PECO ENERGY COMPANY
STATEMENT NO. 3

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

PETITION OF PECO ENERGY COMPANY
FOR APPROVAL OF ITS
SMART METER TECHNOLOGY PROCUREMENT AND
INSTALLATION PLAN

DOCKET NO. M-2009-2123944

DIRECT TESTIMONY
SUPPORTING PECO'S PETITION FOR APPROVAL OF
ITS INITIAL DYNAMIC PRICING AND CUSTOMER
ACCEPTANCE PLAN

WITNESS: DR. AHMAD FARUQUI

SUBJECT: METHODOLOGY USED TO
DERIVE DYNAMIC PRICING
RATE DESIGNS

DATED: OCTOBER 28, 2010

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DIRECT TESTIMONY
OF
DR. AHMAD FARUQUI

I. INTRODUCTION AND PURPOSE OF TESTIMONY

1. Q. Please state your full name, title and business address.

A. My name is Dr. Ahmad Faruqui. I am a Principal with The Brattle Group, a consulting firm with offices in the United States and Europe. My business address is 353 Sacramento Street, Suite 1140, San Francisco, California 94111.

2. Q. Please describe your qualifications.

A. I have three decades of research and consulting experience in the design and evaluation of demand-side programs and have authored or co-authored over 100 papers and edited or co-edited four books on the topic. This year I assisted the Federal Energy Regulatory Commission ("FERC") in developing the National Action Plan for Demand Response. Last year, I assisted FERC in conducting a state-by-state assessment of the potential for demand response and dynamic pricing programs. I also wrote a whitepaper for the Edison Electric Institute on quantifying the benefits of dynamic pricing. During the past few years, I have worked for several utilities, Independent System Operators/Regional Transmission Organizations and state/provincial commissions in assessing the benefits of dynamic pricing by designing pilot programs and conducting cost-benefit analyses. I hold a doctoral degree in economics from The University of California at Davis.

3. Q. What is the purpose of your direct testimony?

A. The purpose of my testimony is to describe the methodology that was used to derive the dynamic pricing rate designs that are being recommended for deployment in PECO Energy Company's ("PECO's") Initial Dynamic Pricing and Customer Acceptance Plan ("Plan"). There is a wide range of dynamic pricing rate designs which could be offered by PECO, and each option brings with it a unique set of advantages and disadvantages. Carefully selected and well designed rates can satisfy a broad range of objectives and provide customers with significant incentives to participate and benefit. In my testimony, I will lay out that rate selection and design process.

4. Q. What are the basic conclusions of your testimony?

A. I conclude that there are two types of dynamic pricing rates that PECO should offer to customers in its Plan. The first, called a critical peak pricing ("CPP") rate, provides customers with an opportunity to lower their electricity bill by reducing usage during a limited number of hours on "event" days when peak demand reductions are most valuable from a power system perspective. The second rate is a simple Time-of-Use ("TOU") rate, designed to encourage permanent load shifting away from high priced hours during every weekday.

5. Q. How is your testimony organized?

A. The remainder of my testimony is organized into five sections. The first section describes the rate screening and selection process. The second section provides detail on how the recommended rates were designed. The third section includes projections of how, on average, participating customers will change their usage profiles in response to the new rates. The fourth section provides a detailed look at how customer bills will be affected when customers enroll in the new rates. Finally, the fifth section provides a summary of my basic conclusions and recommendations.

6. Q. Have you prepared exhibits to accompany your testimony?

A. Yes. I have provided a series of exhibits to graphically illustrate key aspects of my testimony. They are included as PECO Exhibits AF-1 through AF-21.

II. EVALUATING DYNAMIC PRICING RATE OPTIONS

7. Q. What were the steps you took in arriving at the recommended dynamic pricing rate options?

A. The first step was to identify the universe of possible rate options for consideration. Then, criteria were established for evaluating these options against the objectives of the Plan. Each rate option was subjectively screened against these criteria based on existing research and my own judgment and experience developing these rates for other utilities across North America. Based on this initial screening, prototypes of the more attractive rate options were developed and presented at a series of stakeholder

meetings. Stakeholder feedback was incorporated into the analysis, and the rate prototypes were refined to arrive at the final recommendations.

8. Q. Which dynamic pricing rate designs were considered in your analysis?

A. My analysis began by considering a broad spectrum of time-varying rates, ranging from a TOU rate to what is called a critical-peak real-time pricing ("CP-RTP") rate structure (which couples hourly price variation with strong price signals during event periods). Descriptions of each rate type are provided in PECO Exhibit AF-1. These rates have many distinguishing features, such as the type of price signal they provide (higher peak price versus rebate payment for load curtailment), the granularity of the pricing periods (two periods, three periods, or hourly), and the frequency of the pricing periods (every weekday versus during a limited number of days in the summer).

9. Q. What criteria did you use to evaluate these rate designs?

A. Five key criteria were established to determine whether the rates were consistent with PECO's corporate goals and in the best interest of its customers. These criteria are as follows:

1. Simplicity and ease of understanding: Will customers be able to quickly understand the rate? Is it actionable?;

2. Customer value proposition: Does the rate provide customers with a significant bill savings opportunity?;

3. Retail-wholesale market connection: Does the rate tie the structure directly to the wholesale market; are rates developed consistently with how the Company is procuring power through its approved default service plan?;

4. Incentive to reduce peak demand: Is the rate expected to produce significant reductions in peak demand?; and

5. Incentive for permanent load shifting: Will the rate encourage customers to permanently shift load from higher cost hours to lower cost hours?

10. Q. What conclusions did you reach based on your evaluation of the array of time varying-rates?

A. Each rate design was subjectively evaluated against the five criteria. The evaluation used a score of "high," "medium," or "low" to represent how well the rates met each of the criteria. The foundation for the scores was an intuitive understanding of each rate design based on my experience designing and evaluating these rates for utilities in the Northeast and across North America and is supported by published research on the topic. PECO Exhibit AF-2 summarizes the results of the evaluation of the most attractive rate options.

My evaluation identified four rate designs that initially appeared to do the best job of meeting PECO's objectives for the Plan. These are CPP, CPP-TOU, peak time rebates ("PTR"), and CP-RTP. The CPP rate would provide a strong demand response signal and, therefore create significant bill savings opportunities for customers. The CPP-TOU provides a similar demand response signal and also

includes a TOU component that would incentivize permanent load shifting and further bill reduction opportunities. The CP-RTP also provides similar opportunities for bill reduction. Finally, the PTR is an attractive alternative in the sense that it cannot lead to bill increases relative to the existing rate.

Further examination of these rate options led to a preliminary conclusion that both CPP and CPP-TOU be included in the Plan as the best candidates for testing customer response and acceptance. While the CP-RTP would provide the most granularity by offering hourly prices, hourly price variation likely entails too much uncertainty and risk for residential and smaller commercial customers who have been enrolled in flat rates for decades.

An analysis of the PTR suggested that, while it serves as a form of bill protection, the design inherently includes a number of implementation challenges that stem from the need to estimate an individual baseline usage level for every participant in order to calculate the participant's rebate amount. All baseline estimation methods are only an approximation and would ultimately result in some level of free-riding (when customers are paid rebates in the absence of any change in behavior), and this would have to be funded by non-participants. CPP and CPP-TOU rates do not present these issues.

11. Q. Have your recommendations changed due to stakeholder input?

A. Yes. The rates were presented at a series of stakeholder meetings to solicit feedback on the rate designs, particularly with respect to the perceived attractiveness of the rate

structures to customers. Some stakeholders felt that there were significant customer acceptance barriers if only dynamic rate structures with a critical peak pricing ("CPP") component were offered. They further suggested that just offering a TOU would be a good first step into dynamic pricing because the simplicity of the TOU rate is more attractive. To address the concerns of the stakeholders and maintain a program design that evaluates both moderate and strong price signals, we decided to replace the original CPP-TOU option with a TOU structure. The resultant offering has the benefit of providing a load shifting incentive in the TOU rate and a demand response incentive in the CPP rate. Including both a CPP and a TOU in the Plan design allows for a beneficial comparison of which design is more attractive to customers. For example, do customers like the simplicity of the TOU or will they be more receptive to the potential for greater bill savings on the CPP? These questions will be answered through the Plan's implementation.

