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BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

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BOB STUMP
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TOM FORESE

IN THE MATTER OF THE APPLICATION OF 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 ITS OPERATIONS THROUGHOUT THE STATE OF ARIZONA, AND FOR RELATED APPROVALS.	DOCKET NO. E-04204A-15-0142 **ARIZONA PUBLIC SERVICE COMPANY'S NOTICE OF FILING DIRECT TESTIMONY**

Arizona Public Service Company provides notice of filing prepared Direct Testimony of Ahmad Faruqui and Charles A. Miessner on behalf of APS in the above-docketed proceeding.

RESPECTFULLY SUBMITTED this 9th day of December 2015.

By: [signature]
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DIRECT TESTIMONY OF AHMAD FARUQUI

On Behalf of Arizona Public Service Company

Docket No. E-04204A-15-0142

December 9, 2015

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DIRECT TESTIMONY OF AHMAD FARUQUI
ON BEHALF OF ARIZONA PUBLIC SERVICE COMPANY
(Docket No. E-04204A-15-0142)

I. <u>INTRODUCTION</u>

Q. PLEASE STATE YOUR NAME, JOB TITLE, BUSINESS ADDRESS AND 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 35 years of consulting and research experience in the utility industry. During my career, I have advised some one hundred and twenty five electric and gas utilities, regulatory commissions, government agencies, transmission system operators, private energy companies, equipment manufacturers, and IT companies. Besides the United States, my clients have been located in Australia, Canada, Chile, Egypt, Hong Kong, Jamaica, Philippines, Saudi Arabia, South Africa, and Vietnam. I have advised them on a wide range of issues including: rate design, load forecasting, demand response, energy efficiency, distributed energy resources, cost-benefit analysis of emerging technologies, integration of retail and wholesale markets, and integrated resource planning. I have testified or appeared before a dozen state and provincial regulatory commissions and legislative bodies. I have authored or co-authored more than one hundred papers on energy economics and co-edited three books on electricity pricing and customer choice.

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

Q. WHAT ARE YOUR RESPONSIBILITIES AS A PRINCIPAL WITH THE BRATTLE GROUP?

A. I lead the firm's practice in understanding and managing the changing needs of energy consumers.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE ARIZONA CORPORATION COMMISSION ("COMMISSION")?

A. No, I have not formally testified before the Commission. However, I was invited to speak at a technical workshop before the Commission on the 20th of March, 2014. I gave a presentation that discussed the impact of changing customer energy use patterns on utilities. The workshop was entitled, "In the Matter of the Commission's Inquiry into Potential Impacts to the Current Utility Model Resulting from Innovation and Technological Developments in Generation and Delivery of Energy."[1]

II. OVERVIEW AND ORGANIZATION OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY IN THIS PROCEEDING?

A. The purpose of my testimony is to evaluate the merits of UNS Electric's proposal to offer three-part rates to residential customers, including new net metering distributed generation ("DG") customers with rooftop photovoltaic ("PV") panels.[2]

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. My testimony begins with a discussion of ratemaking principles and the merits of a three-part rate design. An overriding principle of electric rate design is that of cost causation—those who create costs should be responsible for paying those costs. Yet the standard residential rate design in the United States does not follow this principle. Fixed costs are most often recovered through volumetric rates (expressed in cents/kWh). The result is that customers might reduce the volume of electricity they consume but not reduce the demand they place on the grid, thereby lowering their load factor. As a result, some of the fixed costs required to meet their demand can go unpaid. The cost-causers do not pay for all the costs they create, and those costs are instead shifted to customers who use more volume of electricity and have higher load factors.

[1] Docket No.E-00000J-13-0375, Substantive Workshop No. 1(a) Special Open Meeting, March 20, 2014.

[2] Throughout my testimony I refer to these customers as "DG PV" customers.

The cost shift from lower load factor customers to higher load factor customers is a structural inefficiency that should be addressed through a rate design that includes three parts: a fixed charge, a demand charge, and a volumetric charge. With a three-part rate design, customers can more efficiently use the electric grid in a way that reduces the cost shift. In addition, demand rates provide a price signal to technologies that reduce demand. If policy-makers wish to encourage innovative distributed technologies, demand rates offer an efficient and equitable method of doing so.

My testimony concludes by evaluating UNS Electric's rate proposal in light of these principles. UNS Electric has proposed the deployment of three-part rates. Based on my review, the proposed rates appear to be based on well-established principles of rate design and would send a better price signal to customers that will encourage adoption of new technologies that are most beneficial to the power system. Given the benefits of these new three-part rate designs, as UNS Electric proceeds with the deployment of automated metering, it would be reasonable to eventually make a demand charge a feature of the rate for all residential customers.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. It is organized into several sections. Section III reviews the principles of rate design. Section IV summarizes UNS Electric's rate design proposal and evaluates the proposal in light of the generally accepted ratemaking principles and the opportunities offered by three-part rates. Section V concludes the testimony.

Q. ARE YOU SPONSORING ANY ATTACHMENTS TO YOUR TESTIMONY?

A. Yes, I sponsor the following attachment to my testimony: Attachment Faruqui Direct-1: Statement of Qualifications.

III. PRINCIPLES OF RATE DESIGN

Q. PLEASE PROVIDE A HISTORICAL PERSPECTIVE ON THE THEORY OF ELECTRIC RATE DESIGN.

A. The principles that guide electric rate design have evolved over time. Many authorities have contributed to their development, beginning with the legendary British rate engineer John Hopkinson in the late 1800's.[3] Hopkinson introduced demand charges into electricity rates. Subsequently, Henry L. Doherty proposed a three-part tariff, consisting of a fixed service charge, a demand charge and an energy charge.[4] The demand charge was based on the maximum level of demand which occurred during the billing period. Some versions of the three-part tariff also feature seasonal or time-of-use ("TOU") variations corresponding to the variations in the costs of energy supply.[5]

In the decades that followed, a number of British, French and U.S. economists and engineers made further enhancements to the original three-part rate design.[6] In 1961, Professor James C. Bonbright coalesced their thinking in his canon, *Principles of Public Utility Rates*,[7] which was reissued in its second edition in 1988. Some of these ideas were further expanded upon by Professor Alfred Kahn in his treatise, *The Economics of Regulation*.[8]

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[3] John R. Hopkinson, "On the Cost of Electricity Supply," *Transactions of the Junior Engineering Society*, Vol. 3, No. 1 (1892), pp.1-14

[4] Henry L. Doherty, *Equitable, Uniform and Competitive Rates,* Proceedings of the National Electric Light Association (1900), pp.291-321

[5] *See, for example*, Michael Veall, "Industrial Electricity Demand and the Hopkinson Rate: An Application of the Extreme Value Distribution," *Bell Journal of Economics*, Vol. 14, Issue No. 2 (1983).

[6] The most notable names include Maurice Allais, Marcel Boiteux, Douglas J. Bolton, Ronald Coase, Jules Dupuit, Harold Hotelling, Henrik Houthakker, W. Arthur Lewis, I. M. D. Little, James Meade, Peter Steiner and Ralph Turvey.

