BEFORE THE ARIZONA CORPORATION C

COMMISSIONERS

DOUG LITTLE, Chairman
BOB STUMP
BOB BURNS
TOM FORESE
ANDY TOBIN

ORIGINAL

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

NOTICE OF FILING SURREBUTTAL TESTIMONY

ARIZONA UTILITY RATEPAYER ALLIANCE

The Arizona Utility Ratepayer Alliance ("AURA") hereby files surrebuttal testimony by its witnesses, Patrick J. Quinn, Thomas Alston, and Scott J. Rubin.

Respectfully submitted on February 23, 2016, by:

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BEFORE THE ARIZONA CORPORATION COMMISSION

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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

SURREBUTTAL TESTIMONY
OF
PATRICK J. QUINN
ON BEHALF OF
ARIZONA UTILITY RATEPAYER ALLIANCE
FEBRUARY 23, 2016

I INTRODUCTION

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND TELEPHONE NUMBER.

A. My name is Patrick J. Quinn. My business address is 5521 E. Cholla St., Scottsdale, AZ 85254, and my phone number is (602) 579-1934.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS MATTER?

A. I am testifying on behalf of the Arizona Utility Ratepayer Alliance ("AURA").

Q. ARE YOU THE SAME PATRICK J. QUINN WHO PREVIOUSLY SUBMITTED TESTIMONY IN THIS DOCKET?

A. Yes

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. AURA proposes modifications to the rate design proposals from Unisource Electric, Inc. ("UNSE") and the Arizona Corporation Commission's Utility Division Staff's ("Staff").

Specifically, the Commission should approve UNSE's rebuttal two-part rate (termed the "transition" rate) as the permanent residential rate design, not UNSE's rebuttal three-part rate. However, the residential customer charge should be lowered from $15.00 to RUCO's proposed $12.26, with any reduction in revenues spread over the usage charges once a revenue requirement is approved. Additionally, as Staff suggests, there should be no changes to net metering until the generic docket on the cost and value of solar is completed.

Q. WHY DOES AURA SUPPORT THE UNSE REBUTTAL TWO-PART RATE?

The rebuttal two-part rate:

- Avoids the numerous problems associated with a mandatory demand charge;

- Is fairer to customers and consistent with best-practice rate design principles that include understandability, ease of administration, nondiscrimination, revenue stability, and gradualism; and
- Is superior to a three-part rate in aligning costs of service with cost recovery.

Q. WHY DOES AURA OPPOSE THE UNSE REBUTTAL THREE-PART RATE?

First, and most importantly, the testimony of nationally-recognized rate design expert Scott Rubin demonstrates that facts do not support UNSE's assertion that its proposed three-part rate design recovers costs more equitably, promotes fairness, and reduces intra-class subsidization. In fact, precisely the opposite is true. Compared to UNSE's rebuttal two-part rate design proposal, its proposed rebuttal three-part rate design is less equitable, unfair to lower-cost customers, and increases intra-class subsidization.

Q. ARE THERE OTHER REASONS WHY THE UNSE REBUTTAL THREE-PART RATE SHOULD NOT BE APPROVED?

Yes. A significant reason that UNSE's three-part rate design does not work is that over 80 percent of UNSE residential demand costs are based on summer peaks and the relationship between billing demand and summer peak demand is relatively weak. This is a common issue with residential demand charges. As a recent article by Jim Lazar published in *Natural Gas and Electricity* points out, "Residential consumers have much more diversity in their usage, with individual customer maximum demands seldom coinciding with the system peak."[1]

[1] Lazar, Jim. "Use Great Caution in Design of Residential Demand Charges." *Natural Gas & Electrify, Regulatory Assistance Project* February, 2016 P.15.

Q. ARE THERE ANY OTHER REASONS WHY THE UNSE REBUTTAL THREE-PART RATE SHOULD NOT BE APPROVED?

Yes. Tom Alston discusses issues inherent to mandatory demand charges as they have currently been proposed. Other downsides of these charges are that they:

- May be overly confusing and limit residential customers' ability to control their bills;
- May negatively affect property values;
- May overly burden low and fixed income customers;
- Are untested in other service territories; and
- Are inconsistent with accepted best practices.

Q. DOES AURA OPPOSE VOLUNTARY DEMAND CHARGES?

A. No, AURA supports customer choice and would not oppose properly designed voluntary demand charges.

Q. WOULD ADOPTING UNSE'S AND STAFF'S RECOMMENDED RATE DESIGNS SUPPORT ECONOMIC DEVELOPMENT?

A. No. UNSE has expressed a desire to "play a bigger role in attracting and promoting the growth of businesses in its service territories," and has proposed an Economic Development Rate ("EDR") to help promote economic development. A proven and well-studied[2] way to support this development is to promote Distributed Generation ("DG"). Unfortunately, demand charges have the effect of greatly reducing the economic benefits

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[2] Solar Jobs Census, *Energy Foundation Arizona* 2014
http://www.thesolarfoundation.org/wp-content/uploads/2015/02/Arizona-Solar-Jobs-Census-2014.pdf

Distributed Generation Standard Contracts and Renewable Energy Fund Jobs, Economic and Environmental Impact Study, *Brattle Group* April 30, 2014
http://www.energy.ri.gov/documents/DG/RI%20Brattle%20DG-REF%20Study.pdf

The Value of Distributed Solar Electric Generation to New Jersey and Pennsylvania *MSEIA* November, 2012
http://mseia.net/site/wp-content/uploads/2012/05/MSEIA-Final-Benefits-of-Solar-Report-2012-11-01.pdf

of Distributed DG systems. Under the proposed three-part rate, a DG system, such as roof-top solar, would not typically be producing energy concurrently with the demand assessment time period (although it may coincide with the system peak) and thus reduce demand charges only slightly if at all. If economic development is truly a concern then DG should be supported through the adoption of the UNS rebuttal two-part rate.

The Alliance for Solar Choice has made a well-reasoned case for the value of DG. AURA supports a thorough investigation of DG costs and benefits, as part of a larger investigation into the costs and benefits of all customer subsidies.

Q. SHOULD ANY RATE DESIGN CHANGES THAT INCLUDE DEMAND CHARGES BE POSTPONED UNTIL THE NEXT RATE CASE?

A. Yes, Mr. Rubin demonstrates that UNSE's three-part rate design would actually further shift costs to low-usage customers, so for that reason alone this proposal should be rejected in this case. Further, because of the radical nature of the rate-designs proposed, the short time for full consideration, and the lack of full participation from the communities most affected (due to a short comment period), any significant rate-design changes should be postponed until UNSE's next rate case.

Q. IF THE COMMISSION APROVES A THREE PART RATE, SHOULD IMPLEMENTATION BE DELAYED FOR STUDY?

A. Should the Commission authorize a three-part rate instead of the rebuttal two-part rate, UNSE should only make the new rate available to customers on a voluntary basis to allow for education and data collection.

The included testimony of Scott Rubin conclusively demonstrates that the three-part rate, as currently proposed, is ineffective in recovering demand-related costs and any revision should be based on data from customers participating in a pilot study.

Q. WHAT IS AURA'S POSITION ON ENERGY EFFICIENCY?

AURA agrees with most of what the Southwest Energy Efficiency Project ("SWEEP") states in its testimony. We support Energy Efficiency as a low-cost energy resource and recognize a need for an increase in funding and a more streamlined method of approving the Integrated Resource Plan. To insure continued funding of EE programs a more stable cost recovery mechanism than is currently utilized must be approved. SWEEP's proposal to fund EE in base rates is a viable alternative.

Q. SHOULD ANY PROPOSED RATE BE BASED ON ACTUAL CUSTOMER DATA?

A. Yes. Actual customer data must be analyzed to evaluate the impact of different rate design options. Rate impacts have the potential to surprise in some analyses, for example, essentially no improvement in cost relationships were achieved after a move to rates based on billing demand. The goal is to Remember One Thing: Customers. UNS must obtain real data from customers and analyze the actual bill impacts (and relationship to cost) of different rates design options. Data and experience from other jurisdictions should also be evaluated.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

DOUG LITTLE, Chairman
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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

SURREBUTTAL TESTIMONY
OF
THOMAS ALSTON
ON BEHALF OF
ARIZONA UTILITY RATEPAYER ALLIANCE
FEBRUARY 23, 2016

I INTRODUCTION

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND TELEPHONE NUMBER.

A. My name is Thomas D. Alston My business address is 5521 E. Cholla St., Scottsdale, AZ 85254, and my phone number is 602-524-9978.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS MATTER?

A. I am testifying on behalf of the Arizona Utility Ratepayer Alliance ("AURA").

Q. ARE YOU THE SAME THOMAS ALSTON WHO PREVIOUSLY SUBMITTED TESTIMONY IN THIS DOCKET?

A. Yes.

Q. ARE DEMAND CHARGES OVERLY CONFUSING?

A. Yes. Demand charges are more difficult to understand than time-of-use charges. Large companies often hire sophisticated consultants to help them effectively manage demand charges. Residential customers do not have access to these resources. Residential demand charges have traditionally favored upper-income home owners with the time, resources, and education to understand complex rate designs and bills. As I discuss later in my testimony, low-income customers may have more difficulty adjusting to a demand-based rate design.

Below, is a typical APS residential bill that includes demand charges. To fully understand this bill, and accordingly how to adjust behavior to minimize charges, a customer would need to know the following:

1. On peak vs off peak per-kWh charges and when peak times occur;
2. What a per-kW demand charge actually is;

3. When the demand charge occurred and what was going on in the house to cause usage to spike;
4. Whether or not peak demand only occurs during on-peak hours;
5. What percentage of the bill can be attributed to per kWh charges vs demand charges (there are several demand charges on this bill that would have to be added together);
6. How to control demand by limiting total usage, for instance, it is intuitive to make sure that lights in a house are turned off when not in use but less intuitive to make sure an AC unit does not kick on while doing laundry; and
7. It is up to the Commission to decide if the answer to these questions can be reasonably derived from bills, such as the one below, by the average residential customer.

Your electricity bill [redacted] **Your account number** [redacted]
August 12, 2015

Your service plan: Combined Advantage 7pm - Noon

Meter number: [redacted]
Meter reading cycle: 08

Charges for electricity services

Cost of electricity you used

Customer account charge	$6.90
Delivery service charge	$52.49
Demand charge on-peak - delivery	$50.40
Environmental benefits surcharge	$11.34
Federal environmental improvement surcharge	$0.41
System benefits charge	$11.13
Power supply adjustment*	$3.33
Metering*	$5.39
Meter reading*	$1.80
Billing*	$2.03
Generation of electricity on-peak*	$43.69
Generation of electricity off-peak*	$68.02
Demand charge on-peak - generation*	$100.80
Federal transmission and ancillary services*	$19.49
Federal transmission cost adjustment*	$24.61
Four-Corners adjustment*	$7.35
LFCR adjustor	$5.97
Cost of electricity you used	$415.15

Taxes and fees

Regulatory assessment	$0.97
State sales tax	$23.77
County sales tax	$2.97
City sales tax	$11.46
Franchise fee	$8.32
Cost of electricity with taxes and fees	$462.64

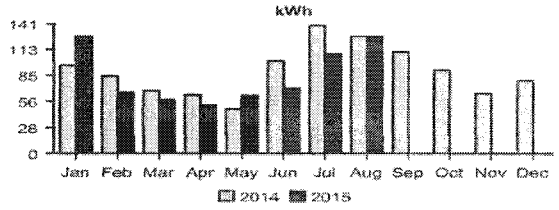
Total charges for electricity services **$462.64**

** These services are currently provided by APS but may be provided by a competitive supplier.*

Amount of electricity you used

Meter reading on Aug 12	43071
Meter reading on Jul 14	39322
Total electricity you used, in kWh	**3749**
On-peak meter reading on Aug 12	6875
On-peak meter reading on Jul 14	6218
On-peak electricity you used, in kWh (Noon to 7 pm Monday to Friday)	**657**
Off-peak electricity you used, in kWh (7 pm to noon weekdays, all day Saturday and Sunday and certain holidays)	**3092**
On-peak demand meter reading	11.2
Your billed on-peak demand in kW	**11.2**

Average daily electricity use per month



Comparing your monthly use

	This month	Last month	This month last year
Billing days	29	32	30
Average outdoor temperature	92°	93°	91°
Your total use in kWh	3749	3513	3884
Percentage of on-peak use	18%	14%	20%
Your billed demand in kW	11.2	7.8	11.7
Your average daily cost	$15.95	$12.15	$15.93

Q. ARE RESIDENTIAL DEMAND CHARGES CONSISTENT WITH BEST PRACTICES FOR HOW SYSTEM CAPACITY COSTS SHOULD BE REFLECTED IN RATES?

A. No, residential customers have a great deal of diversity in their usage, which seldom coincides with the system peak. Below, is a table that shows how three-part vs. two-part rates align with best practices for reflecting capacity costs in rates as outlined in a recent article by Jim Lazar.[1]

Exhibit 3. Garfield and Lovejoy Criteria and Alternative Rate Forms

Garfield and Lovejoy Criteria	CP Demand Charge	NCP Demand Charge	TOU Energy Charge
All customers should contribute to the recovery of capacity costs.	N	Y	Y
The longer the period of time that customers pre-empt the use of capacity, the more they should pay for the use of that capacity.	N	N	Y
Any service making exclusive use of capacity should be assigned 100% of the relevant cost.	Y	N	Y
The allocation of capacity costs should change gradually with changes in the pattern of usage.	N	N	Y
Allocation of costs to one class should not be affected by how remaining costs are allocated to other classes.	N	N	Y
More demand costs should be allocated to usage on-peak than off-peak.	Y	N	Y
Interruptible service should be allocated less capacity costs, but still contribute something.	Y	N	Y

Q. COULD DEMAND CHARGES AFFECT PROPERTY VALUES?

A. Yes. Vacation homes in use one or two days a month could receive dramatically higher bills as a large portion of each bill would be based on the few days a month the property was in use. This could increase electricity costs for a property by hundreds or even

1 Lazar, Jim. "Use Great Caution in Design of Residential Demand Charges." Natural Gas & Electrify, Regulatory Assistance Project February, 2016 P.15 Exhibit 3

thousands of additional dollars per year, putting a damper on the purchase of vacation homes and the associated tourism that comes with it.

Q. WOULD DEMAND CHARGES DISPORPOTIONATELY AFFECT LOW-INCOME CUSTOMERS?

A. Yes, low-income customers are often time-deprived, and as a result do not have the luxury of spreading out usage load so as to avoid raising peak demand. In other words, if one is pressed for time, sometimes the laundry needs to get done at the same time the air conditioning is running. Low-income customers are also less likely to have access to load-limiters, monitoring devices, and energy efficiency improvements that can help wealthier customers limit their demand. AURA shares the concerns on this matter expressed in the testimony submitted on behalf of the Arizona Community Action Association.

Q. ARE MANDATORY RESIDENTIAL DEMAND CHARGES USED BY OTHER UTILITIES?

A. To AURA's knowledge no other utility in the country has implemented mandatory residential demand charges. There is no compelling reason for the Commission to lead the nation into uncharted rate-design testimony. If the Commission were to approve a three-part rate, it would be forcing all residential customers to adopt a rate design that has not been tested in a real-world setting.

AURA has offered compelling reasons why it would be premature to implement mandatory residential demand charges. And the law of unintended consequences ensures that there would likely be other negative consequences that no party can presently foresee.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

DOUG LITTLE , Chairman
BOB STUMP
BOB BURNS
TOM FORESE
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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

SURREBUTTAL TESTIMONY
OF
SCOTT J. RUBIN
ON BEHALF OF
ARIZONA UTILITY RATEPAYER
ALLIANCE FEBRUARY 23, 2016

I INTRODUCTION

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND TELEPHONE NUMBER.

A. My name is Scott J. Rubin. My business address is 333 Oak Lane, Bloomsburg, PA 17815, and my phone number is 570-387-1893.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS MATTER?

A. I am testifying on behalf of the Arizona Utility Ratepayer Alliance ("AURA").

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

A. I am an independent consultant and an attorney. My practice is limited to matters affecting the public utility industry.

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

A. I have been asked by AURA to review the rebuttal testimony on rate design issues filed by UNS Electric Inc. ("UNSE").

Q. WHAT ARE YOUR QUALIFICATIONS TO PROVIDE THIS TESTIMONY IN THIS CASE?

A. I have testified as an expert witness before utility commissions or courts in the District of Columbia; the province of Nova Scotia; and the states of Alaska, Arizona, California, Connecticut, Delaware, Illinois, Kentucky, Maine, Maryland, Mississippi, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, and West Virginia. I also have testified as an expert witness before various legislative committees. I also have served as a consultant to the staffs of state utility commissions, as well as to national utility trade associations, and state and local governments throughout the country. Prior to establishing my own consulting and law practice, I was employed by the Pennsylvania

Office of Consumer Advocate from 1983 through January 1994 in increasingly responsible positions. From 1990 until I left state government, I was one of two senior attorneys in that Office. Among my other responsibilities in that position, I had a major role in setting its policy positions on water and electric matters. In addition, I was responsible for supervising the technical staff of that Office. I also testified as an expert witness for that Office on rate design and cost of service issues.

Throughout my career, I developed substantial expertise in matters relating to the economic regulation of public utilities. I have published articles, contributed to books, written speeches, and delivered numerous presentations, on both the national and state level, relating to regulatory issues. I have attended numerous continuing education courses involving the utility industry. I also have participated as a faculty member in utility-related educational programs for the Institute for Public Utilities at Michigan State University, the American Water Works Association, and the Pennsylvania Bar Institute.

Q. HAVE YOU CONTRIBUTED TO ANY BOOKS ON THE TOPIC OF UTILITY RATE DESIGN?

A. Yes. I served on the editorial committee for the fifth edition of *Water Rates, Fees, and Charges* (Manual M1) published by the American Water Works Association in 2000. That book is the primary rate-setting manual for the water utility industry, including cost-of-service studies and rate design.

Q. HAVE YOU PUBLISHED ANY PAPERS ON THE TOPIC OF UTILITY RATE DESIGN?

A. Yes. In November 2015, I published a paper on this topic in *The Electricity Journal*. The paper is entitled "Moving Toward Demand-Based Residential Rates." In that paper,

I discussed and analyzed several options for designing cost-based residential rates. A copy of the paper is provided as Exhibit SJR-1 accompanying this testimony.

Q. DO YOU HAVE ANY EXPERIENCE THAT IS PARTICULARLY RELEVANT TO THE ISSUES IN THIS CASE?

A. Yes, I do. I have testified on numerous occasions as a rate design and cost of service expert. For example, during the past three years, I have testified as a cost-of-service study and/or rate design expert in electric utility rate cases in Alaska (Chugach Electric and Municipality of Anchorage), Connecticut (United Illuminating), District of Columbia (Potomac Electric), Illinois (Commonwealth Edison and Ameren), Mississippi (Entergy), Ohio (Duke Energy, Dayton Power & Light, and the FirstEnergy companies), and Pennsylvania (Pike County Light & Power). My complete curriculum vitae is attached to this testimony as Appendix A.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THIS COMMISSION?

A. Yes, I testified as a rate design and cost-of-service study expert witness before this Commission in a rate case involving the former Citizens Utilities' water operations in 1996 (Docket Nos. E-1032-95-417, et al.).

II PURPOSE OF TESTIMONY

Q. WHAT IS THE SPECIFIC PURPOSE OF YOUR TESTIMONY IN THIS MATTER?

A. In its rebuttal testimony and exhibits, UNSE presents a new rate design for residential customers. UNSE claims that its new rate design, which includes demand charges for residential customers, more equitably recovers the cost of service than the rate design it proposed in its direct case. My testimony will evaluate UNSE's claim using data provided by UNSE as part of its rebuttal filing and workpapers.

