and I am employed by Union Electric Company d/b/a Ameren Missouri as the Manager of Energy Services.

2. Attached hereto and made a part hereof for all purposes is my Direct Testimony on behalf of Union Electric Company d/b/a Ameren Missouri consisting of 39 pages and Schedule(s) PEJ-01, PEJ-02,PEJ-03, & PEJ-04, all of which have been prepared in written form for introduction into evidence in the above-referenced docket.

3. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded are true and correct.

PATRICK E. JUSTIS

Subscribed and sworn to before me this 21ST day of February, 2018.

Cathleen A. Dehne
Notary Public

My commission expires:

March 7, 2021

CATHLEEN A DEHNE
Notary Public – Notary Seal
St. Louis City – State of Missouri
Commission Number 17119727
My Commission Expires Mar 7, 2021

SUMMARY

Scenario 1: Average Gasoline-Fueled Passenger Vehicle vs BEV

Vehicle	NOx Annual Emissions (lbs/year)	CO2 Annual Emissions (lbs/year)
Gasoline-Fueled Passenger Car	18.32	9,737.44
BEV (Nissan LEAF, 30 kWh/100 miles)	6.12	6,278.40
% Reduction in Emissions	67%	36%

Scenario 2: 2015 Gasoline-Fueled Passenger Vehicle vs BEV

Vehicle	NOx Annual Emissions (lbs/year)	CO2 Annual Emissions (lbs/year)
Gasoline-Fueled Passenger Car	11.87	6,308.40
BEV (Nissan LEAF, 30 kWh/100 miles)	6.12	6,278.40
% Reduction in Emissions	48%	0.5%

Conventional Vehicle - NOx Emissions

ASSUMPTIONS:

24.1 miles per gallon
12,000 miles Distance traveled per year
498 gallons of gasoline/year

18.32 **NOx emissions (lbs/year)**
9,737.44 **CO2 emissions (lbs/year)**

2,205 lbs = 1 metric ton

Alternate Assumptions based on NHTSA CAFÉ Report for 2015:

37.2 miles per gallon
12,000 miles Distance traveled per year
323 gallons of gasoline/year

11.87 Scaling of 2008 report to 2017 (NOx)
6,308.40 Scaling of 2008 report to 2017 (CO2)

SOURCE: USEPA, Average Annual Emissions and Fuels Consumptions for Gasoline-Fueled Passenger Cars and Light Trucks (October 2008)

Emission Facts

Average Emissions and Fuel Consumption for Passenger Cars*

Pollutant/Fuel	Emission & Fuel Consumption Rates (per mile driven)	Calculation	Annual Emission & Fuel Consumption
VOC	1.034 grams (g)	(1.034 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	27.33 lb
THC	1.077 g	(1.077 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	28.47 lb
CO	9.400 g	(9.400 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	248.46 lb
NOx	0.693 g	(0.693 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	18.32 lb
PM_{10}	0.0044 g	(0.0044 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	0.12 lb
$PM_{2.5}$	0.0041 g	(0.0041 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	0.11 lb
CO_2	368.4 g	(368.4 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	9,737.44 lb
Gasoline Consumption	0.04149 gallons (gal)	(12,000 mi/yr) / (24.1 mi/gal)	497.93 gal

*See Endnotes

4

CAFE

CAFE Public Information Center Reports

Fleet Fuel Economy Performance Report

Updated As Of: May-09-2017 01:30 PM

General Notes

The NHTSA fleet and manufacturer reports provide comparisons of fuel economy performance data in relationship to the required fuel economy standards for each model year. These reports include manufacturer compliance information verified by EPA. Future model year estimated data from manufacturer's pre- and mid-model year reports will be added at a later time. NHTSA is providing two different reports to give a comparison of the industry as a whole and on each manufacturer separately. Both reports provide the fuel economy performance results and standards, measured in miles per gallons (mpg), and U.S. sales production volumes for each applicable fleet based upon EPA final report data for each model year. The comparison of fuel economy performance results and standards can be shown in a table and/or graph formats.

Model Year	Domestic Passenger Car		Import Passenger Car	
	FE Performance (MPG)	Fleet Standard (MPG)	FE Performance (MPG)	Fleet Standard (MPG)
2015	37.2	35.2	37.3	35.8

Nov 29, 2017 - 8:47 AM www.nhtsa.gov/cafe_pic.html

Nissan Leaf

30 kWh per 100 miles
12,000 miles Distance traveled per year

3,600 kWh per Year

1.7 NOx Emission Rate MO (lb/MWh),Table 10. State Emission and Output Emission Rates (eGRID2014v2)

6.12 NOx emissions (lbs/year)---MO

1,744.00 CO2 Emission Rate MO (lb/MWh),Table 10. State Emission and Output Emission Rates (eGRID2014v2)

6,278.40 CO2 emissions (lbs/year)---MO

For a 2012 Nissan Leaf, its average rated efficiency of **99** MPGe translates to **34** kilowatt-hours per **100** miles. Just multiply that by your electric cost. So if you pay the U.S. average of **12** cents/kWh, the Leaf will cost you $4.08 to go **100** miles (versus $16 in a **25**-mpg car with gas at $4/gallon). Mar 6, 2013

Electric-Car Efficiency: Forget MPGe, It Should Be Miles/kWh
https://www.greencarreports.com/.../1082737_electric-car-efficiency-forget-mpge-it-sho...

About this result Feedback

How many kWh does it take to charge a Nissan Leaf?

Just as with gasoline cars, some electric vehicles are more efficient than others, and the average EV needs about **30 kWh** of electricity to power the vehicle for 100 miles. For example, the EPA rating for the Nissan LEAF is exactly **30 kWh** per 100 miles.

How Much Does It Cost To Charge An Electric Car? - Plug In America
https://pluginamerica.org/how-much-does-it-cost-charge-electric-car/