[7] James C. Bonbright, Albert L. Danielsen, and David R. Kamerschen, *Principles of Public Utility Rates,* 2d ed. (Arlington, VA: Public Utility Reports, 1988).

[8] Alfred Kahn, *The Economics of Regulation: Principles and Institutions*, rev. ed. (MIT Press, June 1988).

Q. WHAT ARE THE GENERALLY ACCEPTED RATE DESIGN PRINCIPLES?

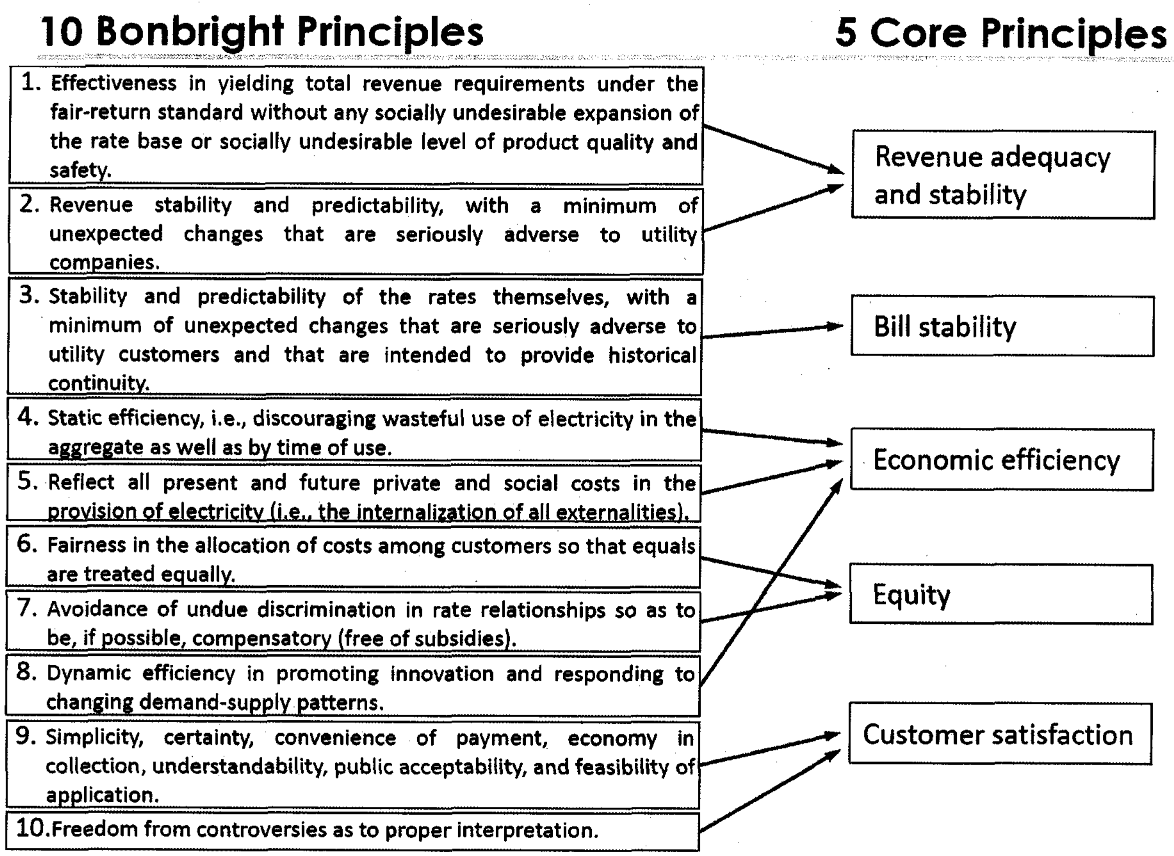
A. Professor Bonbright propounded ten principles of rate design that are widely used as a foundation for designing rates. For ease of exposition, I have grouped these into five core principles that fully encompass the concepts established by Professor Bonbright.

1. Economic Efficiency. The price of electricity should convey to the customer the cost of producing it, ensuring that resources consumed in the production and, delivery of electricity, are not wasted. If the price is set equal to the cost of providing a kWh, customers who value the kWh more than the cost of producing it will use the kWh and customers who value the kWh less will not. This will encourage the development and adoption of energy technologies that are capable of providing the most valuable services to the power grid.
2. Equity. There should be no unintentional subsidies between customer types. A classic example of the violation of this principle occurs under flat rate pricing structures (i.e., cents/kWh). Since customers have different load profiles, "peaky" customers, who use more electricity when it is most expensive, are subsidized by less "peaky" customers who overpay for cheaper off-peak electricity. Note that equity is not the same as social justice, which is related to inequities in socioeconomic status rather than cost. The pursuit of one is not necessarily the pursuit of the other, and vice versa.
3. Revenue adequacy and stability. Rates should recover the authorized revenues of the utility and should promote revenue stability. Theoretically, all rate designs can be implemented to be revenue neutral within a class, but this would require perfect foresight of the future. Changing technologies and customer behaviors make load forecasting more difficult and increase the risk of the utility either under-recovering or over-recovering costs when rates are not cost reflective.

4. Bill stability. Customer bills should be stable and predictable while striking a balance with the other ratemaking principles. Rates that are not cost reflective will tend to be less stable over time, since both costs and loads are changing over time. For example, if fixed infrastructure costs are spread over a certain number of kWh in Year 1, and the number of kWh halves in Year 2, then the price per kWh in Year 2 will double even though there is no change in the underlying infrastructure cost of the utility.
5. Customer satisfaction. Rates should enhance customer satisfaction. Because most residential customers devote relatively little time to reading their electric bills, rates need to be relatively simple so that customers can understand them and perhaps respond to the rates by modifying their energy use patterns. Giving customers meaningful cost-reflective rate choices helps enhance customer satisfaction.

Figure 1 illustrates my grouping of Bonbright's original 10 principles.

Figure 1: Deriving the 5 Core Principles of Rate Design



Q. DID PROFESSOR BONBRIGHT DISCUSS THE CONCEPT OF COST CAUSATION IN DESIGNING RATES?

A. Yes. In the first edition, an entire chapter is devoted to this topic. It is entitled: "Cost of Service as the Basic Standard of Reasonableness." In the chapter he states: "One standard of reasonable rates can fairly be said to outrank all others in the importance attached to it by experts and public opinion alike – the standard of cost of service, often qualified by the stipulation that the relevant cost is necessary cost or cost reasonably or prudently incurred."[9] Later he states that: "The first support for the cost-price standard is concerned with the consumer-rationing function when performed under the principle of consumer sovereignty."[10] He also cites another benefit of the cost-price standard

[9] James C. Bonbright, *Principles of Public Utility Rates*, (Columbia University Press: 1961) 1st Edition, Chapter IV, p. 67.
[10] Op. cit., p. 69.

