BEFORE THE
ILLINOIS COMMERCE COMMISSION

Illinois Commerce Commission On its Own Motion v. Commonwealth Edison Company Investigation of Commonwealth Edison Company's Cost of Service for Low-Use Customers In Each Residential Class	: : : : : : : :	Docket No. 14-0384

Direct Testimony of
Scott J. Rubin

on Behalf of
the People of the State of Illinois

AG Exhibit 1.0

December 4, 2014

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Introduction

Q. Please state your name and business address.

A. My name is Scott J. Rubin. My business address is 333 Oak Lane, Bloomsburg, PA.

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 the Office of the Attorney General ("AG") to review the testimony, exhibits, and workpapers filed by Commonwealth Edison Company ("ComEd" or "Company") in this case.

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 two committees of the U.S. House of Representatives and one committee of the Pennsylvania House of Representatives. I also have served as a consultant to the staffs of three state utility commissions, as well as to several 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. A copy of my curriculum vitae is attached as AG Exhibit 1.1.

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. Specific to ComEd, I have testified in, or advised the AG about, several ComEd proceedings during the past decade. My work involving ComEd includes testifying in Docket No. 13-0387, the rate design case that gave rise to the current proceeding.

Summary

Q. What is the primary focus of your direct testimony?

A. My testimony concerns ComEd's conclusions about the demand characteristics, cost to serve, and appropriate rate design for the residential customer classes.

Q. Please summarize your recommendations.

A. My recommendations are summarized as follows:

- It is not reasonable to draw conclusions from ComEd's hourly demand data from single-family heating customers because of the very low number of customers sampled. ComEd should be directed to revisit that study after AMI meters are more fully deployed to heating customers.

- ComEd's hourly demand data collected from tens of thousands of residential non-heating customers and multi-family heating customers demonstrate that residential customers' peak demands are almost perfectly proportional to annual energy usage. These data prove the unfairness of straight-fixed variable ("SFV") pricing and, if confirmed in future years, would obviate the need to consider demand rates for residential customers.

- ComEd's studies show that lower-use customers' demand costs are significantly lower than such costs for higher-use customers. This provides further evidence of the unfairness of SFV-type pricing.

- ComEd's studies show that the rate design approved by the Commission in Docket No. 13-0387, which takes effect on January 1, 2015, will equitably collect demand-related costs from all residential customers.

- There is no reason to change the residential rate design ordered in Docket No. 13-0387 or to implement separate rates for lower-use customers.

Overview of ComEd's Load Research Data

Q. Have you reviewed the load research data ComEd provided?

A. Yes. The data were provided in large Microsoft Excel files for each residential customer class: Single Family No Heat ("SFNH"), Single Family Heating ("SFH"), Multi-Family No Heat ("MFNH"), and Multi-Family Heating ("MFH").

Q. How are the data presented?

A. The data are divided into 20 separate groups based on annual energy consumption, arranged from lowest consumption (the 1st through 5th percentiles) to highest consumption (the 96th through 100th percentiles). Within each group, the group's average energy consumption in kilowatt-hours ("kWh") is calculated for each hour of the year. A kilowatt-hour for one hour is a kilowatt ('kW"), which is the standard measure of electricity demand. Thus, the data provide both energy consumption levels and the ability to calculate peak demand.

Q. Are there enough data in ComEd's sample to draw reasonable conclusions about the demand characteristics of different groups of customers within each customer class?

A. Yes, except for the SFH customer class. Table SJR-1 shows the number of customers sampled in each customer class, the total number of customers in the class, and the margin of error at a 95% confidence interval.[1] In statistical analysis, the margin of error at a given confidence interval provides information about the likelihood that the results of a random sample accurately represent the population as a whole.

For example, assume that a sample finds that the average age of the population in Chicago is 40 ± 2 years at a 95% confidence interval. This would mean that if 100 separate random samples of the population in Chicago were taken, 95 of the samples would report an average age between 38 years and 42 years (40 ± 2 years). That is, the smaller the margin of error and the higher the confidence interval, the more assurance we have that the results of a single sample provide a realistic portrayal of the actual population.

[1] The margin of error, also known as the confidence interval, is calculated using the sample size calculator at http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator.

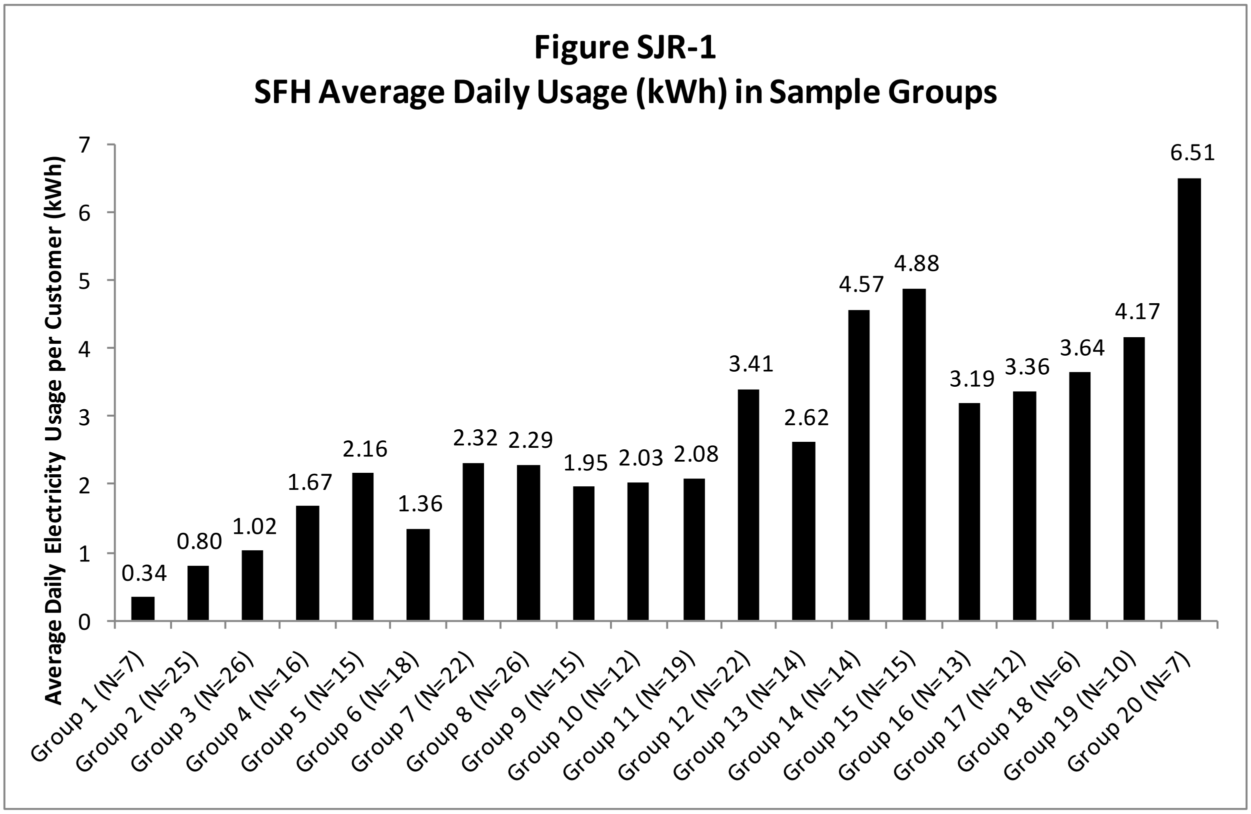
Table SJR-1: Summary of ComEd's Sample Data			
Customer Class	No. of Customers	Sample Size	Class Margin of Error at 95% confidence interval
SFNH	2,249,791	67,467	± 0.4%
SFH	35,237	314	± 5.5%
MFNH	1,055,957	46,538	± 0.4%
MFH	161,093	7,836	± 1.1%

The margins of error in Table SJR-1 are based on the assumption that ComEd is sampling a single group within each customer class to try to determine the characteristics of the average customer in the class. In fact, though, ComEd broke each customer class into 20 separate groups and obtained a separate sample from each group. When the population and sample size are both large (as they are in the SFNH class, for example), then the margins of error would not change significantly when evaluated for each of the 20 subgroups within a class. For example, in the SFNH class each group represents approximately 125,000 customers and ComEd's smallest sample was 1,759 customers. The margin of error for this sample is approximately ± 2.3% at a 95% confidence interval. Thus, the least reliable sample within the SFNH class still provides reasonable assurances that the results of the sample reasonably represent the subgroup as a whole.

