Thomas A. Loquvam, AZ Bar No. 024068
Melissa M. Krueger, AZ Bar No. 021176
Pinnacle West Capital Corporation
400 North 5th Street, MS 8695
Phoenix, Arizona 85004
Tel: (602) 250-3630
Fax: (602) 250-3393
E-Mail: Thomas.Loquvam@pinnaclewest.com
Melissa.Krueger@pinnaclewest.com

Attorneys for Arizona Public Service Company

BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS
TOM FORESE, Chairman
BOB BURNS
ANDY TOBIN
BOYD DUNN
JUSTIN OLSON

IN THE MATTER OF:
STACEY CHAMPION, et al.,
Complainant,
v.
ARIZONA PUBLIC SERVICE COMPANY,
an Arizona Public Service Corporation,
Respondent.

APS provides notice that it is filing the attached direct testimonies of Dr. Ahmad Faruqui, Ms. Jessica Hobbick and Mr. Leland Snook as Exhibits 1-3, respectively.

RESPECTFULLY SUBMITTED this 31st day of July 2018.

By: Thomas A. Loquvam
Melissa M. Krueger
Attorneys for Arizona Public Service Company
ORIGINAL and thirteen (13) copies of the foregoing filed this 31st day of July 2018, with:

Docket Control
ARIZONA CORPORATION COMMISSION
1200 West Washington Street
Phoenix, Arizona 85007

COPY of the foregoing mailed/delivered this 31st day of July 2018 to:

Elijah Abinah
Utilities Division
Arizona Corporation Commission
1200 W. Washington St.
Phoenix, AZ 85007

Stacey Champion
3101 North Central Avenue, Suite 170
Phoenix, AZ 85007

Jane L. Rodda
Chief Administrative Law Judge
Arizona Corporation Commission
1200 W. Washington St.
Phoenix, AZ 85007

Warren Woodward
200 Sierra Road
Sedona, AZ 86336

Andy Kvesic, Director
Legal Division
Arizona Corporation Commission
1200 West Washington Street
Phoenix, Arizona 85007

Richard Gayer
526 West Wilshire Drive
Phoenix, AZ 85003

Adam L. Stafford, Esq.
Wong Carter P.C.
3003 North Central Avenue, Suite 1000
Phoenix, AZ 85012
Attorney for Complainant
EXHIBIT 1

Direct Testimony of
Ahmad Faruqui
DIRECT TESTIMONY OF AHMAD FARUQUI
On Behalf of Arizona Public Service Company
Docket No. E-01345A-18-0002

July 31, 2018
**Table of Contents**

1. **INTRODUCTION** ........................................................................................................ 1
2. **SUMMARY OF TESTIMONY** ..................................................................................... 3
3. **CONCLUSION** ........................................................................................................... 4

Statement of Qualifications ................................................................................................... Attachment AJF-1DR
Expert Report ....................................................................................................................... Attachment AJF-2DR
DIRECT TESTIMONY OF AHMAD FARUQUI
ON BEHALF OF ARIZONA PUBLIC SERVICE COMPANY
(Docket No. E-01345A-18-0002)

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, JOB TITLE, BUSINESS ADDRESS AND THE PARTY FOR WHOM YOU ARE FILING TESTIMONY.

A. My name is Ahmad Faruqui. I am a Principal with The Brattle Group. My business address is 201 Mission Street, Suite 2800, San Francisco, California 94105. I am filing testimony on behalf of Arizona Public Service Company (APS).

Q. PLEASE DESCRIBE YOUR PROFESSIONAL BACKGROUND AND EXPERIENCE.

A. I have 40 years of academic, consulting and research experience as an energy economist. My consulting practice is focused on customer-related issues. 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.

I have worked for nearly 150 clients on five continents. These include electric and gas utilities, state and federal commissions, independent system operators, government agencies, trade associations, research institutes, and manufacturing companies. I have testified or appeared before commissions in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Kansas, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, ECRA (Saudi Arabia), and Texas. Also, I have presented to governments in Australia, Canada, Egypt, Ireland, the Philippines, Thailand and the United Kingdom and given seminars around the world.

Public Radio and Voice of America, and I have authored, co-authored, or co-edited four books and more than 150 articles, papers, and reports on energy economics. I have published in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, Energy Policy, Journal of Regulatory Economics and Utilities Policy and in trade journals such as The Electricity Journal and the Public Utilities Fortnightly.

I hold B.A. and M.A. degrees from the University of Karachi, Pakistan, an M.A. in agricultural economics and a Ph.D. in economics from the University of California at Davis.

