EXHIBIT

Exhibit No.: 200
Issue(s): Distribution Line Extension/
Charge Ahead – Business Solutions/
Charge Ahead – Electric Vehicles
Witness/Type of Exhibit: Marke/Rebuttal
Sponsoring Party: Public Counsel
Case No.: ET-2018-0132

REBUTTAL TESTIMONY

OF

GEOFF MARKE

Submitted on Behalf of
the Office of the Public Counsel

**UNION ELECTRIC COMPANY D/B/A
AMEREN MISSOURI'S**

Case No. ET-2018-0132

P. 17
CORRECTION
MARKED BY
NANCY DIPPELL,
SENIOR REGULATORY
LAW JUDGE

October 1, 2018

OPC Exhibit No. 200
Date 12-4-18 Reporter TK
File No. ET-2018-0132

EXHIBIT

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 GEOFF MARKE

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Geoff Marke, of lawful age and being first duly sworn, deposes and states:

1. My name is Geoff Marke. I am a Regulatory Economist for the Office of the Public Counsel.

2. Attached hereto and made a part hereof for all purposes is my rebuttal testimony.

3. I hereby swear and affirm that my statements contained in the attached testimony are true and correct to the best of my knowledge and belief.

Geoff Marke
Chief Economist

Subscribed and sworn to me this 1st day of October 2018.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

JERENE A. BUCKMAN
My Commission Expires
August 23, 2021
Cole County
Commission #13754037

Jerene A. Buckman
Notary Public

My commission expires August 23, 2021.

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REBUTTAL TESTIMONY

OF

GEOFF MARKE

UNION ELECTRIC COMPANY

d/b/a Ameren Missouri

CASE NO. ET-2018-0132

I. INTRODUCTION

Q. Please state your name, title and business address.

A. Geoffrey Marke, PhD, Chief Economist, Office of the Public Counsel ("OPC"), P.O. Box 2230, Jefferson City, Missouri 65102.

Q. What are your qualifications and experience?

A. I have been in my present position with OPC since 2014 where I am responsible for economic analysis and policy research in electric, gas, and water utility operations.

Q. Have you testified previously before the Missouri Public Service Commission?

A. Yes. A listing of the cases in which I have previously filed testimony and/or comments before the Commission is attached in Schedule GM-1.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of this testimony is to respond to the direct testimony regarding Ameren Missouri's proposed tariff and program additions including the:

- Distribution Line Extension
  - Ameren Missouri witness Michael W. Harding and Steven M. Wills;
- "Charge Ahead – Business Solutions"
  - Ameren Missouri (or "ICF") witness David K. Pickles and Steven M. Wills; and
- "Charge Ahead – Electric Vehicles"
  - Ameren Missouri witness Patrick E. Justis and Steven M. Wills.

Q. Please provide a brief summary of Ameren Missouri's proposal.

A. Ameren Missouri is proposing two new "load building" programs: Charge Ahead-Business Solutions and Charge Ahead-Electric Vehicles; and a revision to an existing program: the distribution line extension. According to Ameren Missouri witness Mr. Wills:

> Each of the programs stands on its own merit and can operate independently of the other.[1]

Q. What is OPC's position?

A. OPC has come to an agreement with parties regarding Ameren Missouri's line extension offering and opposes the Charge Ahead-Business Solutions program in its entirety. Regarding the Charge Ahead—Electric Program, OPC believes the subsidization of EV charging stations is an inappropriate and regressive use of ratepayer dollars. OPC also believes that the estimated revenues and costs associated with the program are suspect; however, in the spirit of compromise OPC is willing to consider a risk-sharing mechanism as a possible path forward towards support from our Office. The rest of this testimony will describe OPC's positions in greater detail.

II. DISTRIBUTION LINE EXTENSION

Q. What is Ameren Missouri's proposed line extension policy?

A. Ameren Missouri has modified its line extension tariff utilizing a similar methodological framework that is currently in place by KCPL/GMO.

Q. What is OPC's position?

A. OPC and Staff have come to an agreement with Ameren Missouri regarding the modifications to its line extension policy. It is my understanding that at stipulation and agreement is forthcoming and expected to be filed on the same day as this testimony or reasonable thereafter.

[1] ET-2018-0132 Direct Testimony of Steven M. Wills p. 5, 3-4.

III. CHARGE AHEAD – BUSINESS SOLUTIONS

Q. What is the Charge Ahead—Business Solutions program?

A. It is a load building program to encourage the adoption of electrically powered equipment in place of fossil-fuel powered equipment. Such adoption should have the effect of reducing average rates to electric customers and may reduce environmental emissions. Mr. Pickles cites similar programs at CenterPoint Energy, Entergy, Southern Company, TVA, Jackson Electric Authority, Alliant Energy, and SRP as utilities with programs in place.

Q. Are you familiar with the programs that he cites?

A. I can speak to CenterPoint Energy, Entergy, and Jackson Electric Authority programs. OPC DR-2007 requested the following information and received the following response:

> Data Request: OPC 2007
>
> Please provide copies of any and all presentations Mr. Pickles has made pertaining to efficient electrification or beneficial electrification over the past six year. For each presentation, include the corresponding date(s) and venue of said presentation. Figure 1, 2 and 3 include snapshots referencing the first three utility-sponsored programs:
>
> Response:
>
> Mr. Pickles has served as a co-presenter in two public presentations (webinars) pertaining to efficient electrification or beneficial electrification over the past six years. The materials used for these webinars are provided as attachments. The dates of the webinars were 7/21/15 and 9/27/16. All other presentations made by Mr. Pickles on this topic are proprietary and confidential to ICF and/or its clients.

Figure 1: CenterPoint Energy Clean Air Technologies (CAT) Program

- No CenterPoint Incentives
- State Incentives

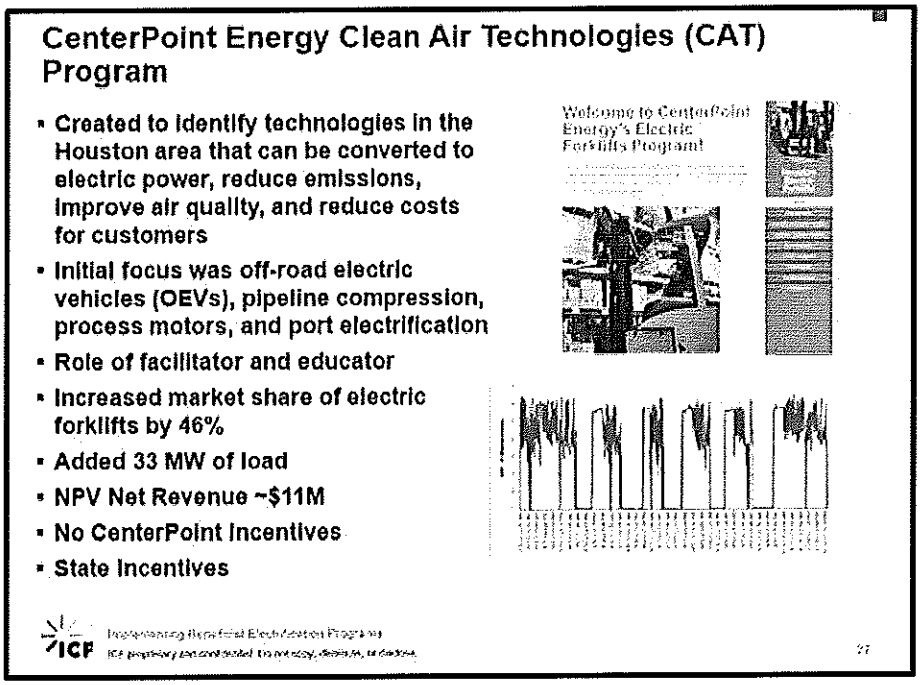


Figure 2: Entergy Agricultural Pumping Program

- No direct customer incentives

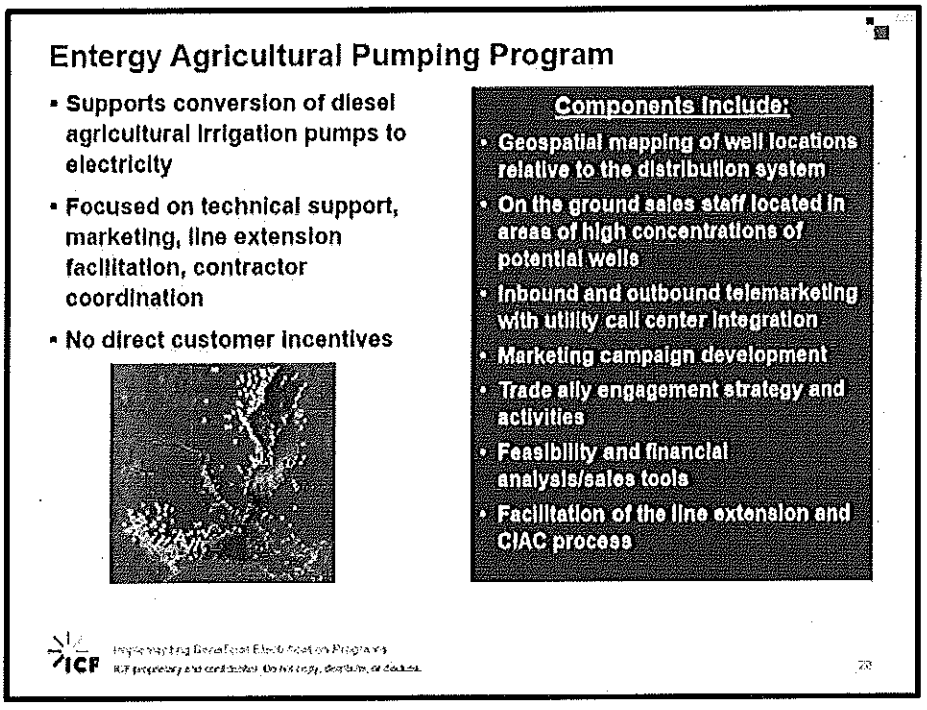
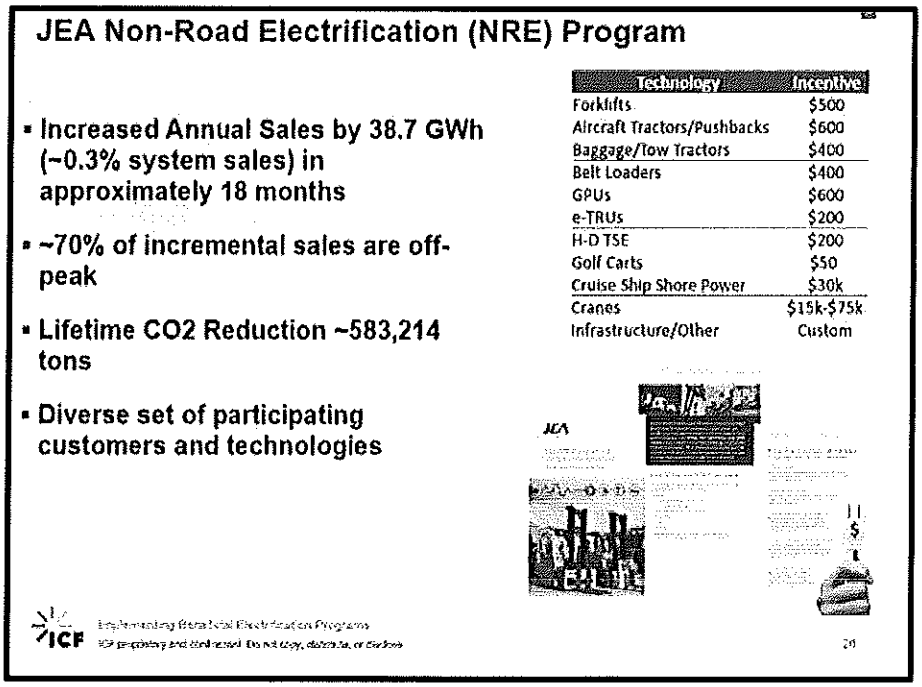


Figure 3: JEA ("Jacksonville Electric Authority") Non-Road Electrification ("NRE") Program



The Commission should note that two of the three utility-sponsored beneficial electrification programs required no direct subsidies from customers. The third program (JEA), was put forward by a municipal electric utility and thus, is not directly comparable as ratepayers in that case are also taxpayers.

Q. What is the expected budget for the Ameren Missouri Charge Ahead-Business Solution proposal?

A. According to Mr. Wills the portfolio of programs is capped at $7 million dollars over a five-year period and is targeted at two specific areas: 1.) the material equipment program (including forklifts and idle truck stop electrification; and 2.) the airport ground support programs. Each of these programs are designed to provide "medium incentive level" rebates. Table 1 below includes the approximate implementation and incentive breakdown:

Table 1: 5-Year Cost Breakdown for Charge Ahead-Business Solutions

	Forklifts and Trucks	Airport	Total
3rd Party Program Administration[2]	$2,888,000	$213,200	$3,101,200 45%
Direct Commercial Subsidy[3]	$3,607,500	$204,200	$3,811,700 55%
Total[4]	$6,495,500 94%	$417,400 6%	$6,912,900.00 100%

Material Equipment: Forklifts

Q. What is Ameren Missouri's electric forklift adoption potential?

A. According to the ICF forklift analysis which consisted of 17 dealers, 26 locations and 8 interviews, it is estimated that approximately 54% of forklifts in Ameren Missouri's service territory are already electric. These figures are largely consistent with electric forklift adoption across North America based on a 2016 Navigant Research Brief which states:

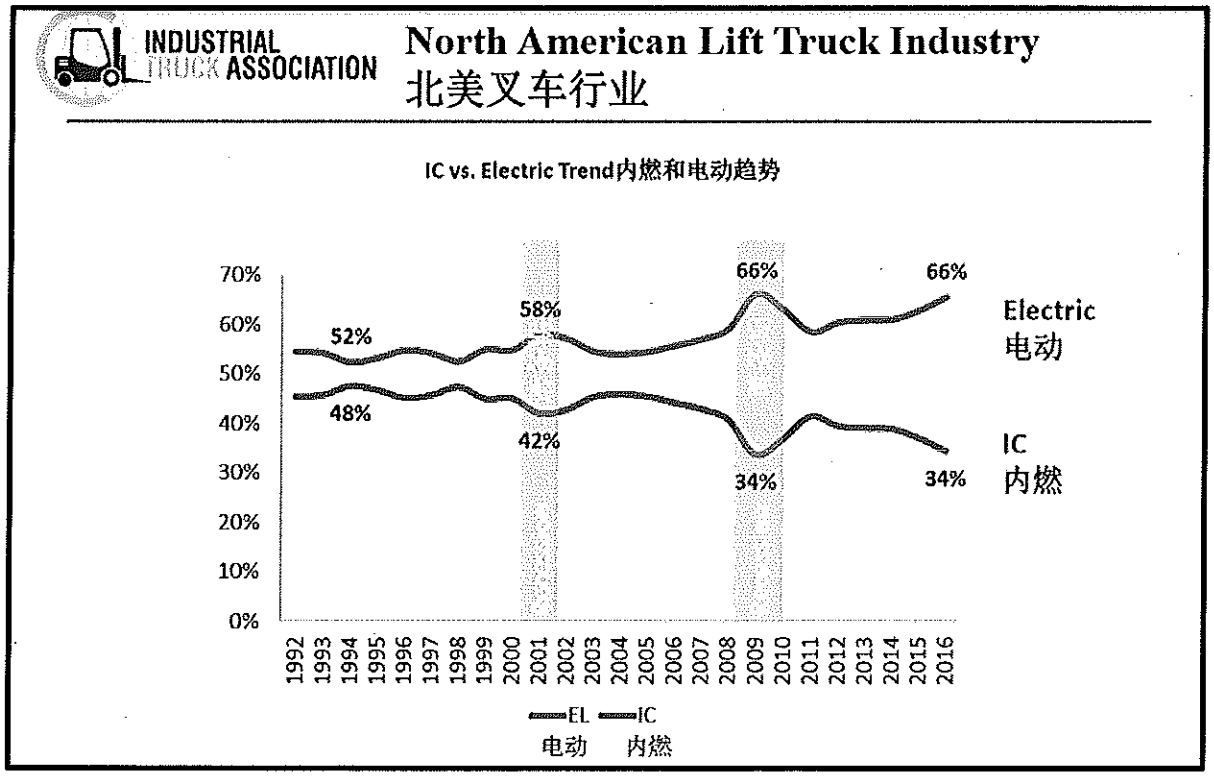
> A shift away from forklifts powered by propane, diesel, and other fossil fuels in favor of electric models for indoor applications started to occur in North America during 2009. To date, traditional lead-acid batteries have been the battery of choice of warehouse managers for Class 1, Class 2, and Class 3 electric forklifts due to their low upfront purchase costs. . . . The Industrial Truck Association (ITA), the leading North American trade organization for manufacturers and suppliers of forklift equipment, reported that electric forklift sales increased by over 8% from 2014 to 2015, representing 63.4% of the entire forklift market.[5]

The Industrial Truck Association year over year trends substantiate that electric forklifts have already gained widespread adoption and this trend will likely continue based on many of the

[2] See Schedule DP-D2-24.
[3] See Schedule DP-D2-29.
[4] The overall portfolio cost breakdown based off of these inputs is at $6,912,900 which is $30,000 more then what is listed as the total costs on DP-D2-31 at $6,882,900 for the two programs.
[5] See GM-2. Provided as s response, in part, to OPC DR-2010.

"beneficial" comments articulated in Ameren Missouri witness Pickles testimony. Figure 4 provides a market breakdown of internal combustion and electric forklifts from 1992 to 2016.

Figure 4: Internal Combustion Vs. Electric Forklifts adoption trends 1992-2016[6]



Q. Do electric forklifts need additional subsidies to spur market adoption?

A. No. Regarding market adoption and saturation, Everett Rogers *diffusion of innovation curve*, is widely cited as a means for understanding market adoption. It is based on the microeconomics of supplier behavior, wherein programs adopt a strategy that increases competition in the field, and that strategy leads to increased availability and diversity of products. Rogers' curve has been cited as a central framework for impact evaluation studies of energy efficiency products conducted by the US Department of Energy[7] and has been

[6] Alliance of Industrial Truck Organizations (2017) President's Forum Chengdu, China. Slide 19. http://www.jiva.or.jp/pdf/2017%20PF_ITA.pdf

[7] US Department of Energy (2007) Impact evaluation framework for technology deployment programs. http://www1.eere.energy.gov/analysis/pdfs/impact_framework_tech_deploy_2007_main.pdf

promoted within the energy efficiency community.[8] Rogers' categorizes five groups of product adopters and identifies market transformation through the percentages of people in each category.

2.5% Innovators – Innovators play "a gatekeeper role" in the social system of adopters. They are the first people in a social system to adopt the innovation. Innovators tend to be "venturesome," technologically savvy, and able to cope with uncertainty.

13.5% Early Adopters – "Early adopters put their stamp of approval on a new idea by adopting it, explains Rogers. Unlike innovators, early adopters enjoy a fair degree of respect among their peers and the general public. If they embrace a new technology, many others will likely follow suit because they have decreased uncertainty about the innovation.

34% Early majority – Individuals in the early majority look to early adopters for leadership regarding innovation but also may deliberate for some time before embracing a new technology; they constitute a numerically large group. Once an early majority member adopts a technology, other early majority members in their social network are likely to follow.

34% Late majority – Rogers describes late majority members as skeptics. Another numerically large group, they often decide to adopt an innovation due to peer pressure or because of some economic or other necessity to do so.

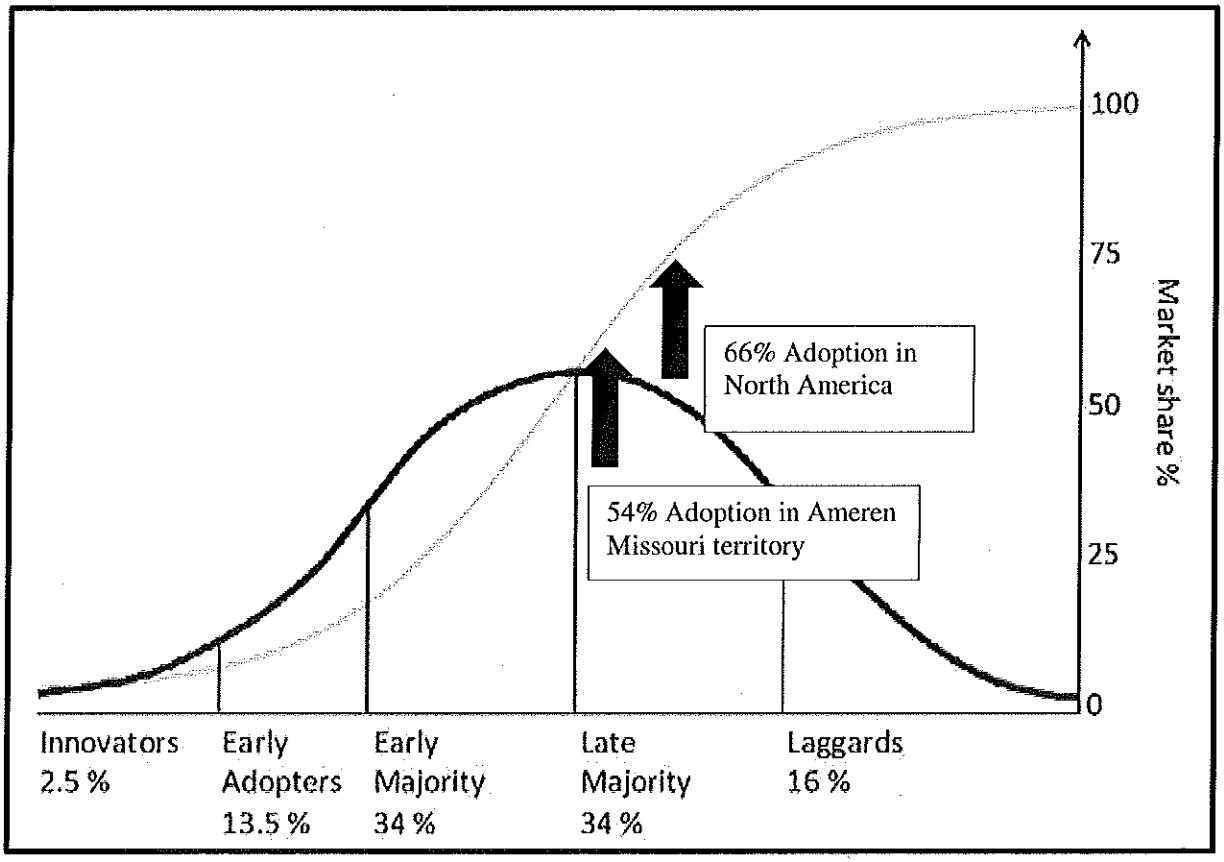
16% Laggards – According to Rogers, "Laggards are the last in a social system to adopt an innovation." They tend to look toward the past for guidance on their actions and remain suspicious not only of change, but also "of change agents [i.e., individuals promoting increased adoption of the innovation]." They may have very

[8] Vine, et al. (2006) An inside look at the U.S. Department of Energy impact evaluation framework for deployment programs. ACEEE. http://aceee.org/files/proceedings/2006/data/papers/SS06_Panel12_Papers12.pdf. OPC is cognizant that the Ameren Missouri, Charge Ahead – Business Solution program is not an energy efficiency program; however, the programs framework and justification is largely based on how the Commission has treated energy efficiency programs. Regardless, Rogers' theory is applicable to any product adoption.

rational and logical reasons for resisting an innovation and must be very sure "that the new idea will not fail before they can adopt."[9]

Figure 5 provides a visualization of Rogers curve and where electric forklifts fit on it in regards to adoption across North America (at least in 2016) and according to ICF's research in Ameren Missouri's service territory.

Figure 5: Rogers' Diffusion of Innovation Curve and electric forklift adoption in North American and Ameren Missouri service territory



[9] NMR Group (2013) A review of effective practices for the planning, design, implementation, and evaluation of market transformation efforts p. 16. http://www.calmac.org/publications/FINAL_NMR_MT_Practices_Report_20131125.pdf.

Readers will note that even though Ameren Missouri's commercial customers may be behind North American adoption trends for electric forklifts, the adoption rate is already in the "late majority" designation on Rogers' curve.

Q. Based on this information, what is OPC's position?

A. That ratepayers should not be subsidizing a load building technology that already has a commanding market share and user adoption. The "late majority" as characterized by Rogers, are customers who will adopt due to peer pressure ("sustainability concerns") or because of some economic or other necessity to do so. Stated differently, at this point, the "late majority" electric forklift program participant would largely be considered a "free rider," or a participant who would likely purchase the electric forklift regardless of the subsidy.

Material Equipment: Electric Standby Truck Refrigeration Units and Truck Stop Electrification

Q. Please describe the truck stop electrification program.

A. While parked, long-haul truck drivers would be able to plug into the grid instead of idling their truck or auxiliary engines to power their heating, air conditioning or other accessories.

Q. Please describe the electric standby truck refrigeration units.

A. Transportation refrigeration units control the temperature of cargo in shipping containers on trucks and are typically used by carriers that transport groceries, produce and other perishables.

Q. Does OPC support ratepayer subsidies for this load building program?

A. No. The Missouri Department of Natural Resources ("DNR") idle reduction rules would already enable much of this action. DNR's rules in 10 CSR 10-2.385 and 10-5.385, require that all commercial, public and institutional diesel vehicles in affected nonattainment counties (Clay, Platte and Jackson in Kansas City and the City of St. Louis, Jefferson, Franklin and St. Charles Counties in the St. Louis Area) limit their idling to 30 minutes while waiting to load or unload at a location. In addition, passenger load and unload locations are prohibited from causing or allowing vehicles covered by this regulation to idle for more than five minutes in

any 60 minute period. Vehicles are also limited from idling for more than five minutes when not waiting to load or unload in any 60 minute period, unless the vehicle meets one of the exemptions (e.g., emergency or law enforcement vehicles).

Airport Ground Support Equipment

Q. What is Ameren Missouri's airport ground support equipment potential?

A. It would consist solely of St. Louis Lambert International Airport.

Q. What does the program consist of?

A. Various baggage handling, belt loading, and ground power units for airport support staff.

Q. What are OPCs concerns with this program?

A. That 3rd party program administrator ($213,200) and commercial subsides ($204,200) are essentially equal yet the entire program consists of only one eligible participant. It is unclear why ratepayers would need to pay an estimated $213,200 to a third-party administrator over a five-year period to entice one customer with rebates that are actually smaller than the administration of the program itself.

Additionally, Lambert would likely be considered a free rider as well. The airport is currently owned by the City of St. Louis, who on October 27th, passed Resolution 124 that committed to 100% clean energy by 2035.[10]

Given the aforementioned information, OPC cannot support ratepayer subsidies for one customer especially in light of the disproportionate administrative overhead.

Load Reduction and Load Building Policy

Q. Is OPC opposed to load building in general?

A. Not necessarily. There are compelling arguments for load building programs; however, allocation of ratepayer funds for such programs need to be consistent and not at odds with other policy objectives. Putting aside the aforementioned flaws that OPC found in this application,

[10] St. Louis-MO.Gov (2018) Resolution No. 124/ Session 2017-2018: The City's Sustainability Plan. http://www.stlouis-mo.gov/government/city-laws/resolutions.cfm?rDetail=true&resolutionId=10762

Mr. Wills makes a reasonable argument for ratepayer subsidized load building and the potential positive impact on fixed cost recovery. Where I disagree with Mr. Wills is on the subject of MEEIA.

Q. Is OPC opposed to load building in conjunction with promoting MEEIA?

A. Yes. As the Commission is well aware, Ameren Missouri currently has a MEEIA application (aka, load reduction or demand-side management) that approaches or will exceed $1 billion dollars in overall cost recovery (program, lost revenues and earnings opportunity). Much of those "savings" are predicated on recovery of lost revenues and savings from avoided costs from Ameren Missouri's cost of service. The Commission should be cognizant that the proposed Charge Ahead program will "find revenues" and cancel out "avoided costs." Ameren Missouri attempts to gloss over this fact by claiming macro-savings from fuel and emissions separate and aside from Ameren Missouri's cost of service (e.g., tailpipe emissions and vehicular gasoline). Though this may be true on an aggregate basis, OPC also believes this claim is both exaggerated (Ameren Missouri is still predominately fossil fuel based) and ultimately not the responsibility of ratepayers.

OPC has already articulated its position in Ameren Missouri Cycle III application and continues to stand by our recommendation to continue programs at a reduced level to reflect the operating environment the Company currently finds itself in. As stated earlier, if the goal of the state of Missouri is to reduce greenhouse gas emissions, policy ought to seek out the cheapest reductions first, such a price-based tools.

OPC cannot support the Charge Ahead-Business Solutions program as currently drafted due to present-levels of market adoption, inefficient program design, and conflicting policy objectives and programs (e.g., load reduction and load building) the utility is seeking.

IV. CHARGE AHEAD – ELECTRIC VEHICLES

Q. Do you agree with Mr. Wills' estimates regarding the impact to ratepayers due to the proposed Charge Ahead-Electric Vehicle programs?

A. No. These estimates are highly dependent on rate-case timing and other confounding variables.

Q. Do you agree with Mr. Justis' assertion that the proliferation of EV charging stations will result in widespread EV adoption?

A. No.[11]

Q. Do you agree that seeking information from 3rd party EV charging station providers is a reasonable and appropriate metric from which to base a decision on whether or not more EV charging stations need to be deployed?

A. No. An analogous situation would be asking a barber whether or not you need a haircut.

Q. Do you believe the 2013 State Zero-Emission Vehicle ("ZEV") Programs Memorandum of Understanding should influence the Commission's decision in this case?

A. No. Other than the fact that Missouri has elected not to be signatory to that MOU.

Q. Are you aware of any investor owned utility that owns and operates a vehicular fuel station that is not subsidized by ratepayers?

A. Yes. Spire Missouri.

Amended Application

Q. How does this element of Ameren Missouri's application differ from what was filed in ET-2016-0246?

A. Ameren Missouri is no longer requesting to rate base the prospective EV charging stations but, instead, requests the Commission approve its plan to encourage EV charging adoption by providing up to $10 million dollars in subsidies for third-party ownership under the proposed tariff/incentive breakdown (see below in Table 2).

[11] See GM-3 and GM-4 and the KCPL & GMO service territories.

Table 2: Proposed Ameren Missouri EV charging station breakdown by type and incentive-level[12]

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.			

What third party would ultimately "own" the long distance corridor stations and at what incentive level is not entirely clear. Further discovery is warranted.

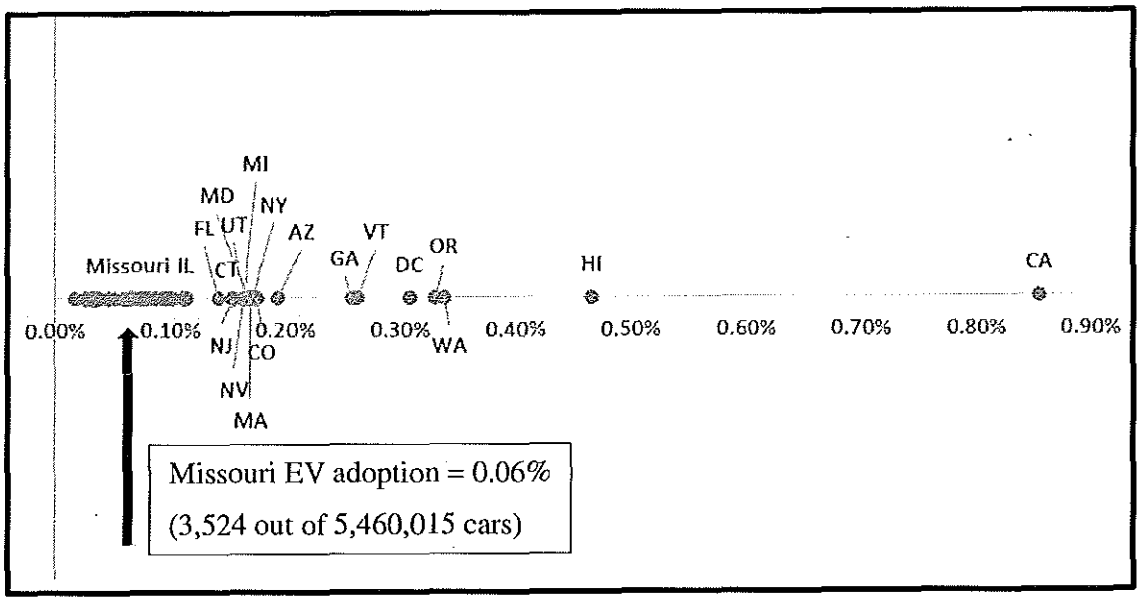
Missouri EV Sales & the KCPL Clean Charge Network ("CCN")

Q. Both Mr. Justis and Mr. Wills's point to depressed EV sales in Missouri. Do you agree?

A. I agree that sales of EV are very low throughout the United States. Missouri is no exception and is ranked #34 overall in US states with an overall adoption rate of 0.06% of registered vehicles.[13] Mr. Wills provides a breakdown of registered plug-in vehicles by state in his testimony and reprinted here in Figure 6.