12. Q. What rate or rates will be offered to commercial and industrial customers?

A. Small and medium commercial and industrial customers ("S/MC&I") will be offered the CPP rate only.[1] PECO anticipates that a relatively small number of these customers will be available for testing dynamic rates because the population that will receive smart meters is relatively small to begin with and many of these customers are likely to shop (i.e., not take default service from PECO). As such, the number of

[1] As explained in the direct testimony of Frank Jiruska (PECO Statement No. 1), pursuant to PECO's approved Default Service Plan, large commercial and industrial customers (those with demand greater than 500 kW) will already be offered a dynamic rate structure starting January 1, 2011, namely, hourly pricing. *See Petition of PECO Energy Company for Approval Of Its Default Service Program And Rate Mitigation Plan*, Docket No. P-2008-2062739 (Order entered June 2, 2009).

options that can be tested among S/MC&I customers is quite limited. Mr. Jiruska further explains PECO's reasoning for selecting the CPP rate in his testimony.

III. DESIGNING DYNAMIC PRICING RATES

13. Q. What are the basic steps you used to develop the CPP and TOU rates?

A. First, I relied on PECO system data to determine the definitions of seasons and peak periods that would optimize the impacts of the rates. Then, using best practices in rate design that I have developed and observed working with utilities around North America, I established prices for each period of the rate. The rates are designed to be cost-based and revenue neutral for each customer class. I designed a CPP and TOU rate for the residential class and only a CPP rate for the small commercial (less than 100 kW of demand) and medium commercial (between 100 kW and 500 kW of demand) customer classes.

14. Q. How did you determine the summer season for the rates?

A. For the purpose of designing dynamic pricing rates, the summer season should include the months when system load and energy prices are highest. Because the critical events (e.g. highest price periods) will occur in these summer months, it is important to communicate to customers the need to reduce usage during these months, which, in turn, would lead to lower system load and lower energy prices during those times. PECO's existing tariff already includes a seasonal component, with the summer months defined as June through September. After examining recent hourly PECO system loads and locational marginal prices ("LMPs"), I concluded that

this current definition reasonably captures the months with the highest load and LMPs. *See* PECO Exhibits AF-3 and AF-4. Therefore, the same four-month summer definition was maintained in the CPP design and, as a consequence; the critical event days can only be called during the summer months. The TOU rate, on the other hand, is designed on a year-round basis. This design increases understanding and simplicity for the customer.

15. Q. How did you determine the timing of the peak period for each rate?

A. System load and energy prices were also used to determine the most effective peak period for the rates. In each summer month, the hours between 2 pm and 6 pm tend to have the highest system loads. Similarly, the LMPs appear to be higher during these four hours of the day, although with more variation. *See* PECO Exhibits AF-5 and AF-6. Given these observations, the peak period was defined as 2 pm to 6 pm on non-holiday summer weekdays. This peak period applies during the critical peak event days of the CPP as well as the peak periods of the TOU. While likely to coincide with the highest demand and highest priced hours on the system, a four hour peak period is still sufficiently short to provide customers with the capability of shifting load to lower-priced (off-peak) hours.

16. Q. How did you set the prices for each rate class?

A. In developing the prices for each rate class, I observed several important principles in dynamic pricing rate design. For example, I designed each rate to be revenue neutral. Revenue neutrality means that, in the absence of any change in customer behavior,

PECO's revenues would be unaffected by the new rate (relative to revenues that would have been generated under the existing rate). For both rates, the off-peak prices were calculated algebraically to provide a discount from the existing rate that offsets the higher peak period price and ensures revenue neutrality.

I also designed the rates to be cost-based. For both rate designs, the peak (or critical peak) period prices reflect the marginal cost of capacity during those hours. The 2012 capacity price is $140 per MW-day, which translates into roughly $51 per kW-year. For the CPP rate, this cost was spread out over the 60 critical peak hours of the year, leading to a marginal capacity cost of 85 cents per kWh. This cost was allocated to the critical peak hours only, since it is the peak load that drives the need for new capacity. To attain the critical peak rate, this capacity cost was added to the energy portion of the existing generation charge, a transparent calculation that is relatively easy to explain to customers.

The calculation of the TOU rate depends on both the forward prices and the cost of capacity. First, a temporary, revenue neutral TOU rate was created to match the ratio found in the forward prices. At this point, the rate was made revenue neutral relative to the existing generation charge, less the capacity portion. Then, similar to the CPP rate, the capacity cost was spread evenly over all 1,044 peak hours, creating a marginal capacity cost of 5 cents per kWh, which was added to the peak rate. The off-peak rate was adjusted to offset the peak price increase and maintain revenue neutrality relative to the entire generation charge. Using this methodology, the expected energy and capacity costs are reflected in the peak price.

Finally, the seasonal factors were considered. Each rate applies year-round, but the critical events of the CPP can only occur during the summer season, when the highest system load hours are likely to occur. The year-round discount embodied in each rate provides an added benefit to the residential heating customers, who tend to have higher loads in the winter months. The calculations are described in detail in Appendix A to my testimony.

17. Q. Do the prices in your illustrative rate designs reflect the cost of PECO's direct purchases?

A. Yes. I have developed the rates such that they are directly based on PECO's forward purchases of energy and capacity. The peak-to-off-peak price differential of the TOU rate is derived from PECO's forward market purchases. For both rate designs, the peak price also reflects the cost of generating capacity in the 2012 PJM capacity auction. Using a methodology such as the one I have described, PECO could regularly update the rate design as their procurement costs change in order to maintain a direct link to market prices. See Appendix A to my testimony for a detailed example.

18. Q. Please describe the final CPP and TOU rates you developed.

A. First, it should be noted that my calculations are intended only to provide an illustrative picture of how the rates might look when deployed. While the methodological approach would remain unchanged in practice, the underlying costs

are likely to change with the dynamics of the market and, therefore, the absolute prices will likely be different during the Plan's rollout.

The CPP rate features a higher-than-average critical peak price during the four-hour peak period on event days (to be called 15 days per summer[2]) and a discounted off-peak rate for the other hours of the year. The critical peak price is 100.9 cents per kilowatt-hour for the residential class. The off-peak rate, which customers see in the remaining 8,700 hours of the year, is 15.6 cents per kilowatt-hour, a non-trivial discount from an assumed default rate of 16.5 cents/kWh. During the non-summer months, the customers on this rate see only the off-peak discount. The residential CPP rate is illustrated in PECO Exhibits AF-7 and AF-8. The non-residential CPP rates are very similar, but with slightly different off-peak discounts due to differences in the class load shapes.

The TOU rate is composed of a moderate peak rate of $0.241 per kWh during 1,044 hours of the year with a small off-peak discount during the other hours. The ratio of the all-in peak rate to the all-in off-peak rate is 1.56, which reflects the ratio found in the forward prices as well as the additional capacity cost during peak hours, as discussed above. The year-round off-peak price provides an additional financial benefit to the residential heating customers who tend to consume more electricity during the winter months. An illustration of the TOU rate is provided in PECO Exhibits AF-9.

[2] PECO will call event days utilizing a similar algorithm that will be used to call the 100 highest hours to comply with Act 129's load reduction requirements.

IV. SIMULATING CUSTOMER RESPONSE TO DYNAMIC PRICING RATES

19. Q. Is there evidence that customers change electricity usage behavior when enrolled in rates such as those that you have developed for PECO?

A. Yes. Once PECO's customers are enrolled in the new dynamic pricing rates, they will likely change their pattern of electricity consumption because the rates will provide a strong incentive to curtail usage during peak hours and shift some or all of that usage to lower-priced off-peak hours. This behavior has been observed in experimental pricing pilots conducted across the U.S. and internationally. I have designed, evaluated, or surveyed 17 such pricing pilots conducted on three continents over the past decade. These pilots included more than 20,000 customers and tested 70 different combinations of dynamic pricing rates and enabling technologies. The results of each pilot showed that customers are responsive to time-varying rates.

Participants in these pilots described a number of ways in which they changed their usage patterns in response to the dynamic pricing rates. Residential customers said they delayed using certain appliances until after the event period had concluded or changed their behavior based on general awareness of inefficient practices, (e.g., leaving lights on in unoccupied rooms). C&I customers said they installed more efficient equipment, made industrial processes more energy efficient, and, in some cases, even modified hours of operation.[3]

20. Q. Have you estimated customer response to the CPP and TOU rates?

[3] Compiled from several reports on end-of-pilot customer surveys conducted during the California Statewide Pricing Pilot.