III RATE DESIGN TESTIMONY

Q. WHAT DOES UNSE SPECIFICALLY CLAIM REGARDING ITS REVISED RATE DESIGN.

A. Four UNSE rebuttal witnesses claim that its new rate design would be fairer to all residential customers. Specifically, Mr. Hutchens states that UNSE "is attempting to modify its rates to (i) recover costs more equitably … [and] (iv) promote the efficient use of the Company's electric system." Hutchens rebuttal, p. 4, lines 14-17. Similarly, Mr. Dukes testifies in his rebuttal that "UNS Electric is trying to address *all* ratepayer subsidization in this case, by moving rates closer to cost-of-service." Dukes rebuttal, p. 19, lines 23-24 (emphasis in original). Mr. Jones's rebuttal testimony contains a similar claim, where he states: UNSE "is attempting to modify its rates to (i) reduce intra-class subsidization where possible, [and] (ii) promote fairness between like situated customers and recover costs from cost causers." Jones rebuttal, p. 1, lines 24-26. Finally, Dr. Overcast states that "a multi-part rate reflects cost causation more accurately [than an energy-only rate] and when unbundled will be consistent with the principles of cost causation and matching costs and revenues with a proper design." Overcast rebuttal, p. 8, lines 15-17.

Q. DID UNSE PROVIDE ANY ANALYSES TO SUPPORT ITS CONTENTION THAT THE CURRENT TWO-PART RATE DESIGN (CUSTOMER CHARGE AND ENERGY CHARGE) IS NOT CONSISTENT WITH THE COST OF SERVING RESIDENTIAL CUSTOMERS?

A. No.

Q. DID UNSE PROVIDE ANY ANALYSES TO SUPPORT ITS CONTENTION THAT ITS PROPOSED THREE-PART RATE DESIGN (CUSTOMER CHARGE, DEMAND CHARGE, AND ENERGY CHARGE) IS CONSISTENT WITH THE COST OF SERVING RESIDENTIAL CUSTOMERS?

A. No.

Q. HAS UNSE PROVIDED DATA THAT ALLOW SUCH ANALYSES TO BE PERFORMED?

A. Yes, at least in part. UNSE has provided a cost-of-service study ("COSS") from which the essential elements of the cost to serve each customer can be calculated. In addition, UNSE has provided hourly meter reading data for an entire 12-month period for a sample of 100 residential customers. While it would be ideal to have such data for all of UNSE's residential customers, I recognize that most residential customers did not have automated metering equipment installed for the entire test year.

Q. HAVE YOU PERFORMED AN ANALYSIS OF THE COST TO SERVE EACH OF THE 100 CUSTOMERS IN UNSE'S SAMPLE?

A. Yes.

Q. HAVE YOU ALSO COMPARED THE REVENUES THAT EACH OF THOSE 100 CUSTOMERS WOULD PROVIDE UNDER UNSE'S DIFFERENT RATE-DESIGN PROPOSALS?

A. Yes.

Q. BEFORE DISCUSSING THE RESULTS OF YOUR ANALYSES, PLEASE EXPLAIN HOW YOU ESTIMATED THE COST TO SERVE EACH CUSTOMER.

A. The best estimate we have of the cost to serve a customer is a COSS. I recognize that different COSS have been presented in this case, and I do not take a position on the various studies that have been presented. For purposes of consistency, I have used UNSE's most recent COSS provided in the file: *2015 UNSE Schedule G-COSS-R.xlsx*. I say that this is for consistency because I am evaluating UNSE's rate design proposals. So it is reasonable to compare those proposals to UNSE's COSS to test UNSE's claim that its rate design was developed to more closely track the results of its own analysis of the cost to serve customers.

UNSE's COSS includes four types of demand-related functions (production, transmission, distribution primary, and distribution secondary); one energy-related function (essentially fuel and purchased power); and four categories of customer-related functions (delivery, meter, billing and collections, and meter reading). UNSE's study develops a specific cost (a dollar amount) to provide each of these functions to the residential class of customers, each of which is based on a particular allocation methodology, as shown in the following table.

Function	Cost of Service	Allocation to Residential
Production demand	$20,709,455	Coincident peak (A&E/4CP)
Transmission demand	8,775,515	A&E/4CP
Distribution primary demand	10,625,712	Class Non-Coincident Peak (NCP)
Distribution secondary demand	1,173,823	NCP
Total demand-related costs	**$41,284,505**	
Energy	**$44,744,078**	Energy Usage (kWh)
Customer delivery	$ 7,991,033	Number of Customers
Customer meter	646,494	Number of Customers
Customer billing & collections	4,113,357	Number of Customers
Customer meter reading	942,211	Number of Customers
Total customer-related costs	**$13,693,095**	
Total residential cost of service	**$ 99,721,678**	

Source: File: *2015 UNSE Schedule G-COSS-R.xlsx*, Tab: *Functionalization_RES.*

Q. HOW IS THIS INFORMATION USED TO ESTIMATE THE COST TO SERVE A SPECIFIC CUSTOMER?

A. In utility rate cases, rate design and COSS experts (including me) are always talking about "cost causation." It is important to understand what that means. With the possible exception of very large customers under special rates, we do not attempt to determine the actual cost to serve each customer. Indeed, such an analysis would be impossible because each customer is slightly different. Some customers are closer to substations meaning that the distribution circuit serving them is shorter (usually meaning less expensive) than the circuit serving customers who are further from the substation. Some customers have underground service which usually is more expensive than overhead service. Some neighborhoods might have transformers that serve five or ten buildings, while others might have transformers that serve just one or two buildings. Some customers are located further from the street than others meaning that the cost of the service line connecting the distribution line to the premises would be different. I could

go on and on. The point is that a cost-of-service study, and ratemaking in general, is designed to estimate the cost to serve the typical customer within a customer class or subclass. The principle of cost causation is not specific to each individual customer, but to customer classes that have certain characteristics in common.

For this reason, when we attempt to determine the cost to serve a particular customer, we are actually determining how a customer's use of the electric system affects the costs that are allocated to the customer's class. For example, secondary distribution costs are allocated among the customer classes based on the class's non-coincident peak ("NCP") demand. During the test year, the residential class's NCP demand occurred on July 24, 2014, in the hour from 4:00 pm to 5:00 pm (appearing in UNSE's data as the hour ending 17).[1] Thus, if we are trying to determine the secondary distribution cost to serve Jane Doe at 123 Any Street, we evaluate how much electricity she used on July 24, 2014, between 4:00 pm and 5:00 pm; that is, how much she contributed to the residential class's demand at the time of the class NCP.

Q. HOW DO YOU USE THIS UNDERSTANDING OF COST CAUSATION TO CONTINUE YOUR ANALYSIS?

A. The next step is to determine the unitized cost of each cost element. For example, as shown in the table above, the residential class has been allocated $13,693,095 of costs based on the number of customers in the class. The class has 82,607 customers.[2] So, each residential customer has "caused" UNSE to incur $165.76 per year in customer-related costs. The following table shows the unitized costs per year for each cost element. A more detailed calculation of these amounts is shown in my Exhibit SJR-2.

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[1] File: *UNSE RES LR Data.xlsx*, Tab: *Res Adj.*
[2] File: *2015 UNSE Schedule G-COSS-R.xlsx* Tab: *G-7 Allocations* Cell: J38

Function	Unitized Cost of Service
Production & transmission	$108.17 per kW based on 4CP
Production & transmission	$70.53 per kW based on average[3]
Distribution demand	$44.13 per kW based on NCP
Energy	$0.054304 per kWh
Customer costs	$165.76 per customer

Q. WHAT DID YOU DO WITH THESE UNITIZED COSTS OF SERVICE?

A. I applied these unitized costs of service to the specific characteristics of each of the 100 customers in the sample provided by UNSE.[4] These specific characteristics are sometimes referred to as a customer's "units of service." That is, for each of the 100 customers in the sample, I determined the customer's demand (in kW) at the time of the system peak (based on the highest coincident peak in each of the four summer months (4CP)),[5] the customer's demand at the time of the class NCP, and the customer's annual energy consumption. In addition, each customer is equal to one customer for the purposes of determining customer-related costs. Each customer's units of service are then multiplied by the corresponding element of the unitized cost of service. When the results for a customer are summed, we have an estimate of the cost to serve each customer.

Q. CAN YOU PROVIDE AN EXAMPLE?

A. Yes. The following table shows these calculations for one customer in UNSE's sample.[6]

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[3] Average demand is equal to annual kilowatt-hour consumption divided by the number of hours in the year (8760 in the test year).
[4] The sample of 100 customers was provided as part of Mr. Dukes's rebuttal workpapers in the file: *UNSE Res Hrly 0713-0615.xlsx.*
[5] According to the file: *UNSE RES LR Data.xlsx*, Tab: *Res Adj* the system coincident peaks occurred on July 15, 2014 hour end 18, July 23, 2014 hour end 16, August 6, 2014 hour end 17, and September 2, 2014 hour end 17.
[6] The data are for the customer with the identifier 52657. Note that the figures in the table are rounded for ease of presentation. The more precise estimate of the cost to serve this customer, without rounding, is $672.64.

Function	Unitized Cost of Service	Units of Service	Cost of Service
Production & transmission	$108.17 per kW 4CP	1.45 kW	$ 156.85
Production & transmission	$70.53 per kW avg.	0.46 kW	32.44
Distribution demand	$44.13 per kW NCP	2.25 kW	99.29
Energy	$0.054304 per kWh	4021.2 kWh	218.37
Customer costs	$165.76 per customer	1	165.76
Total cost of service			$ 672.71

Q. WHY IS THIS ESTIMATE OF THE COST TO SERVE EACH CUSTOMER IMPORTANT?

A. This estimate of the cost to serve each customer can be used to compare the revenues that would be collected from each customer under different rate design options. As I explain below, the difference between the costs and revenues under different options can then be compared to determine how well each rate design tracks the cost to serve customers.

Q. DO YOU USE ALL OF THE DATA IN THE ABOVE TABLE TO COMPARE RATE DESIGN OPTIONS?

A. I considered all of these data, but I found that including Energy costs in the analysis tends to mask important differences in rate design options. Approximately 45% of the residential class's cost of service is for energy costs. Those costs are allocated to the customer class based solely on energy consumption, and all of the rate designs (except one) collect these costs from customers using exactly the same factor (energy consumption in kWh). That is, there is essentially no difference among the rate design options in how they recover fuel, purchased power, and related costs. Because energy-related costs are such a large part of customers' bills and the cost of service, it was difficult to see the differences among different rate design options. The results that I discuss below, therefore, compare the distribution portion of customers' bills (all charges except the Base Power Supply Charge (BPSC) and the Purchased Power and Fuel

Adjustment Charge (PPFAC)) with distribution costs (unitized Demand costs and Customer costs from the COSS).

Q. WHAT RATE DESIGNS DID YOU EVALUATE?

A. I evaluated existing rates and five rate design options under proposed rates. The rate design options are UNSE's originally proposed two-part rate, UNSE's originally proposed three-part rate, UNSE's rebuttal two-part rate (termed the "transition" rate design), UNSE's rebuttal three-part rate with no adjustment for load factor, and UNSE's rebuttal three-part rate based on a minimum load factor of 15% in each month.

Q. PLEASE DESCRIBE YOUR FIRST ANALYSIS AND WHAT CONCLUSIONS YOU REACHED FROM IT.

A. My first analysis is provided in Exhibit SJR-3. The solid black line on the graph represents equality between revenues (shown on the left or y axis) and the distribution cost of service (shown on the bottom or x axis). For ease of reference, I will call this the Equality Line. Points that lie above the Equality Line represent customers who are providing revenues in excess of their cost of service; points below the Equality Line are customers whose revenues are less than their cost of service.

The other line on the graph (the dashed line) is the trend (or regression) line. This line represents the best statistical relationship among the 100 points plotted on the graph. The closer this line is to the Equality Line, the better job the rate design does in tracking the customer-specific cost of service.

Three other factors are important to note here. First, the R-square of the trend line (shown below the graph) provides a numeric representation of how closely the trend line represents the individual customers. The closer the R-square is to 1.0, the better the trend line represents the customer data. The second important factor is the slope of the trend

line (also shown below the graph). The slope is the change in the annual bill for each $1.00 increase in the cost of serving the customer. The closer the slope is to 1, the better the rate design does in increasing revenues by an amount equal to an increase in costs. Third, I calculate the average percentage difference between each customer's cost of service and revenues (using the absolute value). The smaller the average percentage difference, the closer the rate design comes to tracking each customer's cost of service.

Exhibit SJR-3 shows a comparison of the customer-specific distribution cost-of-service with annual distribution revenues under existing rates. UNSE has asked for a significant increase in distribution revenues, so it is not surprising that existing rates produce substantially less revenues than UNSE claims under proposed rates (that is, almost all points lie below the Equality Line). Thus, the average difference between revenues and costs is 36%. The existing slope is 0.607. This indicates that as costs increase, the existing rate design does not do a very good job of collecting the cost of service from higher-cost customers. Stated differently, higher-cost customers (those with larger demands) are paying a lower percentage of the cost to serve them than are lower-cost customers.

My analysis of existing rates shows that there certainly is room for improvement in the rate design. Not only do rates need to be increased (assuming for the sake of illustration, as I do throughout, that UNSE's revenue requirement claims are justified), but the rate design could be modified to do a better job of collecting revenues from higher-cost customers (that is, move the slope of the trend line closer to 1.0).

Q. PLEASE TURN NOW TO YOUR ANALYSIS OF UNSE'S RATE DESIGN PROPOSALS. WHAT IS SHOWN ON EXHIBIT SJR-4?

A. Exhibit SJR-4 shows UNSE's originally proposed rate design. This is a two-part rate consisting of a customer charge of $20.00 per month and a two-block consumption charge: 3.0810¢ per kWh for the first 400 kWh per month, and 5.0810¢ per kWh for all consumption in excess of 400 kWh per month.[7] My exhibit shows that this rate design constitutes an improvement over existing rates. The slope of the trend line is 0.846. This means that for every $100 by which the cost to serve a customer increases, this rate design collects $84.60 in additional revenues from the customer. This is an improvement over the existing rate design, but it still results in some higher-cost customers paying less than their cost of service.

The average difference between revenues and costs is 22% under this rate design. Once again, this is an improvement over the existing rates where customers' revenues differed from costs by 36%.

One troubling factor with this rate design is that the trend line starts above the Equality Line then crosses the Equality Line at about $800 in costs. In other words, lower-cost customers are paying more than the cost to serve them, while higher-cost customers are paying less than cost. It appears that this inequity is primarily due to the customer charge of $20 per month ($240 per year) which is substantially higher than the unitized customer cost of $165.76 per year. Simply, this rate design has a customer charge that is too high resulting in consumption charges that are too low. This leads to some lower-cost customers (those with lower demands) subsidizing some higher-cost customers (those with higher demands) under this rate design.

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[7] UNSE Schedule H-3 (Revised 6/3/2015), page 1.

Finally, the graph at the bottom of Exhibit SJR-4 (known as a histogram) shows the number of customers whose bills would increase by certain percentages compared to existing rates. Under this rate design, annual distribution bill increases range from 47% to 95%. The bill impacts are quite spread out, with most customers seeing increases in the range of 50% to 85%.

Q. PLEASE DESCRIBE EXHIBIT SJR-5.

A. Exhibit SJR-5 provides the same type of presentation as Exhibit SJR-4, but for UNSE's originally proposed residential three-part (demand) rate. I understand that UNSE originally presented this rate as an optional rate.

This original three-part rate consisted of a customer charge of $20 per month, a charge of $6.00 per kW for the first 7 kW of demand (measured as the maximum one hour during the month, regardless of day of week or time of day)[8] in a month, $9.95 per kW for demand in excess of 7 kW, and a consumption charge of 1.0¢ per kWh for all energy consumed.[9]

UNSE's original three-part rate is notably worse in reflecting the cost of service than UNSE's originally proposed two-part rate. The slope of the trend line is only 0.717 meaning that higher-cost customers would pay much less than the cost to serve them. Further, the average difference between revenues and costs is 35% compared to 22% under the original two-part rate. It also appears that this rate structure was not designed to be applicable to all customers because the total revenues that would be collected from these 100 customers would exceed the cost of serving the customers by more than $9,500 per year (15% more than the cost of service). Finally, this rate structure would have

[8] Dukes direct testimony, p. 24, lines 8-9.
[9] UNSE Schedule H-3 (Revised 6/3/2015), p. 1.

enormous customer impacts, with more than 45% of customers seeing their annual distribution bills increase by more than 100%. In contrast, a few customers would have annual increases of less than 35%.

Simply stated, UNSE's original three-part rate design did a much worse job of tracking the cost of service than did UNSE's original two-part rate design. Based on the data in UNSE's sample of 100 customers, a two-block consumption charge came much closer to tracking the cost of serving customers than did a rate based on a customer's single monthly peak demand.

Q. WHAT IS SHOWN IN EXHIBIT SJR-6?

A. Exhibit SJR-6 provides a similar analysis of UNSE's rebuttal two-part rate, which UNSE called a "transition" rate. This rate design consists of a customer charge of $15 per month and it retains the existing three-block consumption charge: 3.2258¢ per kWh for the first 400 kWh per month, 4.2258¢ per kWh for the next 600 kWh per month, and 6.0258¢ per kWh for all consumption in excess of 1,000 kWh per month.[10]

UNSE's rebuttal transition rate does a very good job of having a customer's revenues track the cost of serving the customer. The slope of the trend line is 0.881 meaning that the rate design makes substantial progress toward having higher-cost customers provide higher-revenues. This rate design also has a lower average difference between revenues and costs, at 19%. It also can be seen that with a customer charge that is much closer to the customer-related cost of service ($180 per year in revenues compared to $165.76 in costs), lower-cost customers are not providing significant subsidies to higher-use customers. Finally, because this rate design is similar in structure to existing rates, the range of customer bill impacts is much tighter than in UNSE's originally proposed rates:

[10] UNSE Exhibit CAJ-R-4, Schedule H-3, p. 4.

annual increases in distribution bills range from 42% to 56% for all customers in the sample group.

Q. DID YOU ALSO ANALYZE THE THREE-PART RESIDENTIAL RATE STRUCTURE UNSE PROPOSED IN ITS REBUTTAL?

A. Yes. In its rebuttal testimony, UNSE proposed a three-part rate that differs from its originally proposed demand rate structure in several respects. The new proposal contains a lower customer charge than the original proposal, and has only a single block demand rate instead of the two-block rate proposed initially. In addition, UNSE changed the measure of demand that would be used to bill customers. Its original demand charge was based on a customer's highest single-hour demand at any time during the month. UNSE's rebuttal proposal measures demand only during on-peak hours.[11]

Apparently because of concerns with bill impacts during the transition to a new rate structure, UNSE also proposed limiting the demand for billing purposes to no more than what the customer's demand would be if the customer had a 15% load factor during the month.[12]

For completeness, I analyzed UNSE's rebuttal three-part rate structure both with and without the 15% load factor limiter.

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[11] In the summer months of May through October, on-peak hours are Monday through Friday (excluding Memorial Day, Independence Day, and Labor Day) between 2 pm and 8 pm. In the other six months, on-peak hours are Monday through Friday (excluding Thanksgiving, Christmas Day, and New Year's Day) between 5 am and 9 am and 5 pm and 9 pm. See Dukes rebuttal testimony, p. 7, line 26 and Tariff RES-TOU (Sheet 102-1).

[12] Monthly load factor is the ratio of the customer's average demand to its maximum demand during the month. For example, if a customer uses 720 kWh in a month with 30 days (720 hours), the customer's average demand is 1.0 kW. If the customer's peak demand during the month is 3.0 kW, the customer's load factor would be 0.333.

Q. WHAT DID YOUR ANALYSIS SHOW CONCERNING UNSE'S REBUTTAL THREE-PART RESIDENTIAL RATE WITHOUT THE 15% LOAD FACTOR LIMITER?

A. Exhibit SJR-7 shows my analysis of the rebuttal demand rate without a limiter. The rate consists of a customer charge of $15.00 per month, a demand charge of $5.15 per kW (using on-peak demand as described above), and an energy charge of 1.6760¢ per kWh.[13]

UNSE's rebuttal three-part rate is notably worse in reflecting the cost of service than UNSE's rebuttal two-part rate (the "transition" rate). The slope of the trend line is only 0.636 meaning that higher-cost customers would pay much less than the cost to serve them. This is the worst result of any of UNSE's proposed rate designs, and dramatically worse than the transition rate which had a slope of 0.881. Further, the average difference between revenues and costs is 23% compared to 19% under the rebuttal two-part rate. Finally, this rate structure would have significant customer impacts, with more than 10% of customers seeing their annual distribution bills increase by more than 100% while another 10% of customers would see increases of 25% or less. Overall annual increases would range from 9% to 182%.