[12] ET-2018-0132 Direct Testimony of Patrick Justis p. 36, 5.
[13] ET-2018-0132 Direct Testimony of Patrick E. Justis p. 12.

Figure 6: Registered plug-in vehicles by state [14]



Q. Both Mr. Justis and Wills point to KCPL's Clean Charge Network as a success in promoting EV stations. Do you agree?

A. No. I addressed the KCPL Clean Charge Network ("CCN") recently in my rebuttal testimony in KCPL and GMO most recent rate cases Case No: ER-2018-0145 and ER-2018-0146. My testimony was as follows:

> **Q. Please summarize KCPL/GMO's request.**
>
> A. KCPL and GMO witness Mr. Caisley is requesting that the Commission "reconsider" its position on the unrecoverable capital and O&M costs related to its Clean Charge Network ("CCN").
>
> **Q. What is OPC's position?**
>
> A. Consistent with the Commission's ruling in ER-2016-0285, OPC recommends the continued removal of these costs as the Commission has already ruled it has no statutory authority to regulate the CCN operations. Both ratepayers and drivers

[14] ET-2018-0132 Direct Testimony of Steven M. Wills p. 20, 6, and footnote 5.

are best served by a competitive market for EV charging services rather than by a regulated monopoly. The best ways for KCPL and GMO's *regulated* services to enable the promotion of EV adoption by emphasizing its essential services, primarily through offering time-of-use ("TOU") rates on an opt-in basis that encourages charging during low-cost, off-peak hours (this specific recommendation and its benefits will be discussed at length in my rebuttal rate design testimony).

The Commission has already rejected KCPL and GMO's proposal to recover EV charging station costs "above the line" and there has been no change in circumstances to warrant a different decision. The Commission should continue to leave deployment of EV charging infrastructure to non-regulated services and importantly, to existing and future free-market competition; thereby reducing the risk of future stranded utility assets and costs.

Q. What do you mean by stranded assets?

A. Stranded assets are assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities. There is no question EV charging is a developing technology. EV charging stations can become stranded assets when new technologies are introduced and nimble companies out-compete incumbent utilities. Regulated electric utilities are then exposed to the risk of having stranded assets on their books. Failure to account for changing technologies may result in ratepayers funding assets that are outdated and are no longer useful by or useful to customers.

Q. Would KCPL and GMO's current CCN investments be considered stranded assets?

A. No, not for ratepayers because of the Commission's Order in ER-2016-0285. It may be too soon to know if the Companies' 929 charging stations will prove to

be a stranded investment for shareholders, however, the early returns are not encouraging.

According to the response to OPC DR-2032, from 2010 to 2017 there were 905,455 conventional vehicles (non-electric) registered in the KCPL-KS, KCPL-MO and KCPL-GMO service territories.[15] During that same time span only 2,789 EVs were registered in total (or ~~16.03%~~ .03%), with only 972 in KCPL-MO and 434 in the GMO service territory.[16] [The rest were in Kansas].

Furthermore, according to OPC DR-2034, there have been a total of 2,092 "unique drivers" who have used the CCN through 2017. This means that, at least, more than 700 of the registered EV drivers who reside in the three KCPL service territories have never utilized the CCN. For perspective, there are 1,862 available charging ports on the Clean Charge Network, or roughly one charging port for each of the 2092 unique EV drivers who have *ever* used the CCN.[17]

It is also important to note that up until 2018 using the CCN charging stations was entirely free.[18] Moving forward, drivers will have to pay for charging service, at least at the 749 non-host paid sites. Equally important, the vast majority of these charging stations are also not "fast charging" but instead "Level 2" models that take 4-5 hours to fully charge an EV with a 100-mile battery.[19] The likelihood of generating enough revenues to cover the cost of the capital (and O&M) investments will be a challenge. Thankfully, and correctly, ratepayers do not have to bear those costs.[20]

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[15] See ER-2018-0145 & ER-2018-0146 Rebuttal "Revenue" Testimony of Geoff Marke p. 3 GM-1.
[16] Ibid. GM-3.
[17] Ibid. GM-4.
[18] ER-2018-0145 & ER-2018-0146 Direct Testimony of Charles A. Caisley p. 5, 11-12.
[19] ChargePoint (2018) Level up your EV charging knowledge. https://www.chargepoint.com/blog/level-your-evcharing-knowledge/
[20] ER-2018-0145 & ER-2018-0146 Rebuttal "Revenue" Testimony of Geoff Marke p. 2,7 thru p. 4, 7.

Risks

Q. Do you have the same concerns with Ameren Missouri's proposal?

A. In part. As stated earlier, the Ameren Missouri Charge Ahead—electric vehicle program is categorically better than the KCPL CCN initiative as the capital would not be included in rate base which minimizes some of the concerns raised by OPC in earlier testimony.[21]

That being said, there is still a risk that the $11 million in ratepayer-funded requested subsidies will not produce commensurate value for ratepayers. The Charge Ahead-EV application is built on the premise that the EV market will "further" materialize as a result of populating the Ameren Missouri service territory with a "holistic charging station environment." It's a bet on future consumer actions of non-essential service and OPC is largely risk averse when it comes to speculative value-added services.

Q. Please explain some of those risks.

A. In addition to the concerns I raised in the ET-2016-0246, it has since come to OPC's attention that the global supply chain for cobalt is highly volatile and may perpetuating human rights violations. Cobalt is an essential element in EV batteries and is largely mined from the Democratic Republic of the Congo. According to recent report from the S&P Global:

> Automakers spending fortunes on a bet that electric vehicles are the industry's future are virtually silent on the mining risks tied to cobalt, a key metal for the batteries on which their plans depend. . . .
>
> A critical ingredient in lithium-ion batteries and a core enabling material in electric cars, energy storage systems, smartphones and other electronics, cobalt is chiefly mined in the Democratic Republic of the Congo, which accounted for 58% of global production in 2017 and 49% of world reserves, according to the U.S. Geological Survey. Tight global supplies recently have sent cobalt prices soaring to over $90,000 per metric ton on the London Metal Exchange, almost tripling since January 2017.

[21] See GM-3 and GM-4 for copies of ET-2016-0246 Rebuttal and Surrebuttal Testimony of Geoff Marke which are included in their entirety where many of OPC's policy concerns are explained.

> The DRC, which is already plagued by instability, political polarization and deficient infrastructure, could face more trouble with a long-awaited presidential election scheduled for December. The country is at an "inflection point" that could either lead to a "historic" democratic transition or to a "breakdown and … a great deal of violence," Tom Perriello, a former U.S. special envoy to the Congo and eastern Africa, said in March at the Brookings Institution, a think tank in Washington, D.C.
>
> In addition to supply-chain risks, human rights groups have routinely cited Congolese mines for child labor, forced evictions and water pollution, black marks that may be particularly troublesome for clean energy industries sold on their green credentials.
>
> "We all see this cobalt pinch looming," Chris Berry, founder and president of House Mountain Partners, an advisory firm focused on raw material supply chains, said in an interview. "A large part of it has to do with the fact that it comes from the DRC, and it's just a very challenging place to do business, and there's just no easy solution here if [electric vehicle] adoption continues at its current pace.". . .
>
> "There will be no electric vehicle industry without DRC cobalt," said Simon Moores, managing director of Benchmark Mineral Intelligence, an independent research firm. "It's really the new blood diamond. If investors start talking with their feet, these companies will start to take action."[22]

Like all investments, Ameren Missouri could do everything right and still not see a return on its investment. As noted above, the global supply chain for cobalt could categorically change the cost (and value) of EVs moving forward. Other real risks impacting this investment include rising EV costs due to thin profit margins for automakers. As Reuters recently reported:

> Electric cars are poised to arrive en masse in European showrooms after years of hyped concept-car launches and billions in investment by automakers and suppliers.

[22] Copley, M. & G. Hering (2018) Cobalt key to electric vehicles but automakers hushed on risks. *S&P Global.* https://www.spglobal.com/en/research-insights/articles/cobalt-key-to-electric-vehicles-but-automakers-hushed-on-risks see also GM-5.

> Now comes the hard part: selling them at a profit.
>
> Battery models making their car-show debut in Paris this week, from PSA Group's (PEUP.PA) electric DS3 Crossback to the Mercedes (DAIGn.DE) EQC, will erode profitability as they struggle to stay in the black, executives generally acknowledge.
>
> But concerns are mounting that the impact could be worse, as consumers resist paying more for electrified vehicles - forcing carmakers to sell them at a bigger loss to meet emissions goals.
>
> "What everyone needs to realize is that clean mobility is like organic food – it's more expensive," said Carlos Tavares, chief executive of Peugeot, Citroen and Opel manufacturer PSA. . . .
>
> "It absolutely is impacting the profitability of the industry," said Rebecca Lindland, a senior analyst at Kelley Blue Book, which tracks vehicle pricing. "Demand doesn't justify investment at all - it's all regulation."[23]

Unlike other traditional investments, the notable difference here, is that if Ameren Missouri is wrong, ratepayers will bear the costs.

Risk Sharing

Q. Does OPC have a recommendation on how to move forward?

A. Yes. At a minimum, OPC believes that value-added services should be premised on a sharing of symmetric risk. Symmetry in both potential outcomes and equality in the uncertainty surrounding the investment. No person in a transaction should have certainty about the outcome while the other one has uncertainty, especially when one of the parties in the transaction is "captive."

[23] Frost, L. (2018) Electric cars cast growing shadow on profits (Reuters) https://www.reuters.com/article/us-autoshow-paris-electric-squeeze-analy/electric-cars-cast-growing-shadow-on-profits-idUSKCN1MB2GD

In Mr. Wills's testimony, he puts forward several data points from which a potential resolution to this proposal might be realized. Mr. Wills cites Ameren Missouri's filed 2017 Integrated Resource Plan ("IRP") base forecast of EV adoption in Ameren Missouri's service territory over the next decade at 25,000 EVs by 2028, Mr. Wills then states:

> Given the $11 million proposed budget, and the roughly $1,500 investment that I previously calculated could be supported by each car, simple division suggests that approximately 7,500 new cars over the life of the program would need to be added to the system for the incremental effect of the program to result in rate benefits *directly* arising from the program for all customers.[24]

OPC suggests that the Commission could consider approval of Ameren Missouri's Charge Ahead—Electric Vehicle application with the following customer protections based on forecasted figures Mr. Wills relies on:

- $10 million in subsidies to promote EV charging stations as articulated in Table 2 above;
- $1 million in associated program administration and marketing;
- A 5-year time limit; and
- A risk-sharing mechanism between ratepayers and shareholders based on the number of registered plug-in EVs in Ameren Missouri's service territory by the close of calendar year 2028.

Q. Please describe OPC's risk-sharing mechanism.

A. Keeping in mind that Ameren Missouri's proposal is supposed to further spur sales of already expected EV adoption, OPC believes that cost-recovery of the entire program should be predicated on exceeding 25,000 "new" registered EVs based on calendar years 2019 to 2028 for the counties in which Ameren Missouri provides service.

[24] ET-2018-0132 Direct Testimony of Steven M. Wills p. 32, 22-23 & p. 33, 1-3.

To calculate the risk sharing mechanism, all registered EVs in counties in which Ameren Missouri provides service as of the close of December 2018 would be subtracted from the total number of registered EVs in Ameren Missouri's service territory at the end of 2028.

Ameren Missouri shareholders would bear all program costs if the overall number of registered EVs (minus the aforementioned existing registered EVs as of the close of 2018) is below 25,000 (based on Missouri Department of Revenue registered EVs) in the counties in which Ameren Missouri offers service.

Ratepayers will cover a percentage of the expense of costs related to the program if registered EVs result in 25,001 to 32,500 in counties in which Ameren Missouri serves. For illustrative purposes, the calculation would be as follows:

- Pre-2019 registered EV cars = 2,500
- Registered EV cars 2028 = 30,000
- Pre-2019 registration – 2028 EV registration = 27,500
    - 25,000 registered EVs as a result of regular market adoption absent no investment (base IRP assumption);
    - 2,500 registered EVs attributable to Charge Ahead investment
- 27,500 – 32,500 = 5,000 cars short of expected induced adoption
- Sharing mechanism =
    - 33.3% ratepayer funded or $3,663,000
    - 66.7% shareholder funded $7,337,000

If EV adoption exceeds 32,500 new (post-2018) registered EVs then ratepayers will cover the costs of the program in its entirety.

Q. Does this conclude your testimony?

A. Yes.

CASE PARTICPATION OF GEOFF MARKE, PH.D.

Company Name	Employed Agency	Case Number	Issues
Union Electric Company d/b/a Ameren Missouri	Office of Public Counsel (OPC)	ET-2018-0132	**Rebuttal:** Line Extension / Charge Ahead – Business Solutions / Charge Ahead – Electric Vehicle Infrastructure
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2018-0211	**Rebuttal:** MEEIA Cycle III Application **Surrebuttal:** Cost Effectiveness Tests / Equitable Energy Efficiency Baseline
Union Electric Company d/b/a Ameren Missouri	OPC	EA-2018-0202	**Rebuttal:** Renewable Energy Standard Rate Adjustment Mechanism/Conservation **Surrebuttal:** Endangered and Protected Species
Empire District Electric Company /Kansas City Power & Light & KCP&L Greater Missouri Operations Company/Union Electric Company d/b/a Ameren Missouri	OPC	EO-2019-0066 EO-2019-0065 EO-2019-0064 EO-2019-0063	**Memorandum:** Additive Manufacturing and Cement Block Battery Storage (IRP: Special Contemporary Topics)
Kansas City Power & Light & KCP&L Greater Missouri Operations Company	OPC	ER-2018-0145 ER-2018-0146	**Direct:** Smart Grid Data Privacy Protections **Rebuttal:** Clean Charge Network / Community Solar / Low Income Community Solar / PAYS/ Weatherization/Economic Relief Pilot Program/Economic Development Rider/Customer Information System and Billing **Rebuttal:** TOU Rates / IBR Rates / Customer Charge / Restoration Charge **Surrebuttal:** KCPL-GMO Consolidation / Demand Response / Clean Charge Network / One CIS: Privacy, TOU Rates, Billing & Customer Experience
Union Electric Company d/b/a Ameren Missouri	OPC	ET-2018-0063	**Rebuttal:** Green Tariff
Liberty Utilities	OPC	GR-2018-0013	**Surrebuttal:** Decoupling

Empire District Electric Company	OPC	EO-2018-0092	**Rebuttal:** Overview of proposal/ MO PSC regulatory activity / Federal Regulatory Activity / SPP Activity and Modeling / Ancillary Considerations **Surrebuttal** Response to parties **Affidavit** in opposition to the non-unanimous stipulation and agreement
Great Plains Energy Incorporated, Kansas City Power & Light Company, KCP&L Greater Missouri Operations Company, and Westar Energy, Inc.	OPC	EM-2018-0012	**Rebuttal:** Merger Commitments and Conditions / Outstanding Concerns
Missouri American Water	OPC	WR-2017-0285	**Direct:** Future Test Year/ Cost Allocation Manual and Affiliate Transaction Rules for Large Water Utilities / Lead Line Replacement **Direct:** Rate Design / Cost Allocation of Lead Line Replacement **Rebuttal:** Lead Line Replacement / Future Test Year/ Decoupling / Residential Usage / Public-Private Coordination **Rebuttal:** Rate Design **Surrebuttal:** affiliate Transaction Rules / Decoupling / Inclining Block Rates / Future Test Year / Single Tariff Pricing / Lead Line Replacement
Missouri Gas Energy / Laclede Gas Company	OPC	GR-2017-0216 GR-2017-0215	**Rebuttal:** Decoupling / Rate Design / Customer Confidentiality / Line Extension in Unserved and Underserved Areas / Economic Development Rider & Special Contracts **Surrebuttal:** Pay for Performance / Alagasco & EnergySouth Savings / Decoupling / Rate Design / Energy Efficiency / Economic Development Rider: Combined Heat & Power
Indian Hills Utility	OPC	WR-2017-0259	**Direct:** Rate Design
Rule Making	OPC	EW-2018-0078	**Memorandum** on cogeneration and net metering
Empire District Electric Company	OPC	EO-2018-0048	Integrated Resource Planning: Special Contemporary Topics Comments

Kansas City Power & Light	OPC	EO-2018-0046	Integrated Resource Planning: Special Contemporary Topics Comments
KCP&L Greater Missouri Operations Company	OPC	EO-2018-0045	Integrated Resource Planning: Special Contemporary Topics Comments
Missouri American Water	OPC	WU-2017-0296	**Direct:** Lead line replacement pilot program **Rebuttal:** Lead line replacement pilot program **Surrebuttal:** Lead line replacement pilot program
KCP&L Greater Missouri Operations Company	OPC	EO-2017-0230	**Memorandum** on Integrated Resource Plan, preferred plan update
Working Case: Emerging Issues in Utility Regulation	OPC	EW-2017-0245	**Memorandum** on Emerging Issues in Utility Regulation / **Presentation**: Inclining Block Rate Design Considerations **Presentation**: Missouri Integrated Resource Planning: And the search for the "preferred plan." **Memorandum**: Draft Rule 4 CSR 240-22.055 DER Resource Planning
Rule Making	OPC	EX-2016-0334	**Memorandum** on Missouri Energy Efficiency Investment Act Rule Revisions
Great Plains Energy Incorporated, Kansas City Power & Light Company, KCP&L Greater Missouri Operations Company, and Westar Energy, Inc.	OPC	EE-2017-0113 / EM-2017-0226	**Direct**: Employment within Missouri / Independent Third Party Management Audits / Corporate Social Responsibility
Union Electric Company d/b/a Ameren Missouri	OPC	ET-2016-0246	**Rebuttal**: EV Charging Station Policy **Surrebuttal**: EV Charging Station Policy
Kansas City Power & Light		ER-2016-0156	**Direct:** Consumer Disclaimer **Direct:** Response to Commission Directed Questions **Rebuttal:** Customer Experience / Greenwood Solar Facility / Dues and Donations / Electric Vehicle Charging Stations **Rebuttal:** Class Cost of Service / Rate Design

			Surrebuttal: Clean Charge Network / Economic Relief Pilot Program / EEI Dues / EPRI Dues
Union Electric Company d/b/a Ameren Missouri	OPC	ER-2016-0179	**Direct:** Consumer Disclaimer / Transparent Billing Practices / MEEIA Low-Income Exemption **Direct:** Rate Design **Rebuttal:** Low-Income Programs / Advertising / EEI Dues **Rebuttal:** Grid-Access Charge / Inclining Block Rates /Economic Development Riders
KCP&L Greater Missouri Operations Company	OPC	ER-2016-0156	**Direct:** Consumer Disclaimer **Rebuttal:** Regulatory Policy / Customer Experience / Historical & Projected Customer Usage / Rate Design / Low-Income Programs **Surrebuttal:** Rate Design / MEEIA Annualization / Customer Disclaimer / Greenwood Solar Facility / RESRAM / Low-Income Programs
Empire District Electric Company, Empire District Gas Company, Liberty Utilities (Central) Company, Liberty Sub-Corp.	OPC	EM-2016-0213	**Rebuttal:** Response to Merger Impact **Surrebuttal:** Resource Portfolio / Transition Plan
Working Case: Polices to Improve Electric Regulation	OPC	EW-2016-0313	**Memorandum** on Performance-Based and Formula Rate Design
Working Case: Electric Vehicle Charging Facilities	OPC	EW-2016-0123	**Memorandum** on Policy Considerations of EV stations in rate base
Empire District Electric Company	OPC	ER-2016-0023	**Rebuttal:** Rate Design, Demand-Side Management, Low-Income Weatherization **Surrebuttal:** Demand-Side Management, Low-Income Weatherization, Monthly Bill Average
Missouri American Water	OPC	WR-2015-0301	**Direct:** Consolidated Tariff Pricing / Rate Design Study **Rebuttal:** District Consolidation/Rate Design/Residential Usage/Decoupling **Rebuttal:** Demand-Side Management (DSM)/ Supply-Side Management (SSM) **Surrebuttal:** District

			Consolidation/Decoupling Mechanism/Residential Usage/SSM/DSM/Special Contracts
Working Case: Decoupling Mechanism	OPC	AW-2015-0282	**Memorandum:** Response to Comments
Rule Making	OPC	EW-2015-0105	Missouri Energy Efficiency Investment Act Rule Revisions, Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0084	Triennial Integrated Resource Planning Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0055	**Rebuttal:** Demand-Side Investment Mechanism / MEEIA Cycle II Application **Surrebuttal:** Potential Study / Overearnings / Program Design **Supplemental Direct:** Third-party mediator (Delphi Panel) / Performance Incentive **Supplemental Rebuttal:** Select Differences between Stipulations **Rebuttal:** Pre-Pay Billing
The Empire District Electric Company	OPC	EO-2015-0042	Integrated Resource Planning: Special Contemporary Topics Comments
KCP&L Greater Missouri Operations Company	OPC	EO-2015-0041	Integrated Resource Planning: Special Contemporary Topics Comments
Kansas City Power & Light	OPC	EO-2015-0040	Integrated Resource Planning: Special Contemporary Topics Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0039	Integrated Resource Planning: Special Contemporary Topics Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0029	Ameren MEEIA Cycle I Prudence Review Comments
Kansas City Power & Light	OPC	ER-2014-0370	**Direct** (Revenue Requirement): Solar Rebates **Rebuttal:** Rate Design / Low-Income Weatherization / Solar Rebates **Surrebuttal:** Economic Considerations / Rate Design / Cyber Security Tracker
Rule Making	OPC	EX-2014-0352	**Memorandum** Net Metering and Renewable Energy Standard Rule Revisions,
The Empire District Electric Company	OPC	ER-2014-0351	**Rebuttal:** Rate Design/Energy Efficiency and Low-Income Considerations

Rule Making	OPC	AW-2014-0329	Utility Pay Stations and Loan Companies, Rule Drafting, Comments
Union Electric Company d/b/a Ameren Missouri	OPC	ER-2014-0258	**Direct:** Rate Design/Cost of Service Study/Economic Development Rider **Rebuttal:** Rate Design/ Cost of Service/ Low Income Considerations **Surrebuttal:** Rate Design/ Cost-of-Service/ Economic Development Rider
KCP&L Greater Missouri Operations Company	OPC	EO-2014-0189	**Rebuttal:** Sufficiency of Filing **Surrebuttal:** Sufficiency of Filing
KCP&L Greater Missouri Operations Company	OPC	EO-2014-0151	Renewable Energy Standard Rate Adjustment Mechanism (RESRAM) Comments
Liberty Natural Gas	OPC	GR-2014-0152	**Surrebuttal:** Energy Efficiency
Summit Natural Gas	OPC	GR-2014-0086	**Rebuttal:** Energy Efficiency **Surrebuttal:** Energy Efficiency
Union Electric Company d/b/a Ameren Missouri	OPC	ER-2012-0142	**Direct:** PY2013 EM&V results / Rebound Effect **Rebuttal:** PY2013 EM&V results **Surrebuttal:** PY2013 EM&V results **Direct:** Cycle I Performance Incentive **Rebuttal:** Cycle I Performance Incentive
Kansas City Power & Light	Missouri Public Service Commission Staff	EO-2014-0095	**Rebuttal:** MEEIA Cycle I Application testimony adopted
KCP&L Greater Missouri Operations Company	Missouri Division of Energy (DE)	EO-2014-0065	Integrated Resource Planning: Special Contemporary Topics Comments
Kansas City Power & Light	DE	EO-2014-0064	Integrated Resource Planning: Special Contemporary Topics Comments
The Empire District Electric Company	DE	EO-2014-0063	Integrated Resource Planning: Special Contemporary Topics Comments
Union Electric Company d/b/a Ameren Missouri	DE	EO-2014-0062	Integrated Resource Planning: Special Contemporary Topics Comments
The Empire District Electric Company	DE	EO-2013-0547	Triennial Integrated Resource Planning Comments
Working Case: State-Wide Advisory Collaborative	OPC	EW-2013-0519	Presentation: Does Better Information Lead to Better Choices? Evidence from Energy-Efficiency Labels
Independence-Missouri	OPC	Indy Energy Forum 2014	Presentation: Energy Efficiency

Independence-Missouri	OPC	Indy Energy Forum2015	Presentation: Rate Design
NARUC – 2017 Winter	OPC	Committee on Consumer Affairs	NARUC – 2017 Winter Presentation: PAYS Tariff On-Bill Financing
NASUCA – 2017 Summer	OPC	Committee on Water Regulation	NASUCA – 2017 Summer Presentation: Regulatory Issues Related to Lead-Line Replacement of Water Systems
NASUCA – 2017 winter	OPC	Committee on Utility Accounting	NASUCA – 2017 Winter Presentation: Lead Line Replacement Accounting and Cost Allocation

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RESEARCH

RESEARCH BRIEF

Advanced Electric Forklift Technologies in North America

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1. Executive Summary

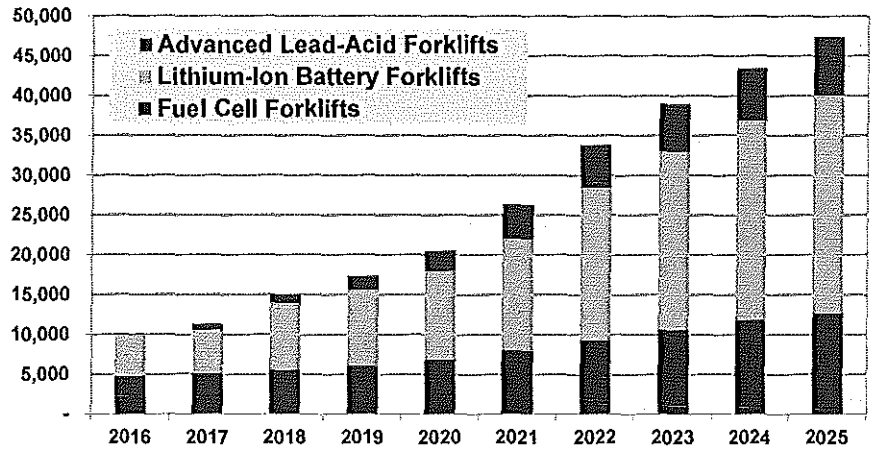
A shift away from forklifts powered by propane, diesel, and other fossil fuels in favor of electric models for indoor applications started to occur in North America during 2009. To date, traditional lead-acid batteries have been the battery of choice of warehouse managers for Class 1, Class 2, and Class 3 electric forklifts due to their low upfront purchase costs. Forklift manufacturers, advanced lead-acid battery manufacturers, lithium ion (Li-ion) battery manufacturers, and fuel cell technology providers are now beginning to help warehouse managers improve throughput and efficiency and save resources by utilizing new electric forklift technologies in their industrial vehicle fleets.

This research brief covers the advanced electric technologies being incorporated in Class 1, Class 2, and Class 3 forklifts. It aims to provide forklift market stakeholders with answers to key questions:

- What are the primary market drivers and barriers that Class 1, Class 2, or Class 3 advanced electric forklifts face in the evolving indoor warehouse sector?
- How can advanced lead-acid batteries, Li-ion batteries, and fuel cells improve the total cost of operations in forklifts for warehouse managers?
- What are the sales forecasts for advanced electric forklift technologies over the next 10 years?

While advanced electric powertrain options for forklifts are nascent technologies in the materials handling industry, they represent improvements over traditional options. Warehouses that operate multiple shifts per day and cold storage will be the main market for advanced electric technologies in forklifts. As shown in Chart 1, the advanced electric forklift market is expected to reach over 47,000 forklifts by 2025.

Chart 1 Advanced Electric Forklift Sales by Technology, North America: 2016-2025



(Source: Navigant Research)

GM-2

2. Market Update

The Industrial Truck Association (ITA), the leading North American trade organization for manufacturers and suppliers of forklift equipment, reported that electric forklift sales increased by over 8% from 2014 to 2015, representing 63.4% of the entire forklift market. Today, the predominant powertrain technology for electric-drive forklift trucks is the lead-acid battery. However, warehouse managers are being pressured to increase the productivity of daily operations, adjust quickly to market demands, and become more environmentally friendly. These pressures, in turn, are spurring companies to explore opportunities for other sources of energy.

In the past decade, materials handling operators in North America have been adopting more advanced electric technologies as alternatives to conventional lead-acid batteries and conventional chargers. This research brief covers the leading alternatives to lead-acid batteries that are now being offered or are under development for the North American electric forklift market. Specifically, the technologies discussed in this report are advanced lead-acid batteries, lithium ion (Li-ion) batteries, and fuel cells.

2.1 Market Overview

The Occupational Safety and Health Administration works alongside the ITA to define forklift classifications used in the North American forklift market. Forklift classifications are distinguished by a number of factors, including:

- Electric versus internal combustion engine (ICE)
- Type of operation
- Sit down versus stand up riders
- Indoor versus outdoor usage (with respect to terrain/steep grades)
- Ambient temperature operations versus hot/cold operations

Forklifts used in similar operations can be classified differently based on one or several of these factors. The ITA outlines seven classifications for forklifts; Classes 1 through 3 are exclusively electric-powered, while Class 6 can be either electric or ICE. These classes are listed in Table 1.

Table 1 Forklift Classifications

Classification	Title	Examples
Class 1	Electric Motor Rider Trucks	Counterbalanced Rider Type, Stand Up or Sit Down
Class 2	Electric Motor Narrow Aisle Trucks	High Lift Straddle, Low Lift Pallet
Class 3	Electric Motor Hand Trucks or Hand/Rider Trucks	Tractors, High Lift Straddle, Reach Type Outrigger
Class 6	Electric and ICE Tractors	Sit Down Rider

(Source: Occupational Safety and Health Administration)

This report highlights the advanced electric technologies being incorporated into Class 1, Class 2, and Class 3 forklifts. Class 6 forklifts are not included in this report because the market for new electric alternatives for this class of vehicles is not large due to the limited towing capacity of electric systems. Table 2 outlines the vehicle classes and associated specifications for traditional lead-acid battery forklifts.

