POTOMAC ELECTRIC POWER COMPANY
DELMARVA POWER & LIGHT COMPANY
BEFORE THE
MARYLAND PUBLIC SERVICE COMMISSION
DIRECT TESTIMONY OF AHMAD FARUQUI
CASE NO. 9207

Q. WHAT IS YOUR NAME?

A. My name is Ahmad Faruqui. I am a Principal with The Brattle Group (Brattle) located in the firm's San Francisco office.

Q. WHAT ARE YOUR QUALIFICATIONS?

A. I have three decades of research and consulting experience in the design and evaluation of customer-side programs. Most recently, I led a team of consultants in conducting a state-by-state assessment of the potential for demand response programs for the Federal Energy Regulatory Commission. The report was filed with Congress in June of 2009. Last year, I worked on a national assessment of energy efficiency programs for the Electric Power Research Institute and wrote a whitepaper for the Edison Electric Institute on quantifying the benefits of dynamic pricing. Since the power crisis in the Western states, I have worked for several utilities, ISOs/ RTOs and state/provincial commissions in assessing the benefits of demand response by designing pilot programs and conducting cost-benefit analyses. I hold a doctoral degree in economics from The

University of California at Davis. Additional details are contained in my resume.

Q. **WHAT IS THE PURPOSE OF YOUR TESTIMONY?**

A. The purpose of this testimony is to summarize the work I have done on quantifying the benefits of demand response associated with Potomac Electric Power Company's (Pepco) and Delmarva Power & Light Company's (Delmarva) proposals to deploy an Advanced Metering Infrastructure (AMI) System in Maryland. In my testimony, I draw heavily on an extensive study that Brattle performed for Pepco Holdings, Inc. (PHI) in 2007. That study quantified customer benefits from reductions in peak loads during critical times that are likely to be achieved by PHI's proposed demand-side management (DSM) initiatives, including demand reductions resulting from AMI enabled dynamic pricing in its District of Columbia, Delaware, Maryland and New Jersey jurisdictions. I have updated the analysis in the 2007 study using current data for Maryland and revised assumptions where applicable. The conclusions of my testimony reflect these 2009 updates.

Q. **SPECIFICALLY, WHAT UPDATES DID YOU MAKE TO THAT STUDY?**

A. I made the following updates:

- Adjusted my estimates of customer price elasticities to be consistent with the results of a dynamic pricing experiment recently conducted by Baltimore Gas & Electric.

- Used new revenue neutral rates with a stronger price signal (i.e. higher critical peak price and lower off peak price) to be more consistent with the types of rates that Pepco and Delmarva are proposing to offer to customers.
- Based my projected dynamic pricing participation rate on an assumption that Standard Offer Service customers would be defaulted on to a critical peak rebate (CPR) rate structure.
- Excluded the benefits of direct load control programs that do not require an AMI system in order to be implemented due to the Maryland Commission decision to deploy this equipment prior to the availability of AMI.
- Included the overall conservation effect that AMI is likely to encourage in residential customers as Pepco and Delmarva are able to provide them with more granular information about their energy use.
- Adjusted my impact projections downward to account for the effect of Commission approved energy efficiency and conservation programs.

- Updated basic inputs such as the number of customers, load profiles, AMI deployment schedules, current SOS rates, residential DLC planned deployment schedules and capacity and energy cost estimates.

Q. HOW WILL PEPCO AND DELMARVA'S DYNAMIC PRICING TARIFFS BENEFIT CUSTOMERS?

A. Pepco's and Delmarva's dynamic pricing tariffs will benefit customers by introducing price elasticity into the regional electricity market. The benefits will be of two types. First, they will lower generation resource costs by reducing or offsetting the amount of capacity, energy, and ancillary services that must be procured by Pepco and Delmarva on behalf of their customers. This reduction in resource costs is likely to persist over the long haul. Secondly, Pepco and Delmarva's dynamic pricing programs will depress wholesale market prices for energy and capacity. This second effect is likely to last for a limited period of time. Additionally, the introduction of price elasticity into the regional markets can be expected to improve system reliability, enhance market competitiveness by mitigating the market power of generators, reduce price volatility, reduce transmission and distribution losses, encourage adoption of new smart grid technologies, possibly obviate or delay the need for investments in transmission and distribution facilities, and accommodate new electric end-uses and the proliferation of small-scale renewable generators.

Q. **AT A HIGH LEVEL, HOW DID YOU ESTIMATE THE DEMAND RESPONSE ASSOCIATED WITH AMI ENABLED DYNAMIC PRICING IN MARYLAND?**

A. We estimated the impact of dynamic pricing programs in the PHI jurisdictions by adapting the Pricing Impact Simulation Model (PRISM) model to the price elasticities that were estimated in Baltimore Gas and Electric's Smart Energy Pricing Pilot.[1]

We analyzed a single dynamic pricing deployment scenario for Pepco Maryland and Delmarva Maryland. It is assumed that customers are defaulted on to a critical-peak rebate (CPR) rate structure. Over time, some customers leave the rate for their existing flat rate. Other customers leave the rate for a critical-peak pricing rate structure.[2]

In the end, 55 percent of residential customers are on a CPR rate, 20 percent are on a CPP rate, and 25 percent are not enrolled in a dynamic rate. Of the eligible commercial and industrial (C&I) customers, 65 percent are

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1 Ahmad Faruqui and Sanem Sergici, "BGE's Smart Energy Pricing Pilot: Summer 2008 Impact Evaluation," *The Brattle Group, Inc.*, April 28, 2009.

2 Eligible customers are assumed to include all residential and non residential SOS customers that do not already have an interval meter. AMI is expected to provide hourly load data to the utility on a daily basis.

enrolled in a CPR, 10 percent are enrolled in a CPP, and 25 percent are not enrolled in a dynamic rate.

Q. WHAT AMOUNT OF DEMAND RESPONSE DID YOU ESTIMATE IN THESE TWO SCENARIOS?

A. The demand response is shown in Exhibit AF-1. Dynamic pricing is expected to achieve a reduction in peak demand of 199 MW in Pepco MD and 63 MW in Delmarva MD by the year 2025.

Q. HOW DID YOU ESTIMATE THE BENEFITS ASSOCIATED WITH THIS DEMAND RESPONSE?

A. Avoided capacity and energy costs were estimated by multiplying the magnitude of demand response by estimated wholesale market prices, which I describe in greater detail below. Market price impacts and their effect on customer costs were estimated by adapting the results of an earlier Brattle study performed for the PJM Interconnection (PJM) and the Mid-Atlantic Distributed Resources Initiative (MADRI). Market price benefits were assumed to diminish over time as suppliers delay new construction and accelerate retirements in response to reduced load and market prices.[3]

[3] The original study considered three scenarios: Immediate Supplier Reaction, Slower Supplier Reaction and Delayed Supplier Reaction. These scenarios differ in the assumed amount of time it would take for the energy and capacity markets to reach equilibrium. For the purposes of my update, I have taken a simple average of benefits across the three scenarios, implicitly assuming that each is an equally likely future state of the world.