I would emphasize that these dramatic bill changes do not bring rates closer to tracking the cost of service. Indeed quite the opposite is true -- rates are further removed from cost, and the subsidies to higher-cost customers are greater, under the rebuttal three-part rate than they are under the rebuttal two-part rate. That is, contrary to the claims of several UNSE witnesses, the three-part rate proposed in rebuttal does not collect the cost of service from residential customers in a more equitable manner.

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[13] UNSE Exh. CAJ-R-4, Schedule H-3, p. 4.

Q. DOES USING THE LOAD FACTOR LIMITER IMPROVE THE FAIRNESS OF UNSE'S REBUTTAL THREE-PART RATE?

A. Yes, but the improvement is very slight. Exhibit SJR-8 uses the same rates as I used in Exhibit SJR-7, but the billing units for demand are different because of the limitation that demand will not be higher than that which the customer would have with a 15% load factor. For example, if a customer used 720 kWh during a 30-day month, its average demand during the month would be 1.0 kW, as I discussed above. If the customer's highest demand during the month were 8.0 kW, its load factor would be 12.5%. UNSE's demand limiter would restate the maximum demand to 6.67 kW (1 / 6.67 = 15%) and use that lower amount for billing purposes in that month.

Exhibit SJR-8 shows that using the demand limiter reduces some of the highest bill impacts, but does little to improve the overall fairness of the rate design. Specifically, the highest bill increase has been reduced from 182% without the limiter to 113% with the limiter. That is still more than 10 times the percentage increase of the customer with the lowest bill impact.

Moreover, the limit does little to improve the overall fairness of this rate design. The slope of the trend line improves just slightly, from 0.636 to 0.657, meaning that higher-cost customers would provide revenues substantially less than the cost to serve them. Further, the average difference between a customer's revenues and the cost to serve the customer also improves just slightly, from 23% without the limiter to 21% with the limiter. Both of these results are worse than UNSE's two-part rebuttal rate, with a slope of 0.881 (enhanced recovery of costs from higher-cost customers) and an average cost-revenue differential of 19%.

Q. WHAT DO YOU CONCLUDE?

A. I conclude that the facts do not support the assertions of UNSE rebuttal witnesses that its proposed three-part rate design recovers costs more equitably, promotes fairness, and reduces intra-class subsidization. In fact, precisely the opposite is true. Compared to UNSE's rebuttal two-part rate design, its proposed rebuttal three-part rate design is less equitable, is unfair to lower-cost customers, and increases intra-class subsidization.

Q. IF SO MUCH OF THE COST OF SERVING RESIDENTIAL CUSTOMERS IS RELATED TO DEMAND, DOES IT MAKE SENSE TO YOU THAT A DEMAND-BASED RATE WOULD DO A WORSE JOB OF RECOVERING COSTS THAN A RATE WITHOUT A DEMAND COMPONENT?

A. Yes, it makes sense given the way these rates have been designed. UNSE's COSS allocates demand-related costs among the customer classes based on various measures of demand, nearly all of which are driven primarily by summer demand. Most demand-related costs are based on either the class non-coincident peak (which occurred on July 24 during the test year) or a demand allocator that uses a combination of non-coincident peak, average demand, and the four system coincident peaks during the months of June through September.

There is a relatively small average-demand component (average demand measures year-round energy consumption). On Exhibit SJR-2, line 25, I showed that the average demand component is $6.6 million out of total demand-related costs of $41.3 million (line 5 of Exhibit SJR-2), or about 16% of demand costs. In other words, approximately 84% of demand costs for the residential class are based on summer peak demands.

The logical question, then, is what type of rate design provides a better proxy for summer demands. Is it better to use each customer's monthly demand throughout the year or to

use a customer's energy consumption throughout the year, weighted using inclining block rates?

Q. HAVE YOU PERFORMED ANY ANALYSIS TO TRY TO ANSWER THIS QUESTION?

A. Yes. In order to try to understand this relationship, I prepared a few simple regression analyses. First, on Exhibit SJR-9, I compared each customer's contribution to peak demands to the customer's average monthly billing demand (using the measure of billing demand in UNSE's rebuttal, including the demand limiter). This exhibit contains two graphs. The top graph shows the relationship between summer coincident peak demand and billing demand; the bottom graph shows class non-coincident peak demand and billing demand. These graphs show that there is some relationship between billing demand and summer coincident peak demand, but the R-square of 0.687 indicates that there is considerable variability in the relationship. The bottom graph shows a much weaker relationship between the customer's demand during the single non-coincident peak hour and the customer's annual billing demand. The R-square is 0.551, but simply looking at the data shows that customers with essentially the same contribution to NCP demand have vastly different monthly billing demands.

Exhibit SJR-10 provides similar comparisons, but instead of using monthly billing demand, I used weighted annual energy consumption. Specifically, I weighted energy usage by using the relative prices in the three rate blocks proposed by UNSE in its rebuttal transition rate design. In that rate design, the block 2 rate is 1.31 times the block 1 rate (4.2258¢ compared to 3.2258¢) and the block 3 rates is 1.87 times the block 1 rate (6.0258¢ compared to 3.2258¢). By weighting energy consumption in this manner, I developed an equivalent level of energy consumption that is used for billing purposes. The exhibit shows that for both summer coincident peaks and non-coincident peak, the

weighted energy consumption used in UNSE's rebuttal two-part rate design bears a stronger relationship to peak demand allocators than does the monthly demand used in UNSE's three-part rebuttal demand rate. Specifically, the R-square is higher for each comparison using weighted energy than it is using billing demand (0.747 compared to 0.687 for CP demand and 0.588 compared to 0.551 for NCP demand).

These relationships show why UNSE's two-part rate design does a better job of reflecting the cost of service and reducing intra-class subsidies than does UNSE's three-part (demand) rate design. Just because a rate uses something called "demand" does not mean that it bears a better relationship to the types of demand measures used in allocating costs in a cost-of-service study.

The essential task of rate design is to try to find understandable, and readily measurable, proxies for each component of the cost of service so that bills can be rendered that fairly reflect each customer's contribution to the cost of service. No method will be perfect, but based on the available data UNSE's rate structure using three consumption blocks (with inclining rates in each block) is a reasonable proxy for class non-coincident demand and system coincident demand. My cost analyses and my demand analyses show that UNSE's rate design with three consumption blocks with inclining block rates is superior to its rate designs that use monthly billing demand.

Q. WHAT DO YOU RECOMMEND?

A. I recommend that the Commission reject UNSE's unsupported assertion that its proposed three-part residential demand rates are superior to a rate structure based on a two-part rate with inclining consumption block rates. My analyses of the available data show that precisely the opposite is true. I further recommend, therefore, that the Commission adopt UNSE's so-called rebuttal "transition" rate design for residential customers who do not

elect time-of-use rates. (Of course, the actual rates need to be adjusted based on the final revenue requirement determined by the Commission.) This rate design is structured in the same manner as existing rates which should minimize any issues with customer understanding, ease of administration, or metering technology. The rate design also is superior to UNSE's other proposed rate designs in its ability to fairly collect the cost of service from each customer and minimize the level of intra-class subsidies. Finally, of all of the rate designs put forth by UNSE, this rate design also has the fairest impact on customers, with all customers in the sample having annual bills for distribution service increase by a fairly consistent percentage.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

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Current Position

Public Utility Attorney and Consultant. 1994 to present. I provide legal, consulting, and expert witness services to various organizations interested in the regulation of public utilities.

Previous Positions

Lecturer in Computer Science, Susquehanna University, Selinsgrove, PA. 1993 to 2000.

Senior Assistant Consumer Advocate, Office of Consumer Advocate, Harrisburg, PA. 1990 to 1994. I supervised the administrative and technical staff and shared with one other senior attorney the supervision of a legal staff of 14 attorneys.

Assistant Consumer Advocate, Office of Consumer Advocate, Harrisburg, PA. 1983 to 1990.

Associate, Laws and Staruch, Harrisburg, PA. 1981 to 1983.

Law Clerk, U.S. Environmental Protection Agency, Washington, DC. 1980 to 1981.

Research Assistant, Rockville Consulting Group, Washington, DC. 1979.

Current Professional Activities

Member, American Bar Association, Public Utility Law Section.

Member, American Water Works Association.

Admitted to practice law before the Supreme Court of Pennsylvania, the New York State Court of Appeals, the United States District Court for the Middle District of Pennsylvania, the United States Court of Appeals for the Third Circuit, and the Supreme Court of the United States.

Previous Professional Activities

Member, American Water Works Association, Rates and Charges Subcommittee, 1998-2001.

Member, Federal Advisory Committee on Disinfectants and Disinfection By-Products in Drinking Water, U.S. Environmental Protection Agency, Washington, DC. 1992 to 1994.

Chair, Water Committee, National Association of State Utility Consumer Advocates, Washington, DC. 1990 to 1994; member of committee from 1988 to 1990.

Member, Board of Directors, Pennsylvania Energy Development Authority, Harrisburg, PA. 1990 to 1994.

Member, Small Water Systems Advisory Committee, Pennsylvania Department of Environmental Resources, Harrisburg, PA. 1990 to 1992.

Member, Ad Hoc Committee on Emissions Control and Acid Rain Compliance, National Association of State Utility Consumer Advocates, 1991.

Member, Nitrogen Oxides Subcommittee of the Acid Rain Advisory Committee, U.S. Environmental Protection Agency, Washington DC. 1991.

Education

J.D. with Honors, George Washington University, Washington, DC. 1981.

B.A. with Distinction in Political Science, Pennsylvania State University, University Park, PA. 1978.

Publications and Presentations (* denotes peer-reviewed publications)

1. "Quality of Service Issues," a speech to the Pennsylvania Public Utility Commission Consumer Conference, State College, PA. 1988.

2. K.L. Pape and S.J. Rubin, "Current Developments in Water Utility Law," in *Pennsylvania Public Utility Law* (Pennsylvania Bar Institute). 1990.

3. Presentation on Water Utility Holding Companies to the Annual Meeting of the National Association of State Utility Consumer Advocates, Orlando, FL. 1990.

4. "How the OCA Approaches Quality of Service Issues," a speech to the Pennsylvania Chapter of the National Association of Water Companies. 1991.

5. Presentation on the Safe Drinking Water Act to the Mid-Year Meeting of the National Association of State Utility Consumer Advocates, Seattle, WA. 1991.

6. "A Consumer Advocate's View of Federal Pre-emption in Electric Utility Cases," a speech to the Pennsylvania Public Utility Commission Electricity Conference. 1991.

7. Workshop on Safe Drinking Water Act Compliance Issues at the Mid-Year Meeting of the National Association of State Utility Consumer Advocates, Washington, DC. 1992.

8. Formal Discussant, Regional Acid Rain Workshop, U.S. Environmental Protection Agency and National Regulatory Research Institute, Charlotte, NC. 1992.

9. S.J. Rubin and S.P. O'Neal, "A Quantitative Assessment of the Viability of Small Water Systems in Pennsylvania," *Proceedings of the Eighth NARUC Biennial Regulatory Information Conference*, National Regulatory Research Institute (Columbus, OH 1992), IV:79-97.

10. "The OCA's Concerns About Drinking Water," a speech to the Pennsylvania Public Utility Commission Water Conference. 1992.

11. Member, Technical Horizons Panel, Annual Meeting of the National Association of Water Companies, Hilton Head, SC. 1992.

12. M.D. Klein and S.J. Rubin, "Water and Sewer -- Update on Clean Streams, Safe Drinking Water, Waste Disposal and Pennvest," *Pennsylvania Public Utility Law Conference* (Pennsylvania Bar Institute). 1992.

13. Presentation on Small Water System Viability to the Technical Assistance Center for Small Water Companies, Pa. Department of Environmental Resources, Harrisburg, PA. 1993

14. "The Results Through a Public Service Commission Lens," speaker and participant in panel discussion at Symposium: "Impact of EPA's Allowance Auction," Washington, DC, sponsored by AER*X. 1993.

15. "The Hottest Legislative Issue of Today -- Reauthorization of the Safe Drinking Water Act," speaker and participant in panel discussion at the Annual Conference of the American Water Works Association, San Antonio, TX. 1993.

16. "Water Service in the Year 2000," a speech to the Conference: "Utilities and Public Policy III: The Challenges of Change," sponsored by the Pennsylvania Public Utility Commission and the Pennsylvania State University, University Park, PA. 1993.

17. "Government Regulation of the Drinking Water Supply: Is it Properly Focused?," speaker and participant in panel discussion at the National Consumers League's Forum on Drinking Water Safety and Quality, Washington, DC. 1993. Reprinted in *Rural Water*, Vol. 15 No. 1 (Spring 1994), pages 13-16.

18. "Telephone Penetration Rates for Renters in Pennsylvania," a study prepared for the Pennsylvania Office of Consumer Advocate. 1993.

19. "Zealous Advocacy, Ethical Limitations and Considerations," participant in panel discussion at "Continuing Legal Education in Ethics for Pennsylvania Lawyers," sponsored by the Office of General Counsel, Commonwealth of Pennsylvania, State College, PA. 1993.

20. "Serving the Customer," participant in panel discussion at the Annual Conference of the National Association of Water Companies, Williamsburg, VA. 1993.

21. "A Simple, Inexpensive, Quantitative Method to Assess the Viability of Small Water Systems," a speech to the Water Supply Symposium, New York Section of the American Water Works Association, Syracuse, NY. 1993.

22. * S.J. Rubin, "Are Water Rates Becoming Unaffordable?," *Journal American Water Works Association*, Vol. 86, No. 2 (February 1994), pages 79-86.

23. "Why Water Rates Will Double (If We're Lucky): Federal Drinking Water Policy and Its Effect on New England," a briefing for the New England Conference of Public Utilities Commissioners, Andover, MA. 1994.

24. "Are Water Rates Becoming Unaffordable?," a speech to the Legislative and Regulatory Conference, Association of Metropolitan Water Agencies, Washington, DC. 1994.

25. "Relationships: Drinking Water, Health, Risk and Affordability," speaker and participant in panel discussion at the Annual Meeting of the Southeastern Association of Regulatory Commissioners, Charleston, SC. 1994.

26. "Small System Viability: Assessment Methods and Implementation Issues," speaker and participant in panel discussion at the Annual Conference of the American Water Works Association, New York, NY. 1994.

27. S.J. Rubin, "How much should we spend to save a life?," *Seattle Journal of Commerce*, August 18, 1994 (Protecting the Environment Supplement), pages B-4 to B-5.

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30. "Surviving the Safe Drinking Water Act," speaker at the Annual Meeting of the National Association of State Utility Consumer Advocates, Reno, NV. 1994.

31. "Safe Drinking Water Act Compliance -- Ratemaking Implications," speaker at the National Conference of Regulatory Attorneys, Scottsdale, AZ. 1995. Reprinted in *Water*, Vol. 36, No. 2 (Summer 1995), pages 28-29.

32. S.J. Rubin, "Water: Why Isn't it Free? The Case of Small Utilities in Pennsylvania," *Utilities, Consumers & Public Policy: Issues of Quality, Affordability, and Competition, Proceedings of the Fourth Utilities, Consumers and Public Policy Conference* (Pennsylvania State University 1995), pages 177-183.

33. S.J. Rubin, "Water Rates: An Affordable Housing Issue?," *Home Energy*, Vol. 12 No. 4 (July/August 1995), page 37.

34. Speaker and participant in the Water Policy Forum, sponsored by the National Association of Water Companies, Naples, FL. 1995.

35. Participant in panel discussion on "The Efficient and Effective Maintenance and Delivery of Potable Water at Affordable Rates to the People of New Jersey," at The New Advocacy: Protecting Consumers in the Emerging Era of Utility Competition, a conference sponsored by the New Jersey Division of the Ratepayer Advocate, Newark, NJ. 1995.

36. J.E. Cromwell III, and S.J. Rubin, *Development of Benchmark Measures for Viability Assessment* (Pa. Department of Environmental Protection 1995).

37. S. Rubin, "A Nationwide Practice from a Small Town in Pa.," *Lawyers & the Internet – a Supplement to the Legal Intelligencer and Pa. Law Weekly* (February 12, 1996), page S6.

38. "Changing Customers' Expectations in the Water Industry," speaker at the Mid-America Regulatory Commissioners Conference, Chicago, IL. 1996, reprinted in *Water* Vol. 37 No. 3 (Winter 1997), pages 12-14.

39. "Recent Federal Legislation Affecting Drinking Water Utilities," speaker at Pennsylvania Public Utility Law Conference, Pennsylvania Bar Institute, Hershey, PA. 1996.

40. "Clean Water at Affordable Rates: A Ratepayers Conference," moderator at symposium sponsored by the New Jersey Division of Ratepayer Advocate, Trenton, NJ. 1996.

41. "Water Workshop: How New Laws Will Affect the Economic Regulation of the Water Industry," speaker at the Annual Meeting of the National Association of State Utility Consumer Advocates, San Francisco, CA. 1996.

42. * E.T. Castillo, S.J. Rubin, S.K. Keefe, and R.S. Raucher, "Restructuring Small Systems," *Journal American Water Works Association*, Vol. 89, No. 1 (January 1997), pages 65-74.

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44. "Capacity Development – More than Viability Under a New Name," speaker at National Association of Regulatory Utility Commissioners Winter Meetings, Washington, DC. 1997.

45. * E. Castillo, S.K. Keefe, R.S. Raucher, and S.J. Rubin, *Small System Restructuring to Facilitate SDWA Compliance: An Analysis of Potential Feasibility* (AWWA Research Foundation, 1997).

46. H. Himmelberger, *et al.*, *Capacity Development Strategy Report for the Texas Natural Resource Conservation Commission* (Aug. 1997).

47. Briefing on Issues Affecting the Water Utility Industry, Annual Meeting of the National Association of State Utility Consumer Advocates, Boston, MA. 1997.

48. "Capacity Development in the Water Industry," speaker at the Annual Meeting of the National Association of Regulatory Utility Commissioners, Boston, MA. 1997.

49. "The Ticking Bomb: Competitive Electric Metering, Billing, and Collection," speaker at the Annual Meeting of the National Association of State Utility Consumer Advocates, Boston, MA. 1997.

50. Scott J. Rubin, "A Nationwide Look at the Affordability of Water Service," *Proceedings of the 1998 Annual Conference of the American Water Works Association*, Water Research, Vol. C, No. 3, pages 113-129 (American Water Works Association, 1998).

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52. Scott J. Rubin, "Effects of Electric and Gas Deregulation on the Water Industry," *Pennsylvania Public Utility Law Conference*, Vol. I, pages 139-146 (Pa. Bar Institute, 1998).

53. Scott J. Rubin, *The Challenges and Changing Mission of Utility Consumer Advocates* (American Association of Retired Persons, 1999).

54. "Consumer Advocacy for the Future," speaker at the Age of Awareness Conference, Changes and Choices: Utilities in the New Millennium, Carlisle, PA. 1999.

55. Keynote Address, $1 Energy Fund, Inc., Annual Membership Meeting, Monroeville, PA. 1999.

56. Scott J. Rubin, "Assessing the Effect of the Proposed Radon Rule on the Affordability of Water Service," prepared for the American Water Works Association. 1999.

57. Scott J. Rubin and Janice A. Beecher, The Impacts of Electric Restructuring on the Water and Wastewater Industry, *Proceedings of the Small Drinking Water and Wastewater Systems International Symposium and Technology Expo* (Phoenix, AZ 2000), pp. 66-75.

58. American Water Works Association, *Principles of Water Rates, Fees, and Charges, Manual M1 – Fifth Edition* (AWWA 2000), Member, Editorial Committee.

59. Janice A. Beecher and Scott J. Rubin, presentation on "Special Topics in Rate Design: Affordability" at the Annual Conference and Exhibition of the American Water Works Association, Denver, CO. 2000.

60. Scott J. Rubin, "The Future of Drinking Water Regulation," a speech at the Annual Conference and Exhibition of the American Water Works Association, Denver, CO. 2000.