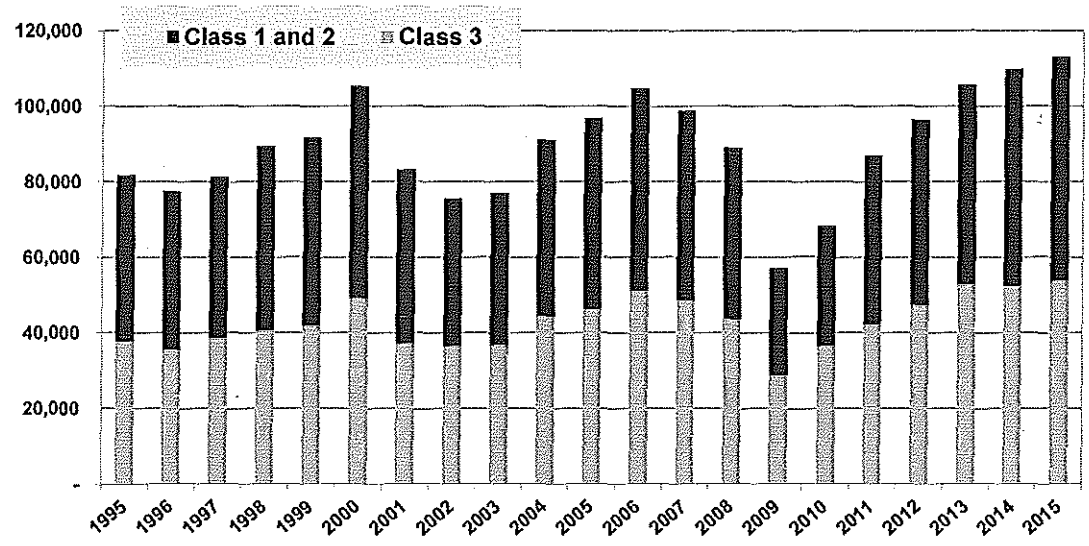
Table 2 Lead-Acid Forklift Characteristics: North America

Metric	Class 1 and Class 2	Class 3
Battery Size	22 kW-50 kW	10 kW-12 kW
Battery Module Cost	$6,500 average	$2,450 average
Lift Capacity	3,000-20,000 lbs	3,000-6,000 lbs
Battery Duration	4-6 hours	6 hours
Battery Life	3-5 years	3-5 years

(Source: Navigant Research)

Class 3 forklifts are the smallest and least expensive option, and they also have the lowest power requirements. These forklifts remain the leading type of forklift procured by warehouses and industrial site managers, representing approximately 47% of annual Class 1-3 forklift sales in the United States during 2015.

Chart 2 Electric Forklift Shipments by Class, United States: 1995-2015



(Source: Industrial Truck Association)

Historical forklift sales are cyclical based on the state of the economy and the lifespan of forklift equipment assets. In North America, the forklift market suffered a drop in sales due to the financial crisis of 2008. However, the forklift market has shown steady growth since 2010, as illustrated by the shipment data provided by the ITA in Chart 2. Note that while the ITA only reports on shipments from its member companies, it represents over 90% of the forklift manufacturers in the United States and Canada.

As the forklift market continues to evolve, it is vital that companies evaluate their operations and seek out customizable solutions to support specific applications and improve facility infrastructure and best practices. Acquiring the correct equipment will considerably improve operations efficiency and eliminate lengthy decision-making processes, enabling managers to spend more time and resources on other aspects of business. Within the forklift truck market, there is value in identifying customizable assets to fit a warehouse's processes. Customizable technology options allow forklifts to provide the necessary tools and support needed to respond quickly to change, manage the fleet throughout lifecycle operations, and expand business opportunities.

2.1.1 Market Drivers

Conventional lead-acid batteries (with a lead dioxide cathode and lead metal anode) are the leading powertrain for electric materials handling vehicles. Although lead-acid batteries have a well-established supply chain and a low initial cost per battery relative to other battery types, they are limited in their performance parameters. Their shortcomings in performance result in higher operations and maintenance (O&M) costs over the lifetime of the battery cells. Some characteristic traits of conventional lead-acid batteries are listed in Table 3.

Table 3 Lead-Acid Battery Characteristics

Metric	Traditional Lead-Acid Battery
Energy Density	25-45 Wh/kg
Efficiency	50%-75%
Discharge Time	4-8 hours
Cycle Life	500-1,000

(Source: Navigant Research)

Additionally, as a lead-acid battery's state of charge (SOC) drops, performance suffers due to the high power requirements for heavy lifting applications while in use. Full discharges result in increased strain on battery cells, furthering the need for additional units across shifts.

Achieving higher levels of productivity and overcoming bottlenecks/disruptions are standard issues that companies that procure forklifts face. Speed and responsiveness are key indicators of how successful they will be in the marketplace, and advanced electric technology options provide the best way to improve on these metrics. Below are key issues that can be addressed with new electric forklift powertrains:

- Long and/or multiple shift operations call for two to three lead-acid batteries per vehicle—one in operation, one recharging, and perhaps another cooling after recharging—resulting in a higher total cost of operations relative to other advanced electric technologies.
- Lead-acid batteries perform poorly in cold warehouse temperature operations.
- Lead-acid battery charging stations and battery swapping equipment take up valuable warehouse space.
- Some companies are transitioning to electric-drive forklift trucks to reduce their overall carbon footprint.

Although innovation in the materials handling industry has been historically flat—largely due to a lack of resources—there is a trend of increased consolidation as smaller companies combine to form larger organizations. Subsequently, these larger companies can gain more capital and move faster in adopting advanced technologies. Today's evolving supply chain service market is heavily driven by technology, and adopting new powertrain options for materials handling equipment can contribute to improved efficiency and less downtime.

2.1.2 Market Barriers

Upfront costs are the biggest obstacle facing new electric technologies in the forklift market. Current lead-acid batteries have price points of $200-$250 per kWh, with conventional charging apparatuses costing around $2,000. These prices are likely to remain flat due to the well-established distribution chain that lead-acid batteries have in the materials handling market. Compounded by the fact that the forklift industry has traditionally been risk averse, alternative technology options must prove that they are able to compete in cost over the lifespan of the vehicle powertrain.

There are technology options that can currently compete with lead-acid batteries in cost over their lifespans, but many companies are unable to address internal accounting challenges to demonstrate overall total cost of operations savings. For example, the person in charge of the budget for procuring new technology is often not the same person that is in charge of the budget for O&M activities. This presents a departmental budget problem that companies must address to accurately evaluate the cost of new forklift powertrain technologies. To help solve the cost issue, leasing rather than purchasing outright could be a way that companies can test and evaluate new powertrain technologies to see how they affect operations. Approximately half of all forklifts currently in use in warehouses across North America are leased from a third-party vendor. Thus, switching from one forklift powertrain technology to another after the leasing period expires could be accomplished without adversely affecting business.

A lack of innovation in the way that forklifts are manufactured is also preventing new technology penetration. Materials handling OEMs design machinery to fit lead-acid batteries exclusively, making it more difficult for battery manufacturers to develop alternative plug-and-play powertrain designs. This presents issues of sustaining the right power level throughout operations and chassis counterbalancing. Forklifts are designed to lift and carry significant weight (anywhere between 3,000 lbs and 20,000 lbs depending on the vehicle class), and utilizing the significant weight of a lead-acid battery is the standard way of stabilizing the chassis during operation.

2.2 Advanced Technology Options for Electric Forklifts

Traditional lead-acid batteries have a well-established supply chain, and therefore are anticipated to play a significant role in the electric-powered forklift market in North America for years to come. This section explores three alternative electric powertrain technologies that can be used in Class 1, Class 2, and Class 3 forklifts.

Table 4 gives a brief overview of the primary advantages and disadvantages of the alternative electric technologies discussed.

Table 4 Comparison of Technology Types

Technology Type	Advantages	Disadvantages	Value Proposition	Market Status
Advanced Lead-Acid	Can be efficiently fast charged without suffering lifespan losses Operates effectively in a partial SOC	New to market and not well understood in the sector Environmental risk of corrosive chemicals	Infrastructure is similar to traditional lead-acid Decreased forklift downtime	Immature technology
Li-Ion	Higher energy density than lead-acid Rapidly decreasing costs	Higher cost per battery than traditional lead-acid Has not gained much traction in sector yet	Decreased forklift downtime Fewer batteries per truck	Early commercial stage
Fuel Cells	Increased runtime and quick refueling times No operational degradation	High capital expenditures Unproven durability and variability of hydrogen fuel	Increased operational efficiency Decreased forklift downtime	Early commercial stage

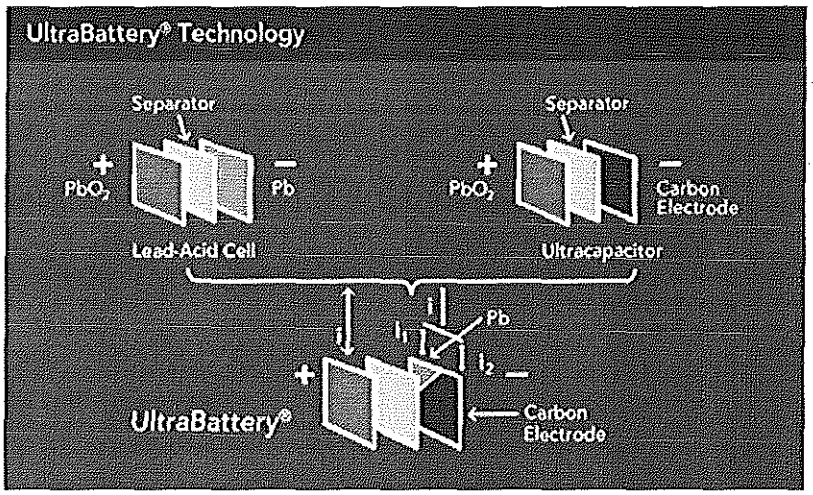
(Source: Navigant Research)

2.2.1 Advanced Lead-Acid Batteries

Advanced lead-acid batteries offer improved discharge capabilities and increased cycle life over traditional lead-acid batteries. The lead-acid chemistry has remained the battery of choice for applications such as uninterruptable power supply and utility vehicles. However, its narrow depth of discharge (DOD) makes it less than ideal for applications that require frequent cycling and rapid charge/discharge.

Perhaps the most popular option in the advanced lead-acid battery arena is the UltraBattery, which combines the energy storage potential of a lead-acid battery with the high charge potential of an ultracapacitor. The cathode uses lead dioxide as the principal material and utilizes a carbon-doped metal to increase discharge time and DOD. An illustration of the makeup of an UltraBattery is provided in Figure 1.

Figure 1 Construction of the UltraBattery



(Source: UltraBattery)

The UltraBattery has a number of advantages over traditional lead-acid batteries:

- The battery has an improved cycle life of 1,000 cycles at 80%-85% DOD.
- It exhibits efficient operation on a partial SOC.
- The UltraBattery has a low hydrogen gassing rate and is not as prone to sulfonation (accumulation of lead sulfate crystals on the anode leading to high internal resistance).
- It can maintain its lifespan when subjected to fast charging, reducing charge times by up to 75%.

Charging infrastructure is largely the same for advanced lead-acid and traditional lead-acid batteries, so from a technical perspective, it may be relatively easy to adapt the UltraBattery to the materials handling industry. UltraBatteries can also be fabricated in existing lead-acid battery factories, making it easy for traditional players to enter the space. Yet, these batteries face various challenges in the industry:

- The UltraBattery represents an emerging technology with limited use in the materials handling industry. It will have to see more adoption among traditional lead-acid players to make headway in the sector.
- The battery's electrolyte is made of corrosive acid, presenting safety and environmental hazards if not handled properly.
- There are a limited number of suppliers of this technology, and few are focused on the materials handling sector.

2.2.2 Li-Ion Batteries

Li-ion batteries have perhaps the largest opportunity to penetrate the Class 1, Class 2, and Class 3 forklift market over the next several years. These batteries are now produced in mass quantities, are much further along the experience curve relative to other electric technologies, and are a flexible option when considering different types of applications.

Li-ion batteries operate by way of lithium ion intercalation between the anode and cathode. The market consists of many different cathode variances classified into subchemistries, but the predominant options are lithium iron phosphate and lithium manganese oxide spinel. Both of these subchemistries are optimized to fit high power or high energy applications and thus can be utilized in a wide variety of applications. The anode is fabricated most often from graphite and is separated from the cathode by a liquid or solid electrolyte. The cells are constructed in a cylindrical, prismatic, or pouch format, allowing for efficient packing into larger battery assemblies.

Compared to traditional lead-acid batteries, Li-ion batteries can offer a number of operational advantages for forklifts:

- Li-ion cells are built for deep-cycle applications and are less subject to cell degredation over time, lasting on average for 1,200-2,000 full cycles (7-10 years depending on the operation).
- Only one battery is needed per truck, eliminating the need for battery swapping equipment and large charging infrastructure and curbing excessive O&M costs.
- Li-ion batteries have a significant runtime advantage (greater than 30%) over lead-acid batteries in cold temperatures (less than 0°C), making them a better fit for warehouses handling perishible items.
- Li-ion batteries do not run hot when in use, aiding in increasing lifespan and making them safer and less subject to thermal runaway under energy-intensive operations.
- Li-ion is a better chemistry for fast charging and can increase productivity over an 8-hour span when utilizing strategic charging techniques during worker breaks (i.e., opportunity charging).

In order to compete in the electric forklift market, the batteries must increase productivity around the clock and decrease overall costs of operations. Leasing forklifts that utilize these batteries could be an initial way for warehouses to determine whether a Li-ion powertrain can positively affect operations. Over the past several years, Li-ion batteries have steadily declined in cost, and Navigant Research estimates that this trend will continue over the next 5-10 years. Yet, there are several challenges that Li-ion batteries face in the materials handling market:

- High upfront cost per kilowatt-hour compared to lead-acid batteries can discourage warehouse budget managers from the initial purchase. Electric forklifts have a complex go-to-market channel; companies that procure forklifts for their warehouse operations need to have a vested interest in decreasing costs over a 7- to 10-year period.
- Lead-acid batteries and Li-ion batteries cycle differently. This means that plug-and-play Li-ion batteries must be compatible with telematics in the forklift and be able to adjust to the power duties of heavy lifting requirements experienced throughout operations.

- Infrastructural inertia must occur in the sector. Lead-acid batteries occupy such a large portion of the current market that it could be difficult for immature technologies to have a noteworthy market share.

2.2.3 Fuel Cells

Fuel cells used for motive applications have often been viewed as an expensive science experiment, but they offer a cost-competitive power delivery system in the materials handling industry. Electrically powered vehicles make up roughly half of all sales in the Class 1, Class 2, and Class 3 forklift industry in North America, according to the ITA, and many companies are exploring the use of fuel cells for these applications. Fuel cells are expected to continue to decrease in price as more OEMs adopt them.

Fuel cells run much like a battery, but instead of the fuel being contained within the cell, it is held outside of the cell. The leading type of fuel cell technology used for motive applications is the proton exchange membrane fuel cell (PEMFC). PEMFCs oxidize hydrogen at the anode (the fuel) and reduce oxygen at the cathode (from air) to produce an electrical charge, forming water and heat as byproducts.

The business case for utilizing fuel cells in electric forklifts largely arises from productivity gains. Some benefits include those listed below:

- Compared to charging conventional lead-acid batteries 2-3 times per day, forklifts equipped with fuel cell stacks can run up to 3 times longer and have refueling times of only 3-4 minutes.
- PEMFC stacks can be used as range extenders in conjunction with a battery, enabling constant operation over multiple shifts and quick refueling times and eliminating the need for battery swapping.
- There is little to no drop in power across the duty cycle when using fuel cells while working across shifts, which enables drivers to perform more lifts much quicker and allows for faster traverses.
- PEMFCs can potentially reduce fuel/electricity costs by lowering peak power needs, reducing the amount of high-priced peak power electricity consumed by the warehouse.

Warehouse owners and operators believe that leasing and having fuel cells available from OEMs rather than forcing manufacturers to purchase stacks from aftermarket suppliers will drive further interest in the technology. Conversely, there are a number of market barriers facing the increased adoption of fuel cells:

- Fuel cell stacks can cost anywhere from $14,000 to $30,000 per system (depending on the power capabilities). A company seeking to adopt them must be committed to supporting maintenance and infrastructure over the lifespan on the system to see a viable return on investment.
- PEMFCs are best suited for companies with medium- to large-sized fleets (30 or more units) and heavy duty operations of high weight/multiple shifts. Installing refueling stations in or around a warehouse costs roughly $100,000 today, and hydrogen fuel costs currently hover around $8 per kg. A site would typically need around 50 kg of hydrogen fuel per day to fuel 30 Class 3 vehicles.

- Reports of fuel variability (not enough fuel synthesized by hydrogen fuel companies to satisfy market demands) could be a major setback for warehouses. If hydrogen fuel is not readily available when needed, operations could be affecting, resulting in a severe loss of revenue.

Since hydrogen infrastructure is relatively nascent to the forklift industry, hydrogen gas distributers are continuing to engage with the materials handling market to provide solutions. There is also a secondary issue relating to siting of the hydrogen storage and dispenser needed to refuel fuel cells. Industrial gas companies are offering trucked-in hydrogen, which is then stored and dispensed onsite. Some smaller independent companies generate hydrogen onsite that must then be stored and dispensed. These storage facilities are situated outside of the operations facility to comply with safety codes, and the hydrogen is piped in for fueling indoors.

It is also important to note the Investment Tax Credit (ITC) that fuel cell modules receive in the North American forklift industry. An 8-year extension of the Emergency Economic Stabilization Act of 2008 (which included the ITC) was approved in 2008, and it was intended to accelerate the full-scale commercialization of fuel cell technologies. Companies can benefit from a credit of 30% of the purchase price (up to $3,000/kW) for procuring fuel cell technologies in their vehicle fleets. Other considerations are that the vehicle must have a minimum capacity of 0.5 kW and an electric-only efficiency of greater than 30%. The ITC entitles the taxpayer to subtract the dollar-for-dollar credit from total federal tax liability. This tax credit is valid until December 31, 2016.

Table 5 compares the total costs of operations for Class 1 and Class 2 forklifts, accounting for the upfront cost (including the ITC), O&M, power packs, and infrastructural/labor costs of recharging/refueling in the annual cost of operations calculation. These costs are calculated assuming that materials handling operations are ongoing, with equipment replacements made on a routine basis. This analysis does not include potential revenue gains for added productivity. Additionally, Class 2 forklifts are higher in cost than Class 1, but the 5- to 10-year total costs of operations are likely to be similar.

Table 5 10 kWh Class 1 and Class 2 Forklift Total Cost of Operations Comparison

Parameter	Fuel Cell-Powered	Lead-Acid Battery
Annual Cost of Ownership	$17,800	$19,700
System Maintenance	$2,200	$3,600
Labor Costs	$800	$4,400
Refueling Infrastructure	$500	$1,900
Fuel Cycle Greenhouse Gas Emissions	800 g/kWh	1,200 g/kWh
Total Fuel Cycle Energy Use	-12,000 BTU/kWh	>14,000 BTU/kWh
Estimated Product Life	8-10 years	4-5 years

(Sources: U.S. Department of Energy, National Renewable Energy Lab)

2.3 Key Industry Players

2.3.1 AeroVironment

Simi Valley, California-based AeroVironment is one of the longest tenured companies serving the electric vehicle (EV) charging industry. Founded in 1971, the publicly traded company offers fast charging and battery solutions for the industrial fleet market and provides proprietary chargers based on its PosiCharge

technology for industrial vehicle charging. The company recently introduced the ProCore Series, its intelligent charging family that supports and charges any materials handling battery chemistry. AeroVironment makes fast charging units for single or double shift operations and for indoor or outdoor use. The company is a leader in the fast charging forklift battery market and reports that it has sold over 18,500 chargers, servicing over 30,000 materials handling vehicles. Other PosiCharge solutions include the PosiNet Systems and Battery Rx fleet management software tools and fuel meter/e-meter assessments, which provide fleet managers with real-time fuel and battery usage data.

2.3.2 Aker Wade Power Technologies

Charlottesville, Virginia-based Aker Wade Power Technologies designs and manufactures advanced fast charging systems for EVs and industrial forklifts. Founded in 2000, the company's primary market is fast charging lead-acid batteries for industrial forklifts. Aker Wade is collaborating with battery companies, infrastructure suppliers, and EV manufacturers to deliver advanced direct current (DC) fast charging solutions for the coming generation of battery EVs. Companies that Aker Wade is working with include EnerSys, A123 Systems, ChargePoint, and Tokyo Electric Power Company. In the North American electric forklift market, Aker Wade products are distributed by industrial battery manufacturer EnerSys. EnerSys offers Aker Wade's fast chargers as part of its line of express fast charge solutions for the materials handling market. Aker Wade reports that it has supplied more than 14,000 DC fast chargers in North America, Europe, Latin America, and Asia.

2.3.3 Crown Equipment

New Bremen, Ohio-based Crown Equipment produces electric-powered forklifts, as well as automation and fleet management technologies, for the materials handling market. As of 2015, it was ranked the fifth top supplier in the global materials handling market based on revenue, according to industry publication *Modern Materials Handling*. With 17 manufacturing facilities worldwide and more than 500 retail locations in 84 countries, Crown has an extensive global production, sales, and service network. The company was one of the early players in promoting fuel cells for forklifts, indicating that it is willing to take a leading role in this new technology option for the materials handling sector. Crown uses a vertical integration strategy to unify 17 global manufacturing facilities, which enables the company to design and manufacture up to 85% of the components used in its forklifts. This strategy will allow the company to offer its electric-powered forklifts at a lower price than other companies that procure parts from several other suppliers.

2.3.4 Hyster-Yale

Cleveland, Ohio-based Hyster-Yale Materials Handling is a global designer, engineer, manufacturer, seller, and servicer of electric, warehousing, and ICE forklift trucks and aftermarket parts. As of December 2014, the company was one of top three world leaders in the forklift industry, with 825,000 forklifts in operation worldwide. Although the company's current and principal focus is battery-powered forklifts (traditionally for lead-acid, but more recently Li-ion retrofits), Hyster-Yale made headlines with its acquisition of fuel cell manufacturer Nuvera in late 2014. The company has said that it intends to commercialize Nuvera's research and technology through rapid integration of its fuel cell modules across Hyster-Yale's forklift products. Its purchase of Nuvera is a strategic acquisition to expand Hyster-Yale's reach in the forklift market, even though the company is expected to accrue operating losses in the next 1-2 years.

2.3.5 Navitas Systems

Woodbridge, Illinois-based Navitas is a leader in the integrated design, technology development, and manufacturing of Li-ion batteries, providing solutions and energy storage products for commercial, industrial, and government agency customers. The company arose from the consolidation of MicroSun Innovative Energy Storage Solutions, MicroSun Electronics, and A123 Systems' Government Solutions Group.

In late 2015, Navitas announced that it was the first battery company to have developed a series of heavy duty Li-ion batteries for Class 1 and Class 2 forklifts. Known as the Starlifter, this battery system spans voltages from 36V to 80V and energy capacities of 10 kWh-30 kWh. The Starlifter pack features a proprietary cell balancing feature that distributes power evenly between cells within the pack, optimizing its performance without the weakest cell diminishing the overall performance. It reportedly lasts up to 10 years depending on the duty cycle and no maintenance is required for the life of the pack.

2.3.6 Plug Power

Latham, New York-based Plug Power is a leading developer of fuel cells for industrial vehicles. The company has carved a first-mover advantage for itself in the North American market. Plug Power sells its GenDrive fuel cell systems for Class 1, Class 2, and Class 3 forklifts in high-throughput materials handling applications. The company has partnered with multiple OEMs, including Crown, Hyster-Yale, and Raymond. Plug Power has shipped more than 6,500 units (accumulating more than 100 million hours of runtime) to more than 20 customers, including some of the largest distributors in North America, such as Kroger, Procter & Gamble, Sysco, and Walmart. The company also recently unveiled its GenDrive 3340 fuel cell unit, the next-generation GenDrive Series 3000 product for pallet jack electric forklift trucks.

2.3.7 Raymond Corp.

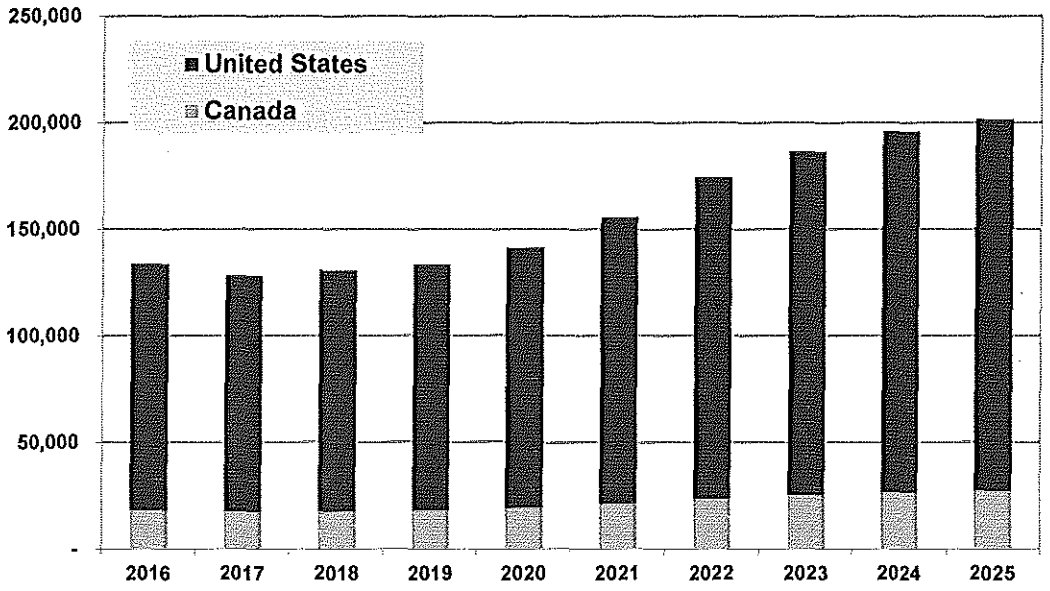
Raymond Corp. is a part of Toyota Industries Corp., which was the No. 1 industrial forklift truck supplier in the world in 2015, according to *Modern Materials Handling.* Based in Greene, New York, Raymond manufactures forklifts and designs end-to-end solutions to improve warehouse operations. The company has been one of the leading electric forklift companies looking at alternatives to conventional batteries. Raymond is committed to the R&D of the application of fuel cells to battery-powered forklift trucks.

3. Market Forecasts

This section forecasts the projected penetration of electric powertrains in forklifts by technology. Navigant Research envisions that conventional lead-acid batteries will retain ownership of around 75%-80% of the Class 1, Class 2, and Class 3 forklift markets in 2025 despite the potential of other technologies to reach lower total cost of operations benefits in the multi-shift operations and cold storage materials handling sectors. It is important to note that lead-acid batteries and advanced lead-acid batteries require similar infrastructure and maintenance procedures within the warehouse setting. Still, lead-acid batteries are expected to remain the leading electric option for forklifts throughout the forecast period.

While prices of advanced lead-acid and Li-ion batteries (collectively referred to as advanced batteries herein) and hydrogen fuel cells are expected to decrease throughout the forecast period, the overall percentage of market share for these technologies is anticipated to remain flat. Chart 3 shows the projected total sales for all Class 1-3 electric forklifts in North America by country, including traditional lead-acid batteries.

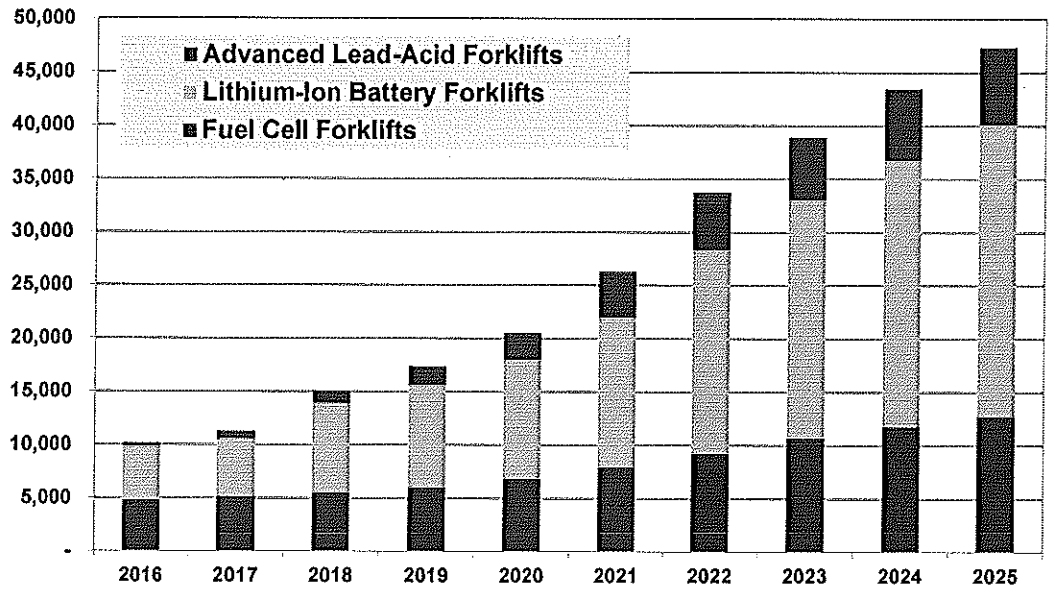
Chart 3 Electric Forklift Sales by Country, North America: 2016-2025



(Source: Navigant Research)

Chart 4 highlights the anticipated market projections for the North American electric forklift market from 2016 to 2025 by electric drivetrain technology, not including traditional lead-acid batteries.

Chart 4 Advanced Electric Forklift Sales by Technology, North America: 2016-2025



(Source: Navigant Research)

The adoption of advanced lead-acid and Li-ion batteries is expected to increase incrementally in North America throughout the next 10 years. Navigant Research expects advanced lead-acid batteries to account for approximately 2.6% of the North American electric forklift market (excluding traditional lead-acid forklifts) in 2016. Li-ion batteries are projected to capture around 50.0% of the market. Combined, Navigant Research expects the market share of the two technologies to increase to over 73% by 2025. The value of fast charging compounded with the expiration of the ITC at the end of 2016 is expected to open up the market for current manufacturers of advanced battery technology and expand their presence in the North American forklift market. An estimated 20%-25% of the market for electric forklifts involves 24/7 operations and/or cold temperature operations, special segments where advanced batteries will likely see the largest adoption. New powertrain technologies have the potential to decrease in cost in this portion of the market, as well as expand to capture a larger portion of the electric forklift sector over the next 5-10 years.

Fuel cell models are projected to account for approximately 47.4% of unit sales in the North American electric forklift market (excluding traditional lead-acid forklifts) in 2016. Overall growth for fuel cell electric forklifts is projected to increase at a steady rate, but this technology is poised to lose its ITC at the end of 2016. With the loss of this credit, warehouses will no longer be incented to procure fuel cell technology, and shipments of these systems are expected to drop as a result. In addition, few companies are currently venturing into the fuel cell electric forklift market. Plug Power has been the leading provider for fuel cell powertrains in materials handling equipment.

4. Conclusions and Recommendations

Opportunities in North America for the incorporation of advanced electric technologies in Class 1, Class 2, and Class 3 forklifts lie in the 20%-25% of the forklift market focused on multiple shift operations and cold storage warehouses. Conventional lead-acid batteries are expected to remain popular in the North American forklift market in the near future because of a well-established supply chain and the conservative nature of the forklift sector. Supported by low first-cost materials, robust recycling processes, mature manufacturing operations, and supply chains, lead-acid batteries will continue to provide consistent support to the materials handling industry.

Important advantages of both advanced lead-acid and Li-ion batteries include longer cycle lives than traditional lead-acid batteries and the fact that both can be quickly charged without compromising the lifespan of cells. The main barrier that both advanced lead-acid batteries and Li-ion batteries must overcome in this sector is upfront cost. Both battery types are more expensive per kilowatt-hour than traditional lead-acid batteries and therefore must show that they are able to compete in cost over their lifespan.

Key solutions that fuel cells provide in this market include quick refueling times, longer durations of operations throughout shifts, and no power drops during operations. Conversely, fuel cells face learning curves and pose their own unique infrastructural requirements in the industry. As these technologies move further along the experience curve in this sector, they will be looked to as viable power options that can increase business and warehouse productivity over lead-acid and ICE powertrains.