A. Yes. I have developed projections of changes in electricity usage behavior for the average residential customer on the CPP and TOU rates as well as the average small commercial and medium commercial customer on the CPP rate.

21. Q. Please describe your process for predicting customer response.

A. To simulate customer response to each of PECO's dynamic pricing rate designs, I relied on the Price Impact Simulation Model ("PRISM"). The PRISM software captures the actual responses of thousands of customers on dynamic pricing rates during several recent pricing experiments across North America and formed the basis for the FERC assessment noted in my response to Question 2. The responses from these experiments are tailored specifically to PECO's system characteristics and dynamic pricing rate designs to produce likely estimates of load shape impacts for the average PECO residential, small commercial and medium commercial customer.

PRISM simulates two distinct impacts on customer usage patterns. The first is called the "substitution effect," which captures a customer's decision to shift usage from higher priced peak periods to lower priced off-peak periods. The second impact is called the "daily effect" and captures the overall change in usage (i.e. conservation or load building) that is induced by differences in the average daily price of the new rate relative to the existing rate. The magnitude of these impacts depends on the structure of the dynamic pricing rate that is being tested, as well as a number of factors that influence the relative price responsiveness of a utility's customers (such as weather, central air conditioning ("CAC") saturation, or presence of enabling technologies).

For example, higher peak-to-off-peak price differentials produce greater reductions in peak demand.

The elasticities used to estimate customer response in PECO's service territory are from recent dynamic pricing pilots. For residential customers, elasticity estimates are from Baltimore Gas and Electric Company ("BGE"). BGE and PECO have roughly comparable CAC saturations, similarly urban service territories, geographic locations east of the Rockies (indicating higher summer humidity than the Western U.S.), and similarities in the rate designs being evaluated. Due to these similarities, the elasticities from BGE's pilot serve as the basis for simulating PECO residential customer response. For S/MC&I customers, elasticities from the California Statewide Pricing Pilot ("SPP") were used. The SPP was conducted over multiple years and tested the price responsiveness of S/MC&I customers similar in size to PECO's small commercial and medium commercial classes. Generally, S/MC&I customers are found to be less responsive than residential customers in terms of the percent of load that is shifted or curtailed, but these classes have still exhibited significant levels of price responsiveness.

PECO Exhibit AF-10 illustrates the PRISM modeling framework, starting first with the basic model inputs and then identifying how these influence the drivers of the model results, which are a function of the substitution and daily effects.

22. Q. What are the results of your simulations of changes in usage during event periods?

A. The PRISM simulations suggest that the CPP and TOU rates will provide sufficient incentives to induce consumption changes among PECO's customers. For both rates, significant reductions in critical peak demand are expected. The simulations predict that the residential class will reduce critical peak demand by 16 percent under the CPP rate and 4 percent under the TOU rate. The S/MC&I classes will have peak reductions in the 9 percent to 10 percent range. The results for each class are illustrated in PECO Exhibit AF-11.

23. Q. What are the results of your simulations of changes in usage during non-event peak periods?

A. Recall that during non-event peak hours, the CPP rate consists of the discounted off-peak rate while the TOU rate maintains the moderate peak price. Given these designs, the TOU rate is expected to produce permanent load shifting away from all peak hours of the year, not just on event days. The PRISM simulations suggest that the residential class will shift 4% of its peak period load away from non-critical peak hours when enrolled in the TOU rate. On the CPP rate, all three classes are expected to increase non-event peak load slightly (roughly 0.2%) due to the off-peak discount. These results are shown in PECO Exhibit AF-12.

V. UNDERSTANDING CUSTOMER BILL IMPACTS

24. Q. Have you estimated the impacts of these dynamic pricing rates on customer electricity bills?

A. Yes. I have simulated bill impacts for the average residential, small commercial and medium commercial customers on both an annual and a seasonal basis. Additionally, I have estimated the distribution of bill impacts across a representative sample of PECO's customers in each of these classes.

To calculate each customer's expected bill change, I use their historical hourly usage data (as provided to me by PECO) and calculated their bills using the existing rate and the new rate. A comparison of these two calculations provides an estimate of the bill change due only to the change in the rate structure. I then calculated the customer's bill using the dynamic pricing rate and an hourly load profile that has been modified to reflect the expected change in usage behavior that was produced using the PRISM simulations.

25. Q. How will annual bills change for the average customer?

A. In the absence of any change in behavior, the class average customer's bill will remain unchanged. This is because the dynamic pricing rates are designed to be revenue neutral. However, after accounting for the projected level of customer response to the new rates, I would expect the average customer's annual electricity bill to decrease. For the residential customers, the CPP and TOU rates are expected to lead to class average annual bill reductions of roughly 0.8% and 0.1%, respectively

with likely bill savings up to 4%. Due to a usage pattern with higher consumption during the discounted winter months and off-peak hours, the residential heating customers are expected to see even greater annual decreases. For the average residential customer and the residential heating customer, the CPP rate provides a greater opportunity for bill savings. The bill impacts are similar for the small commercial and medium commercial classes on the CPP rate. These results are shown in PECO Exhibit AF-13.

26. Q. Will these bill impacts vary on a seasonal basis?

A. Yes. Since critical days occur in the summer, the CPP bill impacts are not spread evenly throughout the year. Thus, the expected bill impact is an increase in the four summer months and a decrease in the eight non-summer months (averaging out to the annual bill reductions shown previously). The average 4-month summer bill increase on the CPP rate should be around 7% for the residential class, balanced out by a bill decrease of 6% during the eight non-summer months. For the small commercial and medium commercial classes, the summer bill increase could be as high as 11%, again balanced out by bill decreases during the non-summer months. Due to the year-round nature of the TOU rate, the bill impacts are close to zero for the average residential customer in both seasons. Seasonal bill impacts for each class are illustrated in PECO Exhibit AF-14.

27. Q. Should all customers expect to see bill impacts similar to those of the average customer?

A. No. Analyzing the bill impacts for the average customer only tells part of the story. Load profiles vary significantly across customers. Some customers tend to be "peaky," with more load during the peak hours of the day, while other customers tend to have flatter load shapes. These different types of load shapes are illustrated in PECO Exhibit AF-15.

28. Q. What will be the range of possible bill impacts across PECO's customers?

A. The bill impact of a dynamic pricing rate is partly driven by the customer's load profile. Under dynamic pricing rates such as the CPP or TOU, customers with higher-than-average load in the peak hours ("peaky" customers) will tend to experience bill increases, while customers with flatter load shapes will tend to experience bill decreases. In order to understand the range of potential bill impacts for these types of customers, I simulated bill impacts for a representative sample of PECO's customers using the CPP and TOU rates. Before customers respond to the rate, the most extreme bill impacts are as large as a six percent increase or decrease. Roughly half of customers experience bill savings and the other half experience a bill increase. These results are shown in PECO Exhibit AF-16. After residential customers respond to the rate, roughly 63 percent would experience bill savings on the CPP rate and 61% on the TOU rate, as shown in PECO Exhibit AF-17.

Residential Heating customers will be even better off. Due to the load shape of these customers, even before any customer response, 73% of customers would experience bill savings on the TOU rate and 91% would experience bill savings on the CPP rate. After customer response, these numbers would increase with 85% of customers

experiencing savings on the TOU and 97% of customers experiencing savings on the CPP.

A similar analysis was conducted for both small commercial and medium commercial customers. Because there is significantly more diversity in load shapes within these two customer classes, the potential range of bill impacts is larger. This is particularly true for the small commercial class, in which some of the smallest customers also have the peakiest load shapes. The results of the small commercial and medium commercial bill impacts analysis are presented in PECO Exhibit AF-18 and AF-19, respectively. After accounting for customer price response, roughly 51 percent of the small commercial customers and 61 percent of the medium commercial customers would experience bill savings.

29. Q. Is there evidence that low income customers can respond to dynamic pricing rates?

A. Yes. Recent studies in California, Connecticut, Maryland, and Washington, D.C. have found that low income customers do respond to dynamic pricing rates. In fact, in some cases the Connecticut and Maryland pilots found that the average low-income customer's response was the same as that of the average residential customer. The low income response as compared to the average response from these studies is shown in PECO Exhibit AF-20.[4]

[4] Note that, in some cases, the "average" customer in the pilot is a combination of low income customers and the remaining sample of participants, because data are not available at the level of granularity necessary to separate the two classes.

