Exhibit No. 25

Ameren Missouri – Exhibit 25
Ahmad Farugui
Direct Testimony
File Nos. ER-2021-0240 & GR-2021-0241

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MISSOURI PUBLIC SERVICE COMMISSION

FILE NO. ER-2021-0240

DIRECT TESTIMONY

OF

AHMAD FARUQUI, Ph.D.

ON

BEHALF OF

UNION ELECTRIC COMPANY

D/B/A AMEREN MISSOURI

St. Louis, Missouri
March, 2021

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DIRECT TESTIMONY

OF

AHMAD FARUQUI, Ph.D.

FILE NO. ER-2021-0240

I. INTRODUCTION

Q. What is your name and address?

A. My name is Ahmad Faruqui, Ph.D. I am a Principal with The Brattle Group. My business address is 201 Mission Street, Suite 2800, San Francisco, California 94105.

Q. On whose behalf are you testifying?

A. I am filing testimony on behalf of Ameren Missouri.

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

A. Yes, I have. I testified in 2019 in File No. ER-2019-0335 on Ameren Missouri's proposed rate designs.

Q. What are your qualifications?

A. I am an energy economist with over 40 years of consulting and research experience. Concurrently, I have also taught economics for seven years at three universities and given guest lectures at several others.

My consulting practice is focused on customer engagement. My areas of expertise include rate design, demand response, energy efficiency, distributed energy resources, advanced metering infrastructure, plug-in electric vehicles, energy storage, inter-fuel substitution, combined heat and power, microgrids, and demand forecasting.

A statement of my qualifications is contained in Schedule AF-D1 attached to my testimony.

II. PURPOSE OF TESTIMONY

Q. What is the purpose of your direct testimony?

A. The purpose of my direct testimony is to review Ameren Missouri's residential rate portfolio and benchmark it against best industry practices, explain why only minor changes to the rates should be made at this time, and explain my review of Ameren Missouri's customer engagement plan.

III. AMEREN MISSOURI'S PORTFOLIO OF RESDIENTIAL RATES IS BEST-IN-CLASS

Q. What is your general assessment of the rates that Ameren Missouri has already rolled out and the rates that it is planning to roll out as a part of the settlement of its last electric rate case, File No. ER-2019-0335?

A. Ameren Missouri is offering a diverse portfolio of new rates to its customers, recognizing that customers have diverse tastes and preferences. Some customers want simplicity in their tariffs, others value comfort, while others want to closely monitor their usage and lower their bills by changing the way they consume energy. Ameren Missouri's portfolio offers choices of tariffs to customers and recognizes the diversity in customer tastes and lifestyles

Q. What specific rates are Ameren Missouri offering to its customers?

A. Ameren Missouri's portfolio consists of the existing rate (which has been renamed as "Anytime Users"), the Morning/Evening Savers rate, the Overnight Savers rate, the Smart Savers rate, and the Ultimate Savers rate. All but the Anytime Users rate feature

time variation in the price of electricity. The Ultimate Savers rate includes a demand charge and much lower electricity prices that also vary by time-of-use.

Q. What is your opinion of the Anytime Users rate?

A. The Anytime Users rate will appeal to customers who value simplicity and comfort. In the summer, customers on this rate currently pay a flat rate of 11.8 cents/kWh. In the winter, they pay a declining block rate. For the first 750 kWh, they pay 8 cents/kWh and for additional electricity consumption they pay 5.4 cents/kWh currently. The declining block rate feature will appeal to customers who use electricity to heat their homes. My understanding is that approximately a quarter of Ameren Missouri's customers use electric heating.

Q. What is your opinion of the Evening/Morning Savers rate?

A. For existing customers, six months after a smart meter has been deployed to a customer's house, they will be moved to this rate.[1] New customers will be placed on this rate, unless they elect another rate. In the summer, during the evening and nighttime hours, they will pay a rate of 11.5 cents/kWh. In the daytime hours, the rate will rise to 12 cents/kWh. The rate will introduce customers to the notion of time-of-use pricing. If they can shift some of their daytime use to evening and nighttime hours, they will save a modest 4.2% on the price they pay per kWh. In the winter, if they use less than 750 kWh, they will pay 7.9 cents/kWh during the off-peak hours and 8.1 cents/kWh during the on-peak period. They will save 2.5% by moving energy from the on-peak to the off-peak period. Both rates drop substantially for usage above 750 kWh. Off-peak consumption is priced at 5.3 cents/kWh and on-peak consumption at 5.5 cents/kWh. In my opinion, this rate will

[1]Subject to variance for residential customers who were the first to receive AMI meters, File No. EE-2021-0103.

introduce customers to the notion of time-of-use pricing. While they will not save much money on the rate, neither will they be exposed to high bills. It's best characterized as being a TOU rate on training wheels. Although I proposed a greater differential between peak and off-peak rates in my testimony in the Company's last rate case, it is critical to maintain a consistent differential during the roll-out of AMI meters to provide a stable and consistent experience for customers.

Q. What is your opinion of the Overnight Savers rate?

A. The rate features a greater savings opportunity than the Evening/Morning Savers rate since the off-peak rate, which will apply from 10 p.m. to 6 a.m., falls to 5.5 cents/kWh during the summer, which compares with the on-peak rate of 13.9 cents/kWh. Customers who are able to shift energy consumption from the on-peak period (which is 16 hours long) to the off-period (which is 8 hours long) in the summer will save 60.4% on each kWh that is shifted. In my opinion, this rate will appeal to those customers who are able to shift significant end use loads from the on-peak to the off-peak period. For example, they could load their dishes and set the timer on their dishwasher to start operating at 10 p.m. They could program their thermostat so it's a few degrees lower during the off-peak hours in the summer months. If their normal setting is 74 degrees, they could raise it to 75 degrees during the on-peak hours and lower it to 73 degrees during the off-peak hours. The greater the differential in the temperature setting, the more they would save. The rate will appeal especially to customers who own electric vehicles. They can simply set the timer on their charger to turn on when the off-peak hours begin and to turn off when the off-peak hours end.

Q. What is your opinion of the Smart Savers rate?

A. This rate features three pricing periods. A major benefit of this rate is that the peak period is shorter. Originally, the peak period was supposed to run from 2 p.m. to 7 p.m. However, as Company witness Steven Wills has proposed in his direct testimony, it would be best to revise the peak period so it runs from 3 p.m. to 7 p.m. The price differential between the on-peak and off-periods is very pronounced, creating greater savings opportunities for customers. For each kWh they shift from the on-peak to the off-peak period, they will save 80.1%. For each kWh they shift from the on-peak to the mid-peak period, they will save 69.1%. In my opinion, this rate will appeal to customers who are seriously interested in saving money by moving significant portions of their load out of the on-peak period to the mid-peak and off-peak periods. This rate exemplifies the trends in modern rate designs: allowing customers to create significant savings opportunities by lowering demand when the grid is stressed. This would help Ameren Missouri in the long run to potentially avoid making expensive investments in peaking capacity along with the associated infrastructure.

Q. Is a shorter peak period likely to attract more customers than a longer peak period?

A. Yes. A shorter peak period is easier for customers to cope with than a longer peak period. Even shortening it from five to four hours makes a difference. Another advantage of the shorter peak period is that the price differential between on-peak and off-peak hours can be higher than with a longer peak period. They would save more for each kWh that is reduced and/or shifted to the off-peak period. In sum, a shorter on-peak period

is easier for customers to cope with and also more rewarding. Thus, a shorter on-peak period rate is likely to attract more customers.

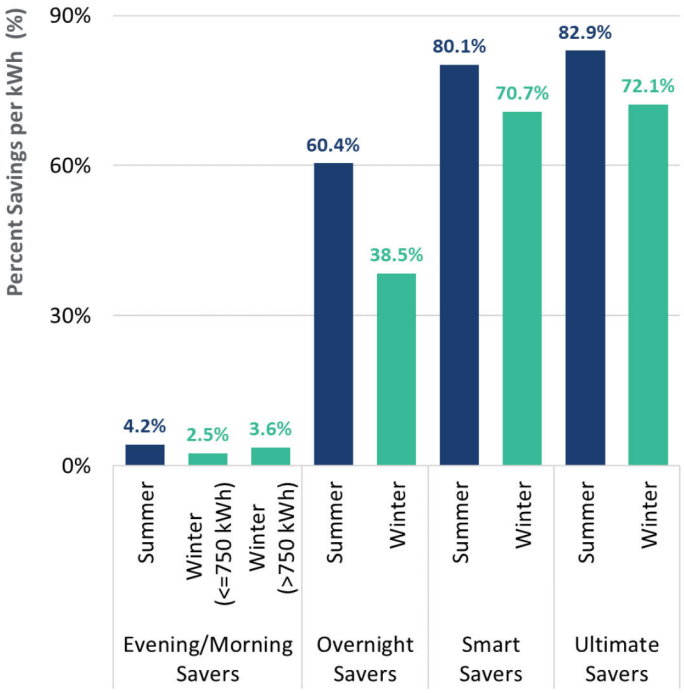
Q. What is your opinion of the Ultimate Savers rate?