More details regarding my professional background and experience are set forth in my Statement of Qualifications, included as Attachment AJF-1DR.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE ARIZONA CORPORATION COMMISSION?
A. Yes. I have previously filed testimony on behalf of APS in Docket No. E-01345A-16-0036. I have also filed testimony and testified in person in the UNS Electric Rate Case, Docket No. E-04204A-15-0142. In addition, I have spoken at a technical workshop at the Arizona Corporation Commission (ACC or Commission) on March 20, 2014, Docket No. E-00000J-13-0375.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?
A. Stacey Champion, a customer of APS, has filed a claim before the Commission in which she has stated that her bills changed by a higher amount than the 4.54% increase, which was granted by the Commission to APS. As evidence, she provided an analysis of the amount by which her bills allegedly increased during a four-month period. The purpose of my testimony is to issue an expert report that evaluates Ms. Champion’s analysis and the appropriateness of APS’s ratemaking process and its implementation.
II. SUMMARY OF TESTIMONY

Q. PLEASE SUMMARIZE YOUR DIRECT TESTIMONY.

I have reviewed Ms. Champion’s analysis and come to the following four conclusions.

First, APS’s ratemaking process is consistent with industry practices. The process has precedent in rate cases conducted elsewhere and is documented as standard industry practice in the literature on the topic. Under this standard practice, APS’s rates were designed to collect the approved $94.624 million in revenue. The 4.54% rate increase is therefore the result of an appropriate and reasonable approach to ratemaking.

Second, the 4.54% rate increase must be understood in the appropriate context. It is the amount of increase in the base rate portion of the class average residential customer’s bill based on Test Year data and exclusive of the adjustor sweep. Thus, it cannot and does not reflect the specific bill change that will be experienced by any individual customer in the Test Year, or even by the average customer or an individual customer in future years. There are seven important factors that contribute to these differences.

Third, I have discovered that Ms. Champion’s conceptual framework for analyzing the changes in her own bills is flawed. She does not account for several of the factors that would cause her bill to deviate from the ACC-approved average 4.54% residential base rate increase.

Fourth, I conclude that the bill comparisons presented by Champion to date are inaccurate and thus irrelevant.

Q. ARE YOU SPONSORING ANY ATTACHMENTS TO YOUR TESTIMONY?

A. Yes. My Expert Report in this matter is Attachment AJF-2DR to my testimony, which is incorporated herein in its entirety.
III. CONCLUSION

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.
Dr. Ahmad Faruqui is an energy economist whose work is focused on the efficient use of energy. His 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. He has worked for nearly 150 clients on 5 continents. These include electric and gas utilities, state and federal commissions, independent system operators, government agencies, trade associations, research institutes, and manufacturing companies. Ahmad has testified or appeared before commissions in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Kansas, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, ECRA (Saudi Arabia), and Texas. He has presented to governments in Australia, Egypt, Ireland, the Philippines, Thailand and the United Kingdom and given seminars on all 6 continents. His research has been cited in Business Week, The Economist, Forbes, National Geographic, The New York Times, San Francisco Chronicle, San Jose Mercury News, Wall Street Journal and USA Today. He has appeared on Fox Business News, National Public Radio and Voice of America. He is the author, co-author or editor of 4 books and more than 150 articles, papers and reports on energy matters. He has published in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, Energy Policy, Journal of Regulatory Economics and Utilities Policy and trade journals such as The Electricity Journal and the Public Utilities Fortnightly. He holds B.A. and M.A. degrees from the University of Karachi, where he was awarded the Gold Medal in Economics, an M.A. in agricultural economics and a Ph.D. in economics from The University of California at Davis, where he was a Regents Fellow and the recipient of a dissertation grant from the Kellogg Foundation.

**AREAS OF EXPERTISE**

- **Expert witness.** He has testified or appeared before state commissions in Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, Illinois, Indiana, Iowa, Kansas, Michigan, Maryland, Ontario (Canada) and Pennsylvania. He has assisted clients in submitting testimony in Georgia and Minnesota. He has made presentations to the California Energy Commission, the California Senate, the Congressional Office of Technology Assessment, the Kentucky Commission, the Minnesota Department of Commerce, the Minnesota Senate, the Missouri Public Service Commission, and the Electricity Pricing Collaborative in the state of Washington.
Ahmad Faruqui

- **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.** He 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 advanced metering infrastructure.** 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 wide 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 wide 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
Ahmad Faruqui