when he says that "an individual with a given income who decides to draw upon the producer, and hence on society, for a supply of public utility services should be made to "account" for this draft by the surrender of a cost-equivalent opportunity to use his cash income for the purchase of other things."[11] Later in Chapter XVI, where he discusses the "criteria of a sound rate structure," he says that a purely volumetric rate assumes that the total costs of the utility vary directly with the changes in the kWh output of energy. He calls this "a grossly false assumption" and says such a rate "violates the most widely accepted canon of fair pricing, the principle of service at cost." Later, while discussing the Hopkinson rate, he says that such a "rate distinguishes between the two most important cost functions of an electric-utility system: between those costs that vary with changes in the system's output of energy, and those costs that vary with plant capacity and hence with the maximum demands on the system (and subsystems) that the company must be prepared to meet in planning its construction program."[12]

Q. PLEASE DISCUSS FURTHER HOW THE CONCEPT OF COST CAUSATION IS IN ACCORD WITH THE BONBRIGHT PRINCIPLES.

A. The Bonbright principles of economic efficiency and equity in particular embody the concept of cost causation. Economic efficiency is achieved by having cost-reflective prices. This ensures that products are only consumed by those customers who value them at more than they cost to produce. Pricing below cost is wasteful because customers will purchase and consume products that they would not choose to consume if faced with the full cost. Similarly pricing above cost is wasteful because customers, who would get a net benefit from consuming the product over its cost of production, lose out on that benefit. Respecting the equity principle requires that the tariff's design not result in unintended cross-subsidies between customers. This differs from a public policy that seeks to intentionally subsidize certain customers through the tariff. Prices

[11] Op. cit., p. 70.
[12] Op. cit., p. 310.

that are cost reflective minimize unintentional subsidies. Cost causation may need to be balanced against the other core principles such as customer satisfaction or bill stability.

Q. GIVEN BONBRIGHT'S EMPHASIS ON COST CAUSATION, WHY DOES HIS FIFTH PRINCIPLE CALL FOR REFLECTING SOCIAL COSTS (OR EXTERNALITIES) IN ELECTRIC RATES?

A. Each of Professor Bonbright's principles should be read in conjunction with the others. Reading a single principle in isolation from the others ensures that it will be taken out of context, resulting in a misinterpretation of his rate design philosophy. The fact is that the cost of service is Professor Bonbright's *basic standard* for designing rates, and it is clear from his writings that above all, rates should be cost-based. This is easily squared with the principle of reflecting social costs in the provision of electricity. If a price has been assigned to a certain externality, in other words, if it has been internalized, and that price is part of the utility's cost structure, then it is economically efficient to reflect the price of that externality in rates for all customers. However, it would violate the core principles of ratemaking if only certain customers or technologies were charged or compensated for their impact on those externalities. For instance, compensating owners of only one specific technology for reductions in emissions would lead to inefficient levels of investment in that technology when there may be other options which, if similarly compensated, would provide even greater environmental benefits. All technologies and customers should be on a level playing field when developing residential rate design.

Q. WHAT IS THE STANDARD RATE STRUCTURE FOR RESIDENTIAL CUSTOMERS?

A. The standard rate structure for residential customers in much of the U.S., and in fact in much of the globe, consists of two parts, a monthly service charge and a volumetric (kWh) energy charge. Most of the revenue is collected from the volumetric charge.

Q. HOW DOES THE COLLECTION OF COSTS ON A VOLUMETRIC BASIS COMPARE TO THE NATURE OF UTILITY COSTS?

A. The collection of utility costs through volumetric charges is at odds with the underlying cost structure of providing electricity to customers. Most of the costs do not vary with the volume of electricity that is produced and delivered to the customer, but vary with maximum demand or are otherwise fixed. In order to provide electricity to a customer, a utility must bear—directly or indirectly—costs related to energy, generation, transmission, distribution, metering, and customer service. It is true that generation energy costs generally vary with kWh electricity consumption. But generation capacity costs vary with system peak demand. Similarly, transmission costs also vary with system peak demand while distribution and transmission costs vary with maximum demand that is more local in nature. Metering, billing, customer care services, and other connection/hookup costs are a fixed cost per each customer of a particular class. Some of these costs vary across time. Generation costs will vary from hour to hour depending on the marginal generation source. Distribution and transmission networks, while used year round, are generally sized to meet class and system peak demand, respectively.

Q. WHAT IS THE CONSEQUENCE OF FIXED CHARGES BEING COLLECTED THROUGH VOLUMETRIC RATES?

A. This mismatch between cost structure and rate structure creates an inevitable and indisputable cost shift from customers with lower load factors to customers with higher load factors. Customers might reduce their load factor if, for instance, they install rooftop solar. With a lower load factor, customers paying for electricity under a volumetric rate design contribute less to the electric grid's fixed costs. Inevitably, customers with high load factors, paying for electric service under a volumetric rate design, wind up paying more for comparable service.

Q. HOW SHOULD THESE COSTS TRANSLATE INTO RATES?

A. According to the notion of cost causation, the rate structure should reflect the nature of the costs. Fixed costs, such as metering, billing, and customer service, should be collected through a fixed monthly service charge. Demand-driven costs, such as capacity costs, should be collected through a demand charge. Variable costs, such as fuel and power grid operations and maintenance (O&M), should be collected through a variable charge (also known as an energy charge).

To address the deficiencies of current two-part rates, I support the institution of a three-part rate design, consisting of a monthly service charge, a demand charge, and a volumetric charge. The fixed charge should be designed to cover the fixed costs such as metering, billing, and customer care. Sometimes it also covers the cost of the line drop and the associated transformer. The demand charge should be designed to cover demand-driven costs, such as transmission, distribution, and generation capacity. It is typically applied to the individual customer's maximum demand, either during a defined on-peak period, or regardless of time of occurrence, or based on a combination of the two. While the concept of demand is instantaneous, in implementation demand is usually measured over 15-minute, 30-minute or 60-minute intervals. The energy charge covers the cost of the fuels that are used to generate electricity. The demand charge and the energy charge might vary with the time of use of electricity and have different seasonal and/or peak/off-peak charges. Such three-part rates align the rate design with costs, a fundamental tenet of rate design.

Q. DID PROFESSOR BONBRIGHT SUPPORT THE USE OF THREE-PART RATES?

A. Yes, he did. Their usage is discussed in several places in Bonbright's canon.[13] Bonbright cites the earlier text by the British engineer D. J. Bolton,[14] who states: "More accurate costing has shown that, on the average, only one-quarter of the total costs of electricity supply are represented by coal[15] or items proportional to energy, while three-

[13] James C. Bonbright, *Principles of Public Utility Rates*, (Columbia University Press: 1961).
[14] Bonbright says that "On many technical issues, no American treatise on electric utility rates can equal that by the distinguished British rate engineer D. J. Bolton," p. 289, n. 3.
[15] Coal was the dominant fuel for generating electricity in the United Kingdom in 1938 when the book by Bolton was first published.

quarters are represented by fixed costs or items proportional to power, etc. If therefore only one rate is to be levied it would appear more logical to charge for power and neglect the energy, were it not for certain practical difficulties of which the following are two. In the first place, the effective power demand on the system made by any particular consumer is extremely difficult to estimate and is very different from the individual maximum demand metered at the consumer's terminals. Secondly, a purely power tariff would probably lead to a waste of energy to a greater extent than a purely energy tariff leads to waste of power."[16]