30. Q. How would the rates that you have designed affect the bills of residential customers enrolled in PECO's Customer Assistance Program ("CAP")?

A. Analysis shows that the current CAP discount that low income customers receive far exceeds any potential savings that low income customers could achieve under dynamic pricing rates. CAP E customers (those who qualify for the smallest discount) would experience average bill increases of 24% and 26% with the CPP and TOU rates, respectively, even after shifting their load. These results are shown in PECO Exhibit AF-21. In light of this analysis, and as discussed by Mr. Jiruska, PECO has decided that CAP customers will not be eligible for the Plan's dynamic rates. PECO will, however, provide a random sampling of CAP customers with in-home displays ("IHDs") and related educational materials in order to evaluate the effect of near real time information feedback on their energy usage.

VI. CONCLUSION

31. Q. What are your final recommendations for PECO regarding the rates that should be included in its Plan?

A. Through a combination of stakeholder input, expert judgment, and quantitative evaluation, I have concluded that the CPP and TOU are the appropriate dynamic pricing rates for PECO to offer in its Plan. An informed simulation of customer response to these rate designs confirms that they will provide bill savings opportunities for customers. Further, they are likely to produce significant reductions in peak demand, which would provide benefits to default service customers through

the prices obtained in default service procurements. As proven through recent pricing pilots, these rates are fairly simple for customers to understand (with some education) and for the utility to implement. And, by providing a time-varying price signal that is tied directly to system costs, the rates would provide a strong link to the wholesale electricity markets.

32. Q. Does this conclude your testimony?

A. Yes, it does.

APPENDIX A

Developing the TOU & CPP Rates

I. TOU Rate for the Residential Class

There are four steps in developing a cost-based TOU rate that reflects future expectations of energy and capacity procurement costs.

First, "shape" the forward prices using historical LMPs. The "peak" and "off-peak" period definitions in the forward prices do not correspond to those periods as defined in the TOU rate. For example, the forward peak period is from 7 am to 11 pm on non-holiday weekdays and the TOU peak period is from 2 pm to 6 pm on non-holiday weekdays. To account for this difference, the forward prices are "shaped" using historical LMPs:

1. Calculate the average 5x16 forward price ($58.28/MWh)
2. Using historical LMPs,[1] calculate the relationship of the average LMP during the TOU peak period to the average LMP during the 5x16 period (a ratio of 1.11-to-1)
3. Scale up the average 5x16 forward price using the factor developed in step 2 (resulting in an adjusted forward "peak" price of $64.48/MWh)
4. Repeat this scaling process to also establish an adjusted off-peak forward price, using the average forward price for the non-5x16 hours and the associated LMPs (resulting in an adjusted "off-peak" forward price of ($45.32/MWh)

Second, calculate the ratio of the shaped peak and off-peak forward prices. The result is a peak-to-off-peak price ratio in the adjusted forward prices of 1.42-to-1.

Third, use this ratio to create the peak and off-peak prices of the TOU rate. At this stage, the revenue neutrality calculation is based on an assumed existing rate of 10 cents/kWh less the 0.58 cent capacity portion of this rate, or 9.42 cents/kWh.[2] The TOU prices are calculated using two constraints: (1) the TOU rate is revenue neutral to a 9.42 cents/kWh flat generation charge and (2) the peak to off-peak ratio of the TOU is the same as that calculated in the adjusted forward prices (1.42). There is a unique solution to this problem, and the resulting generation rates are:

Peak: $0.127 per kWh
Off-Peak: $0.090 per kWh

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[1] We are currently using LMPs for the period between April 2008 and March 2009. Using other years of LMPs would not significantly change the analysis.

[2] To calculate the capacity portion of the 10 cent assumed existing rate, we divide $51.03 kW-year by the 8760 hours of the year, which equals 0.58 cents.

Fourth, add the capacity adder to the peak price and adjust accordingly. The peak price must also reflect a capacity cost of $51.03 kW-year.[3] This is allocated evenly to the 1,044 peak hours of the TOU, resulting in peak price increase of roughly 5 cents per kWh. The off-peak rate is adjusted downward to offset the peak price increase and maintain revenue neutrality. Now, the revenue neutrality calculation is based off of the assumed existing rate of 10 cents/kWh, which includes both energy and capacity. The result is the following generation rates:

Peak: $0.176 per kWh
Off-Peak: $0.089 per kWh

With non-generation costs included, the all-in rates are:

Peak: $0.241 per kWh
Off-Peak: $0.154 per kWh

II. CPP Rate for the Residential, Small C&I, and Medium C&I Classes

The CPP rate development is a relatively simple two-step process.

First, calculate the critical peak price. Given 15 critical peak days with a 4 hour critical peak period, there are 60 critical peak hours per year. As with the TOU rate, the capacity cost of $51.03/kW-year is allocated across these 60 critical peak hours, creating a capacity adder of roughly 85.1 cents. Again, we assume a 10 cent existing generation charge, which includes a 0.58 cent capacity cost. To calculate the critical peak rate, we add the capacity adder to the existing rate less the capacity cost, equaling $0.945/kWh. .

Second, solve the off-peak price for revenue neutrality. In order to maintain revenue neutrality, the off-peak price is slightly different for each class due to differences in class load shapes. The assumed existing rate used in the revenue neutrality calculation is 10 cents/kWh. In this case, the generation-only off-peak rates are as follows:

Residential Class – Off-Peak: $0.091 per kWh
Small C&I Class – Off-Peak: $0.092 per kWh
Medium C&I Class – Off-Peak: $0.092 per kWh

With non-generation costs included, the all-in rates are:

Residential Class – Critical Peak: $1.009 per kWh
Residential Class – Off-Peak: $0.156 per kWh

[3] The average PJM capacity auction outcome for year 2012.

Small C&I Class – Critical Peak: $0.971 per kWh
Small C&I Class – Off-Peak: $0.118 per kWh

Medium C&I Class – Critical Peak: $0.967 per kWh
Medium C&I Class – Off-Peak: $0.114 per kWh

AHMAD FARUQUI EXHIBITS

PECO Exhibit AF-1:
Rate Options Initially Considered

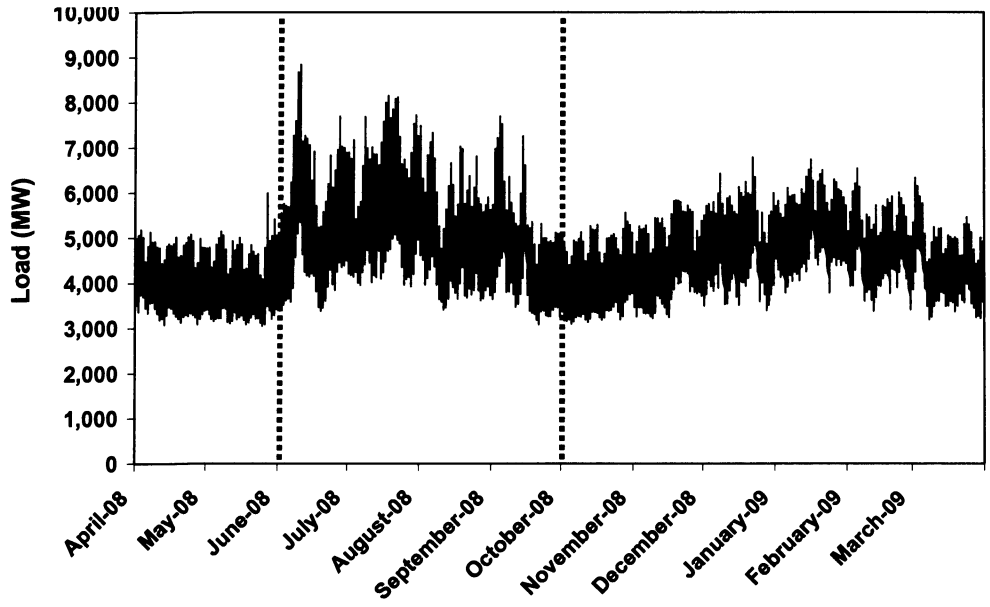
Rate	Description
Time-of-Use (TOU)	Charges a higher price during all weekday peak hours and a discounted price during off-peak and weekend hours
Super Peak TOU	Similar to the TOU except that the peak price is offered during a much smaller number of hours of the year, leading to a stronger price signal
Inclining Block Rate (IBR)	Customer usage is divided into tiers and usage is charged at higher rates in the higher tiers; meant to encourage conservation
Critical Peak Pricing (CPP)	Customers are charged a higher price during the peak period on a limited number of event days (often 15 or less); the rate is discounted during the remaining hours
Variable Peak Pricing (VPP)	Critical Peak Pricing rate with added variability
CPP-TOU Combination	A TOU rate in which a moderate peak price applies during most peak hours of the year, but a higher peak price applies on limited event days
Peak Time Rebate (PTR)	The existing flat rate combined with a rebate for each unit of reduced demand below a pre-determined baseline estimate during peak times on event days
Real Time Pricing (RTP)	A rate with hourly variation that follows Locational Marginal Pricing (LMPs), but with capacity costs allocated equally across all hours of the year
Critical Peak RTP (CP-RTP)	A rate with hourly variation based on LMPs and with a capacity cost adder focused only during event hours, creating a strong price signal at these times