The high margin of error and small sample size in the SFH sample, however, indicate that the results of the sample from that customer class might not be representative of the class as a whole, and certainly not when the class is broken into 20 subgroups. Specifically, the samples of particular five-percentile groups within the SFH class have extremely low numbers. Three of the 20 groups within the class have only six or seven meters that were used to represent 1,760 customers.[2] A sample that small has a margin of error of 40% at a 95% confidence interval. This would mean that if a group showed a peak demand of 4 kW, the actual peak demand could be anywhere from 2.4 kW to 5.6 kW which is a very large difference. In other words, we have no idea what the actual subgroups within the SFH class look like. The sample of that class is too small to provide any meaningful information about the actual electricity consumption of customers in the subgroups during the year.

In fact, as one would expect from such small samples, the SFH data do exhibit serious anomalies. Figure SJR-1 shows the average daily consumption per customer in each SFH group. The data are presented in what are supposed to be the lowest to highest usage groups (group 1 is supposed to be the lowest consumption group; group 20 is supposed to be the highest consumption group).

[2] ComEd Ex. 2.05, Sch. 2a, 14:291 shows that there are 35,237 customers in the SFH class. Each subgroup representing 5% of the customers in the class, therefore, would have 1,762 customers.



It is readily apparent that the very small sample size (shown as "N=" after each group on the graph) is leading to inaccurate results. Groups 14 and 15 have higher average daily consumption than groups 16 through 19; group 12 has higher average consumption than groups 13, 16, and 17, and so on.

Q. How large of a sample would be needed to bring the SFH class's results within a reasonable margin of error?

A. In order to have reliable results for the SFH class -- a margin of error of ± 5% for each subgroup -- it would require a sample size of about 315 customers from each subgroup, or about 3,800 customers in total; not the 314 meters actually included in ComEd's sample for the entire class.

Q. Why do you state that a margin of error of plus or minus 5% is a reasonable figure for each subgroup?

A. Plus or minus 5% appears to be a reliable margin of error for an analysis of this type. The difference in average hourly energy usage among the SFH subgroups appears to be 0.5 kWh or less, so the margin of error would be about 0.025 kWh above and below the observed average, or about 0.05 kWh (10% of the average) in total. A margin of this size would help ensure that the data accurately represent the subgroup and do not overlap with the adjacent subgroups.

Q. Can you draw any conclusions for SFH residential customers using such a small sample size?

A. No. The small sample size and resulting margins of error make it impossible to draw any meaningful conclusions about SFH class usage characteristics. I will not perform any additional analyses using the SFH data because the data do not accurately represent the customer class.

Q. What do you recommend with respect to the SFH customer class?

A. I recommend that, if the Commission finds this type of data and analysis to be useful, that the Commission direct ComEd to perform an additional analysis for the SFH customer class. The data should be collected only when ComEd has deployed enough automated metering infrastructure ("AMI") meters within the SFH class to collect a sufficient amount of data for the results to be reasonably representative of the customer class.

Q. Are the data for the other customer classes sufficient to conduct meaningful analyses?

A. Yes, though particular subgroups in the MFH analysis are under-represented in ComEd's sample, leading to margins of error in excess of 10% for two of the subgroups. The remainder of my testimony will discuss ComEd's results for the SFNH, MFNH, and MFH classes.

ComEd's Analysis

Q. What is your understanding of the analysis ComEd performed for this case?

A. As I understand it, ComEd separated each residential customer class into a "low-use" group (the lowest 25% of customers based on annual consumption) and a second group representing the remaining 75% of customers. (ComEd also performed an analysis that separated a "high-use" group -- the largest 25% of customers based on annual consumption, but neither ComEd nor I found that separation to be particularly meaningful, so I will not discuss it further.) ComEd then performed an embedded cost of service study ("ECOSS") using those groupings.

ComEd also developed rate design options based on the low-use class subgroups. Those rate design options include the methodology employed by the Commission in Docket No. 13- 0387 (the methodology I recommended in that case) and a methodology that moves toward SFV pricing (collecting at least 50% of each subgroup's cost of service through fixed charges).

The Flawed Theory of SFV Pricing

Q. What is the general theory behind SFV pricing?

A. SFV pricing is based on the notion that a utility should recover its fixed costs through fixed charges. One significant problem with SFV pricing is defining what costs are "fixed." In the field of economics, whether a cost is fixed or variable depends on the time period being evaluated. If one were evaluating what could happen today, nearly all of a utility's costs would be fixed: it would have a certain number of employees, the wires and transformers all exist, it has a certain amount of paper on hand, and so on.

If, however, one were evaluating what could happen over the next five years, many of a utility's costs would be variable. The size of transformers could be changed, the number of employees could be increased or decreased, computer systems could be upgraded or consolidated, office space could be expanded or contracted, and so on.

Q. Is there a certain type of cost that is important to understand for SFV pricing?

A. Yes. A utility has three general categories of costs: customer-related, demand-related, and energy-related. Both SFV pricing and traditional utility pricing (the method the Commission adopted in Docket No. 13-0387) usually collect customer-related costs through fixed charges (a customer charge and/or meter charge). Both methods collect energy-related costs through variable (per kWh) charges. The essential difference between the two approaches is the treatment of demand-related costs. SFV pricing treats demand-related costs as "fixed" and attempts to collect them through fixed charges. Traditional pricing treats demand-related costs as related to customer demand (or a proxy for customer demand when demand meters are not available) and recovers demand costs through variable charges.

Q. Do customer demands influence the amount of demand-related costs?

A. Absolutely. ComEd witness Robert Garcia acknowledges this in his testimony. First, he states: "Only if demand rises so much that facility additions are required, or if permanent demand falls so much that equipment can be economically downsized or retired, do these [demand] costs change." ComEd Ex. 1.0, 10:201-203. He then explains that "ComEd determines the capacity of that [distribution] system component based on the projected peak load requirement on that component over the long term. The system is thereby designed and sized to be able to serve long-term peak demands." Id., 10:215-217.

Q. What time period does ComEd use in its discussion of SFV pricing?

A. ComEd focuses on the very short run. That is, it assumes that all of the physical equipment, people, office supplies, buildings, and other costs cannot be changed. The only "variable" cost in ComEd's view is Illinois Electricity Distribution Tax which is based on the amount of electricity purchased by customers. Specifically, Mr. Garcia states: "A fixed cost for the purpose of this rate design is a cost that does not vary in the short run with the use of electricity by a customer or class of customers …." Id., 9:193-194.

