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Witness: Philip Sheehy
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MISSOURI PUBLIC SERVICE COMMISSION

FILE NO. ET-2016-0246

SURREBUTTAL TESTIMONY

OF

PHILIP SHEEHY

ON

BEHALF OF

UNION ELECTRIC COMPANY
d/b/a Ameren Missouri

San Diego, California
December 19, 2016

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I. INTRODUCTION

Q. Please state your name and business address.

A. Philip Sheehy, ICF, 525 B Street, 17th floor, San Diego, California 92101.

Q. Please describe your educational background and employment experience.

A. I received a Bachelor of Arts Degree in Physics and Chemistry from Kalamazoo College in Kalamazoo, Michigan, and a Doctorate of Philosophy in Physical Chemistry from the Massachusetts Institute of Technology ("MIT"). At MIT, I served as a graduate researcher and graduate teaching assistant, during which time I taught undergraduate courses in chemistry. My research was focused on the kinetics and spectroscopy of small-molecules, with an emphasis on atmospheric chemical reactions. I also worked as a post-doctoral associate at the Molina Center for Energy and Environment ("Molina Center") in San Diego and at the University of California, Berkeley ("UC-Berkeley"). At the Molina Center, I was part of a field research team conducting and analyzing novel air quality measurements in Mexico City, one of the most polluted cities in North America. At UC-Berkeley, I researched the potential for using nano-sensors as part of a broader air quality monitoring network.

I am currently a Technical Director at ICF, a management consultancy, where I have worked since June 2010. My work focuses on the technical, regulatory, and economic drivers for the use of alternative and conventional transportation fuels and vehicle technologies. My consulting engagements include private and public entities,

with many recent and ongoing engagements on issues related to electric vehicles ("EVs"), including grid impact assessments of EVs, EV and charging infrastructure strategy development, EV readiness planning, and market forecasting. Prior to joining ICF, I was a Senior Scientist at TIAX LLC ("TIAX"), another consultancy. My work at TIAX was similarly focused on issues impacting the use of alternative and conventional transportation fuels and vehicle technologies.

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 currently serve as the Chair of the Infrastructure Working Group of the EV Everywhere Challenge, an initiative of the U.S. Department of Energy. I serve in this position on a volunteer basis. I am also a member of the Alternative Transportation Fuels and Technologies Committee of the Transportation Research Board, a division of the National Academies of Science. I was recently invited to speak at the California Energy Commission during a workshop regarding the inclusion of transportation electrification in integrated resource planning of California's publicly owned electric utilities as required by the Clean Energy and Pollution Reduction Act of 2015 (SB 350, de León, Chapter 547, Statutes of 2015).

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

A. On behalf of Union Electric Company d/b/a Ameren Missouri ("Ameren Missouri" or "Company"), I am providing this testimony in response to the testimonies filed by other individuals in this proceeding that question the need for an EV pilot to assist in developing the market, particularly the testimonies of Dr. Geoff Marke on behalf of the Office of Public Counsel ("OPC") and Ms. Anne Smart on behalf of ChargePoint, Inc. ("ChargePoint"). My testimony will explain how Ameren Missouri's EV pilot program aligns with current market and policy trends observed in many other states, and will address various inaccuracies in rebuttal testimony that might confuse the case before

the Commission. Please note, just because I have not specifically addressed an argument presented by a party in his or her rebuttal testimony does not mean Ameren Missouri is acquiescing to that argument.

Q. How is your testimony organized?

A. The first section of my testimony addresses the market for electric vehicles and electric vehicle charging infrastructure; the second section discussions the potential engagement of utilities in these markets; and the third section addresses specific aspects of rebuttal testimony that I found inaccurate, misleading, or irrelevant in the context of Ameren Missouri's proposed pilot project.