61. Janice A. Beecher and Scott J. Rubin, "Deregulation Impacts and Opportunities," a presentation at the Annual Conference and Exhibition of the American Water Works Association, Denver, CO. 2000.

62. Scott J. Rubin, "Estimating the Effect of Different Arsenic Maximum Contaminant Levels on the Affordability of Water Service," prepared for the American Water Works Association. 2000.

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79. Scott J. Rubin, Issues Relating to the Affordability and Sustainability of Rates for Water Service, presentation to the Water Utility Council of the American Water Works Association, New Orleans, LA. 2002.

80. Scott J. Rubin, The Utility Industries Compared – Water, NARUC Annual Regulatory Studies Program, East Lansing, MI. 2002.

81. Scott J. Rubin, Legal Perspective on Water Regulation, NARUC Annual Regulatory Studies Program, East Lansing, MI. 2002.

82. Scott J. Rubin, Regulatory Options for Water Utilities, NARUC Annual Regulatory Studies Program, East Lansing, MI. 2002.

83. Scott J. Rubin, Overview of Small Water System Consolidation, presentation to National Drinking Water Advisory Council Small Systems Affordability Working Group, Washington, DC. 2002.

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85. Scott J. Rubin, "Thinking Outside the Hearing Room," *Pennsylvania Public Utility Law Conference*, Pennsylvania Bar Institute, Harrisburg, PA. 2002.

86. Scott J. Rubin, "Update of Affordability Database," White Paper, National Rural Water Association. 2003.

87. Scott J. Rubin, *Understanding Telephone Penetration in Pennsylvania*, Council on Utility Choice, Harrisburg, PA. 2003.

88. Scott J. Rubin, *The Cost of Water and Wastewater Service in the United States*, National Rural Water Association, 2003.

89. Scott J. Rubin, What Price Safer Water? Presentation at Annual Conference of National Association of Regulatory Utility Commissioners, Atlanta, GA. 2003.

90. George M. Aman, III, Jeffrey P. Garton, Eric Petersen, and Scott J. Rubin, Challenges and Opportunities for Improving Water Supply Institutional Arrangements, *Water Law Conference*, Pennsylvania Bar Institute, Mechanicsburg, PA. 2004.

91. Scott J. Rubin, Serving Low-Income Water Customers. Presentation at American Water Works Association Annual Conference, Orlando, FL. 2004.

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93. Scott J. Rubin, Buying and Selling a Water System – Ratemaking Implications, *Pennsylvania Public Utility Law Conference*, Pennsylvania Bar Institute, Harrisburg, PA. 2005.

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98. Scott J. Rubin, Robert Raucher, and Megan Harrod, The Relationship Between Household Financial Distress and Health: Implications for Drinking Water Regulation, National Rural Water Association. 2007.

99. * John Cromwell and Scott Rubin, *Estimating Benefits of Regional Solutions for Water and Wastewater Service*, American Water Works Association Research Foundation, Denver, CO. 2008.

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111. Scott J. Rubin, Water Reliability and Resilience Standards, *Pennsylvania Public Utility Law Conference* (Pennsylvania Bar Institute). 2011.

112. Member of Expert Panel, Leadership Forum: Business Management for the Future, Annual Conference and Exposition of the American Water Works Association, Washington, DC. 2011.

113. Scott J. Rubin, Evaluating Community Affordability in Storm Water Control Plans, *Flowing into the Future: Evolving Water Issues* (Pennsylvania Bar Institute). 2011.

114. Invited Participant, Summit on Declining Water Demand and Revenues, sponsored by The Alliance for Water Efficiency, Racine, WI. 2012.

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Testimony as an Expert Witness

1. *Pa. Public Utility Commission v. Pennsylvania Gas and Water Co. - Water Division*, Pa. Public Utility Commission, Docket R-00922404. 1992. Concerning rate design, on behalf of the Pa. Office of Consumer Advocate.

2. *Pa. Public Utility Commission v. Shenango Valley Water Co.*, Pa. Public Utility Commission, Docket R-00922420. 1992. Concerning cost allocation, on behalf of the Pa. Office of Consumer Advocate

3. *Pa. Public Utility Commission v. Pennsylvania Gas and Water Co. - Water Division*, Pa. Public Utility Commission, Docket R-00922482. 1993. Concerning rate design, on behalf of the Pa. Office of Consumer Advocate

4. *Pa. Public Utility Commission v. Colony Water Co.*, Pa. Public Utility Commission, Docket R-00922375. 1993. Concerning rate design, on behalf of the Pa. Office of Consumer Advocate

5. *Pa. Public Utility Commission v. Dauphin Consolidated Water Supply Co. and General Waterworks of Pennsylvania, Inc.*, Pa. Public Utility Commission, Docket R-00932604. 1993. Concerning rate design and cost of service, on behalf of the Pa. Office of Consumer Advocate

6. *West Penn Power Co. v. State Tax Department of West Virginia*, Circuit Court of Kanawha County, West Virginia, Civil Action No. 89-C-3056. 1993. Concerning regulatory policy and the effects of a taxation statute on out-of-state utility ratepayers, on behalf of the Pa. Office of Consumer Advocate

7. *Pa. Public Utility Commission v. Pennsylvania Gas and Water Co. - Water Division*, Pa. Public Utility Commission, Docket R-00932667. 1993. Concerning rate design and affordability of service, on behalf of the Pa. Office of Consumer Advocate

8. *Pa. Public Utility Commission v. National Utilities, Inc.*, Pa. Public Utility Commission, Docket R-00932828. 1994. Concerning rate design, on behalf of the Pa. Office of Consumer Advocate

9. *An Investigation of the Sources of Supply and Future Demand of Kentucky-American Water Company*, Ky. Public Service Commission, Case No. 93-434. 1994. Concerning supply and demand planning, on behalf of the Kentucky Office of Attorney General, Utility and Rate Intervention Division.

10. *The Petition on Behalf of Gordon's Corner Water Company for an Increase in Rates*, New Jersey Board of Public Utilities, Docket No. WR94020037. 1994. Concerning revenue requirements and rate design, on behalf of the New Jersey Division of Ratepayer Advocate.

11. *Re Consumers Maine Water Company Request for Approval of Contracts with Consumers Water Company and with Ohio Water Service Company*, Me. Public Utilities Commission, Docket No. 94-352. 1994. Concerning affiliated interest agreements, on behalf of the Maine Public Advocate.

12. *In the Matter of the Application of Potomac Electric Power Company for Approval of its Third Least-Cost Plan*, D.C. Public Service Commission, Formal Case No. 917, Phase II. 1995. Concerning Clean Air Act implementation and environmental externalities, on behalf of the District of Columbia Office of the People's Counsel.

13. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of the Dayton Power and Light Company and Related Matters*, Ohio Public Utilities Commission, Case No. 94-

105-EL-EFC. 1995. Concerning Clean Air Act implementation (case settled before testimony was filed), on behalf of the Office of the Ohio Consumers' Counsel.

14. *Kennebec Water District Proposed Increase in Rates*, Maine Public Utilities Commission, Docket No. 95-091. 1995. Concerning the reasonableness of planning decisions and the relationship between a publicly owned water district and a very large industrial customer, on behalf of the Maine Public Advocate.

15. *Winter Harbor Water Company, Proposed Schedule Revisions to Introduce a Readiness-to-Serve Charge*, Maine Public Utilities Commission, Docket No. 95-271. 1995 and 1996. Concerning standards for, and the reasonableness of, imposing a readiness to serve charge and/or exit fee on the customers of a small investor-owned water utility, on behalf of the Maine Public Advocate.

16. *In the Matter of the 1995 Long-Term Electric Forecast Report of the Cincinnati Gas & Electric Company*, Public Utilities Commission of Ohio, Case No. 95-203-EL-FOR, and *In the Matter of the Two-Year Review of the Cincinnati Gas & Electric Company's Environmental Compliance Plan Pursuant to Section 4913.05, Revised Cost*, Case No. 95-747-EL-ECP. 1996. Concerning the reasonableness of the utility's long-range supply and demand-management plans, the reasonableness of its plan for complying with the Clean Air Act Amendments of 1990, and discussing methods to ensure the provision of utility service to low-income customers, on behalf of the Office of the Ohio Consumers' Counsel..

17. *In the Matter of Notice of the Adjustment of the Rates of Kentucky-American Water Company*, Kentucky Public Service Commission, Case No. 95-554. 1996. Concerning rate design, cost of service, and sales forecast issues, on behalf of the Kentucky Office of Attorney General.

18. *In the Matter of the Application of Citizens Utilities Company for a Hearing to Determine the Fair Value of its Properties for Ratemaking Purposes, to Fix a Just and Reasonable Rate of Return Thereon, and to Approve Rate Schedules Designed to Provide such Rate of Return*, Arizona Corporation Commission, Docket Nos. E-1032-95-417, *et al.* 1996. Concerning rate design, cost of service, and the price elasticity of water demand, on behalf of the Arizona Residential Utility Consumer Office.

19. *Cochrane v. Bangor Hydro-Electric Company*, Maine Public Utilities Commission, Docket No. 96-053. 1996. Concerning regulatory requirements for an electric utility to engage in unregulated business enterprises, on behalf of the Maine Public Advocate.

20. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Monongahela Power Company and Related Matters*, Public Utilities Commission of Ohio, Case No. 96-106-EL-EFC. 1996. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

21. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Cleveland Electric Illuminating Company and Toledo Edison Company and Related Matters*, Public Utilities Commission of Ohio, Case Nos. 96-107-EL-EFC and 96-108-EL-EFC. 1996. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

22. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Ohio Power Company and Columbus Southern Power Company and Related Matters*, Public Utilities Commission of Ohio, Case Nos. 96-101-EL-EFC and 96-102-EL-EFC. 1997. Concerning the costs and

procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

23. *An Investigation of the Sources of Supply and Future Demand of Kentucky-American Water Company (Phase II)*, Kentucky Public Service Commission, Docket No. 93-434. 1997. Concerning supply and demand planning, on behalf of the Kentucky Office of Attorney General, Public Service Litigation Branch.

24. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Cincinnati Gas and Electric Co. and Related Matters*, Public Utilities Commission of Ohio, Case No. 96-103-EL-EFC. 1997. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

25. *Bangor Hydro-Electric Company Petition for Temporary Rate Increase*, Maine Public Utilities Commission, Docket No. 97-201. 1997. Concerning the reasonableness of granting an electric utility's request for emergency rate relief, and related issues, on behalf of the Maine Public Advocate.

26. *Testimony concerning H.B. 1068 Relating to Restructuring of the Natural Gas Utility Industry*, Consumer Affairs Committee, Pennsylvania House of Representatives. 1997. Concerning the provisions of proposed legislation to restructure the natural gas utility industry in Pennsylvania, on behalf of the Pennsylvania AFL-CIO Gas Utility Caucus.

27. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Cleveland Electric Illuminating Company and Toledo Edison Company and Related Matters*, Public Utilities Commission of Ohio, Case Nos. 97-107-EL-EFC and 97-108-EL-EFC. 1997. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

28. *In the Matter of the Petition of Valley Road Sewerage Company for a Revision in Rates and Charges for Water Service*, New Jersey Board of Public Utilities, Docket No. WR92080846J. 1997. Concerning the revenue requirements and rate design for a wastewater treatment utility, on behalf of the New Jersey Division of Ratepayer Advocate.

29. *Bangor Gas Company, L.L.C., Petition for Approval to Furnish Gas Service in the State of Maine*, Maine Public Utilities Commission, Docket No. 97-795. 1998. Concerning the standards and public policy concerns involved in issuing a certificate of public convenience and necessity for a new natural gas utility, and related ratemaking issues, on behalf of the Maine Public Advocate.

30. *In the Matter of the Investigation on Motion of the Commission into the Adequacy of the Public Utility Water Service Provided by Tidewater Utilities, Inc., in Areas in Southern New Castle County, Delaware*, Delaware Public Service Commission, Docket No. 309-97. 1998. Concerning the standards for the provision of efficient, sufficient, and adequate water service, and the application of those standards to a water utility, on behalf of the Delaware Division of the Public Advocate.

31. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Cincinnati Gas and Electric Co. and Related Matters*, Public Utilities Commission of Ohio, Case No. 97-103-EL-EFC. 1998. Concerning fuel-related transactions with affiliated companies and the appropriate ratemaking treatment and regulatory safeguards involving such transactions, on behalf of the Ohio Consumers' Counsel.

32. *Olde Port Mariner Fleet, Inc. Complaint Regarding Casco Bay Island Transit District's Tour and Charter Service*, Maine Public Utilities Commission, Docket No. 98-161. 1998. Concerning the standards and requirements for allocating costs and separating operations between regulated and unregulated operations of a transportation utility, on behalf of the Maine Public Advocate and Olde Port Mariner Fleet, Inc.

33. *Central Maine Power Company Investigation of Stranded Costs, Transmission and Distribution Utility Revenue Requirements, and Rate Design*, Maine Public Utilities Commission, Docket No. 97-580. 1998. Concerning the treatment of existing rate discounts when designing rates for a transmission and distribution electric utility, on behalf of the Maine Public Advocate.

34. *Pa. Public Utility Commission v. Manufacturers Water Company*, Pennsylvania Public Utility Commission, Docket No. R-00984275. 1998. Concerning rate design on behalf of the Manufacturers Water Industrial Users.

35. *In the Matter of Petition of Pennsgrove Water Supply Company for an Increase in Rates for Water Service*, New Jersey Board of Public Utilities, Docket No. WR98030147. 1998. Concerning the revenue requirements, level of affiliated charges, and rate design for a water utility, on behalf of the New Jersey Division of Ratepayer Advocate.

36. *In the Matter of Petition of Seaview Water Company for an Increase in Rates for Water Service*, New Jersey Board of Public Utilities, Docket No. WR98040193. 1999. Concerning the revenue requirements and rate design for a water utility, on behalf of the New Jersey Division of Ratepayer Advocate.

37. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Ohio Power Company and Columbus Southern Power Company and Related Matters*, Public Utilities Commission of Ohio, Case Nos. 98-101-EL-EFC and 98-102-EL-EFC. 1999. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

38. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Dayton Power and Light Company and Related Matters*, Public Utilities Commission of Ohio, Case No. 98-105-EL-EFC. 1999. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

39. *In the Matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of Monongahela Power Company and Related Matters*, Public Utilities Commission of Ohio, Case No. 99-106-EL-EFC. 1999. Concerning the costs and procedures associated with the implementation of the Clean Air Act Amendments of 1990, on behalf of the Ohio Consumers' Counsel.

40. *County of Suffolk, et al. v. Long Island Lighting Company, et al.*, U.S. District Court for the Eastern District of New York, Case No. 87-CV-0646. 2000. Submitted two affidavits concerning the calculation and collection of court-ordered refunds to utility customers, on behalf of counsel for the plaintiffs.

41. *Northern Utilities, Inc., Petition for Waivers from Chapter 820*, Maine Public Utilities Commission, Docket No. 99-254. 2000. Concerning the standards and requirements for defining and separating a natural gas utility's core and non-core business functions, on behalf of the Maine Public Advocate.

42. *Notice of Adjustment of the Rates of Kentucky-American Water Company*, Kentucky Public Service Commission, Case No. 2000-120. 2000. Concerning the appropriate methods for allocating costs and designing rates, on behalf of the Kentucky Office of Attorney General.

43. *In the Matter of the Petition of Gordon's Corner Water Company for an Increase in Rates and Charges for Water Service*, New Jersey Board of Public Utilities, Docket No. WR00050304. 2000. Concerning the revenue requirements and rate design for a water utility, on behalf of the New Jersey Division of Ratepayer Advocate.

44. *Testimony concerning Arsenic in Drinking Water: An Update on the Science, Benefits, and Costs*, Committee on Science, United States House of Representatives. 2001. Concerning the effects on low-income households and small communities from a more stringent regulation of arsenic in drinking water.

45. *In the Matter of the Application of The Cincinnati Gas & Electric Company for an Increase in Gas Rates in its Service Territory*, Public Utilities Commission of Ohio, Case No. 01-1228-GA-AIR, *et al.* 2002. Concerning the need for and structure of a special rider and alternative form of regulation for an accelerated main replacement program, on behalf of the Ohio Consumers' Counsel.

46. *Pennsylvania State Treasurer's Hearing on Enron and Corporate Governance Issues*. 2002. Concerning Enron's role in Pennsylvania's electricity market and related issues, on behalf of the Pennsylvania AFL-CIO.

47. *An Investigation into the Feasibility and Advisability of Kentucky-American Water Company's Proposed Solution to its Water Supply Deficit*, Kentucky Public Service Commission, Case No. 2001-00117. 2002. Concerning water supply planning, regulatory oversight, and related issue, on behalf of the Kentucky Office of Attorney General.

48. *Joint Application of Pennsylvania-American Water Company and Thames Water Aqua Holdings GmbH*, Pennsylvania Public Utility Commission, Docket Nos. A-212285F0096 and A-230073F0004. 2002. Concerning the risks and benefits associated with the proposed acquisition of a water utility, on behalf of the Pennsylvania Office of Consumer Advocate.

49. *Application for Approval of the Transfer of Control of Kentucky-American Water Company to RWE AG and Thames Water Aqua Holdings GmbH*, Kentucky Public Service Commission, Case No. 2002-00018. 2002. Concerning the risks and benefits associated with the proposed acquisition of a water utility, on behalf of the Kentucky Office of Attorney General.

50. *Joint Petition for the Consent and Approval of the Acquisition of the Outstanding Common Stock of American Water Works Company, Inc., the Parent Company and Controlling Shareholder of West Virginia-American Water Company*, West Virginia Public Service Commission, Case No. 01-1691-W-PC. 2002. Concerning the risks and benefits associated with the proposed acquisition of a water utility, on behalf of the Consumer Advocate Division of the West Virginia Public Service Commission.

51. *Joint Petition of New Jersey-American Water Company, Inc. and Thames Water Aqua Holdings GmbH for Approval of Change in Control of New Jersey-American Water Company, Inc.*, New Jersey Board of Public Utilities, Docket No. WM01120833. 2002. Concerning the risks and benefits associated with the proposed acquisition of a water utility, on behalf of the New Jersey Division of Ratepayer Advocate.

52. *Illinois-American Water Company, Proposed General Increase in Water Rates*, Illinois Commerce Commission, Docket No. 02-0690. 2003. Concerning rate design and cost of service issues, on behalf of the Illinois Office of the Attorney General.

53. *Pennsylvania Public Utility Commission v. Pennsylvania-American Water Company,* Pennsylvania Public Utility Commission, Docket No. R-00038304. 2003. Concerning rate design and cost of service issues, on behalf of the Pennsylvania Office of Consumer Advocate.

54. *West Virginia-American Water Company,* West Virginia Public Service Commission, Case No. 03-0353-W-42T. 2003. Concerning affordability, rate design, and cost of service issues, on behalf of the West Virginia Consumer Advocate Division.

55. *Petition of Seabrook Water Corp. for an Increase in Rates and Charges for Water Service*, New Jersey Board of Public Utilities, Docket No. WR3010054. 2003. Concerning revenue requirements, rate design, prudence, and regulatory policy, on behalf of the New Jersey Division of Ratepayer Advocate.

56. *Chesapeake Ranch Water Co. v. Board of Commissioners of Calvert County*, U.S. District Court for Southern District of Maryland, Civil Action No. 8:03-cv-02527-AW. 2004. Submitted expert report concerning the expected level of rates under various options for serving new commercial development, on behalf of the plaintiff.

57. *Testimony concerning Lead in Drinking Water*, Committee on Government Reform, United States House of Representatives. 2004. Concerning the trade-offs faced by low-income households when drinking water costs increase, including an analysis of H.R. 4268.

58. *West Virginia-American Water Company,* West Virginia Public Service Commission, Case No. 04-0373-W-42T. 2004. Concerning affordability and rate comparisons, on behalf of the West Virginia Consumer Advocate Division.

59. *West Virginia-American Water Company,* West Virginia Public Service Commission, Case No. 04-0358-W-PC. 2004. Concerning costs, benefits, and risks associated with a wholesale water sales contract, on behalf of the West Virginia Consumer Advocate Division.