With forklift OEMs and warehouse owners becoming more conscious of ways to reduce capital and operating costs and increase productivity, advanced lead-acid batteries, Li-ion batteries, and fuel cells are expected to see increased demand in the materials handling field in the next decade. Warehouse owners and operators looking to introduce their technologies to this market should keep the following factors in mind:

- The materials handling industry is anticipated to increase the adoption of electric forklifts (compared to ICE forklifts), but other niche technologies may also provide competition for electric alternatives. Several companies have explored using other alternative fuel powertrains. OEMs of the technologies discussed in this report will expect a warehouse owner to demonstrate the applicability of new electric technologies to forklift operations before venturing into this market.
- The advanced technology options discussed in this report offer an improved total cost of operations because they remove the need for multiple batteries for one truck, storage space for those batteries, large charging stations, and battery swapping machinery.
- Leasing new technology may be a cost-effective option for warehouses that are interested in realizing potential gains in around-the-clock productivity but do not want to purchase new equipment outright. Leasing can reduce the upfront cost hurdle and improve total cost of operations benefits.

- Companies looking to procure forklifts must develop communications methods within internal accounting departments (sectors in charge of capital cost must work with those in charge of O&M budget) to assess the total cost of operations for new forklift powertrain technologies.
- Plug-and-play technology options could be an easy way for warehouses to adopt electric alternatives discussed in this report in their forklift fleet. Doing so could reduce sunk costs in an existing lead-acid infrastructure.

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Exhibit No.:	
Issue(s):	EV Charging Station Policy
Witness/Type of Exhibit:	Marke/Rebuttal
Sponsoring Party:	Public Counsel
Case No.:	ET-2016-0246

REBUTTAL TESTIMONY

OF

GEOFF MARKE

Submitted on Behalf of
the Office of the Public Counsel

**UNION ELECTRIC COMPANY D/B/A
AMEREN MISSOURI'S**

Case No. ET-2016-0246

November 29, 2016

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 a Tariff Setting a Rate for Electric Vehicle Charging Stations.	))))	Case No. ET-2016-0246

AFFIDAVIT OF GEOFF MARKE

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Geoff Marke, of lawful age and being first duly sworn, deposes and states:

1. My name is Geoff Marke. I am a Regulatory Economist for the Office of the Public Counsel.

2. Attached hereto and made a part hereof for all purposes is my rebuttal testimony.

3. I hereby swear and affirm that my statements contained in the attached testimony are true and correct to the best of my knowledge and belief.

Geoff Marke

Subscribed and sworn to me this 29th day of November 2016.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

JERENE A. BUCKMAN
My Commission Expires
August 23, 2017
Cole County
Commission #13754037

Jerene A. Buckman
Notary Public

My Commission expires August 23, 2017.

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REBUTTAL TESTIMONY

OF

GEOFF MARKE

UNION ELECTRIC COMPANY

d/b/a Ameren Missouri

CASE NO. ET-2016-0246

I. INTRODUCTION

Q. Please state your name, title and business address.

A. Geoff Marke, PhD, Economist, Office of the Public Counsel (OPC or Public Counsel), P.O. Box 2230, Jefferson City, Missouri 65102.

Q. By whom are you employed and in what capacity?

A. I am employed by the OPC as a Regulatory Economist.

Q. Please describe your education and employment background.

A. I received a Bachelor of Arts Degree in English from The Citadel, a Masters of Arts Degree in English from The University of Missouri, St. Louis, and a Doctorate of Philosophy in Public Policy Analysis from Saint Louis University ("SLU"). At SLU, I served as a graduate assistant where I taught undergraduate and graduate course work in urban policy and public finance. I also conducted mixed-method research in transportation policy, economic development and emergency management.

I have been in my present position with OPC since April of 2014 where I have been responsible for economic analysis and policy research in electric, gas and water utility operations. Prior to joining OPC, I was employed by the Missouri Public Service Commission as a Utility Policy Analyst II in the Energy Resource Analysis Section, Energy Unit, Utility Operations Department, Regulatory Review Division. My primary duties were reviewing, analyzing and writing recommendations concerning integrated resource planning, renewable energy standards, and demand-side management programs for all investor-owned electric

utilities in Missouri. I have also worked for the Missouri Department of Natural Resources (later transferred to the Department of Economic Development), Energy Division as a Planner III and was the lead policy analyst on electric cases. My private sector work includes Lead Researcher for Funston Advisory in Detroit, Michigan, where I did a variety of specialized consulting engagements for both private and public entities.

Q. Have you been a member of, or participate in, any work groups, committees, or other groups that have addressed electric utility regulation and policy issues?

A. Yes. I am currently a member of the National Association of State Consumer Advocates (NASUCA) Distributed Energy Resource Committee which shares information and establishes policies regarding energy efficiency, renewable generation, and distributed generation, and considers best practices for the development of cost-effective programs that promote fairness and value for all consumers. I am also a member of NASUCA's Electricity Committee and NASCUA's Water Committee which are tasked with analyzing current issues affecting residential consumers.

Q. Have you testified previously before the Missouri Public Service Commission?

A. Yes. A listing of the cases in which I have previously filed testimony and/or comments before this commission is attached in GM-1.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of this rebuttal testimony is to respond to the direct testimony of Ameren Missouri's witness Mark J. Nealon regarding Ameren Missouri's request for approval of a tariff setting a rate for electric vehicle ("EV") charging stations.

Q. Please provide an overall summary of Ameren Missouri's justification for treating this project as a regulated service as opposed to a non-regulated affiliate.

A. While not prepared to claim that long-distance EV charging is an "essential service," Ameren Missouri believes that in the absence of free market activity it has the obligation to provide long-distance EV charging services as a regulated offering and that the situation is analogous to public area lighting.

Q. Please provide an overall summary of Ameren Missouri's proposal.

A. Ameren Missouri is seeking to build six EV "charging islands" each of which will feature charging stations available to the public for a price. The proposal is for each site to include a direct current fast-charging ("DCFC") station priced at $10.00 per hour and a standard level 2 alternating current ("AC") station priced at $1.20 per hour. The Company intends to include the cost of these projects in its rate base and paid for by all ratepayers. In effect, ratepayers will be subsidizing the cost of the Company's experimental project that will benefit the small group of people who have chosen to purchase electric vehicles. The stations will be deployed at undetermined locations along the I-70 corridor as well as at a Jefferson City location. Ameren Missouri expects to spend approximately $10,000 in total marketing the six stations during the three-year "pilot project" (or $30,000 over the fifteen-year period).

Ameren Missouri lists a variety of assumed societal benefits as justification for why ratepayers should subsidize the experimental program including emission reductions, economic development, efficient grid utilization, and greater energy security.

Ameren Missouri's main argument is articulated by Mr. Nealon as follows:

> Put another way, in the absence of any action being taken to deploy public charging means, along medium and long-distance driving routes in particular, the infrastructure barriers to consumer adoption of EV will remain despite the last of the vehicle barriers having been removed.

> The longer this kind of vehicle choice is constrained, the longer the associated societal benefits are forestalled. So, rather than wait for the full emergence, Ameren Missouri believes we should be on the front end of the EV breakthrough, with infrastructure in place not just to accommodate, but to foster, its growth.[1]

To his credit, Mr. Nealon is forthright in stating that Ameren Missouri does not believe the expected revenues from the six proposed charging stations will cover the costs of the pilot project, but offers that:

> any subsidy provided by Non-Participating Customers will be very modest. . . . According to the UCT ["Utility Cost Test"] model, the total non-NPV ["net present value"] valuation of this subsidy accumulated over this period of time is approximately $475,000, requiring an average 11.3 cents annually from each residential Non-Participating Customer for those four years.[2]

To reach the Company's cost estimates requires reliance on certain assumptions. Ameren Missouri claims that these six charging stations will ease range anxiety *and* induce adoption of an additional 7,050 EVs (full credit for 25% of the projected EV-modified hybrid adoption curve) in its service territory as a direct result of the presence of these stations over the next fifteen years. It will be the revenue generated at the six stations over the life of those assets *and* the revenues captured at home, from residential charging, from the 7,050 Ameren Missouri induced EV's that cost justifies the pilot program under the UCT calculations at 1.42 if the pilot programs assumptions are extended over a fifteen-year period. However, the same project and assumptions were not deemed to be cost effective under the total resource cost ("TRC") test at 0.80.

[1] Direct Testimony of Mark J. Nealon, p. 7, 6-13.
[2] Direct Testimony of Mark J. Nealon, p. 25, 2-3 & 17-20.

Q. What are your recommendations?

A. The Commission should reject Ameren Missouri's request. Both ratepayers and drivers are best served by a competitive market for charging services rather than a regulated monopoly. There is no reason why Missouri cannot have a competitive market in EV charging and Ameren Missouri (and other investor-owned utilities "IOUs") *non-regulated* services should be allowed to participate in that market.

OPC believes that Ameren Missouri's *regulated* services can best enable the promotion of EV adoption and by offering well-formed, time-of-use (TOU) rates on an opt-in basis that encourages charging during low-cost, off-peak hours. At this initial stage, this can best be promoted by educating customers and vehicle dealers on the value proposition of current and future rates. As it stands, Ameren Missouri's proposed costs to be recovered "above the line" do not justify the espoused benefits, especially if those benefits are gained through the creation of barriers to entry from competition for a non-essential service. The deployment of EV charging infrastructure should be left to its non-regulated services (if Ameren Missouri elects to participate) and to free market competition.

Both Ameren Missouri and free market EV charging stations *can* and *should* provide a symbiotic force for ratepayers and consumers alike moving forward assuming vehicle choice and technological advances favor this path. If Ameren Missouri is to be believed, that serious penetration of EVs is just around the horizon as range anxiety is eased by longer battery life and reduced automobile costs, then demand should increase and the market will respond accordingly with both EV cars and EV charging stations as appropriate. Under this favorable scenario, the risks of stranded assets are eliminated and consumers, Ameren Missouri, and the economy as a whole benefit from fair, efficient competition.

Mr. Nealon's testimony addresses a number of economic, environmental and policy justifications for Ameren Missouri's proposal to provide rate based treatment for its proposed

EV charging stations. This rebuttal testimony will address each of those points in turn as well as provide additional comments for the Commission's consideration.

II. ANTI-COMPETIVE ENVIRONMENT

Q. Is Ameren Missouri's EV charging station proposal analogous to public area lighting?

A. No. Public area lighting (whether owned outright by a governmental entity or Ameren Missouri) is paid through public tax dollars and is generally considered a classic "public good" because it is non-rivalrous and non-excludable. ExxonMobile, BP, Spire's natural gas stations, ChargePoint, EVgo, etc. are all entities that are operating in a competitive market for a finite amount of customers. I am unaware of any such competition for public area street lighting.

Q. What is Mr. Nealon's argument regarding utilities providing a single point of electric service to Utility Customers' premises?

A. Mr. Nealon opines that an EV functions as a modern-day mobile premise where:

> Inhabitants are sheltered from the environment, are heated and cooled, and can work, play, eat and/or sleep. Today modern technology has introduced a new kind of premises—a "mobile premises"—occupied by a new kind of customer—a "mobile customer"—wherein they are sheltered from the environment, are heated and cooled, and can work, play, eat, and/or sleep, for the period of time they are transversing the service territory. Like the traditional structural premises, this new "mobile" premises also requires a single point of electric service—the charging port—in order for it to serve its intended purpose.[3]

[3] Direct Testimony of Mark J. Nealon p. 13, 19-23 & p. 14, 1-3.

Q. Do you agree?

A. No. I would offer up the observation that the Commission has not felt the need to regulate the resale of water from Anheuser Busch or Coca-Cola. Both entities repackage and resell water as part of their respective products even though that water service was obtained from a single point supplied through Missouri American Water—a faucet—in order for it to serve its intended purpose. Certainly, the currently operating EV charging stations run by competitive private firms would be adversely impacted if the Commission were to determine that charging stations should function as an extension of a regulated utilities service.

Q. Is there a problem with providing a guaranteed rate of return on nonessential, competitive services?

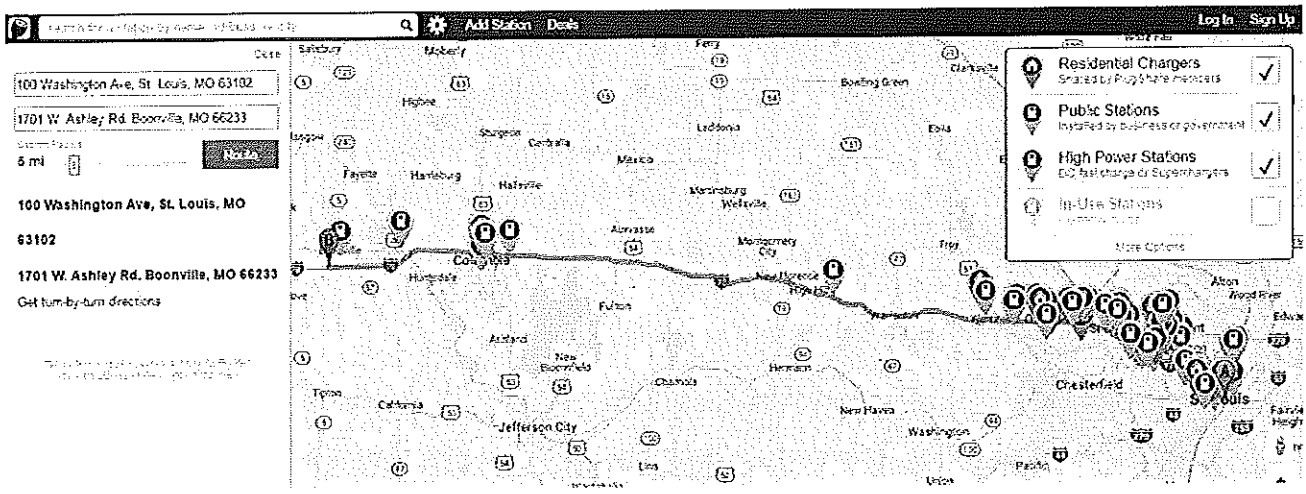
A. Yes. By placing the charging stations into rate base, utilities receive a guaranteed rate of return on an investment. This is problematic for services that can be considered both nonessential and/or in which a competitive market already exists as it effectively creates a regulatory barrier for new entries, unfairly punishes existing competition, and shifts risk from utility shareholders to ratepayers. Instead of promoting growth, an insulated regulated monopoly can undermine competition which may reduce efficiency.

Ameren Missouri is not proposing to rate base thousands of charging stations in more densely populated urban and suburban areas. Instead, Ameren Missouri argues that no private entity has serviced the I-70 corridor and that installing six charging islands represents a financially small inequitable impact on nonparticipating ratepayers. However, regulatory treatment of a nonessential, competitive service raises policy concerns. The concern with any utility treating these types of assets "above the line" as opposed to "below the line" is that the shift in risk from shareholder to ratepayer is not warranted and comes at the expense of market efficiencies.

Q. Are there any EV charging stations throughout the I-70 corridor?

A. Most of the EV charging stations are presently concentrated in St. Louis and St. Charles counties with several stations listed in the Columbia, Missouri area. Figure 1 shows a screenshot of known charging stations according to the website Plugshare.com that are within a five mile radius along I-70 between Boonville and St. Louis.

Figure 1: Location of the 68 EV charging stations on I-70[4]



Q. Is there reason to believe a market could develop absent Ameren Missouri's proposal?

A. Absolutely. The stations listed on Figure 1 are evidence of that sentiment as they are a direct result of the modest uptick in EV growth in the St. Louis region. Demand for EVs will likely continue to increase if battery capacity increases and if the upfront cost of EVs decreases. Consequently, the supply of necessary charging station infrastructure will adjust accordingly.

Q. Will permitting Ameren Missouri to install and own EV charging stations impact other market participants?

A. Yes. Regulated utilities operate in a system that is designed, in part, to provide a level of certainty to investors based on the large sums of capital needed to finance long-term

[4] PlugShare (2016) EV Charging Station Map, St Louis to Booneville, November 26. https://www.plugshare.com/#

generation, transmission and distribution projects. EVs and the current and future state of the transportation market is one shrouded in uncertainty and outstanding questions leading to a greater level of investment risk. Investors in private EV charging stations expect to be rewarded for bearing these risks and by operating in a market in which the return on investments are not guaranteed. Introducing a regulated entity, a protective incumbent, into a competitive market creates the potential for inefficiencies as the negative consequences of any given risk are merely shifted to captive ratepayers.[5] Because risk and reward is distorted, innovation is less likely to proliferate at the local level. For example, this could be especially problematic if Missouri elects to regulate EV charging stations but surrounding states do not (e.g., Kansas). In that scenario, non-regulated EV charging station states let the free market effectively determine the appropriate demand, while Missouri is relegated to a quasi-command-and-control model that increases the likelihood of stranded assets.

Q. What do you mean by stranded assets?

A. Stranded assets are assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities. Assets can become stranded in a dynamic system when new technologies are introduced and new companies out-compete incumbents. Regulated electric utilities are also exposed to the risk of having stranded assets on their books. [6,7,8] A project that is cost-effective (from one vantage point) should also account for future cost and market considerations. Failure to account for this may result in ratepayers funding an asset that no longer operates the way it was designed to or is poorly supported by the utility because it is operating and maintaining version 2.0 while the retail market is working on version 4.0.

[5] See also, "Moral Hazard." http://www.rpieurope.org/Beesley/2010/Lecture%205%20Clare%20Spottiswoode.pdf
[6] Boyd, J. (1998). The "Regulatory Compact" and Implicit Contracts: should stranded costs be recoverable? *The Energy Journal*, 19(3), 69-83. http://www.bcuc.com/Documents/Proceedings/2012/DOC_30551_A2-12-1998%20Energy%20Journal%20Article%20%E2%80%93%20The%20Regulatory%20Compact.pdf
[7] Brennan T. & James B. (1996) Stranded costs, takings, and the law and economics of implicit contracts. *Journal of Regulatory Economics*, 11(1), 41-54. http://www.economics.jku.at/members/Buchegger/files/Juristen/brennan_1997_implicit%20contracts.pdf
[8] Baumol, W. & J. G. Sidak (1995) Stranded Costs. *Harvard Journal of Law & Public Policy*, 18, 835-849. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=283232

Q. Could you provide examples of the potential risks Ameren Missouri's EV charging stations could be exposed to?

A. Yes. First, it should be recognized that there is no guarantee that EVs will materialize at the levels predicted or displace the incumbent technology—internal combustion engines. Consumers no doubt will respond to price signals if gasoline fuel decreases, or conversely, if electric prices increase. It is also possible that new business models such as ride-sharing services like Uber or Lyft will depress overall new vehicle sales in densely populated areas. Even if everything aligns for a seamless transition into an electrified transportation sector, it is not entirely clear that "plug-in" charging stations will be the preferred venue for charging cars in the future. For example, earlier this year, plug-less (or wireless) charging was demonstrated at 20-kilowatts by the Oak Ridge National Laboratory, which is three times the rate of the plug-in systems commonly used for EVs today.[9,10]

Putting aside the potential risk that Ameren Missouri's deployed infrastructure becomes obsolete over its lifetime, it is important to consider that the very fear of "range anxiety" may already be overstated based on research published since Ameren Missouri's initially filed testimony.

For example, this past September, Idaho National Laboratory released the results of a three-year study which captured the profiles for 125 million miles of driving and 6 million charging events through partnerships with states, municipalities, electric utilities, and other stakeholders across 22 regions in the United States. The study reached the following conclusions:

> **The answer is clear: despite installation of extensive public charging infrastructure, in most of the project areas, the vast majority of charging was done at home and work**. About half the EV Project

[9] Walli, R. (2016) ORNL surges forward with 20-kilowatt wireless charging for vehicles. Oak Ridge National Laboratory. https://www.ornl.gov/news/ornl-surges-forward-20-kilowatt-wireless-charging-vehicles
[10] Qtd in. Roberts, D. (2016) Wireless charging: the key to unlocking an electric vehicle revolution. Vox. http://www.vox.com/2016/5/24/11677684/wireless-charging-electric-vehicles

> participants charged at home almost exclusively. Of those who charged away from home, the vast majority favored three or fewer away-from-home charging locations, with one or more of these locations being at work for some drivers. . . . In the end, it was apparent that exact factors that determine what makes a public charging station popular are predominantly community-specific. More research is needed to pinpoint these local factors. Nevertheless, **the projects demonstrated that a ubiquitous charging network is not needed to support PEV driving**. Instead, charging infrastructure should be focused at home, workplaces, and in public "hot spots," where demand for AC Level 2 EVSE or DCFC stations is high (emphasis added).[11]

In another study released in *Nature Energy*, a team of researchers from the Massachusetts Institute of Technology ("MIT") and the Santa Fe Institute modeled variation in vehicle trips to determine whether or not current EV battery capacity could achieve the desired trip length outcomes of U.S. drivers. That is, whether or not "range anxiety" is real or largely imagined.

The results showed that 87 percent of vehicles on the road could be replaced by a low cost EV with current battery size (assuming a 2013 Nissan Leaf battery at 19.2 kWh) even if there is no possibility to recharge during the day. The authors also concluded that if useful battery capacity were increased to 55 kWh, then 98 percent of all daily trips would be covered.[12] To offer some perspective, the 2017 Chevy Bolt is expected to have a 60 kWh battery system.[13]

Such analysis, not available when Ameren Missouri filed their proposed project, goes a long way in explaining why EV charging stations have struggled even in regions where EV

[11] Idaho National Laboratory (2016). Plug-in electric vehicle and infrastructure analysis.https://avt.inl.gov/sites/default/files/pdf/arra/ARRAPEVnInfrastructureFinalReportHqltySept2015.pdf
[12] Needel, Z.A. et al. (2016) Potential for widespread electrification of personal vehicle travel in the United States. *Nature Energy*. (1) 1- 7. http://www.nature.com/articles/nenergy2016112
[13] Chevrolet. (2016) Drive unit and battery at the heart of Chevrolet Bolt EV http://media.chevrolet.com/media/us/en/chevrolet/news.detail.html/content/Pages/news/us/en/2016/Jan/naias/chevy/0111-bolt-du.html

adoption has accelerated like the Pacific Northwest. For example, in Eugene-Springfield, Oregon the taxpayer-funded EV fast charging stations deployed throughout the city sit idle most of the time and run the risk of becoming a stranded asset. According to the *Seattle Times*:

> In the city of Eugene's public parking garages, for example, each charging unit is used an average of once every two weeks. Springfield officials want seven charging units removed from downtown because some are little used and others are broken.
>
> In 2013, the last year that data were collected for the federal government, electric vehicles throughout Oregon were plugged into public chargers installed through The EV Project just 4 percent of the time, compared with 42 percent of the time at home-charging units.
>
> The same pattern is true in the eight other states and District of Columbia where the devices also were installed by the federal government, at a total cost to the taxpayer of about $100 million.[14]

III. Cost-Benefit Tests

Q. What are the California cost effectiveness tests?

A. A standardized procedure developed by the California Public Utility Commission ("CPUC") to analyze demand-side management programs cost-effectiveness from a variety of perspectives including: the participant, the ratepayer, the utility, the total service territory, and society as a whole. The tests are designed to ensure that ratepayer dollars are prudently spent and to help prioritize amongst future resource options.

[14] Russo. E. (2015) Public electric-car charging stations sit idle most of time. Seattle Times. http://www.seattletimes.com/seattle-news/public-electric-car-charging-stations-sit-idle-most-of-time/

Q. Is it appropriate to use the UCT test as the primary perspective threshold for a proposed EV charging station project?

A. No. It is unclear why Ameren Missouri has elected to apply any demand-side management cost-effective test to a non-demand-side management program. To be clear, promotion of EVs will result in increased load not a decrease in load. In instances where load is increased as a result of a program the only test that merits consideration is the ratepayer impact measure test ("RIM"). According to the California Standard Practice Manual:

> **It should be noted that for some types of demand-side management programs, meaningful cost-effectiveness analyses cannot be performed using the tests in this manual**. The following guidelines are offered to clarify the appropriated "match" of different types of programs and tests: . . .
>
> 3. **For load building programs, only the RIM tests are expected to be applied.** The Total Resource Cost and Program Administrator Cost tests are intended to identify cost-effectiveness relative to other resource options. It is inappropriate to consider increased load as an alternative to other supply options.[15]

It should be noted that Mr. Nealon references the UCT cost effective ratio throughout his testimony but a review of his workpapers list both the UCT and RIM with the same ratio and cost calculations. Further clarification on this topic is warranted.

Q. Should a cost-effective test be applied to this program?

A. As it stands, there is no basis for applying the UCT test results as a cost justification for a load building program. The RIM test may be a more appropriate analysis as it measures what happens to customer bills or rates due to changes in utility revenues and operating costs by a

[15] California Standard Practice Manual: Economic analysis of demand-side programs and projects. (2001) http://webcache.googleusercontent.com/search?q=cache:OtrOQtnIbBUJ:www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx%3Fid%3D7741+&cd=2&hl=en&ct=clnk&gl=us

given program. Historically, this test has been applied to energy efficiency programs to measure equity considerations. If an energy efficiency program causes a larger increase in utility revenues than utility costs, rates will decrease. If a program results in a larger increase in utility costs than revenues, rates will increase. That is, the RIM test maximizes economic efficiency but at the expense of total future costs (i.e., increased costs for future load growth). This is why the test has largely been abandoned as a threshold perspective by states determining the cost-effectiveness of its DSM programs. Results of the RIM test are probably less certain than those of the other California tests because the RIM is sensitive to the differences between long-term projections of marginal costs and long-term projections of rates, two costs streams that are difficult to quantify with certainty.

Q. What does this mean from a ratepayer perspective?

A. Again, EV adoption or the cost-effectiveness of an EV charging station should not be confused with an energy efficiency program. Promotion of EVs will increase load. Promotion of energy efficiency will decrease load. More importantly, it is difficult to definitively state the full impact and potential outcomes of effectively pursuing a load building program in light of the many uncertainties in place in the energy and transportation policy arena. Any informed response to that question is beyond the scope of this testimony which is centered on the inappropriateness of Ameren Missouri offering a nonessential, competitive service as a regulated, rate based expense.

Q. Putting aside the appropriateness of a ratepayer-funded load building program, was the UCT/RIM test calculated correctly in your opinion?

A. I do not believe so. The key input into Ameren Missouri's calculation is the 25% incremental increase in EV adoption and subsequent residential revenue collection due to the deployment of Ameren Missouri's EV pilot program. Stated differently, the program would not be cost-effective during the three-year pilot period under *any* scenario. Extending the time frame to fifteen years *and* including the residential revenues generated from the induced adoption of 7,050 additional cars in Ameren Missouri's service territory as a result of the six charging

islands existence allows the program to be cost-effective under the RIM (and possibly the UCT) analysis.

Although I understand how Ameren Missouri came to this conclusion, projections that far into the future are burdened with uncertainty especially in light of aforementioned data on EV charging habits and expected increase in battery size. Reasonable minds have already differed over the appropriateness of solely crediting Ameren Missouri a 25% increase for future EV adoption; ultimately it is an academic exercise in uncertainty with many potential confounding variables that can distort the outcome.

IV. ENVIRONMENTAL CONSIDERATIONS

Ameren Missouri's Generation

Q. Will increased use of EVs reduce Ameren Missouri's carbon emissions?

A. No. Ameren Missouri is largely dependent on coal and natural gas/oil fossil fuel mix to supply its generation needs. This means that electric vehicles will require Ameren Missouri to continue burning carbon intense fossil fuels. Table 1 breaks down Ameren Missouri's resource mix by source, capacity and fuel type based on the Company's expected 2015 summer peak demand as found currently on Ameren Missouri's homepage.

Table 1: Ameren Missouri Electric Generation Source and Capacity based on expected 2015 peak summer electric demand[16]

Energy Center	Type of Fuel	Capacity (MW)	Fuel Mix Average
Labadie	Coal	2,372	
Rush Island	Coal	1,180	
Sioux	Coal	970	
Meramec	Coal	831	5,353 MW of Coal = 53.0%
Audrain	Gas/Oil	600	
Venice	Gas/Oil	487	
Goose Creek	Gas/Oil	432	
Raccoon Creek	Gas/Oil	300	
Kinmundy	Gas/Oil	206	
Peno	Gas/Oil	188	
Pickneyvile	Gas/Oil	188	
Other CTG	Gas/Oil	315	2,716 MW of Gas/Oil = 26.9%
Callaway	Nuclear	1,193	1,193 MW of Nuclear = 11.8%
Taum Sauk	Hydro	440	
Osage	Hydro	240	
Keokuk	Hydro	140	820 MW of Hydro = 8.1%
Maryland Heights	Renewable	8	
O'Fallon	Renewable	3	11 MW of Renewable = 0.1%
	Total	10,093	

It seems a foregone conclusion, both in policy and media representations, that EVs are a climate change solution. A look at Ameren Missouri's current fuel mix should give all parties pause over the soundness of ramping up load building activities. Coal accounts for more than 50% of Ameren Missouri's generation and is the most greenhouse gas intensive ("GHG") electricity fuels according to the U.S. Energy Information Administration ("EIA") seen in Table 2:

[16] Ameren Missouri (2015) Ameren Missouri fact sheet. https://www.ameren.com/-/media/missouri-site/files/aboutus/amerenmissourifactsheet.pdf

Table 2: Pounds of CO_2 emitted per million British thermal units (Btu) of energy for various fuels[17]

Fuel Source	Pounds of CO_2 emitted per million British thermal units (Btu)
Coal (anthracite)	228.6
Coal (bituminous)	205.7
Coal (lignite)	215.4
Coal (subbituminous)	214.3
Diesel fuel and heating oil	161.3
Gasoline	157.2
Propane	139.0
Natural Gas	117.0

Moreover, many of the arguments used in favor of promoting the deployment of EVs and EV enabling subsidies centers on the vision of the grid being comprised of substantially less coal and substantially more renewable energy sources. Based on Ameren Missouri's integrated resource planning this will neither be a quick nor an inexpensive process. The uncertainty surrounding the Clean Power Plan only magnifies this point.

Q. Mr. Nealon claims that a 2011 internal analysis showed carbon dioxide ("CO_2") emissions were 35% less than CO_2 tailpipe emissions. Do you agree?