A. This rate features two pricing periods for energy consumption and also includes a demand charge. The on-peak period runs from 3 p.m. to 7 p.m. and is only four hours long. If customers can switch their usage out of the on-peak to the off-peak period, they will save nearly 82.9% on each kWh shifted. A demand charge will apply from 6 a.m. to 10 p.m. It will be priced at $7.03/kW of demand currently. To minimize their demand charges, customers would have to avoid running all their major loads at the same time, which is not as difficult as it sounds. Examples of major loads are the clothes dryer, the electric stove, the electric oven, the electric central air conditioner, the electric heater, and the electric vehicle charger. In my opinion, this rate would appeal to customers who really value saving money and are willing to avoid running their major electric loads at the same time from 6 a.m. to 10 p.m. Of all the rates being offered by Ameren Missouri, this is the most cost-reflective rate. It will promote efficient utilization of the grid by Ameren Missouri's customers while promoting equity between customers.

Q. The new rates provide customers an incentive to reduce their consumption during the peak period and to shift it to less expensive off-peak periods. How much would a customer save for each kWh they shift from the peak to the off-peak period?

A. The savings opportunities for customers vary significantly across the rates. For each kWh that they shift from the on-peak period to the off-peak period, customers will save different percentage amounts for the different rates, as shown in the Figure 1 below.

Figure 1 Percent Savings per kWh Shifted by Rate

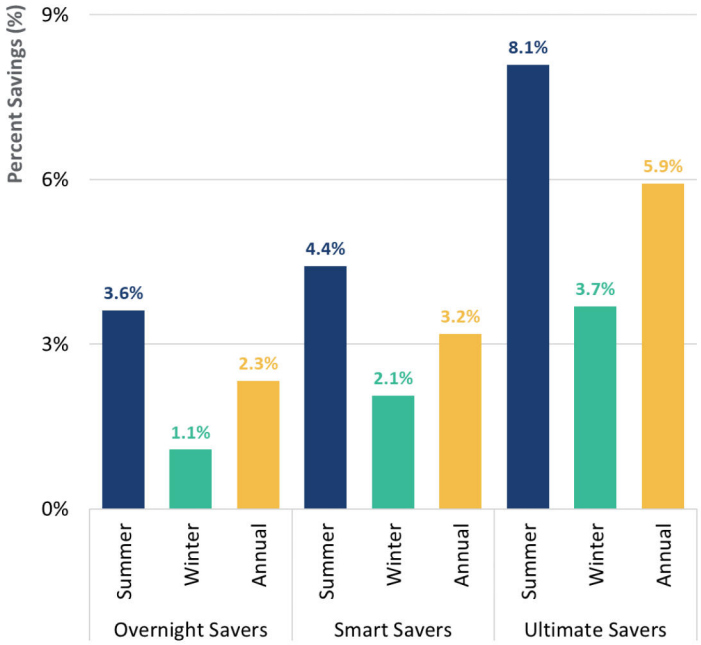


Q. How much would a typical Ameren Missouri customer save on their monthly bill under these different rates?

A. I have computed an estimate of the reduction in monthly bills that are likely to occur under the different rates. I obtained information from Ameren Missouri on how energy used by the typical Ameren Missouri customer varies across the pricing periods for each rate. For each rate, I estimated how much load shifting would occur by combining the energy information by pricing period with the prices in each rate. I used information in Brattle's Arcturus database to carry out the analysis. Arcturus contains the results of 383 tests involving time-varying rates in the US and abroad. These 383 tests including time-of-use rates, critical-peak pricing rates, and peak time rebates. Within this total number of tests, 191 tests specifically deal with the type of time-of-use rates in Ameren Missouri's

filing. The results are shown in Figure 2. The highest savings are realized by the ultimate savers rate, followed by the smart savers rate and then by the overnight savers rate.

Figure 2 Percent Savings in Monthly Bill by Rate



Q. Do you think Ameren Missouri has proposed a portfolio of rate options that will be attractive to customers?

A. Yes, the portfolio is one of the best in the country. It will help enhance customer satisfaction. Some customers will be able to simplify their lives and maximize their comfort. Others will be able to maximize their savings.

IV. ONLY MINOR CHANGES TO RATE PARAMETERS SHOULD BE MADE

Q. Should Ameren Missouri change any of its rates while the advanced metering infrastructure ("AMI") deployment is underway?

A. I would advise against significantly changing the rate structures and parameters until the AMI deployment has been completed in 2024. Significantly changing the rate structures and parameters while customers are having their first exposure to these new rates

will confuse and potentially aggravate customers. The rate portfolio has enough diversity in it that customers should be able to find a rate that appeals to them. If the chosen rate does not work out for them, they will have the opportunity to switch rates. The advice not to significantly change rate structures and parameters applies especially to the default tariff, the Evening/Morning Savers rate. As I have mentioned earlier, its purpose is simply to introduce customers to the notion of time variation in the price of electricity. They are unlikely to save much on it since prices only differ by 4.2% between the on-peak and off-peak period in the summer. While it may sound tempting to increase that savings opportunity by raising the differential between on-peak and off-peak periods, it would be best not to do so. Customers on that rate will be exposed to the risk of facing higher bills than they had estimated at the time they were placed on it. If some customers don't save much on this rate, they will have the opportunity to switch to other rates in the Ameren Missouri portfolio with bigger differentials. In other words, it's best to leave the differential in the Evening/Morning savers at roughly its current value and encourage those who want bigger savings to migrate to the other choices that exist.

Q. What is the optimal frequency for changing rates?

A. In my view, rate structures and parameters should not be changed frequently to prevent customer confusion and frustration. Ideally, the structure of the rates and parameters should be kept constant over a five-year period. Of course, the price levels in each period may change during this period to reflect changes in the cost of service, market prices and other factors. But the price ratios and period definitions should not be changed frequently.

Q. You mentioned above that the Company is proposing to shorten the on-peak period for the Smart Savers rate by one hour. Is Ameren Missouri proposing any other changes to its rates?

A. Only minor changes. It is proposing to raise its monthly service charge for some of the rates. There will be no change in the fixed charge for the Ultimate Savers Rate since it is the most cost-reflective rate in the portfolio. The Smart Savers rate is the next most cost-reflective rate and its fixed charge will go up from $9 to $10 a month. For all the other rates, the fixed charge will go up from $9 to $11 a month.

Q. What is your opinion of this change?

A. The change in the fixed charge is guided by the information in Ameren Missouri's cost of service study. The study indicates that the fixed customer-related cost of serving residential customers is around $24.34/month. By moving the fixed charge to $11 per month for the rates that are least cost-reflective, Ameren Missouri is moving its rates to be more reflective of its cost structure.

Q. What is the advantage of making rates more cost-reflective?

A. Cost-reflective rates do a better job of promoting economic efficiency and inter-customer equity than non-cost reflective rates. Professor Bonbright in his widely quoted text on public utility rates says cost causation should be the primary principle guiding rate design.[2]

Q. In general, how is the fixed charge computed?

A. The vast majority of utilities use embedded cost of service analysis to compute their fixed charge. The elements included in the fixed charge are the customer-

[2] https://www.raponline.org/knowledge-center/principles-of-public-utility-rates/.

related costs of metering, billing, and customer care. Some utilities base their fixed charge on a marginal cost of service study. Others use the zero-intercept technique or a minimum size technique to reflect a portion of the fixed cost of the shared distribution system.