60. *Kentucky-American Water Company,* Kentucky Public Service Commission, Case No. 2004-00103. 2004. Concerning rate design and tariff issues, on behalf of the Kentucky Office of Attorney General.

61. *New Landing Utility, Inc.,* Illinois Commerce Commission, Docket No. 04-0610. 2005. Concerning the adequacy of service provided by, and standards of performance for, a water and wastewater utility, on behalf of the Illinois Office of Attorney General.

62. *People of the State of Illinois v. New Landing Utility, Inc.,* Circuit Court of the 15th Judicial District, Ogle County, Illinois, No. 00-CH-97. 2005. Concerning the standards of performance for a water and wastewater utility, including whether a receiver should be appointed to manage the utility's operations, on behalf of the Illinois Office of Attorney General.

63. *Hope Gas, Inc. d/b/a Dominion Hope*, West Virginia Public Service Commission, Case No. 05-0304-G-42T. 2005. Concerning the utility's relationships with affiliated companies, including an appropriate level of revenues and expenses associated with services provided to and received from affiliates, on behalf of the West Virginia Consumer Advocate Division.

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105. *Commonwealth Edison Company Petition for General Increase in Delivery Service Rates*, Illinois Commerce Commission Docket No. 10-0467. 2010. Concerning rate design and cost of service study, on behalf of the Illinois Office of Attorney General.

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117. *City of Nashua Acquisition of Pennichuck Corporation*, New Hampshire Public Utilities Commission, Docket No. DW 11-026. 2011. Concerning the proposed acquisition of an investor-owned utility holding company by a municipality, including appropriate ratemaking methodologies, on behalf of the New Hampshire Office of Consumer Advocate.

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cost of service, on behalf of the Nova Scotia Consumer Advocate.

119. *An Application of Halifax Regional Water Commission for Approval of a Cost of Service and Rate Design Methodology,* Nova Scotia Utility and Review Board , Case NSUARB-W-HRWC-R-11. 2011. Concerning rate design and cost of service, on behalf of the Nova Scotia Consumer Advocate.

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130. *Pa. Public Utility Commission v. City of Lancaster Sewer Fund*, Pennsylvania Public Utility Commission, Docket No. R-2012-2310366. 2012. Concerning rate design, cost of service, and cost

allocation, on behalf of the Pennsylvania Office of Consumer Advocate.

131. *Aquarion Water Company of New Hampshire*, New Hampshire Public Utilities Commission, Docket No. DW 12-085. 2013. Concerning tariff issues, including an automatic adjustment clause for infrastructure improvement, on behalf of the New Hampshire Office of Consumer Advocate.

132. *In the Matter of the Application of Duke Energy Ohio, Inc., for an Increase in Electric Distribution Rates*, Public Utilities Commission of Ohio, Case No. 12-1682-EL-AIR, et al. 2013. Concerning rate design and tariff issues, on behalf of the Office of the Ohio Consumers' Counsel.

133. *In the Matter of the Application of Duke Energy Ohio, Inc., for an Increase in Natural Gas Distribution Rates*, Public Utilities Commission of Ohio, Case No. 12-1685-GA-AIR, et al. 2013. Concerning cost-of-service study, rate design, and tariff issues, on behalf of the Office of the Ohio Consumers' Counsel.

134. *In the Matter of the Application of The Dayton Power and Light Company to Establish a Standard Service Offer in the Form of an Electric Security Plan*, Public Utilities Commission of Ohio, Case No. 12-426-EL-SSO, et al. 2013. Concerning rate design, on behalf of the Office of the Ohio Consumers' Counsel.

135. *Application of the Halifax Regional Water Commission, for Approval of Amendments to its Schedule of Rates and Charges and Schedule of Rules and Regulations for the delivery of water, public and private fire protection, wastewater and stormwater services*, Nova Scotia Utility and Review Board, Matter No. M05463, 2013. Concerning rate design, cost-of-service study, and miscellaneous tariff provisions, on behalf of the Consumer Advocate of Nova Scotia.

136. *California Water Service Co. General Rate Case Application* , California Public Utilities Commission, Docket No. A.12-07-007. 2013. Concerning rate design, phase-in plans, low-income programs, and other tariff issues, on behalf of The Utility Reform Network.

137. *Application of The United Illuminating Company to Amend its Rate Schedules*, Connecticut Public Utility Regulatory Authority, Docket No. 13-01-19. 2013. Concerning sales forecast, rate design, and other tariff issues, on behalf of the Connecticut Office of Consumer Counsel.

138. *Application of Aquarion Water Company of Connecticut to Amend its Rate Schedules*, Connecticut Public Utility Regulatory Authority, Docket No. 13-02-20. 2013. Concerning sales forecast and rate design on behalf of the Connecticut Office of Consumer Counsel.

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140. *Commonwealth Edison Company, Tariff filing to present the Illinois Commerce Commission with an opportunity to consider revenue neutral tariff changes related to rate design*, Docket No. 13-0387. 2013. Concerning rate design and cost of service study issues, on behalf of the Illinois Office of Attorney General.

141. *In the Matter of the Potomac Electric Power Company for Authority to Increase Existing Retail Rates and Charges for Electric Distribution Service*, District of Columbia Public Service Commission, Formal Case No. 1103. 2013. Concerning rate design, revenue allocation, and cost-of-service study issues, on

behalf of the District of Columbia Office of Peoples' Counsel.

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145. *Pa. Public Utility Commission v. City of Bethlehem Bureau of Water*, Pennsylvania Public Utility Commission, Docket No. R-2013-2390244. 2014. Concerning rate design, cost of service study, and revenue allocation on behalf of the Pennsylvania Office of Consumer Advocate.

146. *In the Matter of the Tariff Revision Designated as TA332-121 filed by the Municipality of Anchorage d/b/a Municipal Light and Power Department*, Regulatory Commission of Alaska, U-13-184. 2014. Concerning rate design and cost-of-service study issues, on behalf of the Alaska Office of the Attorney General.

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150. *Apple Valley Ranchos Water Company*, California Public Utilities Commission, Docket No. A.14-01-002. 2014. Concerning rate design and automatic rate adjustment mechanisms on behalf of the Town of Apple Valley.

151. *Application by Heritage Gas Limited for Approval to Amend its Franchise Area*, Nova Scotia Utility and Review Board, Matter No. M06271. 2014. Concerning criteria, terms, and conditions for expanding a utility's service area and using transported compressed natural gas to serve small retail customers, on behalf of the Nova Scotia Consumer Advocate.

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Utilities Staff.

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155. *Investigation of Commonwealth Edison Company's Cost of Service for Low-Use Customers In Each Residential Class*, Illinois Commerce Commission, Docket No. 14-0384. 2014. Concerning rate design on behalf of the Illinois Office of Attorney General.

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157. *Testimony concerning organization and regulation of Philadelphia Gas Works*, Philadelphia City Council's Special Committee on Energy Opportunities. 2015.

158. *Testimony concerning proposed telecommunications legislation*, Maine Joint Standing Committee on Energy, Utilities, and Technology. 2015.

159. *Pa. Public Utility Commission v. United Water Pennsylvania, Inc.*, Pennsylvania Public Utility Commission, Docket No. R-2015-2462723. 2015. Concerning rate design, cost of service study, and revenue allocation on behalf of the Pennsylvania Office of Consumer Advocate.

160. *Ameren Illinois Company Proposed General Increase in Gas Delivery Service Rates*, Illinois Commerce Commission, Docket No. 15-0142. 2015. Concerning rate design on behalf of the Illinois Office of Attorney General.

161. *Maine Natural Gas Company Request for Multi-Year Rate Plan*, Maine Public Utilities Commission, Docket No. 2015-00005. 2015. Concerning rate design and automatic rate adjustment tariffs on behalf of the Maine Office of the Public Advocate.

162. *Application of Ohio Edison Company, The Cleveland Electric Illuminating Company and The Toledo Edison Company for Authority to Provide for a Standard Service Offer*, Public Utilities Commission of Ohio, Case No. 14-1297-EL-SSO. 2015. Concerning rate design and proposed rate discounts on behalf of the Office of the Ohio Consumers' Counsel.

163. *An Application of the Halifax Regional Water Commission, for approval of revisions to its Cost of Service Manual and Rate Design for Stormwater Service*, Nova Scotia Utility and Review Board, Matter No. M07147. 2016. Concerning stormwater rate design and cost of service, on behalf of the Nova Scotia Consumer Advocate.

164. *In The Matter Of An Application By Heritage Gas Limited For Enhancement To Its Existing Residential Retro-Fit Assistance Fund*, Nova Scotia Utility and Review Board, Matter No. M07146. 2016. Concerning costs and benefits associated with utility system expansion, on behalf of the Nova Scotia Consumer Advocate.

Moving Toward Demand-Based Residential Rates

The widespread use of automated metering infrastructure in the electricity distribution industry is generating increasing discussion of residential demand charges. An analysis of six types of residential rate designs shows that designing residential rates with seasonal consumption charges might make significant progress toward a more efficient rate design. Seasonal usage rates are understandable to customers, avoid many of the problems with demand-based rates, do not require significant implementation expenditures, and may avoid the extreme bill impacts of some demand-based rate options.

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I. Background

The widespread use of automated metering infrastructure (AMI) in the electricity distribution industry is generating increasing discussion of residential demand charges. Conferences are being held where pro-demand-charge consultants (Ryan Hledik, 2015) square off against anti-demand-charge consultants (Barbara Alexander, 2015); interest groups are posting blogs about the desirability of residential demand charges (Rocky Mt. Institute, 2015); and articles are being published in this *Journal* to try to elucidate points on both sides of the issue (Blank and Gegax, 2014; Hledik, 2014).

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Both sides make valid points. On the one hand, every electricity distribution cost-of-service study (COSS) recognizes that a substantial portion of distribution costs are demand-related. Most utilities, however, have residential rates that contain a customer charge and one or more rates based on energy consumption (rates per kilowatt-hour). Residential demand charges are rare. Where they exist, they are nearly always optional. This means that most residential customers continue to pay demand-related costs through a combination of a flat-rate customer charge and per-kWh charges, rates that may not precisely mirror a customer's demand.

On the other side are those who suggest that residential demand charges are fraught with problems, not the least of which are the need for substantial consumer education and difficulties with tariff administration (including reprogramming utility billing systems and training customer service personnel). Those on the "anti" side of the debate also note that there are important rate design concerns other than strict adherence to the results of a COSS. These include understandability, efficiency, gradualism, revenue stability, and affordability.

With AMI the industry has an unprecedented opportunity to better understand the relationship between peak demand and energy consumption on a very granular level – that is, that of the individual customer. The challenge will be to use this information to move toward a residential rate design that is more efficient (that is, improves the collection of demand-related costs from residential customers who cause the demand), yet remains understandable, affordable, and easy to administer.

Any potential rate design must represent a compromise involving a series of trade-offs.

II. Advantages and Disadvantages of Different Rate Designs

Before discussing any specific analyses, it is worth remembering that there is no "perfect" rate design. The rate design process involves developing averages and groupings for thousands, or even millions, of customers. No rate design will exactly capture the actual cost to serve an individual residential customer, but the goal is to have a rate design that treats all customers fairly within the confines of the averaging and grouping process.

Thus, any potential rate design must represent a compromise involving a series of trade-offs. Prof. Bonbright taught that among the factors to be evaluated in a rate design are fairness (including relationship of the rates to cost), encouraging the wise use of the service, understandability, ease of administration, non-discrimination, revenue stability, and gradualism (Bonbright, 1961).

Billing based on annual demand has a certain theoretical appeal, but the annual demand is not known until the end of the peak season. A summer-peaking utility might experience its peak in July or August, or even in September during an unusual weather event. Similarly, a winter-peaking utility could reach its peak in December, January, or February. Moreover, a utility whose peak fluctuates (winter peaking some years, summer peaking in others) might not know its annual peak until an entire year passes. In any event, billing based on the annual peak always will be based on some event in the past, often many months before, that the customer can no longer control. When a customer moves during the year or a new home is added to the service territory, there also could be a serious question about the fairness of the billing determinant that will be used for the new account.

Further, the customer's ability to control its peak-period usage might be limited, or simply the

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result of luck (good or bad). For instance, if a customer happens to be on vacation during the peak day, her contribution to the annual peak might be unusually low compared to her normal seasonal consumption. Similarly, if a customer happens to have the bad luck of having visitors on the peak day, her contribution to the peak might be unusually high compared to her normal seasonal usage.

Other events also could hamper a customer's ability to control consumption during the precise peak hour, especially because the time of the peak is not knowable when energy is being consumed. These might include appliance cycling during the day (how the refrigerator was cycling during the peak hour), whether the customer has a medical device (such as an oxygen concentrator) that was required to work during the peak hour, whether the peak hour occurred during the work day or after the customer returned home from work, and so on.

Rates based on billing (that is, monthly) demand would eliminate some of the temporal shift involved when annual demand is used, but there is a question about the relationship between a customer's monthly peak demands and his contribution to the annual system peak. This is particularly the case for customers who peak off-season, such as space-heating customers in a summer-peaking utility.

Similarly, billing based on annual energy consumption has some advantages (it is easy to understand and administer, and it spreads the utility's revenues throughout the year), but it may not be fair to consumers who use electricity efficiently (that is, high-load-factor customers who control their peak usage). Such a rate also can send the incorrect price signal that the cost of electricity distribution is the same throughout the year, regardless of the time of day or season of consumption.

From a utility's perspective, having most distribution costs collected in the peak season could create concerns with revenue stability.

Collecting demand costs partially through customer charges also can be problematic. Implicitly, this type of rate design assumes that all customers contribute equally to peak demand, which is rarely the case. It also assumes that there are no differences in distribution facilities based on a customer's peak demand. This ignores the fact that transformers and other facilities might be sized differently depending on the expected demands from connected customers. For example, why should a customer in an apartment without air conditioning pay the same amount for demand-related costs as a customer in a large, air-conditioned home where the thermostat is set to 70 °F? Per-customer billing of demand-related costs also fails to send any price signal to a customer about the longer-term costs the customer's energy usage patterns cause to the system.

Seasonal billing also can create problems, both for the utility and for customers. For example, high summer charges essentially give space-heating customers a "free ride" on the distribution network. While heating customers may not "cause" the system peak, heating customers certainly use wires, poles, transformers, and other distribution facilities that were sized to meet summer peak demands. Setting a non-summer distribution charge very low, therefore, could be unfair to customers.

Finally, from a utility's perspective, having most distribution costs collected in the peak season could create concerns with revenue stability, particularly if weather happens to be unusual (a summer that is much cooler than normal, for example). Such seasonal pricing certainly would change the cash flows of electric distribution utilities, making the cash-flow patterns similar to those experienced by natural gas distribution utilities (very high

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peak-season revenues) that may require a utility to have a significant line of credit to provide adequate off-season cash flows.

III. Previous Research

In 2014, Blank and Gegax (Blank and Gegax, 2014), working with a small data set (43 households), used linear regression analysis to show that annual energy consumption (kWh) was positively but somewhat weakly correlated with a customer's contribution to peak demand (expressed in kilowatts). Their regression analysis showed that while the result was statistically significant ($\rho < 0.001$) annual kWh explained only 38 percent of the variability in peak demand (kW).

That study also posited that a regression through the origin (that is, an intercept equal to zero) might do a better job of explaining the relationship between kWh and kW. Given the different measurements involved in linear regression analyses with and without an intercept term, Eisenhauer explains that the *R*-squared cannot be used to compare results; rather, results using the two approaches must be evaluated by comparing the standard errors of the analyses (the lower the standard error, the closer the correlation between the variables) (Eisenhauer, 2003). On this basis, the analyses of Blank and Gegax show that the regression with an intercept term is superior (a standard error of 1.96 compared to the regression without an intercept's standard error of 3.06).

Blank and Gegax also suggested that a rate that divided demand charge recovery between the customer charge and the kWh charge might enhance fairness. They did not develop any analyses, however, that would evaluate this hypothesis.

Blank and Gegax suggested that a rate that divided demand charge recovery between the customer charge and the kWh charge might enhance fairness.

IV. Methods

This article expands on the Blank and Gegax approach to evaluate the ability of different residential rate designs. Rate designs are compared for their ability to collect demand-related costs in a manner that might be fairer to customers and consistent with other important rate design principles and goals.

In particular, linear regression analysis is used on a data set containing monthly energy consumption and annual contribution to the system peak demand for 77,675 residential accounts. The data set contains data for a portion of the service area of an electric distribution utility in U.S. Department of Energy climate zone 5 (U.S. Department of Energy, 2013). Some customers in the data set use electricity for space heating in the winter, but most do not. Many (but not all) non-heating customers have summer peak usage evidencing energy usage for air conditioning or other seasonal space cooling. Prior to developing the final data set, some outliers were eliminated (such as accounts with highly atypical usage or demand profiles, those with missing data, etc.).

Hledik (2014) notes that some residential demand charges are developed using billing demand (that is, each customer's maximum demand in each billing period), rather than contribution to annual peak demand. In order to evaluate a rate design using billing demand, it is necessary to have the monthly peak demand for each customer. The data set does not contain those monthly demands, so monthly demands were estimated for each customer using the base, low, and high usage load profiles developed by the U.S. Department of Energy (DOE) for a city within the utility's service area.

Specifically, the "low" load profile was used for accounts with annual usage less than 7,500 kWh; the "base" profile was used for accounts using between 7,500 and 12,500 kWh during the year; and

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the "high" profile was used for accounts using more than 12,500 kWh in the year. From each load profile, the peak demand was determined for each month. From that monthly peak demand, a monthly load factor (ratio of average demand to peak demand) was calculated for each month. The July load factor from the applicable load profile was then compared to the actual July load factor (July was the month when the peak occurred in the data set) for each customer to calibrate the results. For example, if a customer had a load factor in July of 0.50 but the applicable DOE load profile had a July load factor of 0.45, the actual load factor for the month was 11 percent higher than the profile. It was assumed, therefore, that the load factor would be 11 percent higher than the applicable DOE profile in all other months. The monthly load factor was then used to calculate the monthly billing demand. The following equation shows the calculation of May billing demand for a customer in the "base" group (using between 7,500 and 12,500 kWh in the year).

$$kW_{May} = \frac{kWh_{May}/744}{BLF_{May} \times [(kWh_{Jul}/744)/(kW_{Annual}/BLF_{Jul})]}$$

where kW = Peak kW demand in a period (month or Annual); kWh = kWh consumption in a period; BLF = Load factor calculated from DOE Base profile in a period; 744 = Number of hours in a 31-day month.

Illustrative rates were then calculated for six different rate design options, as described in Table 1. The rates are based on the customer cost ($13.25 per month per customer) and demand charge ($4.93 per kW per month based on annual peak demand) used by Blank and Gegax. Applying those rates to the customers in the data set produces revenues of approximately $27.7 million. All other rate design options were designed to collect the same amount of revenues.

For purposes of these analyses, it is assumed that the existing rate design is the All kWh design. Thus, the existing rate has a customer charge that collects customer-related costs of $13.25 per month. All other costs (to simplify, it is assumed that all other distribution costs are demand-related) are collected through a flat charge of 1.52¢ per kWh throughout the year.

The second assumption is that the Annual Demand rate represents the cost to serve each customer. That is, this rate collects all customer-related costs in an equal amount per customer and all demand-related costs based solely on each customer's contribution to the annual peak demand. This also makes the

Table 1: Rate Design Options.