Emission Rate---SOURCE: USEPA eGRID Emission Rates (eGRID2014v2). 2/27/2017

10. State Emissions and Output Emission Rates (eGRID2014v2)

State	Nitrogen oxides (NO_2)				Sulfur dioxide (SO_2)		Carbon dioxide (CO_2)		Methane (CH_4)	Nitrous oxide (N_2O)	Carbon dioxide equivalent (CO_2e)
	Annual		Ozone season								
	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (lbs)	Emissions (lbs)	Emissions (tons)
AK	11,021	3.6	4,139	3.5	2,104.7	0.7	2,644,805	875.0	268,515	41,817	2,654,106
AL	50,855	0.7	21,689	0.7	120,922.1	1.6	78,643,037	1,053.9	13,209,154	1,922,314	79,077,486
AR	39,444	1.3	18,555	1.4	77,729.0	2.5	39,535,585	1,283.8	8,476,457	1,245,139	39,817,585
AZ	49,434	0.9	22,134	0.8	22,610.6	0.4	60,422,378	1,110.9	11,309,165	1,625,491	60,793,076
CA	23,056	0.2	9,952	0.2	5,334.2	0.1	54,587,169	553.5	6,680,665	817,719	54,774,531
CO	42,389	1.6	18,486	1.6	27,258.7	1.0	42,616,654	1,582.9	8,508,112	1,226,827	42,896,148
CT	6,909	0.4	2,697	0.4	1,831.8	0.1	8,987,822	534.2	2,245,481	292,375	9,056,717
DC	0	0.0	0	0.0	0.2	0.0	40,047	1,184.6	1,511	151	40,086
DE	2,292	0.6	928	0.5	829.3	0.2	3,961,772	1,042.8	380,229	50,486	3,973,589
FL	74,600	0.6	33,715	0.6	102,244.5	0.9	125,753,313	1,093.7	20,718,376	2,859,030	126,414,006
GA	40,115	0.6	13,585	0.5	75,258.5	1.2	69,106,579	1,098.6	13,292,244	1,988,687	69,554,394
HI	19,553	3.8	8,705	3.9	37,542.1	7.4	6,781,193	1,329.1	1,444,170	223,276	6,830,965
IA	34,130	1.2	14,621	1.3	74,295.9	2.6	38,055,322	1,338.9	8,586,910	1,247,567	38,338,857
ID	17,168	2.3	7,272	2.1	1,056.3	0.1	1,107,906	146.7	156,640	25,686	1,113,532
IL	49,458	0.5	19,811	0.5	148,984.2	1.5	99,999,815	989.4	22,342,952	3,245,544	100,737,475
IN	112,929	2.0	46,715	1.9	293,960.0	5.1	113,232,515	1,968.9	24,404,650	3,544,614	114,038,178
KS	27,726	1.1	12,925	1.2	31,570.7	1.3	35,029,736	1,408.9	7,652,670	1,111,421	35,282,360
KY	87,906	1.9	34,350	1.8	202,494.9	4.5	94,007,833	2,068.5	21,727,248	3,166,312	94,726,748
LA	44,407	0.9	21,104	0.9	67,219.2	1.3	50,474,153	975.1	7,060,837	1,025,434	50,707,234
MA	10,452	0.7	3,651	0.5	5,780.3	0.4	13,778,384	888.5	3,512,907	465,487	13,887,420
MD	16,264	0.9	5,574	0.7	25,339.6	1.3	21,940,311	1,160.3	5,412,138	780,765	22,118,156
ME	3,184	0.5	1,158	0.4	2,342.3	0.4	2,292,308	346.1	2,228,291	315,950	2,359,734
MI	64,216	1.2	28,311	1.2	156,964.4	2.9	67,940,296	1,272.9	15,393,448	2,222,701	68,446,445
MN	27,615	1.0	11,122	1.0	29,008.2	1.0	34,198,306	1,200.3	8,776,872	1,258,627	34,472,152
MO	75,218	1.7	31,674	1.6	135,591.0	3.1	76,592,409	1,744.0	18,373,315	2,668,813	77,198,996
MS	20,771	0.8	10,508	0.8	92,660.9	3.4	27,209,854	987.2	3,502,986	505,592	27,325,002
MT	20,194	1.3	8,069	1.3	15,063.6	1.0	19,566,329	1,293.3	4,114,465	612,223	19,704,426
NC	43,456	0.7	17,476	0.6	43,435.0	0.7	61,856,263	979.7	13,214,881	1,905,777	62,288,821
ND	46,632	2.6	18,253	2.6	50,584.9	2.8	32,978,634	1,808.9	7,396,552	1,075,713	33,223,034
NE	25,213	1.3	10,533	1.2	61,637.9	3.1	27,467,791	1,393.2	6,305,349	916,903	27,676,117
NH	3,952	0.4	959	0.2	2,893.5	0.3	3,691,522	377.9	2,090,124	278,464	3,756,630
NJ	10,574	0.3	4,607	0.3	2,434.7	0.1	18,512,129	554.1	2,699,756	348,363	18,594,473
NM	45,223	2.8	19,677	2.8	12,065.7	0.7	27,162,310	1,681.6	5,365,411	772,786	27,338,429
NV	14,438	0.8	6,926	0.8	10,623.5	0.6	17,268,190	964.7	2,123,037	291,683	17,335,693
NY	27,896	0.4	10,478	0.4	21,144.7	0.3	34,851,025	521.5	5,008,633	655,961	35,005,293
OH	91,403	1.4	34,457	1.2	313,246.5	4.7	107,527,606	1,599.1	22,886,922	3,318,339	108,282,178
OK	39,471	1.1	17,013	1.1	76,340.8	2.2	47,430,123	1,355.1	8,405,594	1,205,609	47,705,251
OR	9,564	0.3	3,870	0.3	7,794.7	0.3	9,317,739	310.0	1,710,318	230,628	9,371,445
PA	131,572	1.2	48,219	1.0	275,665.3	2.5	109,308,571	989.0	20,508,739	3,258,758	110,028,992
RI	839	0.3	333	0.2	76.9	0.0	2,785,268	892.8	105,997	11,010	2,788,087
SC	16,861	0.3	7,524	0.4	28,206.6	0.6	35,581,835	732.5	8,026,422	1,174,252	35,840,698
SD	10,613	1.9	4,080	1.8	13,860.0	2.5	9,399,901	618.4	725,854	105,225	3,423,833
TN	19,108	0.5	8,889	0.5	54,968.1	1.4	42,356,033	1,065.5	8,999,702	1,316,877	42,652,133
TX	147,530	0.7	69,302	0.7	348,425.9	1.6	259,515,373	1,184.9	37,686,790	5,336,892	260,736,900
UT	55,166	2.5	23,931	2.4	29,271.1	1.3	38,780,766	1,771.4	8,166,905	1,198,102	39,052,224
VA	28,359	0.7	11,167	0.7	33,404.4	0.9	33,907,673	876.8	8,251,390	1,170,183	34,171,819
VT	426	0.1	161	0.1	59.8	0.0	66,889	19.0	446,684	58,696	80,677
WA	9,586	0.2	3,547	0.1	4,370.0	0.1	13,039,063	224.3	2,754,726	395,650	13,129,314
WI	26,600	0.9	11,203	0.8	45,583.7	1.5	46,199,118	1,514.5	10,164,502	1,473,223	46,534,194
WV	70,967	1.8	29,615	1.8	95,102.7	2.4	79,396,883	1,976.1	18,397,243	2,707,265	80,009,680
WY	42,689	1.7	17,543	1.8	37,992.1	1.5	49,643,934	1,997.9	11,164,764	1,623,554	50,012,815
U.S.	1,889,441	0.9	791,214	0.9	3,325,186	1.6	2,290,550,472	1,122.9	452,386,805	65,319,979	2,305,378,134

(created 2/27/2017)

https://autoalliance.org/energy-environment/zev-sales-dashboard/
Data from Auto Alliance PDF pages by state capturing 2016 sales data