Q. Does a short-run analysis make sense for a utility?

A. No. The utility business requires long-term investments in plant, equipment, and people. Those investment decisions are based on expectations about the future: the number of customers to be served, the amount of electricity they will use, and what their electrical demands will be during peak periods. Plant and equipment have useful lives of many years and it takes years to train certain types of employees (such as line workers and substation electricians). A utility makes very few decisions based on the short run and it makes no sense to price utility services based on short-run marginal costs.

Q. Do short-run changes in customer demands cause a change in the cost of service?

A. That is a complex question. An electricity distribution system is designed to serve the anticipated peak demands and energy requirements of all customers. Very little if any of that investment is actually "caused" by a single customer. When we talk about the principle of cost causation, we are actually talking about a fair way to allocate shared costs among customer classes and customers.

For example, when a substation is installed in a certain location, it is very unlikely that one customer "caused" that substation to be sized and installed, because the equipment is designed to serve hundreds or thousands of customers. It is the collective peak demands and energy needs of customers that "caused" the equipment to be installed. A change in one customer's usage usually will not "cause" a substation transformer to be made larger or smaller.

That obvious statement, however, misses the point. When we allocate costs among customer classes in a cost-of-service study, we recognize the shared nature of these common costs. When done correctly, we allocate those costs to each customer class in a way that is fair to all customers. In the case of most of the common equipment in an electric distribution system, the costs are allocated based on a measure of peak demand. As. Mr. Garcia states, approximately 80% of distribution facility costs are allocated among customer classes using coincident peak demand ("CP") (that is, each class's contribution to the system's peak demand), with the remaining 20% of distribution costs based on non-coincident peak demand ("NCP") (that is, a customer class's highest demand at any time during the year). ComEd Ex. 1.0, 24:465-466.

That same principle needs to apply when rates are designed. It is illogical and unreasonable to say that the cost of serving residential customers is based, in large part, on demand, but then to design rates using a methodology – SFV --- that ignores demand.

Q. Can you provide an example to illustrate what you mean?

A. Yes, consider this very simple example. Assume we have a utility that has two customer classes, residential and non-residential. Each class has exactly the same peak demand and annual energy consumption: a peak demand of 50 and annual energy use of 1,000 (the units don't matter for this illustration), or total system demand of 100 and total system energy usage of 2,000. Also assume that the residential class has 10 customers, each of whom has exactly the same usage profile -- a peak demand of 5 and annual energy use of 100. To simplify the example, we can also assume that each class peaks at the same time, so NCP and CP are the same.

Based on a demand allocator, each class would be allocated 50% of the cost of a substation, and each of our 10 residential customers should be responsible for exactly the same amount (one-tenth of the class's costs, or 5% of the overall cost of substations).

Now assume that one residential customer decides to buy an electric car, resulting in the customer's annual energy usage and peak demand doubling. So while all other residential customers still have demand of 5 and usage of 100, this one customer has demand of 10 and usage of 200. We can also assume for the sake of this illustration that the utility would not have to install any new equipment to serve this increased demand.

What happens as a result of this one customer's change? System demands increase from 100 to 105. System energy usage increases from 2000 to 2100. The residential share of both demand and energy usage has gone from 50% to about 52.4% (55/105 and 1100/2100). So instead of being allocated 50% of the cost of substations, as used to be the case, the residential class would now be allocated 52.4% of the cost -- all because this one customer increased its demand and energy usage. System costs have not changed at all, but the costs allocated to the class -- which are the costs designed to be collected through rates -- have increased.

This is where rate design plays such an important role. Under SFV pricing, each residential customer would pay exactly the same amount toward the cost of substations. In our example, the residential class's share of costs increases from 50% to 52.4% (almost a 5% increase), so with SFV rates all residential customers' bills would be increased to collect this additional cost of service.

In contrast, under a rate design that mimics the way in which costs are fairly allocated to classes (which is what is meant by cost causation), rates would recognize that the "cost increase" (a shorthand expression for the increase in costs allocated to the class) was caused by just one customer. If substation costs are collected based on a customer's energy consumption or demands, then the customer whose consumption doubled would pay most (or ideally all) of the cost increase. That is exactly what happens under a traditional rate design that collects demand-related costs either through a demand charge (when demand metering is in place) or through an energy charge (when demand-metering is not feasible).

In our example, a proper rate design -- a rate design that is consistent with the cost-of-service study's allocation methodology -- provides a result that is fair to all customers. The customer who caused the residential class's cost allocation to increase bears the responsibility for those increased costs. Other customers, whose demands and energy usage did not change, are not asked to subsidize the high-use/high-demand customer.

Q. Have utility economists evaluated the efficacy of short-run pricing?

A. Yes. To the best of my knowledge, there is no support among reputable public utility economists for setting utility rates based on short-run marginal costs. This notion was floated by a few economists during the 1940s and 1950s and quickly was discredited by those who understood the public utility industry. The essential flaw in pricing electricity distribution service based on short-run marginal cost is that the industry exhibits economies of scale (as one would expect from a natural monopoly). This means that the marginal cost declines as more of the product is supplied (at least up to some point). We see this in the price of nearly every component of the distribution system: installing and maintaining a transformer or distribution wire with twice the capacity of a smaller facility does not result in doubling the cost; indeed, the cost increment often is relatively small compared to the increase in capacity. In an industry that exhibits economies of scale (that is, declining marginal costs for at least a portion of the supply curve), setting prices equal to short-run marginal cost results in the firm being unable to recover its costs. In an industry providing an essential public service like electricity distribution, this is simply untenable, as it would force the utility to go out of business, or at least to stop replacing and maintaining its facilities.

In the first edition of Professor James Bonbright's seminal work, *Principles of Public Utility Rates*, published in 1961, he devotes an entire chapter to the theory of marginal cost pricing. One portion of that chapter (pages 395-399) is a section entitled "Critique of Proposal to Fix Rates at Short-Run Marginal Cost." In his critique, Professor Bonbright explains that pricing based on short-run cost is inconsistent with the long-run time horizon and function of a public utility and the proper setting of utility rates. First, he explains that pricing based on short-run costs would violate consumers' expectations (one of his fundamental principles: rate continuity). Specifically, he writes:

> By and large, the major influence exercised on consumer demand for utility services by any current rates of charge for these services is an influence based on the expectation that these rates indicate, at least in a general way, the rates that will remain in effect over a considerable period of time. For it is the anticipated, fairly long-run costs of service which a potential consumer wisely takes into account when he faces a decision … whether to equip his home with an electric range or with electric space heating; or whether to locate his aluminum plant on the St. Lawrence River rather than in the state of Washington. Once having become dependent on the services required for the operation of expensive complementary equipment, the consumer's responsiveness to temporary changes in rates of charge will probably be very limited. In short, the price elasticity of demand for utility services can be expected to be much greater in the fairly long run than in the very short period of time. But if utility rates were to be made as volatile as would be required by the mandate of conformity to short-run marginal costs, they would deprive consumers of those expectations of "reasonable continuity" of rates and of rate relationships on which they must rely in order to make rational advance preparations for the use of service.[3]

Professor Bonbright also explains that short-run marginal cost pricing of utility services (because of the economies of scale) would require some type of payment to the

[3] James C. Bonbright, *Principles of Public Utility Rates* (New York, NY 1961), pp. 396-397 (emphasis added).