Of course, with the arrival of smart meters, customer demand at times of system and distribution peak can be accurately recorded. And the choice is no longer a binary one of imposing either a demand-only rate or an energy-only rate. It is possible now to deploy a three-part pricing structure for residential customers that better reflects the cost of providing electric services. When Bonbright discusses a two-part rate structure, he is referring to what he characterizes as "the two most important cost functions of an electric-utility system"[17] -- demand and energy charges. When he moves into a discussion of three-part rate structures, he adds truly fixed charges, customer charges, to the two-part rate concept. Three-part rates are discussed at length in Bonbright's canon, beginning on page 346.[18]

Q. HOW HAS THE PRINCIPLE OF COST CAUSATION AND THREE-PART RATES BEEN APPLIED IN PRACTICE?

A. Most medium and large commercial and industrial customers across the U.S. are served under the more cost-reflective three-part rate structures. And those structures have been the norm for these customer classes for decades in much of the U.S.

[16] D. J. Bolton, *Costs and Tariffs in Electricity Supply*, (Chapman & Hall Ltd.: 1951) p. 59.
[17] Bonbright, p. 310.
[18] Bonbright, 2nd Edition, p. 401, credits Doherty with extending the Hopkinson two-part rate into a three part rate. Henry L. Doherty, *Equitable, Uniform and Competitive Rates*, Proceedings of the National Electric Light Association (1900), pp. 291-321.

Q. HAVE THESE COST CAUSATION PRINCIPLES BEEN APPLIED TO RESIDENTIAL CUSTOMERS?

A. Historically, these principles have rarely been fully applied to residential customers. Most residential customers in the U.S. are on two-part rates, with some or all of the fixed and demand-driven charges being recovered through a variable charge.

Q. WHAT HAS PREVENTED THREE-PART RATES FROM BEING BROADLY DEPLOYED TO RESIDENTIAL CUSTOMERS?

A. Until recently, metering technology for residential customers has been a significant limiting factor. The traditional electromechanical meters that most customers had installed at their homes measured only cumulative electricity consumption and not demand. Without the ability to meter demand, utilities could not cost-effectively offer three-part rates to these customers. Advances in metering technology have changed this situation.

Q. HOW HAVE ADVANCES IN METERING TECHNOLOGY CHANGED THE UTILITY'S ABILITY TO OFFER THREE-PART RATES?

A. With the deployment of automated meters (sometimes also referred to as advanced metering infrastructure or AMI), consumption can be recorded in intervals of an hour or less. This allows the utility to collect the consumption data necessary to incorporate demand charges into rates. It has removed a large barrier to the wider dissemination of cost-reflective rates to residential customers. Given these technological developments, rate structures for residential customers should be changed.

Q. SHOULD UTILITIES UTILIZE THREE-PART RATES?

A. Yes. Now is the time to take advantage of this opportunity to make cost-reflective three-part rates a standard offering for all residential customers. These rates will recover costs from customers in an equitable manner by more accurately charging customers for their use of the power grid. A more cost-reflective rate will also encourage the adoption of emerging energy technologies and changes in energy consumption behavior that will lead to more efficient use of power grid infrastructure and resources.

Q. HOW WOULD A THREE-PART RATE ENCOURAGE THE ADOPTION OF EMERGING ENERGY TECHNOLOGIES?

A. By providing customers with a price signal that includes a component for demand, a three-part rate would encourage the adoption of technologies that are designed to smooth out a customer's load profile. Behind-the-meter battery storage, for example, could be used to release electricity during hours of high electricity demand and store electricity during hours of low electricity demand. Load control technologies, such as programmable communicating thermostats, demand limiters, and smart appliances could also help customers manage their electricity demand. If a customer took service under a three-part rate, the use of battery storage, or other demand-reducing technologies, would reduce the customer's bill. This reduction in the customer's bill is an economic value that forms the basis of the price signal created by three-part rates.

Q. ASIDE FROM TRANSMITTING PRICE SIGNALS THAT ENCOURAGE TECHNOLOGICAL INNOVATION, WOULD THREE-PART RATES PROVIDE OTHER BENEFITS TO RESIDENTIAL CUSTOMERS?

A. Three-part rates will incentivize customers to smooth their energy consumption profile even if they are not equipped with enabling technologies. More than 40 pilot studies and full-scale rate deployments involving over 200 rate offerings over roughly the past dozen years have found that customers respond to new price signals by changing their energy consumption pattern.[19]

Further, there is some evidence that customers respond not just to changes in the rate structure generally, but specifically to demand charges. The following studies arrived at this conclusion:

[19] Some of these studies are summarized in Ahmad Faruqui and Sanem Sergici, "Arcturus: International Evidence on Dynamic Pricing," *The Electricity Journal*, (August/September 2013). Similar results were obtained from an earlier generation of 14 pricing pilots that were funded in the late seventies and early eighties by the U.S. Federal Energy Administration (later part of the Department of Energy). There were also early studies producing similar results. *See* Ahmad Faruqui and Bob Malko, "The Residential Demand for Electricity by Time-of-Use: A Survey of Twelve Experiments with Peak Load Pricing," *Energy*, Vol. 8, No. 10, (1983).

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Q. HAVE THREE-PART RATES BEEN OFFERED TO RESIDENTIAL CUSTOMERS IN OTHER U.S. JURISDICTIONS?

A. Yes. There are at least 18 utilities in 14 states that offer a three-part rate to residential customers, including APS which has over 100,000 of its customers on a three-part rate. In most cases, the rates are available to all customers on an opt-in basis. In the case of Salt River Project ("SRP"), a three-part rate is mandatory for all residential customers who choose to install a new grid-connected DG PV system.[20]

IV. UNS ELECTRIC'S RATE PROPOSAL

Q. WHAT ARE UNS ELECTRIC'S CURRENT RATES FOR RESIDENTIAL CUSTOMERS, AND HOW ARE THEY DESIGNED?

A. My understanding is that UNS Electric's current residential rate offerings include Residential Service ("RES-01"), Residential Service Time-of-Use ("RES-01 TOU"), and Residential Service Time-of-Use Super Peak ("RES-01 TOU SP"). All three are two-part rates with a fixed monthly service charge and a volumetric charge. The

[20] SRP website: http://www.srpnet.com/prices/home/customergenerated.aspx.

Residential Service option includes a $10 fixed monthly service charge and a tiered volumetric charge with a price of 8.4 cents/kWh for the first 400 kWh per month, 9.9 cents/kWh for the next 600 kWh per month, and 10.3 cents/kWh for all remaining kWh per month. The other two options include a slightly higher fixed monthly service charge and a volumetric rate that is time-varying.

Q. HOW IS UNS ELECTRIC PROPOSING TO REDESIGN ITS RESIDENTIAL RATES?

A. UNS Electric has proposed four specific changes to its residential rate offering: (1) increasing the fixed monthly service charge, (2) reducing the number of tiers in the inclining block rate, (3) modifying the net metering payment policy for excess generation from DG PV, and (4) introducing two three-part rate options. The focus of my testimony is on the three-part rates that are being proposed.