Rank	State	Total Registered Vehicles 2016	Cumulative# of EVs through 2016	Total EV Sales 2016	Total Vehicle Sales 2016	EV % of Market 2016
1	**CA**	**30,280,165**	**261,506**	**73,482**	**2,086,880**	**3.52**
2	**OR**	**3,510,389**	**11,910**	**3,475**	**185,258**	**1.87**
3	WA	6,356,986	22,206	5,345	302,601	1.76
4	HI	1,155,823	5,455	1,246	89,160	1.39
5	**VT**	**558,127**	**1,485**	**496**	**42,697**	**1.16**
6	DC	323,295	1,047	406	38,900	1.04
7	CO	4,882,258	8,873	2,724	276,921	0.98
8	MI	8,325,386	13,833	5,377	645,029	0.83
9	UT	2,427,093	4,033	1,137	138,834	0.82
10	**CT**	**2,971,572**	**4,633**	**1,450**	**180,518**	**0.81**
11	**MA**	**5,128,971**	**10,219**	**2,806**	**369,021**	**0.76**
12	WI	5,126,449	4,861	1,773	256,298	0.69
13	NV	2,213,097	3,683	950	145,918	0.65
14	**NJ**	**7,077,772**	**11,092**	3,915	**605,570**	**0.64**
15	**MD**	**4,612,232**	**7,926**	**2,145**	**343,233**	**0.62**
16	DE	821,276	918	329	52,741	0.62
17	AZ	5,698,022	11,396	2,307	387,866	0.59
18	**NY**	**11,448,368**	**19,954**	**5,909**	**1,047,317**	**0.56**
19	**RI**	**831,847**	**808**	**284**	**52,146**	**0.54**
20	VA	7,270,919	7,514	2,128	404,104	0.52
21	NH	1,244,800	1,427	472	98,307	0.49
22	GA	8,555,387	22,598	2,573	528,990	0.48
23	FL	16,050,134	23,376	6,451	1,352,271	0.48
24	**ME**	**1,203,053**	**1,216**	**287**	**65,123**	**0.44**
25	PA	11,545,745	9,100	2,990	677,143	0.44
26	MN	4856561	4,315	1,081	262,481	0.42
27	IL	10,316,936	11,829	2,733	674,154	0.40
28	TN	5,773,154	4,593	1,175	293,133	0.40
29	NC	8,516,942	7,075	1,697	456,444	0.38
30	KS	2,656,883	1,616	411	109,884	0.37
31	ID	1,587,698	1,064	213	62,048	0.34
32	AK	641,727	409	96	28,406	0.34
33	TX	21,599,174	19,281	4,612	1,551,868	0.30
34	**MO**	**5,460,015**	**3,524**	**890**	**308,843**	**0.29**
35	NM	1,783,423	1,255	263	95,478	0.28
36	IN	5,707,801	3,791	674	251,219	0.27
37	OH	10,328,138	7,633	1,660	627,756	0.27
38	NE	1,886,437	924	207	91,461	0.22
39	SC	4,619,623	2,144	479	229,760	0.21
40	IA	2,980,447	1,610	275	136,691	0.20
41	KY	3,834,722	1,421	283	154,827	0.18
42	WY	599,231	171	42	23,607	0.18
43	MT	1,224,850	486	114	69,031	0.16
44	AL	4,614,792	1,574	349	219,225	0.15
45	LA	3,705,520	1,125	288	223,092	0.13
46	ND	748,296	236	39	36,151	0.11
47	SD	888,661	314	37	37,497	0.10
48	AR	2,517,624	642	139	142,427	0.10
49	MS	2,546,454	445	91	107,287	0.09
50	WV	1,519,052	419	72	84,585	0.08
51	OK	4,218,121	1,575	270	777,864	0.03

Summary light duty vehicle inventory and sales stats through 2016	Vehicles	% Market	
Total cumulative US vehicles	264,751,448		
Total U.S. EVs cumulative	550,540		
Total ZEV States' EVs	322,823		
Total US Vehicle Sales 2016	17,428,065		
Total US EV Sales 2016	148,648	0.85%	<--this is EV% of US total vehicle sales
Total ZEV States' Vehicle Sales 2016	4,977,763		
ZEV States' EV Sales 2016	90,334	1.81%	<--this is EV % of ZEV states' total vehicle sales
ZEV States' EV % of US cumulative EVs	59%	59%	
ZEV States' % of total US vehicle new sales market	29%		
ZEV States' % of US new EV sales	61%		

December 6, 2017

Carol Comer, Director
Missouri Department of Natural Resources
Main Department Office
1101 Riverside Drive
Jefferson City, MO 65102

Comments on the Missouri Volkswagen Settlement Environmental Mitigation Trust Funds

Director Comer:

We submit these following comments on behalf of the following companies and organizations:

Ameren Missouri	City Utilities
Clean Cities of Kansas City	Columbia Water & Light
Empire District	Independence Power & Light
Kansas City Power & Light	Kirkwood Electric
Missouri Public Utility Alliance	NRDC
Sierra Club	

We provide the following recommendations on the use of the $41.2 million in funds that the state of Missouri will receive from the environmental mitigation trust (EMT) established by the Volkswagen (VW) consent decree. In brief, the EMT presents a significant opportunity for Missouri to reduce harmful nitrogen oxide (NOx) emissions, reduce the state's dependence on petroleum-based fuels, and offer greater customer choice to Missouri residents by modernizing Missouri's transportation sector. We recommend that the Missouri Beneficiary establish a formal stakeholder process, allocate the maximum 15 percent of funds for light-duty electric charging infrastructure, and prioritize use of remaining funds to replace old diesel vehicles with qualified electric versions of those vehicles and associated charging infrastructure.

Introduction

The VW EMT should be allocated to support a critical transformation of the transportation sector in Missouri. This transformation should meaningfully reduce transportation NOx emissions in the short term as well as make investments that will enable large-scale reductions in the mid- to long-term. To the

extent practical, funds should benefit all areas of Missouri. To achieve these objectives, we ask that the Beneficiary consider:

1) **The establishment of a robust stakeholder process to receive guidance on the development of its state plan**. We appreciate that the Missouri Department of Natural Resources (DNR) is now receiving preliminary input on the use of the EMT funds, and recommend that the agency take additional action to foster transparency and meaningful engagement on the development of its mitigation plan (for example: making all submitted comments available for review, and issuing a draft plan for public comment after initial input is received). The stakeholder processes facilitated by other states in the region and across the country may provide a useful model or guidance for the Missouri DNR and some good examples include efforts by sister agencies in Ohio, Minnesota, Iowa and Michigan.

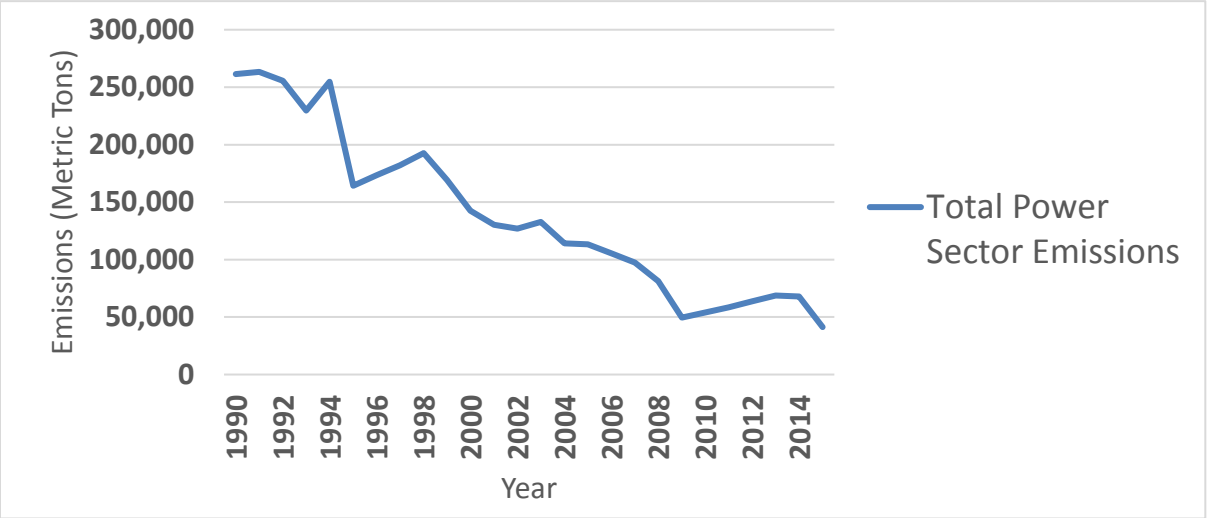
2) **The maximum allocation allowed (15 percent, or roughly $6.2 million) to deploy light duty plug-in electric vehicle charging stations.** Charging station deployment should target highway corridors, multifamily housing, and workplaces to increase Missouri residents' access to electricity as a transportation fuel. The state should also seek to encourage the alignment of investments by electric utilities and public-private partnerships to create a more robust, reliable, and comprehensive network where possible.

3) **A heavy focus on medium- and heavy- duty electrification investments for the remaining 85 percent – or $35 million.** Given the current state of the market, the greatest near-term opportunity could be to replace diesel engines with electric technologies spanning from school and transit buses to material handling equipment such as forklifts and shipping port and airport ground support equipment. However, the state should avoid investments that merely replace existing diesel vehicles with newer diesel vehicles. While this might accelerate vehicle replacements by a few years, ultimately these replacements will occur anyway, leading to a very limited NOx mitigation benefit relative to electric transportation.