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, University of Karachi, Massachusetts Institute of Technology, Michigan State University, Northwestern University, University of San Francisco, San Jose State University, 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 the university level 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.
Ahmad Faruqui

- 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 as to fulfill 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 reviews 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 discusses ways in which dynamic pricing can 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 includes 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 is international regulators in regions that are 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
Ahmad Faruqui

subsequently evaluated the Plan-It Wise Energy program (PWEP) in the summer of 2009. 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 from 2008 to 2011. 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 to real-time prices. 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.
Ahmad Faruqui

- **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. Catalogued the barriers to implementing real-time pricing in California, and developed a program of research for mitigating the impacts of these barriers.
Ahmad Faruqui

- **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 staffs 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 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 in June 2010.
Ahmad Faruqui


- 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 also 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 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.** We conducted a strategic review of why sales had been lower than forecast in a year when economic activity had been brisk. We 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. We 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. We 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, we developed a base case forecast and several alternative case forecasts of electric energy consumption by end use and sector. We 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
Ahmad Faruqui

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 are likely to operate in a competitive market, such as third-
Ahmad Faruqui

party energy service companies (ESCOS) 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 size of product. 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 on 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**

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.


**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**


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.

Colorado


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.

Idaho


Illinois


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.

**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**


**Louisiana**

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.

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


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.

Nevada

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


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.


Pennsylvania


Washington

REGULATORY APPEARANCES

Arkansas


Delaware


Kansas


Ohio


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

Books


Chapters in Books


Technical Reports


Ahmed Faruqui

Quantifying the Amount and Economic Impacts of Missing Energy Efficiency in PJM’s Load Forecast, with Sanem Sergici and Kathleen Spees, prepared for The Sustainable FERC Project, September 2014.


Electrotechnologies for Multifamily Housing. With Omar Siddiqui. EPRI TR-106442, Volumes 1 and 2. Electric Power Research Institute, September 1996.


Articles and Papers

https://www.fortnightly.com/fortnightly/2018/05/rate-design-30


http://www.energyregulationquarterly.ca/articles/moving-forward-with-tariff-reform#sthash.ZADdmZ2h.D211yz9z.dpbt

http://mydigimag.rrd.com/publication/?i=435343"issue_id=435343"page=42"


https://www.fortnightly.com/fortnightly/2017/08/enhancing-customer-centricity


https://www.fortnightly.com/fortnightly/2017/07/rethinking-customer-research

http://www.energyregulationquarterly.ca/articles/do-manufacturing-firms-relocate-in-response-to-rising-electric-rates#sthash.ULnrPMwh.dpbt

https://www.fortnightly.com/fortnightly/2017/05/dynamic-pricing-works-hot-humid-climate


“Competing Perspectives on Demand Charges,” with Ryan Hledik, Public Utilities Fortnightly, September 2016.

“An Economist’s Dilemma: To, PV or Not to PV, That Is the Question,” Electricity Policy, March 2016.
http://www.electricitypolicy.com/Articles/an-economists-dilemma-to-pv-or-not-to-pv-that-is-the-question

https://www.fortnightly.com/fortnightly/2016/03/response-king-datta-re-time-varying-rates


http://www.fortnightly.com/fortnightly/2014/08/smart-default?page=0%2C0&authkey=e5h59c3e26805e2c6b9e469cb9c1855a9b0f18c67bbe7d8d4ca08a8abd39c54d

“Quantile Regression for Peak Demand Forecasting,” with Charlie Gibbons, SSRN, July 31, 2014.

“Study Ontario for TOU Lessons,” Intelligent Utility, April 1, 2014.
http://ssrn.com/abstract=2411832


http://spark.fortnightly.com/fortnightly/charting-dsm-sales-slump


http://www.fortnightly.com/fortnightly/2013/07/benchmarking-your-rate-case

http://www.electricitypolicy.com/articles/5677-surviving-sub-one-percent-growth

http://www.fortnightly.com/fortnightly/2012/12/demand-growth-and-new-normal?page=0%2C1&authkey=4a6cf0a67411ee5c7c2ae5da4616b72fde10e3fbc215164cd4e5dbd8e9d0c98

Available at SSRN: http://ssrn.com/abstract=2029150


http://www.electricenergyonline.com/?page-show_article&mag=76&article=618

“Dynamic Pricing of Electricity and its Discontents” with Jennifer Palmer, Regulation, Volume 34, Number 3, Fall 2011, pp. 16-22.