Option	Description	Customer Charge (per month)	Demand Charge (per kW per month)	Summer Energy (per kWh)	Non-Summer Energy (per kWh)
Annual Demand	Per kW charge based on annual peak	$13.25	$4.93	– 0 –	– 0 –
Billing Demand	Per kW charge based on monthly peak	$13.25	$5.55	– 0 –	– 0 –
All kWh	All demand costs per kWh	$13.25	– 0 –	1.52¢	1.52¢
Split	Demand costs 60% per kWh; 40% in customer charge	$19.84	– 0 –	0.91¢	0.91¢
All Summer	All demand costs per summer (Jun–Sep) kWh	$13.25	– 0 –	4.79¢	– 0 –
Seasonal	Summer kWh charge is 2 times non-summer charge	$13.25	– 0 –	2.31¢	1.15¢

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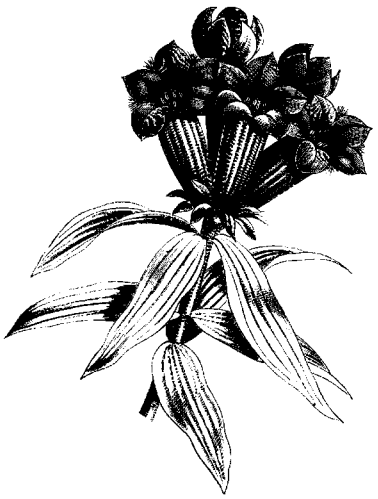
simplifying assumption that all demand-related costs are allocated to customer classes based solely on a single coincident peak (that is, each class's contribution to the single hour of the year with the highest system demand).

Thus, the assumed cost to serve each customer (the Annual Demand rate) can be compared to the charges under other rate designs to assess the relationship between the cost of service and revenues for each customer. Rather than comparing demand (measured in kW) against charges (measured in dollars per year), the analyses compare the customer-specific cost of service (in dollars per year) against charges under other rate design options (also in dollars per year for each customer). Because of the existence of a fixed customer charge, bills will never approach zero, which avoids one of the analytical issues raised by Blank and Gegax in their analyses that compared demand (kW) to energy (kWh).

V. Results

Initially, the characteristics of the cost of service are examined. The data show that the cost to serve customers varies from a low of $159.35 per year (a customer with almost no contribution to peak demand) to $750.48 per year (the highest-demand customer), with an average of $356.79 per year (standard deviation of 103.78).

Next, the existing rate (All kWh) is compared to the cost of service. While the cost of service indicated a maximum cost of $750.48, the existing rates result in a maximum annual bill that is substantially higher: $919.00. While the average annual bill is essentially the same as the cost of service ($356.75 versus $356.79), the existing rates' standard deviation is higher (127.77 versus 103.78), providing an initial



indication that there is a meaningful difference between revenues and costs for many customers.

A linear regression analysis provides further evidence that the existing rate does not ideally track the cost of service for many customers. The analysis shows that the existing rate is positively but modestly correlated with the cost of service, and the relationship is statistically significant ($\rho < 0.001$). Specifically, both the intercept (169.200) and slope (0.526) are positive, indicating that the relationship is logical (customers with higher costs pay higher rates). The *R*-squared, however, is 0.419, which indicates that there is a substantial unexplained variance between the cost of service and customers' annual bills.

The next stage in the analysis is to evaluate each rate design option in two ways. First, the option is compared to the cost of service with a linear regression analysis. Second, the magnitude of rate change (compared to the existing All kWh rate) is described to indicate whether this type of rate design change might create unacceptable customer impacts. The results of these analyses are shown in Tables 2 and 3.

Several points are noteworthy in these results. First, to move immediately to rates based on annual demand (even if other obstacles could be overcome) would result in dramatic rate changes, ranging from a 76 percent decrease to a 162 percent increase. Ten percent of customers would experience annual bill decreases of 29 percent or less, while another 10 percent of customers would face annual bill increases of 32 percent or more, as shown in Fig. 1. It is unlikely that a revenue-neutral rate design change having changes of this magnitude would be consistent with the rate design criteria of public acceptability and gradualism. The difference from existing (kWh-based) rates is simply too severe.

Interestingly, adopting a rate design based on billing demand

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Table 2: Results of Linear Regression Analyses Compared to Cost (All Demand).

Option	Intercept	Slope	*R*-squared	Significance
All kWh	169.200	0.526	0.419	$\rho < 0.001$
Billing Demand	178.876	0.499	0.426	$\rho < 0.001$
Split	43.695	0.878	0.419	$\rho < 0.001$
All Summer	60.580	0.830	0.846	$\rho < 0.001$
Seasonal	125.856	0.648	0.550	$\rho < 0.001$

Table 3: Bill Changes from Rate Design Options Compared to Existing Bills (All kWh).

Option	Average % Change	Min/Max % Change	10th/90th Percentile	% Bills Increased
Annual Demand	4.4%	−76%/+162%	−29%/+32%	62%
Billing Demand	0.6%	−40%/+183%	−14%/+16%	43%
Split	4.6%	−25%/+49%	−14%/+24%	60%
All Summer	3.0%	−76%/+74%	−26%/+26%	63%
Seasonal	0.7%	−19%/+18%	−6%/+6%	61%

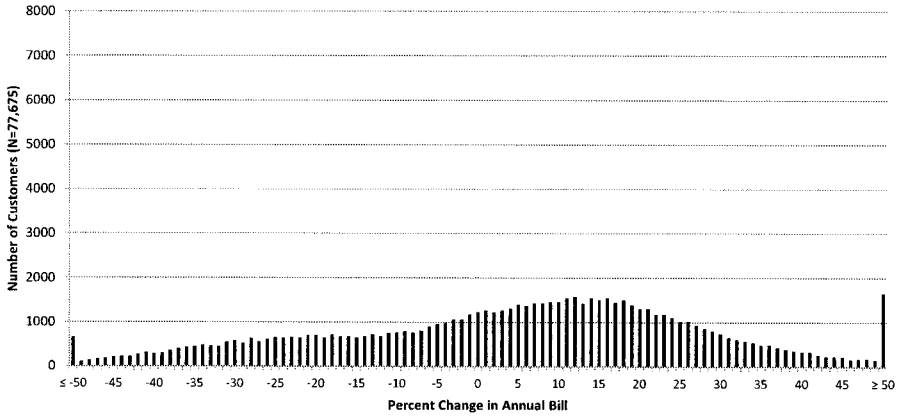

Fig. 1: Distribution of Rate Increases Required to Move from All kWh Rates to Rates Based on Annual Demand

(that is, the customer's peak demand in each billing month) would make almost no progress toward aligning rates with the cost of service. Specifically, this option (Billing Demand) has an *R*-squared of just 0.426 (compared to existing rates' *R*-squared of 0.419) when compared to the cost of service. While this option would have a less severe rate impact than moving to the Annual Demand option, there are still sizeable rate dislocations, with some customers experiencing increases even higher than those experienced under the Annual Demand option (as high as 183 percent). Most customers, however, would experience increases in the range of ±15% (Fig. 2), which is somewhat more acceptable than the ±30% range under the Annual Demand option. Further, this is the only rate design option evaluated that has more customers receiving annual bill decreases than increases (43 percent receive increases, compared to the other options where more than 60 percent of customers receive increases).

It also is interesting to note that the Split option that collects 60 percent of demand-related costs through a kWh charge and 40 percent through the customer charge, does nothing to better align costs and revenues. The *R*-squared under this option is identical to the *R*-squared of existing rates at 0.419. In this

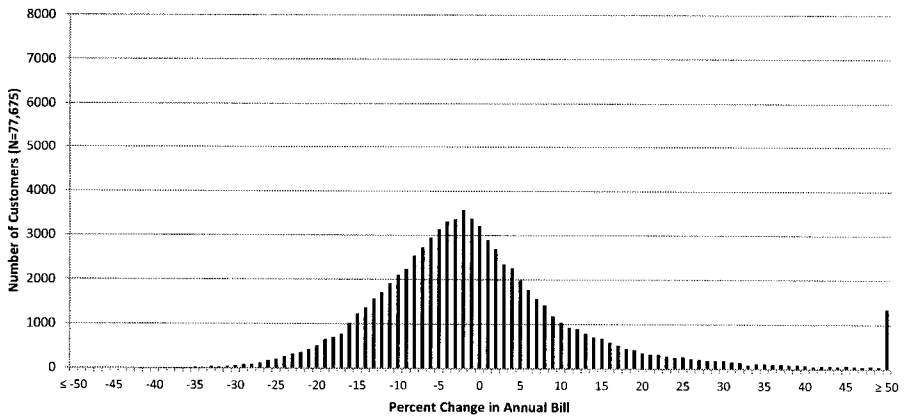

Fig. 2: Distribution of Rate Increases Required to Move from All kWh Rates to Rates Based on Billing Demand

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example, this option represents a classic case of a rate design that creates winners and losers but does nothing to improve the overall efficiency of the rate design (that is, the rate design's ability to more closely track the cost of service).

The last two options evaluated represent cases that may achieve some of the benefits of demand-based rates without using a kW billing determinant. The rate design that collects all demand-related costs through peak-season (summer) kWh charges comes much closer to tracking the cost of service, with an *R*-squared of 0.846. This type of rate could avoid the educational and implementation problems of a demand-based rate while better aligning rates with costs. This type of rate design, however, does have theoretical problems, as discussed above (particularly the problems of revenue stability and off-season customers getting the free use of the distribution network). Moving to this type of rate design also would create significant annual bill changes for customers. Most customers would experience increases in the range of ±26%, with the highest and lowest increases of approximately ±75% (Fig. 3).

The final option evaluated has a summer kWh charge that is double the non-summer kWh charge. This might represent an incremental change in the rate design that does not involve the issues associated with demand-based billing, but moves closer toward cost-based rates in a gradual manner that considers customer impacts. This type of rate design makes meaningful movement toward tracking the cost of service (*R*-squared of 0.550 compared to the existing rate design's 0.419), but without the drastic changes in annual bills that the other rate design options would engender. Under this option, most customers would see bills change within the range of ±6%, with no customer experiencing a change outside the range of ±19%, as shown in Fig. 4.

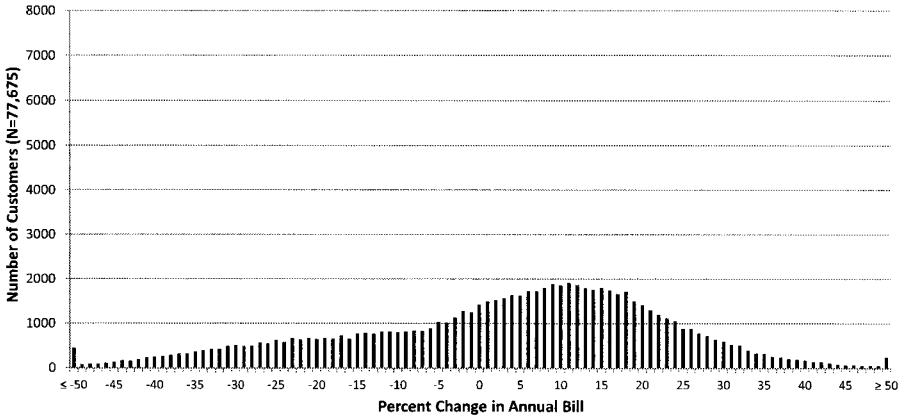

Fig. 3: Distribution of Rate Increases Required to Move from All kWh Rates to Rates Based on Summer kWh

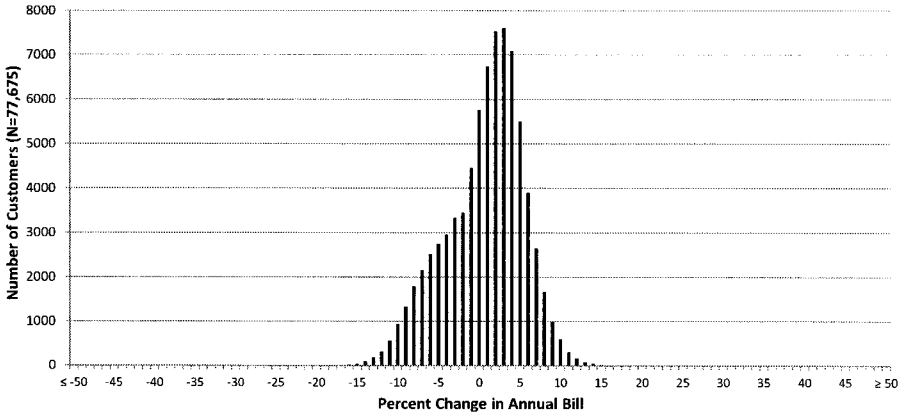

Fig. 4: Distribution of Rate Increases Required to Move from All kWh Rates to Seasonal kWh Rates

VI. Conclusion

The illustrative rate design options evaluated in this article contain some important results. For example, shifting costs between consumption and customer charges may do nothing to improve the efficiency of the

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rate design, even though customers experience dramatic changes in their annual bills. Similarly, while one might expect monthly billing demands to be closely correlated with annual peak demand, that is not the case in this data set. In fact, using monthly billing demands does very little to improve the efficiency of the rate design compared to a simple kWh-based rate design. Once again, while winners and losers are created, the overall rate design is no better at tracking the cost of serving customers than a consumption-based design.

From these examples, it appears that designing residential electric distribution rates with seasonal consumption charges (higher peak-season charges) might make significant progress toward a more efficient rate design. Seasonal kWh rates are understandable to customers, avoid many of the problems with demand-based rates (such as the "lucky" customer who happens to be away from home on the day of the annual peak), do not require significant implementation expenditures, and may avoid the extreme bill impacts of some demand-based rate options.

There are a limitless number of rate design options available to utilities and regulators. With the wide-scale deployment of AMI, data will be available that will allow analysts to develop rate design options that improve the efficiency of the rate design (that is, its ability to have a customer's revenues collect the cost of serving the customer) while also evaluating the impacts of the rate design change on customers. This article has highlighted some of the statistical and comparative techniques that should be helpful in the development of such rates. It is hoped that analysts and researchers will further explore these topics with more extensive data sets, other rate design options, and different statistical techniques for evaluating the ability to improve rate design efficiency while remaining sensitive to other longstanding rate design principles and goals.■

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UNS Electric Inc. Exhibit SJR-2
Arizona Corp. Comm'n Docket No. E-04204A-15-0142

Residential Cost of Service, Units of Service, and Unit Cost
(All data from: 2015 UNSE Schedule G-COSS-R.xlsx)

Cost of Service

1	Production demand	$	20,709,455	A&E/4CP	
2	Transmission demand		8,775,515	A&E/4CP	
3	Distribution primary demand		10,625,712	NCP	
4	Distribution secondary demand		1,173,823	NCP	
5	Total demand	$	41,284,505		
6	Energy	$	44,744,078	KWH	Data from the Functionalization_RES tab
7	Customer delivery	$	7,991,033	Customers	
8	Customer meter		646,494	Customers	
9	Customer billing & collections		4,113,357	Customers	
10	Customer meter reading		942,211	Customers	
11	Total customer	$	13,693,095		

Units of Service

12	Residential customers	82,607		G-7 Allocations tab, J38
13	Residential sales	823,953,185	kWh	G-7 Allocations tab, I32
14	Residential NCP	267,360	kW	NCP tab, C65
15	Residential CP	211,252	kW	NCP tab, C60
	For calculation purposes, simplify the A&E/4CP allocator to			
16	Average demand	22.50%		Calculated in Work copy of COSS
17	4 CP	77.50%		
18	Equals	184,883.48	kW	(line 13 / 8760 x line 16) + (line 15 x line 17)

Annual Unit Costs

19	Production demand	$	112.01	per kW (A&E/4CP)	line 1 / line 18
20	Transmission demand	$	47.47	per kW (A&E/4CP)	line 2 / line 18
21	Distribution primary demand	$	39.74	per kW (NCP)	line 3 / line 14
22	Distribution secondary demand	$	4.39	per kW (NCP)	line 4 / line 14
23	Energy	$	0.054304	per kWh	line 6 / line 13
24	Customer-related costs	$	165.76	per customer	line 11 / line 12

Restated Annual Unit Costs

Average demand:

25	22.50% of A&E/4CP costs	$	6,634,118		(line 1 + line 2) x line 16
26	Average demand		94,059	kW	line 13 / 8760
27	Average demand-related	$	70.53	per kW @ avg.	line 25 / line 26
28	Convert to cost per kWh	$	0.008052	per kWh	line 27 / 8760
29	Energy costs	$	44,744,078		line 6
30	Energy costs per kWh	$	0.054304	per kWh	line 29 / line 13
31	**Energy-related unit cost**	**$**	**0.062356**	**per kWh**	line 28 + line 30

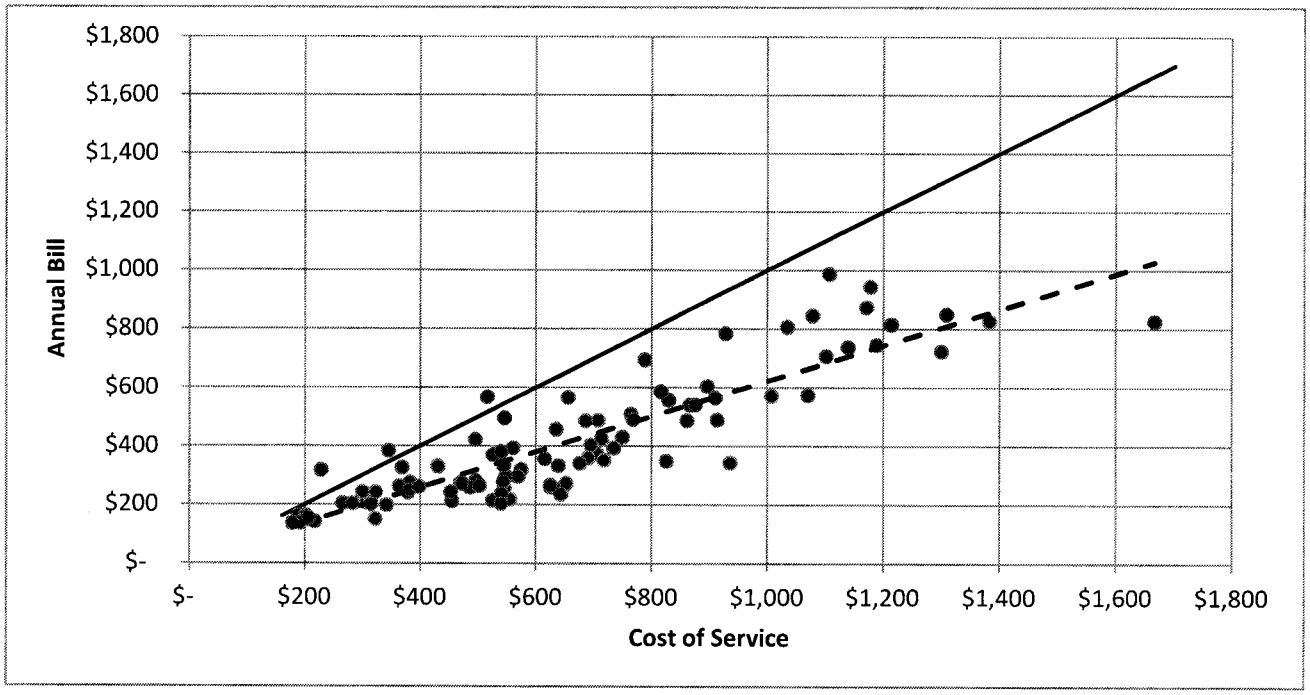
4 CP related:

32	77.50% of A&E/4CP costs	$	22,850,852		line 1 + line 2 - line 25
33	**4 CP related unit cost**	**$**	**108.17**	**per kW @ 4 CP**	line 32 / line 15
34	**NCP related unit cost**	**$**	**44.13**	**per kW @ NCP**	line 21 + line 22
35					
32	**Customer related unit cost**	**$**	**165.76**	**per customer**	line 24