The foundation of these recommendations lies in the understanding that emissions of NOx and other pollutants from the electric sector are generally declining. In the graph below, Energy Information Administration data reveals that Missouri's power sector has markedly reduced NOx emissions, even as generation has generally increased: relative to 1990 levels, annual NOx emissions were 84 percent lower in 2015.[1] We expect these emissions – and the emissions of other criteria pollutants will continue to decline in Missouri as the region's generation portfolio includes additional low-emission energy resources like renewables and energy efficiency. Given this underlying trend and the greater fuel efficiency of electric transportation relative to petroleum powered transportation, switching from diesel to electric can yield substantial NOx and co-pollutant reductions and fuel cost savings.

[1] U.S. Energy Information Administration. 2017. U.S. Electric Power Industry Estimated Emissions by State (EIA-767, EIA-906, EIA-920, and EIA-923). 1990-2015. Available at https://www.eia.gov/electricity/data/state/

Missouri Power Sector NOx Emissions



Data from Energy Information Administration

Unlocking Investment in Plug-In Electric Vehicle Charging Infrastructure

Regrettably, transportation policy rivals the environmental policy in its use of acronyms. The charging infrastructure component of the EMT can be used to support plug-in electric vehicles (PEVs), which can be charged with electricity from the grid. This includes both battery electric vehicles (BEVs) that rely entirely upon electricity and plug-in hybrid electric vehicles (PHEVs) that rely on electricity for daily driving needs, but can also use gasoline to complete trips. Because PHEVs produce tailpipe emissions when driving on gasoline, they cannot be considered zero emission vehicles (ZEVs).

Light-duty vehicles are the second highest emitter of mobile source NOx emissions in Missouri after heavy-duty vehicles.[2] Any comprehensive strategy to reduce transportation sector NOx and co-pollutant emissions should consider the electrification of the light-duty vehicle fleet as a key mitigation strategy. The development of a robust, strategic charging station network is critical to achieving that goal. However, a dearth of this supporting infrastructure currently presents a barrier to a broader, more diverse PEV market.[3] To overcome this hurdle, investment in charging stations along key highway corridors, in multifamily housing and at workplaces in communities currently most affected by air pollution should play a role in the Beneficiary's allocation of EMT funds.

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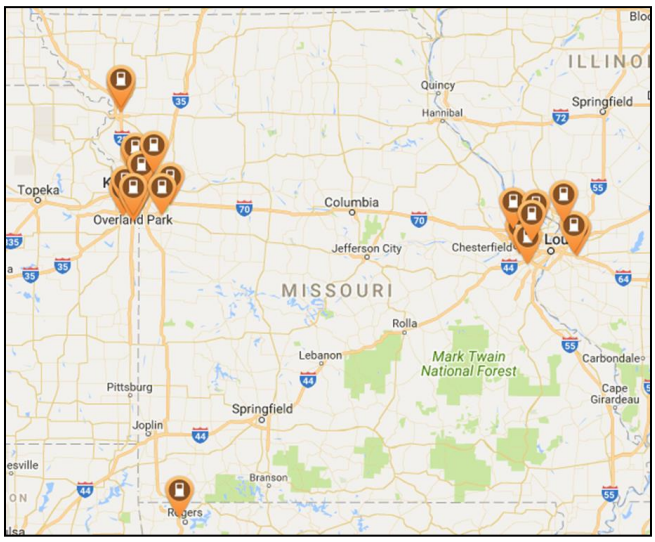
[2] Light-duty vehicle NOx emissions accounted for 28 percent (65,000 tons) of Missouri's mobile source NOx emissions. Heavy-duty NOx emissions accounted for 39 percent (91,000 tons). https://app.powerbi.com/view?r=eyJrIjoiMjk3YTdiYTAtZTA2Yi00MmIxLWIyM2QtZjhiYzk1YzM1Y2Y5IiwidCI6IjFiYjQ4ZGE0LTMxNDMtNDAzMS1iZGFlLWNjYzA0MDc1MDhmZSIsImMiOjF9&pageName=ReportSection

[3] John G. Kassakian, David Bodde, and Jeff Doyle. "Overcoming Barriers to Deployment of Plug-in Electric Vehicles." The National Academies Press. 2015.

Highway Charging Corridors are Necessary to Support Light-Duty NOx Reductions

The deployment of DC Fast Charging stations – which can refuel PEVs much more quickly than 110 volt or 240 volt AC charging stations – are necessary to enable long distance PEV travel and eliminate the "range anxiety" that would-be PEV drivers may confront when embarking on long distance trips.[4] DC Fast Charging typically provides 80% of full charge in 20-30 minutes for light-duty PEVs and is minimally disruptive to travel plans. Below, a map generated by the Plugshare website reveals the location of existing non-Tesla DC Fast Charging stations in Missouri.[5] High priority should be placed on publicly-available DC fast charging equipment on major highway corridors, to allow long-distance travel across the state.



While DC Fast Charging stations are clustered in the St. Louis and Kansas City metro areas, there is very little deployment along highway corridors in rural areas that enable PEV drivers to complete longer trips that would otherwise have occurred in a gasoline vehicle. Would-be PEV drivers need to know they can drive from, for example, St. Louis to Springfield, Joplin, Jefferson City, Columbia, Kansas City, and any other Missouri destinations before making the decision to purchase a PEV.

To this end, Missouri should also coordinate with Volkswagen on Appendix C ZEV Investment Plan activities and surrounding states on their use of EMT funds to build out a more robust, complementary fast charging network. In short, DC Fast Charging deployment is a critical strategy for accelerating the light-duty PEV market and driving NOx emissions reductions statewide and particularly where there is a density of vehicles, including non-attainment areas.

We have developed a draft corridor DC Fast Charging plan that the MO EV Collaborative will continue to develop and submit to the Beneficiary. Below is a draft map of a statewide corridor network that would make PEV travel across Missouri not only possible, but practical.