http://www.fortnightly.com/archive/puf_archive_1011.cfm


“Are LDCs and customers ready for dynamic prices?” with Jürgen Weiss, Fortnightly’s Spark, August 25, 2011.


http://www.fortnightly.com/archive/puf_archive_0311.cfm


http://www.fortnightly.com/archive/puf_archive_1110.cfm


“Unlocking the €53 billion savings from smart meters in the EU: How increasing the adoption of dynamic tariffs could make or break the EU’s smart grid investment,” with Dan Harris and Ryan Hledik, Energy Policy, Volume 38, Issue 10, October 2010, pp. 6222-6231.


http://www.drgcoalition.org/resources/other/Pricing_Programs_TOU_and_RTP.pdf


http://www.crai.com/uploadedFiles/RELATING_MATERIALS/Publications/files/Controlling%20the%20Thirst%20for%20Demand.pdf


Expert Report of Dr. Ahmad Faruqui in the Matter of Stacey Champion, et al., versus Arizona Public Service Company

PREPARED ON BEHALF OF
Arizona Public Service Company

July 26, 2018

THE Brattle GROUP
Table of Contents

I. Introduction................................................................................................................. 1

II. APS's ratemaking process is consistent with industry practices............................ 4

III. The 4.54% residential rate increase must be understood in the appropriate context ...... 8

IV. Ms. Champion's bill impact analysis is based on a flawed conceptual framework......... 11

V. Conclusions............................................................................................................... 14
I. **Introduction**

**Witness Qualifications**

I am a Principal with The Brattle Group. I have 40 years of academic, consulting and research experience as an energy economist. My consulting practice is focused on customer-related issues. 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.

I have worked for nearly 150 clients on five continents. These include electric and gas utilities, state and federal commissions, independent system operators, government agencies, trade associations, research institutes, and manufacturing companies. I have testified or appeared before commissions in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Kansas, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, ECRA (Saudi Arabia), and Texas. Also, I have presented to governments in Australia, Canada, Egypt, Ireland, the Philippines, Thailand and the United Kingdom and given seminars around the world.

My research has been cited in Business Week, The Economist, Forbes, National Geographic, The New York Times, San Francisco Chronicle, San Jose Mercury News, Wall Street Journal and USA Today. I have appeared on Fox Business News, National Public Radio and Voice of America. I serve on the editorial board of The Electricity Journal and I have authored, co-authored, or co-edited 4 books and more than 150 articles, papers, and reports on energy economics. I have published in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, Energy Policy, Journal of Regulatory Economics, Regulation, and Utilities Policy and in trade journals such as The Electricity Journal and the Public Utilities Fortnightly.

I hold B.A. and M.A. degrees from the University of Karachi, Pakistan, an M.A. in agricultural economics and a Ph.D. in economics from the University of California at Davis.
I previously filed written testimony on behalf of Arizona Public Service Company (APS) before the Arizona Corporation Commission (ACC or Commission) in Docket No. E-01345A-16-0036. I also filed testimony and testified in the UNS Electric Rate Case in Docket No. E-04204A-15-0142. I have also spoken at a technical workshop before the Commission on March 20, 2014.¹

More details regarding my professional background and experience are set forth in my Statement of Qualifications, included as Attachment AJF-1DR to my Direct Testimony.

**Background and Purpose**

On August 18, 2017, APS received approval from the ACC for a settlement of its Rate Case through Decision No. 76295.² Among many aspects of the settlement was approval for an increase in revenue to be collected through APS’s rates. The increase in revenue to be collected from the residential class equated to 4.54% of the 2015 Test Year base revenue, or roughly $6 per residential customer on average.³

In January 2018, Stacey Champion filed a complaint related to Decision No. 76295. Through subsequent filings, Stacey Champion and Richard Gayer have asserted that residential bill increases have exceeded the aforementioned 4.54%. To support their assertions, Ms. Champion and Mr. Gayer have provided analyses of their own bills.

The purpose of my expert report is to analyze Ms. Champion’s complaint and evaluate the appropriateness of APS’s ratemaking process and its implementation. I begin by reviewing and commenting on the extent to which APS’s process to design and calculate the residential rates was consistent with industry practices. Then, in the context of my review of APS’s ratemaking

---

² Docket No. E-01345A-16-0036.
³ Throughout my testimony, I simply refer to this as the “rate increase.” It excludes the impact of transferring a portion of adjustor revenue into base rates.
process, I analyze and refute Ms. Champion’s claims that the rates introduced by APS are inconsistent with the approved rates in the ACC’s Decision No. 76295.

