Exhibit No.:
Issue: *Charge Ahead – EV Program*
Witness: *Sarah L.K. Lange*
Sponsoring Party: *MoPSC Staff*
Type of Exhibit: *Surrebuttal Testimony*
Case No.: *ET-2018-0132*
Date Testimony Prepared: *November 16, 2018*

MISSOURI PUBLIC SERVICE COMMISSION

COMMISSION STAFF DIVISION

TARIFF AND RATE DESIGN

SURREBUTTAL TESTIMONY

OF

SARAH L.K. LANGE

UNION ELECTRIC COMPANY, d/b/a AMEREN MISSOURI

CASE NO. ET-2018-0132

Jefferson City, Missouri
November 2018

** Denotes Confidential Information **

SURREBUTTAL TESTIMONY

OF

SARAH L.K. LANGE

UNION ELECTRIC COMPANY,
d/b/a AMEREN MISSOURI

CASE NO. ET-2018-0132

Q. Please state your name and business address.

A. My name is Sarah L.K. Lange and my business address is Missouri Public Service Commission, P.O. Box 360, Jefferson City, Missouri 65102.

Q. Did you file rebuttal testimony in this matter?

A. Yes, I filed rebuttal testimony concerning the reliability of the assumptions presented in the direct testimony of Union Electric Company, d/b/a Ameren Missouri ("Ameren Missouri") witnesses concerning the Charge Ahead program. I also prepared the Staff Report on the Estimated Costs and Benefits of a Make Ready Tariff for Separately-Metered EV Charging.

Q. Have you reviewed the Rebuttal Testimony of James Ellis filed on behalf of ChargePoint, Inc.?

A. Yes.

Q. What level of electrical infrastructure is necessary to support the products sold by ChargePoint?

A. Per Mr. Ellis's testimony, the current products offered by ChargePoint support charging of up to 500kW. Thus, infrastructure to support 500kW of demand is necessary to

use the upper end of ChargePoint's current suite of products.[1] On page 5, Mr. Ellis states the following:

> ChargePoint offers a complete line of L2 and DCFC products and services, including the CT4000 family of Level 2 charging stations for public and workplace charging, ChargePoint Home for single-family residential use, ChargePoint Multi-Family for commercial multi-unit dwellings, ChargePoint Fleet, and both 24 kilowatt ("kW") and 50 kW DC Fast Charging stations for rapid-charging needs. ChargePoint's next generation DCFC platform solutions, ChargePoint Express 250 and Express Plus, are capable of charging from 62.5 kW to 500 kW to meet the needs for today's vehicles and prepare for tomorrow's vehicles, including medium and heavy-duty transportation options.

Q. Did your rebuttal testimony include estimates for infrastructure costs associated with 500 kW of charging demand?

A. No. In my rebuttal testimony to remain consistent with the kW assumptions in Ameren Missouri's direct filing, I used demand levels of 6.6 kW for Level 2 demand, and 19.8 kW for Level 3 demand. Using those demands, current rates, and based on the values provided in Ameren Missouri's 2019 MEEIA Application for the avoided costs projected in Ameren Missouri's 2017 IRP, the annual revenues in excess of system costs estimated to be produced from an average EV as provided in my rebuttal testimony is provided below, by class.

[1] It is not clear from Mr. Ellis's testimony if the indicated level of demand is on the customer side or the utility side of the charging equipment. If the indicated level of demand is the level of kW supplied to the charging customer, then the level of utility infrastructure required would be higher.

Estimated Residential Additive Margin Per EV	
Miles per Day	30
Miles / kWh	3.39
kWh / Month	265
Average Bill Change / Year	$ 261.77
Average Cost Increase / Year	$ 195.27
Average Margin per EV / Year	$ 66.50

Estimated SGS Additive Margin Per EV	
Miles per Day	30
kW/ Mile	3.39
kWh / Month	265
Average Bill Change / Year	$ 296.81
Average Cost Increase / Year	$ 195.27
Average Margin per EV / Year	$ 101.54

Estimated LGS Additive Margin Per EV	
Miles per Day	30
kW/ Mile	3.39
kWh / Month	265
Average Bill Change / Year	$ 275.47
Average Cost Increase / Year	$ 168.30
Average Margin per EV / Year	$ 107.17

Q. Using these same assumptions, have you recalculated these values for the higher charging levels discussed in Mr. Ellis's testimony?