Q. PLEASE DESCRIBE THE THREE-PART RATES THAT UNS ELECTRIC HAS PROPOSED.

A. UNS Electric has proposed two rates, one called "RES-01 Demand" and a second rate called "RES-01 Demand TOU." DG PV customers would have the option of enrolling in one of these two rates. Other residential customers would have these as options in addition to the standard residential rate options described previously (subject to the additional rate design changes that have been proposed by UNS Electric).

My understanding is that the RES-01 Demand rate includes a tiered demand charge with a price of $6/kW on the first 7 kW of monthly demand and a price of $9.95/kW on demand in excess of 7 kW. The rate also includes a fixed monthly service charge of $20/month and a variable energy charge of approximately 5.9 cents/kWh.[21] Demand is measured as the customer's maximum one-hour demand in the billing month. The "RES-01 Demand TOU" rate has the same demand and fixed monthly service charges, but a time-varying energy charge which is approximately 11.1 cents/kWh during the

[21] Direct Testimony of Craig A. Jones on Behalf of UNS Electric, Inc., May 5, 2015, Exhibit CAJ-3, Docket No. E-04204A-15-0142.

peak period and 4.4 cents/kWh during the off-peak period in the summer, and approximately 10.9 cents/kWh during the peak period and 4.4 cents/kWh during the off-peak period in the winter. Summer is defined as May through October and the summer peak period is from 2 pm to 8 pm, excluding weekends and holidays. Winter is from November through April and the winter peak period is from 5 am to 9 am and from 5 pm to 9 pm, excluding weekends and holidays. The off-peak period is all other hours. These rates are summarized in Table 1 below.

Table 1: Summary of UNS Electric's Proposed Three-Part Rates for DG PV Customers

	RES-01 Demand	RES-01 Demand TOU
Basic service charge ($/month)	20.00	20.00
Energy charge (cents/kWh)		
Summer on-peak	5.9260	11.1110
Summer off-peak	5.9260	4.3900
Winter on-peak	5.9260	10.8960
Winter off-peak	5.9260	4.3579
Demand charge ($/kW)		
First 7 kW	6.00	6.00
Over 7 kW	9.95	9.95

Source: Direct Testimony of Craig A. Jones on Behalf of UNS Electric, Inc., May 5, 2015, Exhibit CAJ-3, Docket No. E-04204A-15-0142.

Note: Energy charge includes both delivery services charge and power supply charges

Q. ARE UNS ELECTRIC'S PROPOSED THREE-PART RATES CONSISTENT WITH THE RATEMAKING PRINCIPLE OF EQUITY?

A. Yes. Each customer imposes costs on the system some of which are fixed and the rest of which demand-driven and energy driven. Under purely volumetric tariffs, customers with high demand but low monthly consumption would not be paying their fair share of the cost of maintaining, upgrading, and expanding the utility's generation, transmission and distribution system. Instead, lower-demand customers would be covering the deficit and paying more than their fair share. UNS Electric's proposed three-part rates more closely match demand, fixed, and variable costs with demand, fixed, and variable charges and will reduce this inequity so that all customers will pay their fair share of the costs associated with the generation of electricity, its delivery through utility's transmission and distribution system, and customer service.

Q. ARE UNS ELECTRIC'S PROPOSED THREE-PART RATES CONSISTENT WITH THE RATEMAKING PRINCIPLE OF ECONOMIC EFFICIENCY?

A. Yes. As I discussed previously, the cost-based price signals in the three-part rates proposed by UNS Electric provide customers with the financial incentive to make investments in technologies or otherwise change their behavior in ways that are most beneficial to the system. Technologies and behaviors that reduce a customer's demand should ultimately lead to a more efficient use of the grid, reduced costs, and lower bills.

Q. ARE UNS ELECTRIC'S PROPOSED THREE-PART RATES CONSISTENT WITH THE RATEMAKING PRINCIPLE OF CUSTOMER SATISFACTION?

A. Yes. UNS Electric is proposing to offer new rate options to residential customers. Having a choice of cost-based pricing products is a benefit to customers. Three-part rates send customers a more accurate price signal than traditional two-part rate structures, which then allows customers to properly assess and, where appropriate, adopt technologies that can help them manage their bills.

Q. ARE UNS ELECTRIC'S PROPOSED THREE-PART RATES CONSISTENT WITH THE RATEMAKING PRINCIPLE OF BILL STABILITY?

A. For the residential class as a whole, there will be no change in electric bills. That would also be true for customers whose load profile is similar to that of the class. Customers whose load factors are higher than the class average will experience lower bills. As for customers whose load factor is worse than the class average, since they have been subsidized for years by the customers whose load factor was higher than the class average, and the change in rates will remove that subsidy, they will experience higher bills. However, they will have an opportunity to lower their bills by reducing their demand. And that would also be true for customers who are automatically seeing lower bills. They will have an opportunity to further lower their bills by reducing their demand.

Q. ARE UNS ELECTRIC'S PROPOSED THREE-PART RATES CONSISTENT WITH THE RATEMAKING PRINCIPLE OF REVENUE ADEQUACY AND STABILITY?

A. Yes. The introduction of a three-part rate will not change the utility's revenues. All other things being equal, a properly designed three-part rate will be revenue neutral for the class as a whole and therefore collect the same revenue as the otherwise applicable two-part rates. The main reason for moving to three-part rates is the ability to more accurately recover costs from those customers who are imposing costs on the system, and to provide customers with an incentive to consume electricity in a more efficient manner.

V. CONCLUSION

Q. WHAT ARE YOUR CONCLUSIONS ABOUT UNS ELECTRIC'S THREE-PART RATE DESIGN PROPOSALS?

A. The two-part rate which is presently employed throughout the industry must give way to three-part rates. Not only are two-part rates ineffective at providing the proper pricing signals, as discussed above, they do not facilitate the integration of distributed energy resources with the grid, nor do they stimulate the deployment of other innovative technologies such as customer-sited battery storage and plug-in electric vehicles.

UNS Electric proposes to begin replacing its legacy two-part rate with three-part rates that are reasonable, cost-based, efficient, and equitable. In sum, they are consistent with well-established principles of rate design. In addition, UNS Electric's proposed three-part rates better align costs with prices. In so doing, the proposed rates will provide a more accurate price signal to customers, promote the efficient use of energy around-the-clock, and encourage the development of new, demand-reducing technologies. I would recommend that UNS Electric make the demand charge a feature of the rate for all residential customers as it proceeds with the deployment of automated metering to all its customers.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

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Principal

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Dr. Ahmad Faruqui leads a consulting practice focused on understanding and managing the way customers use energy. His clients include utilities, commissions, equipment manufacturers, technology developers, and energy service companies. The practice encompasses a wide range of activities:

- **Rate design.** The recent decline in electricity sales has generated an entire crop of new issues that utilities must address in order to remain profitable. A key issue is the under-recovery of fixed costs and the creation of unsustainable cross-subsidies. To address these issues, we are creating alternative rate designs, testing their impact on customer bills, and sponsoring testimony to have them implemented. We are currently undertaking a large-scale project for a large investor-owned utility to estimate marginal costs, design rates, and produce a related software tool, working in close coordination with their internal executives. We have created a Pricing Roundtable which serves as virtual think tank on addressing the risks of under-recovery in the face of declining growth. About 18 utilities are a part of the think tank.