Q. Is it important now to raise the monthly fixed service charge?

A. Yes. Customers are changing the way in which they interact with the grid. They are installing energy efficient appliances and smart thermostats and paying more attention to the manner in which they consume energy. Some of them are buying electric vehicles, others are installing solar panels on their roofs, and others are pairing those solar panels with batteries. As a result, their load shapes are changing and so is their net use of energy from the grid. In the foreseeable future, we may see lower rates of sales growth. To ensure equitable and efficient recovery of utility costs, which have a very large fixed cost element and a smaller volumetric element, the fixed charge that customers pay will have to rise. Otherwise, inequities among customers within a class will rise.

Q. Does a higher fixed charge also serve to promote the long-term objective of electrification?

A. Yes, a higher fixed charge leads to a lower energy charge. A lower energy charge incentivizes electrification investments on the part of consumers, such as the purchase of electric vehicles, heat pumps for space heating and heat pumps of water heating, clothes dryers and induction cooktops. This point is also made in a recent report put out by Next10. Org that is written by economists at the Energy Institute at the Haas School of Business at the University of California, Berkeley.[3]

[3] https://www.next10.org/publications/electricity-rates, https://www.utilitydive.com/news/california-power-pricing-discourage-electrification/595697/ and https://www.greentechmedia.com/articles/read/should-california-link-electricity-bills-to-customer-incomes.

Q. Is Ameren Missouri proposing any other changes related to the offering of its new portfolio of rate designs?

A. Yes, Ameren Missouri is proposing to institute a rate tracker mechanism to ensure it has a reasonable opportunity to recover its revenue requirement.

Q. Why is Ameren Missouri proposing this tracker mechanism?

A. As I have noted earlier, Ameren Missouri is providing customers with a variety of tools to empower customers to pick the rate that is best for them. Once they pick their "best" rates, their bills are likely to go down. Since only one of the rates includes a demand charge, and since all of them have a fixed charge that does not come close to recovering Ameren Missouri's fixed costs, the Company will not fully cover all its fixed costs as customers migrate to the their best rate. The tracker mechanism will compute the lost or additional fixed costs by year for each residential customer that adopts any of the optional TOU rates (Overnight Savers, Smart Savers, and Ultimate Savers rates). Other utilities that have deployed opt-in time-of-use rates have seen significant customer adoption of these rates. In Arizona, the Salt River Project has about 30% of its customers on such rates and Arizona Public Service has nearly double that percentage on time-of-use rates. In Oklahoma, OGE has around 20% of its customers on a dynamic pricing rate.

Q. Is a tracker mechanism the best way to recover lost fixed costs?

A. In the absence of tariffs that cover all fixed costs in fixed charges, some mechanism has to be found for recovering lost fixed costs. Other mechanisms include decoupling, a lost revenue adjustment mechanism (LRAM), and building in an estimate of the revenue loss into the rates. Decoupling is widely used across the country. An LRAM is used by OGE for its variable-peak pricing program. Utilities in Arizona and Colorado build

in an estimate of revenue loss into their rates. Of all these mechanisms, a tracker is the most appropriate for Ameren Missouri.

Q. Why is that?

A. In Missouri, my understanding is that riders like decoupling and LRAM cannot be used without specific statutory authorization. Ameren Missouri is not authorized to use decoupling because it has chosen to use the grid modernization cost recovery mechanism which is mutually exclusive to decoupling. LRAM is only authorized for energy efficiency programs and time-of-use rates do not count as an energy efficiency program.

Q. Do you support the minor changes to the rates and the tracker described above?

A. Yes. Such minor changes and the tracker are reasonable. After AMI is fully deployed, more significant changes might be pursued.

Q. How could Ameren Missouri add even more variety to its rate portfolio after AMI is fully deployed?

A. As the share of renewable energy resources rises in the generation mix, which is likely to happen as Ameren Missouri seeks to decarbonize its grid, electricity supply will become more variable and intermittent. Power supply will vary with the incidence of sunshine and the speed and direction of the wind. Under those conditions, it will be important to create load flexibility.

Q. What is the best way to create load flexibility?

A. The best way to create load flexibility is to introduce dynamic pricing. This includes critical-peak pricing, variable peak pricing, and real-time pricing. It can also

include variations such as peak-time rebates.[4] Dynamic pricing can be supplemented with other demand response mechanisms.

Q. Are there any other rate designs Ameren Missouri might consider after AMI is fully deployed?

A. Yes, at the other end of the spectrum, certain customers may want to further simplify their lives beyond what is provided to them by the Anytime Users tariff. They might be interested in locking in their utility bills by signing on to a subscription plan. Subscription plans can be designed around their historical use patterns or be based on a subscribed level of kW demand. They can also introduce advanced features such as incentives for reducing the subscription amount by earning credits. Credits might be earned in a variety of ways. For example, a customer could agree to adjust their thermostat by a couple of degrees in response to a signal from the utility.

V. AMEREN MISSOURI'S CUSTOMER ENGAGEMENT PLAN IS WELL THOUGHT OUT

Q. Have you reviewed Ameren Missouri's plan to engage with residential customers while it rolls out the new rate plans?

A. Yes, I have reviewed the customer engagement plan.

Q. What's included in it?

A. It includes a variety of customer touch points, beginning with an initial mailer informing the customer of the new rates that will be offered, informing them they will be moved to the Evening/Morning Savers rate but will have the option to pick one of several other rates. Once they have picked a rate, they will be provided tips on how best to take

[4] https://magazine.ieee-pes.org/wp-content/uploads/sites/50/2020/05/PE_MayJun_Faruqui.pdf

advantage of the rate. They will also be provided access to a rate comparison tool which will empower them to pick the rate that's best for them. The tool will also explain to them the role that different end uses such as central air conditioning, lighting, cooking, dishwashing and laundry play in their total energy consumption by hour.

Q. How does Ameren Missouri's customer engagement plan compare with industry best practices?

A. It compares favorably with best industry practices. Ameren Missouri has thought through the different ways of engaging with customers, laid out a realistic timeline, and developed appropriate communication materials to educate and inform customers about new rate design choices. Additionally, it will be providing tools to customers to better understand their usage patterns, identify the key end-uses that are driving their usage, and empower customers to pick the rate that best matches their lifestyle.

Q. Does this conclude your direct testimony?

A. Yes, it does.

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Dr. Faruqui is an energy economist whose consulting practice encompasses rate design, demand response, distributed energy resources, demand forecasting, decarbonization, electrification and energy efficiency and load flexibility.

In his career, Dr. Faruqui has advised some 150 clients in 12 countries on 5 continents and appeared before regulatory bodies, governments, and legislative councils in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Egypt, FERC, Georgia, Illinois, Indiana, Iowa, Jamaica, Kansas, Kentucky, Michigan, Maryland, Minnesota, Missouri, Nevada, New Brunswick (Canada), Nova Scotia (Canada), Ohio, Oklahoma, Ontario (Canada), Pennsylvania, the Philippines, Saudi Arabia (ECRA), Texas, and Washington.

He has authored or coauthored more than 150 papers in peer-reviewed and trade journals and co-edited 5 books on industrial structural change, customer choice, and electricity pricing. His innovations have been cited in *Bloomberg*, *Businessweek*, *The Economist*, *Forbes*, and *National Geographic*, in addition to news outlets including the *Los Angeles Times*, *The New York Times*, *San Francisco Chronicle*, *San Jose Mercury News*, and the *Washington Post*. He has also appeared on Fox Business News and NPR.

He has taught economics at San Jose State University, the University of California, Davis, and the University of Karachi and delivered guest lectures at Carnegie Mellon, Harvard, Idaho, MIT, New York University, Northwestern, Rutgers, Stanford, UC Berkeley, and UC Davis. He has also given seminars on energy issues on 20 countries on 6 continents.

EDUCATION

- BA (highest honors) and MA (highest honors) in economics, mathematics, and statistics, University of Karachi
- MA in agricultural economics and PhD in economics, The University of California at Davis
- Regents' Fellowship, The University of California at Davis
- Dissertation Grant, Kellogg Foundation

SELECTED AWARDS & RECOGNITION

- *Who's Who Legal*: Energy Experts 2020
- Association of Energy Services Professionals (AESP): He was recognized as one of seven individuals who was a game changer in the profession during the past 30 years (1990-2020)

AREAS OF EXPERTISE

Expert witness

Dr. Faruqui has testified or appeared before state commissions in Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Iowa, Kansas, Michigan, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, Nova Scotia (Canada), and Texas. He has been engaged by regulatory bodies in Alberta (Canada), FERC, Hawaii, New Brunswick (Canada), Ontario (Canada) and Saudi Arabia (ECRA).