Summary

My review leads to the following conclusions:

- APS’s ratemaking process is consistent with industry practices. The process has precedent in rate cases conducted elsewhere and is documented as standard industry practice in the literature on the topic. Under this standard practice, APS’s rates were designed to collect the approved $94.624 million in revenue. The 4.54% rate increase is therefore the result of an appropriate and reasonable approach to ratemaking.

- The 4.54% rate increase must be understood in the appropriate context. It is the amount of increase in the base rate portion of the class average residential customer’s bill based on Test Year data and exclusive of the adjustor sweep I discuss later in my report. Thus, it cannot and does not reflect the specific bill change that will be experienced by any individual customer in the Test Year, or even the average customer or individual customer in future years. I highlight seven important factors that contribute to these differences.

- I have discovered that Ms. Champion’s conceptual framework for analyzing the changes in her own bills is flawed. She does not account for several of the factors that would cause her bill to deviate from the ACC-approved average 4.54% residential base rate increase.

- I conclude that the bill comparisons presented by Ms. Champion to date are inaccurate and thus irrelevant.
II. APS’s ratemaking process is consistent with industry practices

Review of APS’s Ratemaking Process

I conducted a conceptual review of APS’s ratemaking process. Specifically, I focused on the process that was used to determine the 4.54% rate increase net of the adjustor transfer that was approved for the residential class. My review was based on examination of APS witness testimony filed in the rate case (including the settlement filing), workpapers associated with the testimony, and supplemental clarifying discussions with APS staff.

At a high level, APS’s process for arriving at an average 4.54% rate increase across all customers can be deconstructed into seven steps. Where applicable, I put the steps in the context of established ratemaking practices in other jurisdictions.

Step 1: Establish the Test Year

APS used a historical Test Year as the basis for determining its revenue requirement. This means APS used a one-year backward-looking snapshot of costs and various electricity consumption metrics. In the 2016 Rate Case, APS used 2015 as it was the most recent year for which a full year of data was available.

It is common to use a historical Test Year in rate cases. As of 2016, nineteen states relied on historical Test Years, and an additional 16 states plus the District of Columbia used either both historical and future Test Years or a hybrid, partially-forecasted Test Year.4

Step 2: Determine total Test Year cost to serve all customers

After establishing the Test Year, APS quantified the costs and billing determinants from that year. Costs include, for example, distribution capacity costs, customer-related costs, generation capacity costs, and fuel costs. Billing determinants include factors such as customer count, energy sales, and measures of peak demand, which are used to allocate the costs across rate classes. The costs are derived from audited financial data and reflect actual costs incurred by the utility during the 2015 Test Year. APS then made standard pro forma adjustments to the Test Year results to reflect the typical year, for instance by normalizing weather.

Step 3: Allocate Test Year costs to customer classes

The costs from Step 2 are then allocated to each customer class. APS uses an “embedded cost” approach to cost allocation. This means that each cost category is assigned an allocation factor that is determined to be the driver of that cost. For instance, meter costs would be allocated based on number of customers, capacity costs are largely allocated based on measures of peak demand (i.e., megawatts), and fuel costs are allocated based on volumetric energy sales (i.e., megawatt-hours).

APS’s allocation process is based on methods established in the NARUC Electric Utility Cost Allocation Manual (NARUC Manual). For decades, it has served as the standard industry reference for cost allocation studies in the United States.

---


6 Allocation of meter costs is also based on differences in type of meter equipment across customer classes, along with the customer count.

Step 4: Determine shortfall in revenue

The Test Year revenue requirement is then compared to Test Year revenue produced by the current rate. If there is a shortfall in revenue relative to the revenue requirement, a rate increase is needed. The amount of rate increase needed is the amount that would make the Test Year revenue equal to the revenue requirement.

This comparison of revenues to the revenue requirement is a necessary step in every utility ratemaking proceeding. In the 2016 Rate Case, APS identified a revenue shortfall of $165.9 million. An amount of $94.624 million was ultimately approved in Decision No. 76295.