A. Yes. Assuming a charging demand of 19.8 kW – 24 kW would result in the following rate calculations:

Estimated Residential Additive Margin Per EV	
Miles per Day	30
Miles / kWh	3.39
kWh / Month	265
Average Bill Change / Year	$ 261.77
Average Cost Increase / Year	$ 411.06
Average Margin per EV / Year	$ (149.29)

Estimated SGS Additive Margin Per EV	
Miles per Day	30
kW/ Mile	3.39
kWh / Month	265
Average Bill Change / Year	$ 296.81
Average Cost Increase / Year	$ 411.06
Average Margin per EV / Year	$ (114.24)

Estimated LGS Additive Margin Per EV	
Miles per Day	30
kW/ Mile	3.39
kWh / Month	265
Average Bill Change / Year	$ 496.25
Average Cost Increase / Year	$ 330.14
Average Margin per EV / Year	$ 166.11

Q. Using these same assumptions, have you calculated the bill a customer would be charged and the infrastructure and other capacity costs associated with the higher charging levels discussed in Mr. Ellis's testimony, consistent with the values used in Ameren Missouri's MEEIA filing?

A. Yes. Because of the various levels of demand Mr. Ellis describes as supported by ChargePoint's current products, I have prepared a range of installation assumptions and kW demand assumptions. For each scenario and voltage level, I provide the annual bill a customer would receive for stand-alone electric service to support that charger, the capacity cost estimate derived consistent with the values contained in Ameren Missouri's MEEIA filing, the contribution to fixed costs that the bill would provide consistent with the values

contained in Ameren Missouri's MEEIA filing, and the result of dividing the annual bill by the annual kWh consumption. That $/kWh value is then used to calculate the average cost of charging a modern EV to travel 100 miles. These assumptions and results are provided on the following pages:

# of Fast Charge Ports	1	1	1	1	1	1
# of Charges per Port per Day	1	2	3	4	5	6
Annual Average Bill if 100kW	$ 8,052	$ 8,484	$ 8,915	$ 9,347	$16,258	$16,690
Annual Average Bill if 200kW	$14,532	$14,964	$15,395	$15,827	$29,218	$29,650
Annual Average Bill if 300kW	$21,012	$21,444	$21,875	$22,307	$42,178	$42,610
Annual Average Bill if 400kW	$27,492	$27,924	$28,355	$28,787	$55,138	$55,570
Annual Average Bill if 500kW	$33,972	$34,404	$34,835	$35,267	$68,098	$68,530
Capacity Costs if 100kW	$ 2,375	$ 2,375	$ 4,750	$ 4,750	$ 4,750	$ 9,500
Capacity Costs if 200kW	$ 4,750	$ 4,750	$ 9,500	$ 9,500	$ 9,500	$19,000
Capacity Costs if 300kW	$ 7,125	$ 7,125	$14,250	$14,250	$14,250	$28,500
Capacity Costs if 400kW	$ 9,500	$ 9,500	$19,000	$19,000	$19,000	$38,000
Capacity Costs if 500kW	$11,875	$11,875	$23,750	$23,750	$23,750	$47,501
Contribution to Fixed Costs						
@ 100 kW	$ 5,469	$ 5,753	$ 3,661	$ 3,944	$10,708	$ 6,241
@ 200 kW	$ 9,574	$ 9,857	$ 5,391	$ 5,674	$18,918	$ 9,701
@ 300 kW	$13,679	$13,962	$ 7,121	$ 7,404	$27,127	$13,161
@ 400 kW	$17,784	$18,067	$ 8,851	$ 9,134	$35,337	$16,621
@ 500 kW	$21,889	$22,172	$10,581	$10,864	$43,547	$20,080
kWh @ secondary	5,400	10,800	16,200	21,600	27,000	32,400
$ / kWh						
@ 100 kW	$ 1.49	$ 0.79	$ 0.55	$ 0.43	$ 0.60	$ 0.52
@ 200 kW	$ 2.69	$ 1.39	$ 0.95	$ 0.73	$ 1.08	$ 0.92
@ 300 kW	$ 3.89	$ 1.99	$ 1.35	$ 1.03	$ 1.56	$ 1.32
@ 400 kW	$ 5.09	$ 2.59	$ 1.75	$ 1.33	$ 2.04	$ 1.72
@ 500 kW	$ 6.29	$ 3.19	$ 2.15	$ 1.63	$ 2.52	$ 2.12
Cost of 100 mile "fill up"						
@ 100 kW	$ 22.37	$ 11.78	$ 8.25	$ 6.49	$ 9.03	$ 7.73
@ 200 kW	$ 40.37	$ 20.78	$ 14.25	$ 10.99	$ 16.23	$ 13.73
@ 300 kW	$ 58.37	$ 29.78	$ 20.25	$ 15.49	$ 23.43	$ 19.73
@ 400 kW	$ 76.37	$ 38.78	$ 26.25	$ 19.99	$ 30.63	$ 25.73
@ 500 kW	$ 94.37	$ 47.78	$ 32.25	$ 24.49	$ 37.83	$ 31.73