I. EV and Charging Infrastructure Markets

Q. What is the status of the market for EVs?

A. As of early December 2016, nearly 540,000 EVs have been sold nationally since 2011. Despite persistently low gasoline prices for the past 12 to 18 months, new sales of EVs have held steady. The number of manufacturers offering EVs has increased over the same timeframe, as well as the number of models offered for sale or lease. As a point of comparison, the rate of adoption of EVs today is actually out-pacing the rate of adoption of hybrid vehicles at the same time in their market deployment.

Q. What is the status of the market for electric vehicle charging infrastructure?

A. The electric vehicle charging infrastructure market continues to evolve rapidly. It is important to understand that there are many market participants related to EV charging infrastructure. The rebuttal testimony of Dr. Marke appears to over-simplify the market via the use of sweeping generic terms and discussion of "fair, efficient competition," "market efficiencies," and "competitive markets," all of which are introduced without quantification or even qualitative characterization. The rebuttal testimony of Ms. Smart makes reference to the so-called "attach rate," the ratio of EV

drivers to EV charging ports, as some sort of measure of the market successfully providing needed charging infrastructure to support future EV adoption. While a convenient quantitative metric, it is not widely accepted as some indicator of market success. The initial wave of EV charging infrastructure, for instance, was largely deployed on an *ad hoc* basis with, at most, modest planning. With state and federal grant programs providing the initial wave of funding support for publicly accessible EV charging infrastructure deployment, the emphasis was on meeting goals and deadlines, and getting hardware in the ground, preferably in high profile locations rather than in areas designed to maximize utilization. All that to say, the "attach rate" is, at best, a shallow metric of EV charging market success.

Understanding the status of the EV charging infrastructure market requires a better understanding of the market participants, which include hardware and equipment manufacturers, installers and maintenance providers, charging station owners or hosts, network operators, system operators, and utility providers (as outlined in Table 1 below).

Market Participant	**Brief Description**
Hardware Manufacturer / Equipment Retailer	Manufactures the electric vehicle supply equipment ("EVSE") that is installed; may be branded or unbranded. Manufacturers may also sell their equipment directly to market or to network managers/operators (i.e., retailer).
Installers / Maintenance providers	Installs EVSE; in some cases installers also provide routine maintenance for the equipment.
Charging station owner / host	Entity that owns or hosts the equipment, such as a retail outlet. May also resell electricity to Plug-in Electric Vehicle ("PEV") driver.
Charging Station Network Operator	Has the ability to connect, control, and monitor charging stations on its network; generally provides metering capability. Collects payment from users (potentially on behalf of charging station owners); may also resell electricity to PEV driver.
System operator	The California Independent System Operator (ISO) provides open and non-discriminatory access to the state's wholesale transmission grid. There are several Publicly Owned Utility-based organizations that provide system operations as well.
Utility provider	Electrical utilities in California–including investor- and publicly-owned utilities.

There are a variety of business models in the market today that bundle the aforementioned services; some providers only sell the physical hardware or networking

services to site hosts, whereas others sell both services. In some cases, site hosts own and operate the infrastructure; in some cases, the installer maintains ownership.

The EV charging infrastructure market has had high profile failures (e.g., ECOtality's bankruptcy after receiving and implementing the EV Project, a project funded in part by a $115 million federal grant and the bankruptcy of Better Place), unscrupulous activity (e.g., the allegedly fraudulent activity of 350 Green), and significant consolidation over the last several years (coincidentally, both ECOtality and 350 Green were purchased by Car Charging Group).

At the same time, some members of the investment community have continued to demonstrate support for EV charging service providers, highlighted by a $50 million round of funding for ChargePoint and NRG's spin-off of its eVgo service to Vision Ridge Partners.

Q. Is third party ownership of EV charging infrastructure a sustainable revenue model?

A. It is unclear at this time. However, there is good reason to be skeptical of the underlying revenue model, which is based on the resale of electricity, a commodity that is inexpensive compared to the high cost of charging infrastructure. For instance, publicly accessible charging installations of Level 2 EVSE can cost in excess of $10,000 in some cases, whereas DC fast charge EVSE installations can cost in excess of $150,000. Many industry observers and market analysts believe that investing in publicly accessible charging infrastructure may be predicated on an unsustainable revenue model if the charging transactions are the sole source of revenue and the only business driver to deploy charging stations. For instance, in a report entitled *Overcoming Barriers to Electric-Vehicle Deployment*, the National Academy of Sciences (NAS) states that the high cost of installing public charging stations and the minimal revenue obtained from providing electricity present challenges for developing business models.