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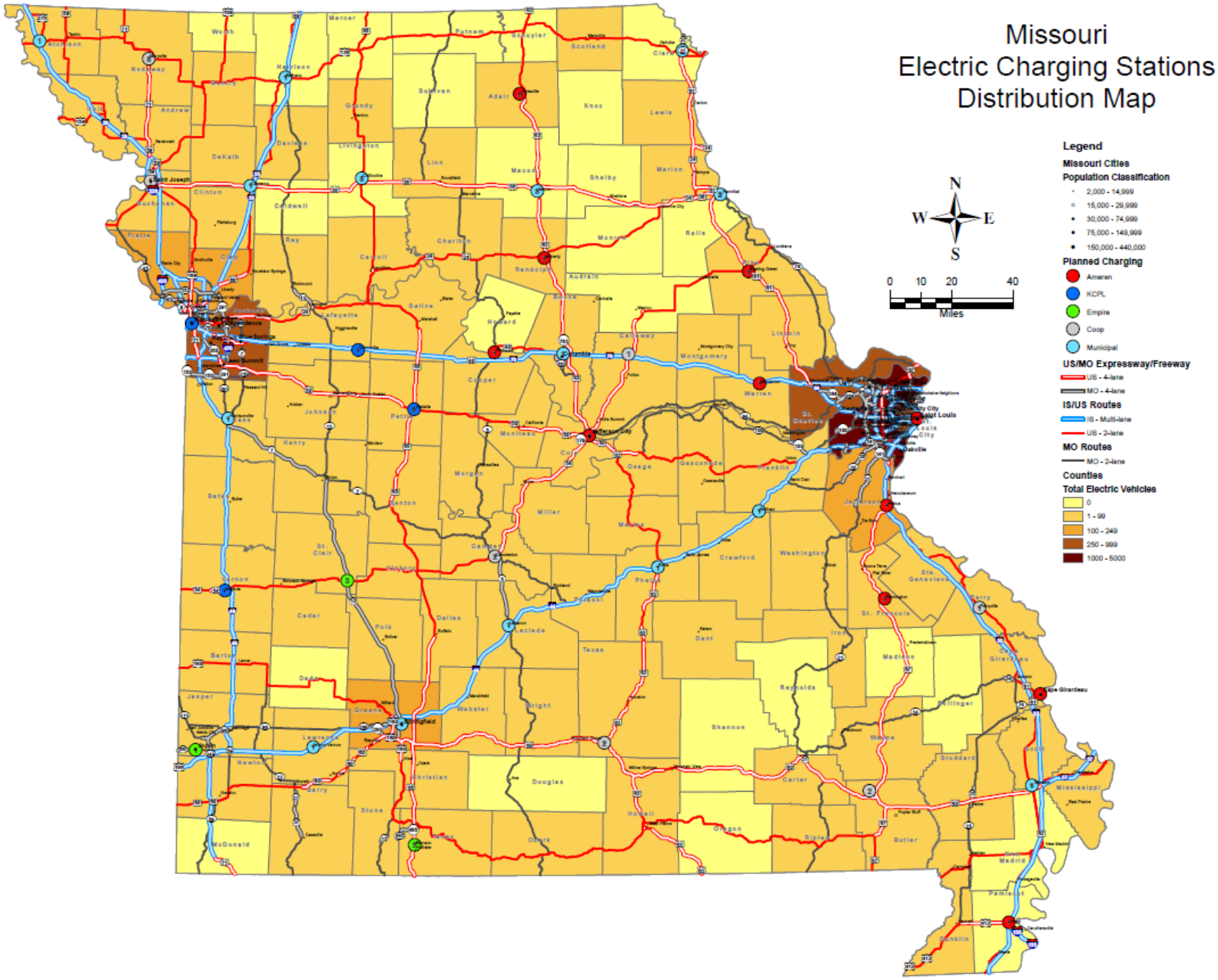
[4] While AC Level 2 charging is able to deliver up to 25 miles of range per hour of charging, DC fast charging can deliver 150-210 miles of range per hour of charging. See Alternative Fuels Data Center, "Developing Infrastructure to Charge Plug-In Electric Vehicles," U.S. Department of Energy available at: http://www.afdc.energy.gov/fuels/electricity_infrastructure.html

[5] *See* https://www.plugshare.com/ There is a focus on non-Tesla DC Fast Charging stations because Tesla employs proprietary charging technology that is only accessible to owners of Tesla vehicles. In order to assuage range anxiety and meaningfully accelerate the PEV market, access to fast and reliable highway corridor charging is a necessity for all PEV models.



SCHEDULE PEJ-03-5

Multi-unit Dwellings

The Beneficiary should target a portion of funds towards multifamily housing. Access to overnight residential charging is critical to support PEV adoption; it is highly unlikely that a prospective driver would purchase a PEV without the ability to plug in at home. Unlike single-family homeowners, multifamily housing tenants face unique market barriers that may limit reliable access to overnight charging and ultimately impede the decision to drive a PEV. For this reason, targeting the multifamily housing segment can help spur PEV adoption where it otherwise would not have occurred.

Deployment of charging infrastructure in economically disadvantaged communities can also help residents overcome impediments to PEV adoption and improve local health outcomes.

Workplace Charging

Finally, workplaces present another key opportunity for charging infrastructure deployment. Outside of the home, workplaces are where PEVs sit for the longest period during the day. It has been demonstrated that employees of companies that provide charging are significantly more likely to purchase a PEV than an average worker. The Department of Energy recently concluded that employees of companies who participated in its "Workplace Charging Challenge" were 20 times more likely to purchase a PEV than an average worker.[6] Workplace charging can also increase electric vehicle miles traveled (eVMT) of plug-in hybrid electric vehicles and provide greater visibility for PEVs generally.

Utility Engagement

As fuel and infrastructure providers for PEVs, electric utilities can also play a significant role in charging infrastructure investment, customer education and outreach, and other market acceleration programs. We encourage the Beneficiary to work with Missouri's electric utilities to ensure appropriate electric distribution infrastructure is in place to support the integration of charging stations into the target markets discussed above. This coordination ensures that investments made by VW and utilities are complementary, efficiently allocated, and effective in spurring PEV growth.

With the introduction of new long range, relatively affordable, all electric vehicles such as the Chevy Bolt EV, now available nationwide, Missouri should ensure that a robust long distance charging network is in place to support widespread transportation electrification. To the extent VW invests in charging infrastructure in certain target segments described above as part of Appendix C in the VW Consent Decree, the Beneficiary should focus its efforts on deploying infrastructure in other areas not covered by Appendix C or other available funding.

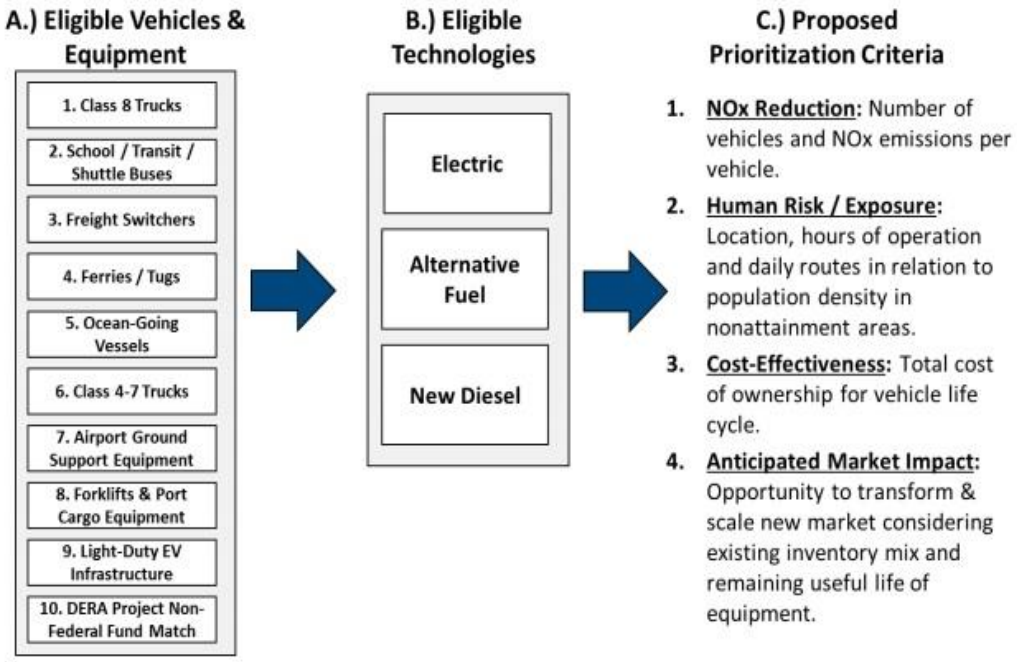
Driving Opportunities for Clean, Electric Transportation

The remaining 85 percent of Missouri's EMT could be allocated to accelerate the transition to transportation with zero tailpipe emissions. In order to achieve improved environmental and human health outcomes in an equitable manner, the Beneficiary should generally target a) the replacement of the heaviest-polluting diesel transportation; b) that operates in close proximity to humans, with some emphasis in ozone and PM2.5 non-attainment areas; c) that offers the greatest cost-effectiveness as

[6] U.S. Department of Energy, Workplace Charging Challenge – Progress Update 2014: Employers Take Charge

measured by the total cost of ownership over the vehicle lifecycle; and d) that will result in the greatest market transformation.