Q. CAN YOU SUMMARIZE THE ESTIMATED BENEFITS?

A. Exhibits AF-2 and AF-3 show the annual value of AMI benefits to customers in Pepco MD and Delmarva MD.

Q. HOW DID YOU DERIVE THE SAVINGS IN RESOURCE COSTS?

A. With dynamic pricing, Pepco and Delmarva can monetize the value of capacity reductions through the PJM demand response market or avoid purchasing as much capacity from generators as they would in the absence of dynamic pricing. Nor do the companies need to buy as much energy from suppliers during high-priced periods. Reducing the *quantity* of capacity and energy that must be provided by generation suppliers saves money even if wholesale prices remain unchanged and those savings benefit customers. Assuming a competitive wholesale market, suppliers can be expected to offer capacity and generation based on their costs to serve and to pass changes in their costs onto customers. If the wholesale market is not fully competitive, it is likely that savings would be even greater because dynamic pricing enhances market competitiveness.

Capacity savings are estimated by multiplying the projected reduction in physical capacity requirements by the value of physical capacity. The reduction in physical capacity requirements is estimated by assuming that all expected demand response could either supply capacity or reduce the load forecast, thus avoiding the need for physical capacity to the extent that the simultaneous peak load forecast is reduced.

Reducing demand also reduces the amount of energy that must be generated and purchased by customers during high-priced periods. Further, I have assumed that residential customers will reduce their consumption during all hours as a result of having access to better feedback information about their electricity consumption patterns.[4] The economic savings depends on the particular type of generation that is being avoided, which could come from a combination of new capacity not constructed and old capacity retired or not dispatched.

Q. **HOW DID YOU ESTIMATE THE IMPACT OF DYNAMIC PRICING ON PEAK DEMAND?**

A. Deployment of AMI will allow PHI to provide dynamic rates to its standard offer service ("SOS") customers. This is expected to yield additional significant reductions in peak demand beyond those that would be achieved through energy efficiency and direct load control programs alone. Specifically, dynamic pricing would allow Pepco and

[4] The assumption that I used in this analysis is a 1.5% reduction in consumption during all hours outside of the critical peak (applicable year-round).

Delmarva to provide customers with rates that can be varied in response to situations in which the market price of electricity is high, or in response to conditions that would lead to decreased system reliability, such as unit outages. Dynamic rates typically provide a strong incentive to the customer to reduce demand during a utility-specified "critical peak period." This incentive could be in the form of avoiding a higher price during that period (which would be accompanied by a discount during the non-critical hours) or in the form of a rebate for every kWh that is conserved during the critical-peak hours relative to a customer baseline usage level. Either way, the rates are designed to provide peak reductions to the utility when they are needed most, while at the same time giving the utility's customers the opportunity to achieve bill savings.

We relied on PRISM for predicting the amount of demand response that would result from dynamic pricing. PRISM, originally developed in California, was calibrated to the results of the Baltimore Gas and Electric Company's recent Smart Energy Pricing (SEP) Pilot. I did this because, due to regional similarity, it is likely that Pepco and Delmarva's Maryland customers are more similar to BGE's Maryland customers than they are to the California customers who participated in the original pilot upon which PRISM is based. This calibration resulted in a lower level of price response than I would have otherwise modeled for customers on the same rate using the California model.

PRISM was used to forecast the customer-level peak demand reductions that would occur in response to various PHI-specific dynamic rates. When combined with a forecast of the number of customers participating in the rate, a system-wide forecast of annual peak demand reductions was obtained. Inputs to PRISM were developed using data specific to Pepco and Delmarva. The development of each input and their relevance to the modeling effort are described below.

Q. WHAT DYNAMIC PRICING RATES DID YOU MODEL?

A. Dynamic pricing rate designs include critical peak pricing (CPP), critical peak rebate (CPR), and real time pricing (RTP). For this analysis, we modeled a CPP rate and a CPR rate. They can be used conveniently with PRISM because the BGE Smart Energy Pricing Pilot specifically measured customer response to CPP and CPR rates. The all-in residential CPP and CPR rates for Pepco MD are provided in Exhibits AF-4 and AF-5.

The all-in CPP rate would charge customers approximately $1.54/kWh during critical peak hours, representing a surcharge of $1.39/kWh over the current all-in rate of $0.156/kWh. In return, customers are given a discount of about $0.029/kWh during all other hours of the summer (which represent 3,632 hours or over 98.9 percent of the total hours in the summer).

This CPP rate is designed to be revenue neutral for Delmarva and Pepco's Maryland residential customer base. This means that the utility would not gain or lose revenues if all residential customers were enrolled in the CPP rate (in the absence of any changes to consumption patterns). In other words, the average customer's electric bill would not change if he/she switched from his/her current rate to the new CPP rate. Roughly half of the customers would be expected to experience bill increases (the customers with "peakier" load shapes), and the other half could expect bill savings (customers with flatter load shapes). Of course, this is all in the absence of demand response. As customers change load patterns in response to the new CPP rate, a higher percentage will see bill savings.

The CPR rate would charge customers the existing rate during all hours of the year. However, during critical events, customers would be eligible for a rebate if they reduced their consumption from a predetermined "baseline" level.[5] In the case of Pepco's residential CPR, customers would receive a rebate of approximately $1.30 (on an all-in basis) for every kilowatt-hour of consumption that they reduced.

The Pepco non-residential rates and the Delmarva rates are structured in the same fashion. The resulting rates for each utility and customer type are summarized in Table 1.

Table 1. Summary of CPP Rates ($/kWh)

	Existing All-In Rate	New CPP Rate		New CPR Rate	
	All Hours	Critical Peak	Off Peak	Rebate (Critical peak)	Rate (All hours)
Pepco MD					
Residential	0.156	1.545	0.127	-1.295	0.156
Residential TOU	0.142	1.532	0.114	-1.282	0.142
C&I	0.158	1.532	0.135	-1.282	0.158
DPL MD					
Residential	0.137	1.534	0.114	-1.284	0.137
C&I	0.142	1.524	0.121	-1.274	0.142

For the purposes of this analysis, the rates are assumed to be dispatched on 10 critical days during the summer.[6] Since each critical event lasts four hours, this represents a total of 40 critical hours during the summer.

[5] The baseline is an estimation of the customer's consumption level in the absence of being offered a rebate.
[6] They could be dispatched as many as 15 times, but that represents an upper-bound rather than a midpoint.

During the remaining 3,632 hours of the summer,[7] customers on a CPP receive the discounted off-peak price. Customers are notified the day before a critical event will be dispatched.

Q. FOR WHICH CUSTOMER CLASSES DID YOU SIMULATE THE IMPACTS OF DYNAMIC RATES?

A. In Pepco, I assumed that residential customers on Schedule R and Schedule R TM would be eligible for the dynamic pricing rates. For the non-residential customers, I limited my analysis to standard offer service customers with peak demand up to 600 kW. I used rate schedule MGT LV-II as the proxy for these customers. I did not model impacts for small non-residential customers (i.e. below 25 kW of demand) because recent experiments have not found these customers to be responsive to dynamic pricing in the absence of enabling technologies (such as programmable communicating thermostats). Although, I would note that offering small non-residential customers a dynamic pricing rate will encourage adoption of demand response enabling technology and help to accommodate new electric end-uses and small-scale generators.