He has made presentations to the California Energy Commission, the California Senate, the Congressional Office of Technology Assessment, the Indiana General Assembly, the Kentucky Commission, the Michigan Commission, the Minnesota Department of Commerce, the Minnesota Senate, the Missouri Public Service Commission, and the Electricity Pricing Collaborative in Washington State.

Innovative pricing

He has identified, designed and analyzed the efficiency and equity benefits of introducing innovative pricing designs such as three-part rates, including fixed monthly charges, demand charges and time-varying energy charges; dynamic pricing rates, including critical peak pricing, variable peak pricing and real-time pricing; time-of-use pricing; and inclining block rates.

Regulatory strategy

Dr. Faruqui has helped design forward-looking programs and services that exploit recent advances in rate design and digital technologies in order to lower customer bills and improve utility earnings, while lowering the carbon footprint and preserving system reliability.

- **Cost-benefit analysis of grid modernization**. He has assessed the feasibility of introducing smart meters and other devices, such as programmable communicating thermostats that promote demand response, into the energy marketplace, in addition to new appliances, buildings, and industrial processes that improve energy efficiency.
- **Demand forecasting and weather normalization**. He has pioneered the use of a variety of models for forecasting product demand in the near-, medium-, and long-term, using econometric, time series, and engineering methods. These models have been used to bid into energy procurement auctions, plan capacity additions, design customer-side programs, and weather normalize sales.
- **Customer choice**. He has developed methods for surveying customers in order to elicit their preferences for alternative energy products and alternative energy suppliers. These methods have been used to predict the market size of these products and to estimate the market share of specific suppliers.

- **Hedging, risk management, and market design**. He has helped design a range of financial products that help customers and utilities cope with the unique opportunities and challenges posed by a competitive market for electricity. He conducted a widely-cited market simulation to show that real-time pricing of electricity could have saved Californians millions of dollars during the Energy Crisis by lowering peak demands and prices in the wholesale market.
- **Competitive strategy**. He has helped clients develop and implement competitive marketing strategies by drawing on his knowledge of the energy needs of end-use customers, their values and decision-making practices, and their competitive options. He has helped companies reshape and transform their marketing organization and reposition themselves for a competitive marketplace. He has also helped government-owned entities in the developing world prepare for privatization by benchmarking their planning, retailing, and distribution processes against industry best practices, and suggesting improvements by specifying quantitative metrics and follow-up procedures.
- **Design and evaluation of marketing programs**. He has helped generate ideas for new products and services, identified successful design characteristics through customer surveys and focus groups, and test-marketed new concepts through pilots and experiments.
- **Academic experience**. He has given lectures at the University of California, Berkeley, University of California, Davis, Harvard University, University of Idaho, Massachusetts Institute of Technology, Michigan State University, Northwestern University, University of San Francisco, Stanford University, University of Virginia, and University of Wisconsin-Madison. Additionally, he has led a variety of professional seminars and workshops on public utility economics around the world. Finally, he has taught economics at San Jose State University, University of California, Davis, and the University of Karachi.

EXPERIENCE

Innovative Pricing

- **Cost of service and tariff design study.** For a large electric utility in South-East Asia, Brattle provided consulting services for their cost of service and tariff design studies for incentive-based regulation, covering regulatory period 2 (2018–2020). Our work focused on understanding the cost drivers, reviewing the extent to which the current tariffs reflect the cost drivers, and developing new tariffs that better align with current and projected costs.
- **Impact analysis for TOU rates in Ontario.** Measured the impacts of a system-wide Time of Use (TOU) deployment in the province of Ontario, Canada, on behalf of the Ontario Power Authority. To account for the lack of a designated control group, Brattle created a quasi-experimental design that took advantage of differences in the timing of the TOU rollout.

- **Measurement and evaluation for in-home displays, home energy controllers, smart appliances, and alternative rates for Florida Power & Light (FPL).** Carried out a 2-year impact evaluation of a dynamic and enabling technology pilot program. Used econometric methods to estimate the changes in load shapes, changes in peak demand, and changes in energy consumption for three different treatments. The results of this study were shared with Department of Energy to fulfil the data reporting requirements of FPL's Smart Grid Investment Grant.
- **Report examining the costs and benefits of dynamic pricing in the Australian energy market.** For the Australian Energy Market Commission (AEMC), developed a report that reviewed the various forms of dynamic pricing, such as time-of-use pricing, critical peak pricing, peak time rebates, and real-time pricing, for a variety of performance metrics including economic efficiency, equity, bill risk, revenue risk, and risk to vulnerable customers. It also discussed ways in which dynamic pricing could be rolled out in Australia to raise load factors and lower average energy costs for all consumers without harming vulnerable consumers, such as those with low incomes or medical conditions requiring the use of electricity.
- **Whitepaper on emerging issues in innovative pricing.** For the Regulatory Assistance Project (RAP), developed a whitepaper on emerging issues and best practices in innovative rate design and deployment. The paper included an overview of AMI-enabled electricity pricing options, recommendations for designing the rates and conducting experimental pilots, an overview of recent pilots, full-deployment case studies, and a blueprint for rolling out innovative rate designs. The paper's audience was international regulators in regions that were exploring the potential benefits of smart metering and innovative pricing.
- **Assessing the full benefits of real-time pricing.** For two large Midwestern utilities, assessed and, where possible, quantified the potential benefits of the existing residential real-time pricing (RTP) rate offering. The analysis included not only "conventional" benefits such as avoided resource costs, but under the direction of the state regulator, was expanded to include harder-to-quantify benefits such as improvements to national security and customer service.
- **Pricing and technology pilot design and impact evaluation for Connecticut Light & Power (CL&P).** Designed the Plan-It Wise Energy pilot for all classes of customers and subsequently evaluated the Plan-It Wise Energy program (PWEP). PWEP tested the impacts of CPP, PTR, and time of use (TOU) rates on the consumption behaviors of residential and small commercial and industrial customers.
- **Dynamic pricing pilot design and impact evaluation: Baltimore Gas & Electric.** Designed and evaluated the Smart Energy Pricing (SEP) pilot, which ran for four years. The pilot tested a variety of rate designs including critical peak pricing and peak time rebates on residential customer consumption patterns. In addition, the pilot tested the impacts of smart thermostats and the Energy Orb.

- **Impact evaluation of a residential dynamic pricing experiment: Consumers Energy (Michigan).** Designed the pilot and carried out an impact evaluation with the purpose of measuring the impact of critical peak pricing (CPP) and peak time rebates (PTR) on residential customer consumption patterns. The pilot also tested the influence of switches that remotely adjust the duty cycle of central air conditioners.
- **Impact simulation of Ameren Illinois utilities' power smart pricing program.** Simulated the potential demand response of residential customers enrolled in real-time prices. The results of this simulation were presented to the Midwest ISO's Supply Adequacy Working Group (SAWG) to explore alternative ways of introducing price responsive demand in the region.
- **The case for dynamic pricing: Demand Response Research Center.** Led a project involving the California Public Utilities Commission, the California Energy Commission, the state's three investor-owned utilities, and other stakeholders in the rate design process. Identified key issues and barriers associated with the development of time-based rates. Revisited the fundamental objectives of rate design, including efficiency and equity, with a special emphasis on meeting the state's strongly-articulated needs for demand response and energy efficiency. Developed a score-card for evaluating competing rate designs and applied it to a set of illustrative rates that were created for four customer classes using actual utility data. The work was reviewed by a national peer-review panel.
- **Analyzed the economics of self-generation of steam.** Specified, estimated, tested, and validated a large-scale model that analyzes the response of some 2,000 large commercial customers to rising steam prices. The model includes a module for analyzing conservation behavior, another module for the probability of self-generation switching behavior, and a module for forecasting sales and peak demand.
- **Design and impact evaluation of the statewide pricing pilot: Three California utilities.** Working with a consortium of California's three investor-owned utilities to design a statewide pricing pilot to test the efficacy of dynamic pricing options for mass-market customers. The pilot was designed using scientific principles of experimental design and measured changes in usage induced by dynamic pricing for over 2,500 residential and small commercial and industrial customers. The impact evaluation was carried out using state-of-the-art econometric models. Information from the pilot was used by all three utilities in their business cases for advanced metering infrastructure (AMI). The project was conducted through a public process involving the state's two regulatory commissions, the power agency, and several other parties.
- **Economics of dynamic pricing: Two California utilities.** Reviewed a wide range of dynamic pricing options for mass-market customers. Conducted an initial cost-effectiveness analysis and updated the analysis with new estimates of avoided costs and results from a survey of customers that yielded estimates of likely participation rates.
- **Economics of time-of-use pricing: A Pacific Northwest utility.** This utility ran the nation's largest time-of-use pricing pilot program. Assessed the cost-effectiveness of alternative

pricing options from a variety of different perspectives. Options included a standard three-part time-of-use rate and a quasi-real time variant where the prices vary by day. Worked with the client in developing a regulatory strategy. Worked later with a collaborative to analyze the program's economics under a variety of scenarios of the market environment.