Step 5: Allocate revenue increase to customer classes

After the total increase in revenue requirements has been determined, it has to be allocated to the rates in each customer class. This step requires that judgement be exercised regarding the amount of rate increase to be borne by any individual customer class. In particular, this step often involves recognition of the ratemaking principle of "gradualism," which may limit the magnitude of rate increase to be experienced by a class of customers in any given rate case.8

The APS 2016 Rate Case settlement stipulated an overall revenue increase of 3.28%. The class allocation based on revenue shortfall by customer class resulted in a base revenue increase of 4.54% for the residential class.9

Step 6: Transfer portion of adjustor revenue to base rates

As part of the approved settlement, APS transferred a portion of "adjustor" revenue into base rates. Adjustors are charges that collect costs from customers in a manner similar to base rates. The difference is that adjustors change on an annual basis in between rate cases, to track closely

---


9 Decision No. 76295, Docket No. E-01345A-16-0036, p. 22.
to costs that are known to change frequently (e.g., fuel costs or utility-administered energy efficiency program costs).

It is important to note that this "sweep" of adjustor revenue into base rates did not impact the total revenue requirement or average bills. In other words, this change did not impact customer bills on average. Rather, it simply changed the method through which those adjustor revenues were collected. Base rates were increased on average by the same amount that total adjustor revenues were decreased. The 4.54% rate increase is the overall average increase in base revenues before the transfer of adjustor revenues. It is also the average net increase after the transfer of adjustor revenues.

Step 7: Allocate class rate increase to individual rate schedules

The last step is to allocate the class revenue increase to individual rate schedules within the class. Changes to the design of the rates (e.g., changing the timing of the peak period of the TOU rate) combined with the load characteristics of the participants in each rate will lead to a change in the revenue collected by each rate that is different than 4.54%. However, across all customers the change adds up to a 4.54% increase.

Conclusion of review of APS's ratemaking process

Based on my review, I conclude that APS's ratemaking process is entirely consistent with industry practices. The process has precedent in rate cases conducted elsewhere and is documented as standard industry practice in the literature on the topic. APS's rates have been designed consistent with this process to collect the revenue associated with the appropriate 4.54% increase.
III. The 4.54% residential rate increase must be understood in the appropriate context

The ratemaking steps described in the previous section of my report can lead to a number of different ways to describe the "rate increase" that was approved in Decision No. 76295. The average dollar amount of the residential revenue increase is unambiguous ($5.37 per customer per month, relative to an average monthly bill of $118). However, that rate increase may be expressed in a variety of ways in percentage terms. For instance, the increase may appropriately be viewed as an increase in base rates prior to accounting for the adjustor revenue transfer (i.e., 4.54%). Alternatively, it may be viewed as a change in the total residential bill. It would not be useful or appropriate to view the rate increase as the change in total base revenues, as this perspective would not account for the offsetting reduction in adjustor revenues. For clarity, Table 1 summarizes these perspectives on the rate increase. This information depicts an average residential bill, before taxes and fees, during the 2015 Test Year. As shown, the total Test Year bill of $138.81 is comprised of $118.32 from base rates and $20.49 from adjustor charges. The net bill increase from this rate case is $5.37, which incorporates the adjustor transfer of $13.44. The $5.37 expressed as a percent of base rates represents a 4.54% increase ($5.37 divided by $118.32).

Table 1: Average Monthly Customer Bill Under Prior and New Rates

<table>
<thead>
<tr>
<th>Prior Rates ($/customer/month)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] 2015 test year base rate</td>
<td>$118.32</td>
</tr>
<tr>
<td>New Rates ($/customer/month)</td>
<td></td>
</tr>
<tr>
<td>[4] Approved residential revenue increase</td>
<td>$5.37</td>
</tr>
<tr>
<td>[5] Adjustor revenue transferred to base rate</td>
<td>$13.44</td>
</tr>
<tr>
<td>Bill Change Estimates (%)</td>
<td></td>
</tr>
<tr>
<td>[10] Change in average residential bill (relevant comparison)</td>
<td>3.87%</td>
</tr>
<tr>
<td>[11] Total change in base revenues (irrelevant comparison)</td>
<td>15.9%</td>
</tr>
</tbody>
</table>
In a nutshell, the 4.54% rate increase appropriately represents the average annual impact on residential bills due to ACC-approved changes in residential rates, expressed as a percent of base rates. It is the increase in the amount of base revenue that APS collects from residential customers as a result of the approved settlement, holding constant various external factors that vary from one year to the next.