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[7] The analysis of load reductions likely to be achieved by CPP assumes four-hour events, but the benefits component of this study assumes the same level of load reductions would be extended to five hours in order to be consistent with the *Brattle*-PJM-MADRI study, from which some of the customer benefits are derived.

I used this same approach for Delmarva. Specifically, I modeled the residential rate class and the Small General Service Type II non-residential rate class.

Q. **WHAT EXISTING RATES DID YOU USE IN THE PRISM ANALYSIS?**

A. The existing rate is a necessary input to the analysis, because a customer's responsiveness to a new CPP rate will be driven by the price increase or decrease that the CPP rate provides relative to the customer's existing rate. In other words, during the critical peak hours, a customer is responding not just to the high absolute price level of the CPP, but to the relationship of that price to the existing rate. Similarly, in the off peak period, the customer's response is assumed to be driven by the relative discount that he or she receives through the CPP rate.

Existing 2008 all-in rates were provided to me by Pepco and Delmarva. These are summarized for the residential customers in Table 2.

Table 2. Existing Residential All-In Summer Rates

	Pepco MD		DPL MD
Rate Schedule	"R"	"RTM"	"Res"
Average Summer Bill ($/month)	155.32	246.98	124.21
All-In Rate ($/kWh)	0.156	0.142	0.137

Existing C&I rates were provided as well. The all-in rates are summarized in Table 3.

Table 3. Existing C&I All-In Summer Rates

	Pepco MD	DPL MD
Rate Schedule	"MGT LV II"	"SGS II"
Average Summer Bill ($/month)	4,091	2,549
All-In Rate ($/kWh)	0.158	0.142

Q. **USING THESE INPUTS, WHAT MAGNITUDE OF DEMAND RESPONSE DID YOU PROJECT ON A PER-PARTICIPATING CUSTOMER BASIS?**

A. The demand response impacts of dynamic pricing on a per-customer basis are summarized in Exhibits AF-6 and AF-7 on a percent-of-peak demand basis and in Exhibits AF-8 and AF-9 on a nominal kWh/hr basis.

Impacts for C&I customers are estimated to be 50 percent of the impacts for a residential customer on the same rate. In other words, if a residential customer were to reduce peak demand by 10 percent in response to dynamic pricing, a C&I customer on the same rate would reduce peak demand by 5 percent. This is a conservative estimate that is supported by the findings of the C&I impacts study that was conducted through the California SPP.[8]

The average residential customer is expected to produce a greater peak reduction on a percentage basis than the peak reduction from the average C&I customer. However, this does not always translate into a greater peak reduction on a kWh/hour basis. This depends on the size of the customer. In fact, C&I customers provide larger impacts on an absolute per-customer basis.

Q. **WERE THE BENEFITS OF DIRECT LOAD CONTROL (DLC) PROGRAMS INCLUDED IN YOUR ANALYSIS?**

A. The direct benefits of DLC programs were excluded from this analysis because these programs could be offered in the absence of AMI.[9] In other words, one could add the DLC-attributable peak reductions to my estimates of AMI-related peak reductions and there would be no double-counting of benefits.

8 See CRA International, "California's Statewide Pricing Pilot: Commercial & Industrial Analysis Update," June 2006.

9 Note that these programs were included in the original 2007 analysis I mentioned previously.

I did indirectly include one benefit of AMI that is related to DLC. Over time, the compressor direct load control equipment that are required to implement a DLC program may fail and/or become disconnected. Without AMI, this technology failure cannot be remotely detected. But with AMI in place, the failure is detectable and the technology can quickly be replaced. For this reason, I have assumed a decay rate of DLC technologies of roughly 1.3 percent per year, so that by 2025, 20 percent of the technologies have failed. I assume that 80 percent of these failed technologies could be detected and replaced because of AMI and therefore, I have attributed the post-technology replacement benefits of those participants to AMI.

Additionally, I have assumed that DLC customers would be enrolled in a dynamic rate. I have modeled the peak reductions that those customers would likely provide in response to the dynamic rate by reducing consumption from various end-uses other than their air conditioner. These peak reductions are attributable to AMI.

Q. HOW DID YOU ESTIMATE THE NUMBER OF PARTICIPATING CUSTOMERS?

A. Customers can only enroll in a dynamic rate if they are equipped with AMI because that allows their electricity consumption to be measured in hourly intervals (or shorter) as opposed to being measured on a monthly basis. All residential and C&I customers will be equipped with AMI. The number of eligible customers modeled in my analysis is summarized in Table 4, along with the annual growth rates that are assumed for each segment of the population.[10]

Table 4. 2011 Customer Population Estimates and Annual Growth Rates

	Pepco MD	DPL MD
Residential		
Total	425,799	191,054
Annual Growth Rate	0.674%	0.813%
Residential TOU		
Total	55,271	N/A
Annual Growth Rate	0.674%	N/A
C&I		
Total	31,027	4,715
Annual Growth Rate	0.359%	1.164%

Based on information provided to me by PHI, I assumed that Pepco would deploy AMI over the period from 2011 to 2012 and that all of Delmarva MD's residential customers would have AMI by mid-year 2011. Fifty percent of Pepco MD customers would have AMI at mid-year 2011 and AMI would be fully deployed to the residential class by the end of 2011.

[10] Recall that I have only included certain rate classes in my analysis.

All C&I customers billed under Standard Offer Service rates would become eligible for dynamic pricing mid-year 2012.

It is assumed that customers are eligible to participate in dynamic pricing once they have been equipped with AMI. In other words, it is not necessary for a jurisdiction to achieve 100 percent of its scheduled deployment before customers can begin enrolling in dynamic pricing rate.

Delmarva and Pepco propose to enroll all Standard Offer Service customers in critical peak rebate rates on a default basis. The Companies also propose to permit these customers to migrate either to a Critical Peak Pricing rate or to return to a flat SOS rate. My analysis is based upon these rate applicability assumptions.

It should also be noted that in Pepco and Delmarva's service territories, customers have the option of "shopping" for another retail supplier of electricity. Pepco and Delmarva expect that some customers will continue to exercise this option and impacts have not been modeled for these customers.

Forecasts of customer participation in dynamic rates are summarized in Exhibits AF-10 and AF-11.

Q. WHAT ARE THE SYSTEM-WIDE PEAK DEMAND IMPACTS OF DYNAMIC PRICING?

A. Multiplying the per-customer kWh/hour peak reductions by the forecast of participating customers results in an annual forecast of system-wide peak demand reductions for Pepco's and Delmarva's Maryland service territories. These forecasts are summarized in Exhibit AF-12.

The total peak reduction attributable to AMI will be 64 MW in Pepco Maryland and 47 MW in Delmarva Maryland in 2011, the first year of AMI deployment. This is expected to grow to 199 MW and 63 MW by 2025, respectively.