Furthermore, the demand for non-home charging is unclear due to many variables, including the EV architecture that is deployed (full battery electric, plug-in hybrid electric, or so-called extended range electric vehicles), battery technology, the availability of charging, consumer willingness to pay, and driver behavior (e.g., non-residential dwell time and daily vehicle miles traveled).

II. Overview of Utility Engagement in EV Charging Infrastructure Market

Q. How are utilities engaging in EV charging infrastructure?

A. Multiple jurisdictions across the country are grappling with the finer points of promoting EV adoption, including how much charging infrastructure is or will be required, and how to finance EV charging infrastructure. State legislatures and public utility commissions are seeking to understand how utilities should be involved.

California is at the forefront of this issue, with three investor owned utility ("IOU") charging infrastructure pilot projects approved by the California Public Utilities Commission ("CPUC"): Southern California Edison ("SCE"), San Diego Gas and Electric ("SDG&E"), and Pacific Gas and Electric Company ("PG&E"). SCE's Charge Ready Program includes $22 million in ratepayer spending on 1,500 charging stations. The way the program is structured, SCE retains ownership of the electrical infrastructure and provides financing, whereas customers are allowed to select, own, and maintain charging stations. The project also allows third party providers to own and/or maintain the equipment. SDG&E's Vehicle-Grid Integration Program includes the installation of 3,500 charging units at 350 locations, with a focus on workplaces and multi-dwelling units. It has a price tag of $45 million in ratepayer funds. SDG&E will retain ownership of the charging infrastructure, but third parties will be contracted to build, install, operate and maintain the charging infrastructure. On December 15, 2016, PG&E's Charge Smart

and Save Program was approved,[1] which outlines a $130 million ratepayer-funded program to deploy up to 7,500 charging stations, with PG&E owning the electrical infrastructure assets. The ruling states that as many as 35% of the charging stations deployed in multi-dwelling units or disadvantaged communities can be owned by PG&E. The balance of stations will be owned by site hosts or third party providers.

The legislature in Oregon passed a bill [2] earlier this year stating:

> [T]he Public Utility Commission shall direct each electric company to file applications, in a form and manner prescribed by the commission, for programs to accelerate transportation electrification. A program proposed by an electric company may include prudent investments in or customer rebates for electric vehicle charging and related infrastructure.

The Washington Utilities and Transportation Commission approved an electric vehicle charging pilot program developed by Avista Utilities, including the installation of 120 charging stations in homes and 80 in workplaces and public locations in Eastern Washington, as well as seven DC fast chargers in strategic locations "in close proximity to major arterials and driver amenities."[3]

Municipally owned utilities have active engagements in charging infrastructure. The Sacramento Municipal Utility District ("SMUD," California) provides a rebate of $300 to customers who purchase or lease an EV. Seattle City Light (Washington) has two pilot programs over the next several years, one focusing on public DC fast charging and another on residential EV charging. Orlando Utilities Commission ("OUC," Florida) has a $200 rebate for customers that purchase or lease an EV. Austin Energy (Texas) provides rebates on Level 2 EVSE at homes, businesses, and multi-family properties.

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[1] Proposed Decision Directing Pacific Gas and Electric Company to Establish an Electric Vehicle Infrastructure and Education Program, November 14, 2016, CPUC Proceeding A1502009, http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=169668696

[2] SB 1547 (Beyer), Elimination of Coal From Electricity Supply, available online: https://olis.leg.state.or.us/liz/2016R1/Downloads/MeasureDocument/SB1547/Enrolled

[3] Avista's Electric Vehicle Charging Program, https://www.avistautilities.com/services/transportation/Pages/evcharging.aspx, accessed December 2016.