Framework for Assessing EMT Funding Decisions



Electric Transit Buses

Another reliable source of deep NOx reductions is the replacement of diesel transit buses with electric buses. Advances in battery technologies can now propel electric buses up to 350 miles before needing to recharge, making them a reliable transit option.[7] St. Louis Metro transit service has had the opportunity to test several electric buses, noting that the buses' driving range exceeds the mileage needed for some daily routes and that fuel and maintenance costs are markedly lower than that of diesel buses.[8] Because transit agency buses travel hundreds of miles per day while in service, electrifying this source of criteria pollutant emissions can yield substantial NOx mitigation results to the benefit of the cities and communities it serves. All Missouri transit authorities may also benefit from the ability to pilot and operate electric buses with EMT funds.

To the extent it is necessary for the successful operation of an electric bus fleet, the Beneficiary should permit the allocation of eligible funding for associated fleet charging infrastructure and associated utility

[7] See Proterra Catalyst Bus Specifications, https://www.proterra.com/wp-content/uploads/2016/08/ProterraCatalyst-Vehicle-Specs.pdf. See also Aarian Marshall, This New Electric Bus Can Drive 350 Miles on One Charge, Wired, Sept. 12, 2016, https://www.wired.com/2016/09/new-electric-bus-can-drive-350-miles-one-charge/

[8] http://www.stltoday.com/business/local/metro-begins-test-driving-electric-bus-on-downtown-st-louis/article_e4a529e2-8a18-5a76-aae7-6c145c99d4a8.html

line extensions and stretch EMT funds further by covering the difference in upfront cost between diesel and electric buses, rather than covering the full cost of the bus. This may include the replacement of several buses in an agency's fleet, or the purchase of only one electric bus as a pilot project to allow agencies to become more comfortable with future adoption of these technologies.

Electric School Buses

Electric school buses present a unique and practical opportunity to reduce NOx emissions. Regrettably, children are often the most exposed and most vulnerable to diesel emissions from school buses. Children breathe diesel fumes while riding and getting on and off diesel school buses. Asthma, which diesel pollution exacerbates, is now the most common chronic condition among U.S. children, affecting approximately 1 in 10 in the U.S.[9] Asthma attacks are triggered by pollutants like NOx emissions from diesel school and transit buses. Attacks can cause hospitalizations and even deaths.

The opportunity to use VW settlement funds towards electric school bus pilots means that school districts would have time to test the technology now while the initial purchase price is relatively higher than diesel buses and potentially be ready to make more substantial investments in the technology as up-front costs drop. State mitigation funds could be used to fund the purchase of multiple school buses as a pilot to gain experience and increase future adoption of the technology. For future purchases, the funds could be leveraged to greater effect if they are used to cover the difference between the purchase price of electric school buses and conventional buses for districts that have already slated fleet replacement in their budgets.

Electric Trucks

Another vehicle category ripe for electrification - medium duty trucks (Class 4-8) i.e. street sweepers, trash haulers, switch engines, and terminal trucks. Because battery technology to date keeps the electric range of these vehicles around 100 miles, these trucks are best suited for short or medium distance applications. Vehicle range notwithstanding, electric trucks can offer enormous fuel cost savings relative to their inefficient diesel counterparts. Diesel delivery trucks have been observed to register a maintenance cost of 22 cents per mile while electric delivery trucks typically run around 5.6 – 11.1 cents per mile.[10] In accounting for these variable costs as well as the up-front cost of the vehicle, median total cost of ownership of an electric delivery truck was 22 percent lower than that of a diesel equivalent – while eliminating all tailpipe NOx emissions.[11] Missouri is already a leader in industrial EV truck manufacturing: Orange EV, based out of Kansas City, became the first U.S. company to build and commercially deploy Class 8 heavy-duty EV trucks.[12] In short, investments in EV trucks can lower fleet ownership and operating costs while growing the local economy.

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[9] https://www.cdc.gov/healthyschools/asthma/

[10] Dong-Yeon Lee, et al., Electric Urban Delivery Trucks: Energy Use, Greenhouse Gas Emissions, and Cost Effectiveness, Environ. Science & Tech. 47, 8022 (2013).

[11] *Ibid.*

[12] https://orangeev.com/company-info/

Conclusion

Missouri's portion of the overall EMT presents the state with a significant opportunity to reduce its transportation sector emissions now and for years to come. We recommend that this funding be used to accelerate the adoption of electric transportation across a suite of end uses. To effectively drive down light-duty NOx emissions, we strongly recommend the Beneficiary invest the full 15 percent cap on charging infrastructure that enables long-distance PEV corridor travel and unlocks light-duty PEV growth in areas underserved by the current charging station market. The State should also seek to leverage partnerships with the electric utility industry to further stretch VW funds to develop charging infrastructure networks. With the remaining funds, the agency should include opportunities to electrify transportation such as transit and school buses and medium- and heavy-duty work trucks as well as material handling equipment. Though the upfront costs of these transportation technologies exceed those of diesel, the fuel and maintenance cost savings realized over the life of the vehicle can make up for, or even exceed, the incremental purchase cost. **With this in mind, EMT funding should be allocated in a way that meaningfully lowers barriers to the adoption of electric transportation, yet balances this objective with the goal of achieving substantial, targeted NOx emissions reductions.**

We look forward to working with the Beneficiary and other interested stakeholders to develop a robust, comprehensive, and equitable mitigation plan. Thank you for your consideration.

Missouri EV Collaborative Members

(specific names listed on next page)

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Kansas City Power & Light Chuck Caisley, Vice President Marketing & Public Affairs (816) 556-2320 chuck.caisley@kcpl.com	Kirkwood Electric Mark Petty, Director (314) 822-5847 Pettyma@kirkwoodmo.org
Municipal Public Utility Alliance Ewell Lawson, Vice President Government Affairs & Member Relations (573) 445-3279 elawson@mpua.org	NRDC Ashok Gupta, Senior Energy Economist (212) 243-4351 agupta@nrdc.org
Sierra Club Andy Knott, Sr. Campaign Representative (314) 644-1011 andy.knott@sierraclub.org	

This comment letter is intended to reflect the shared recommendations of signatory parties for the use of the VW EMT funds in Missouri. However, the letter does not necessarily represent the full extent of the signatory parties' recommendations or concerns with respect to use of the VW EMT funds. Some signatory parties may submit additional comments or recommendations to DNR during this public process.

Proposal For

Development of Missouri Statewide

Highway Corridor DC-Fast Charging

December 6, 2017

Submitted by the
Missouri EV Collaborative

SCHEDULE PEJ-04-1

Contents

Section 1: Executive Summary

The "Missouri EV Collaborative" (EV Collaborative) recognizes that the VW Mitigation Trust represents a unique opportunity to accelerate the adoption of electric vehicles by eliminating the long-distance charging barrier for EV drivers traveling within and through Missouri. Electric vehicles represent a major opportunity for reducing net emissions of NOx.

The EV Collaborative presents this proposal for consideration by Missouri's Mitigation Trust Beneficiary, Missouri DNR Air Pollution Control Program (APCP). The proposal describes the case and basic plan for development of a minimum practical network for corridor charging and requests consideration for funding for the full 15%, or approximately $6M, allowed under the settlement agreement for development and installation of electric vehicle (EV) charging stations.

The draft plan includes up to 40 public charging "islands" that could serve all types of EVs and that are distributed strategically to enable EV travel throughout Missouri. The initial estimated cost of such a project is in the broad range of $6.8-14.4M with utilities and communities making investments leveraged by the settlement funding and maximizing impact of mitigation funds on behalf of Missourians.

If this proposal is well received by APCP, the EV Collaborative will establish appropriate oversight with APCP, develop more detailed planning over 6-9 months, and then implement the detailed plan over the following 12-18 months.