- **Economics of dynamic pricing options for mass-market customers - Client: A multi-state utility.** Identified a variety of pricing options suited to meet the needs of mass-market customers, and assessed their cost-effectiveness. Options included standard three-part time-of-use rates, critical peak pricing, and extreme-day pricing. Developed plans for implementing a pilot program to obtain primary data on customer acceptance and load shifting potential. Worked with the client in developing a regulatory strategy.
- **Real-time pricing in California - Client: California Energy Commission.** Surveyed the national experience with real-time pricing of electricity, directed at large power customers. Identified lessons learned and reviewed the reasons why California was unable to implement real-time pricing. Cataloged the barriers to implementing real-time pricing in California, and developed a program of research for mitigating the impacts of these barriers.
- **Market-based pricing of electricity - Client: A large Southern utility.** Reviewed pricing methodologies in a variety of competitive industries including airlines, beverages, and automobiles. Recommended a path that could be used to transition from a regulated utility environment to an open market environment featuring customer choice in both wholesale and retail markets. Held a series of seminars for senior management and their staff on the new methodologies.
- **Tools for electricity pricing - Client: Consortium of several U.S. and foreign utilities.** Developed Product Mix, a software package that uses modern finance theory and econometrics to establish a profit-maximizing menu of pricing products. The products range from the traditional fixed-price product to time-of-use prices to hourly real-time prices, and also include products that can hedge customers' risks based on financial derivatives. Outputs include market share, gross revenues, and profits by product and provider. The calculations are performed using probabilistic simulation, and results are provided as means and standard deviations. Additional results include delta and gamma parameters that can be used for corporate risk management. The software relies on a database of customer load response to various pricing options called StatsBank. This database was created by metering the hourly loads of about one thousand commercial and industrial customers in the United States and the United Kingdom.
- Risk-based pricing - Client: Midwestern utility. Developed and tested new pricing products for this utility that allowed it to offer risk management services to its customers. One of the products dealt with weather risk; another one dealt with the risk that real-time prices might peak on a day when the customer does not find it economically viable to cut back operations.

Demand Response

- **Combined heat and power generation study.** Investigated the economic potential for combined heat and power and regulatory policies to unlock that potential in a Middle Eastern country.
- **National action plan for demand response: Federal Energy Regulatory Commission.** Led a consulting team developing a national action plan for demand response (DR). The national action plan outlined the steps that need to be taken in order to maximize the amount of cost-effective DR that can be implemented. The final document was filed with U.S. Congress.
- **National assessment of demand response potential: Federal Energy Regulatory Commission.** Led a team of consultants to assess the economic and achievable potential for demand response programs on a state-by-state basis. The assessment was filed with the U.S. Congress, as required by the Energy Independence and Security Act.
- **Demand response program review for Integrated Resource Plan development.** In response to legislation requiring the Connecticut utilities to jointly prepare a 10-year integrated resource plan, we conducted the analysis and helped prepare the plan. In coordination with the two leading utilities in the state, we conducted a detailed analysis of alternative resource solutions (both supply- and demand-side), drafted the report, and presented it to the Connecticut Energy Advisory Board. The analysis involved a detailed review and critique of the companies' proposed DR programs.
- **Integration of DR into wholesale energy markets.** Developed a whitepaper, "Fostering Economic Demand Response in the Midwest ISO," evaluating alternative approaches to efficiently integrating DR into its energy markets while encouraging increased participation. This work involved interviewing market participants and analyzing several approaches to economic DR regarding economic efficiency, participation rates, operational fit with other ISO rules, and susceptibility to state-level and ISO-level implementation barriers. This work involved an extensive survey of DR programs (qualification criteria, bidding rules, incorporation into market clearing software, measurement and verification, and settlement) in ISO/ Regional Transmission Organization (RTO) markets around the country. The project also required a detailed review of existing DR program tariffs for utilities in the RTO's service territory and development of a matrix for summarizing the various characteristics of these programs.

- **Integration of DR into resource adequacy constructs.** For the Midwest ISO, assisted in developing qualification criteria for DR as a capacity resource (we also developed estimates of likely future contributions of DR to resource adequacy, for use by their transmission planning group). For PJM, as part of our review of its capacity market, we developed recommendations on how to treat DR comparably to generation resources while accounting for the special attributes of DR. Our recommendations addressed product definition, auction rules, and penalty provisions. For the Connecticut utilities in their integrated resource planning, we evaluated future resource needs given various levels of demand response programs.
- **Evaluation of the demand response benefits of advanced metering infrastructure: Mid-Atlantic utility.** Conducted a comprehensive assessment of the benefits of advanced metering infrastructure (AMI) by developing dynamic pricing rates that are enabled by AMI. The analysis focused on customers in the residential class and commercial and industrial customers under 600 kW load.
- **Estimation of demand response impacts: Major California utility.** Worked with the staff of this electric utility in designing dynamic pricing options for residential and small commercial and industrial customers. These options were designed to promote demand response during critical peak days. The analysis supported the utility's advanced metering infrastructure (AMI) filing with the California Public Utilities Commission. Subsequently, the commission unanimously approved a $1.7 billion plan for rolling out nine million electric and gas meters based in part on this project work.

Smart Grid Strategy

- **Development of a smart grid investment roadmap for Vietnamese utilities.** For the five Vietnamese power corporations, developed a roadmap to guide future smart grid investment decisions. The report identified and described the various smart grid investment options, established objectives for smart grid deployment, presented a multi-phase approach to deploying the smart grid, and provided preliminary recommendations regarding the best investment opportunities. Also presented relevant case studies and an assessment of the current state of the Vietnamese power grid. The project involved in-country meetings as well as a stakeholder workshop that was conducted by Brattle staff.
- **Cost-benefit analysis of the smart grid: Rocky mountain utility.** Reviewed the leading studies on the economics of the smart grid and used the findings to assess the likely cost-effectiveness of deploying the smart grid in one geographical location.
- **Modeling benefits of smart grid deployment strategies.** Developed a model for assessing the benefits of smart grid deployment strategies over a long-term (e.g., 20-year) forecast horizon. The model, called iGrid, is used to evaluate seven distinct smart grid programs and technologies (e.g., dynamic pricing, energy storage, PHEVs) against seven key metrics of value (e.g., avoided resource costs, improved reliability).

- **Smart grid strategy in Canada.** The Alberta Utilities Commission (AUC) was charged with responding to a Smart Grid Inquiry issued by the provincial government. Advised the AUC on the smart grid, and what impacts it might have in Alberta.
- **Smart grid deployment analysis for collaborative of utilities.** Adapted the iGrid modeling tool to meet the needs of a collaborative of utilities in the southern U.S. In addition to quantifying the benefits of smart grid programs and technologies (e.g., advanced metering infrastructure deployment and direct load control), the model was used to estimate the costs of installing and implementing each of the smart grid programs and technologies.
- **Development of a smart grid cost-benefit analysis framework.** For the Electric Power Research Institute (EPRI) and the U.S. DOE, contributed to the development of an approach for assessing the costs and benefits of the DOE's smart grid demonstration programs.
- Analysis of the benefits of increased access to energy consumption information. For a large technology firm, assessed market opportunities for providing customers with increased access to real-time information regarding their energy consumption patterns. The analysis includes an assessment of deployments of information display technologies and analysis of the potential benefits that are created by deploying these technologies.
- **Developing a plan for integrated smart grid systems.** For a large California utility, helped to develop applications for funding for a project to demonstrate how an integrated smart grid system (including customer-facing technologies) would operate and provide benefits.