My estimates of peak demand reduction have been reduced to account for the impact of the EmPOWER Maryland energy efficiency and conservation programs. To make this adjustment, I calculated the percentage reduction in class peak demand attributable to the programs (using data provided by Pepco and Delmarva), and scaled my impacts downward by this percentage. This effectively adjusts for the lower peak usage that customers would have in the future as a result of participating in these energy efficiency and conservation programs.

Q. PLEASE DESCRIBE THE MANNER THAT PEPCO AND DELMARVA'S DYNAMIC PRICING PROGRAMS WILL INTERACT WITH THE PJM CAPACITY MARKET.

A. Currently dynamic pricing programs can derive PJM market capacity benefits using two primary methods. The first method would be for customers to reduce their market capacity obligations by reducing their peak demands during PJM market peak load hours. As a result, the resulting capacity market costs of providing electric service to these customers would be reduced. The second method would be through possible participation in the PJM demand response program. These potential market opportunities currently include the Interruptible Load for Reliability Program (being phased out after 2011), the Reliability Pricing Model Base Residual Auctions, and the interim Reliability Pricing Model Base Residual Auctions. Pepco and Delmarva representatives are working through the PJM stakeholder process on the most appropriate manner of integrating dynamic pricing derived load reductions into the PJM capacity market.

Q. PLEASE DESCRIBE THE MANNER THAT PEPCO AND DELMARVA'S DYNAMIC PRICING PROGRAMS WILL INTERACT WITH THE PJM ENERGY MARKET.

A. There are currently three methods of deriving PJM energy market benefits. The first method is by selling energy through the day ahead or real time energy market, the second is through bilateral agreement with suppliers and the third method is through the existing PJM demand response market. Under the existing PJM demand response market, there are three alternative methods of deriving energy market benefits: 1) the day ahead energy market, 2) the real time energy market, and 3) the emergency market. The Companies anticipate that energy market opportunities will evolve as additional dynamic pricing programs are offered throughout PJM as a result of the deployment of advanced metering infrastructures. Pepco and Delmarva representatives are working through the PJM stakeholder process on the most appropriate manner of integrating dynamic pricing derived load reductions into the PJM energy market.

Q. HOW DID YOU DERIVE THE IMPACT OF PEPCO AND DELMARVA'S DEMAND REDUCTION PROGRAMS ON PRICES IN WHOLESALE ENERGY AND CAPACITY MARKETS?

A. Even a small reduction in demand during tight market conditions may lower the market price for energy. This lowers the price of energy for all customers, not just those curtailing load, and not just for customers in the zone where dynamic pricing is implemented. Similarly, reducing the peak demand lowers the demand for capacity, which can lower the market price for capacity, which affects all customers in the same locational delivery area and more broadly throughout the PJM market.

Short-term energy price reductions are estimated by adapting the results of the *Brattle*-PJM-MADRI study to reflect the differences in load reductions expected from Pepco and Delmarva's DSM programs. To the extent that load reductions differ from the load reductions simulated in the *Brattle*-PJM-MADRI study, price impacts are estimated using linear extrapolation (e.g., twice the MW of load reductions causes twice the price impact). This linear approach does not consider that the marginal price effect could diminish as load reductions increase.

As in the *Brattle*-PJM-MADRI study, the customer benefit from reduced energy prices can be estimated by multiplying the expected price reduction by the quantity of load exposed to market prices.[11] In addition, we have similarly developed an estimate of the capacity price impact from dynamic pricing.

Q. WILL PEPCO AND DELMARVA'S DEMAND REDUCTION PROGRAMS PRODUCE ANY OTHER BENEFITS?

A. **Yes.** Other benefits will include (1) improved reliability; (2) enhanced market competitiveness; (3) reduced rate volatility; (4) reduced transmission and distribution losses; (5) reducing the need for investments in transmission and distribution; and (6) the introduction of rates that will incent the appropriate use of new electric end-uses, such as plug-in vehicles and small scale renewable generators.

Reliability Benefits. Dynamic pricing programs can reduce the probability and extent of rolling blackouts. In a supply-inadequate scenario, demand response would help prevent intolerably low reserve margins with likely blackouts and would allow the system to operate reliably.

Reliability also has economic value. Monetizing reliability benefits requires estimating the effect of dynamic pricing on the expected loss of load, and then

[11] Benefits are partially offset approximately 15 percent by associated reductions in the value of Financial Transmission Rights ("FTRs"), as described in the *Brattle*-PJM-MADRI study.

applying an economic value to each megawatt-hour of lost load. Several studies have quantified the value of lost load, finding $1,600 to $4,700 per megawatt-hour for residential customers and $7,000 to $50,000 for small C&I customers, so the economic value of incremental reliability can be quite high.[12]

The reliability value of dynamic pricing has not been captured in any of the capacity-related benefits quantified in this study. Although PJM's capacity market prices in the RPM are partly based on reliability factors, market-clearing prices are capped at 1.5 times the net cost of new entry (Net CONE). Therefore, under extremely tight market conditions, when the value of new capacity is very high from a reliability perspective, the reliability value of load reductions would not be fully reflected in the market clearing capacity prices. For example, in our capacity market simulations, Southwestern MAAC LDA market clearing prices were at the price cap both with and without dynamic pricing, and hence no capacity market price effect was projected.

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[12] See *Value of Lost Load*, Prepared by SAIC for Midwest ISO, May 2006; *Value of a Reliable Supply of Electricity*, prepared by ICF for EEI, December 2005; *A Framework and Review of Customer Outage Costs*, prepared by LBL and Population Research Systems for DOE, November 2003; *Value of Service Reliability Study*, prepared by Hagler Bailly for SCE, September 2000.

Market Competitiveness Benefits. During high-load periods, electricity markets suffer from structural problems that increase the incentive and ability for generators to exercise market power. Market power is exacerbated if most customers are not enrolled in dynamic pricing programs, so they have no incentive to reduce even their lowest-value consumption when spot prices spike to $1,000 per megawatt-hour or higher, leading to a demand curve that is almost completely inelastic. Pepco and Delmarva's proposed dynamic pricing programs would increase the elasticity of demand and thereby increase the competitiveness of the market. Simple game-theoretic models suggest that doubling the elasticity of demand - not an overly-ambitious goal, given the nascence of dynamic pricing programs - would enhance competitiveness as effectively as a 50% reduction in market concentration.

Insurance Benefits/Reducing Rate Volatility. Many customers are risk-averse and value rate stability, for example because they need to be able to forecast their costs accurately for budgeting purposes. Hence, there is value to reducing the price variance, not just reducing expected prices.

As recent history has demonstrated, retail electricity prices can fluctuate in response to spot prices (for customers on real-time pricing) or in response to expected wholesale prices (for other customers, e.g., those on standard offer service). To the extent that demand reduction reduces volatility in the spot market, it improves overall electricity price stability for at least some customers. Dynamic pricing reduces volatility by preventing the market from becoming as tight during normal peaks in load. This mitigating effect is greatest under extreme conditions. Even though this analysis presents a range of benefits, reflecting a range of market conditions, it does not account for the fact that the greatest benefits occur when rates are highest, when rate relief would be the most valuable.