# of Fast Charge Ports	3	3	4	4	4	4
# of Charges per Port per Day	1	6	1	4	8	12
Annual Average Bill if 100kW	$21,012	$ 23,170	$ 27,492	$ 28,787	$ 30,513	$ 32,238
Annual Average Bill if 200kW	$40,452	$ 42,610	$ 53,412	$ 54,707	$ 56,433	$ 58,158
Annual Average Bill if 300kW	$59,892	$ 62,050	$ 79,332	$ 80,627	$ 82,353	$ 84,078
Annual Average Bill if 400kW	$79,332	$ 81,490	$105,252	$106,547	$108,273	$109,998
Annual Average Bill if 500kW	$98,772	$100,930	$131,172	$132,467	$134,193	$135,918
Capacity Costs if 100kW	$ 7,125	$ 14,250	$ 9,500	$ 9,500	$ 19,000	$ 19,000
Capacity Costs if 200kW	$14,250	$ 28,500	$ 19,000	$ 19,000	$ 38,000	$ 38,000
Capacity Costs if 300kW	$21,375	$ 42,750	$ 28,500	$ 28,500	$ 57,001	$ 57,001
Capacity Costs if 400kW	$28,500	$ 57,001	$ 38,000	$ 38,000	$ 76,001	$ 76,001
Capacity Costs if 500kW	$35,625	$ 71,251	$ 47,501	$ 47,501	$ 95,001	$ 95,001
Contribution to Fixed Costs						
@ 100 kW	$13,679	$ 7,971	$ 17,784	$ 18,634	$ 10,267	$ 11,401
@ 200 kW	$25,994	$ 13,161	$ 34,204	$ 35,054	$ 17,187	$ 18,321
@ 300 kW	$38,309	$ 18,351	$ 50,624	$ 51,474	$ 24,107	$ 25,240
@ 400 kW	$50,624	$ 23,540	$ 67,044	$ 67,894	$ 31,027	$ 32,160
@ 500 kW	$62,939	$ 28,730	$ 83,464	$ 84,314	$ 37,947	$ 39,080
kWh @ secondary	5,400	32,400	5,400	21,600	43,200	64,800
$ / kWh						
@ 100 kW	$ 3.89	$ 0.72	$ 5.09	$ 1.33	$ 0.71	$ 0.50
@ 200 kW	$ 7.49	$ 1.32	$ 9.89	$ 2.53	$ 1.31	$ 0.90
@ 300 kW	$ 11.09	$ 1.92	$ 14.69	$ 3.73	$ 1.91	$ 1.30
@ 400 kW	$ 14.69	$ 2.52	$ 19.49	$ 4.93	$ 2.51	$ 1.70
@ 500 kW	$ 18.29	$ 3.12	$ 24.29	$ 6.13	$ 3.11	$ 2.10
Cost of 100 mile "fill up"						
@ 100 kW	$ 58.37	$ 10.73	$ 76.37	$ 19.99	$ 10.59	$ 7.46
@ 200 kW	$112.37	$ 19.73	$ 148.37	$ 37.99	$ 19.59	$ 13.46
@ 300 kW	$166.37	$ 28.73	$ 220.37	$ 55.99	$ 28.59	$ 19.46
@ 400 kW	$220.37	$ 37.73	$ 292.37	$ 73.99	$ 37.59	$ 25.46
@ 500 kW	$274.37	$ 46.73	$ 364.37	$ 91.99	$ 46.59	$ 31.46

# of Fast Charge Ports	5	5	6	6
# of Charges per Port per Day	1	10	1	12
Annual Average Bill if 100kW	$ 33,972	$ 37,855	$ 40,452	$ 45,198
Annual Average Bill if 200kW	$ 66,372	$ 70,255	$ 79,332	$ 84,078
Annual Average Bill if 300kW	$ 98,772	$ 102,655	$ 118,212	$ 122,958
Annual Average Bill if 400kW	$ 131,172	$ 135,055	$ 157,092	$ 161,838
Annual Average Bill if 500kW	$ 163,572	$ 167,455	$ 195,972	$ 200,718
Capacity Costs if 100kW	$ 11,875	$ 23,750	$ 14,250	$ 28,500
Capacity Costs if 200kW	$ 23,750	$ 47,501	$ 28,500	$ 57,001
Capacity Costs if 300kW	$ 35,625	$ 71,251	$ 42,750	$ 85,501
Capacity Costs if 400kW	$ 47,501	$ 95,001	$ 57,001	$ 114,001
Capacity Costs if 500kW	$ 59,376	$ 118,751	$ 71,251	$ 142,502
Contribution to Fixed Costs				
@ 100 kW	$ 21,889	$ 12,564	$ 25,994	$ 14,861
@ 200 kW	$ 42,414	$ 21,214	$ 50,624	$ 25,240
@ 300 kW	$ 62,939	$ 29,864	$ 75,254	$ 35,620
@ 400 kW	$ 83,464	$ 38,513	$ 99,884	$ 46,000
@ 500 kW	$ 103,989	$ 47,163	$ 124,513	$ 56,380
kWh @ secondary	5,400	54,000	5,400	64,800
$ / kWh				
@ 100 kW	$ 6.29	$ 0.70	$ 7.49	$ 0.70
@ 200 kW	$ 12.29	$ 1.30	$ 14.69	$ 1.30
@ 300 kW	$ 18.29	$ 1.90	$ 21.89	$ 1.90
@ 400 kW	$ 24.29	$ 2.50	$ 29.09	$ 2.50
@ 500 kW	$ 30.29	$ 3.10	$ 36.29	$ 3.10
Cost of 100 mile "fill up"				
@ 100 kW	$ 94.37	$ 10.52	$ 112.37	$ 10.46
@ 200 kW	$ 184.37	$ 19.52	$ 220.37	$ 19.46
@ 300 kW	$ 274.37	$ 28.52	$ 328.37	$ 28.46
@ 400 kW	$ 364.37	$ 37.52	$ 436.37	$ 37.46
@ 500 kW	$ 454.37	$ 46.52	$ 544.37	$ 46.46