utility to recover the remainder of its revenue requirement. Some economists suggested that a tax payment should be made while others suggested that a large fixed charge could be imposed by the utility (that is, a rate design similar to SFV pricing). Professor Bonbright explained that such a charge or tax would be unfair to those who did not consume the product or who consumed relatively little of it. That unfairness is not just a social welfare concern, but a fundamental economic concern: requiring a non-user (or low user) of a service to subsidize the service for those who use it more does not increase overall economic welfare; rather, it transfers the "consumer surplus" (that is, the benefits of a service in excess of the costs paid for the service) from one group of customers (the low users) to another group (the large users).[4]

Professor Robert Harbeson, an economist specializing in utility regulation at the University of Illinois starting in the 1950s (and to whom Bonbright cites) explicitly addressed this concern in a paper published in 1955.[5] Professor Harbeson discusses proposals to implement a two-part utility tariff consisting of a charge to "assess the portion of the costs which varied with output and would be based on marginal cost" and the second part that would "assess the portion of the costs which were independent of output" – that is, the type of SFV pricing ComEd advocates. Professor Harbeson explains that this type of two-part tariff would be reasonable only on the condition that "the individual's share of the fixed costs must be arrived at voluntarily on the basis of individual negotiation; only in this way can we be certain that the contributions of the

[4] Id., p. 397.
[5] Robert W. Harbeson, A Critique of Marginal Cost Pricing, *Land Economics*, 31:1:54-74 (Feb. 1955).

individual users toward the fixed costs do not exceed their respective estimates of the utility of the project to themselves, and hence that there has been an increase in welfare."[6]

Professor Harbeson recognized this would not be possible when there are a large number of users, but he explained that if the fixed-cost component is not individually negotiated, it would have the same economic effect as a tax: transferring consumer welfare from non-users (or low users) to large users of the service.[7] As he states: "a lump-sum tax is likely to exceed consumers surplus for some individuals and to fall short of consumer surplus for others and no conclusion can be reached as to whether or not welfare has been increased …."[8]

In short, economists considered and rejected ComEd's type of pricing proposal more than 50 years ago. SFV pricing lacks any reasoned basis in economic theory. Such a pricing scheme is not more efficient and is not fairer to customers. In fact, exactly the opposite is true: pricing that assumes each customer is responsible for the same amount of demand-related costs is inherently unfair -- it recovers excessive costs from low-demand customers and fails to recover the cost of service from high-demand customers. Economists who have studied this problem concluded that SFV pricing is simply a method of transferring wealth (or consumer surplus) from one group of customers to another. There is no discernible increase in overall societal welfare and no improvement in the efficiency of use of the utility's service. In fact, such a pricing proposal could lead consumers and utilities to make decisions that are not in their long-run best interests.

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[6] Id., p. 61.
[7] Id.
[8] Id., p. 60.

Indeed, a critical flaw in the SFV methodology is that it ignores the fact that electricity distribution service is, by its very nature, a long-run service.

Q. Are Professors Bonbright and Harbeson the only utility economists that have addressed this issue?

A. No. Professor Charles Phillips also discusses marginal cost pricing in his comprehensive book, *The Regulation of Public Utilities: Theory and Practice*. Professor Phillips writes:

> On balance, should minimum rates be determined by short-run or long-run marginal costs? Despite the greater difficulty in measurement, most economists would probably favor the long-run. In using the concept of long-run marginal costs, the added costs of providing a service (e.g., the additional operating expenses and the cost of any additional construction, including a full rate of return thereon) would be taken into account. Only when a firm has significant and continuing excess capacity (such as off-peak periods) may short-run marginal costs be a better guide to pricing decisions.
>
> It is important to emphasize, however, that marginal costs set the lower boundary – the floor below which rates should not fall. But they should not determine rates, since the upper boundary is set by demand conditions and regulation.[9]

Q. What do you conclude about the reasonableness of using SFV-type pricing; that is, setting rates based on short-run marginal costs, as ComEd proposes?

A. The use of short-run marginal cost for utility rate-setting was discredited more than 50 years ago and there is no need to resuscitate that proposal today. It simply is not proper to use short-run marginal costs to set utility rates. Moreover, the use of such costs in setting utility rates would require sizeable lump-sum payments from customers (as ComEd is proposing in its SFV-type pricing) that do nothing to promote economic

[9] Charles F. Phillips, Jr., *The Regulation of Public Utilities: Theory and Practice* (Arlington, VA, 3rd ed. 1993), p. 449 (emphasis added).

efficiency and are not consistent with the cost of service. They are simply transfer payments (equivalent to taxes) from low-demand customers to high-demand customers. Not only do such payments have no net effect on social welfare, they can encourage high-use customers to use even more electricity, which is directly contrary to the promotion of energy efficiency.

Residential Energy Consumption as a Proxy for Demand

Q. Is demand measurement important to determining an appropriate rate design?

A. Yes. As discussed above, the critical difference between SFV rate design and traditional rate design is the treatment of demand-related costs. Pure SFV pricing collects all demand-related costs on a per-customer basis (that is, each customer pays the same amount). Traditional rate design collects demand-related costs through a per-kWh charge, so that customers who use more electricity pay more toward demand-related costs. ComEd's ECOSS shows that more than 50% of ComEd's residential cost of service is demand-related. ComEd Ex. 2.05, Sch. 2a, 13:279:284 (the largest residential class, SFNH, has distribution [or demand] related costs of $663,649,234 out of a total cost of service of $1,102,560,002, or 60.0%).

Q. Do most residential customers have demand meters?

A. Historically, no. With the advent of so-called "smart meters," or Advanced Metering Infrastructure (AMI), the capability will exist to measure individual residential customers' demands.

Q. Without demand meters, how are residential customers' demands estimated?

A. Residential class demands are estimated through load research studies. Until this case, however, ComEd has not provided data that would make it possible to estimate individual residential customers' demands.

Q. Without individual customer demand measurements, is there a reasonable way to estimate those demands?

A. In the past, I have used monthly billing data to show that peak demand appears to be proportional to annual energy consumption. That is, lower-use customers have peak-month demands that are much lower than the peak-month demands of higher-use customers. Such an analysis is not as precise as demand meters would provide, but it was the best that could be done with the available data.

Q. Has ComEd provided data in this case that shows the relationship between energy consumption and peak demand?

A. ComEd has provided data for each of 20 groups of customers within each residential customer class. Each group is a sample that is supposed to represent five percent of the customers in the class, arranged from lowest consumption to highest consumption. As I discussed above, however, some of those samples are much too small to accurately represent 5% of the customers in a class. For the largest customer class, SFNH, each group represents approximately 125,000 customers. ComEd's data provides actual hourly meter readings for an entire year for between 1,700 and 4,000 customers in each group. For the other customer classes, the groups and sample sizes are smaller, as I discuss below.

Q. Before you discuss the details for each customer class, why are these new data important?

A. These data are important because they allow us to see, for the first time, the actual relationship between residential customers' energy consumption and the contribution to class or system-wide peak demand. If, as I estimated in previous cases, customers' peak demands are closely related to energy consumption, then this would confirm the reasonableness of traditional rate design that collects demand-related costs on a per-kWh basis. If, however, customers' contributions to peak demand were largely unrelated to annual energy consumption, then it would lend credence to ComEd's advocacy of SFV-type pricing that collects demand-related costs in roughly equal amounts from each customer.