A. No. I have reviewed the report Mr. Nealon references and it appears as though the analysis examined the "average" carbon intensity factor of Ameren Missouri's fuel mix. This can be a misleading input as GHGs from power generation have large spatial (location) and temporal

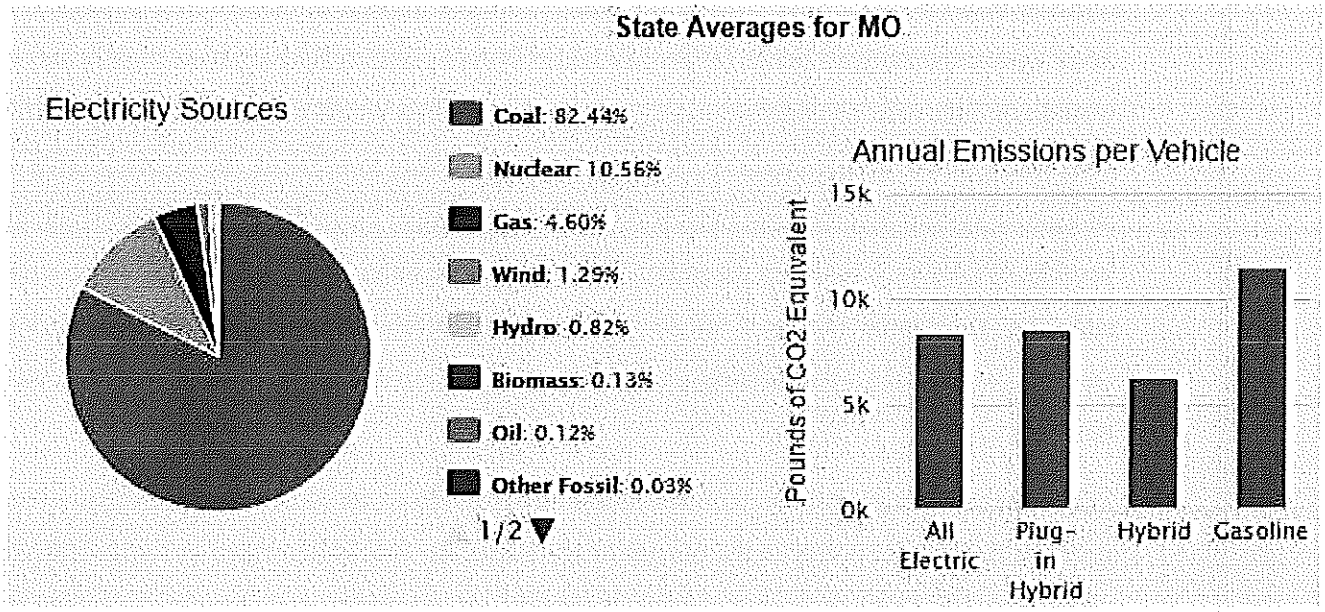
[17] Energy Information Agency (2016) Frequently Asked Questions: How much carbon dioxide is produced when different fuels are burned?. https://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11

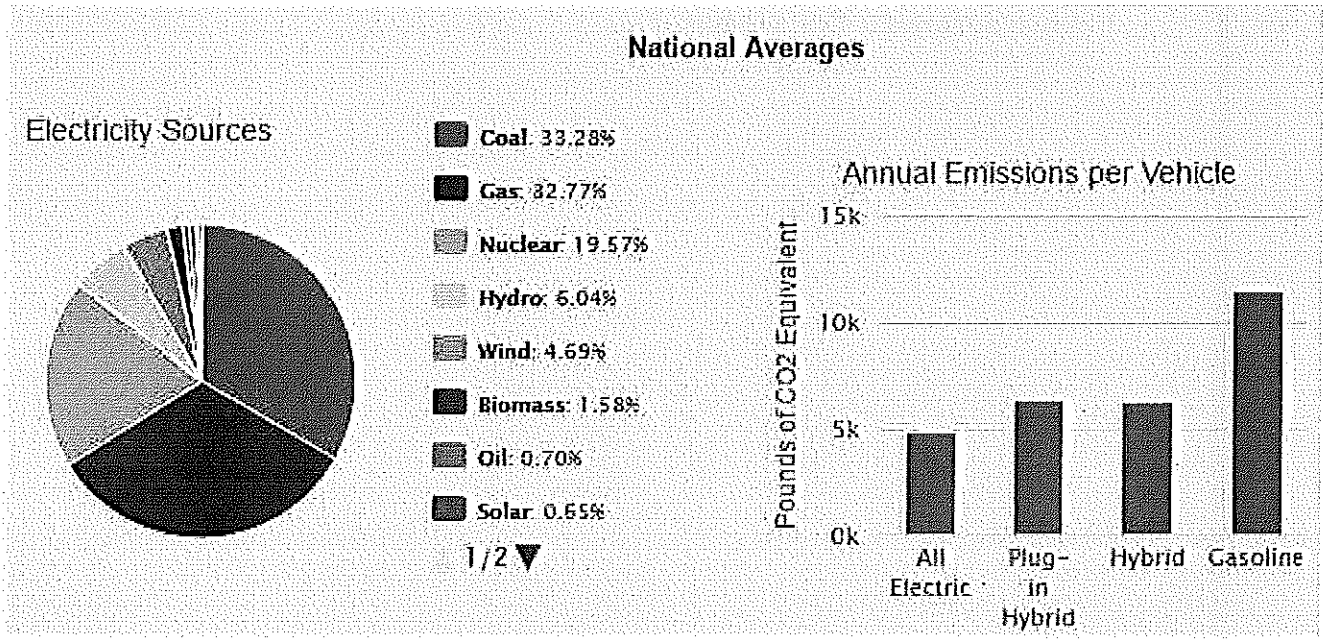
(timing) heterogeneity which means it is more accurate to factor in the marginal emissions released when an EV owner charges the battery, not the average emissions on a system.[18] In other words, the analysis needs to identify which power plants would produce slightly less or would not otherwise be called to meet peak production in a world without that particular EV demanding power at that moment. Credibly modeling a way to estimate the dispatch order of an electric system that does not exist is no doubt a challenge. Nevertheless, at a high level, the benefits of EVs vary based on the price of electricity, the source of electricity, grid congestion, and other substantial factors. I fail to see those considerations in Ameren Missouri's 2011 analysis, which calls into question the soundness of the environmental conclusions that were reached.

Given the current generation fuel mix, Missouri is far from an ideal setting to aggressively promote first-mover policy in the pursuit of EV adoption. This is illustrated in Figure 2 which shows the US DOE estimated annual "averages" of electricity and vehicle emissions for Missouri compared to U.S. averages.

[18] Archsmit, J. et al. (2015) From cradle to junkyard: assessing the life cycle greenhouse gas benefits of electric vehicles. *Research in Transportation Economics* 52 (2015): 72-90.
https://ei.haas.berkeley.edu/research/papers/WP263.pdf

Figure 2: Comparison of Electricity Sources and Vehicle Emissions: Missouri and the U.S. Average[19]

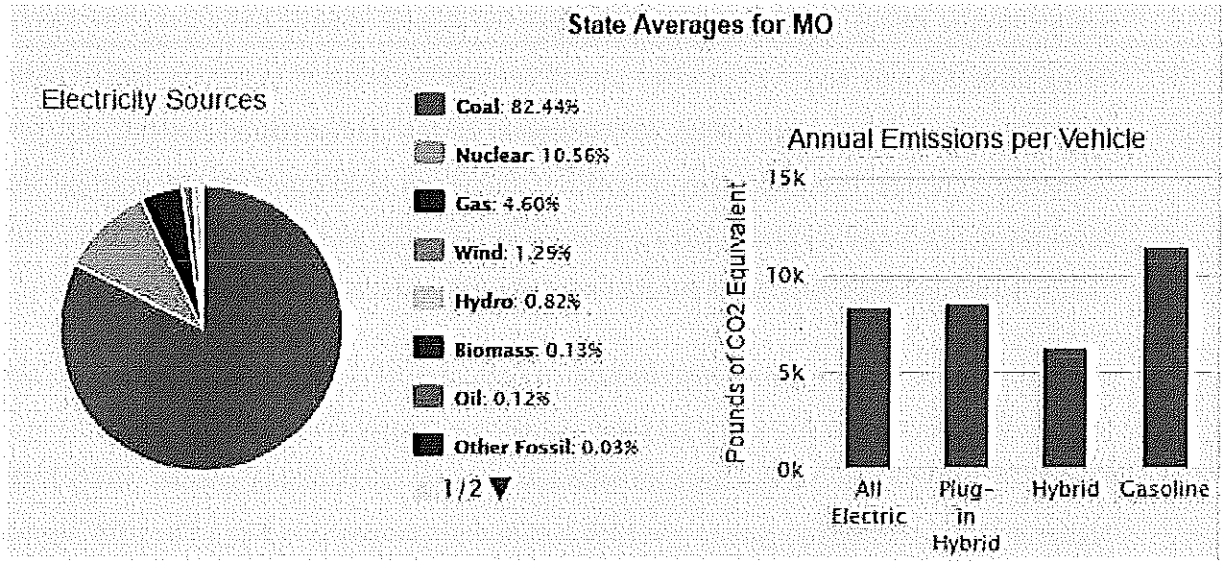


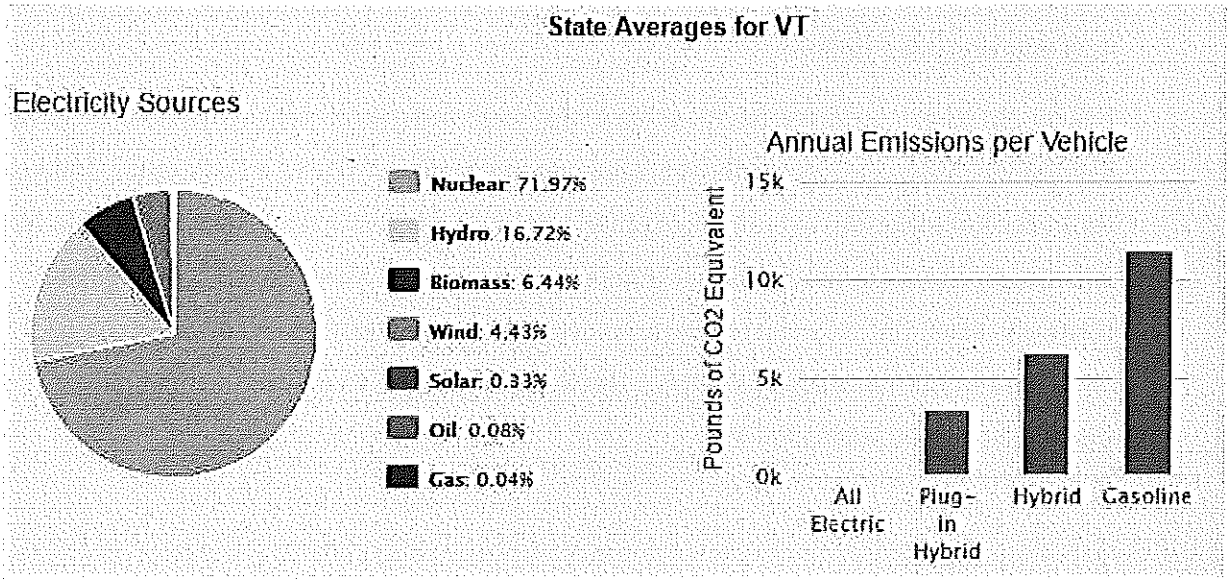


[19]US DOE (2016) Alternative Fuels Data Center. Emissions from hybrid and plug-in electric vehicles http://www.afdc.energy.gov/vehicles/electric_emissions.php

Clearly, location matters in terms of the relative environmental benefits that can be achieved from the promotion of EVs. To provide another illustrative example, Figure 3 compares Missouri against Vermont; a state where EV promotion makes sound environmental sense.

Figure 3: Comparison of Electricity Sources and Vehicle Emissions: Missouri and Vermont[20]





[20] Ibid.

CAFÉ Standards, Biofuels, and Power Laws

Q. Should we assume that gasoline vehicles will produce the same amount of average emissions into the future?

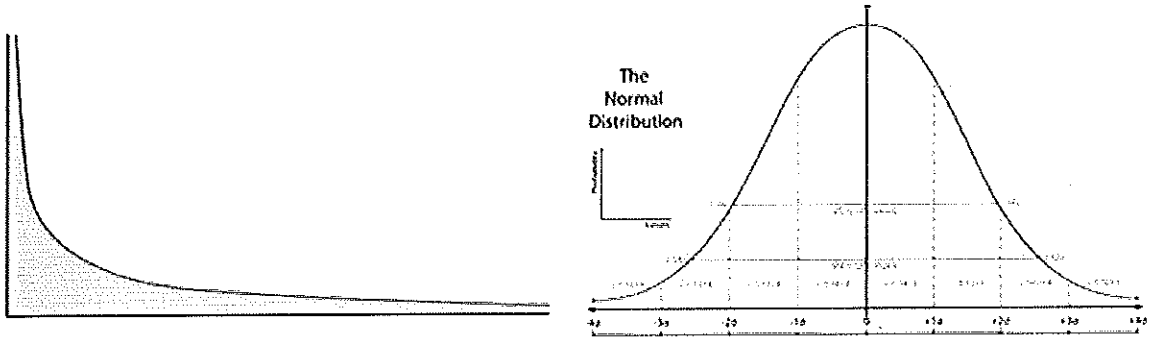
A. No. Multiple streams of policy and technological changes are converging in response to the air quality threats facing our environment. Changes in electric vehicle technology are clearly taking place and may very well produce overall net benefits in many important policy arenas. However, even absent nation-wide electrification of the transportation system, the U.S. Corporate Average Fuel Economy ("CAFÉ") Standards mandate that the average fuel economy of new passenger cars increase from 30 mpg in 2013 to 54 mpg by 2040, this would yield a 44 percent reduction in combustion-related GHG emissions from ICEs.

Furthermore, the U.S. Environmental Protection Agency ("EPA") recently issued a statement that the federal government would be requiring energy companies to use a record amount of biofuel in 2017 setting a total target for renewable fuel at 19.28 billion gallons which is 6% higher than the 18.8 billion gallons the EPA had initially proposed in May. The EPA also set the advanced biofuels mandate (fuels that are more environmentally friendly than ethanol) at 4.28 billion gallons for 2017.[21]

Finally, it would be incorrect to assume that emissions from vehicles follow a normal distribution. Most cars, especially new ones, are extraordinarily clean. In contrast, a polluting car in need of repair can stay on the road for quite awhile before it requires inspection. In fact, it is largely believed that emissions from vehicles follow a power law distribution where a relatively small but extremely dense concentration of offenders produces most of the emissions.[22] An illustrative difference between a normal ("bell-curve") and power law distribution can be seen in Figure 4.

[21] US EPA (2016) EPA finalizes increase in renewable fuel volumes https://www.epa.gov/newsreleases/epa-finalizes-increase-renewable-fuel-volumes
[22] Gladwell, M. (2006) Million-Dollar Murray. *The New Yorker*. http://gladwell.com/million-dollar-murray/

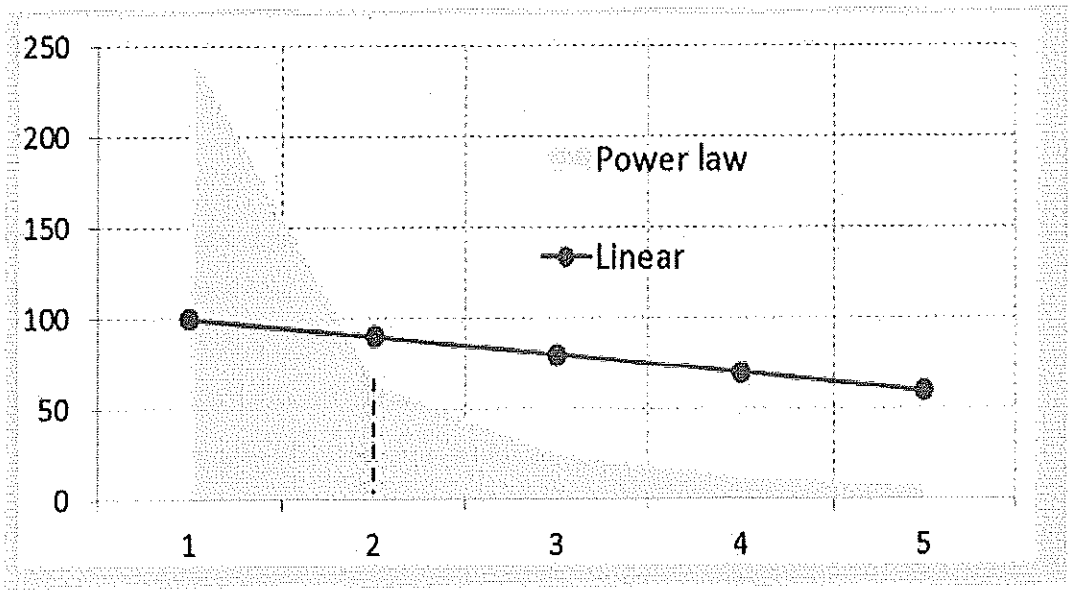
Figure 4: Power Law "Long Tail" and Bell-Shaped Curve Distribution



Power Law Distribution **Normal Distribution**

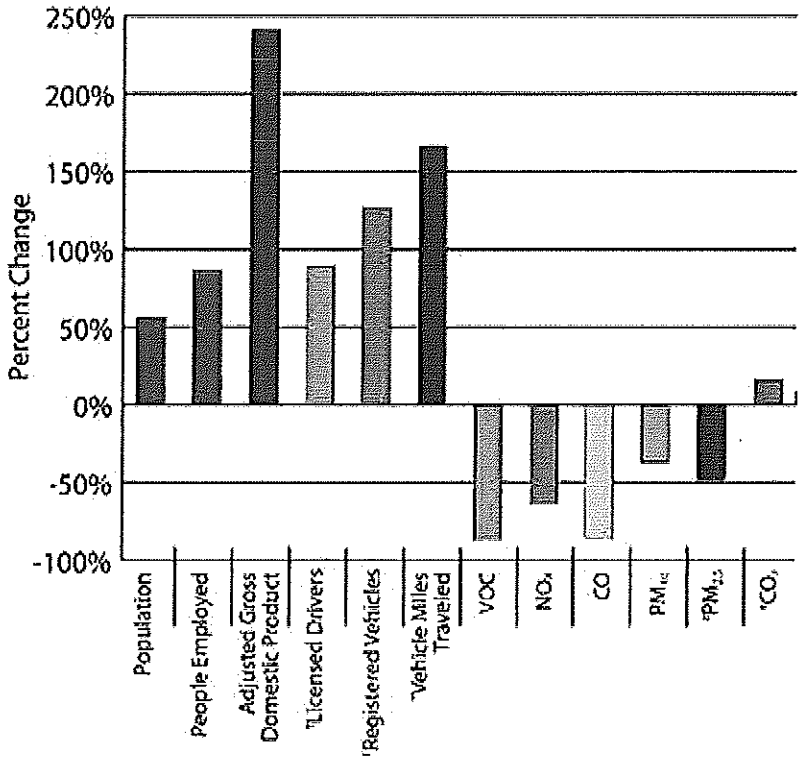
Power law distribution occurs when one quantity varies as a power of another. This would be graphed exponentially, not linearly. An illustrative example of this can be seen in Figure 5 which shows how much pollution cars 1,2,3,4, and 5 emit. Under a power law distribution, car #1 had emissions of 250, while car #2 emits fewer than 100. If this data were graphed linearly, the first car would show emissions of 100 and the second car at emissions at 90.

Figure 5: Example of exponential vs. linear graphing of emissions.



This suggests that curbing vehicle emissions isn't so much a policy problem as it is an enforcement or compliance issue. That being said, there has been a long and steady progress in emission reductions in the United States despite overall increases in population, employment, and adjusted gross domestic product as illustrated in Figure 6 from the U.S. Department of Transportation, Federal Highway Administration's data fact book.

Figure 6: Percent change in motor vehicle emissions, demographics, and travel (1970-2013)[23]



If the goal is to reduce greenhouse emissions, policy ought to seek out the cheapest reductions first, which would (ideally) be administered through a price-based instrument and/or targeting specific outlier emission offenders. More to the point, if carbon emission reductions are to be met on par with what many environmentalists cite, the least-cost societal solution revolves less around promoting EVs and more on public transit and/or less driving overall.

[23] US Department of Transportation. Federal Highway Administration (2016) Transportation Air Quality Selected Facts and Figures. Have we made progress in reducing motor vehicle emissions? https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/page07.cfm

V. EQUITY CONSIDERATIONS

Q. Does OPC have any equity concerns regarding rate based treatment of the EV charging stations?

A. Yes, there is a concern that the long-term benefits purported by Ameren Missouri for all ratepayers are highly speculative, will not materialize until well into the future, and are contingent on multiple moving policy objectives coming to fruition. In the near-term, only EV drivers and Ameren shareholders would reap the financial rewards with non-participants bearing most of the risk and cost. Equally troubling, at least for the immediate future given the current tax code, is that only a small subset of largely affluent Ameren Missouri's ratepayers are likely to benefit from this service. It is difficult to justify raising rates on households that struggle to make ends meet to enable higher income households a more convenient lifestyle, especially in light of the rising electric bills regardless of this proposal.

Q. Is there any data to substantiate your claim that affluent ratepayers would likely reap most of the benefits?

A. Yes. The University of California, Berkeley Energy Institute at Haas examined the distributional effects of all U.S. Clean Energy Tax Credits since 2006 to get a sense of what type of households were benefiting from these subsidies. Since 2006, U.S. households have received more than $18 billion in federal income tax credits to promote clean energy such as rooftop solar and energy efficiency. An analysis of federal tax return data over the past decade showed that:

> Taxpayers with AGI [adjusted gross income] in excess of $75,000 have received about 60% of all credit dollars aimed at energy-efficiency, residential solar, and hybrid vehicles, and **about 90% of all credit dollars aimed at electric cars.** Thus while there may well be political or other

rationales to prefer this approach to first-best policies, it would seem to be difficult to argue for these policies on distributional grounds.[24]

The socio-economic disparity is most pronounced for affluent households when the *Qualified Plug-in Electric Drive Motor Vehicle Credit* is analyzed. The size of that credit ranges from $2,500 to $7,500 depending on the battery capacity of the vehicle. Table 3 provides an overview of the distribution of tax credits across income groups for select clean energy and other major tax credits.

Table 3: The Distributional Outcomes of Selected Tax Credits[25]

	Percent of Credit Received by Income Category (in thousands)						Concentration Index
	$0-$10	$10-$20	$20-$40	$40-$75	$75-$200	$200+	
Panel A. Clean Energy Tax Credits							
Residential Energy Credits	0%	1%	10%	28%	48%	14%	0.606
Alternative Motor Vehicle Credit	0%	1%	9%	32%	47%	11%	0.584
Plug-in Electric Drive Vehicle Credit	0%	0%	1%	10%	54%	35%	0.801
Panel B. Other Major Tax Credits							
Earned Income Tax Credit	18%	49%	32%	1%	0%	0%	-0.415
Making Work Pay Credit	7%	14%	25%	28%	26%	0%	0.163
Child Tax Credit	2%	13%	31%	31%	23%	0%	0.185
First-time Home Buyer Credit	7%	6%	23%	40%	24%	1%	0.222
Foreign Tax Credit	0%	0%	1%	2%	9%	88%	0.954

Each of three selected Clean Energy Tax Credits listed above are largely concentrated within the top two quintile income categories; the Plug-in Electric Drive Vehicle Credit is most pronounced in high income earning households and most closely aligned with the Foreign Tax Credit in terms of high-income concentrated distribution.

[24] Borennstein S. & L. Davis (2016) The Distributional Effects of U.S. Clean Energy Tax Credits. Chapter in the National Bureau of Economic Research book Tax Policy and the Economy. Volume 30. U. of Chicago press. http://www.nber.org/chapters/c13692 see also. NBER working paper 21437 http://www.nber.org/papers/w21437

[25] Ibid.

It is worth noting that much of the explanation for the disparity in the distribution of these clean tax credits centers on its non-refundable provision. In short, the tax credits can be used to offset a filer's tax bill, but a filer cannot go negative and receive a net payment from the IRS like a filer can from the Earned Income Tax Credit and many other tax credits. This becomes problematic from a distributional standpoint because roughly one-third of U.S. tax returns had zero tax liability and thus were not eligible for any clean energy tax credit return. Additional eligibility issues are present with energy efficiency and solar PV for filers who are renters. This is known as the "split-incentive" problem and has been addressed at length in multiple MEEIA proceedings in front of this Commission.

VI. OTHER CONSIDERATIONS

Economic Impact

Q. Please summarize the economic development benefits Mr. Nealon claims Ameren Missouri's pilot project may produce.

A. Although not discussed in any detail, Mr. Nealon states that:

> Macroeconomic studies indicate that money saved annually by EV owners on fuel costs and vehicle maintenance will ultimately be spent as disposable income in other sectors of the local economy. The combination of fuel and maintenance savings together can approach thousands of dollars annually per EV owner that would be re-directed into the communities served in Ameren Missouri's service territory, creating more local jobs and economic activity.[26]

OPC has requested a copy of the macroeconomic studies Mr. Nealon references and reserves the right to comment further on the economic impact of EV deployment in future testimony.

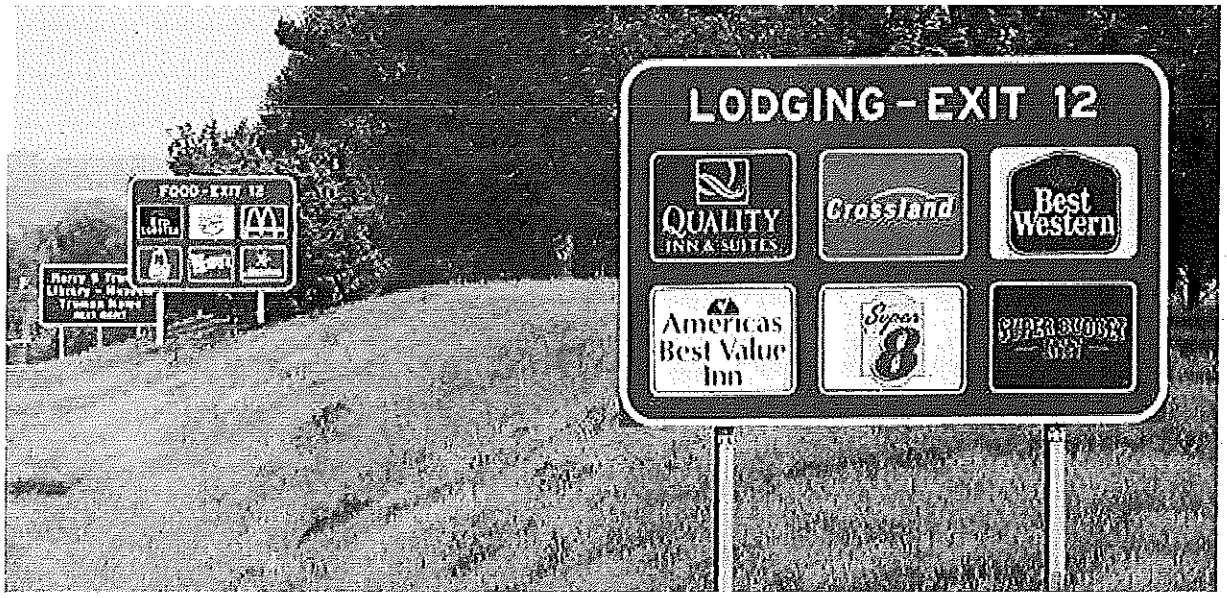
[26] Direct Testimony of Mark J. Nealon p. 31, 5-10.

Marketing Considerations

Q. Ameren Missouri is proposing to spend $10,000 on marketing and awareness over the three-year pilot period and up to $30,000 over the fifteen-year life of the assets. Is this an appropriate amount?

A. I do not believe so. To provide an illustrative marketing expense, The Missouri Department of Transportation ("MoDOT") provides food, lodging, and gas "logo" signage at applicable exits throughout Missouri's highways as seen in Figure 7:

Figure 7: MoDOT signage example



Currently, MoDOT charges $1,000 and $1,500 annually for standard[27] and high volume[28] interchanges respectively.[29] At a minimum, if Ameren Missouri were to utilize MoDOT signage for each of its six charging stations on "average" interchanges it would cost the Company $12,000 annually. That would amount to $2,000 a piece in advertising for each

[27] 0-29,999 average daily traffic count.
[28] 30,000 average daily traffic count
[29] Missouri Department of Transportation (2016) Missouri logos participation fees. http://www.missouri.interstatelogos.com/state/participationFees.aspx?programId=465

charging station to account for traffic going east *and* west on I-70 at any given exit. Under this minimalist approach, the Company would be exceeding its three-year marketing budget each year and its fifteen-year budget within two-and-half years. Even then, it is not clear whether or not the EV charging stations would even be eligible to participate in this advertising offering as the criteria for participation includes the following items for "gas" locations:

- Continuous operation at least 12 hours per day, 7 days a week
- Provide fuel, oil, water and free air
- Provide restroom facilities
- Provide public telephone
- Provide drinking water
- Maximum distance of service: 6 miles[30]

As it stands, it does not appear as though Ameren Missouri has correctly calculated the potential costs necessary to market its proposed service.

Maintenance of Roads

Q. Are there other potential equity issues to consider?

A. Yes. EV drivers would not be paying their fair share of the transportation infrastructure in Missouri.

Q. How are Missouri roads funded?

A. Highway construction and road maintenance is primarily supported through a combination of revenues collected at the gas pump from federal and state taxes. Both the federal and state fuel taxes/fees are based on gallons sold, which means as the price of gas goes up and down the taxes/fee remain constant, regardless of whether or not you are paying $4.02 per gallon (US average monthly high in July 2008)[31] or $0.90 per gallon (US average monthly low in

[30]Missouri Department of Transportation (2016) Missouri logos eligibility critera. http://www.missouri.interstatelogos.com/state/eligibilityCriteria.aspx?programId=465
[31] Federal Reserve Bank of St. Louis. (2016) US Regular Conventional Gas Price https://fred.stlouisfed.org/series/GASREGCOVM

February 1999).[32] The federal gas tax has not been raised since 1993 and Missouri has not raised its gas tax since 1992. Neither revenue stream has kept pace with inflation as the costs of this infrastructure do not scale with the consumption of these fuels. [33,34] Consequently, funding for the nation's transportation infrastructure and Missouri's roads in particular are constantly at risk of becoming insolvent. [35,36]

Missouri's Department of Transportation ("MoDOT") had been operating with a capital program budget of $1.4 billion in 2009 but has since seen that budget shrink to around $325 in recent years until its road reserve balance funds were tapped into earlier this year bringing its capital budget to approximately $800 million annually over the next five years. However, this amount still falls well short of the estimated $125 billion needed to replace the 34,000-mile MoDOT managed system. According to MoDOT Director, Patrick McKenna, "If you were putting the same percentage into your own homes, your house would depreciate in value. That's the situation we're in. We know we can't take care of this entire system with that level of funding, even in its current condition, even if that condition is not satisfactory."[37]

Table 4 magnifies the difference in gasoline taxes a driver in Missouri pays compared to the US average based on amounts compiled by the American Petroleum Institute.

[32] Ibid.
[33] US Department of Transportation. Federal Highway Administration. Highway History (2016) https://www.fhwa.dot.gov/infrastructure/gastax.cfm
[34] Missouri Department of Transportation: Funding History (2016) http://www.modot.org/about/funding/fundinghistory.htm
[35] Baker P. & J. Weisman (2014) House passes interim fix for highway trust fund. *The New York Times.* http://www.nytimes.com/2014/07/16/us/politics/house-passes-interim-fix-for-highway-trust-fund.html?_r=0
[36] CBS St. Louis (2016). MoDOT cites dwindling funds for State's poor infrastructure. http://stlouis.cbslocal.com/2016/11/07/modot-cites-dwindling-funds-for-states-poor-infrastructure/
[37] Hunsicker J. (2016) Kirksville Daily Express. MoDOT director: Transportation funding issues must be addressed for Missouri to move forward http://www.kirksvilledailyexpress.com/news/20160720/modot-director-transportation-funding-issues-must-be-addressed-for-missouri-to-move-forward

Table 4: Comparison of US and Missouri average gasoline taxes[38]

	US Average	Missouri (47th)	Difference
State Excise Tax	20.76¢/gal	17.00¢/gal	-18%
Other State Taxes/Fees	9.71¢/gal	0.30¢/gal	-96.9%
Total State Taxes/Fees	30.46¢/gal	17.30¢/gal	-43.2%
Total State and Federal Taxes	48.86¢/gal	35.70¢/gal	-26.9%

Q. What should the Commission note from this table?

A. That it is relatively inexpensive to drive an internal combustion engine vehicle in Missouri compared to the US average. The low price of gas at the pump in Missouri relative to the rest of the country serves as a large barrier towards the full adoption of EVs and diminishes the likelihood that nonparticipant ratepayers will realize the benefits that Mr. Nealon champions. It is also important to note that Missouri has no sales tax tied to the cost of gasoline. For example, in Illinois, where the per gallon tax is just one cent higher than Missouri, there is also a 6.25 percent sales tax. Consequently, St. Louis drivers can enjoy anywhere from a 0.10 to 0.15¢ lower cost per gallon than their counterparts across that border. Given current and historical prices (as well as the current fossil-fuel intensive generation fuel mix of the incumbent utilities), from a policy, economic and environmental perspective, almost any other state would be a more attractive alternative as a "first mover" for the deployment of EV charging stations than Missouri.