It is crucial to understand these many external factors that will cause any individual customer’s monthly bill to deviate from the 4.54% increase. By external factors, I am referring to variables which, by design, are not accounted for in the ACC-approved ratemaking process. In other words, while 4.54% is the appropriate metric for measuring the change in base rates net of the adjustor transfer, the change in any given customer’s bill is unlikely to be equal to this amount. A description of the factors that will cause a customer’s bill to deviate from the 4.54% annual average increase is provided in Table 2. These factors will affect the percentage increase experienced by individual customers even if the original increase had been an “across the board” equal percentage increase on every rate element.
Table 2: Factors Causing Individual Customer Bills to Deviate from the 4.54% Rate Increase

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differences between test year and year of bill analysis</td>
<td>The 4.54% rate change reflects the impact of an increase in rates assuming consumption patterns and levels remain unchanged at test year levels. Any analysis of future bills will be based on future year consumption data that has deviated from the test year data, and will therefore lead to bill impact estimates that are different than 4.54%.</td>
</tr>
<tr>
<td>Changes in weather</td>
<td>Electricity consumption levels are weather dependent. Hot summers and cold winters lead to higher-than-average consumption (and vice versa). Differences in weather conditions between the year of the bill analysis and the test year will result in bill impact estimates that are different than 4.54%.</td>
</tr>
<tr>
<td>Variability in load shapes across customers</td>
<td>Every customer has a different electricity consumption pattern. That is why some customers have bills that are higher or lower than other customers. It is also why no individual customer has an electricity consumption pattern that exactly equals the class average. Since the 4.54% bill impact is an average across all customers and all residential rate schedules, any individual customer's bill will differ from this amount.</td>
</tr>
<tr>
<td>Seasonal rate changes</td>
<td>The 4.54% bill impact is an annual average. Changes in the rate design established in the settlement proceeding led to an increase in winter charges that is higher than 4.54%, and an increase in summer charges that is lower than 4.54%. As a result, analysis of bill changes in only one season will produce bill impacts that differ from 4.54%.</td>
</tr>
<tr>
<td>Changes in duration of billing cycle</td>
<td>Bills are computed on a roughly monthly basis. However, the precise duration of the billing cycle typically does not perfectly align with the beginning and end of the month. Historically, this was to accommodate manual meter reading schedules. As a result, the &quot;January&quot; billing cycle could be 30 days one year, 29 days the next, etc. A comparison of monthly bills across two different years must take into account differences in billing cycles. Otherwise, the estimate of bill impacts will be distorted.</td>
</tr>
<tr>
<td>Annual changes to &quot;adjustors&quot;</td>
<td>Adjustors are charges that change in between rate cases, and therefore change more frequently than total rates. Comparing bills from two different years will capture changes in the adjustors which were not within the scope of the 4.54% bill impact calculation, since it was based on the 2015 test year and accounted for no change in adjustor levels.</td>
</tr>
<tr>
<td>Customers switching rates</td>
<td>APS's customers have the option to choose from several different rate schedules. Moving to a new rate will lead to changes in the customer's bill. The 4.54% rate impact is based on an average across all residential rate schedules. The bill impact for an individual customer switching rates would deviate from this average.</td>
</tr>
</tbody>
</table>
IV. Ms. Champion’s bill impact analysis is based on a flawed conceptual framework

Ms. Champion has submitted analysis of her own bills as evidence that APS’s rates are inconsistent with the ACC-approved 4.54% rate increase. She compares her bills for the four consecutive months from October 2016 to January 2017 to her bills in the same four months the following year (i.e., October 2017 to January 2018). In Ms. Champion’s assessment of her bills, she finds that they have increased by more than APS’s approved 4.54% rate increase. Ms. Champion points to her estimate of her bill increase as evidence to support her claim.

It appears that Ms. Champion’s methodology used the billing determinants from the bills in the first analysis period (2016-17) to re-calculate her bills in the second analysis period (2017-18), in an attempt to isolate the impact of the rate change between those two years and control for any changes in monthly usage or other billing determinants that would also impact the bill. Ms. Champion reports bill changes of 9.42% in October, 8.09% in November, 8.03% in December, and 7.68% in January. Across all four months, the aggregate change is around 8.1%.

I have reviewed Ms. Champion’s bill analysis. Implicit in Ms. Champion’s analysis is an assumption that her own individual bill for those four months should have increased between

---

10 I did not have access to Ms. Champion’s underlying files supporting these calculations. However, my own replication of this approach produces numbers that are similar to those reported by Ms. Champion.


12 I calculate the 8.1% aggregate change across all four months using my replication of Ms. Champion’s analysis, which recalculates her 2017/18 bills by applying actual 2017/18 rates to her 2016/17 billing determinants for the respective months.
2016 and 2017 by the same 4.54% rate increase that was approved by the ACC for the residential class as a whole. However, Ms. Champion has not accounted for several of the factors I describe in Table 1 in Section III of this report.