SFNH

Q. Have you analyzed the data from ComEd's SFNH class?

A. Yes. The data were provided in ComEd's workpapers in the file-: *ComEd Ex. 2.0 WP 7 (ComEd Ex 2.04 C23 SFNH AMI Profiles).xlsx*. The data appear on tabs numbered 1 through 20, with each tab representing a group of 5% of the class's customers, or approximately 112,000 customers. The sample sizes range from 1,759 customers in group 1 to 4,024 customers in group 4. In total, data were collected from 67,467 customers for each hour of the year.[10] The margins of error of the samples within each subgroup range from 1.5% to 2.3% which provide reasonably reliable results.

[10] Technically, ComEd collected data from meters, not customers. If a residence changed ownership during the year, a single meter might represent data from more than one customer, but each for a partial year. For simplicity, I will refer to customers rather than meters.

Q. How did you use these data?

A. I compiled the hourly consumption data for each group into a single data set (or spreadsheet), so the data set consists of 8,760 rows (one for each hour of the year) and 20 columns (one for each customer group). The data points (or cells in a spreadsheet) are average electricity consumption in kWh in that hour. ComEd calculated these averages by taking the total consumption from all customers sampled and dividing that figure by the number of customers.

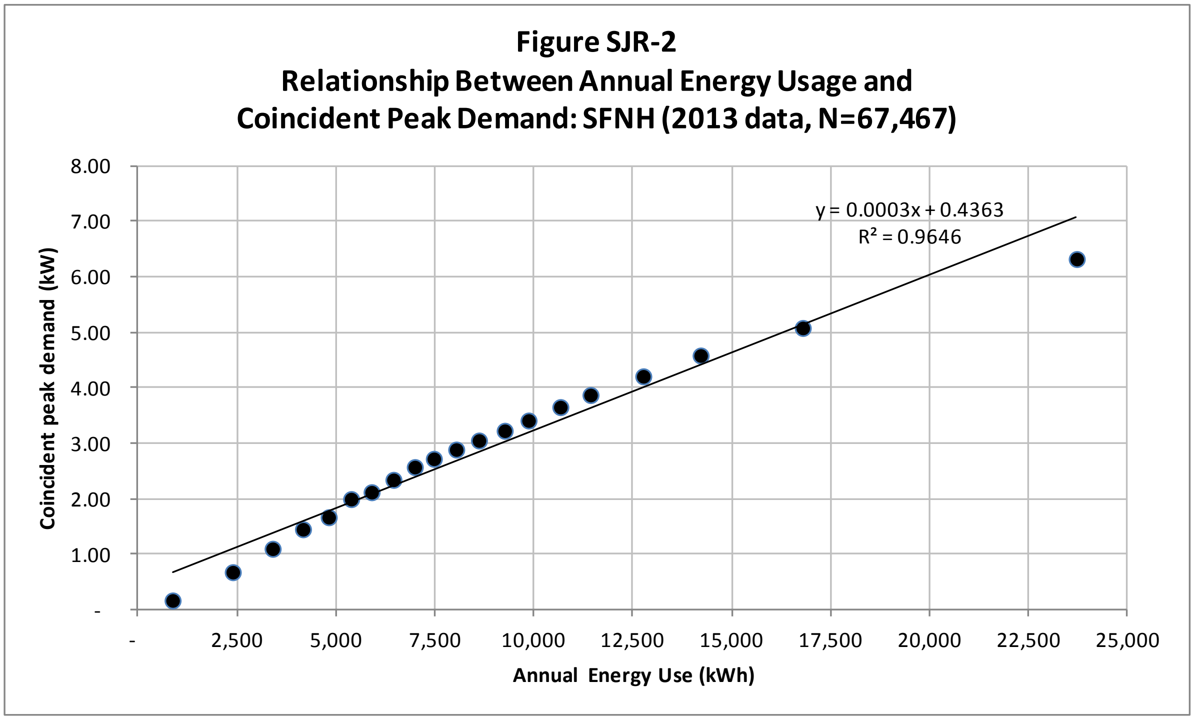
I then calculated the total annual energy consumption per customer for each customer group. I also calculated each group's contribution to the system-wide peak (the CP) and the class's peak (the NCP) demands.

ComEd's workpapers show that the system coincident peak occurred on July 18 at 1800 hours (6:00 p.m.). I calculated from the data set that the SFNH class NCP occurred on July 19 at 1900 hours (7:00 pm).

I determined each group's contribution to the system and class peaks, plotted them against annual (per customer) energy consumption, and then plotted a trend line to show the relationship between the two. The trend line is a linear regression analysis. The results of a linear regression show the intercept (the hypothetical demand associated with zero energy consumption), the slope (the amount by which demand changes with each increase of 1 kWh in annual energy consumption), and the R-squared (R^2) which measures the "goodness of fit" or the amount of variance between each data point and the trend line. The higher the R^2, the closer the line fits the data.

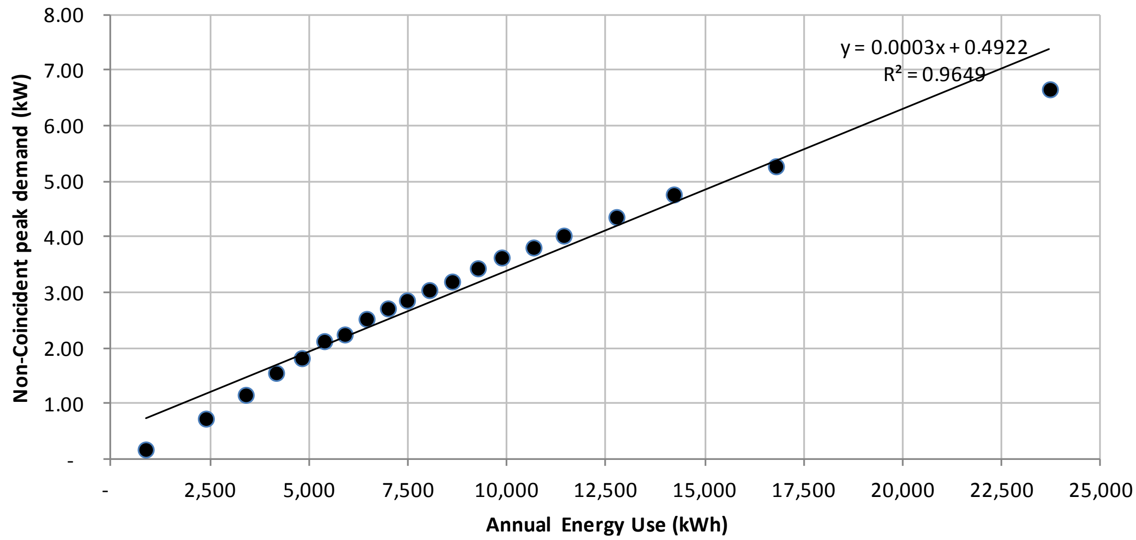
Q. What are the results of your analysis for the SFNH class?

A. The results of my analysis for the SFNH class are shown on Figures SJR-2 and SJR-3 (CP and NCP, respectively).[11]



[11] Each of the following graphs shows the sample size in the title ("N=").

Figure SJR-3
Relationship Between Annual Energy Usage and Non-Coincident Peak Demand: SFNH (2013 data, N=67,467)



This analysis shows that there is almost a perfect linear relationship between annual energy consumption and a customer's contribution to either system-wide (CP) or class (NCP) demand. In each instance, the R^2 exceeds 96% which means that the trend line provides an excellent representation of the actual, observed data. Indeed, the equations for both the CP and NCP analyses show that as a customer's annual energy consumption increases by 1 kWh, the customer's contribution to the system's or class's peak demand increases by 0.0003 kW. In more readily understandable terms, for each 1,000 kWh increase in annual consumption, a customer's contribution to peak demand increases by 0.3 kW. So a customer who uses 10,000 kWh annually will have a peak demand that is approximately 1.5 kW higher than a customer who uses only 5,000 kWh annually.