This is not meant to be an exhaustive list, rather a useful introduction to the diversity of interest and geographic scope of engagement that has been initiated by utilities in EV markets over the last several years.

Q. Does Ameren Missouri's EV pilot project align with EV market trends and national objectives related to promoting electric vehicles and charging infrastructure?

A. Yes, Ameren Missouri's proposed pilot project, albeit narrow in scope, is aligned with national objectives and trends related to utility engagement in EV deployment and EV charging infrastructure. Most notably, it is very well aligned with the *Guiding Principles to Promote Electric Vehicles and Charging Infrastructure*, released by the Obama Administration and supported by a broad EV coalition (including Ameren Missouri and ChargePoint, for instance). The pilot project is appropriately designed to improve Ameren Missouri's understanding of its potential role in supporting EV adoption moving forward. Further, the focus on DC fast charging infrastructure is particularly novel amongst utility programs and will make for interesting observations and results. The EV market—inclusive of vehicle deployment, charging infrastructure deployment, and understanding consumer behavior—is undoubtedly operating in a period of uncertainty. At this stage of development, more clarity regarding the benefits of multiple approaches is needed. Ameren Missouri's EV pilot project will provide valuable insights into the role of utility engagement, albeit small, along the I-70 corridor.

Despite its narrow scope, I do caution against using this pilot project as an opportunity to define narrowly the role of the utility in EV adoption and EV charging infrastructure. The risk of narrowly defining the role of utilities based on our understanding of the market today may well impede the ability of utilities to help provide the solutions needed in the future. While analyses which my team and I have conducted generally indicate that an increased role for utilities in EV charging infrastructure deployment is warranted, the role and strategy that a utility will pursue is considerably

different. To that end, my team and I have always focused on recommendations that utilities be afforded flexibility in their ability to engage in the EV charging infrastructure market—this should not be misconstrued as an endorsement of some carte blanche strategy supporting any utility engagement in the EV market. Rather, the emphasis is on the role(s) of the utility reflecting the dynamic and local nature of the EV charging infrastructure market to date. The solutions that will accelerate deployment of EVs and charging infrastructure are not uniform across utilities or time. In other words, the solutions that will be required to achieve national and state level targets for EV deployment are much different in the nascent market today than those that will be required to support a more mature market tomorrow. Pilot projects like Ameren Missouri's will allow us to explore various models now, and will help define that future mature market in a more studied and efficient manner.

Q. How will utility engagement impact the competitiveness of EV charging markets?

A. It is unclear; however, the scope of Ameren Missouri's proposed pilot project suggests that the immediate impact is likely to be small or non-existent with regard to anticompetitiveness. There is a common misconception that utility engagement will definitively and negatively impact the EV service provider market; however, this is not an evidenced-based conclusion. Further, this conclusion does not consider more broadly the viability of various EV service provider business models, of which there is considerable skepticism amongst market observers. The CPUC's determination that potential anticompetitive impacts associated with utility ownership of charging infrastructure can be prevented or adequately mitigated through the exercise of existing rules and subject to certain conditions and modifications is particularly compelling. Realistically, in order to identify those conditions and modifications to offset anticompetitive impacts, utilities must start somewhere. To that end, Ameren Missouri's proposed pilot project will enable data collection and a market assessment that can

inform utility engagement in a more substantive fashion in the near-term future, especially as it relates to DC fast charging infrastructure.