- **Demand forecasting.** We help utilities to identify the reasons for the slowdown in sales growth, which include utility energy efficiency programs, governmental codes and standards, distributed general, and fuel switching brought on by falling natural gas prices and the weak economic recovery. We present widely on the issue and are researching new methods for forecasting peak demand, such as the use of quantile regression.

- **Demand response.** For several clients in the United States and Canada, we are studying the impact of dynamic pricing. We have completed similar studies for a utility in the Asia-Pacific region and a regulatory body in the Middle East. We also conduct program design studies, impact evaluation studies, and cost-benefit analysis, and design marketing programs to maximize customer enrollment. Clients include utilities, regulators, demand response providers, and technology firms.

- **Energy efficiency.** We are studying the potential role of combined heat and power in enhancing energy efficiency in large commercial and industrial facilities. We are also carrying out analyses of behavioral programs that use social norming to induce change in the usage patterns of households.

- **New product design and cost-benefit analysis of emerging customer-side technologies.** We analyze market opportunities, costs, and benefits for advanced digital meters and associated infrastructure, smart thermostats, in-home displays, and other devices. This includes product design, such as proof-of-concept assessment, and a comparison of the costs and benefits of these new technologies from several vantage points: owners of that technology, other electricity customers, the utility or retail energy provider, and society as a whole.

In each of these areas, the engagements encompass both quantitative and qualitative analysis. Dr. Faruqui's reports, and derivative papers and presentations, are often widely cited in the media. The Brattle Group often sponsors testimony in regulatory proceedings and Dr. Faruqui has testified or appeared before a dozen state and provincial commissions and legislative bodies in the United States and Canada.

Dr. Faruqui's survey of the early experiments with time-of-use pricing in the United States is referenced in Professor Bonbright's treatise on public utilities. He managed the integration of results across the top five of these experiments in what was the first meta-analysis involving innovative pricing. Two of his dynamic experiments have won professional awards, and he was named one of the world's Top 100 experts on the smart grid by Greentech Media.

He has consulted with more than 50 utilities and transmission system operators around the globe and testified or appeared before a dozen state and provincial commissions and legislative bodies in the United States and Canada. He has also advised the Alberta Utilities Commission, the Edison Electric Institute, the Electric Power Research Institute, FERC, the Institute for Electric Efficiency, the Ontario Energy Board, the Saudi Electricity and Co-Generation Regulatory Authority, and the World Bank. His work has been cited in publications such as *The Economist, The New York Times*, and *USA Today* and he has appeared on Fox News and National Public Radio.

Dr. Faruqui is the author, co-author or editor of four books and more than 150 articles, papers, and reports on efficient energy use, some of which are featured on the websites of the Harvard Electricity Policy Group and the Social Science Research Network. He has taught economics at San Jose State University, the University of California at Davis and the University of Karachi. He holds a 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 B.A. and M.A. degrees in economics from The University of Karachi, where he was awarded the Gold Medal in economics.

AREAS OF EXPERTISE

- *Innovative pricing.* He has identified, designed and analyzed the efficiency and equity benefits of introducing innovative pricing designs such as dynamic 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 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.
- *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. In addition, he has led a variety of professional seminars and workshops on public utility economics around the world and taught economics at the university level.

EXPERIENCE

Innovative Pricing

- **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 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.

- **Developed a Customer Price Response Model: Consolidated Edison.** 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 forecasting fuel 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. Catalogued 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 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

- **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.
- **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 in 2009, as required by the Energy Independence and Security Act of 2007.
- **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

- **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 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-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

California

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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.

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

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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.

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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

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Kansas

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.

Maryland

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

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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

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Pennsylvania

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REGULATORY APPEARANCES

Arkansas

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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

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Texas

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DIRECT TESTIMONY OF CHARLES A. MIESSNER

On Behalf of Arizona Public Service Company

Docket No. E-04204A-15-0142

December 9, 2015

Table of Contents

DIRECT TESTIMONY OF CHARLES A. MIESSNER
ON BEHALF OF ARIZONA PUBLIC SERVICE COMPANY
(Docket No. E-04204A-15-0142)

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. Charles A. Miessner, 400 North Fifth Street, Phoenix, Arizona 85004.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am the Manager of Rates for Arizona Public Service Company ("APS").

Q. WHAT ARE YOUR PROFESSIONAL QUALIFICATIONS?

A. My qualifications are provided in Attachment Miessner Direct-1, Statement of Qualifications.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY IN THIS PROCEEDING?

A. The purpose of my testimony is to evaluate the residential rate designs proposed by UNS Electric Company ("UNSE") in their efficiency and appropriateness for recovering costs and for setting an effective platform to incent new technologies in the home. I will specifically comment on the proposed three-part rate that incorporates a service charge, energy charge, and demand charge.

III. SUMMARY OF TESTIMONY

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. In my Direct Testimony, I explain that the current residential rates at UNSE, although typical of electric utilities across the country, are based on decades-old designs that were developed when metering equipment was limited and customers had few, if any, options to invest in (what is now referred to as) distributed technologies. I discuss that these old rate designs do not adequately reflect the costs or even the services that utilities provide. These services include basic services for accessing the grid and receiving electrical service each month, a demand or capacity service for the grid infrastructure investments like power plants, transmission lines, substations, and local distribution equipment necessary to serve the customer's load, and an energy service for the fuel and other variable costs for the actual electricity consumed in a month. I further discuss how the grid infrastructure is sized to accommodate the customer's maximum electrical draw or "demand" in any hour, as measured in kW, not the total monthly energy consumption, which is measured in kWh. I explain that these old two-part rate structures that include a monthly service charge and a kWh charge are misaligned with the utility's costs to serve customers because they recover all of the grid investment costs and some of the basic service costs with volumetric kWh energy charges, instead of kW demand charges and monthly service fees. By doing so, the charges on the bill do not accurately reflect either the services provided to the customer or the cost of those services. In addition, the two-part rate only provides one opportunity for customers to save on their bill – by reducing their total kWh consumption. In contrast, a three-part rate rewards customers for reducing both their energy and their demand. Furthermore, under the three-part rate, the bill savings for the demand and energy charges will be linked to reductions in both the utility's grid costs and energy costs and thus will minimize any adverse impacts on other customers. Conversely, under a two-part rate the customer's bill savings are not linked to the utility's total cost savings, but only to the energy savings, which results in unfunded grid costs that are shifted to other customers in the form of higher rates.