Q. Why is this analysis, which reveals a near-perfect linear relationship between annual energy consumption and a customer's contribution to either system-wide (CP) or class (NCP) demand, important?

A. This analysis is important because it demonstrates that a customer's annual energy consumption serves as a reasonable proxy for the customer's contribution to peak demand. With a statistical relationship this strong, it may not be necessary to go to the expense (not to mention potential customer confusion) of measuring individual customers' demands and developing residential demand charges. These data show that collecting demand-related costs on a per-kWh basis is fair to customers because those customers who use more electricity on an annual basis contribute more to demand-related costs in a directly proportional manner.

This analysis also highlights the fallacy of SFV pricing. As I explained above, SFV pricing is based on the theory that each customer should bear an equal responsibility for demand-related costs. These data conclusively show that customers' demands are nowhere near equivalent because those customers who use more electricity also contribute more to peak demands. SFV pricing is not consistent with principles of cost causation that direct us to collect costs in a manner that bears a reasonable relation to the manner in which they are incurred. Demand-related costs account for more than half of all residential costs, and they are not incurred equally for each customer -- those customers who use more electricity contribute more to peak demands in direct proportion to their increase in energy consumption.

MFNH

Q. Did you perform a similar analysis for the MFNH class?

A. Yes. I performed the same type of analysis comparing annual energy consumption to peak demand for the MFNH class. I followed the same methodology I explained above. The data were provided in ComEd's workpapers in the file *ComEd Ex. 2.0 WP 8 (ComEd Ex 2.04 C24 MFNH AMI Profiles).xlsx*. The data appear on tabs numbered 1 through 20, with each tab representing a group of 5% of the class's customers, or approximately 53,000 customers. The sample sizes range from 911 customers in group 1 to 2,959 customers in group 14. In total, data were collected from 46,538 customers for each hour of the year. The margins of error of the samples within each subgroup range from 1.8% to 3.2% which provide reasonably reliable results.

Q. What are the results of your analysis for the MFNH class?

A. The results of my analysis for the MFNH class are shown on Figures SJR-4 and SJR-5 (CP and NCP, respectively). For reference, the time of the system peak (CP) is the same for all classes (July 18 at 1800 hours); based on the data set, the MFNH class NCP occurred on the same day four hours later (2200 hours).

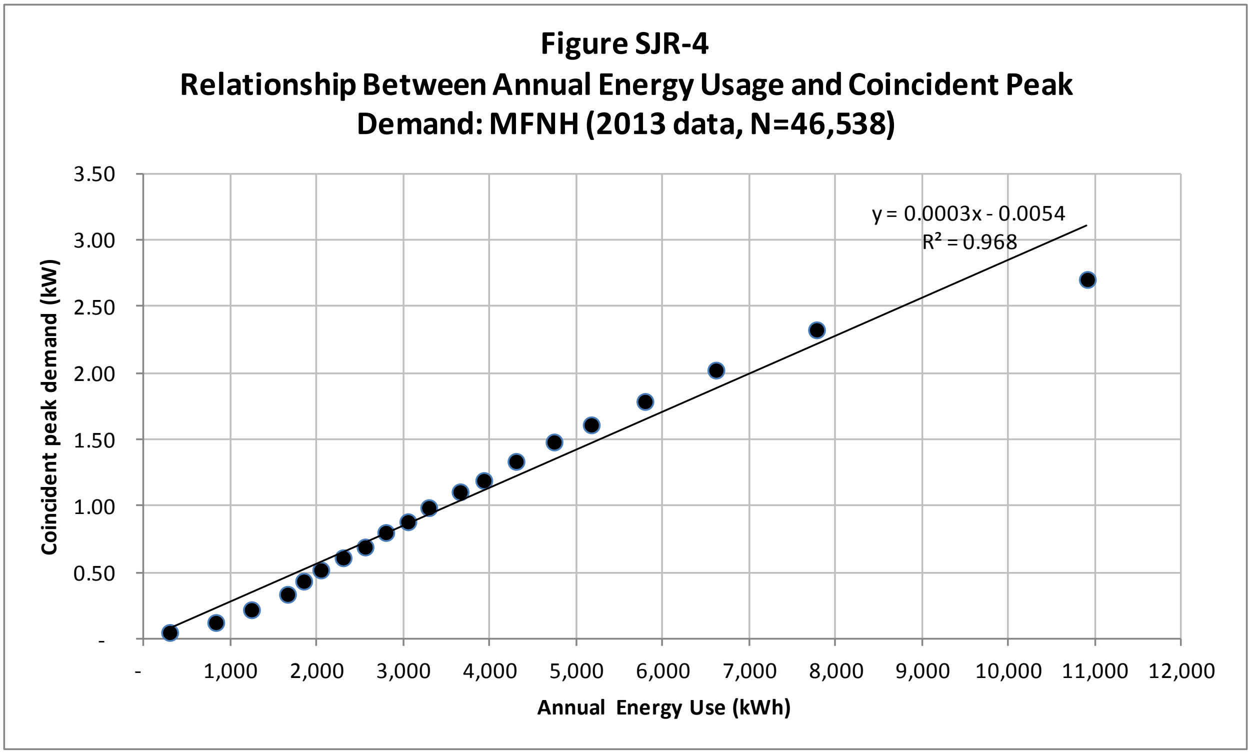


Figure SJR-4
Relationship Between Annual Energy Usage and Coincident Peak Demand: MFNH (2013 data, N=46,538)