Ms. Smart's focus on competitiveness[4] in her rebuttal testimony is mostly well received, although, it appears to be misplaced. Her points ultimately boil down to: ChargePoint objects to the outcome of Ameren Missouri's competitive bidding process and wants the Commission to direct the Company to engage the EV market via alternative business models. While this would provide benefits to ChargePoint, it undermines the point of the pilot, which is to understand what role Ameren Missouri might play in the EV market in its service territory (including information that could be extrapolated to other utility constructs). As noted above, the actual impacts on competitiveness are unclear. However, the limited scope of the proposed pilot project has to offer some comfort to market observers and participants that, in the unlikely event there are competitive impacts, they are unlikely to be long-lasting or irreversible. By comparison, the initially proposed pilot projects from the California IOUs included a $654 million investment from PG&E with 25,000 charging stations, a $355 million plan for up to 30,000 charging stations by SCE, and a $103 million plan to deploy 5,500 charging stations by SDG&E. In other words, it is imperative to raise competitiveness concerns when more than a billion dollars of proposed investment is on the table in a nascent market, dwarfing the level of investment that had been committed at that time. Nothing to this massive scale has been proposed for the State of Missouri. Ameren Missouri has proposed a modest investment of less than a million dollars, is using a competitive bidding process, and is seeking to play a comparatively small role in its initial foray into the EV charging market.

[4] Rebuttal Testimony of Anne Smart, p. 8—11.

This is not to say that the Commission should dismiss competitiveness concerns completely; rather, there has not been a compelling case that competitiveness concerns are so dire here as to warrant rejection of the proposed pilot.

III. Other Considerations

Q. Will increased use of EVs reduce carbon emissions in Missouri?

A. Yes, even if those EVs are charged using electricity with a generation profile similar to the expected 2015 peak summer electric demand. The rebuttal testimony of Dr. Marke[5] regarding the deployment of EVs in Ameren Missouri's territory is misleading on this point. The question stated in his testimony reads: *"Will increased use of EVs reduce Ameren Missouri's carbon emissions?"* This is the wrong question to ask. The more accurate question is: Will the increased use of EVs reduce carbon emissions? And the answer is yes.

The greenhouse gas ("GHG") emissions of transportation fuels should be considered on a lifecycle basis. The policy and regulatory framework for this is established through California's Low Carbon Fuel Standard Program, Oregon's Clean Fuels Program, and the federal Renewable Fuels Program (administered by the US Environmental Protection Agency, "EPA"). The lifecycle GHG emissions of transportation fuels account for the so-called upstream activities associated with delivering a finished transportation fuel to the vehicle. In the case of petroleum-based fuels, for instance, this includes the GHG emissions associated with extraction, transport to a refinery, and subsequent refining of crude oil into a refined product such as gasoline. The other component of lifecycle emissions is the more commonly understood (and cited) tailpipe emissions, which result from the combustion of fuel to propel a vehicle. Using the electricity generation profile that Dr. Marke employed in his rebuttal testimony, I employed the GREET model - developed by Argonne National Laboratory - to calculate

[5] Rebuttal Testimony of Geoff Marke, p. 15—20

the lifecycle GHG emissions factor of electricity at an adjusted rate of about 61 grams of carbon dioxide equivalents per megajoule of fuel (gCO2-eq/MJ). By comparison, the national average of gasoline is around 95 to 100 gCO2-eq/MJ.

I do not disagree with Dr. Marke's point that the most sophisticated way to determine the GHG emissions profile of EVs would be to conduct some sort of dispatch modeling that accounts for increased load from EVs to pair it with generating capacity at different times of day. However, I have found in similar analyses that the results do not yield significant differences in GHG emissions. Absent a future in which the overwhelming majority of increased demand for electricity is met through the dispatch of coal generation (e.g., 85% or more), which seems extremely unlikely based on Ameren Missouri's generation profile and integrated resource plan, the deployment of EVs in the Company's territory will reduce GHG emissions relative to conventional vehicles using gasoline.

Q. Are CAFE standards, biofuels, and power laws relevant to the discussion at hand?

A. No, these issues are not relevant to the discussion of environmental benefits of EVs. Dr. Marke's testimony regarding corporate average fuel economy ("CAFÉ") standards and biofuels in the Renewable Fuel Standards ("RFS") program [6] is both irrelevant and inaccurate. This part of his testimony conflates GHG emissions and criteria pollutant emissions (or at the very least, fails to distinguish between them appropriately). These are different considerations that warrant distinction. Furthermore, the fuel economy numbers cited in his testimony are numbers used in statutory language, but he failed to note that these are not real world fuel economy numbers that will be achieved by vehicle manufacturers. For instance, it is commonly understood that the 54.5 miles per gallon ("MPG") fuel economy target for new vehicles in 2025 (as cited in Dr.