Q. **HOW DO PEPCO AND DELMARVA'S PROJECTED IMPACTS AND BENEFITS COMPARE WITH BEST INDUSTRY PRACTICES?**

A. In a year-long project for the Federal Energy Regulatory Commission, I have surveyed the projected per-customer impacts of a variety of demand response programs around the country along with projected participation rates. I have also reviewed the history of such programs and contributed to the design and evaluation of such programs over the past three decades for more than fifty utilities and state commissions in the United States and Canada. Finally, I have written case studies of several international programs for the World Bank. In my opinion, the dynamic pricing program is consistent with best industry practices. It addresses all key market segments and both existing and future end-uses. Dynamic pricing of course requires the prior deployment of AMI, which is an integral part of Pepco's *Blueprint* strategy. Once AMI is in place and dynamic pricing has been designed in a manner that appeals to customers and executed with sufficient resources for marketing and implementation, I am confident that the projected impacts will be realized.

Q. WHAT ARE YOUR CONCLUSIONS?

A. I have reached several conclusions. First, Pepco and Delmarva's AMI deployment is critical to the provision of dynamic pricing for customers and this proposed program is on par with the best programs in the industry. The Companies' proposed deployment of an AMI system represents an important milestone on the road to the smart grid. Second, the bulk of the program benefits are associated with lowering resource costs associated with the acquisition of capacity and energy. Customer benefits are greatest if dynamic pricing is the default rate structure. Customer benefits would be significant in a supply-adequate market in which suppliers are highly responsive to the introduction of demand response, but they are much greater in a scarcity situation in which generation supply is static for the first several years of the forecast (except for projects already in PJM's queue). If such scarcity were realized, having AMI in place would enable the Public Service Commission to substantially mitigate customer energy costs by permitting Pepco and Delmarva to implement dynamic pricing as the default standard offer service rate structure.

Third, short-term savings to all customers, including those outside of Pepco and Delmarva's zones, would be much larger because load reductions would have a PJM market-wide impact on energy and capacity prices. The aggregate load reductions would create a much greater, market-wide short-term price impact.

Fourth, although dynamic programs typically designate peak periods on a day-ahead basis, making the programs callable on a real-time basis (instead of a day-ahead time frame) would enable customers to mitigate the impacts of real-time surprises in load or supply outages.

Fifth, although this analysis does not quantify the reliability benefit in financial terms, we expect the dynamic pricing programs to materially boost reserve margins in all the areas served by PHI. This insurance value would be of great significance to customers.

Q. ON A NATIONAL LEVEL, COULD YOU BRIEFLY DESCRIBE UTILITY PLANS FOR AMI DEPLOYMENT?

A. Currently, AMI is deployed for five percent of the nation's 142 million customers, up from just one percent just two years ago. Based on current projections, another 40 to 50 million customers will be included by AMI deployments that have already been advanced or at fairly advanced stages of business case development. This additional deployment is expected to take place over the next decade. Deployment is expected to take place at a faster pace after Federal stimulus funding awards are made.

Q. COULD YOU BRIEFLY DESCRIBE AMI-ENABLED DYNAMIC PRICING INITIATIVES NATIONALLY?

A. AMI-enabled dynamic pricing is receiving great interest in the United States and Canada. More than a dozen experiments involving several thousand customers have been carried out in these two countries and there is convincing evidence that customers do respond to dynamic pricing by reducing peak loads during critical times. Utilities and state commissions are engaged in serious deliberations about how best to deploy dynamic pricing, once AMI deployment has occurred. In California, the Public Utilities Commission has ordered that dynamic pricing should be made the default pricing structure once

AMI is deployed for all customer classes (unless it is so prevented by legislation).

Q. IS THERE A "BEST" FORM OF DYNAMIC PRICING?

A. No. Several alternative AMI-enabled rate designs can accomplish the goal, which is to provide customers an accurate, cost-based price signal that tells them (in near real time conditions) when to conserve energy use in an easy to understand and communicate fashion.

Q. COULD YOU CHARACTERIZE THE PERCENTAGE OF PEAK LOAD REDUCTIONS THAT HAVE BEEN MEASURED FROM AMI-ENABLED DYNAMIC PRICING IN OTHER REGIONS OF THE UNITED STATES?

A. Critical peak pricing has achieved load reductions in the 10 to 20 percent range without enabling technologies and in the 20 to 50 percent range when accompanied with enabling technologies. This is based on a review of 15 pricing pilots from around the globe that involved more than 15,000 customers over the past several years.

Q. BASED ON YOUR PROFESSIONAL EXPERIENCE, IS THE DEPLOYMENT OF AN AMI SYSTEM IN MARYLAND LIKELY TO BE FINANCIALLY BENEFICIAL TO CUSTOMERS?

A. Absolutely, to do otherwise would simply ensure that electricity costs in Maryland will be higher than they need to be.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

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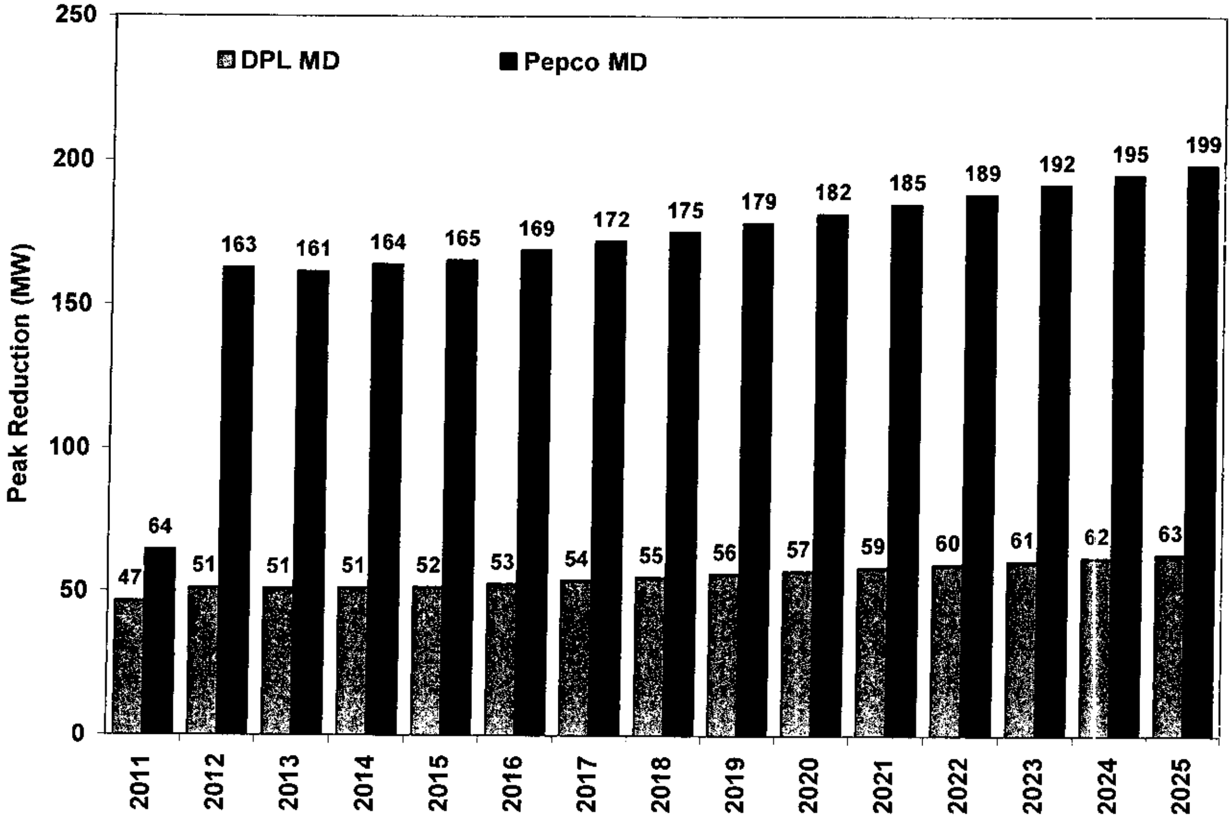
Introduced as:
DPL/PEPCO __ EXHIBIT AF-1