Moreover, the low cost of fuel means that our State's roads are largely dependent on inefficient cars and/or more miles traveled by the average driver relative to the rest of the nation (all else being equal). The emergence of more fuel efficient cars or cars that are gasoline independent (EVs) will shift those road maintenance costs to those nonparticipants.

[38] American Petroleum Institute. Gasoline Tax (2016) http://www.api.org/oil-and-natural-gas/consumer-information/motor-fuel-taxes/gasoline-tax

For example, a Ford Escort may tear up the same pavement as a Tesla Model S, but only the former is going to be paying for those repairs.

Similar to an influx of rooftop solar panels on the electric grid, the emergence of EV cars creates a situation where individual consumers (heavily subsidized through federal tax incentives) make choices, in part, driven by opportunities to shift costs onto others. Far from an equitable solution, as pointed out earlier, the data suggests that these subsidies are largely regressive with only the affluent most likely to benefit. Although federal subsidies *may* be justified in moving emerging technology for a brief period, it is important to not dismiss the spirit of the free market or fail to recognize the unintended consequences a top-down policy "solution" can create. Clearly, **promoting vehicles that do not use gasoline that drive on roads maintained largely through the purchase of gasoline** exacerbates one policy problem (funding of roads) at the expense of trying to solve for others (load growth, curbing carbon emissions).

Safety Considerations

Q. Are there additional considerations the Commission should consider?

A. There are a host of outstanding safety and security issues that were not discussed in Mr. Nealon's testimony that merit further inquiry. Issues such as vandalism, copper theft, frayed cables or accidents involving the charging devices all pose potential liabilities with this business model. OPC is not aware of any statutes in place requiring periodic inspections of EV charging stations or any requirements for homeowners to utilize an electrician to safely install a charging unit at home. OPC would offer that additional dialogue with first responders, road-side assistance technicians, and even the insurance industry may be prudent endeavors that should be explored if the Commission elects to move forward with regulating this extended service.

Rate Design

Q. What is Ameren Missouri's proposed EV charging rates?

A. Ameren Missouri is proposing a $10.00 an hour charge rate for its DCFS station and a $1.20 an hour rate for its level 2 station.

Q. Has that been a common rate design for EV stations?

A. No. It is my understanding that historically many EV stations have provided free electricity to further promote the adoption of EVs. In those cases, the electricity has largely been paid for by a host facility or even by the car manufacturer itself (e.g., Nissan or Tesla). Absent having free electricity provided to the driver, host sites have priced their services according to the market demand of their product.

Q. Is Ameren Missouri proposing an EV charging rate for off-peak hours at home?

A. No. Ratepayers would be utilizing rates available on the Company's tariff as they do today.

Q. Has Ameren Missouri proposed an EV rate in its upcoming rate case?

A. No.

Q. Is this a concern?

A. Yes. Today, electricity prices do not adjust to reflect the volatile cost of providing energy at different times. Because electricity is not storable, the wholesale cost can change by a factor of five or more within a single day, but the price to most end-use customers remains constant. It is the equivalent of the price at the gas pump being held fixed while the world oil price ranges between $20 and $140 a barrel, only compressed in time. Absent any price signal, EV drivers may raise peak demand of electricity and collectively raise the costs for everyone. Such a scenario would also negate the emission reductions gained from moving to EV to begin with.

Time-of-Use electricity pricing offers benefits both now and in the future. The immediate benefit is that raising prices at peak times (when producing each extra kilowatt-hour is most

expensive) and lowering them at off-peak times would move some consumption off the peak and reduce the need to build future "peaking" power plants. In the long run, sending such time-varying price signals would allow Ameren Missouri to better synchronize consumption with electricity production from intermittent resources, such as solar and wind as they come on line in the future.

Q. What does OPC recommend?

A. It is OPC's opinion that Ameren Missouri and its ratepayers would be better served by having the regulated utility promote regulated activity such as educating and attracting potential EV drivers through proper rate design and leave competitive entities to determine the appropriate demand for EV charging stations. If one the primary goals are the reduction of greenhouse gas emissions, policy ought to seek out the cheapest reductions first which would be administered in a price-based instrument such as rate design. Offering a favorable, easily understood rate design for potential drivers will likely have more of an impact on adoption rates of EVs than Ameren Missouri's current proposal.

Consistent with the rest of this testimony, OPC would recommend that the EV charging stations resale of electricity be left to the market to decide as far as most efficient pricing. Second, OPC would recommend that an opt-in TOU tariff be considered in the near future if EV adoption increases. Although not proposed, OPC would be categorically against providing free electricity service to EV drivers.

The federal government has deemed it appropriate to allocate tax dollars to spur clean investment and promote disruptive market forces. Ratepayers should not be confused as taxpayers. They represent an entirely different classification by virtue of their captive status. As proposed, Ameren Missouri's "pilot" project blurs and distorts that distinction by undermining the market element that tax dollars were designed, in part, to promote, and will ultimately inhibit the promotion of the desired policy outcomes. Ratepayers (especially non-EV participating ratepayers) should not shoulder the risk of a regressive, command-and-

control hypothetical when opportunity costs dictate that utility resources would be better allocated towards endeavors focusing on cost-effective regulated services benefitting all ratepayers.

Similar conclusions were reached by the Kansas Corporation Commission recently in its Order Denying KCP&L's Application of its Clean Charge Network Project and Electric Vehicle Charging Station Tariff (see GM-2).

Q. Does this conclude your testimony?

A. Yes.

CASE PARTICPATION OF GEOFF MARKE, PH.D.

Company Name	Employed Agency	Case Number	Issues
Union Electric Company d/b/a Ameren Missouri	Office of Public Counsel (OPC)	ET-2016-0246	**Rebuttal:** EV Charging Station Policy
KCP&L Greater Missouri Operations Company	OPC	ER-2016-0156	**Direct:** Consumer Disclaimer **Rebuttal:** Regulatory Policy / Customer Experience / Historical & Projected Customer Usage / Rate Design / Low-Income Programs **Surrebuttal:** Rate Design / MEEIA Annualization / Customer Disclaimer / Greenwood Solar Facility / RESRAM / Low-Income Programs
Empire District Electric Company, Empire District Gas Company, Liberty Utilities (Central) Company, Liberty Sub-Corp.	OPC	EM-2016-0213	**Rebuttal:** Response to Merger Impact **Surrebuttal:** Resource Portfolio / Transition Plan
Working Case: Polices to Improve Electric Regulation	OPC	EW-2016-0313	Comments on Performance-Based and Formula Rate Design
Working Case: Electric Vehicle Charging Facilities	OPC	EW-2016-0123	Comments on Policy Considerations of EV stations in rate base
Empire District Electric Company	OPC	ER-2016-0023	**Rebuttal:** Rate Design, Demand-Side Management, Low-Income Weatherization **Surrebuttal:** Demand-Side Management, Low-Income Weatherization, Monthly Bill Average
Missouri American Water	OPC	WR-2015-0301	**Direct:** Consolidated Tariff Pricing / Rate Design Study **Rebuttal:** District Consolidation/Rate Design/Residential Usage/Decoupling **Rebuttal:** Demand-Side

			Management (DSM)/ Supply-Side Management (SSM) **Surrebuttal:** District Consolidation/Decoupling Mechanism/Residential Usage/SSM/DSM/Special Contracts
Working Case: Decoupling Mechanism	OPC	AW-2015-0282	**Memorandum:** Response to Comments
Rule Making	OPC	EW-2015-0105	Missouri Energy Efficiency Investment Act Rule Revisions, Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0084	Triennial Integrated Resource Planning Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0055	**Rebuttal**: Demand-Side Investment Mechanism / MEEIA Cycle II Application
The Empire District Electric Company	OPC	EO-2015-0042	Integrated Resource Planning: Special Contemporary Topics Comments
KCP&L Greater Missouri Operations Company	OPC	EO-2015-0041	Integrated Resource Planning: Special Contemporary Topics Comments
Kansas City Power & Light	OPC	EO-2015-0040	Integrated Resource Planning: Special Contemporary Topics Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0039	Integrated Resource Planning: Special Contemporary Topics Comments
Union Electric Company d/b/a Ameren Missouri	OPC	EO-2015-0029	Ameren MEEIA Cycle I Prudence Review Comments
Kansas City Power & Light	OPC	ER-2014-0370	**Direct** (Revenue Requirement): Solar Rebates
Rule Making	OPC	EX-2014-0352	Net Metering and Renewable Energy Standard Rule Revisions, Comments
The Empire District Electric Company	OPC	ER-2014-0351	**Rebuttal:** Rate Design/Energy Efficiency and Low-Income Considerations
Rule Making	OPC	AW-2014-0329	Utility Pay Stations and Loan Companies, Rule Drafting,

			Comments
Union Electric Company d/b/a Ameren Missouri	OPC	ER-2014-0258	**Direct:** Rate Design/Cost of Service Study/Economic Development Rider **Rebuttal:** Rate Design/ Cost of Service/ Low Income Considerations **Surrebuttal:** Rate Design/ Cost-of-Service/ Economic Development Rider
KCP&L Greater Missouri Operations Company	OPC	EO-2014-0189	**Rebuttal:** Sufficiency of Filing **Surrebuttal:** Sufficiency of Filing
KCP&L Greater Missouri Operations Company	OPC	EO-2014-0151	Renewable Energy Standard Rate Adjustment Mechanism (RESRAM) Comments
Liberty Natural Gas	OPC	GR-2014-0152	**Surrebuttal:** Energy Efficiency
Summit Natural Gas	OPC	GR-2014-0086	**Rebuttal:** Energy Efficiency **Surrebuttal:** Energy Efficiency
Union Electric Company d/b/a Ameren Missouri	OPC	ER-2012-0142	**Direct:** PY2013 EM&V results / Rebound Effect **Rebuttal:** PY2013 EM&V results **Surrebuttal:** PY2013 EM&V results **Direct:** Cycle I Performance Incentive
Kansas City Power & Light	Missouri Public Service Commission Staff	EO-2014-0095	**Rebuttal:** MEEIA Cycle I Application testimony adopted
KCP&L Greater Missouri Operations Company	Missouri Division of Energy (DE)	EO-2014-0065	Integrated Resource Planning: Special Contemporary Topics Comments
Kansas City Power & Light	DE	EO-2014-0064	Integrated Resource Planning: Special Contemporary Topics Comments
The Empire District Electric Company	DE	EO-2014-0063	Integrated Resource Planning: Special Contemporary Topics Comments
Union Electric Company d/b/a Ameren Missouri	DE	EO-2014-0062	Integrated Resource Planning: Special Contemporary Topics Comments
The Empire District Electric Company	DE	EO-2013-0547	Triennial Integrated Resource Planning Comments

THE STATE CORPORATION COMMISSION
OF THE STATE OF KANSAS

Before Commissioners: Jay Scott Emler, Chairman
Shari Feist Albrecht
Pat Apple

In the Matter of Kansas City Power & Light's Application to Deploy and Operate its Proposed Clean Charge Network.	)))	Docket No. 16-KCPE-160-MIS

ORDER DENYING KCP&L'S APPLICATION FOR APPROVAL OF ITS CLEAN CHARGE NETWORK PROJECT AND ELECTRIC VEHICLE CHARGING STATION TARIFF

This matter comes before the State Corporation Commission of the State of Kansas (Commission) for consideration and decision. Having reviewed the pleadings and record, the Commission makes the following findings:

1. On January 26, 2015, Kansas City Power & Light Company (KCP&L) announced its planned Clean Charge Network (CCN) to install and operate more than 1,000 electric vehicle (EV) charging stations capable of supporting more than 10,000 EVs in KCP&L's service territories. On June 17, 2015, in Docket No. 15-KCPE-116-RTS, the Parties filed a Joint Motion for Approval of Unanimous Partial Settlement Agreement on Revenue Requirement (Settlement),[1] which included an agreement to jointly petition the Commission to investigate and evaluate the issue of EV charging stations. Accordingly, on September 24, 2015, KCP&L, Commission Staff (Staff), and the Citizens' Utility Ratepayer Board (CURB) filed a Joint Petition to Open a General Investigation Docket (Petition) requesting the Commission open a docket to investigate issues related to EV charging stations.

2. On February 2, 2016, the Commission issued an Order Opening Docket to address KCP&L's proposed CCN and EV charging station tariff. While KCP&L requested a general

[1] The Settlement was approved by the Commission on September 10, 2015.

investigation, since the Commission was presented with a specific program proposed by KCP&L, the Commission limited the scope of this Docket to evaluating the CCN proposed by KCP&L.[2] On February 16, 2016, KCP&L filed its Application for Approval of its Clean Charge Network Project and Electric Vehicle Charging Station Tariff. KCP&L intends the tariff to take effect January 1, 2017.[3] The CCN will consist of EV charging stations manufactured by ChargePoint, Inc. (ChargePoint), and which will be part of ChargePoint's network of more than 20,000 charging spots in North America.[4] Through partnerships with companies at host locations and with Nissan Motor Company, KCP&L plans to offer free charging on every station in its CCN to all drivers for the first two years or until a tariff is in place.[5]

3. The CCN is expected to cost approximately $16.6 million, of which approximately $5.6 million would be borne by Kansas jurisdictional customers.[6] KCP&L is requesting Kansas ratepayers pay for the appropriately $5.6 million in capital costs, along with the depreciation and approximately $250,000 in annual operations and maintenance costs.[7] Currently 230 of the planned 315 stations are in service,[8] with the CCN expected to be completed by the end of the third quarter of this year.[9] According to Charles A. Caisley, Vice President – Marketing and Public Affairs for KCP&L, based on customer research and national studies, there is "significant customer interest in electric vehicles."[10] KCP&L claims its proposed CCN is in the public interest "because it places Kansas in the forefront of

[2] Order Opening Docket, Feb. 2, 2016, ¶ 4.
[3] Application of Kansas City Power & Light Company for Approval of Its Clean Charge Network Project and Electric Vehicle Charging Station Tariff (Application), Feb. 16, 2016, ¶ 10.
[4] Attachment A to Application, Feb. 16, 2016, p. 1.
[5] *Id.*
[6] Direct Testimony of Charles A. Caisley (Caisley Direct), Feb. 16, 2016, p. 8.
[7] Direct Testimony of Darrin Ives (Ives Direct), Feb. 16, 2016, p. 15.
[8] Rebuttal Testimony of Darrin R. Ives (Ives Rebuttal), June 16, 2016, p. 18.
[9] Direct Testimony of Kristin L. Riggins, Feb. 16, 2016, p. 11.
[10] Caisley Direct, p. 10.

accommodating and promoting development of an industry that is expected to advance quickly in the near future."[11] Specifically, Caisley explains:

> The [EV] industry can only advance if there are adequate charging stations throughout the country, similar to what we now have for gasoline-powered vehicles. The lack of EV charging station infrastructure presents a barrier to market penetration at scale in the industry and the lack of a standardized financial transaction infrastructure also inhibits the industry's growth. KCP&L can help alleviate those barriers in its service territory.[12]

4. As part of its Application, KCP&L filed a brief addressing the legal issues presented in this Docket. The first issue that KCP&L raises is whether providing EV charging services qualifies as a public utility function under Kansas law. After explaining offering EV charging services is a legitimate public utility function under Kansas law under K.S.A. 66-104 and K.S.A. 66-101a,[13] KCP&L noted:

> should the Commission determine that promoting and provisioning electric service for transportation purposes is necessary for carrying out Kansas public policy with regard to promoting and expanding the use of EVs in the state, then it would become part of the services and activities a public utility should make available to Kansas customers in order to meet the legal standard of providing "efficient and sufficient service and facilities" at just and reasonable rates, as required by K.S.A. 66-101b.[14]

5. In essence, K.S.A. 66-101b requires every electric public utility to furnish reasonably efficient and sufficient service.

6. On June 6, 2016, Commission Staff filed their Brief on Legal Issues, explaining while "EV charging service is a public utility function, the Kansas statutes do not answer important questions pertaining to the necessity or scale of such service."[15] Staff characterized the crux of this Docket as "what, if any, CCN property and operating expenses are reasonably

[11] Application, ¶ 14.
[12] Caisley Direct, pp. 10-11.
[13] Brief of Kansas City Power & Light Company on Legal Issues, Feb. 16, 2016, p. 2.
[14] *Id.*, p. 3.
[15] Commission Staff's Brief on Legal Issues, June 6, 2016, ¶ 4.

necessary to maintain reasonably sufficient and efficient electric service."[16] CURB did not brief the legal issues.

7. On June 6, 2016, Joshua P. Frantz and Robert H. Glass, Ph.D. filed direct testimony on behalf of Staff and Andrea Crane filed direct testimony on behalf of CURB. All three testified against the proposed program. Staff's main critique of the proposed program is KCP&L has not demonstrated a demand for charging stations.[17] Frantz characterized the proposed CCN program as a speculative investment to create demand for EVs.[18] Furthermore, Frantz opined that KCP&L is already providing reasonably sufficient and efficient service to its EV customers without the CCN.[19] Frantz concluded EV drivers typically charge their EVs at home[20] based on: (1) the testimony of KCP&L witness Daniel Bowermaster,[21] (2) Tesla recommending home charging for its vehicles, and (3) studies of EV drivers' charging habits conducted by Idaho National Laboratory. He explained EVs can easily be charged at home with a proper cord and ordinary three-prong 120-volt outlet.[22] Frantz also questioned whether the CCN stations would be used or useful throughout the expected lifespan of the project based on technological advances.[23] With improved battery life and the possibility that wireless charging could become the dominant charging method, Frantz cautions the CCN could be obsolete before 2025.[24]

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[16] *Id.*, ¶ 6.
[17] Direct Testimony of Robert H. Glass Ph.D. (Glass Direct), June 6, 2016, p. 7.
[18] Direct Testimony of Joshua P. Frantz (Frantz Direct), June 6, 2016, p. 5.
[19] *Id.*, p. 6.
[20] *Id.*, pp. 6-7.
[21] *Id.*
[22] *Id.*, p. 6.
[23] *Id.*, p. 9.
[24] *Id.*, pp. 11, 13.

8. Dr. Glass explained Staff opposed the proposed network as a highly speculative, ratepayer-funded program to expand rate base, customer load, and customer demand.[25] According to Glass, "KCP&L does not present any statistical evidence of correlation between interest in EVs and a demand for commercial charging stations."[26] As an alternative, Glass suggested recommending the legislature amend K.S.A. 66-104 to grant an exemption to private charging stations akin to the one given to private natural gas providers, and establishing a time of use rate for home charging of EVs.[27]

9. Crane also urged the Commission to reject the proposed CCN program because: (1) KCP&L has not demonstrated a need for the program; (2) the program is potentially anti-competitive; and (3) the program would result in all Kansas customers cross-subsidizing EV owners.[28]

10. On June 16, 2016, Darrin R. Ives and Charles A. Caisley filed rebuttal testimony on behalf of KCP&L. Ives reiterated that customers have requested and are utilizing the EV stations installed as part of the CCN.[29] In doing so, Ives admits, "it is true that KCP&L does not have a specific forecast for the growth in EV purchases within the KCP&L service territory, the fact is that customers are demonstrating firsthand that there is a need and a demand for the charging stations."[30] Ives also appears to acknowledge the speculative aspect of the CCN proposal by expressing a willingness to share the costs of the program between customers and shareholders "to be reassessed at the time of KCP&L's next full general rate case, when additional information and analysis will be available".[31]

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[25] Direct Testimony of Robert H. Glass, Ph.D., June 6, 2016, p. 3.
[26] *Id.*, p. 6.
[27] *Id.*, p. 26.
[28] Direct Testimony of Andrea C. Crane, June 6, 2016, p. 5.
[29] Ives Rebuttal, p. 2.
[30] *Id.*, p. 12.
[31] *Id.*, p. 25.

11. Caisley disputes Frantz's assertion that home charging is adequate for the majority of KCP&L customers who own or are considering purchasing EVs.[32] He cites four factors to argue home charging is not sufficient: (1) drivers sometimes travel more miles than their average daily use; (2) EVs lose some functionality as battery life diminishes; (3) fully recharging a nearly depleted battery at home could take twelve to sixteen hours; and (4) range anxiety is more pronounced for EV drivers.[33] Caisley also explained that 52% of households cannot park a car within 20 feet of an electrical outlet, and thus cannot charge at home.[34] In addressing Frantz's concerns that CCN stations will not be useful throughout their lifetime, Caisley testified "KCP&L is unaware of any automaker, especially U.S. automakers, that has provided commercially available EVs with built-in wireless charging as Navigant predicted in early 2014. Nor is the Company aware of any U.S. automaker that plans to introduce this technology in their commercial product line within the immediate future."[35] But wireless charging is only one example of a technological advancement that Frantz identified that might render the CCN obsolete.[36] Another possibility is improved battery life. Caisley ignored his own testimony on the potential for improved battery life ("[i]n just a few, short years, we have seen the second generation of EVs nearly double their battery life and range").[37] As Frantz points out, with continued improvements to battery life, there is less need for public charging stations, as EVs can remain charged on one night's worth of home charging.[38] Caisley did not rebut Frantz's testimony that improved battery life would decrease the demand for public charging stations.

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[32] Rebuttal Testimony of Charles A. Caisley, June 16, 2016, p. 2.
[33] *Id.*, pp. 4-5.
[34] *Id.*, p. 5.
[35] *Id.*, p. 18.
[36] Transcript of Evidentiary Hearing (Tr.), p. 298.
[37] Caisley Direct, p. 21.
[38] Frantz Direct, p. 13.

12. An evidentiary hearing was held on June 28 and June 29, 2016. KCP&L, Staff, CURB, and ChargePoint appeared by counsel, with KCP&L, Staff, and CURB having submitted prefiled testimony. The Commission heard live testimony from a total of eight witnesses, including four on behalf of KCP&L, two on behalf of Staff, one each on behalf of CURB and ChargePoint. The parties had the opportunity to cross-examine the witnesses at the evidentiary hearing as well as the opportunity to redirect their own witnesses. Following the evidentiary hearing, all of the parties submitted posthearing briefs.

13. The issue facing the Commission is not whether KCP&L can or should build and operate the CCN, but whether KCP&L should be able to recover the costs of building and operating the CCN from all of its customers, rather than its shareholders and EV owners.[39]

14. The threshold issue is whether the CCN network is necessary to provide sufficient and efficient service.[40] The Commission concludes it is not.

15. As the Applicant, KCP&L bears the burden of proof. It failed to meet its burden. As the Commission will explain in greater detail below, based on the evidence presented, the Commission finds KCP&L has failed to demonstrate a legitimate demand for the CCN. Admittedly, KCP&L's CCN is designed to promote EV adoption.[41] At the hearing, Caisley testified, "one of the benefits of the Clean Charge Network is to create the platform to discuss these things [cost of EVs] as part of being an enabler and catalyst for this industry."[42] While stimulating EV ownership and usage may be a laudable goal, it is not within the scope of KCP&L providing sufficient and efficient service. Promoting EV ownership and usage is better left to the automobile industry.

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[39] *See* Initial Post-Hearing Brief of Kansas City Power & Light Company, July 15, 2016, p. 13; *see also* Tr., pp. 25-26.
[40] *See* Tr., p. 26.
[41] Tr., p. 52 (Caisley Cross).
[42] *Id.*, p. 81.

16. Similarly, Caisley acknowledges that under KCP&L's proposal, KCP&L's ratepayers, rather than retail businesses will bear the cost of the CCN.[43] Caisley explained businesses "want to do something that will attract customers and be valuable to their customers that they don't have to outlay capital for."[44] The Commission does not agree that ratepayers should be subsidizing the cost of the CCN for the benefit of businesses. Businesses have already demonstrated that they are willing to install stations to attract and retain employees, customers, or tenants.[45] As Anne Smart, Director of Government Relations and Regulatory Affairs for ChargePoint, testified 92 charging ports have already been sold outside KCP&L's program to private entities in Kansas, such as universities, cities, and Sprint.[46] Even more to the point, Ives cited to his colleague Caisley's testimony that, "our hosts...have been signing up to participate in this. And we probably will have a waiting list when we run out of capacity for the network. And none of them are charging us for the space".[47] Therefore, the evidence suggests that rather than add a costly program to rate base, it is best left to private businesses and landlords to install stations as incentives to attract customers. Accordingly, it is not necessary for ratepayers to fund the CCN. The private sector appears willing to finance an effective EV charging network.

17. KCP&L views the CCN as part of its regulated distribution network necessary to provide efficient and sufficient service.[48] It follows that KCP&L believes that EV owners currently lack efficient electric service in KCP&L's service territory.[49] Yet the evidence does not suggest there is a legitimate demand for the CCN.

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[43] *Id.*, p. 120.
[44] *Id.*, p. 121.
[45] Tr., p. 161 (Riggins Cross).
[46] Tr., p. 256-257, 271 (Smart Cross).
[47] Tr., p. 247 (Ives Redirect).
[48] *Id.*
[49] *Id.*

18. When presented with a California Transportation Electrification study from his direct testimony, which concluded most drivers of battery/electric vehicles do not need a charge outside their home on most days, Caisley acknowledged "[w]e do believe that 70, 80 percent of the charging occurs at home."[50]

19. When challenged on his claim that 52% of households cannot park a car within 20 feet of an electrical outlet, and thus cannot charge at home, Caisley admitted he had no statistics on EV adoption levels by residents of multi-dwelling units and that since he presumed that such residents did their due diligence, he was not making a demand claim.[51] Accordingly, the Commission does not believe Caisley's testimony offers any reason to believe a significant number of KCP&L customers need the CCN.

20. In evaluating the credibility of the witnesses on the question of the necessity of the CCN program, the Commission finds KCP&L sorely lacking. KCP&L resorts to character assassination, questioning the seriousness of Glass's analysis, which KCP&L alleges arises to a lack of sincerity;[52] and questioning the expertise of both Frantz and Crane. Frantz is criticized for relying on online research.[53] Yet, KCP&L fails to support its conclusions with any studies or data. For example, during KCP&L's cross-examination of Frantz on whether the CCN is necessary for an EV driver who does not have a garage or access to an electrical outlet, Frantz testified that KCP&L did not provide any data to show any EV drivers were unable to charge their vehicles or that the vehicles were underused.[54] While neither KCP&L nor Staff performed any primary research or provided any data on the question of whether such customers exist or

[50] *Id.*, p. 58.
[51] *Id.*, pp. 63-63.
[52] Post-Hearing Reply Brief of Kansas City Power & Light Company, Aug. 5, 2016, ¶ 7.
[53] *Id.*, ¶ 4.
[54] Tr., p. 292 (Frantz Cross).

have experienced difficulty in charging their EVs,[55] KCP&L bears the burden of proving the necessity of the program. Therefore, the lack of supporting studies or data is fatal to their claim.

21. KCP&L relies on Crane's admitted lack of familiarity with the EV network in her home state of Connecticut to question her expertise.[56] But the Commission does not see the relevance in this line of attack. There is no evidence that Crane has consulted on Connecticut's network. Likewise, the record is devoid of any evidence on whether Connecticut has similar legislation to K.S.A. 66-101b. KCP&L tries to undermine Crane's ability to testify on the EV charging network as being outside the scope of her knowledge.[57] Yet her testimony deals with possible rate base treatment of the CCN.[58] Based on her numerous appearances before the Commission, where she has offered expert testimony on rate base treatment of programs, the Commission finds Crane qualified to offer her opinion on whether the CCN should be incorporated in rate base. The Commission agrees with Crane's recommendation that KCP&L's shareholders should absorb the CCN program costs since KCP&L took it upon itself to make the investment and the sheer size of the program.[59]

22. In evaluating the evidence presented, the Commission finds KCP&L did not introduce credible evidence supporting the need for the CCN. First, KCP&L fails to provide support for its claims that there is demand for such a large EV network. As envisioned, the CCN could support 12,000 EVs with no wait time for users, and as many as 25,000 EVs with moderate wait time.[60] But under the Electric Power Research Institute (EPRI)'s most optimistic estimate, there would still be less than 12,000 EVs in KCP&L's service territory by 2020.[61] KCP&L relies

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[55] *Id.*
[56] Post-Hearing Reply Brief of Kansas City Power & Light Company, ¶ 8.
[57] *Id.*, ¶ 8.
[58] Tr. p., 285 (Crane Cross).
[59] Tr., p. 285 (Crane Cross).
[60] Tr., p. 157 (Riggins Cross).
[61] Tr., p. 159 (Riggins Cross).

on EPRI to demonstrate demand for the EV network. EPRI also presents a more pessimistic estimate of 2,954 EVs by 2020, and an intermediate estimate of 8,245 by 2020.[62] Through February 2016, an estimated 969 EVs were sold in KCP&L's service territory.[63] Based on the few EVs sold thus far and the wildly varying estimates of future sales presented by EPRI, the Commission appreciates how speculative any demand for a charging station is and questions why ratepayers should fund a CCN scaled to EPRI's most optimistic projections.

23. Despite KCP&L's repeated claims of strong interest for the CCN from its customers, Caisley admits KCP&L did not keep track of residential customers who called his Marketing and Public Affairs Department about charging stations.[64] So, KCP&L has no evidentiary support for its claims of strong consumer interest. Instead, they are forced to extrapolate territory-wide demand based on a survey of 1,169 members of their Customer Advisory Online Panel.[65] In that survey, one-third of the respondents would consider purchasing an EV.[66] KCP&L attempts to use the survey of 1,169 to argue that one-third of its overall Kansas customer base would consider purchasing an EV.[67] It stretches credibility to think 70,000 KCP&L customers would consider purchasing an EV based on an online advisory panel survey of less than 1,200 customers. Not only is the Commission troubled that KCP&L is attempting to extrapolate system-wide demand based on its survey of its online advisory panel, the Commission notes the survey simply asks if they would "consider" purchasing an EV, not whether they were likely to purchase an EV. The distinction is critical. The same survey reveals

[62] *Id.*
[63] *Id.*, pp. 159-160.
[64] Tr. p. 105 (Caisley Cross).
[65] Tr., pp. 162-163 (Riggins Cross).
[66] Tr., p. 166 (Riggins Cross).
[67] Tr., pp. 168-169.

that 64% of KCP&L's customer advisory panel would not consider buying an EV even if KCP&L located a station in their area.[68]

24. If anything, the survey KCP&L relies on indicates there is little demand for the CCN. Darrin Ives, KCP&L's Vice President of Regulatory Affairs, acknowledged KCP&L could not demonstrate customer demand for the CCN when he testified, "while it is true that KCP&L does not have a specific forecast for the growth in EV purchases within the KCP&L service territory, the fact is that customers are demonstrating firsthand that there is a need and demand for the charging station."[69] KCP&L offers no measurable evidence of customer demand for the CCN. Therefore, the Commission cannot in good conscience ask ratepayers to finance the CCN based on mere conjecture.

25. If anything, KCP&L's own witnesses make the case for home charging of EVs or allowing private businesses and landlords to install their own stations, rather than building the CCN. As Caisley testified, "obviously overnight is when a lot of charging is going to occur or when you get to your place of employment, if you can charge there."[70] Since a significant amount of charging will take place overnight or at work, it is difficult to articulate a reason to have ratepayers fund the CCN. Caisley inadvertently advocated for in-home charging by analogizing the CCN to the internet. In his testimony, Caisley recalled going to his college library to access his email and wondering why anyone would ever go to the trouble of going to a computer lab to use email.[71] One of the reasons internet use is so widespread is it can be and is typically accessed on smart phones or on personal computers. People no longer need to go to computer labs or public libraries to use the internet. In other words, people use the internet

[68] Tr. p. 166 (Riggins Cross).
[69] Tr., p. 210 (Ives Cross).
[70] Tr., pp. 129-130 (Caisley).
[71] Tr., pp. 93-94 (Caisley Cross).

because it is convenient. It follows that people are more likely to purchase EVs if they can charge at home, rather than go to an EV station where there may be a wait or they have to leave their EV unattended for a lengthy period of time as the EV charges. It is far more convenient to charge a vehicle in the security of one's own garage or office parking lot. The EV industry is more likely to develop through home charging.