A. Are you concerned with the results indicated by these tables?

Q. Yes. A number of things strike me. First, the high infrastructure costs associated with these installations. For example, using assumptions consistent with Ameren Missouri's MEEIA filing the addition of a 100kW charger would incur an annual revenue

requirement impact of approximately $2,375 - $9,500. Second, the apparent incompatibility of the LGS rate design with fast charging. While the contributions to fixed costs provided by the installation appear very attractive at first look, those contributions only occur if usage materializes. When looking at the average $/kWh that these installations would be subject to, it is hard to imagine a scenario where these installations would be utilized at all. The "cheapest" realized customer rate is approximately $0.43/kWh, where a single 100 kW port is consistently utilized 4 times per day.

Q. Does this reflect a problem with the LGS rate design?

A. Not necessarily. Recognizing that the infrastructure necessary to support these installations is very expensive – for example a transformer with an installed cost in the tens of thousands of dollars may be required to support fast charging[2] - it is reasonable to charge a rate that will reasonably result in recovery of the investment that is reflected in rate base. Also, given the variables involved, I have not reflected a scenario where these chargers are appended to an ongoing business behind a single meter. Under such a scenario, charging demands and timing could be optimized to cause very little need for new system investment or system capacity costs and with minimal impact to the customer's bill.

Q. What should the Commission take from these examples?

A. The importance of these examples is that the level of demand associated with charging equipment is not only relevant to the customer's charge time and customer experience, but also that it has an overwhelming impact on the system costs associated with charging. This is not to say that faster charging is bad. It simply reinforces that the charger market is developing, and so it is important that any Commission Order include language to

[2] See Confidential response to Staff Data Request No. 0032, attached as Schedule SLKL-s1.

reasonably reflect the Commission's intent in terms that are as specific as possible. For example, if the Commission orders that Ameren Missouri ratepayers provide funds to support 20 "fast chargers", it is important that the parties understand whether that Order refers to 20 chargers that support up to 24 kW of demand, or 20 chargers that support up to 500 kW of demand.

Q. What additional implications does Staff's analysis of Mr. Ellis's testimony indicate?

A. The significant difference in the residential, SGS, and LGS margin recovery associated with increasing the studied demands of Level 2 and Level 3 charging from the level studied by Ameren Missouri to the upper end of the commonly understood range for each level reinforces the concept that the most desirable margins are associated with EV charging that is at the lowest level of demand that is consistent with customers using the charging equipment. For example, in a residential or employee parking setting, the difference between 6.4 kW and 19.8 kW charging has minimal impact on usability and convenience, but a tremendous impact on the infrastructure required, the capacity costs incurred, and ultimately the marginal revenue recovered.

Q. Does this conclude your surrebuttal testimony?

A. Yes. A summary of Staff's recommendations in this matter is provided in the Surrebuttal Testimony of Robin Kliethermes.

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	)))	Case No. ET-2018-0132

AFFIDAVIT OF SARAH L.K. LANGE

STATE OF MISSOURI	)	
	)	ss.
COUNTY OF COLE	)	

COMES NOW SARAH L.K. LANGE and on her oath declares that she is of sound mind and lawful age; that she contributed to the foregoing *Surrebuttal Testimony*; and that the same is true and correct according to her best knowledge and belief.

Further the Affiant sayeth not.

Sarah L.K. Lange

SARAH L.K. LANGE

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 15th day of November 2018.

D. SUZIE MANKIN
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: December 12, 2020
Commission Number: 12412070

D Suzie Mankin

Notary Public

SCHEDULE SLKL-s1

HAS BEEN DEEMED

CONFIDENTIAL

IN ITS ENTIRETY