Exhibit AF-1. Demand Response Attributable to AMI



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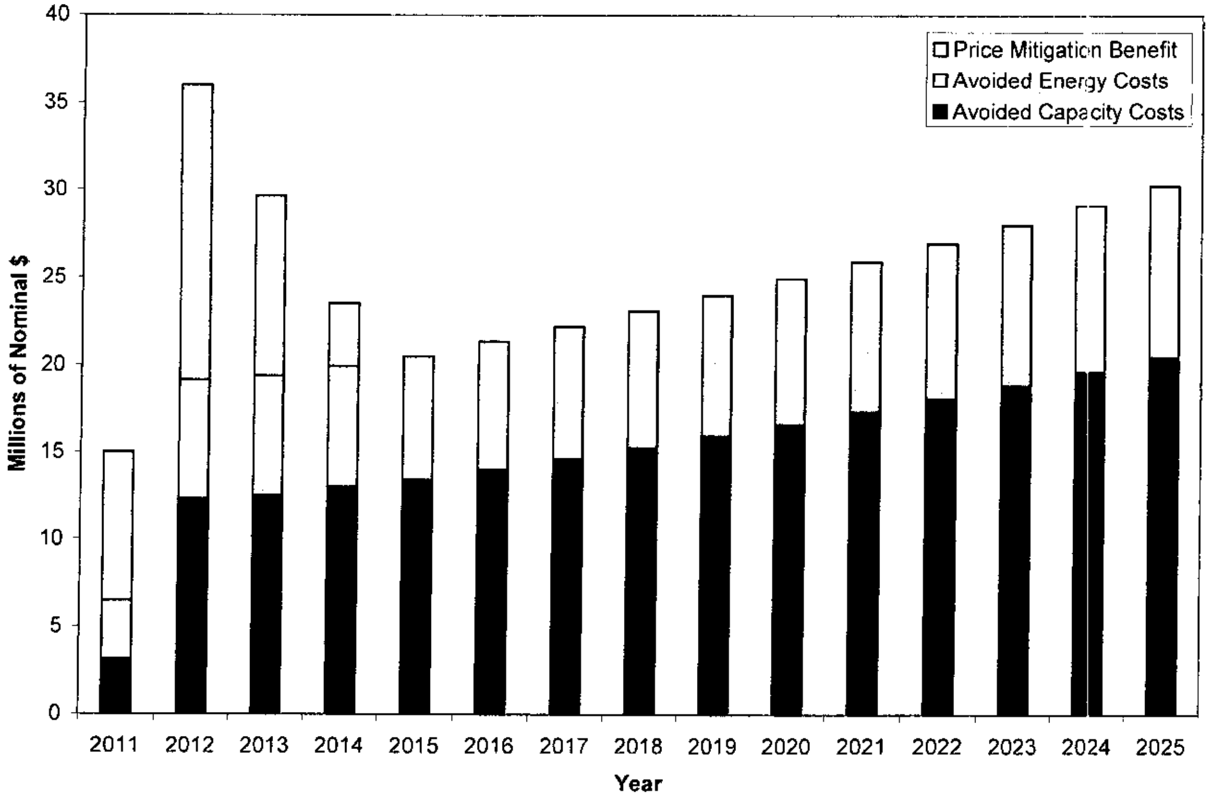
Introduced as:
DPL/PEPCO __ EXHIBIT AF-2

Exhibit AF-2. Annual Value of Quantified Customer Benefits in Pepco MD Between 2011 and 2025 (Millions of Nominal Dollars)



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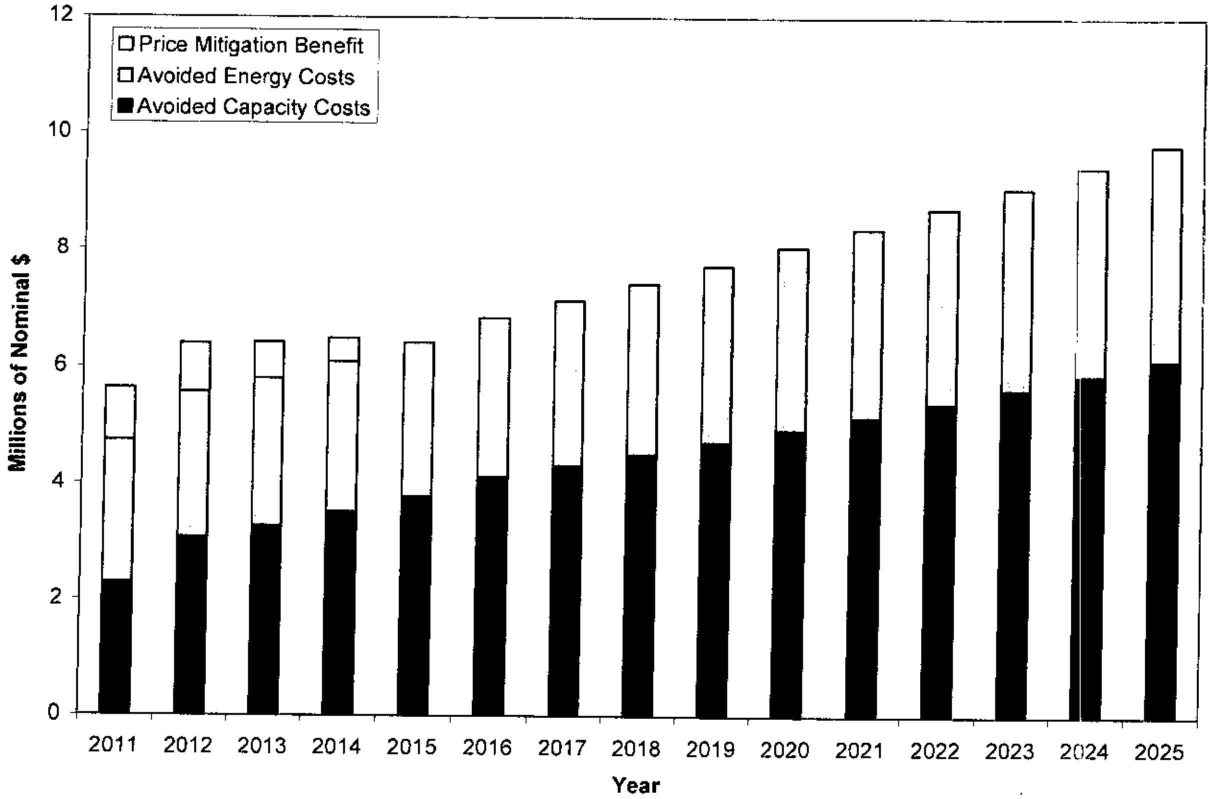
Introduced as:
DPL/PEPCO __ EXHIBIT AF-3