PECO Exhibit AF-2:
Results of Rate Evaluation

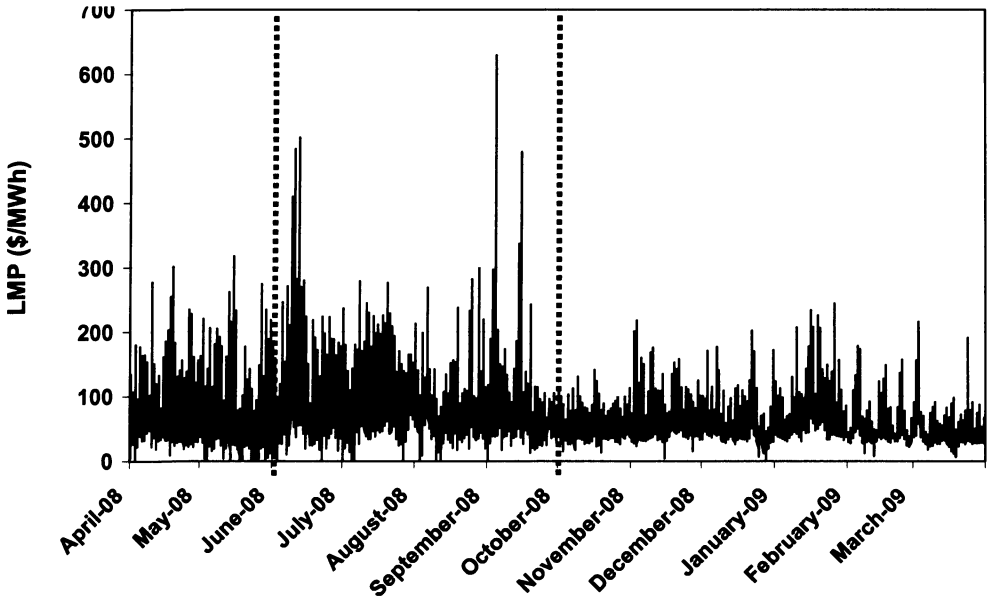
	Simplicity	Value Proposition	Retail-Wholesale Connection	Peak Reduction	Load Shifting	Description
TOU	H	L	M	M	H	**Provides strong incentive for permanent load shifting**
CPP	M	H	M	H	L	**Simple, focused rate for targeted reductions during top load hours**
CPP/ TOU	M	H	H	H	M	**Provides combined incentive of load shifting and demand response**
PTR	M	M	L	H	L	**Residential rate produces no immediate "losers"; potentially most applicable for low income residential customers**
RTP	L	L-H	H	L	M	**Conveys variability in hourly LMP which provides some load shifting value**
CP RTP	L	L-H	H	H	M	**Provides additional curtailment incentive beyond LMP during top load hours**

L = Low, M = Moderate, H = High

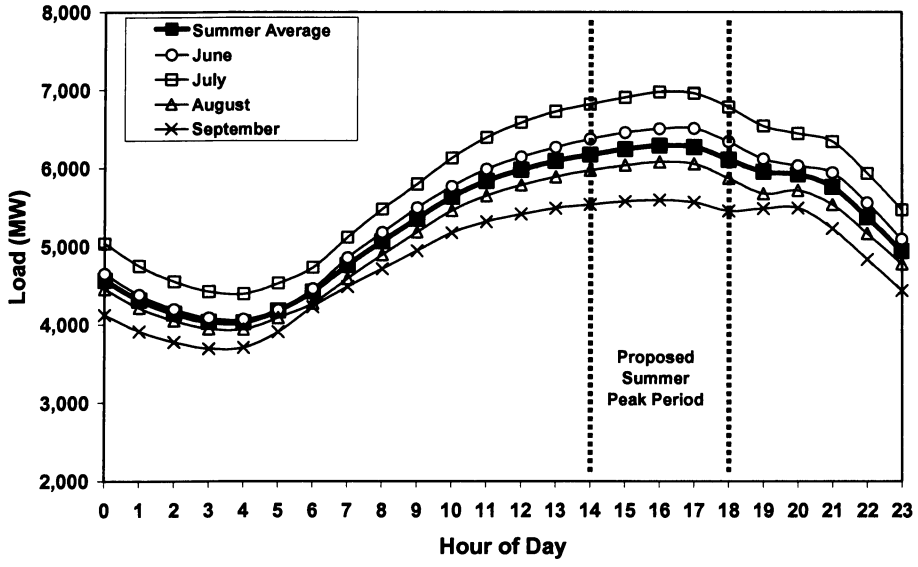
PECO Exhibit AF-3:
PECO System Load (April 2008 – March 2009)



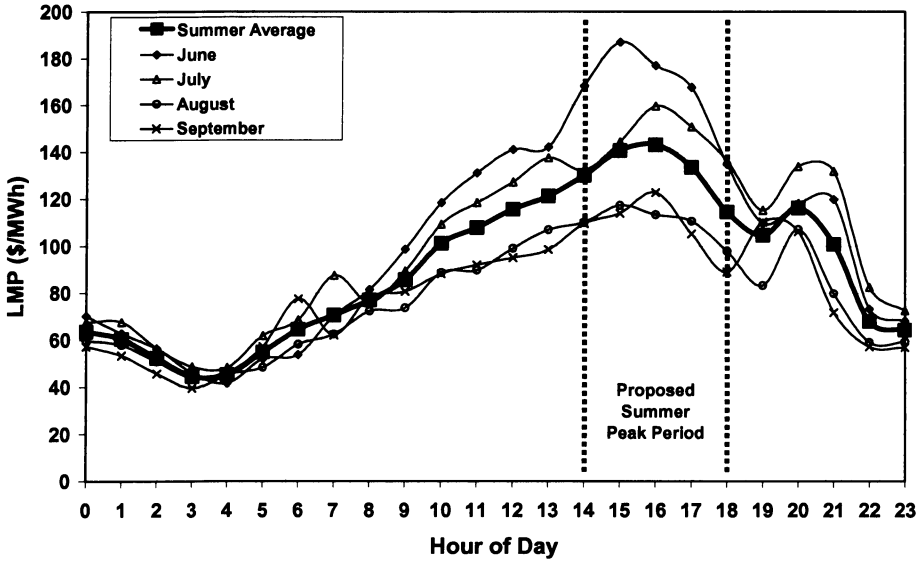
PECO Exhibit AF-4:
PECO Locational Marginal Price (April 2008 – March 2009)