In short, the old two-part rate designs are economically inefficient, ineffective in reducing a utility's total costs to serve, and ultimately unfair to customers. They are inefficient because they do not provide the right price signals for when and how customers use electricity. Nor do they provide the correct incentives for customers desiring to invest in distributed technologies because such technologies will not be rewarded for, or focused on, reducing demand-related grid costs. Both of these issues will result in the inefficient use of, and inadequate funding for, the grid. In addition, for similar reasons, the two-part rates are also ineffective in reducing a utility's overall costs because they do not effectively incent customers to lower their monthly demand. As a result, the rates would likely only reduce the utility's energy-related costs, like fuel, and not the demand-related costs, which include all of the extensive grid investment costs. The two-part rates are also ultimately unfair because they can result in grid costs that are caused by one customer to be paid by others, as discussed earlier. This is a direct result of the three utility services - basic services, demand-related grid services, and energy-related services - being billed with two charge types instead of three. I conclude that residential rates should be reformed and modernized to better align rates with costs, provide appropriate price signals to customers, and improve the efficient use of, and funding for, the grid and other necessary infrastructure.

I next summarize APS's extensive experience with residential three-part demand rates and explain that customers on these rates can and do understand the demand concept and manage their monthly demand on their bill. APS has offered a three-part demand rate to residential customers for decades and is currently serving approximately 117,000 on the rate. When customers switch to the rate, they typically reduce both their demand and energy consumption, and some 90% save on their monthly bill.

I then review UNSE's current cost of service, rates and proposed revisions. I note that its costs to serve residential customers include: basic service costs such as meters, point of delivery equipment, transformers, and billing and customer care costs; demand-related costs such as capital infrastructure investments for power plants and the transmission and distribution grid; and energy-related costs such as fuel and purchased power. However, UNSE's current residential rates recover some of the basic service costs and all of the demand costs through kWh energy charges, rather than monthly service charges and kW demand charges, respectively.

I also evaluate UNSE's proposed revisions to the residential rates and conclude that its proposals are consistent with the types of rate reform discussed in my testimony. UNSE improves the recovery of basic service costs through the monthly service charge, rather than through a kWh energy charge; it reduces the tail block kWh charge in the inclining block rate to better reflect cost of service; it introduces a three-part rate that recovers basic services with a monthly service charge, demand services with a kW demand charge, and energy services with a kWh energy charge.

IV. RESIDENTIAL RATE REFORM

Q. WHY MUST RESIDENTIAL RATES BE REFORMED?

A. Today most, if not all, electric utilities have residential rates that are not aligned with the types of costs necessary to serve the customers. Rather they reflect old, outmoded designs that may have made sense in the past when metering technology was limited and customers had no interest or options to invest in distributed technologies. However, today's Automated Metering Infrastructure ("AMI") offers significant flexibility in residential rate design and allows energy usage information to be integrated with home controls and smart appliances. Also today, customers have meaningful opportunities to invest in distributed generation, energy storage, electric vehicles, smart thermostats and appliances, home energy controls, advanced HVAC systems and other new technologies.

So it is imperative that we have new rate designs that incent the right type of technologies; provide accurate price signals for incenting how and when customers use electricity; accurately reflect the types of services provided by the utility and the costs for those services; and provide opportunities for customers to save on their bills without shifting costs to other customers. All of these factors will result in the improved use of, and funding for, the electrical grid.

Q. HOW ARE TYPICAL RESIDENTIAL RATES AND COSTS CURRENTLY MISALIGNED?

A. Residential rates and costs are currently misaligned because they rely on volumetric kWh energy charges to recover grid investment costs – wires, poles, transformers, and generating plants, which are by far the predominant costs to serve residential customers.

In contrast, these grid costs are recovered through kW demand charges and/or monthly service charges for most non-residential customers like businesses, schools, colleges, hospitals, fast-food restaurants and government buildings.

Q. WHAT IS THE DIFFERENCE BETWEEN DEMAND AND ENERGY?

A. Energy is the total consumption of electricity over a billing month, measured in kWh (1,000 Watt-hours). Demand is the instantaneous electrical draw of a customer's load at a single point in time, measured in kW (1,000 Watts). If you turned on ten 100-Watt lightbulbs at the same time they would draw (or demand) 1 kW at that instant. If you left them all on for 5 hours they would consume 5 kWh of energy (1 kW used over 5 hours).

Q. WHY IS THIS DISTINCTION IMPORTANT?

A. Demand and energy reflect different costs of service, both of which are necessary to serve customers. The size of the grid necessary to serve the home is driven by the home's kW demand. This includes infrastructure investments in power plant capacity, wires, poles, substations, transformers and other capital equipment. For example, a home that draws a maximum load of 8.0 kW in one hour requires 8.0 kW of grid investment to serve it, regardless of the overall energy consumption during the month.

Other costs, such as fuel and variable operation and maintenance costs are driven by a customer's total kWh energy consumption during the month. In this same home, the customer's average load over all of the hours in a month may be more like 2.5 kW per hour, which would equate to 1,825 kWh (2.5 kW times 730 hours in a month).

Suppose the customer goes on vacation for two weeks and reduces their monthly kWh energy consumption, but still drew 8.0 kW demand sometime during the other two weeks. What costs would they reduce? They would certainly reduce the fuel and other variable costs needed to serve them because of the reduction in monthly kWh consumed. However, they would still require 8.0 kW of grid services for the home because they still drew 8.0 kW demand in some hour before or after the vacation. Stated another way, the fixed infrastructure costs don't go away just because the customer leaves for a couple of weeks.

Q. HOW DOES THIS TRANSLATE TO THE RATES?

A. In a sense, the utility provides the customer with three types of services: basic services for connection to the grid each month, kWh energy, and kW demand. Business customers, except for extremely small accounts, are charged separately for these services through a three-part rate. The customer pays for basic services through a monthly service charge, energy services through a kWh energy charge, and demand services through a kW demand rate. In contrast, residential customers are typically billed through a two-part energy rate, where the energy services, demand services, and some of the basic services are billed with a kWh energy charge, and a portion of the basic services with a monthly service charge.

V. APS'S RESIDENTIAL THREE-PART DEMAND RATES

Q. WHAT IS APS'S EXPERIENCE WITH RESIDENTIAL DEMAND RATES?

A. APS has significant experience with residential three-part demand rates. We currently have about 117,000 customers, or 11% of our total customers, on a demand rate.

Q. HOW LONG HAS APS OFFERED THESE RATES?

A. APS has offered residential demand rates for nearly 35 years.

Q. WHY WERE DEMAND RATES FIRST ADOPTED?

A. APS's earliest three-part demand rates date back to 1981. In approving the rate at that time, the Arizona Corporation Commission ("ACC") stated that a residential rate based primarily on each customer's kWh energy consumption "ignores the fact that the cost of providing electric service is increasingly a function the demand for electricity places on the system rather than total power consumed."[1] The Commission further recognized that including a demand component in residential customers' bills would provide "an

[1] Decision No. 51472 (Oct. 21, 1980) at Finding of Fact 1.

incentive to customers to manage their electric load in a manner that can result in lower electric bills for the individual customers and equally important, a reduction in APS peak demand which can have the effect of reducing the need for expensive additional generating facilities."[2]

Q. CAN CUSTOMERS UNDERSTAND AND MANAGE DEMAND?

A. Yes. While the experience varies for each customer, we have found that customers can and do understand and manage demand. Some customers maximize their experience and bill savings by actively managing their demand through investments in home energy controls, efficient appliances, HVAC systems and other devices. Others are generally aware of the new charge on their bill and try to reduce it by changing their energy usage behavior and patterns, such as avoiding using major appliances at the same time to lower the home's maximum electrical draw. There are some customers who are not interested in any of the specific components of the electric bill, including the demand charge; they are only concerned that the total seems to be reasonable and comports to some typical expected amount. These customers may have a more limited knowledge of demand, energy, or even the service charge component of the bill, and may not try to actively manage any of them. However, some of these customers end up saving on their bill under a demand rate because their electrical usage patterns naturally benefit from a demand charge. For example, they may have a lower maximum kW draw in any hour in relation to their monthly kWh energy consumption.