Section 2: Background

2.1 VW Settlement – Mitigation Trust

Through the VW Settlement, Missouri will receive approximately $41M for mitigation actions. One of the eligible actions is the installation of **Light Duty Zero Emission Vehicle Supply Equipment**, otherwise known as EV charging stations. According to the settlement requirements, Beneficiaries may utilize up of to 15% of their allocation of Trust Funds on the costs to acquire, install, operate and maintain new light duty ZEV supply equipment. Eligible projects include: Level 1, Level 2 or DC fast chargers located in a public place, workplace, or multi-unit dwelling. For Missouri, 15% of the $41M total is approximately $6M.

More detail about EV charging equipment is in section 2.5 below.

2.2 Missouri EV Collaborative

Since November 2016 a voluntary group of utilities and non-profits has been collaborating on the topic of electric vehicle infrastructure. The following companies and organizations have been part of the discussions:

- Ameren Missouri
- City Utilities - Springfield
- Clean Cities-KC
- Columbia Water and Light
- Empire District
- Independence Power and Light
- Kansas City Power & Light
- Kirkwood Electric
- Missouri Public Utility Alliance
- NRDC
- Sierra Club

This "Missouri EV Collaborative" (EV Collaborative) recognizes that the VW Mitigation Trust represents a unique opportunity to eliminate the long-distance charging barrier for EV drivers in and through Missouri. The EV Collaborative has worked together and presents this proposal for consideration by Missouri's Mitigation Trust Beneficiary, Missouri DNR Air Pollution Control Program (APCP). The proposal describes the case and basic plan for development of a minimum practical network for corridor charging and requests consideration for funding for the full 15%, or approximately $6M allowed under the settlement agreement.

2.3 Environmental Benefits of EVs

Electric vehicles are inherently more efficient and less polluting than their internal combustion engine (ICE) counterparts. In fact, according to government figures[1], "EVs convert about 59%–62% of the electrical energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about 17%–21% of the energy stored in gasoline to power at the wheels." In fact, EVs boast fuel economy figures that exceed 100 MPGE, or miles per gallon equivalent, for fuel usage by the vehicle. Because EVs are charged from utility electricity, it is important to also consider the source energy mix in Missouri, which includes coal, nuclear, gas, wind, solar, and hydro.

[1] USDOE's www.fueleconmy.gov, All-Electric Vehicles page.

Even when accounting for the largely fossil-based source energy mix for Missouri, EVs emit approximately **50% less NOx** than ICE vehicles, as calculated using the following assumptions and the eGRID2014v2 Missouri emissions rate of 1.7lbs/MWh:

	ICE	**EV**
Miles per year	12,000	12,000
Fuel economy	37.2 mpg	3.3 miles/kWh
NOx in lbs/yr	11.87	6.12

In addition to less overall NOx emissions, EVs emit zero tailpipe emissions at ground level where drivers, cyclists, and pedestrians are subject to direct tailpipe emissions while in traffic. Though most of the electricity consumed in Missouri is produced from fossil fuel, the generators typically have control devices and, as stated above, provide lower overall NOx emissions than those from ICE tailpipes. Further, as utilities add more renewable, zero-emission sources to the energy mix, the fueling of EVs becomes proportionally cleaner.

For Missouri consumers, charging an EV at home costs roughly half of fueling with gasoline. From a utility perspective, EVs charging at home or work represent a flexible load that can also put downward pressure on retail electricity rates. This downward rate pressure results from the vast majority of charging that can occur during "off-peak" hours and increased utilization of existing grid resources.

2.4 Accelerating Adoption of Light Duty Electric Vehicles

Given the customer choice, environmental and economic benefits of EVs, enabling the adoption of EVs is worthy of significant effort. There exist several barriers to widespread EV adoption. And there are many approaches to accelerate adoption, with some having quick but limited impact while other approaches have slower but much more significant impact in the medium to long run. While automakers are steadily working to increase the range of EVs, with at least three relatively affordable models having ranges over 150 miles available by early 2018, one practical barrier that will still exist is long-distance corridor charging stations. As more long range models appear in the marketplace, one factor that will certainly slow consumer purchase of EVs is the lack of long-distance corridor charging along Missouri's highways. A well-planned minimum practical network of DC fast charging infrastructure would eliminate this barrier for Missourians and establish Missouri as an "EV friendly" state for drivers and serve to accelerate adoption of EVs.

Properly placed in communities along the interstates and multilane highways, and in areas accessible to the public, these charging stations would also increase adoption in those communities due to visibility and local access, especially for those without charging capability at home nor their workplace.

2.5 EV Charging Types

Today there are three common levels of EV charging in existence today:

Level	Power	Range added /hour
1 AC	1.5 kW	Up to 5 miles
2 AC	7 kW	Up to 25 miles
3 DCFC	50 kW	Up to 150 miles
	150 kW	Up to 450 miles

Note that power levels for DCFC are rising to reduce driver dwell times for charging, but 50 kW is the most common DCFC power rating today. The near future's higher power DCFC, from 100kW – 350kW, will be backward compatible and will accommodate today's EVs, and may be available for this proposed project.

Commercial grade charging equipment is able to withstand outdoor environments, provide cellular or Ethernet connectivity, and take customer payments via credit card, RFID membership, or smartphone app. Most EV drivers locate charging stations via mobile smartphone apps or through their EV's touchscreen menu. Networked charging stations make available their status (available or unavailable) to mobile apps, such as PlugShare and ChargePoint, so that drivers can make informed decisions about where and when to stop. *Key to a **practical** long-distance DCFC corridor is having more than a single charging stop option along their long-distance route rather than the minimum **possible.** In these early years when there will be few options, it is important that there is reliability through redundancy as well as distribution to make long distance travel practical.*

SECTION 3: Proposal for Highway Corridor DC-Fast Charging

3.1 DC Fast Charging Currently Insufficient

There is currently a lack of sufficient DCFC equipment along highway corridors in Missouri, with just a few instances of charging stations established in urban areas that are coincidentally near highways (as shown in the figure to the right). The EV Collaborative recognizes the importance of a minimum practical network of corridor DCFC along highways for accelerating growth in electric vehicle adoption, but realizes that the private

market likely does not view a network of corridors in Missouri as a viable business at this time. Thus, a classic “chicken and egg” dilemma exists.

3.2 Minimum Practical Network for Corridor EV Charging

The EV Collaborative suggests that development of a minimum practical network of DCFC along Missouri’s highways requires not just financial support but also coordinated statewide planning to cost-effectively ensure sufficient number and appropriate placement of charging stations occurs rather than only having DCFC near higher population urban areas.

This vision for a minimum practical network for corridor DCFC in Missouri is a public network that makes long-distance EV travel across Missouri **not only possible but, practical**, for EVs having a nominal range of 100 miles or greater. The following specifications include important requirements to achieve the "minimum practical network" goal:

- Minimum of 2 DCFC having the following capability:
  - 150kW charging rate, but minimum of 50 kW, DC output
  - Both CHAdeMO and CCS Combo connectors
- Minimum 2 Level 2 ports having ~7kW AC output
- Credit card capability
- Spacing of islands no less than 25 miles and no more than 75 miles apart
- Located in communities within approximately 3 miles of interstates or multilane state highways
- Located on real estate having a "no cost easement"
- Located within walking distance of amenities
- High reliability/availability

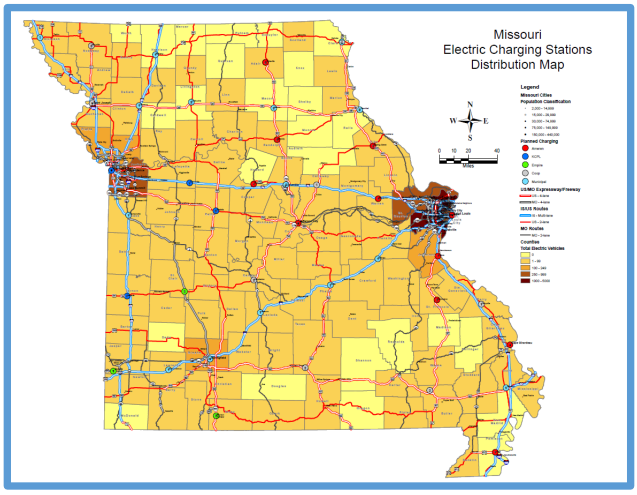
The EV Collaborative has drafted a map of recommended DCFC island locations to cover the majority of Missouri. These initial draft locations were developed without regard for which utility serves the location. Factors for initial locations were developed as follows:

1)	Along Interstates	Priority 1
2)	Along multi-lane highways having >10,000 daily trips	Priority 2
3)	Along multi-lane highways having <10,000 daily trips	Priority 3
4)	All located in communities with populations >2,000	

The resulting number of charging islands by priority level is:

Priority 1	Interstates	24
Priority 2	Multi-lane "heavy"	10
Priority 3	Multi-lane "light"	6

Note that the map below does not show locations of any Electrify America charging islands that will be constructed under the ZEV portion of the VW Settlement. The EV Collaborative anticipates that Electrify America will provide charging islands at some locations in Missouri but the locations have not been publicly identified. Once these locations have been identified and confirmed, the EV Collaborative would avoid those locations to avoid duplication. Avoiding Electrify America locations would reduce the number of charging islands required and associated cost.



(Larger map provided at the end of this document).

3.3 Estimated Cost and Sustainability

Missouri's electric grid is comprised of many operating companies, municipalities, and cooperatives. For this reason, it is important to plan this practical corridor charging network in a collaborative and coordinated manner to maximize benefit for the driving public.

The estimated turn-key cost of each charging island is as follows:

2 L2AC + 2 DCFC @ 50kW	$170,000 to $240,000 (150 miles range/hour)
2 L2AC + 2 DCFC @150kW	$270,000 to $360,000 (450 miles range/hour)

There are several factors that play into the turn-key cost of developing charging islands. Factors include:

- -Charging rate/capacity of equipment
- -Line extension size and complexity
- -Location of site
- -Site development complexity

The range of cost for the full network is $6.8M to $14.4M for development of 40 DCFC islands. Beyond the initial cost for the equipment, there are ongoing operation and maintenance costs (O&M), not including energy, to ensure connectivity and reliability. The estimated annual cost for non-energy O&M is $5,000-$10,000 per island.

Because the goal of building this minimum practical network for corridor EV charging is to break down the long-distance barrier to accelerate adoption of EVs, it is imperative that the equipment has high reliability so that drivers can

rely on getting refueled in these early years of EV infrastructure development. Utilities will ensure that the equipment has high reliability and that repair issues are dealt with in a timely manner and commit to maintaining the equipment long-term.

3.5 Ownership Models

There are three types of utilities within the EV Collaborative: Investor Owned Utilities (IOU), Municipal Utilities, and Cooperative Utilities. Each type has its own governance and/or regulatory requirements and, therefore, the process from planning under the EV Collaborative to project completion will likely have at least three different paths. For example, municipals and cooperatives may be able to get approval to own and operate the equipment, while the IOUs will likely have to pursue a third-party operational model due to current regulatory rules and restrictions.

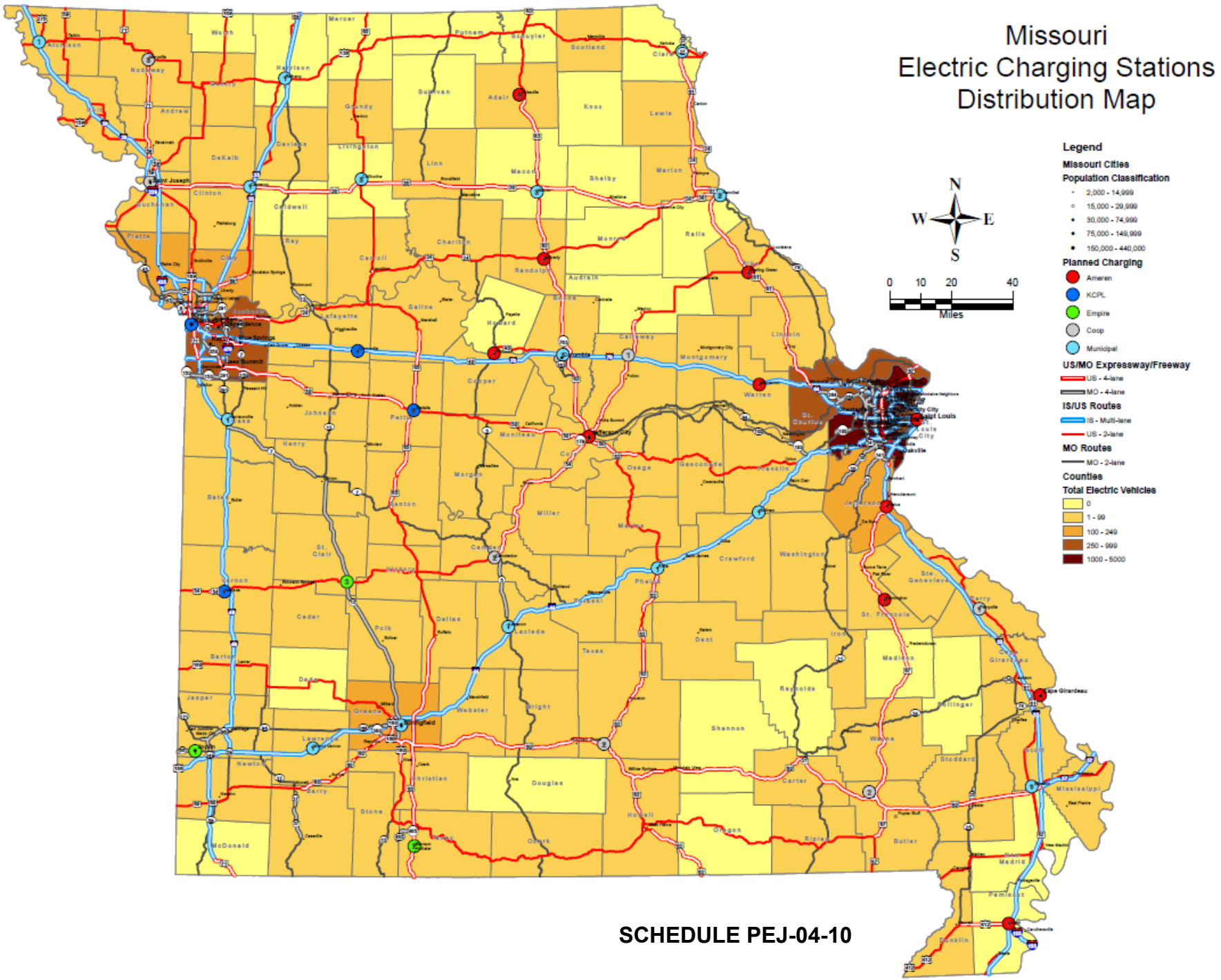
These differences should not impact the ability of the EV Collaborative utilities to jointly plan, build, and make operational the corridor charging network.

3.6 Next Steps

The EV Collaborative has provided this draft plan in this document for consideration for funding. If the APCP can provide an indication that the project is likely to receive the funding requested, then the EV Collaborative will pursue the following next steps:

1. Formalize expectations between EV Collaborative utilities and APCP and establish APCP-approved oversight plan;
2. Further develop the corridor plan with specific locations and designate lead utilities for each site;
3. Determine an equitable division of funding needed to develop the network;
4. Develop a coordinated approach to sourcing the equipment and any necessary services;
5. Develop final plan with timeline for approval and implementation.

Depending upon the APCP requirements, these steps will take 6-9 months to complete and then design and construction would begin with completion of the entire network in 12-18 months.



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