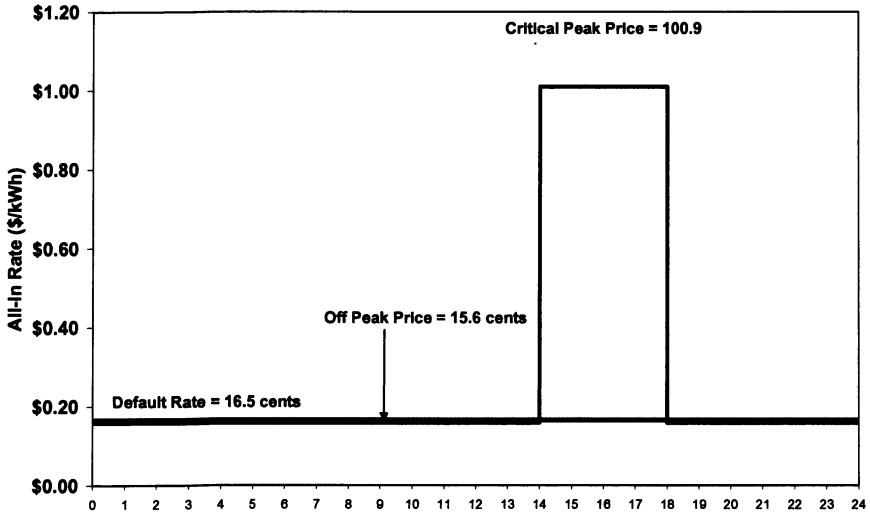
PECO Exhibit AF-5:
PECO 2008 Summer Average Hourly System Load



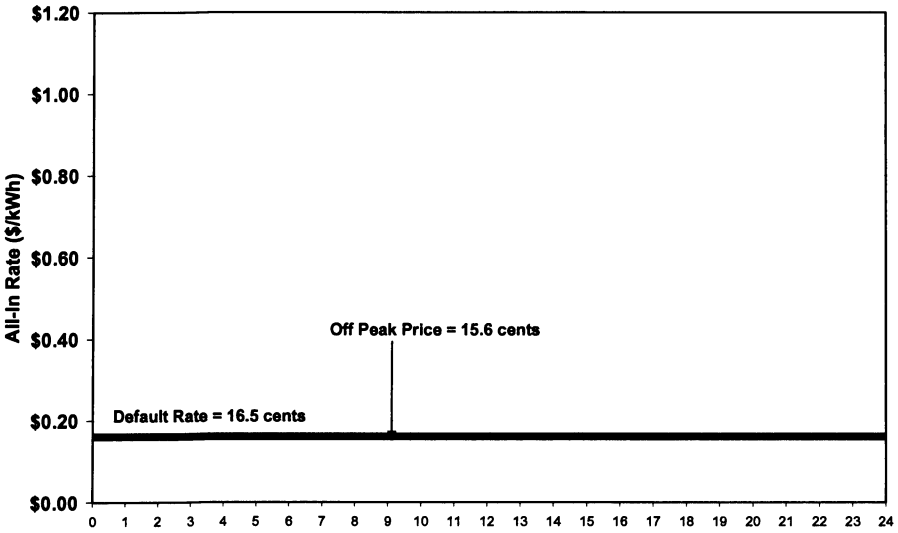
PECO Exhibit AF-6:
PECO 2008 Summer Average Hourly System LMP



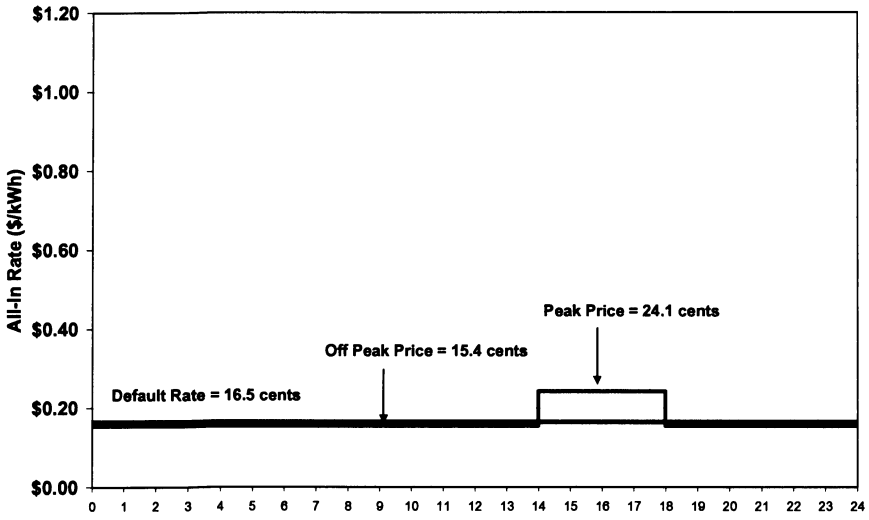
PECO Exhibit AF-7:
Illustrative CPP Rate for Residential Class – Summer (All-In Rates)



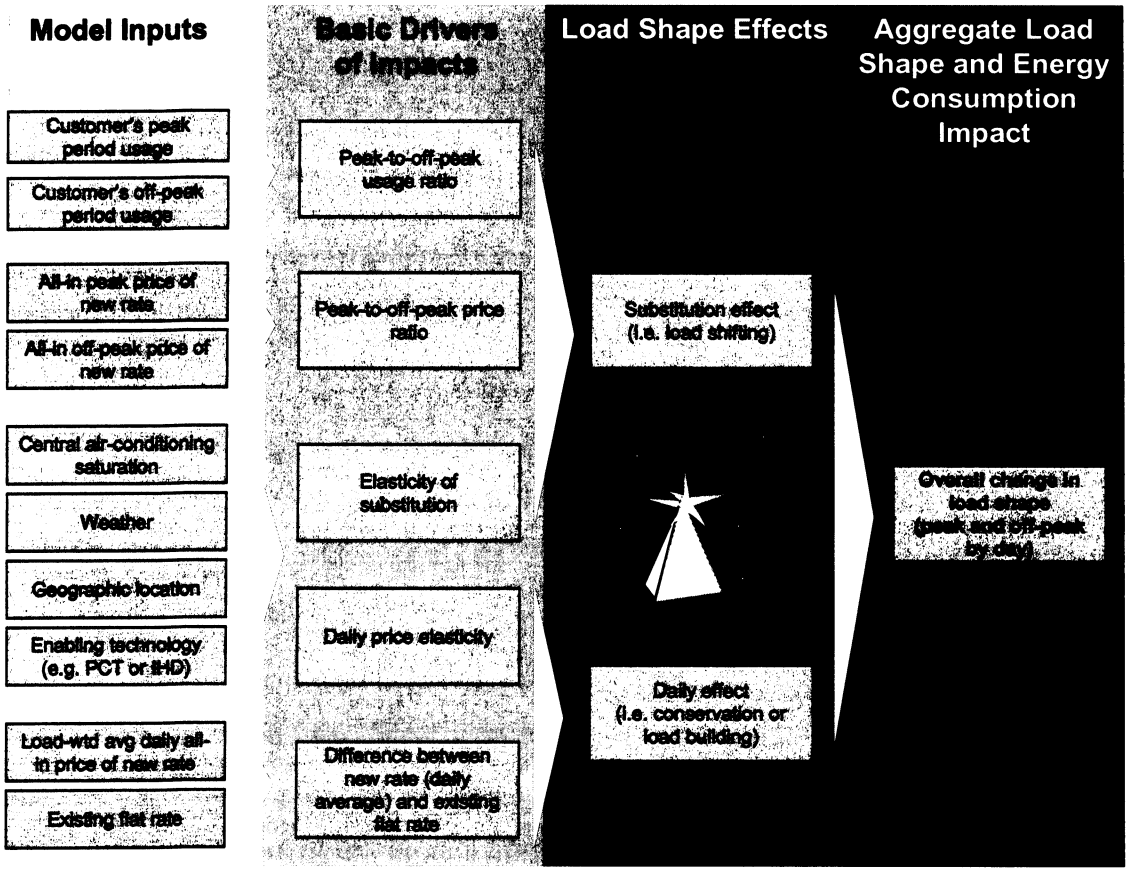
PECO Exhibit AF-8:
Illustrative CPP Rate for Residential Class – Non-Summer (All-In Rates)