UNS Electric Inc.
Arizona Corp. Comm'n Docket No. E-04204A-15-0142

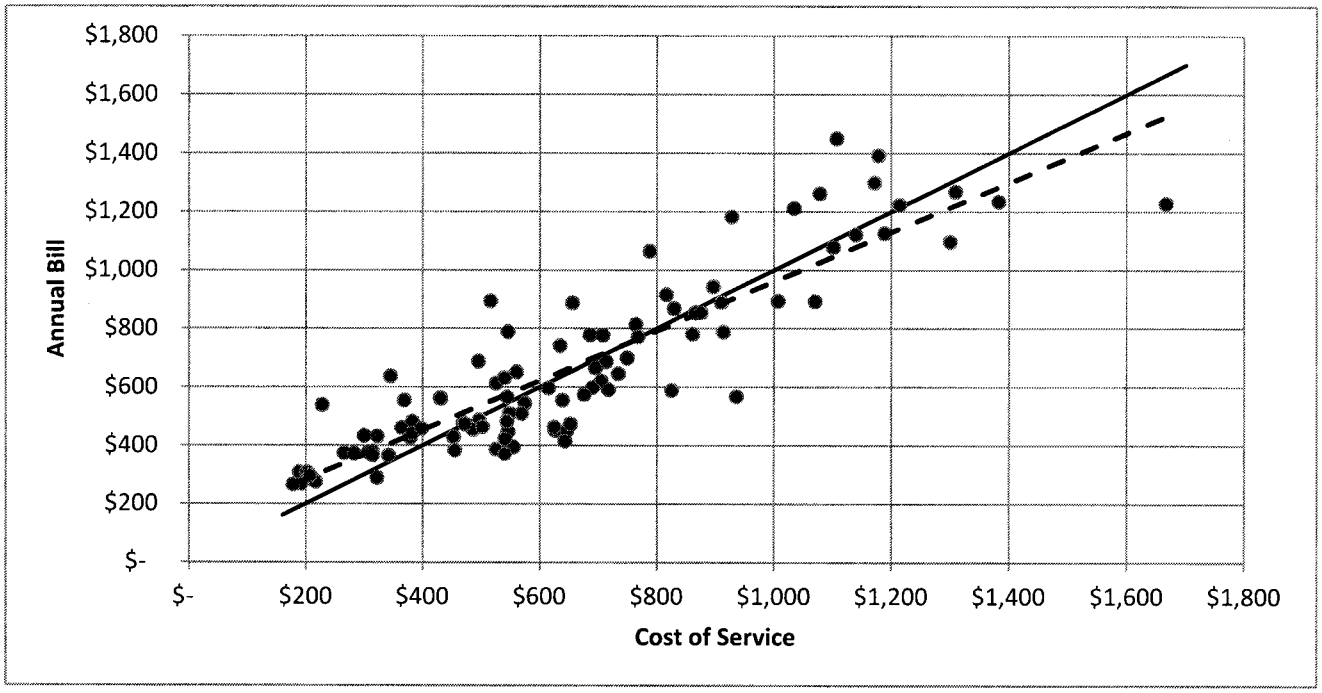
Exhibit SJR-3

Sample of 100 Residential Customers
Comparison of Cost of Service and Present Distribution Bill

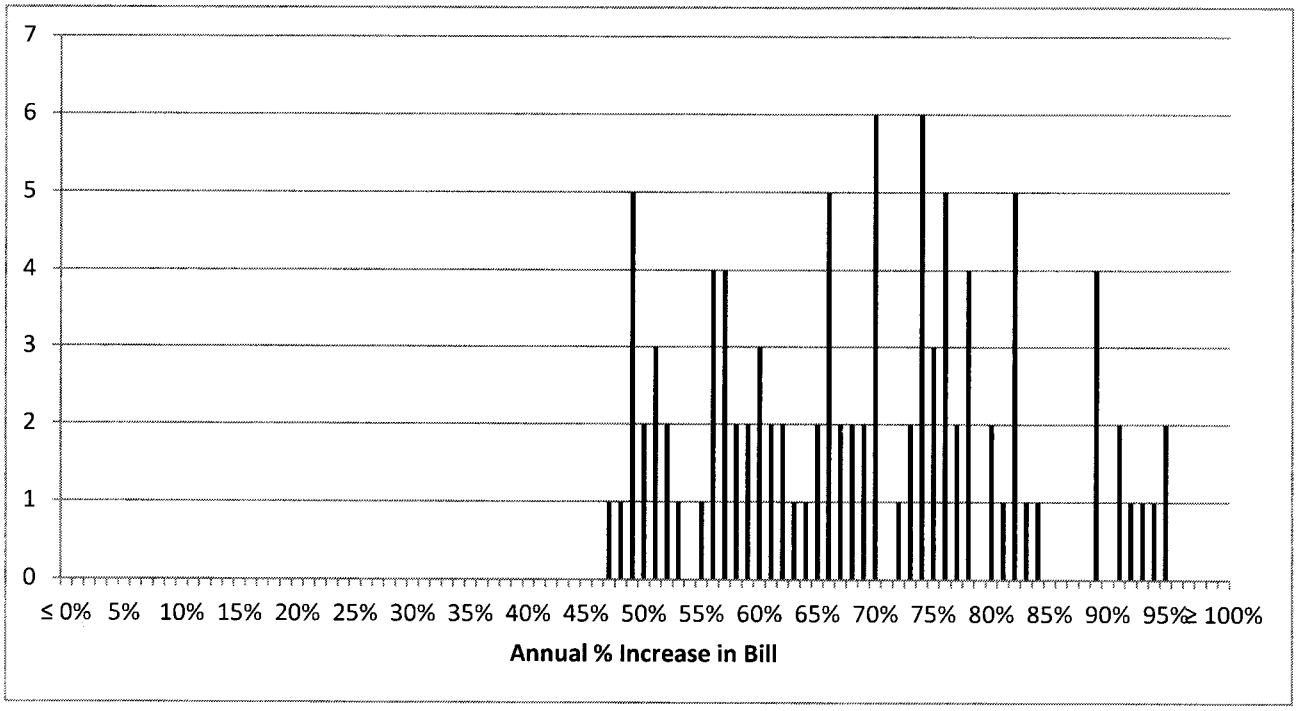


Slope	0.607	N	100			
Intercept	15.805	Avg. Diff.	36%	Tot. Rev.	$	39,934
R-square	0.797	% > Cost	3	Tot. Cost	$	63,175

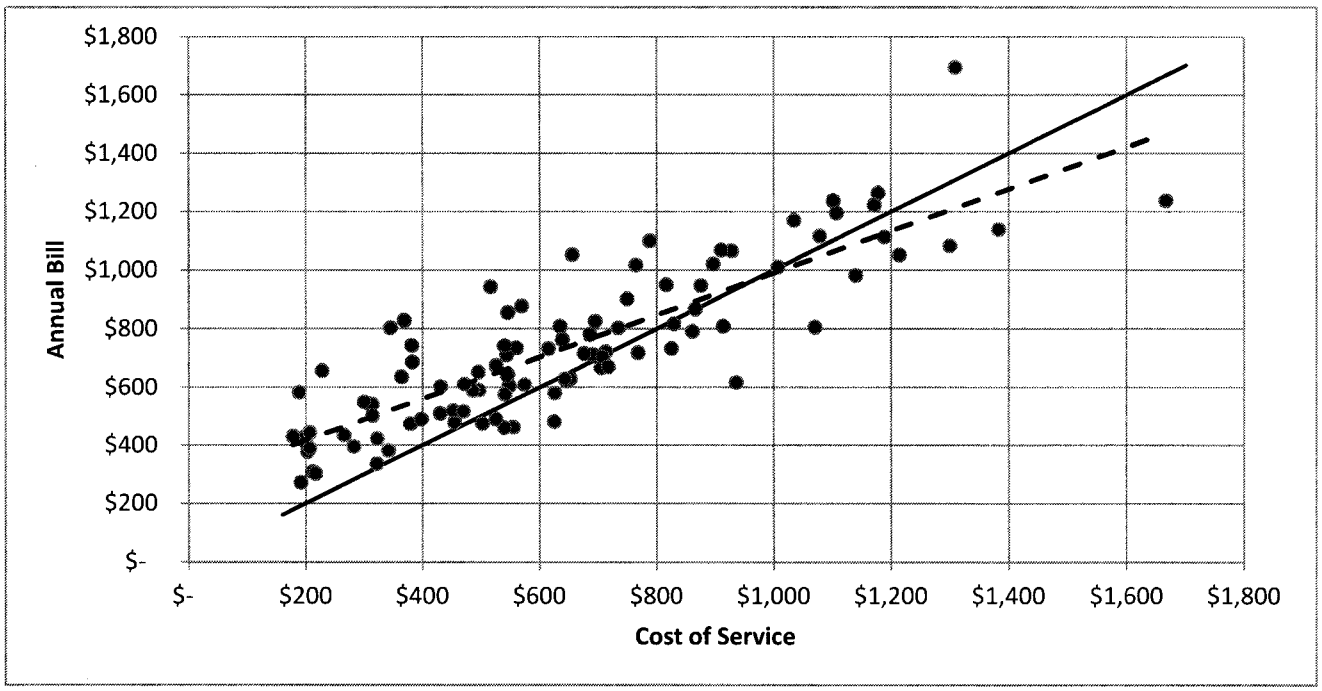
Sample of 100 Residential Customers
Comparison of Cost of Service and UNS Originally Proposed Distribution Bill



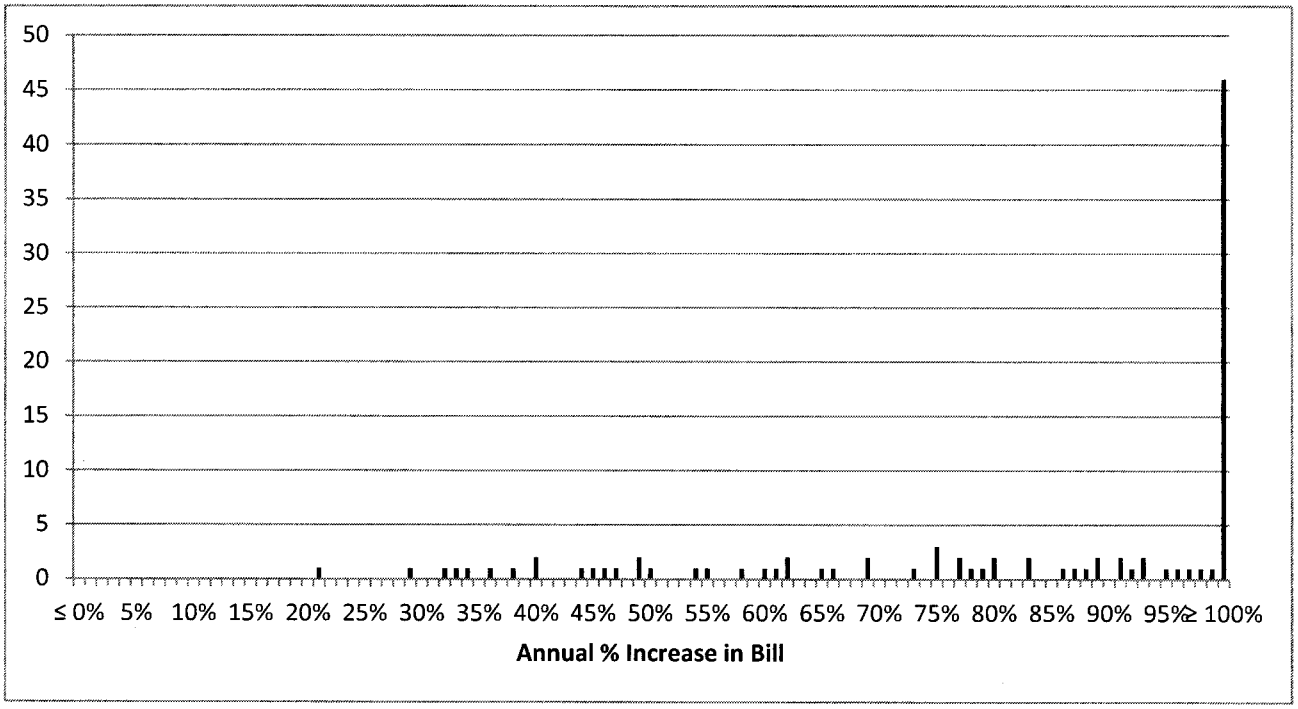
Slope	0.846	N	100	Range	47% to 95%
Intercept	114.490	Avg. Diff.	22%	Tot. Rev.	$ 64,904
R-square	0.797	% > Cost	54	Tot. Cost	$ 63,175



Sample of 100 Residential Customers
Comparison of Cost of Service and UNS Originally Proposed Demand Distribution Bill



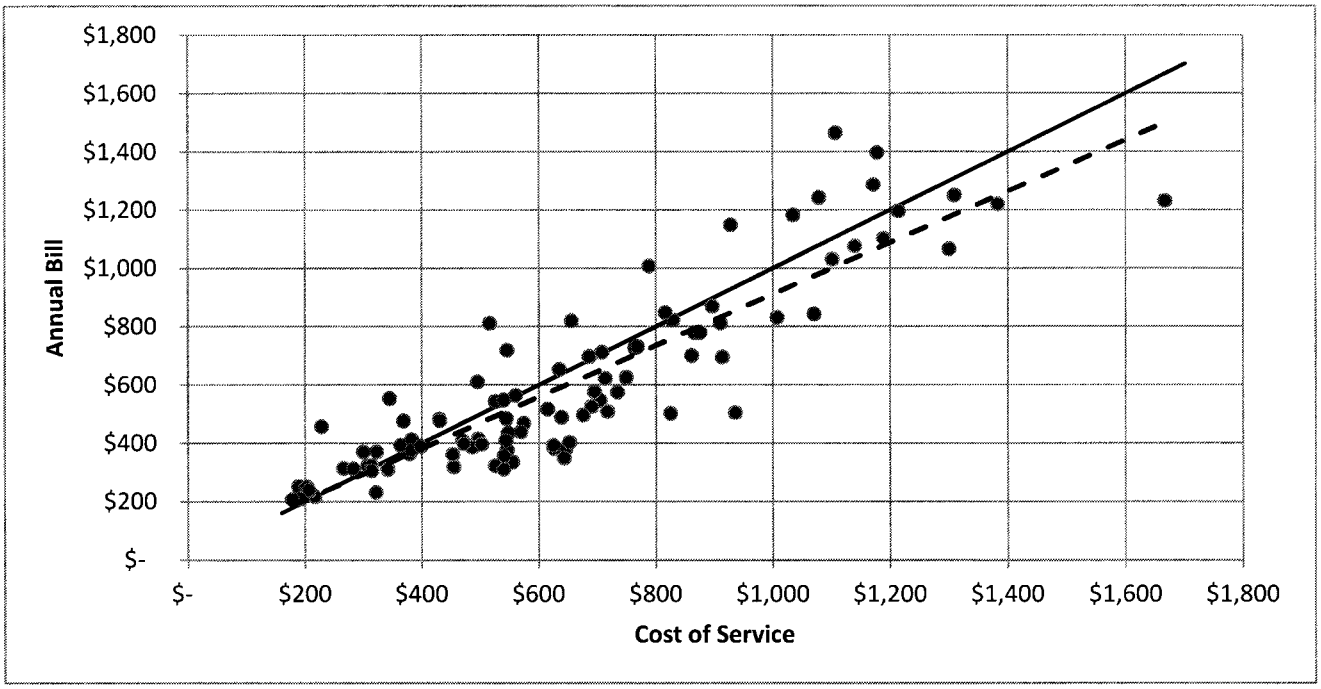
Slope	0.717	N	100	Range	21% to 257%
Intercept	273.979	Avg. Diff.	35%	Tot. Rev.	$ 72,685
R-square	0.725	% > Cost	75	Tot. Cost	$ 63,175



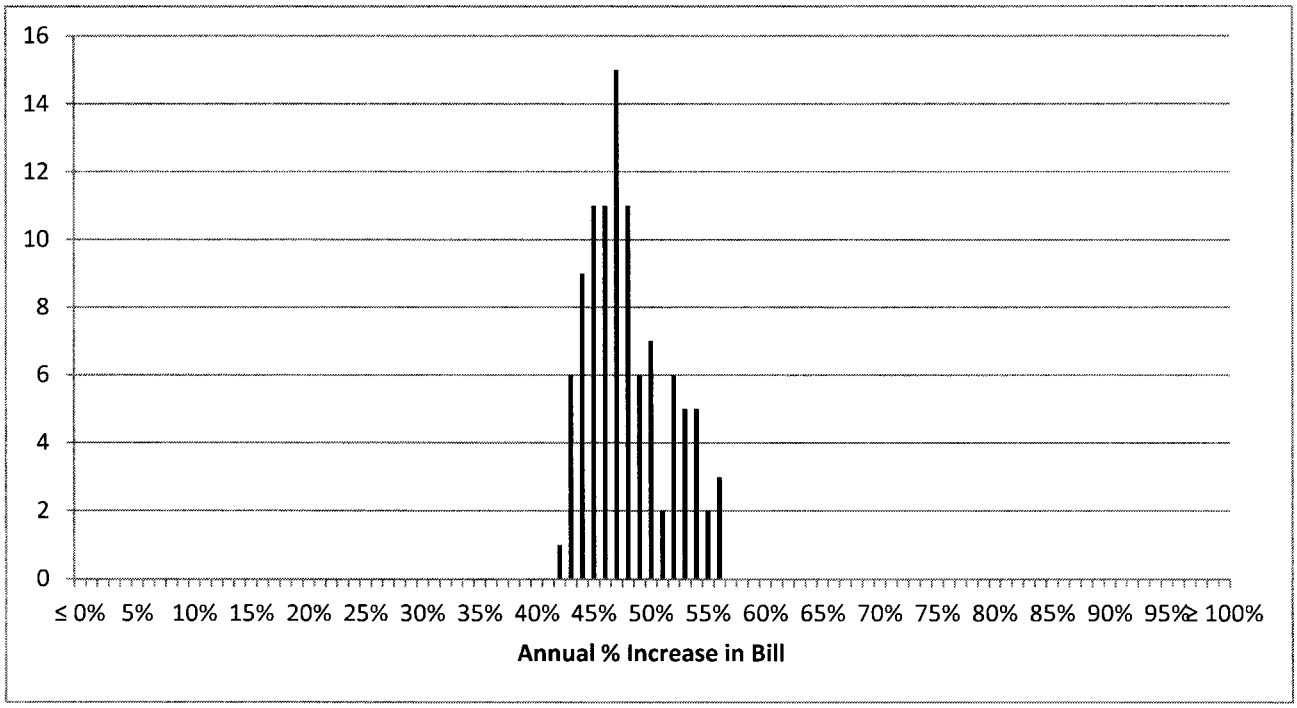
UNS Electric Inc.
Arizona Corp. Comm'n Docket No. E-04204A-15-0142

Exhibit SJR-6

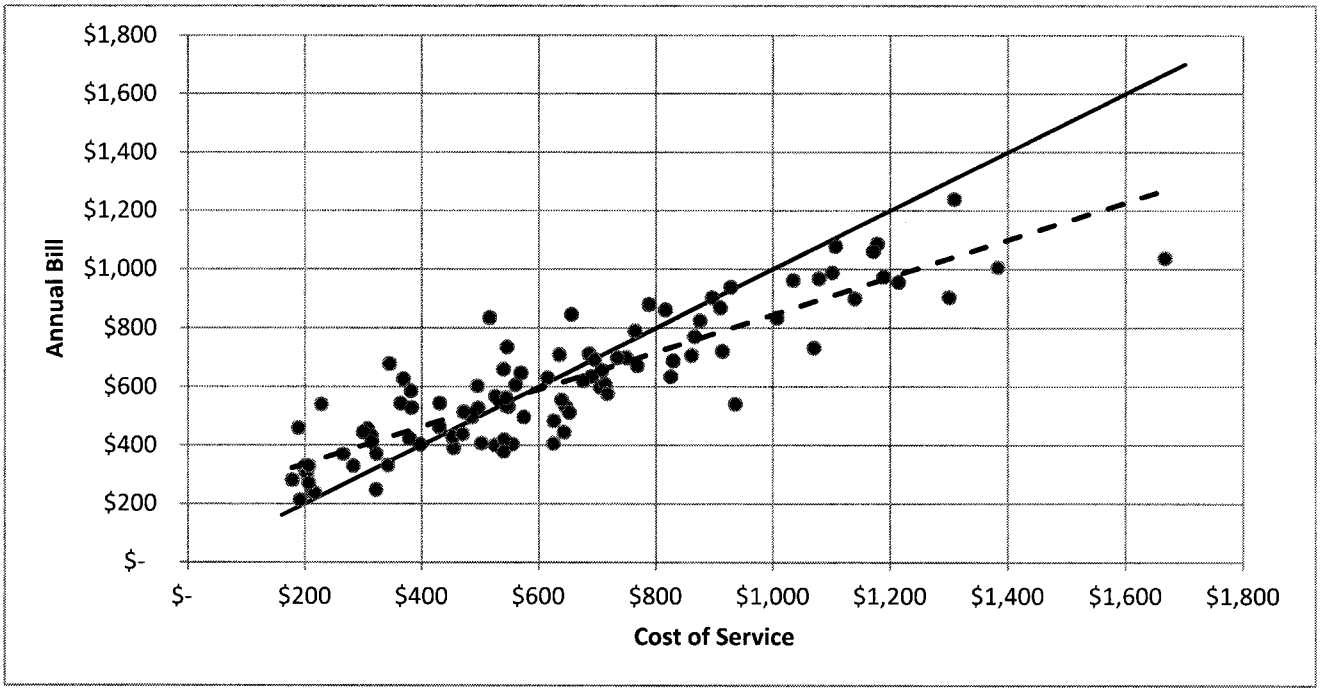
Sample of 100 Residential Customers
Comparison of Cost of Service and UNS Rebuttal Proposed Transition Distribution Bill