Exhibit AF-3. Annual Value of Quantified Customer Benefits in Delmarva MD Between 2011 and 2025 (Millions of Nominal Dollars)



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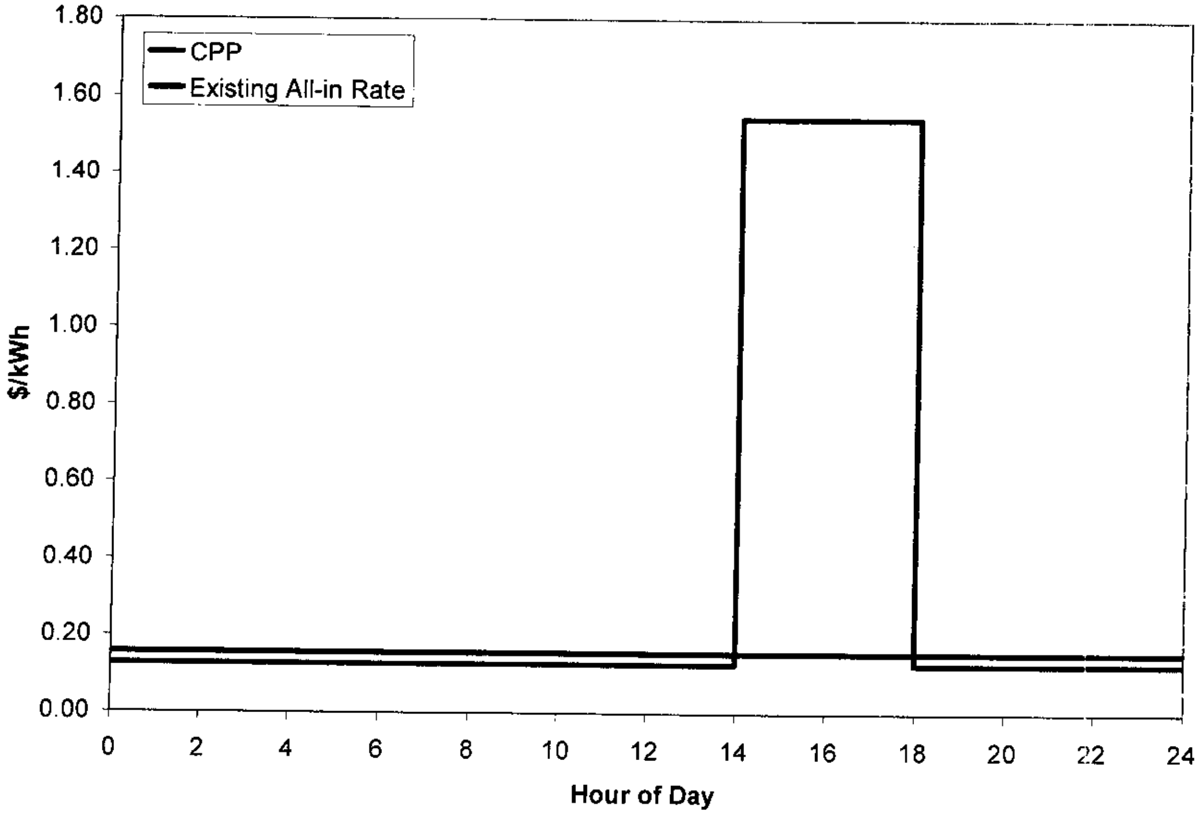
Introduced as:
DPL/PEPCO __ EXHIBIT AF-4

Exhibit AF-4. All-in Residential Summer CPP Rate in Pepco MD on Critical Day



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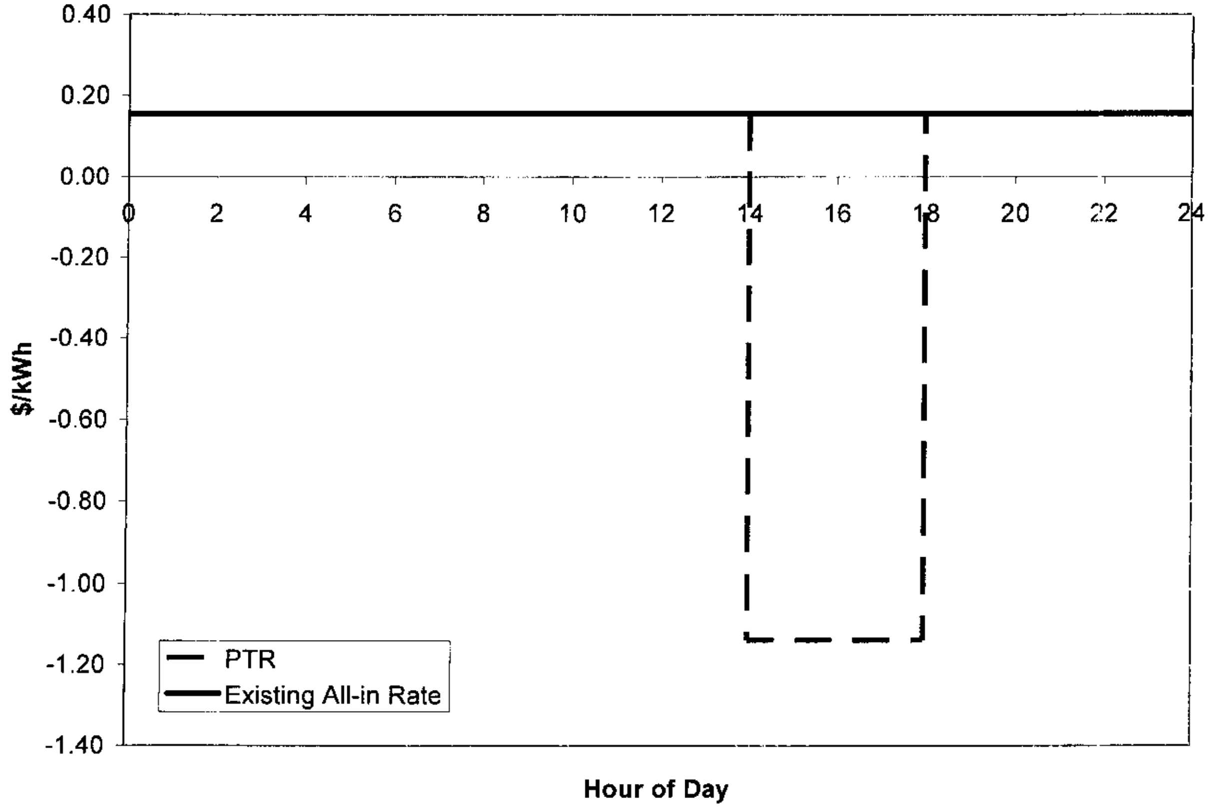
Introduced as:
DPL/PEPCO __ EXHIBIT AF-5