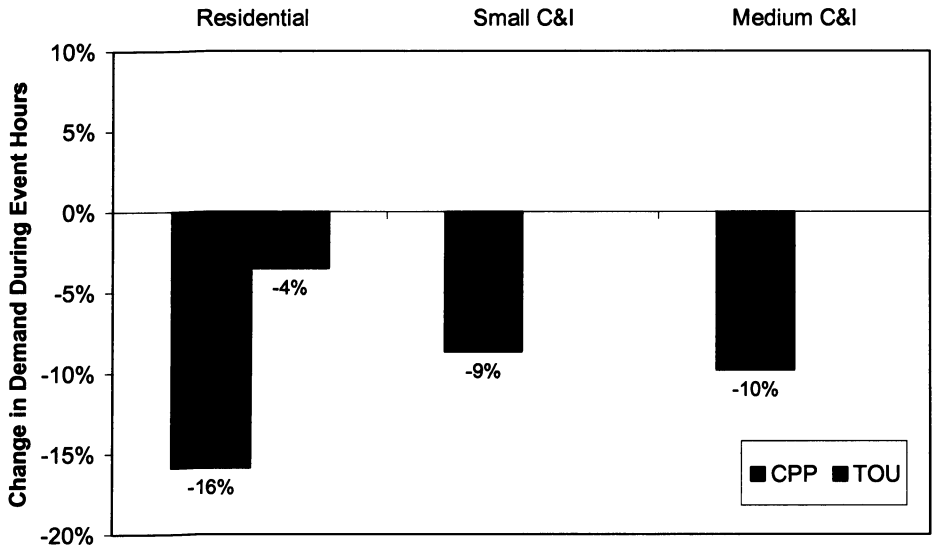
PECO Exhibit AF-9:
Illustrative TOU Rate for Residential Class – Year-Round (All-In Rates)



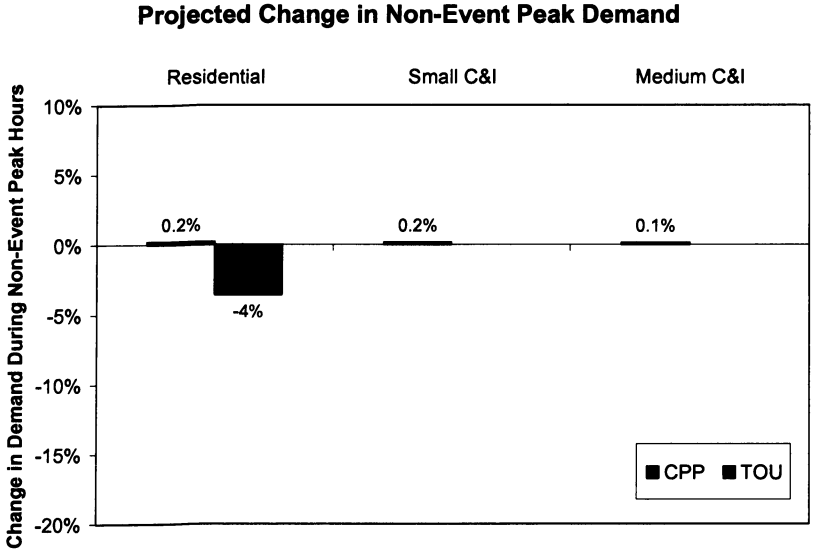
PECO Exhibit AF-10:
The PRISM Model



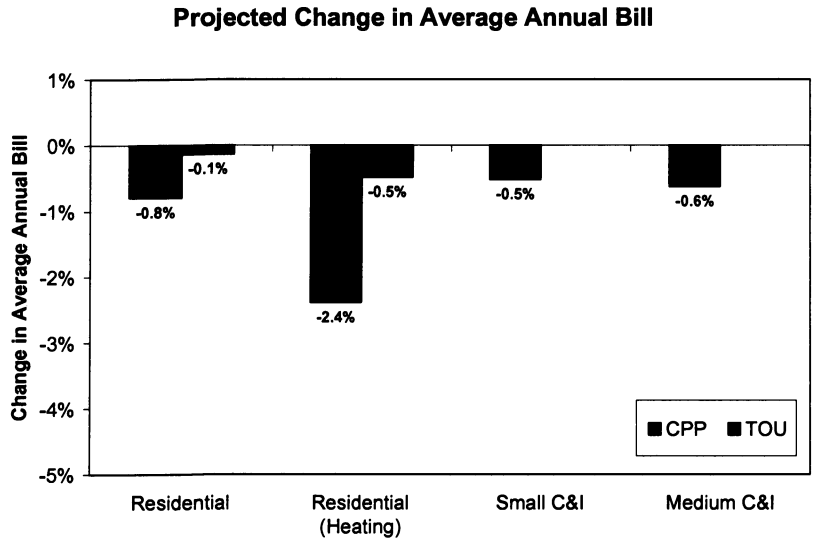
PECO Exhibit AF-11:
Projected Change in Critical Peak Demand



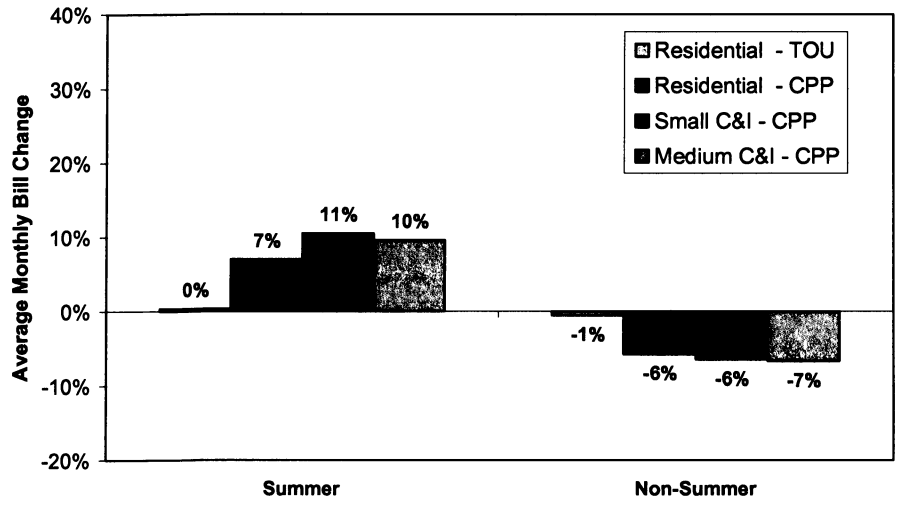
PECO Exhibit AF-12:
Projected Change in Non-Event Peak Demand



PECO Exhibit AF-13:
Projected Change in Average Annual Bill

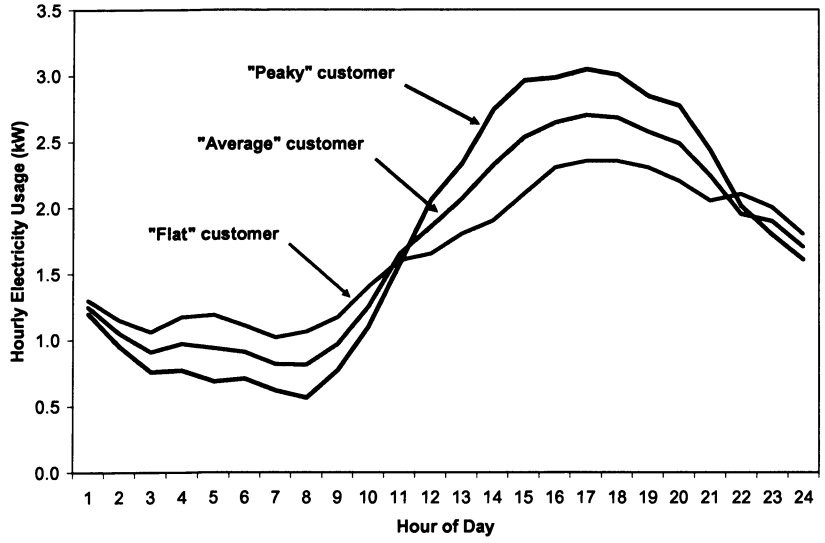


PECO Exhibit AF-14:
Average Seasonal Bill Impacts After Customer Response

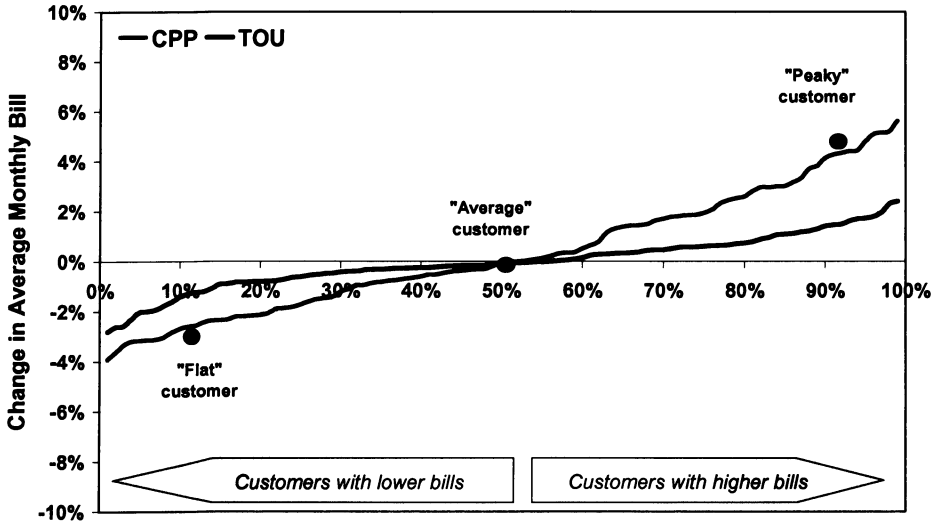


*Summer months include June through September; non-summer months include October through May