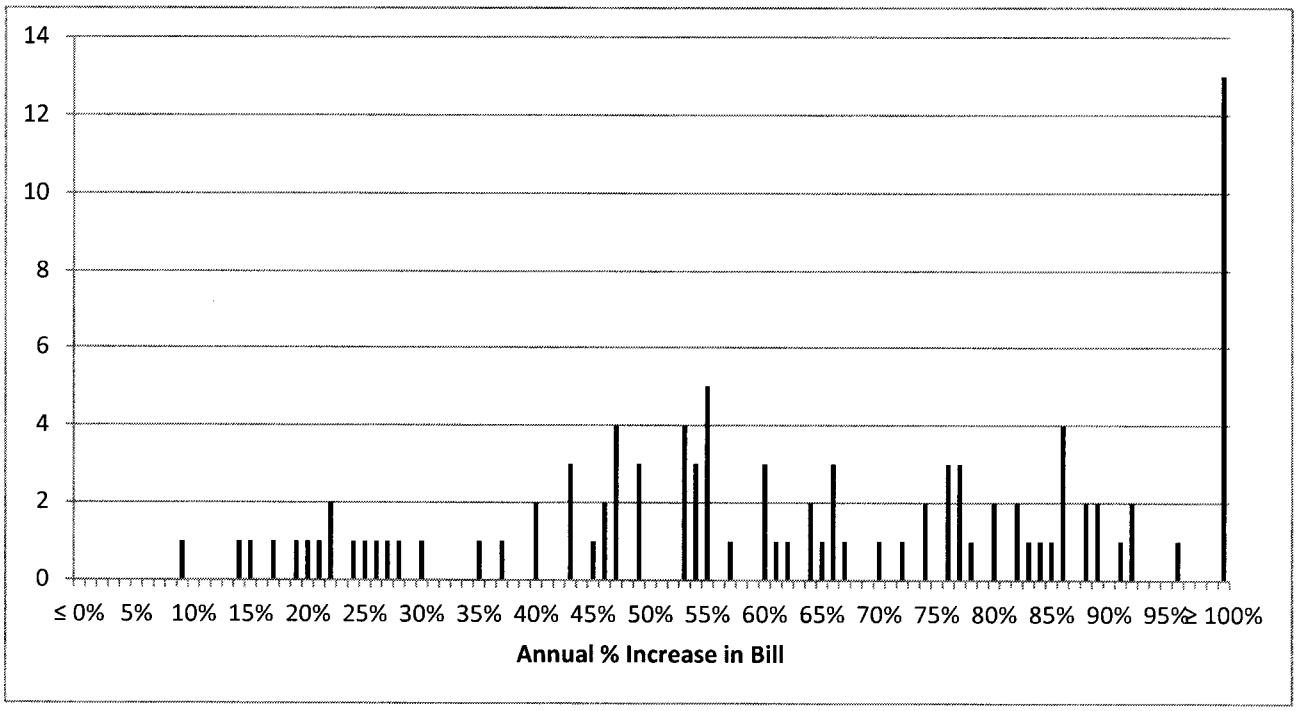
Slope	0.881	N	100	Range	42% to 56%
Intercept	30.202	Avg. Diff.	19%	Tot. Rev.	$ 58,692
R-square	0.797	% > Cost	41	Tot. Cost	$ 63,175



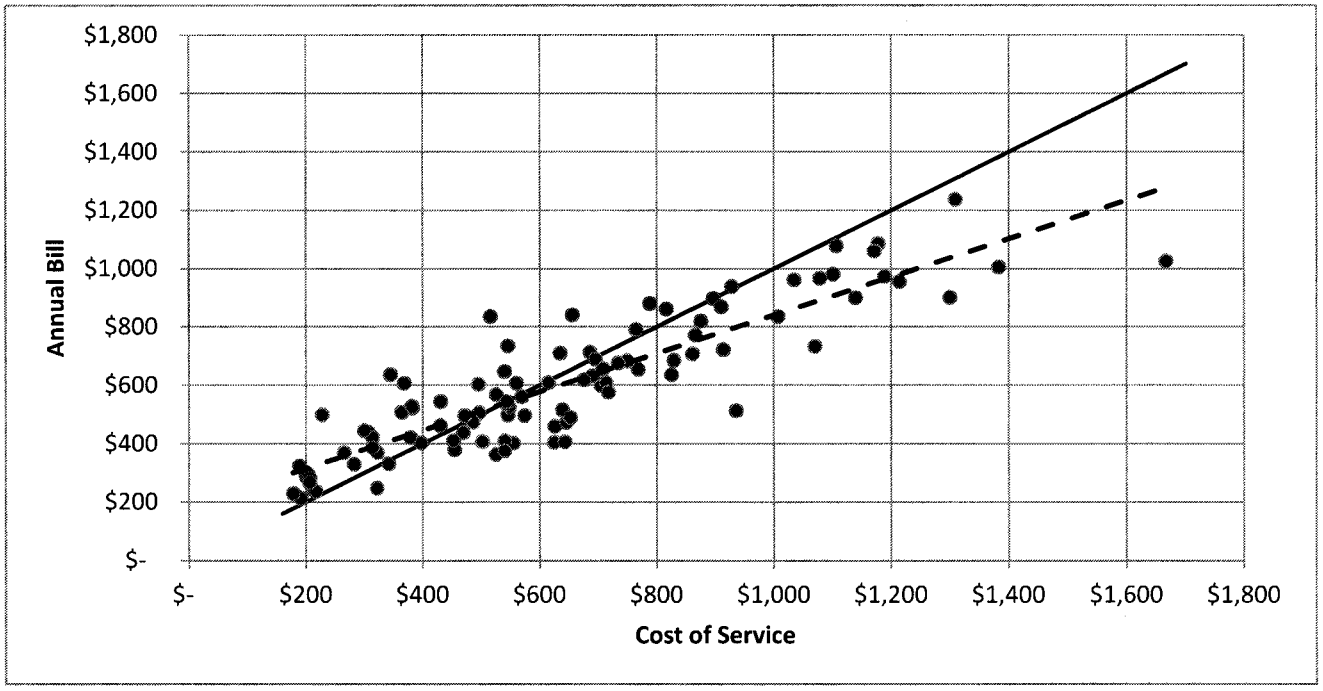
Sample of 100 Residential Customers
Comparison of Cost of Service and UNS Rebuttal Proposed Demand Distribution Bill (No Limiter)



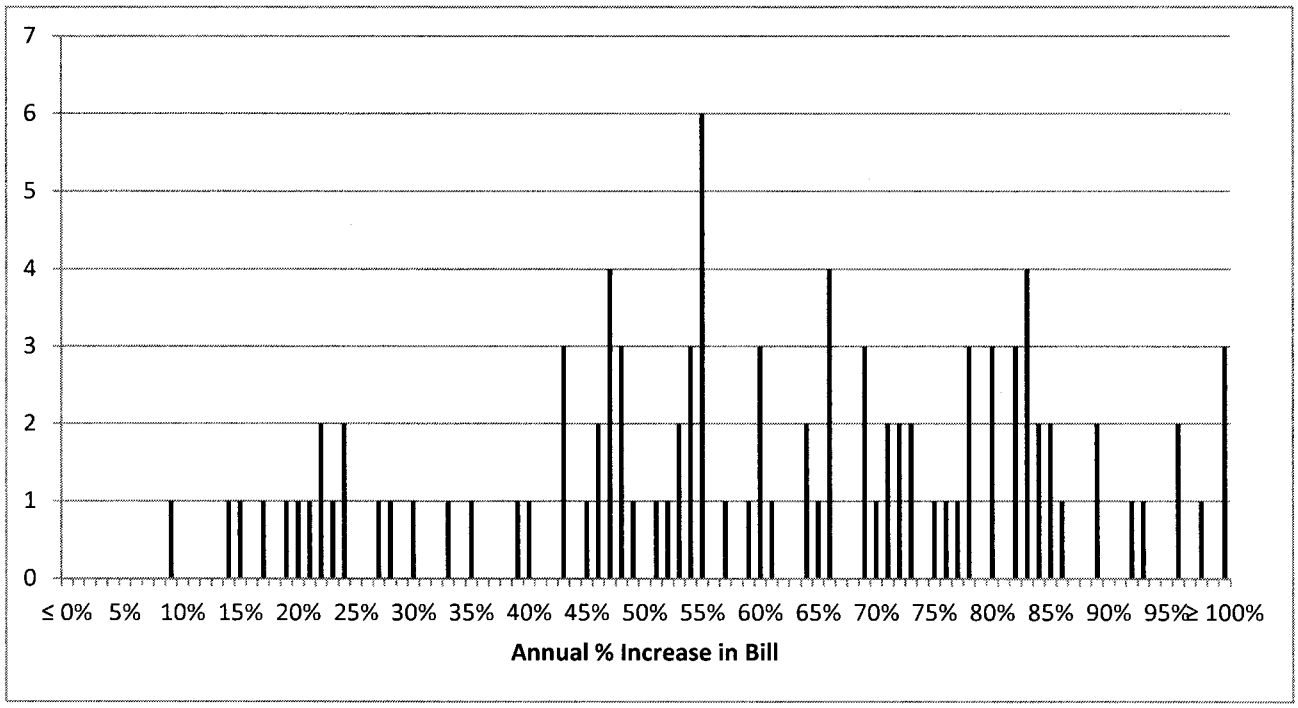
Slope	0.636	N	100	Range	9% to 182%
Intercept	208.738	Avg. Diff.	23%	Tot. Rev.	$ 61,078
R-square	0.773	% > Cost	49	Tot. Cost	$ 63,175



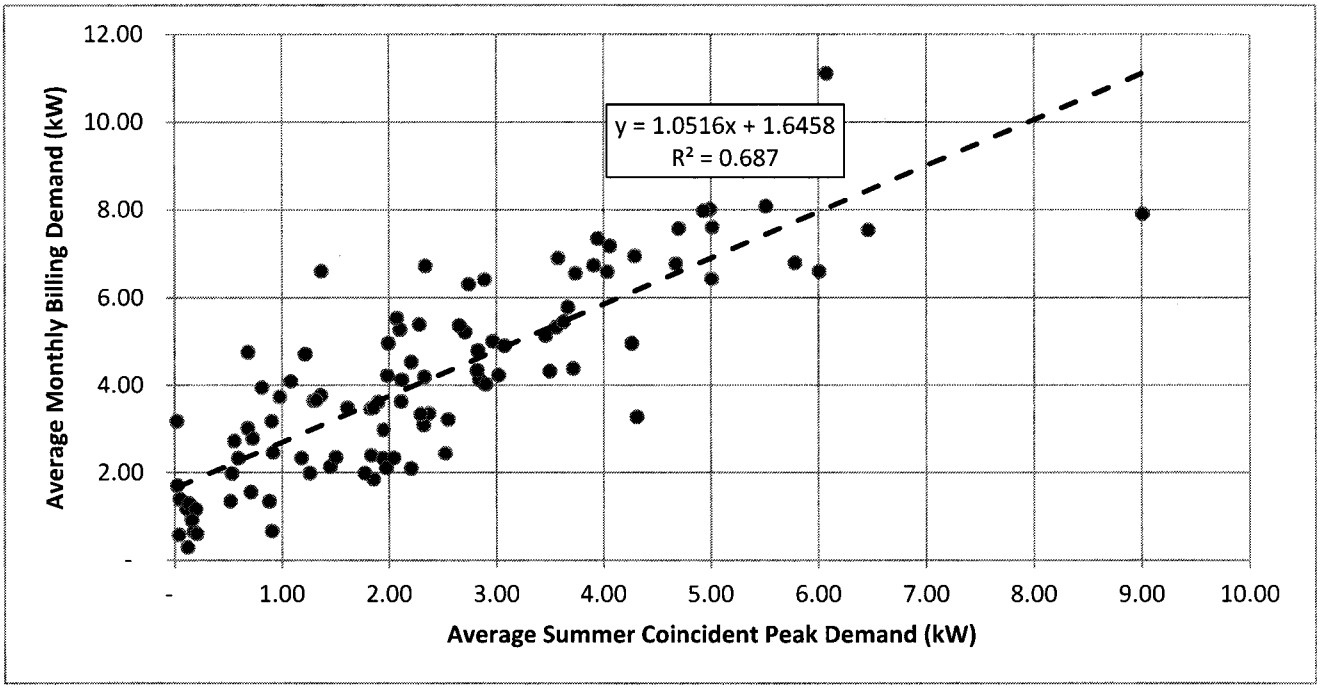
Sample of 100 Residential Customers
Comparison of Cost of Service and UNS Rebuttal Proposed Demand Distribution Bill (15% L.F. Limit)



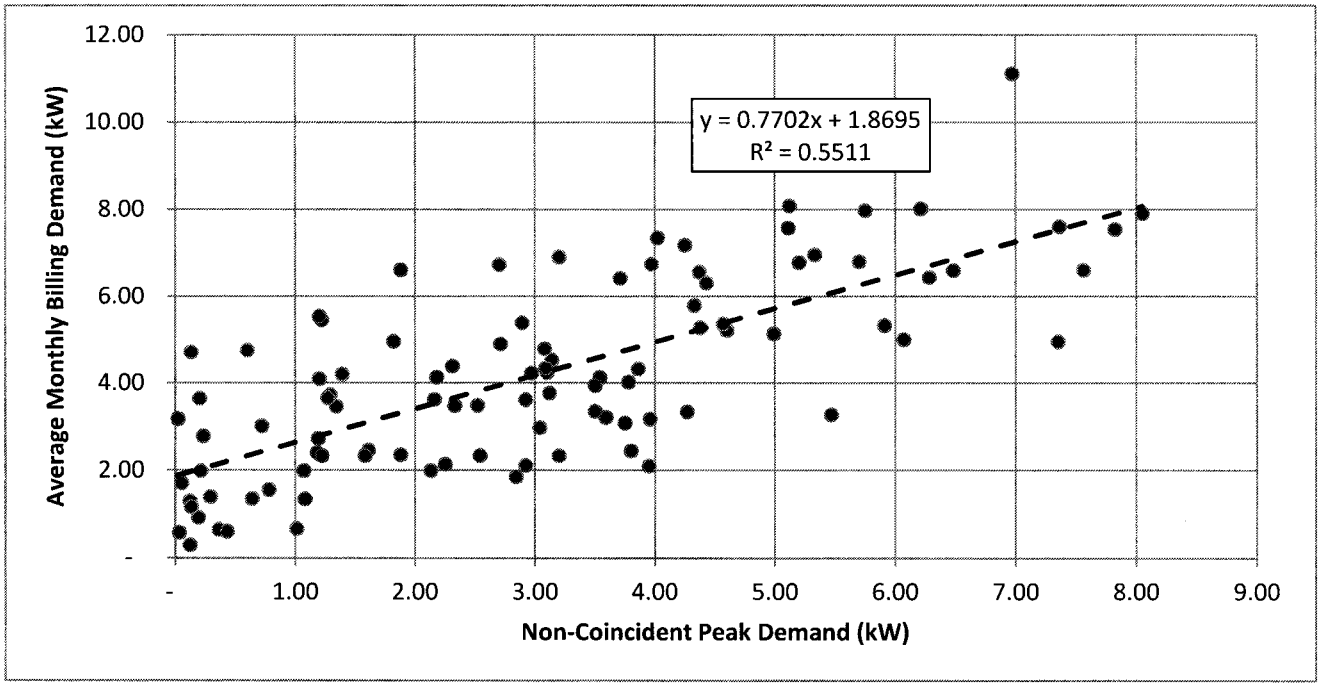
Slope	0.657	N	100	Range	9% to 113%
Intercept	183.234	Avg. Diff.	21%	Tot. Rev.	$ 59,847
R-square	0.785	% > Cost	44	Tot. Cost	$ 63,175



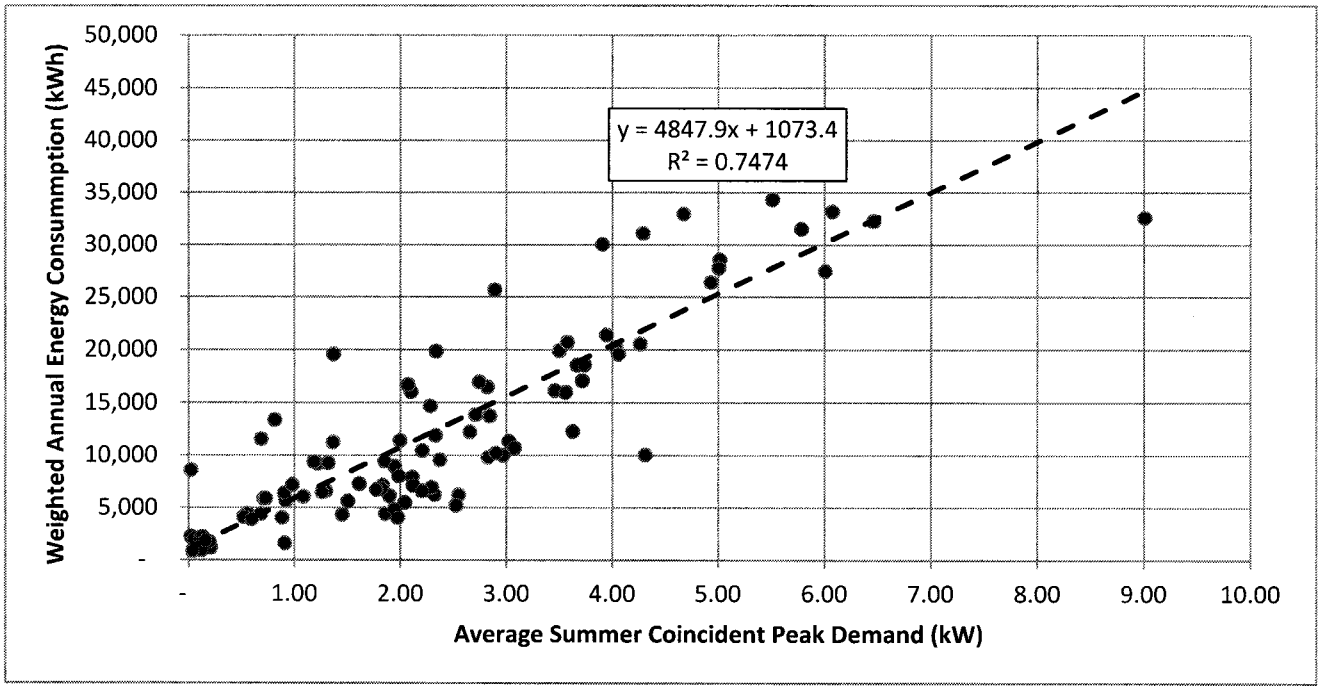
Sample of 100 Residential Customers
Comparison of Summer Coincident Peak Demand and Monthly Billing Demand (With 15% L.F. Limit)



Comparison of Non-Coincident Peak Demand and Monthly Billing Demand (With 15% L.F. Limit)



Sample of 100 Residential Customers
Comparison of Summer Coincident Peak Demand and Annual Energy Consumption (Weighted)



Comparison of Non-Coincident Peak Demand and Annual Energy Consumption (Weighted)