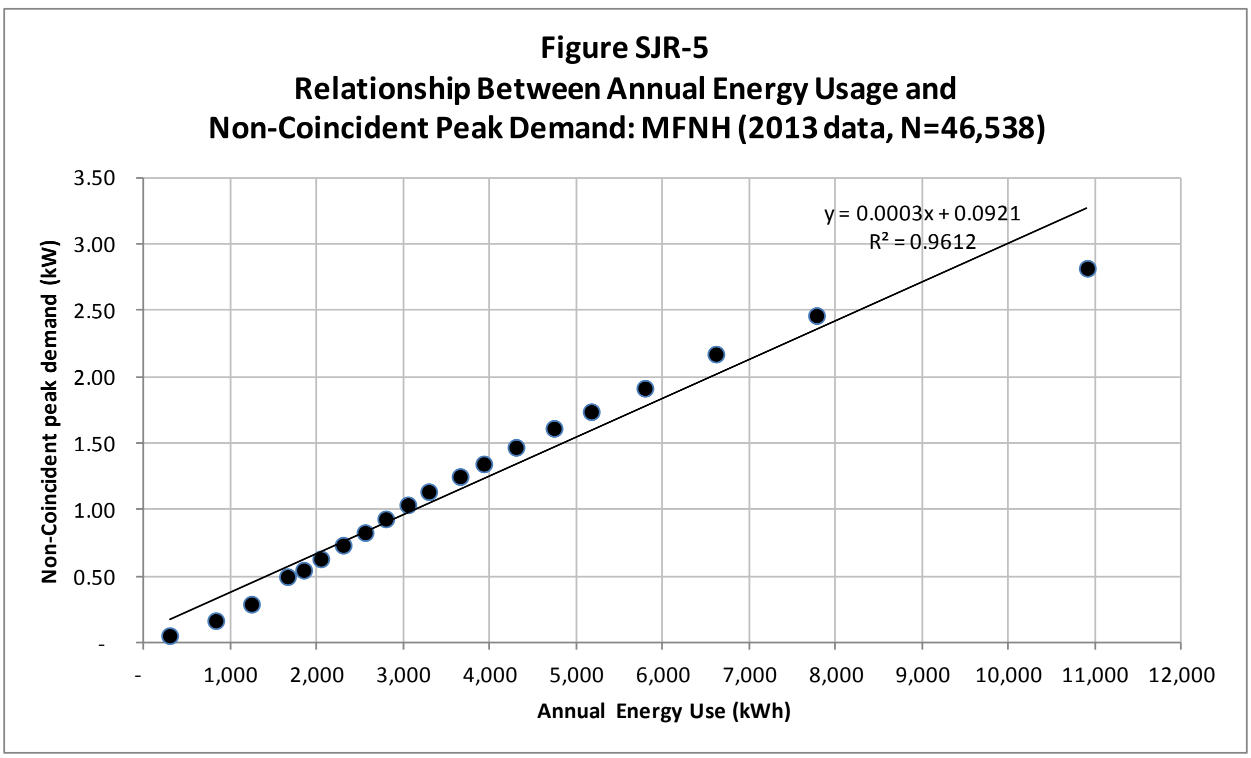


Figure SJR-5
Relationship Between Annual Energy Usage and Non-Coincident Peak Demand: MFNH (2013 data, N=46,538)

The results for the MFNH class are almost identical to those for the SFNH class analysis. There is almost a perfect linear relationship between annual energy consumption and a customer's contribution to either system-wide (CP) or class (NCP) demand. In each instance, the R^2 exceeds 96% which means that the trend line provides an excellent representation of the actual, observed data. Indeed, the equations for both the CP and NCP analyses show that as a customer's annual energy consumption increases by 1 kWh, the customer's contribution to the system's or class's peak demand increases by 0.0003 kW (a customer whose annual energy consumption increases by 1,000 kWh will see an increase in peak demand of 0.3 kW).

Thus, like the results in the SFNH class, these data conclusively show that (1) customers' demands are nowhere near equivalent because those customers who use more electricity also contribute more to peak demands; and (2) a customer's annual energy consumption serves as a reasonable proxy for the customer's contribution to peak demand.

MFH

Q. Did you perform a similar analysis for the MFH class?

A. Yes. I performed the same type of analysis comparing annual energy consumption to peak demand for the MFH class. I followed the same methodology I explained above. The data were provided in ComEd's workpapers in the file *ComEd Ex. 2.0 WP 10 (ComEd Ex 2.04 C26 MFH AMI Profiles).xlsx*. The data appear on tabs numbered 1 through 20, with each tab representing a group of 5% of the class's customers, or approximately 8,000 customers. The sample sizes range from 58 customers in group 1 to 3,851 customers in group 3, with most groups having a sample between 175 and 250 customers. In total, data were collected from 7,836 customers for each hour of the year.

The margins of error of the samples within each subgroup range from 1.1% to 12.9%, with most of the subgroups' margins of errors in the 6% to 7% range. I will discuss the results of my analysis of ComEd's data for the MFH class, but I am concerned about the reliability of some of the data given the relatively small sample sizes and higher margins of error. If the Commission finds this type of analysis useful and would want to see it replicated in future cases, then ComEd should be directed to provide data from a larger sample of customers within the subgroups in the MFH class.

Q. What are the results of your analysis for the MFH class?

A. The results of my analysis for the MFH class are shown on Figures SJR-6 and SJR-7 (CP and NCP, respectively). The time of the system peak (CP) is a summer peak that is the same for all classes (July 18 at 1800 hours); based on the data set, the MFH class NCP occurred during the winter (January 22 at 800 hours).

Figure SJR-6
Relationship Between Annual Energy Usage and Coincident Peak Demand: MFH (2013 data, N=7,836)

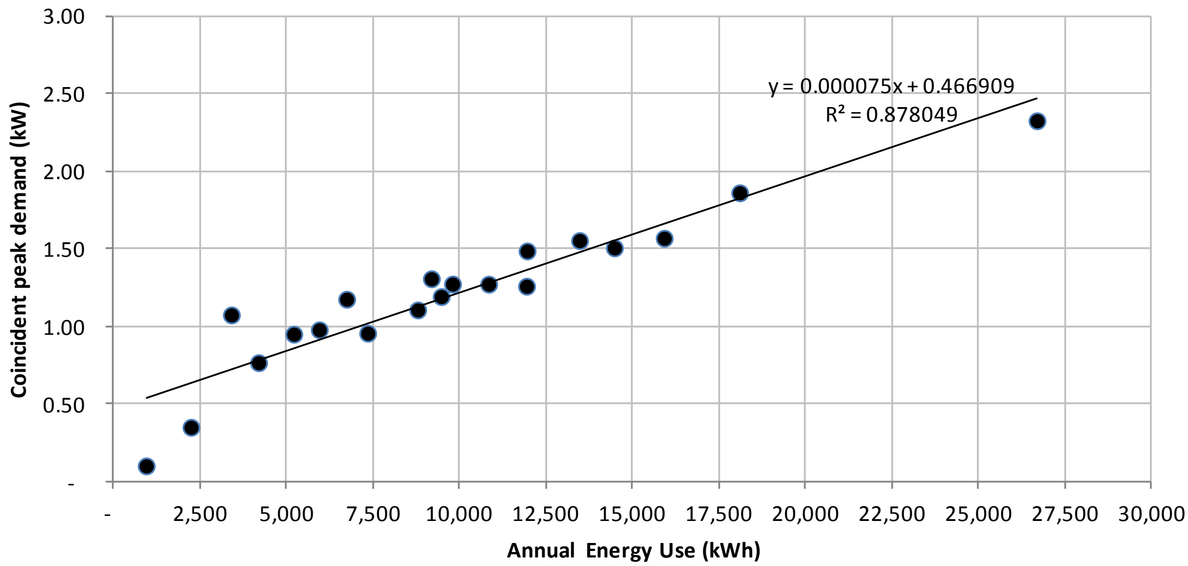
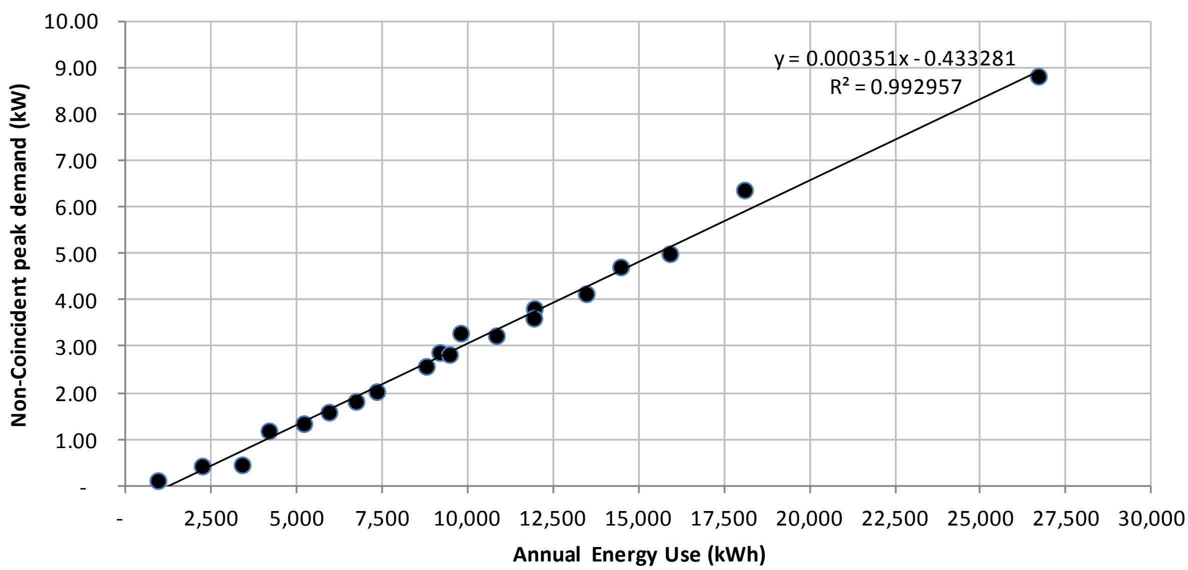