Demand Forecasting

- **Electricity sales and peak demand forecasting study:** For a large electric utility in South-East Asia, Brattle provided consulting services that involved assessing the performance of their load forecasting methodology and developing new models that provided more accurate forecasts.
- **Electricity consumption and maximum demand forecasting:** For a medium-sized utility in Asia-Pacific, Brattle provided consulting services on forecasting electricity consumption and maximum demand. Our work focused on analyzing drivers of growth in electricity sales, reviewed model performance, identified best practices and provided recommended approaches for analyzing trends in electricity sales and load forecasting.
- **Forecasting review.** Evaluated and critiqued the process conducted by an Australian utility company's electricity market forecasting, including the forecasting of electricity demand, supply, and price.
- **Comprehensive review of load forecasting methodology. PJM Interconnection.** Conducted a comprehensive review of models for forecasting peak demand and re-estimated new models to validate recommendations. Individual models were developed for 18 transmission zones as well as a model for the RTO system.

- **Analyzed downward trend: Western utility.** Conducted a strategic review of why sales had been lower than forecast in a year when economic activity had been brisk. Developed a forecasting model for identifying what had caused the drop in sales and its results were used in an executive presentation to the utility's board of directors. Also developed a time series model for more accurately forecasting sales in the near term and this model is now being used for revenue forecasting and budgetary planning.
- **Analyzed why models are under-forecasting: Southwestern utility.** Reviewed the entire suite of load forecasting models, including models for forecasting aggregate system peak demand, electricity consumption per customer by sector and the number of customers by sector. Ran a variety of forecasting experiments to assess both the ex-ante and ex-post accuracy of the models and made several recommendations to senior management.
- **U.S. demand forecast: Edison Electric Institute.** For the U.S. as a whole, developed a base case forecast and several alternative case forecasts of electric energy consumption by end use and sector. Subsequently developed forecasts that were based on EPRI's system of end-use forecasting models. The project was done in close coordination with several utilities and some of the results were published in book form.
- **Developed models for forecasting hourly loads: Merchant generation and trading company.** Using primary data on customer loads, weather conditions, and economic activity, developed models for forecasting hourly loads for residential, commercial, and industrial customers for three utilities in a Midwestern state. The information was used to develop bids into an auction for supplying basic generation services.
- **Gas demand forecasting system - Client: A leading gas marketing and trading company, Texas.** Developed a system for gas nominations for a leading gas marketing company that operated in 23 local distribution company service areas. The system made week-ahead and month-ahead forecasts using advanced forecasting methods. Its objective was to improve the marketing company's profitability by minimizing penalties associated with forecasting errors.

Demand-Side Management

- **The economics of biofuels.** For a western utility that is facing stringent renewable portfolio standards and that is heavily dependent on imported fossil fuels, carried out a systematic assessment of the technical and economic ability of biofuels to replace fossil fuels.
- **Assessment of demand-side management and rate design options: Large Middle Eastern electric utility.** Prepared an assessment of demand-side management and rate design options for the four operating areas and six market segments. Quantified the potential gains in economic efficiency that would result from such options and identified high priority programs for pilot testing and implementation. Held workshops and seminars for senior management, managers, and staff to explain the methodology, data, results, and policy implications.

- **Likely future impact of demand-side programs on carbon emissions - Client: The Keystone Center.** As part of the Keystone Dialogue on Climate Change, developed scenarios of future demand-side program impacts, and assessed the impact of these programs on carbon emissions. The analysis was carried out at the national level for the U.S. economy, and involved a bottom-up approach involving many different types of programs including dynamic pricing, energy efficiency, and traditional load management.
- **Sustaining energy efficiency services in a restructured market - Client: Southern California Edison.** Helped in the development of a regulatory strategy for implementing energy efficiency strategies in a restructured marketplace. Identified the various players that were likely to operate in a competitive market, such as third-party energy service companies (ESCO's) and utility affiliates. Assessed their objectives, strengths, and weaknesses and recommended a strategy for the client's adoption. This strategy allowed the client to participate in the new market place, contribute to public policy objectives, and not lose market share to new entrants. This strategy has been embraced by a coalition of several organizations involved in the California PUC's working group on public purpose programs.
- **Organizational assessments of capability for energy efficiency - Client: U.S. Agency for International Development, Cairo, Egypt.** Conducted in-depth interviews with senior executives of several energy organizations, including utilities, government agencies, and ministries to determine their goals and capabilities for implementing programs to improve energy end-use efficiency in Egypt. The interviews probed the likely future role of these organizations in a privatized energy market, and were designed to help develop U.S. AID's future funding agenda.
- **Enhancing profitability through energy efficiency services - Client: Jamaica Public Service Company.** Developed a plan for enhancing utility profitability by providing financial incentives to the client utility, and presented it for review and discussion to the utility's senior management and Jamaica's new Office of Utility Regulation. Developed regulatory procedures and legislative language to support the implementation of the plan. Conducted training sessions for the staff of the utility and the regulatory body.

Advanced Technology Assessment

- **Competitive energy and environmental technologies - Clients: Consortium of clients, led by Southern California Edison, included the Los Angeles Department of Water and Power and the California Energy Commission.** Developed a new approach to segmenting the market for electrotechnologies, relying on factors such as type of industry, type of process and end-use application, and product size. Developed a user-friendly system for assessing the competitiveness of a wide range of electric and gas-fired technologies in more than 100 four-digit SIC code manufacturing industries and 20 commercial businesses. The system includes a database of more than 200 end-use technologies and a model of customer decision making.

- **Market infrastructure of energy-efficient technologies - Client: EPRI.** Reviewed the market infrastructure of five key end-use technologies, and identified ways in which the infrastructure could be improved to increase the penetration of these technologies. Data was obtained through telephone interviews with equipment manufacturers, engineering firms, contractors, and end-use customers

TESTIMONY

Arizona

- Rebuttal Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of *Stacey Champion, et al., v Arizona Public Service Corporation*, Docket No. E-01345A-18-0002, August 17, 2018.
- Direct Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of *Stacey Champion, et al., v Arizona Public Service Corporation*, Docket No. E-01345A-18-0002, July 31, 2018.
- Direct Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of the Application of Arizona Public Service Company for a Hearing to Determine the Fair Value of the Utility Property of the Company for Ratemaking Purposes, to Fix a Just and Reasonable Rate of Return Thereon, to Approve Rate Schedules Designed To Develop Such Return, Docket No. E-01345A-16-0036, June 1, 2016.
- Direct Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of the Application for UNS Electric, Inc. for the Establishment of Just and Reasonable Rates and Charges Designed to Realize a Reasonable Rate of Return on the Fair Value of the Properties of UNS Electric, Inc. Devoted to the its Operations Throughout the State of Arizona, and for Related Approvals, Docket No. E-04204A-15-0142, December 9, 2015.
- Testimony before the Board of Directors on behalf of Salt River Project, in the matter of "An Evaluation of SRP's Electric Rate Proposal for Residential Customers with Distributed Generation," December 31, 2014.

Arkansas

- Direct Testimony before the Arkansas Public Service Commission on behalf of Entergy Arkansas, Inc., in the matter of Entergy Arkansas, Inc.'s Application for an Order Finding the Deployment of Advanced Metering Infrastructure to be in the Public Interest and Exemption from Certain Applicable Rules, Docket No. 16-060-U, September 19, 2016.

California

- Testimony before the Board of Directors on behalf of SMUD, in the matter of "Encouraging Rooftop Solar without Creating Cross-subsidies," April 30, 2019.

- Rebuttal Testimony before the Public Utilities Commission of the State of California, Pacific Gas and Electric Company Joint Utility on Demand Elasticity and Conservation Impacts of Investor-Owned Utility Proposals, in the Matter of Rulemaking 12-06-013, October 17, 2014.
- Prepared testimony before the Public Utilities Commission of the State of California on behalf of Pacific Gas and Electric Company on rate relief, Docket No. A.10-03-014, Summer 2010.
- Qualifications and prepared testimony before the Public Utilities Commission of the State of California, on behalf of Southern California Edison, Edison SmartConnect™ Deployment Funding and Cost Recovery, exhibit SCE-4, July 31, 2007.
- Testimony on behalf of the Pacific Gas & Electric Company, in its application for Automated Metering Infrastructure with the California Public Utilities Commission. Docket No. 05-06-028, 2006.