26. KCP&L has given the Commission no reason to believe the stations installed prior to the CCN are inadequate to meet the needs of current and future EV owners. As Smart testified, there are already 92 stations installed at universities, municipalities, and private businesses. Those entities have demonstrated a willingness to finance those stations as an incentive for customers to use their business or rent at their apartment buildings. Similarly, Ives testified that several employers in the Kansas City metropolitan area have installed EV charging stations as a benefit to their employees, guests and customers.[72] In testifying that a number of entities have advised KCP&L that they are never going to charge drivers to use their stations because the entities believe it incentivizes customers to come to their locations, Caisley leads the Commission to believe the best approach is to let private industry install stations as they will be the beneficiaries of increased business.[73] In other words, let the private sector invest in the EV market, rather than have ratepayers finance the speculative venture.

27. Another reason to conclude that the CCN is not necessary to provide service is that KCP&L has no plans on how to proceed if the Commission denies its Application.[74] If the CCN were truly necessary, KCP&L would commit to building the network and having its shareholders finance the project. If KCP&L is as confident in EPRI's projections as it claims to

[72] Ives Rebuttal, p. 17.
[73] Tr., p. 92 (Caisley Cross).
[74] Tr., p. 132 (Caisley Cross).

be, KCP&L should be willing to invest its own money in the CCN as it stands to make a handsome profit if EV usage increases tenfold.

28. Since KCP&L fails to demonstrate the necessity of the CCN, the Commission must reject its Application. Besides there being no showing of necessity, the Commission is also troubled that the CCN might be technologically obsolete before the program expires. Frantz raised concerns that the CCN would not be "used and required to be used" throughout its expected lifespan due to wireless charging, Level 3 DC charging, and improved battery life.[75] Rather than provide facts to support why the CCN will remain used and useful throughout its expected ten-year lifespan, KCP&L engages in pure speculation. Caisley testified, "even if there is inductive charging that is not widespread and useable at that point, we fully expect from our conversations with auto manufacturers, we expect that the Level 2 and Level 3 plugs will still be on every vehicle and not obsolete".[76] Again, in contrast to Frantz's research and reference to studies, KCP&L refers to its expectations, without providing any sources to support those expectations.

29. Even if the Commission were to have found there is a need for the CCN and that the program would be used and useful throughout its lifespan, there is still the issue of cross-subsidization. "One class of consumers should not be burdened with costs created by another class."[77] KCP&L's proposal presents three cross-subsidization concerns: (1) KCP&L customers in Leavenworth, Miami, Wyandotte, and Linn Counties may be subsidizing Johnson County EV owners since all of the stations are deployed in Johnson County;[78] (2) the 275,000-300,000

[75] Frantz Direct, pp . 9, 11-13.
[76] Tr., p. 127 (Caisley Cross).
[77] *Jones v. Kansas Gas & Elec.*, 222 Kan. 390, 401 (1977).
[78] Post-Hearing Brief of the Citizens' Utility Ratepayer Board (CURB Brief), July 29, 2016, p. 25.

Kansas jurisdictional customers[79] will be subsidizing the approximately 1,000 EV owners in KCP&L's service territory; and (3) the EV owners that will benefit are generally high income earners, who will be subsidized by lower income individuals unable to afford EVs.[80] KCP&L's response to concerns over cross-subsidization is essentially all consumers will benefit through cleaner air and increased load, which will spread the overall fixed costs of its system over more kilowatts.[81]

30. The Commission is not convinced that there are benefits to non-EV owners that outweigh its concerns over cross-subsidization. Daniel Bowermaster, a Program Manager at EPRI, who testified on behalf of KCP&L, explained charging an average EV using KCP&L's generation fleet results in power plant emissions equivalent to emissions produced by a gasoline powered vehicle with a 35 mpg fuel economy rating.[82] To conclude there is an environmental benefit, Bowermaster compared that fuel economy to a 25.3 mpg average for new vehicles.[83] On cross-examination, Bowermaster refused to hypothesize whether EVs would replace smaller sedans with higher fuel economies or larger vehicles with lower fuel economies.[84] Based on Bowermaster's testimony, it is far from certain the CCN would produce environmental benefits sufficient to overcome cross-subsidization concerns. Even if KCP&L could demonstrate environmental benefits from the CCN, the Commission has previously rejected societal tests, recognizing that it is too difficult to quantify indirect societal environmental and health benefits.[85]

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[79] Tr., p. 104 (Caisley Cross).
[80] CURB Brief, p. 23.
[81] Ives Rebuttal, p. 20.
[82] Tr., p. 150 (Bowermaster Cross).
[83] *Id.*
[84] *Id.*, pp. 150-152 (Bowermaster Cross).
[85] Order, Docket No. 12-GIMX-337-GIV, March 6, 2013, ¶ 15.

31. The Commission also questions whether additional off-peak electricity sales will occur. As Ives admits, KCP&L has not conducted statistical modeling or forecasting to support its assumptions of future EV load.[86] More importantly, KCP&L's argument of additional off-peak sales is based on nighttime home charging.[87] If anything, the CCN would compete with nighttime home charging. If the CCN deterred nighttime home charging, it might actually impair off-peak sales and cause more electricity sales during peak hours. Again, the supposed benefit of additional load does not overcome concerns related to cross-subsidization.

32. At the time of its announcement, the CCN would have been the largest EV charging network in the country. While KCP&L repeatedly characterizes the CCN as a pilot plan, its scale exceeds that of a typical pilot program. KCP&L downplays its earlier pilot program, a partnership with the United States Department of Energy (DOE), which began around 2012 with approximately 50 stations.[88] The Commission questioned why KCP&L seeks to expand the scale of stations from 50 to 1,000.[89] Essentially, KCP&L explained the pilot program was too small in scope and not supported with enough advertising to affect customer behavior.[90] The lesson KCP&L apparently learned from its pilot program with DOE was not that there was insufficient demand for charging stations, but that the program was not large enough to stimulate demand. The Commission reaches a far different conclusion -- the results of the pilot program do not justify rapid expansion of the build out of charging stations at the ratepayers' expense.

33. Frantz raised an additional reason to discount the utilization data – it did not account for how customers would react if they were asked to pay for the electricity at the EV

[86] Tr., p. 194.
[87] Post-Hearing Brief of Commission Staff, July 29, 2016, ¶ 57.
[88] Tr., p. 109 (Caisley Cross).
[89] Tr., p. 111.
[90] Tr., p. 112-113 (Caisley Cross).

stations.[91] Currently, EV drivers are using the charging stations without having to pay for their electricity. Frantz testified that by providing free electricity at the EV stations, KCP&L's already sparse demand data is skewed, and that once customers are required to pay for the electricity, demand for charging outside the home will decline.[92] The Commission finds Frantz's reasoning compelling. It is a matter of common sense that individuals may be very willing to accept something free, but scoff at having to purchase that same item. Until KCP&L actually charges its customers for using the EV stations, the data collected from its EV charging stations is suspect.

34. KCP&L claims it will take several years to gather sufficient data to draw reasonable conclusions from the CCN.[93] Based on that timeframe, the Commission questions the timing of KCP&L's Application. Adding to the Commission's consternation is Caisley's testimony that it takes upwards of one year to plan and install a station.[94] The Commission believes KCP&L would have been better served to gradually expand its EV network and seek approval of the CCN after it had sufficient data to establish actual demand for the program.

35. The Commission denies KCP&L's request to have ratepayers finance the CCN. The evidence demonstrates the CCN is not necessary. To the contrary, private businesses are already installing stations to incentivize customers, employees, and guests. Rather than burden the ratepayers, the Commission believes either KCP&L shareholders or private businesses should bear the costs of building and operating EV charging stations, as they are the beneficiaries of increased EV ownership. Relying on the private sector to finance an EV network also eliminates concerns of cross-subsidization.

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[91] Frantz Direct, p. 8.
[92] *Id.*
[93] *Id.*
[94] Caisley Rebuttal., p. 8.

THEREFORE, THE COMMISSION ORDERS:

A. KCP&L's Application for approval of its Clean Charge Network project and electric vehicle charging station tariff is denied.

B. The parties have 15 days from the date of electronic service of this Order to petition for reconsideration.[95]

C. The Commission retains jurisdiction over the subject matter and parties for the purpose of entering such further orders as it deems necessary.

BY THE COMMISSION IT IS SO ORDERED.

Emler, Chairman; Albrecht, Commissioner; Apple, Commissioner

Dated: SEP 13 2016

Amy L. Gilbert
Secretary to the Commission

BGF

EMAILED

SEP 13 2016

[95] K.S.A. 66-118b; K.S.A. 77-529(a)(1).

CERTIFICATE OF SERVICE

16-KCPE-160-MIS

I, the undersigned, certify that the true copy of the attached Order has been served to the following parties by means of Electronic Service on SEP 13 2016.

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/S/ DeeAnn Shupe
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EMAILED

SEP 13 2016

Exhibit No.:	
Issue(s):	EV Charging Station Policy
Witness/Type of Exhibit:	Marke/Surrebuttal
Sponsoring Party:	Public Counsel
File No.:	ET-2016-0246

SURREBUTTAL TESTIMONY

OF

GEOFF MARKE

Submitted on Behalf of
the Office of the Public Counsel

**UNION ELECTRIC COMPANY D/B/A
AMEREN MISSOURI'S**

File No. ET-2016-0246

December 19, 2016

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 a Tariff Setting a Rate for Electric Vehicle Charging Stations.	))))	File No. ET-2016-0246

AFFIDAVIT OF GEOFF MARKE

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Geoff Marke, of lawful age and being first duly sworn, deposes and states:

1. My name is Geoff Marke. I am a Regulatory Economist for the Office of the Public Counsel.

2. Attached hereto and made a part hereof for all purposes is my surrebuttal testimony.

3. I hereby swear and affirm that my statements contained in the attached testimony are true and correct to the best of my knowledge and belief.

Geoff Marke
Regulatory Economist

Subscribed and sworn to me this 19th day of December 2016.

JERENE A. BUCKMAN
My Commission Expires
August 23, 2017
Cole County
Commission #13754037

Jerene A. Buckman
Notary Public

My Commission expires August 23, 2017.

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SURREBUTTAL TESTIMONY

OF

GEOFF MARKE

UNION ELECTRIC COMPANY

d/b/a Ameren Missouri

CASE NO. ET-2016-0246

I. INTRODUCTION

Q. Please state your name, title and business address.

A. Geoff Marke, PhD, Economist, Office of the Public Counsel (OPC or Public Counsel), P.O. Box 2230, Jefferson City, Missouri 65102.

Q. Are you the same Dr. Marke that filed rebuttal testimony in ET-2016-0246?

A. Yes.

Q. What is the purpose of your surrebuttal testimony?

A. The purpose of this rebuttal testimony is to respond to the surrebuttal testimony of Sierra Club witness Douglas Jester regarding:

- Misuse and omission of the National Academy of Science Report;
- Impact on "Missouri" electric rates; and
- Missouri's economic-fuel dependence argument.

Q. Has OPC's position changed since rebuttal testimony?

A. It has not. OPC continues to recommend the Commission reject Ameren Missouri's request and states that both ratepayers and drivers are best served by a competitive market for EV charging services rather than by a regulated monopoly. There is no reason why a *non-regulated* affiliate of Ameren Missouri could be created to provide this nonessential service.

OPC believes that Ameren Missouri's *regulated* services can best enable the promotion of EV adoption by emphasizing its essential services, primarily through offering time-of-use ("TOU") rates on an opt-in basis that encourages charging during low-cost, off-peak hours. At this initial stage, this can best be promoted by educating customers and vehicle dealers on the value proposition of off-peak charging rates.

Ameren Missouri's proposal to recover EV charging station costs "above the line" is not prudent or justified. This is especially true when Ameren Missouri's entry will create barriers to entry from competition to provide a non-essential service. The Commission should leave deployment of EV charging infrastructure non-regulated services and importantly, to existing and future free-market competition.

II. RESPONSE TO SIERRA CLUB

Q. Please summarize the Sierra Club's position in this filing?

A. The Sierra Club is in support of Ameren Missouri's pilot project. Sierra Club witness Douglas Jester believes that ratepayer subsidies are warranted in the short-run but that at some unspecified time in the future, costs of charging should be borne solely by EV drivers. Mr. Jester also makes the recommendation the Commission clarify that non-utility owners and operators of EV charging stations who would offer the same service, are not public utilities subject to the Commission's oversight.

The latter recommendation is a curious position given that one page earlier, Mr. Jester suggests the Commission oversee pricing on utility-invested-charging infrastructure for fear of price gorging:

> At the same time, during market development most charging stations will be local monopolies in which the unregulated pricing could be excessive, risking electricity prices that eliminate fuel cost savings and may likely exceed gasoline prices, so the Commission should ensure that pricing is

appropriate for use of charging stations in which Ameren Missouri invests, regardless of whether those stations are owned and operated by the utility or a third party.[1]

Mr. Jester apparently has no concerns regarding excessive pricing for charging stations not owned by public utilities.

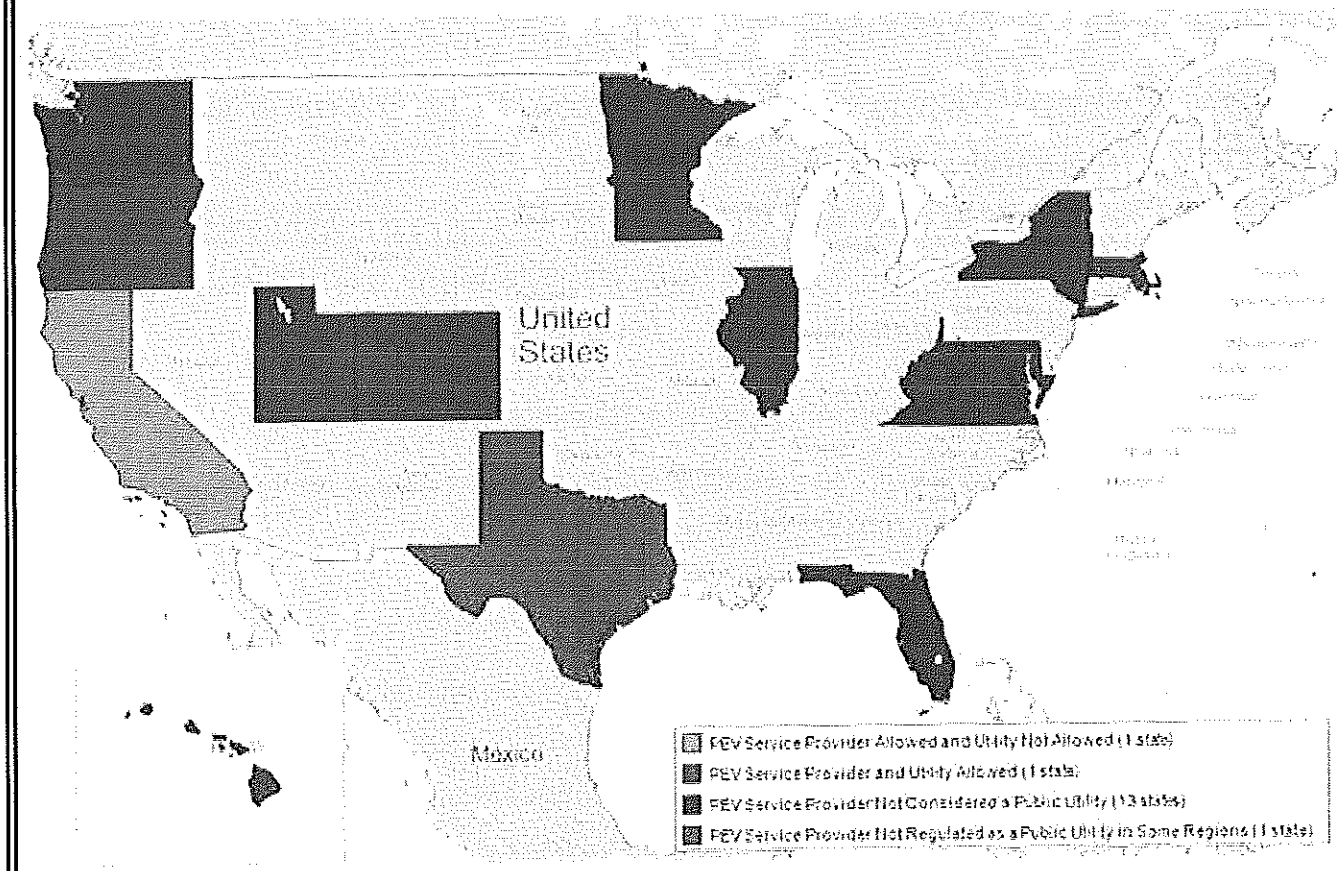
Q. Do you agree with Mr. Jester's conclusions?

A. No, from an economic perspective, the argument is wrong. The price of any product is simply the market price, or the price people are prepared to pay. It is simply an automatic function of supply and demand. Imposing governmental restrictions on pricing for *nonessential electric services* can produce unintended consequences that distort the market and the "real" cost of the service. There may be situations where inefficient markets require government intervention but these situations should be handled with the utmost care. Centralized, command-and-control planning has historically not been a viable economic model in which to operate.

OPC's position remains that if Ameren Missouri wants to install EV charging infrastructure, it should be done as a non-regulated service. Further, third party providers should not be regulated as public utilities. This position is also consistent with the majority of states that have formally taken a position on the regulatory treatment of EV charging stations. Figure 1, taken from the National Academies of Science Report and referenced in Mr. Jester's rebuttal testimony, is reprinted below.

[1] ET-2016-0246 Rebuttal Testimony of Douglas Jester p. 30, 4-9.

Figure 1: States that have regulations regarding who can own or operate charging stations[2]



Misuse and Omission of the National Academies of Science Report

Q. What is the National Academies of Science?

A. The National Academies of Sciences, Engineering, and Medicine are private, nonprofit institutions that provide independent, expert advice on scientific matters. Their charter was formed in 1863 by President Lincoln to "investigate, examine, experiment, and report upon any subject of science." The National Academy of Sciences eventually expanded to include

[2] The National Academies Press (2015) Overcoming barriers to deployment of plug-in electric vehicles. https://www.nap.edu/catalog/21725/overcoming-barriers-to-deployment-of-plug-in-electric-vehicles

the National Research Council in 1916 and later the National Academy of Engineering (1964) and Medicine (1970).[3]

Q. What National Academies of Science report did Mr. Jester reference in his testimony?

A. The National Academies of Science's subcommittee, the National Research Council, authored a report entitled *Overcoming Barriers to Deployment of Plug-In Electric Vehicles*. Excerpts from this report were cited in Mr. Jester's testimony and the entire 150 page document was included as an attachment.

Q. What conclusions does Mr. Jester draw from this report?

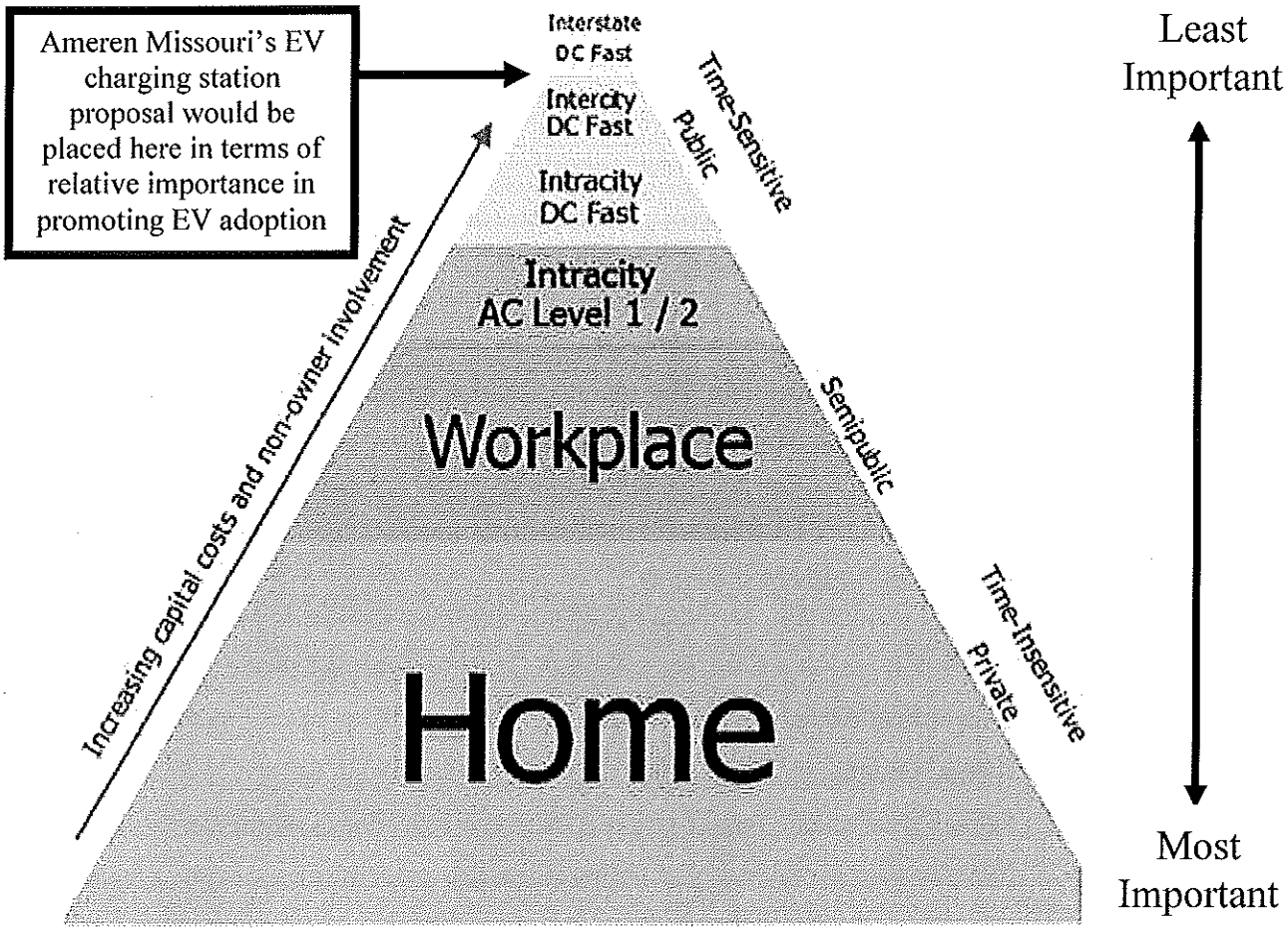
A. Mr. Jester implies that the National Research Council endorses rate base treatment of EV charging stations by investor owned electric utilities.

Q. Did your review of the report lead you to this conclusion?

A. No. The report places an unequivocal emphasis on the promotion of home charging followed by workplace charging. The report does not explicitly opine on interstate or intercity EV charging stations, and it is all together silent on rate base treatment by investor-owned electric utilities. There is a table in the report, reprinted in Figure 2 below, that includes the type of project Ameren Missouri is proposing and places it in terms of relative funding importance compared to other EV charging locations.

[3] National Academies of Sciences. (2016) Who we are.
http://www.nationalacademies.org/about/whoweare/index.html?_ga=1.36472800.1708491510.1480620147

Figure 2: Reprint of EV charging infrastructure ranked by importance by committee members[4]



Q. What was the National Research Council's explicitly stated concerns' regarding EV deployment as it pertains to the electricity sector?

A. The report states:

> Potential impediments to PEV adoption include (1) high electricity costs that reduce the financial benefit of PEV ownership, (2) regional differences in

[4] The National Academies Press (2015) Overcoming barriers to deployment of plug-in electric vehicles. https://www.nap.edu/catalog/21725/overcoming-barriers-to-deployment-of-plug-in-electric-vehicles

> electricity costs that add confusion and prevent a uniform explanation of the economic benefits of PEV ownership, (3) residential electric rate structures that provide no incentive to charge the vehicle at the optimal time for the utility, and (4) high costs for commercial and industrial customers if demand charges are incurred as noted above. The committee notes that state jurisdiction over retail electricity rates constrains the federal role in directing the electricity sector to foster PEV growth.[5]

The report places its emphasis and guidance for utilities clearly on the importance of pricing and consumer education. The report does not make any recommendations regarding utility-sponsored rate based treatment of EV charging stations.

Q. What was the National Research Council's recommendation regarding EV deployment as it pertains to the electricity sector?

A. The report states:

> **Recommendation**: To ensure that adopters of PEVs have incentives to charge vehicles at times when the costs of supplying energy is low, the federal government should propose that state regulatory commissions offer PEV owners the option of purchasing electricity under the time-of-use or real-time pricing.[6]

Q. Is this recommendation consistent with OPC's recommendation in this case?

A. Yes. The National Research Council's recommendation is consistent with OPC's recommendations in rebuttal testimony.

[5] Ibid.
[6] Ibid.

Q. What specific "non-recommendation" did the National Research Council make in its concluding remarks?

A. The report states:

> Equally important to recognize is a recommendation that the committee does not make. **The committee does not at this point recommend additional direct federal investment in the installation of public charging infrastructure until the relationship between infrastructure availability and PEV adoption and use is assessed** (emphasis added).[7]

Q. What implications do you draw from this conclusion?

A. This conclusion raises the question why it makes sense for Ameren Missouri's ratepayers to be charged for public EV charging infrastructure if the National Research Council no longer supports investment at the federal level. This further places the Sierra Club's endorsement in doubt.

Q. What empirical evidence been produced since publication of the National Research Council's report to substantiate a link between EV promotion and EV charging stations?

A. As stated in my rebuttal testimony, the Idaho National Laboratory released the results of a three-year study which captured the profiles for 125 million miles of driving and 6 million charging events through partnerships with states, electric utilities, and other stakeholders across 22 regions in the United States. The study reached the following conclusions:

> **The answer is clear: despite installation of extensive public charging infrastructure, in most of the project areas, the vast majority of charging was done at home and work.** About half the EV Project participants charged at home almost exclusively. Of those who charged

[7] Ibid.

away from home, the vast majority favored three or fewer away-from-home charging locations, with one or more of these locations being at work for some drivers. . . . In the end, it was apparent that exact factors that determine what makes a public charging station popular are predominantly community specific. More research is needed to pinpoint these local factors. Nevertheless, **the projects demonstrated that a ubiquitous charging network is not needed to support PEV driving**. Instead, charging infrastructure should be focused at home, workplaces, and in public "hot spots," where demand for AC Level 2 EVSE or DCFC stations is high (emphasis added).[8]

Impact on "Missouri" Electric Rates

Q. Please summarize Mr. Jester's fixed cost calculation of a fully electrified Missouri transportation sector.

A. Mr. Jester argues Missouri's entire electric utility revenue cost recovery can be generally broken down as 70% for generation and 30% for transmission, distribution, and other costs. Mr. Jester then posits that, if every vehicle mile traveled in Missouri were electrified, Missouri, as a whole, would produce an additional 28.364 terawatt hour ("TWh") of energy. If transmission, distribution, and other costs (30% total) were to remain static and generation (70%) remain unchanged (regardless of the increased load), then average rates across Missouri would collectively decrease by 8%. Note that Mr. Jester speaks for the entire state and not the area proposed by Ameren Missouri.

Q. How did Mr. Jester support his calculation?

A. There are no work papers accompanying Mr. Jester's testimony or any explanation provided otherwise on which utilities or what point in time he considered in making these assertions.

[8] Idaho National Laboratory (2016). Plug-in electric vehicle and infrastructure analysis. https://avt.inl.gov/default/files/pdf/arra/ARRAPEVnInfastructureFinalReportHqltySept2015.pdf

Q. Do you agree?

A. No. Mr. Jester's conclusions have no basis in reality. There are entirely too many variables involved in his hypothesis for it to be taken seriously. The simple fact that this calculation is Missouri-specific as opposed to Ameren Missouri-specific should give readers pause. The Commission should not be distracted by sweeping proclamations void of data and substance and should dismiss such cavalier conjectures in total.

Q. Does Mr. Jester opine on any Ameren Missouri specific inputs?

A. He does. As referenced earlier in my testimony, Mr. Jester claims that:

> Ameren Missouri's 2013 Demand-Side Management Potential Study estimated economic potential electricity efficiency as 22.9% of baseline 2030 sales absent energy efficiency programs.[9]

According to Mr. Jester, such energy savings could mitigate two-thirds of the increased load from fully electrifying transportation in Ameren Missouri's service territory.

Q. Do you agree?

A. No. There are many things wrong with this conclusion. Chief among them is the omission of any consideration of costs needed to achieve a 22.9% reduction in energy use from ratepayer-funded energy efficiency programs.

Based on my professional experience, such energy savings would: (1) require billions of dollars in ratepayer expenditures, (2) be burdened with many potential unintended consequences (e.g., pronounced cost shifting and equity issues) (3) become increasingly more expensive as energy savings returns diminished, and (4) be subject to the whims of individual market adoption rates. These expected savings (and associated costs) would also have to

[9] ET-2016-0246 Rebuttal Testimony of Douglas Jester p. 15, 17-19.

adjust to changes in socio-economic patterns in the overall population as well as any pronounced temperature variation (e.g., increase in cooling degree days means more hours of an air conditioner) or other confounding variables (emergence of new technology).

I am unaware of any utility, anywhere, claiming such savings solely from ratepayer-funded energy efficiency investments.

It is "inappropriate" to assert that the "average" ratepayer would see an 8% reduction in their bill from an electrified transportation system.

Q. Mr. Jester justifies Ameren Missouri's proposal, in part, because it is "limited" and small in scale. Do you agree?

A. No. OPC does not support this proposal, regardless of the size, for the reasons articulated in OPC's previous testimony. The scale of this project is irrelevant to the question of whether this project is a regulated service. Even though Ameren Missouri is describing this as a pilot project, Commission approval of the proposal would ignore Ameren's plans outlined publically in EW-2016-0313, "The Working Case to Consider Policies to Improve Electric Utility Regulation." In that filing, the Company outlined plans that include putting $43 million in rates over a five-year period to fund vehicle/equipment electrification. See Figure 3 below:

Figure 3: Excerpt from Ameren Missouri's "Building a Smarter Energy Grid for the Future"[10]

Sustainable Energy, Micro-Grid & Vehicle/Equipment Electrification[1,2]:

$43 million allocated for 2018-2022

Solar Partnerships		$ 10	$ 10	$ 10	$ 10	-
Micro-Grid Projects		$ 10	-	$ 10	-	$ 10
EV Charging, Metro Link EV, Industrial Equip. Electrification		$ 5	$ 8	$ 10	$ 10	$ 10
Universal Solar (Montgomery)		-	-	-	-	$ 30
Total		$ 25	$ 18	$ 30	$ 20	$ 50

	Years					
	2018	2019	2020	2021	2022	Years 1-5 Total
Investment Supportive Regulatory Framework Incremental $s (M) - TOTAL:	$160	$188	$215	$210	$245	$1,018

[10] EW-2016-0313. Ameren Missouri. Item no. 58. "The critical need to replace aging electric infrastructure and build a smarter and more efficient grid to meet customer's needs and expectations.", Attachment A, Infrastructure Plan, p. 5.

Missouri's Economic-Fuel Dependence Argument

Q. Mr. Jester argues that Missouri is not a major oil producer or refiner and therefore local economies will benefit from electrifying the State's transportation. Do you agree?