Figure SJR-7
Relationship Between Annual Energy Usage and Non-Coincident Peak Demand: MFH (2013 data, N=7,836)



As was the case with the SFNH class and the MFNH class analyses, the analysis for the MFH class shows that there is an excellent linear relationship between annual energy consumption and a customer's contribution to either system-wide (CP) or class (NCP) demand. Because the MFH class is a winter-peaking class, the relationship between annual energy consumption and the system peak (which occurred in the summer) is less strong, but still quite robust with an R^2 of approximately 88%. The relationship between annual energy usage and the class NCP is almost perfect with an R^2 exceeding 99%.

The equation for the CP analysis shows that an increase in a customer's annual energy consumption of 1,000 kWh would increase the customer's contribution to the summer peak demand by about 0.07 kW. A similar increase of 1,000 kWh in annual energy usage would increase the customer's contribution to the winter NCP by approximately 0.35 kW.

Thus, like the results in the SFNH and MFNH classes, these data show that (1) customers' demands are nowhere near equivalent because those customers who use more electricity also contribute more to peak demands; and (2) a customer's annual energy consumption serves as a reasonable proxy for the customer's contribution to peak demand.

Summary of Demand Analyses

Q. What do you conclude from the analyses of data for the SFNH, MFNH, and MFH customer classes?

A. The analyses show that there is an excellent linear relationship between annual energy consumption and a customer's contribution to either system-wide (CP) or class (NCP) demand for each customer class. For the non-heating classes, the changes in contribution to both system peak (CP) and class peak (NCP) are similar: a 1,000 kWh increase in annual energy consumption is associated with a 0.3 kW increase in the customer's contribution to demand. For the heating class, a similar relationship holds for the class NCP, but the contribution to the summer system peak is lower (only about 0.07 kW per 1,000 kWh increase in annual energy usage).

Importantly, the analyses demonstrate that a customer's annual energy consumption serves as an excellent proxy for the customer's contribution to peak demand. In each of these customer classes, therefore, it is reasonable to collect demand-related costs on a per-kWh basis. Doing so will result in cost-based rates that are fair to all customers -- those who use more electricity on an annual basis cause more demand-related costs on the distribution system. The relationship is linear and quite strong.

Finally, as I explained above, these analyses highlight the inherent fallacy of SFV pricing. SFV pricing assumes that each customer should bear an equal responsibility for demand-related costs. These data show that customers' demands are nowhere near equivalent. Customers who use more electricity contribute more to peak demands. SFV pricing, is not consistent with principles of cost causation that direct us to collect costs in a manner that bears a reasonable relation to the manner in which they are caused. Demand-related costs account for more than half of all residential costs, and they are not incurred equally for each customer -- customers who use more electricity contribute more to peak demands in almost direct proportion to their increase in energy consumption.

ComEd's ECOSS Analyses

Q. Did you review ComEd's ECOSS analyses?

A. Yes, I did. Those analyses are sponsored by Mr. Tenorio as ComEd Exhibits 2.05, 2.06, and 2.08.

Q. How are those studies organized?

A. ComEd Exhibit 2.05 is the base ECOSS, meaning that it is based on the current customer class structure of four residential classes (SFNH, SFH, MFNH, SFH), with all customers within a class being on the same rate schedule. ComEd Exhibit 2.06 illustrates the changes that would occur if a low-use subgroup were established in each residential class, meaning that there would be eight residential classes and rate schedules. ComEd Exhibit 2.08 illustrates what would happen if each rate schedule were broken into three parts: a low-use group, a high-use group, and the remaining customers. This option would result in 12 residential classes and rate schedules.

Q. Based on your findings about the relationship between energy consumption and demand, is there any reason to subdivide the residential classes into smaller groups?

A. No. My analysis shows that because of the very strong relationship between annual energy consumption and contribution to class and system-wide peak demands, there is no reason to separate low-use from higher-use customers within a customer class. The differences in the cost of serving those types of customers are almost exclusively demand-related. Because of the direct linear relationship between annual energy use and demand, collecting demand-related costs on a per-kWh basis is fair to all customers, regardless of usage, and will result in cost-based rates for all customers. There is no need to complicate the ratemaking process, develop multiple rates schedules within each class, or move customers from one rate schedule to another based on their annual consumption. If demand-related costs are collected on a per-kWh basis -- as they will be starting January 1, 2015, under the rate design ordered by the Commission in Docket No. 13-0387 -- rates will reasonably reflect the cost of serving each residential customer.

Q. Does ComEd's two-group ECOSS provide data to support your approach?

A. Yes. ComEd's two-group ECOSS (ComEd Ex. 2.06) shows that demand-related costs for low-use customers in each rate class are much lower than demand-related costs for higher-use customers in the class, and are proportional to energy consumption.

For example, under the two-group ECOSS analysis the SFNH class would be divided into two groups. The low-use group would have 561,948 customers, while the remaining group would have 1,685,843 customers. ComEd Ex. 2.06, Sch. 2a, 19:291. That is, the low-use group accounts for approximately 25% of the SFNH customers.

Those low-use customers, however, have total demand-related costs of only $54,517,110, while the other customers have demand-related costs of $609,140,769. Id., Sch. 2a, 19:282. That is, 25% of the customers are responsible for only 8.2% of demand-related costs.

Similarly, those low-use customers use only 7.6% of the electricity in the SFNH class (1,562,766,875 kWh for the low-use customers; 18,999,955,171 kWh for the remaining 75% of customers). Id., Sch. 2a, 19:289.

In other words, the proportion of demand-related costs allocated to the low-use customers is nearly the same as the proportion of the class's electricity (kWh) used by the low-use customers. Collecting demand-related costs on a per-kWh basis makes sense and is consistent with cost-causation principles.

In contrast, SFV pricing would have collected 25% of demand-related costs from the 25% of customers placed in the low-use group. The ECOSS demonstrates, however, that those customers should be responsible for only 8% of those demand-related costs, as noted above. As economists have stated for more than 50 years, setting rates based on short-run variable costs would greatly over-collect costs from low-use customers and under-collect costs from higher-use customers. Such subsidies are not consistent with either economic theory or sound ratemaking practices.

Conclusion

Q. What is your conclusion?

A. I conclude that the Commission need not create a separate low-usage class nor change the residential rate design ordered in Docket No. 13-0387. That rate design is based on sound cost-of-service and ratemaking principles. As noted above, ComEd's own ECOSS and low-use customer study reveal the near-perfect linear relationship between usage and contribution to peak demand. The new data provided by ComEd in this case confirm and highlight the wisdom of the Commission's decision to reject SFV-type pricing.

Q. Does this conclude your direct testimony?

A. Yes, it does.