[6] Rebuttal Testimony of Geoff Marke, p21—23.

Marke's testimony) will actually be 40 MPG as a result of crediting mechanisms and compliance flexibility. Similarly, Dr. Marke fails to note that the fuel economy standards (established by the National Highway Traffic Safety Administration, "NHTSA") and the GHG tailpipe standards (established by the US EPA), both incentivize the deployment of EVs. In both cases, higher deployment of EVs would decrease compliance pressure on automakers to improve fuel efficiency of gasoline vehicles.

Dr. Marke's note regarding the RFS, for instance, that the advanced biofuel mandate is for "fuels that are more environmentally friendly than ethanol" is incorrect. There are various types of ethanol, albeit from different feedstocks other than corn that qualify as advanced biofuels under the RFS. Further Dr. Marke failed to note that the RFS incentivizes the use of biodiesel and biogas as a transportation fuel, both of which are irrelevant to the discussion of displacing gasoline-powered vehicles with EVs. If Dr. Marke seeks to somehow link the emissions performance of EVs to compliance with the federal RFS, it would need to be an argument built around the potential for use of higher blends of ethanol used in gasoline vehicles (e.g., increase the blend of ethanol in gasoline from 10% to 15%) or the increased use of high-level blends (e.g., 85% ethanol, 15% gasoline) in flexible fuel vehicles. Regardless, the testimony as it stands is irrelevant at best, and woefully inaccurate at worst.

Q. Is the discussion of transportation infrastructure revenue a relevant aspect of this case?

A. No, it is not. Dr. Marke's assessment that EVs do not pay gasoline tax is correct. However, the current state fuel excise tax of 17 cents per gallon of gasoline was passed in 1996. The national fuel excise tax of 18.4 cents per gallon of gasoline was set in 1993. It is hardly relevant to note that EVs are somehow contributing to a problem that is more than 20 years in the making. It is not within the scope of Ameren Missouri's pilot project to compensate for declining revenues at the Missouri Department of Transportation ("MDOT"), particularly when, as Ameren Missouri witness Mark Nealon

testified, the Company has communicated with MDOT on this project in order to support its "Road to Tomorrow" initiative.[7] Furthermore, Dr. Marke fails to note that Missouri currently assesses an additional $75 fee to EV drivers for the annual purchase of a Special Fuel Decal to offset this particular issue. For the sake of reference, that is equivalent to the revenue that would be purchased for using 441 gallons of gasoline and traveling more than 11,000 miles in a car that gets 25 MPG. By a note of comparison, the average Nissan LEAF driver travels about 10,000 miles annually. Consider the purchase of a MY2017 Toyota Prius, rated at 52 MPG. Traveling the same 10,000 miles annually yields about 192 gallons of gasoline, and yields total state fuel tax of $33, less than half of what the Nissan LEAF owner would pay for the Special Fuel Decal.

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does.

[7] Direct Testimony of Mark Nealon, p5.

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 PHILIP SHEEHY

STATE OF CALIFORNIA)
) ss
COUNTY OF SAN DIEGO)

Philip Sheehy, being first duly sworn on his oath, states:

1. My name is Philip Sheehy. I work in the city of San Diego, California, in San Diego County, and I am employed by ICF as Technical Director.

2. Attached hereto and made a part hereof for all purposes is my Surrebuttal Testimony on behalf of Union Electric Company d/b/a Ameren Missouri consisting of 14 pages, all of which have been prepared in written form for introduction into evidence in the above-referenced docket.

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

Philip Sheehy

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

Notary Public
Dzhyparkul Akmatova

My commission expires:
February 12, 2019

DZHYPARKUL AKMATOVA
COMM. # 2099874
NOTARY PUBLIC • CALIFORNIA
SAN DIEGO COUNTY
My Comm. Exp. February 12, 2019