I have performed analysis which illustrates how the change in Ms. Champion's bill is consistent with the 4.54% rate increase approved by the ACC. In other words, even though Ms. Champion's average bill did not change by 4.54% in the few months she analyzed, her rate reflects the appropriate implementation of the ACC-approved increase.

My analysis is broken out into five steps.

1. **Ms. Champion's year-over-year change in total bills.** The first step in my analysis is to simply compare Ms. Champion's bills from the 2016/2017 period to her bills from the 2017/2018 period, without any modifications. Ms. Champion's analysis of her own bills focused on four months from October through January. However, since additional billing data for the subsequent months of February and March was made available as an attachment to APS's Answer to Ms. Champion's Revised Complaint, I relied on this expanded dataset and analyzed the broader six-month period from October to March. Without accounting for any of the aforementioned factors, Ms. Champion's average bill for these months decreased by 4.7% between 2016/17 and 2017/18.

2. **Accounting for changes in usage and billing cycle.** Next, I removed the effect of changes in monthly usage between the two analysis periods. In doing so, I used the same approach that I believe Ms. Champion used in her bill analysis. I recalculated her 2017/18 bills using her 2016/17 billing determinants for the respective months. After controlling for changes in usage, the analysis identifies a net increase of 9.2% in the average bill, which is consistent with the observation that Ms. Champion's total usage decreased between 2016/17 and 2017/18. This net increase of 9.2% is effectively the equivalent of the value that Ms. Champion reported (though my analysis is based on the extended period of six monthly bills). However, there are several remaining factors that must be accounted for.
3. Focusing on change in base rate (net of adjustor transfer). In order to put Ms. Champion's bill change in the context of the 4.54% rate increase, it was necessary to isolate the base portion of her total bill. Doing so required two steps. First, I subtracted all adjustor-related charges from her bills. This left the change in the base portion of the bill. However, the 2017/18 base charges still included the adjustor revenue that had been transferred into base rates. To net out the impact of the adjustor transfer, I subtracted from Ms. Champion's 2017/18 base charges an amount equal to 11.35% of the 2016/17 base charges. The result of this step reduces the net bill impact, suggesting that year-to-year fluctuation in charges other than the base rate contributed to Ms. Champion's aggregate bill change.

4. Accounting for usage that is different than that of the class average customer. Ms. Champion's monthly usage for the study period is different than Test Year annual usage for the class average customer. Since the base rate increase was established using Test Year usage for the class average customer, it is important to account for this difference. The impact of the difference is amplified since there is not a full year of usage data available from Ms. Champion's bills. Adjusting Ms. Champion's usage to match that of the class average customer has a modest increasing effect on the bill change calculation, bringing it to 4.55%.

5. Adjusting for an ET-2 rate increase that is different than the residential average. The change in base rates net of the adjustor transfer was slightly different for each residential rate schedule due to modest differences in the share of adjustor revenue that was transferred. In the case of the ET-2 rate schedule, this difference was very minor and amounted to a 4.55% net increase in base rates, rather than 4.54%. Adjusting for this

---

13 APS's proof of revenue analysis indicates that schedule ET-2 base revenues were increased by 11.35% due to the adjustor transfer.
small difference brings the cumulative effect of all of the above adjustments in line with the total 4.54% increase approved by the ACC.

Figure 1 illustrates how these five steps account for the difference between Ms. Champion's bill changes and the approved 4.54% increase in base revenues. Each step described above is labeled with the same numbering in the figure.

**Figure 1: Factors explaining the difference between Ms. Champion's bill change and the 4.54% base rate increase approved by the ACC**

Notes: Ms. Champion's bill change is based on a comparison of her bills for the months from October through March of 2016/17 to the same months in 2017/18.

**V. Conclusions**

I have reviewed the ACC-approved ratemaking process that APS relied upon in Docket No. E-01345A-16-0036. Based on my review, I have concluded that APS's process is in line with established industry practices. The 4.54% rate increase is therefore the result of an appropriate
and reasonable approach to ratemaking. I also found that APS appropriately expressed the average rate increase to the residential class as 4.54%.

There are many valid reasons why an individual customer’s bill increase during specific months between 2016 and 2017 would be different than the authorized annual increase of 4.54%. Ms. Champion’s analysis suggests that her bill went up by 8.42%. In fact, a comparison of her bills without any modifications shows that they decreased by 4.7%. After accounting for the various factors that would naturally – and correctly – lead to a monthly bill change that is different than 4.54%, my analysis shows that Ms. Champion’s bill change is fully consistent with APS’s authorized base rate increase.