Q. WHAT KIND OF DEMAND SAVINGS HAVE CUSTOMERS ACHIEVED?

A. Again, it varies by home. We looked at a sample of customers that switched from an energy-only time-of-use rate to the three-part demand rate and found that about 60% of those customers saved on their demand and energy. We also found that those who actively manage their demand have achieved demand savings of 10% - 20% or more. On average, customers on the three-part rate reduce their monthly demand by 3% to 4%

[2] *See id.* at Finding of Fact 3.

depending on the season. These customers also tend to save on their on-peak and monthly kWh usage after switching to the three-part rate.

Q. HAVE CUSTOMERS ON DEMAND RATES SAVED ON THEIR BILL?

A. Typically, yes. Looking at this same sample of customers we found that over 90% of the customers that switched to the demand rate saved on their monthly bill. The average bill savings was 9%, and the top 25% saved over 20% on average (excluding taxes and adjustments).

Q. WHAT CAUSES THESE BILL SAVINGS?

A. The three-part rate structure rewards customers for reducing both their demand and energy. And because it's also a time-of-use rate, it also provides savings for shifting usage to the off-peak hours. In essence, APS's three-part rate provides customers three opportunities to save on their bill. In comparison, our two-part inclining block rate only provides one opportunity to save – namely, reducing the total monthly kWh energy usage.

Q. BUT IS THIS A WIN-WIN SITUATION OR ARE THESE BILL SAVINGS SHIFTED TO OTHER CUSTOMERS?

A. It's a win-win situation. As discussed earlier, when customers reduce their demand and energy, they reduce both the grid investment costs and the fuel and other variable costs necessary to serve them. Because the bill savings from the reduced demand and energy charges are directly aligned with the demand-related and energy-related costs to serve the customer, there are fewer costs shifted to other customers. Simply stated, the bill savings customers achieve on three-part rates better match APS's cost savings so there are only minimal spillover effects to other customers.

In contrast, a two-part rate only incents customers to reduce their monthly kWh consumption, not their demand. Thus, under a two-part rate, only the fuel and other variable costs are reduced, typically not the grid investment costs. But customers are rewarded as if they had reduced both types of costs.

VI. UNSE'S RESIDENTIAL RATES AND COST RECOVERY

Q. PLEASE DESCRIBE UNSE'S RESIDENTIAL RATES.

A. UNSE's current residential rates are based on the two-part rate, which include a monthly service charge and kWh energy charges. The service charge is a flat amount per month. The kWh energy charges have two varieties – an inclining block and time-of-use structure. Most UNSE customers are on the inclining block rate.

Q. WHAT ARE UNSE'S COSTS TO SERVE RESIDENTIAL CUSTOMERS?

A. The cost of service study provided in standard filing requirement "G Schedules" and other relevant information show that UNSE's costs to serve residential customers include power supply and fuel costs, transmission infrastructure investments and ancillary services, local grid infrastructure cost for delivering the energy to the home and hookup costs such as some secondary service costs, meters, meter reading, billing and customer care.

Q. ARE UNSE'S CURRENT RESIDENTIAL RATE STRUCTURES ALIGNED WITH THEIR COST OF SERVICE?

A. While the overall proposed level of cost recovery for each residential rate class appears to be generally consistent with the class cost of service, the current residential rate structures do not align rates with the costs to serve individual customers as well as they could with three-part rates. Specifically, UNSE's two-part rate structure recovers grid infrastructure investments through volumetric kWh charges, even though the costs are determined by the size of the home's electrical draw (or demand), not the monthly kWh consumption. Likewise, even some of the basic service costs also are recovered through kWh charges.

Q. WHAT CHANGES DOES UNSE PROPOSE IN THIS RATE CASE?

A. UNSE proposes to (1) increase the monthly service charge, (2) revise the kWh charges in the inclining block rate, and (3) offer a new three-part rate with a demand charge.

Q. DO YOU BELIEVE THESE CHANGES WILL IMPROVE THE ALIGNMENT OF UNSE'S RESIDENTIAL RATES WITH COSTS?

A. Absolutely.

Q. PLEASE EXPLAIN.

A. I believe UNSE's proposed revisions to its residential rates will result in substantial improvements in aligning the rate structures with costs and to the services provided. For example, the proposed rate revisions increase the amount of the basic service costs that are recovered through the monthly service charge, rather than through a kWh energy charge, for all residential rates. They also reduce the tail block kWh charge in the inclining block rate to better reflect cost of service. And they introduce a three-part rate consistent with the type of design that I detailed in the rate reform discussion. This new rate recovers basic services with a monthly service charge, demand services with a kW demand charge, and energy services with a kWh energy charge, which results in bills that are more aligned with the costs and services provided.

Q. WHAT ARE THE BENEFITS OF THESE PROPOSED CHANGES?

A. As discussed above, rate structures that are better aligned with costs will provide more accurate price signals for customers that wish to invest in distributed technologies, smart appliances and energy controls in their home, and result in a more efficient use of, and funding for, the grid. In particular, the three-part rate will provide an opportunity for customers to save on both the demand and energy components on their bill. And these bill savings will be aligned with a reduction in UNSE's demand and energy-related costs, which will mitigate potential adverse impact on the rates of other customers.

Q. WHAT IS APS RECOMMENDING THAT THE COMMISSION DO?

A. APS recommends that the Commission approve UNSE's proposed residential rate design.

Q. DOES THAT CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

Charles Miessner
Statement of Qualifications

Charles Miessner has over 30 years experience in the electric utility industry in the areas of pricing, planning, and business development for both utilities and private energy companies. He currently serves as Manager of Rates at Arizona Public Service. Prior to joining Arizona Public Service he served in management and leadership positions for Progress Energy, Tucson Electric Power, AES - New Energy, New West Energy and The Salt River Project. His accomplishments include: developing, implementing and evaluating retail rates; developing integrated resource planning methods and models; and directing strategic planning. Charles has appeared before regulators and legislators on energy issues in Arizona, California, Nevada and New Mexico. He serves on the national rates committee for the Edison Electric Institute. Charles has a B.S. in Economics from Arizona State University and has completed all requirements, excluding dissertation, towards a PH.D. in Economics from the University of North Carolina.