Canada

A. Alberta

- Virtual proceedings in front of the Alberta Utilities Commission, Application No. 24116-A001, Proceeding ID No. 24116. June 24, 2020.
- Information Response to Alberta Utilities Commission in Electric Distribution System Inquiry - Combined Module Proceedings ID 24116. June 17, 2020.

B. New Brunswick

- Presented before the New Brunswick Energy and Utilities Board in the Matter of the Stakeholder recommendations on rate design reform: Matter 357. May 12, 2020.

C. Nova Scotia

- Presented before the Nova Scotia Utility and Review Board in the Matter of The Public Utlities Act, R. S. N. S. 1989, c380, as amended. Time-Varying Pricing Tariff Application No. M09777. November 20, 2020.
- Presented before the Nova Scotia Utility and Review Board to provide an assessment of Nova Scotia Power, Inc.'s proposed Extra Large Industrial Active Demand Control (ELIADC) tariff for Port Hawkesbury Paper (PHP). February 2020.

Colorado

- Rebuttal testimony before the Public Utilities Commission of the State of Colorado in the Matter of Advice Letter No. 1535 by Public Service Company of Colorado to Revise its Colorado PUC No.7 Electric Tariff to Reflect Revised Rates and Rate Schedules to be Effective on June 5, 2009. Docket No. 09al-299e, November 25, 2009.
- Direct testimony before the Public Utilities Commission of the State of Colorado, on behalf of Public Service Company of Colorado, on the tariff sheets filed by Public Service Company of Colorado with advice letter No. 1535 – Electric. Docket No. 09S-__E, May 1, 2009.

Connecticut

- Testimony before the Department of Public Utility Control, on behalf of the Connecticut Light and Power Company, in its application to implement Time-of-Use, Interruptible Load Response, and Seasonal Rates- Submittal of Metering and Rate Pilot Results- Compliance Order No. 4, Docket no. 05-10-03RE01, 2007.

District of Columbia

- Direct testimony before the Public Service Commission of the District of Columbia on behalf of Potomac Electric Power Company in the matter of the Application of Potomac Electric Power Company for Authorization to Establish a Demand Side Management Surcharge and an Advance Metering Infrastructure Surcharge and to Establish a DSM Collaborative and an AMI Advisory Group, case no. 1056, May 2009.

Georgia

- Direct testimony before the State of Georgia Public Service Commission on behalf of Georgia Power Company, in the matter of Georgia Power Company's 2019 Base Rate Case, Docket No. 42516, June 28, 2019.

Idaho

- Rebuttal Testimony before the Idaho Public Utilities Commission on behalf of Idaho Power Company (Idaho Power), in the matter of the Application of Idaho Power Company for Authority to Establish New Schedules for Residential and Small General Service Customers with On-Site Generation, Case No. IPC-E-17-13, January 26, 2018.

Illinois

- Direct testimony on rehearing before the Illinois Commerce Commission on behalf of Ameren Illinois Company, on the Smart Grid Advanced Metering Infrastructure Deployment Plan, Docket No. 12-0244, June 28, 2012.

- Testimony before the Illinois Commerce Commission on behalf of Commonwealth Edison Company regarding the evaluation of experimental residential real-time pricing program, 11-0546, April 2012.

- Rebuttal Testimony before the Illinois Commerce Commission on behalf of Commonwealth Edison Company in the matter of the Petition to Approve an Advanced Metering Infrastructure Pilot Program and Associated Tariffs, No. 09-0263, August 14, 2009.
- Prepared rebuttal testimony before the Illinois Commerce Commission on behalf of Commonwealth Edison, on the Advanced Metering Infrastructure Pilot Program, ICC Docket No. 06-0617, October 30, 2006.

Indiana

- Direct testimony before the State of Indiana, Indiana Utility Regulatory Commission, on behalf of Vectren South, on the smart grid. Cause no. 43810, 2009.

Kansas

- Rebuttal testimony before the State Corporation Commission of the State of Kansas on behalf of Evergy Kansas Central, Inc. and Evergy Kansas South, Inc. in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, December 04, 2020.
- Direct testimony before the State Corporation Commission of the State of Kansas on behalf of Evergy Kansas Central, Inc. and Evergy Kansas South, Inc. in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, October 13, 2020.
- Rebuttal testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company for Approval to Make Certain Changes in their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, July 3, 2018.
- Direct testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company for Approval to Make Certain Changes in their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, February 1, 2018.
- Reply affidavit before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the General Investigation to Examine Issues Surrounding Rate Design for Distributed Generation Customers, Docket No. 16-GIME-403-GIE, May 5, 2017.

- Direct testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Service, Docket No. 15-WSEE-115-RTS, March 2, 2015.

Louisiana

- Rebuttal testimony before the Council of the City of New Orleans on behalf of Entergy New Orleans, LLC, in the matter of Application of Entergy New Orleans, LLC for a Change in Electric and Gas Rates Pursuant to Council Resolutions R-15-194 and R-17-504 and for Related Relief, Docket No. UD-18-07, March 2019.
- Direct testimony before the Council for the City of New Orleans on behalf of Entergy New Orleans, LLC, in the matter of Application of Entergy New Orleans, LLC for a Change in Electric and Gas Rates Pursuant to Council Resolutions R-15-194 and R-17-504 and for Related Relief, Docket No. UD-18-07, July 2018.
- Direct testimony before the Louisiana Public Service Commission on behalf of Entergy Louisiana, LLC, in the matter of Approval to Implement a Permanent Advanced Metering System and Request for Cost Recovery and Related Relief in accordance with Louisiana Public Service Commission General Order dated September 22, 2009, R-29213, November 2016.
- Direct testimony before the Council of the City of New Orleans, on behalf of Entergy New Orleans, Inc., in the matter of the Application of Energy New Orleans, Inc. for Approval to Deploy Advanced Metering Infrastructure, and Request for Cost Recovery and Related Relief, October 2016.

Maryland

- Direct Testimony before the Maryland Public Service Commission, on behalf of Potomac Electric Power Company in the matter of the Application of Potomac Electric Power Company for Adjustments to its Retail Rates for the Distribution of Electric Energy, April 19, 2016.
- Rebuttal Testimony before the Maryland Public Service Commission on behalf of Baltimore Gas and Electric Company in the matter of the Application of Baltimore Gas and Electric Company for Adjustments to its Electric and Gas Base Rates, Case No. 9406, March 4, 2016.
- Direct testimony before the Public Service Commission of Maryland, on behalf of Potomac Electric Power Company and Delmarva Power and Light Company, on the deployment of Advanced Meter Infrastructure. Case no. 9207, September 2009.
- Prepared direct testimony before the Maryland Public Service Commission, on behalf of Baltimore Gas and Electric Company, on the findings of BGE's Smart Energy Pricing ("SEP") Pilot program. Case No. 9208, July 10, 2009.

Minnesota

- Rebuttal testimony before the Minnesota Public Utilities Commission State of Minnesota on behalf of Northern States Power Company, doing business as Xcel Energy, in the matter of the Application of Northern States Power Company for Authority to Increase Rates for Electric Service in Minnesota, Docket No. E002/GR-12-961, March 25, 2013.
- Direct testimony before the Minnesota Public Utilities Commission State of Minnesota on behalf of Northern States Power Company, doing business as Xcel Energy, in the matter of the Application of Northern States Power Company for Authority to Increase Rates for Electric Service in Minnesota, Docket No. E002/GR-12-961, November 2, 2012.

Mississippi

- Direct testimony before the Mississippi Public Service Commission, on behalf of Entergy Mississippi, Inc., in the matter of Application for Approval of Advanced Metering Infrastructure and Related Modernization Improvements, EC-123-0082-00, November 2016.

Missouri

- Direct testimony before the Missouri Public Service Commission, on behalf of Union Electric Company d/b/a Ameren Missouri, in the matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Increase Its Revenues for Electric Service, ER-2019-0335, July 3, 2019.

Montana

- Rebuttal testimony before the Public Service Commission of the State of Montana on behalf of NorthWestern Energy, in the matter of NorthWestern Energy's Application for Authority to Increase Retail Electric Utility Service Rates and for Approval of Electric Service Schedules and Rules and Allocated Cost of Service and Rate Design, Docket No. D2018.2.12, April 2019.
- Prefiled direct testimony before the Public Service Commission of the State of Montana on behalf of NorthWestern Energy, in the matter of NorthWestern Energy's Application for Authority to Increase its Retail Electric Utility Service Rates and for Approval of its Electric Service Schedules and Rules, Docket No. D2018.2.12, September 28, 2018.