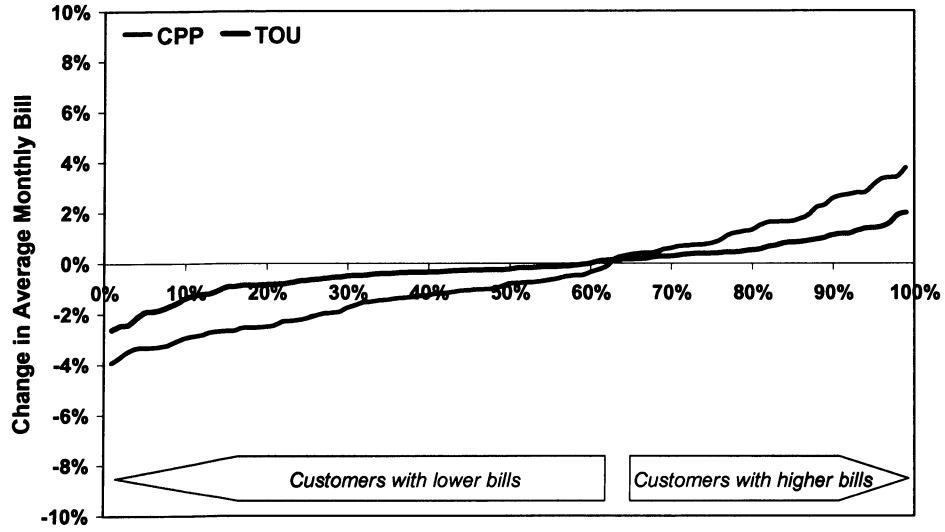
PECO Exhibit AF-15:
Illustrations of Average, Flat, and Peaky Load Profiles



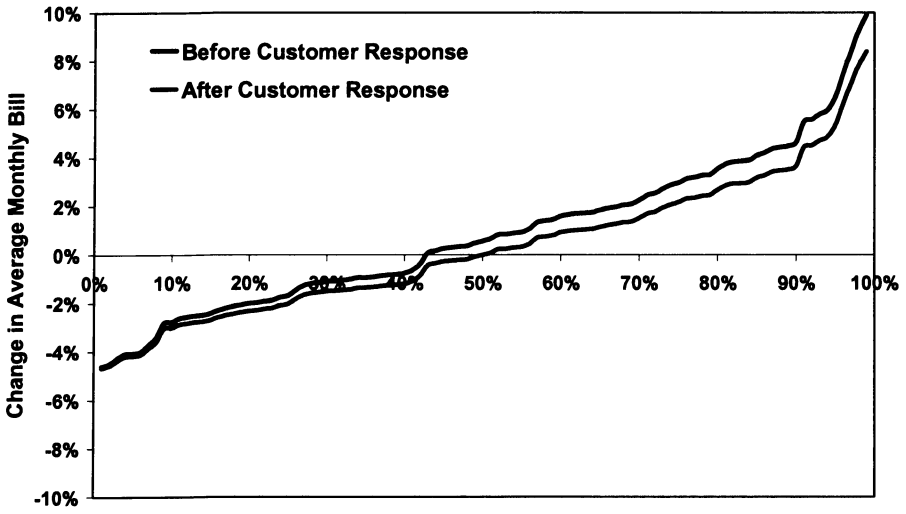
PECO Exhibit AF-16:
Distribution of Dynamic Pricing Bill Impacts (Residential CPP and TOU Before Customer Response)



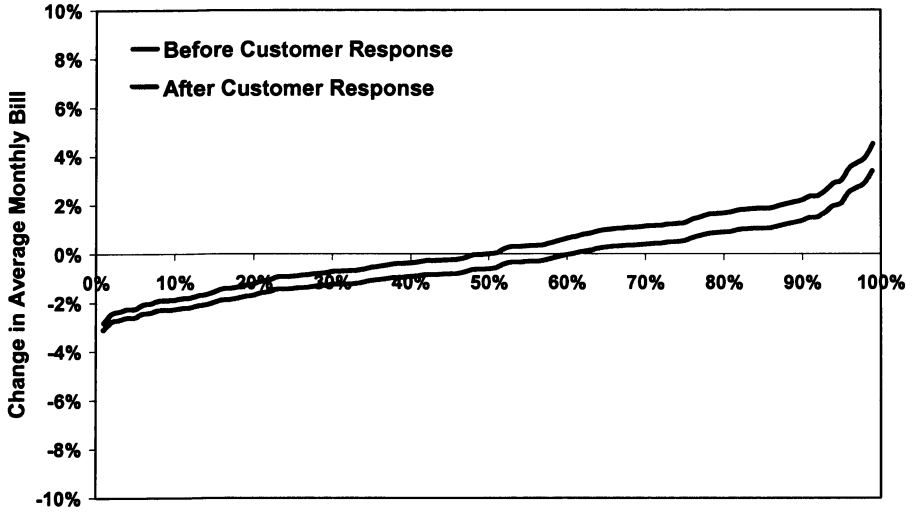
PECO Exhibit AF-17:
Distribution of Dynamic Pricing Bill Impacts (Residential CPP and TOU After Customer Response)



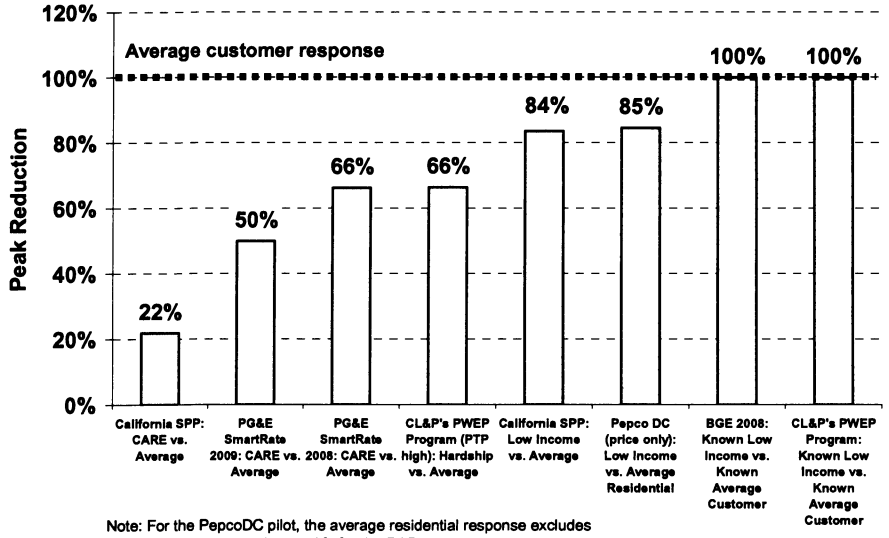
PECO Exhibit AF-18:
Distribution of Dynamic Pricing Bill Impacts (Small C&I on CPP Rate Before and After Customer Response)



PECO Exhibit AF-19:
Distribution of Dynamic Pricing Bill Impacts (Medium C&I on CPP Rate Before and After Customer Response)



PECO Exhibit AF-20:
Low Income Customer Responsiveness Relative to Average Customer



Note: For the PepcoDC pilot, the average residential response excludes low income customers that qualify for the RAD program

PECO Exhibit AF-21:
Distribution of Bill Impacts: (CAP E Low Income Customers on CPP and TOU After Customer Response)