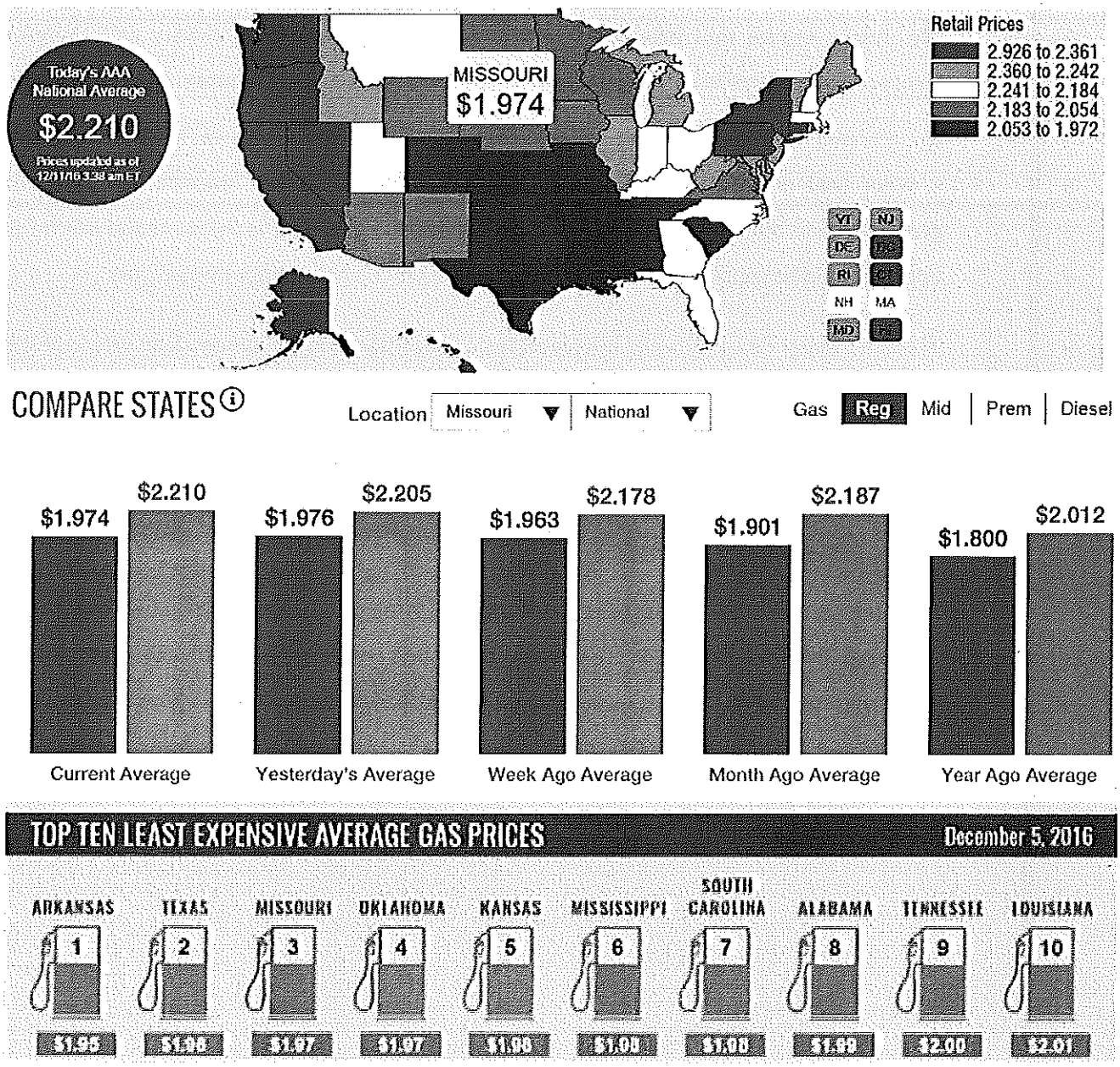
A. No. It is true that Missouri is not a major oil producer or refiner. However, Missouri is also not a major coal or natural gas producer or refiner. Missouri largely imports both its power generation and transportation fuel. Mr. Jester's unstated inference is that coal and natural gas imports could be supplanted by locally produced solar or wind energy investments.

There are many flaws with that inference, not least of which is the intermediate nature of solar and wind generation. Putting aside the very real substantive issue of reliability for a moment, if Ameren Missouri's power generation were to fundamentally change in total it would further call into question Mr. Jester's cost savings calculations referenced earlier.

Q. Is Missouri uniquely at risk from future fuel shocks?

A. No more than the rest of the country currently enjoying pronounced levels of extraction from improved fracking technology. Missouri also enjoys some of the least expensive gasoline prices in the United States as seen from in Figure 4 with data produced from the American Automobile Association ("AAA"):

Figure 4: AAA Missouri and National Gas Prices first week of December 2016[11]



[11] AAA(2016) Gas Prices, State Gas Prices. http://gasprices.aaa.com/ & http://gasprices.aaa.com/?state=MO

Missouri's central location means that it is crisscrossed with both crude oil and gasoline pipelines linked to refineries throughout the US allowing it easy access to more affordable fossil fuels. Moreover, Missouri has some of the lowest gasoline taxes in the United States allowing prices at the gasoline pump to be some of the most competitive in the nation.[12]

Such low gasoline prices combined with a pronounced carbon intensive power generation fuel mix, suggests Missouri is not an attractive location to promote "first-mover" EV policy either from an economic or environmental perspective.

Q. Does this conclude your testimony?

A. Yes.

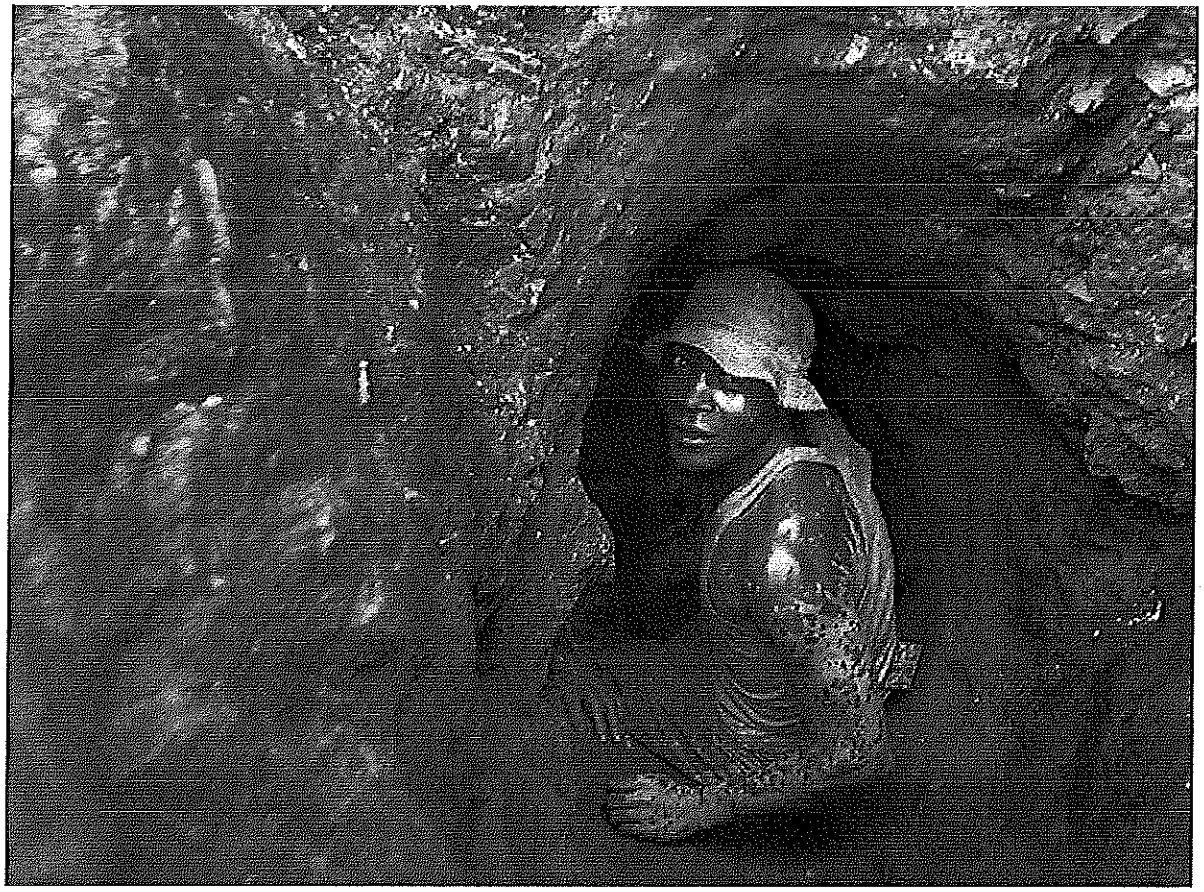
[12] Altman, M. (2014) St. Louis Public Radio. Why does Missouri have the lowest gas prices in the country? http://news.stlpublicradio.org/post/why-does-missouri-have-lowest-gas-prices-country#stream/0

S&P Global

Cobalt key to electric vehicles but automakers hushed on risks

Tuesday, June 05, 2018 8:06 AM CT

By Michael Copley and Garrett Hering



A man enters a hand-dug tunnel at a cobalt mine in the Democratic Republic of the Congo.
Source: Associated Press

Automakers spending fortunes on a bet that electric vehicles are the industry's future are virtually silent on the mining risks tied to cobalt, a key metal for the batteries on which their plans depend.

Car companies expect evolving technology will eventually reduce or even eliminate their need for the blue metal ore, but, in the meantime, they could face pressure from investors who are asking questions about the new "blood diamond" and wondering why companies are not disclosing more information about their involvement with it.

A critical ingredient in lithium-ion batteries and a core enabling material in electric cars, energy storage systems, smartphones and other electronics, cobalt is chiefly mined in the Democratic Republic of the Congo, which accounted for 58% of global production in 2017 and 49% of world reserves, according to the U.S. Geological Survey. Tight global supplies recently have sent cobalt prices soaring to over $90,000 per metric ton on the London Metal Exchange, almost

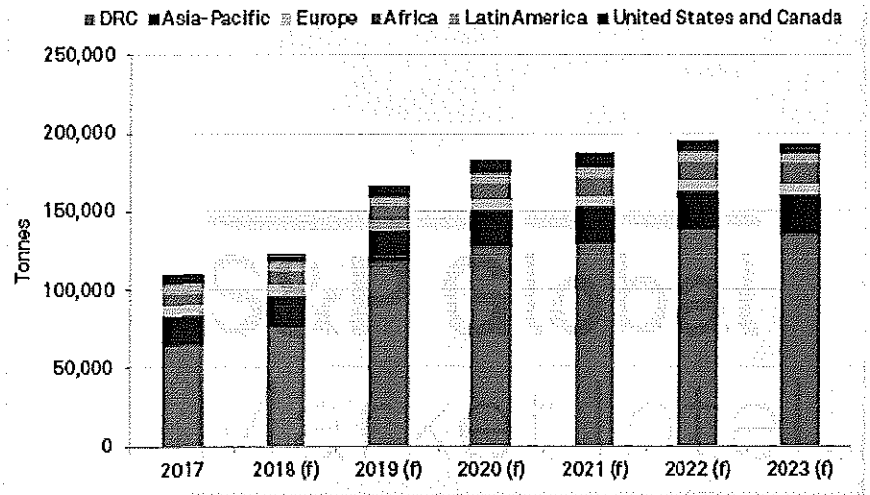
tripling since January 2017.

The DRC, which is already plagued by instability, political polarization and deficient infrastructure, could face more trouble with a long-awaited presidential election scheduled for December. The country is at an "inflection point" that could either lead to a "historic" democratic transition or to a "breakdown and ... a great deal of violence," Tom Perriello, a former U.S. special envoy to the Congo and eastern Africa, said in March at the Brookings Institution, a think tank in Washington, D.C.

In addition to supply-chain risks, human rights groups have routinely cited Congolese mines for child labor, forced evictions and water pollution, black marks that may be particularly troublesome for clean energy industries sold on their green credentials.

"We all see this cobalt pinch looming," Chris Berry, founder and president of House Mountain Partners, an advisory firm focused on raw material supply chains, said in an interview. "A large part of it has to do with the fact that it comes from the DRC, and it's just a very challenging place to do business, and there's just no easy solution here if [electric vehicle] adoption continues at its current pace."

Global cobalt production by region, 2017 - 2023



Reported and estimated supply datax.
Data as of April 27, 2018.
African production excludes the DRC.
f = forecast
Source: S&P Global Market Intelligence

The auto industry's reluctance to discuss the issue publicly is striking in light of the information mining companies provide.

General Motors Co., for example, which aims to roll out 20 new all-electric vehicles by 2023, has never mentioned the metal in filings to the U.S. Securities and Exchange Commission, according to a review of company documents by S&P Global Market Intelligence. Neither has Ford Motor Co., which plans to offer 16 electric vehicles by 2022.

Meanwhile, Glencore PLC Chairman Anthony Hayward said in an annual report in March that the Anglo-Swiss mining giant is working on human rights guidance for the commodities sector and on "addressing the challenges associated with the cobalt value chain." China Molybdenum Co. Ltd., another major producer, said in its latest annual report that an affiliate that mines cobalt and copper in the DRC is investing in water infrastructure, agricultural work programs and vocational training there to mitigate risks.

In February, Glencore CEO Ivan Glasenberg was asked how the company's cobalt customers were reacting to proposed DRC mining regulations that Glasenberg said could threaten future supplies: "We haven't heard" from automakers, he said. "But I'm sure they've got to look at it and monitor it just like what we're doing. ... [What] happens in the DRC is going to be very important going forward."

However, while Glencore executives have spoken at length about the relationship between cobalt and electric vehicles during the past two years, auto executives have rarely if ever commented on the subject, according to a review of

transcripts of corporate earnings calls.

Mining companies may operate in closer proximity to the Congo's problems, but electric-vehicle manufacturers are the ones driving demand for cobalt. And as consumer brands, they run the highest risk of a public backlash.

Automakers "can definitely do more to bring this ... to the attention of investors and stress more clearly what they're doing" to reduce risks, said Sonja Wallenborn, a research manager at Sustainalytics, an investment consulting firm focused on environmental, social and governance, or ESG, issues. "The main risk really stems from the automakers and not necessarily the companies delivering these resources."

A young man carries cobalt at a mine in the Democratic Republic of the Congo.
Source: Associated Press

Automakers engaging, if not disclosing

At the direction of Congress, the SEC in 2012 began requiring companies to disclose their use of the "conflict minerals" tin, tantalum, tungsten and gold that originate in the DRC or neighboring countries if those materials are "necessary to the functionality or production of a product." While cobalt was omitted from the list, analysts say that, for now, the metal is essential for electric vehicles. The U.S. Department of the Interior recently said cobalt is one of 35 minerals that are "critical" for America's economy and national security.

While some automakers have avoided discussing the topic openly, executives appear to be well aware of the risks in the cobalt supply chain — and are taking actions to avoid them.

At a March battery conference in Florida, Mark Verbrugge, director of General Motors' Chemical and Materials Systems Laboratory, said raw material supplies — particularly of cobalt — pose the biggest threat to battery producers. GM declined to say whether the risks Verbrugge identified also apply to electric vehicle makers. While the company's SEC filings do not flag any risks specifically tied to cobalt, a sustainability report on its website notes "human rights issues"

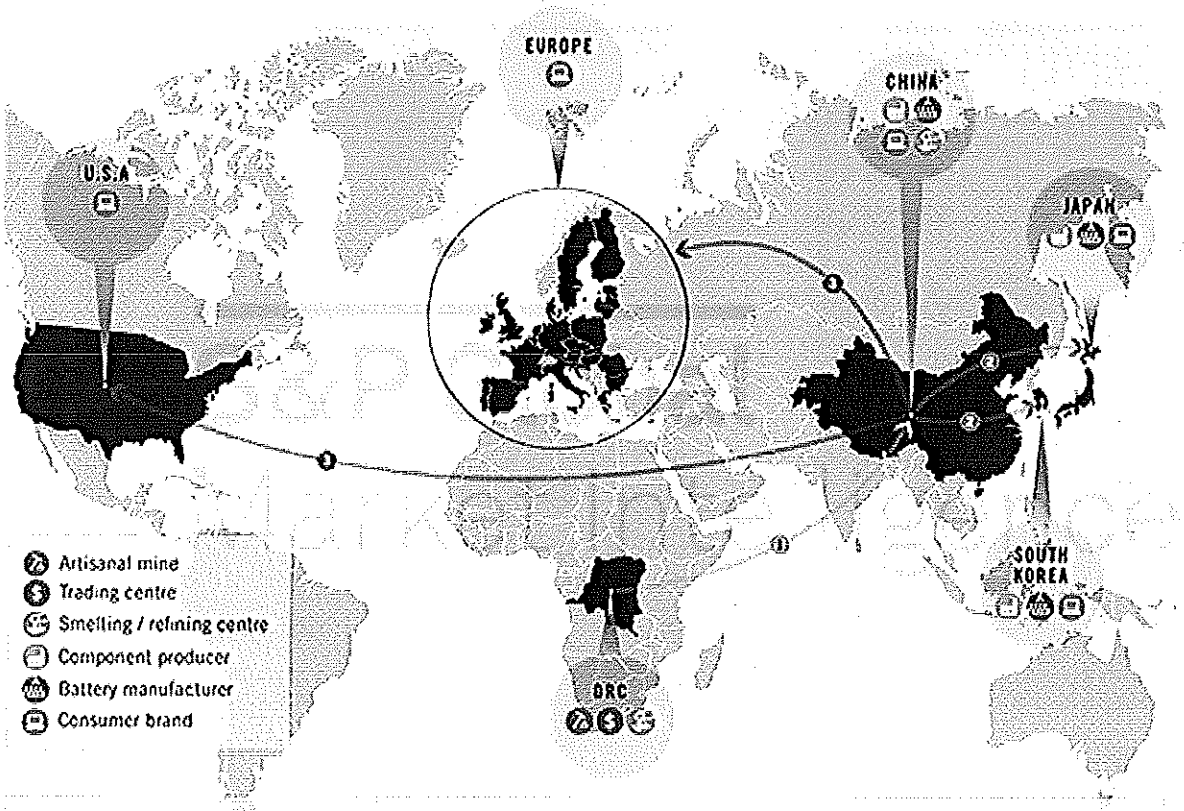
associated with the metal.

"We continue to work with our suppliers to reduce the amount of cobalt in our battery cells," GM spokesman Kevin Kelly wrote in an email. "GM does not source individual cell chemistry materials ourselves but we do assure that our suppliers meet our requirements for responsible sourcing."

Ford did not respond to messages seeking comment.

At a shareholder meeting May 10, Ford executives were asked about a CNN investigation of the cobalt supply chain. Ford is "committed to respecting human rights everywhere we operate," said Bradley Gayton, a vice president and the company's general counsel. "And that includes robust purchasing processes that we have, supplier training and education on human rights issues," as well as third-party social-responsibility audits for suppliers. Gayton referred shareholders to a sustainability report on Ford's website for more information. That document does not mention cobalt.

Movement of cobalt from artisanal mines in the DRC to the global market



1. Export of cobalt from DRC artisanal mines to China for processing. Over half the world's cobalt comes from the DRC, 20% of which is from artisanal mines.
2. Supply of processed cobalt to factories in Asia to make rechargeable batteries.
3. Supply of batteries to global technology and car companies.

Source: Amnesty International

A Tesla Inc. spokesperson said the electric vehicle and energy storage startup conducts "on-site audits to the best of our ability during the sourcing and vetting process for suppliers, to view operations and methods of risk management." Tesla mentioned cobalt twice in its latest annual report to the SEC, as one of a handful of materials that present supply and pricing risk; it did not identify any humanitarian concerns. The company has said that "the overwhelming majority" of its cobalt comes from outside of the DRC.

The annual report that Fiat Chrysler Automobiles NV filed with the SEC did not mention cobalt. However, a sustainability report posted on the company's website mentioned some of the "undesirable practices" related to cobalt and other raw materials. Fiat Chrysler, which is based in the U.K. but lists shares on the NYSE, did not respond to messages seeking comment.

Risk disclosures by electric-vehicle manufacturers listed outside of the U.S. have also been limited.

Germany's Volkswagen AG, which recently ordered €20 billion worth of lithium-ion batteries, mentioned cobalt once in its annual report, saying the metal carries pricing risk due to "political and economic uncertainty." In a sustainability report, the company said it directs suppliers to ensure their use of minerals, including cobalt, does not "directly or indirectly promote or support armed conflicts, and are in no way connected to human rights violations." Fellow German automakers Daimler AG and BMW AG did not address cobalt in their annual reports but did mention it in sustainability reports.

A young man carrying cobalt at a mine in the Democratic Republic of the Congo.
Source: Associated Press

Quietly, automakers have joined in partnerships intended to address some of cobalt's problems. One of the groups is working with Chinese refiners on a pilot program to improve supply chain transparency and reduce harm in the DRC. Another group, which includes Samsung SDI Co. Ltd., a battery affiliate of the South Korean electronics giant, is targeting "the worst forms of child labor."

However, initiatives like those are only "a start," said Nicholas Garrett, the CEO of RCS Global, a battery supply chain audit and advisory firm. Consumer brands "want to be seen on the right side of history," Garrett said. But "it would be extremely difficult to back up any child labor-free cobalt claim right now."

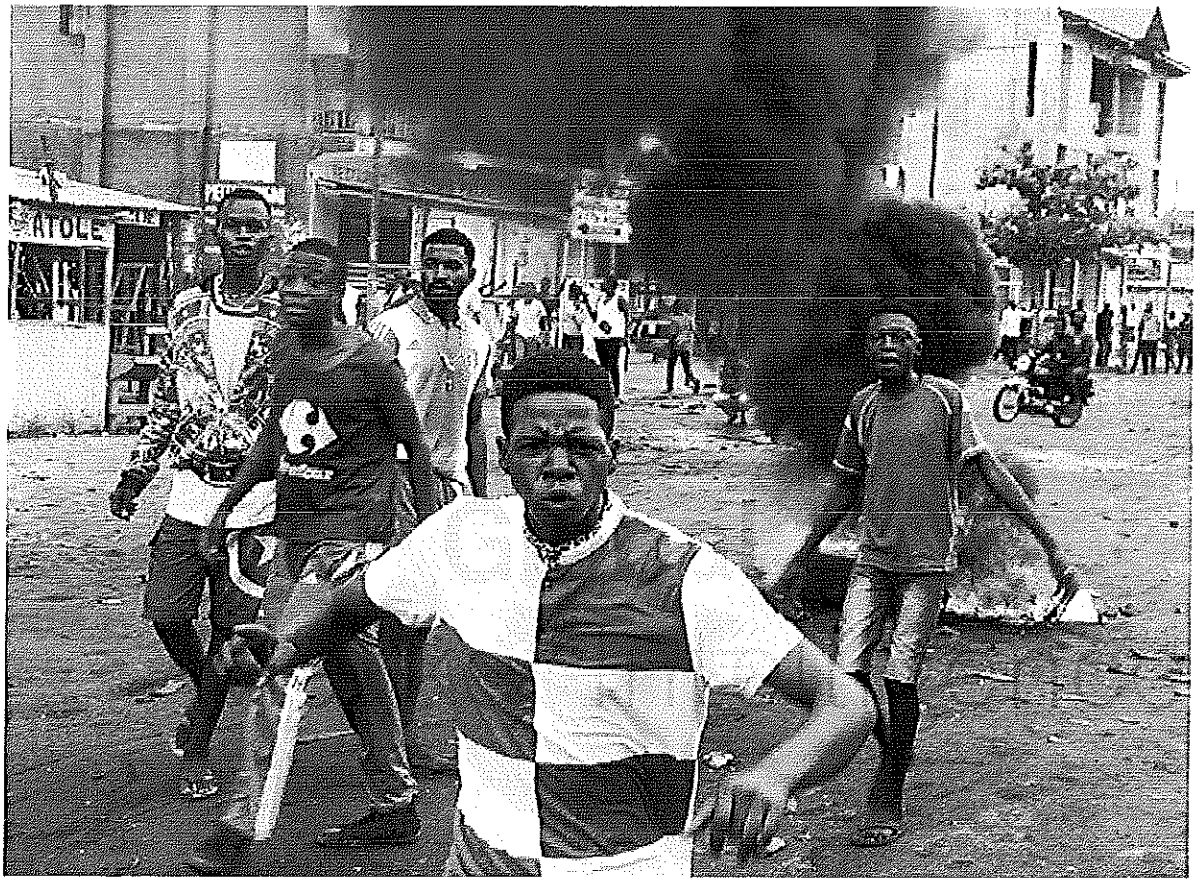
Amnesty International, a human rights group, said corporate due diligence alone cannot fix the human rights abuses in the cobalt supply chain. But "companies that are not performing due diligence in line with international standards risk contributing to, and benefiting from, those abuses," the group said in a 2017 report.

According to Amnesty International, GM and Daimler have made "minimal" efforts to detect, disclose and remediate human rights risks and abuses in their cobalt supply chains. Detection and disclosure efforts by Tesla, Fiat Chrysler and Volkswagen have also been minimal, though the companies have taken "moderate" steps to mitigate risks. BMW scored slightly better, taking moderate steps to detect and mitigate risks; however, disclosure by the company is still minimal,

Amnesty International said. The group did not evaluate Ford.

Amnesty International said it accounted for input from automakers who disputed their rankings before the report was published. GM, Daimler, Fiat Chrysler, Volkswagen and BMW did not respond to requests for comment. A Tesla spokesperson said the company has a human rights and conflict minerals policy for its suppliers and is "committed to only sourcing responsibly-produced materials."

Kristina Friedman, an ESG research analyst at Calvert Research and Management, said corporate initiatives around cobalt "significantly lag other conflict minerals disclosures where regulations, international frameworks, and reporting standards exist."



Congolese boys take part in a protest against President Joseph Kabila's refusal to step down from power in Kinshasa in 2017.
Source: Associated Press

New blood diamond

The stakes are high for the DRC, where the economics of resource extraction have been a major source of the country's woes, according to Omékongo Dibinga, a lecturer at American University's School of International Studies.

"It's not like people in eastern Congo ... want to stop producing the minerals that are in our phones and in our televisions," Dibinga said, but "they want to get paid for it. They want to get a livable wage. They want health insurance. They want to be able to not have to work sun up to sunset without a mine collapsing on them. And that's what people are in the street fighting for."

For many in the industry, though, avoiding the need for the mineral is exactly the plan.

"We think we can get the cobalt [usage] to almost nothing," Tesla Chairman and CEO Elon Musk told investors May 2.

Tesla's main battery cell supplier, Panasonic Corp., is reportedly working on a cobalt-free technology.

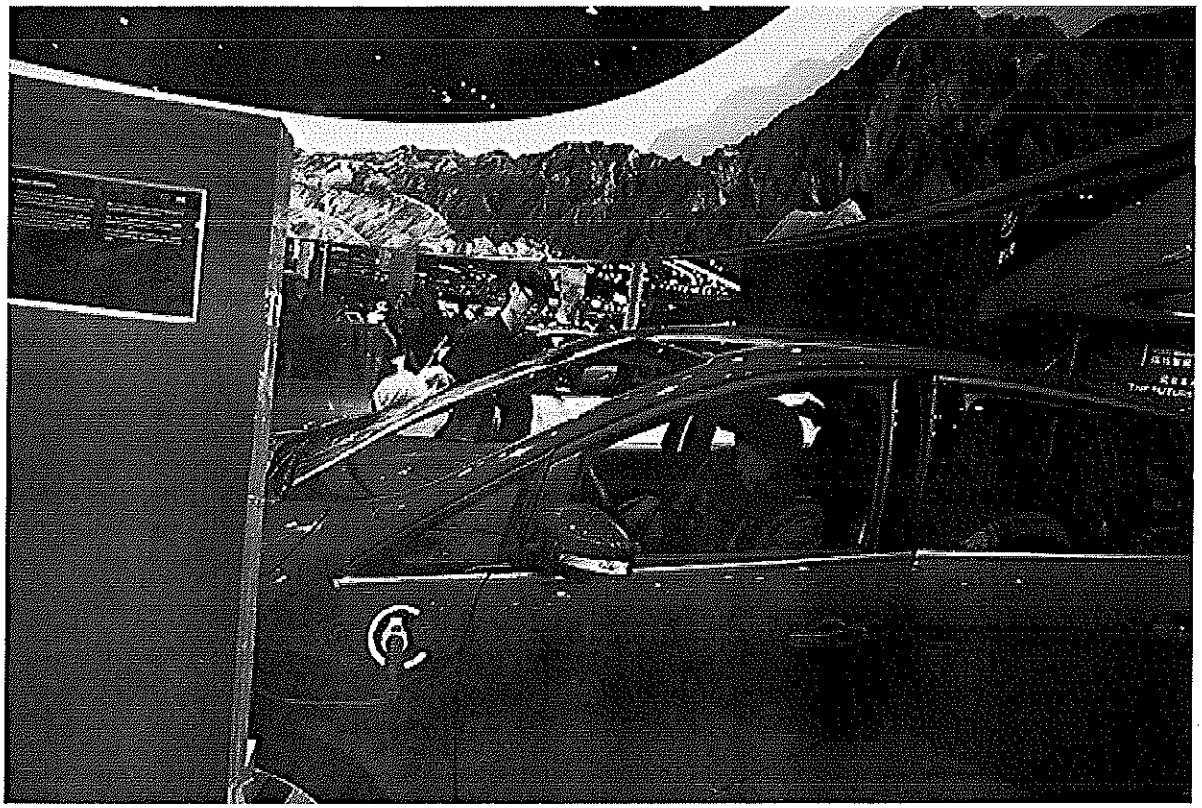
BYD Co. Ltd., a China-based manufacturer of electric vehicles, energy storage systems and batteries, relies on cobalt-free lithium-iron-phosphate batteries, in addition to batteries that use cobalt sourced from nickel mines it owns in China.

The company "has a roadmap to a sustainable future," Micheal Austin, vice president of subsidiary BYD America Corp., said. In addition to being "chemistry neutral," BYD advocates for comprehensive battery recycling programs.

Additionally, electric vehicle producers, including Nissan Motor Co. Ltd., Renault SA, Mitsubishi Motors Corp., Volkswagen and BMW, as well the U.S. Department of Energy's Advanced Research Projects Agency-Energy, are funding research and startups focused on low- to no-cobalt batteries.

Such alternatives, however, could take years to commercialize. In the meantime, big consumer electronics and auto brands are trying to lock up as much cobalt as possible in long-term supply deals, ensuring years of exposure to the metal's risks.

"There will be no electric vehicle industry without DRC cobalt," said Simon Moores, managing director of Benchmark Mineral Intelligence, an independent research firm. "It's really the new blood diamond. If investors start talking with their feet, these companies will start to take action."



A visitor sits in a Ford electric vehicle during the Shanghai International Automobile Industry Exhibition in China in 2017.
Source: Associated Press

'Why don't you start disclosing?'

The tension between the potential benefits and risks of electric vehicles is a familiar one to ESG investors, said Christopher Ailman, chief investment officer of the California State Teachers' Retirement System.

"That's what makes ESG [investing] so hard," Ailman said. "Sometimes the energy issues come with environmental

problems and social problems. So it's got to be balanced and all together." The key is for companies to identify those risks and explain "How do they see this, how are they adjusting, how are they planning for the future?" he said.

While companies in the U.S. are unlikely to face new requirements to report on their cobalt supplies any time soon — President Donald Trump in 2017 reportedly considered suspending the rule requiring companies to disclose their use of conflict minerals from the DRC — the risks related to cobalt are "increasingly getting on investors' radar," said Wallenborn of Sustainalytics.

As a result, automakers could find themselves under more pressure from investors.

"The question I'm always asking when I deal with companies is, are they learning from these errors, or [do] they just [not] care and ... see it as a cost of doing business? Do they really understand that there's an issue here with the branding or around their brand and the value of their brand?" Jeremy Cote, a research analyst at Trillium Asset Management LLC, said of companies exposed to ESG-related risks.

Cote added: "We need to show them these are our concerns ... and go through our process, which starts off with, 'Hey, why don't you start disclosing stuff?'"