Nevada

- Prepared rebuttal testimony before the Public Utilities Commission of Nevada on behalf of Nevada Power Company and Sierra Pacific Power Company d/b/a NV Energy, in the matter of net metering and distributed generation cost of service and tariff design, Docket Nos. 15-07041 and 15-07042, November 3, 2015.
- Prepared direct testimony before the Public Utilities Commission of Nevada on behalf of Nevada Power Company d/b/a NV Energy, in the matter of the application for approval of a cost of service study and net metering tariffs, Docket No. 15-07, July 31, 2015.

New Mexico

- Direct testimony before the New Mexico Regulation Commission on behalf of Public Service Company of New Mexico in the matter of the Application of Public Service Company of New Mexico for Revision of its Retail Electric Rates Pursuant to Advice Notice No. 507, Case No. 14-00332-UT, December 11, 2014.

Oklahoma

- Rebuttal Testimony before the Corporation Commission of Oklahoma on behalf of Oklahoma Gas and Electric Company in the matter of the Application of Oklahoma Gas and Electric Company for an Order of the Commission Authorizing Applicant to modify its Rates, Charges and Tariffs for Retail Electric Service in Oklahoma, Cause No. PUD 201500273, April 11, 2016.
- Direct Testimony before the Corporation Commission of Oklahoma on behalf of Oklahoma Gas and Electric Company in the matter of the Oklahoma Gas and Electric Company for an Order of the Commission Authorizing Applicant to modify its Rates, Charges and Tariffs for Retail Electric Service in Oklahoma, Cause No. PUD 201500273, December 18, 2015.
- Responsive Testimony before the Corporation Commission of Oklahoma on behalf of Oklahoma Gas and Electric Company in the matter of the Application of Brandy L. Wreath, Director of the Public Utility Division, for Determination of the Calculation of Lost Net Revenues and Shared Savings Pursuant to the Demand Program Rider of Oklahoma Gas and Electric Company, Cause No. PUD 201500153, May 13, 2015.

Pennsylvania

- Direct testimony before the Pennsylvania Public Utility Commission, on behalf of PECO on the Methodology Used to Derive Dynamic Pricing Rate Designs, Case no. M-2009-2123944, January 11, 2011.

South Carolina

- Rebuttal Testimony before the Public Service Commission of South Carolina on behalf Duke Energy Carolinas, LLC and Duke Energy Progress, LLC in the matter Duke Energy Carolinas, LLC's Establishment of Solar Choice Metering Tariffs Pursuant to S.C. Code Ann. Section 58-40-20, Febrauray 23, 2021.

Washington

- Pre-filed Direct Testimony before the Washington Utilities and Transportation Commission on Behalf of Puget Sound Energy, Dockets UE-151871 and UG-151872, February 25, 2016.

REGULATORY APPEARANCES

Arkansas

- Presented before the Arkansas Public Service Commission, "The Emergence of Dynamic Pricing," at the workshop on the Smart Grid, Demand Response, and Automated Metering Infrastructure, Little Rock, Arkansas, September 30, 2009.

Delaware

- Presented before the Delaware Public Service Commission, "The Demand Response Impacts of PHI's Dynamic Pricing Program," Delaware, September 5, 2007.

Kansas

- Presented before the State Corporation Commission of the State of Kansas, "The Impact of Dynamic Pricing on Westar Energy," at the Smart Grid and Energy Storage Roundtable, Topeka, Kansas, September 18, 2009.

Ohio

- Presented before the Ohio Public Utilities Commission, "Dynamic Pricing for Residential and Small C&I Customers," at the Technical Workshop, Columbus, Ohio, March 28, 2012.

Texas

- Presented before the Public Utility Commission of Texas, "Direct Load Control of Residential Air Conditioners in Texas," at the PUCT Open Meeting, Austin, Texas, October 25, 2012.

PUBLICATIONS

Articles and Papers

- "Flexible Demand Side Grid Assets" by Matthew Schuerger, Public Utilities Fortnightly, December 2020.
  https://www.fortnightly.com/fortnightly/2020/12/flexible-demand-side-grid-assets
- "Resiliency in the West" by Ann Rendahl, Public Utilities Fortnightly, December 2020.
  https://www.fortnightly.com/fortnightly/2020/12/resiliency-west
- "The Road to Net Zero: Decorbonizing Household Consumption," by Clark Gellings and Ahmad Faruqui, *Public Utilities Fortnightly*, December 2020.
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- "Designing Tariffs for Tomorrow's Customer: The Innovation Imperative," presented to the Electricity Authority, September 2, 2020.

- "Designing Pilots and Proceeding with Full Scale Deployment," presented at the Washington Utilities and Transportation Commission, June 8, 2020.
- "The Five "Immortal Objections" to Time-of-Use Rates," presented at the PLMA Load Management Dialogue, May 28, 2020.
- " Stakeholder recommendations on rate design reform: Matter 357," with Cecile Bourbonnais, presented at the New Brunswick Energy and Utilities Board, May 12, 2020.
- "Moving Ahead with Time-Varying Rates (TVR): US and Global Perspectives," presented at the MI Power Grid: Energy Programs and Technology Pilots Stakeholder Meeting, April 16, 2020.
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- "Demand on Demand," presented at the AESP Annual Conference, February 20, 2020.
- "Empirical Assessment of the Demand for Residential Solar Distributed Generation and the Impact of Electricity Rate Design Reform," with Agustin J. Ros and Cecile Bourbonnais, presented at the Rutgers University Center for Research in Regulated Industries, January 17, 2020.
- "Assessment of APS's Bill Comparison Web Tool: Methodology and Findings," with Ryan Hledik and Cecile Bourbonnais, December 10, 2019.
- "A Survey of Residential Time-of-Use (TOU) Rates," with Ryan Hledik and Sanem Sergici, November 12, 2019.
- "Advancing the Practice of Rate Design," presented at the 40th PLMA Conference, November 6, 2019.
- "The Total Value Test (TVT) for Assessing Electrification Programs," with Ryan Hledik and Omar Siddiqui, presented at the California Efficiency + Demand Management Council (CEDMC), October 24, 2019.
- "A Conversation about Customer Centricity," presented at Virtual Speaker Forum, October 21, 2019.
- "Encouraging Rooftop Solar without Creating Cross-Subsidies," presented to SMUD, April 30, 2019.
- "Post-Modern Rate Design: The 'Secret Sauce' in Customer Engagement," presented at the Entergy Regulatory Conference, April 9, 2019.
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- "Forecasting the Impact of DSM on Energy Sales," with Zhen Wang, presented to the Edison Electric Institute (EEI), September 14, 2017.
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- "Moving Forward with Tariff Reform," presented during the EEI Webinar on Rate Design, April 6, 2017.
- "An Irreverent Take on Customer Research in Our Industry," presented at the EPRI Workshop: Understanding Customer Preferences for and Adoption of New Services and Technology, April 4, 2017.
- "The Tariffs of Tomorrow," presented at the University of California, Davis Energy Efficiency Center Seminar, January 11, 2017.

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- "Curating the Future of Rate Design," presented at the EUCI's Residential Demand Charges Conference, October 20, 2016.
- "Understanding Residential Customer Response to Demand Charges: Present and Future," with Sanem Sergici and Ryan Hledik, presented at EUCI's Residential Demand Charges Conference, October 20, 2016.
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- "Retail Costing and Pricing for Electricity," with Philip Q Hanser and Sanem Sergici, presented at IPU's 58th Annual Regulatory Studies Program: The Fundamentals Course, August 11, 2016.
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BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Adjust Its Revenues for Electric Service.	)))	Case No. ER-2021-0240

AFFIDAVIT OF AHMAD FARUQUI, Ph.D.

STATE OF CALIFORNIA)
) ss
CITY OF SAN FRANCISCO)

Ahmad Faruqui, Ph.D., being first duly sworn on his oath, states:

My name is Ahmad Faruqui, Ph.D, and on his oath declare that he is of sound mind and lawful age; that he has prepared the foregoing *Direct Testimony*; and further, under the penalty of perjury, that the same is true and correct to the best of my knowledge and belief.

/S/ Ahmad Faruqui, Phd
Ahmad Faruqui, Ph.D

Sworn to me this 30th day of March, 2021.