Exhibit AF-5. All-in Residential Summer CPR Rate in Pepco MD



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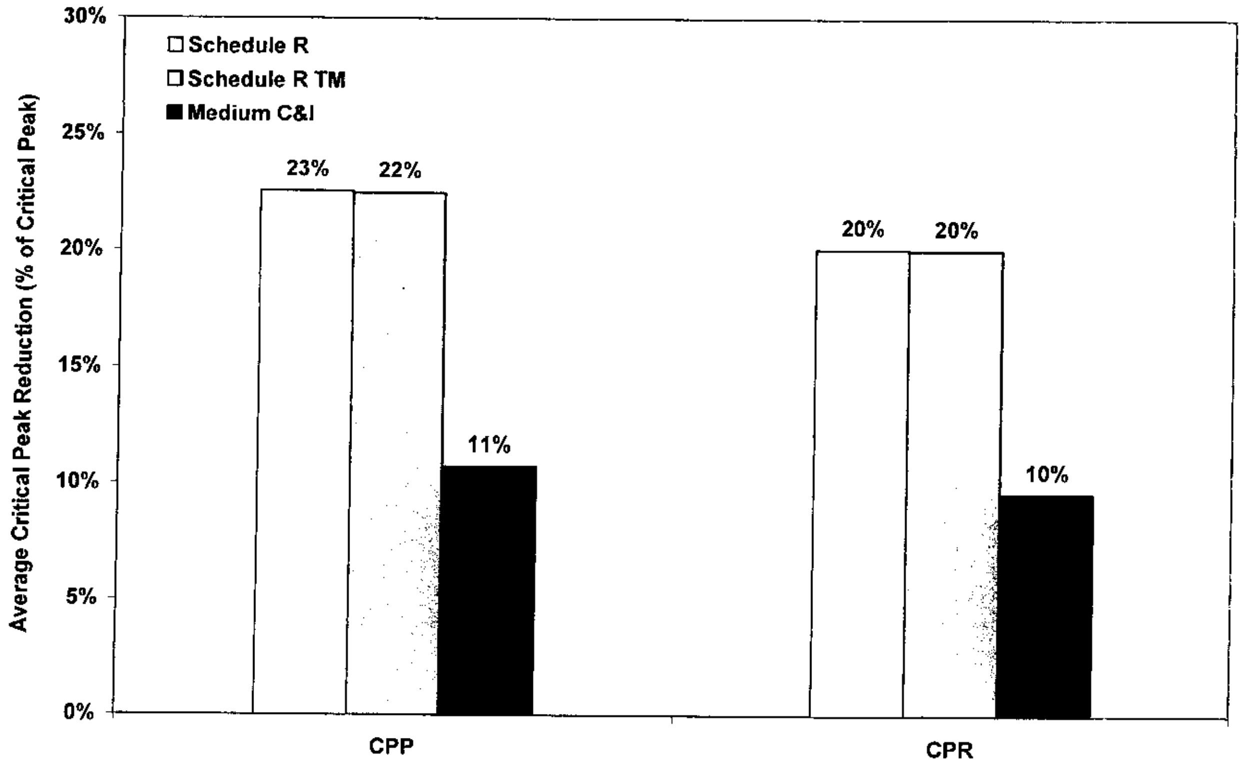
Introduced as:
DPL/PEPCO __ EXHIBIT AF-6

Exhibit AF-6. Expected Average Demand Response Resulting from Dynamic Pricing in Pepco MD (Percent of Critical Peak)



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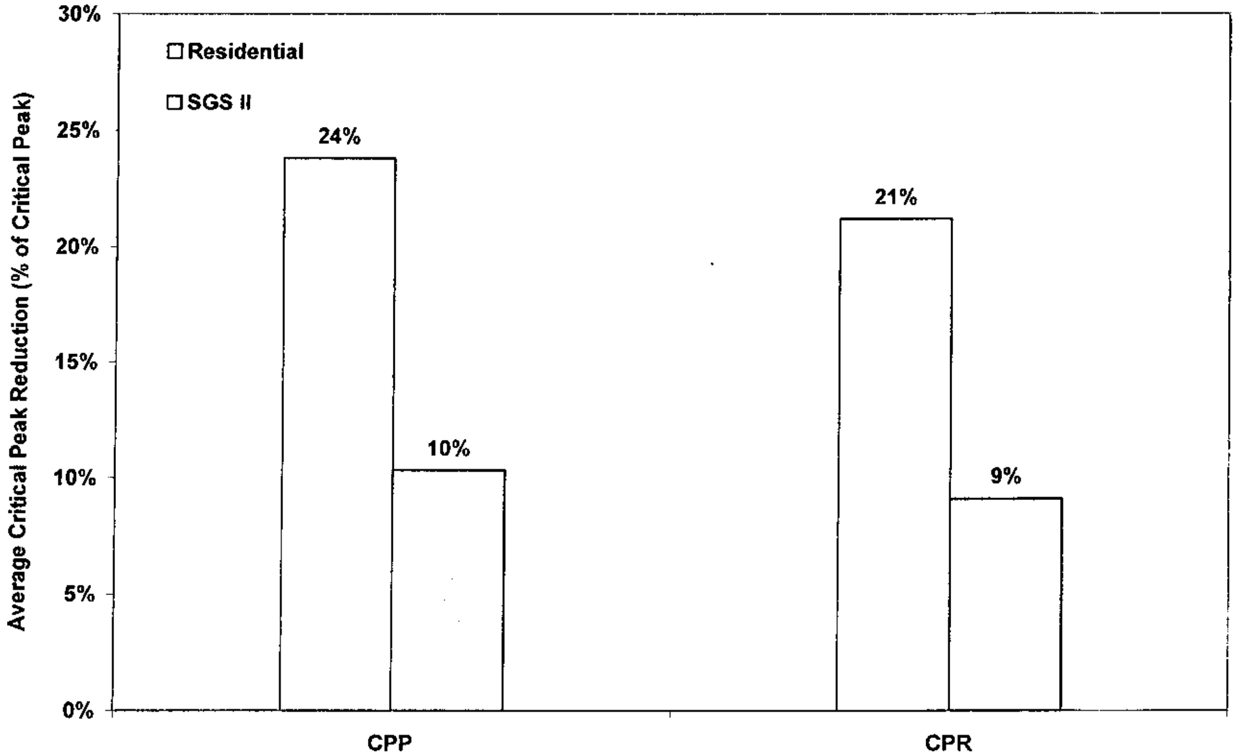
Introduced as:
DPL/PEPCO __ EXHIBIT AF-7

Exhibit AF-7. Expected Average Demand Response Resulting from Dynamic Pricing in Delmarva MD (Percent of Critical Peak)



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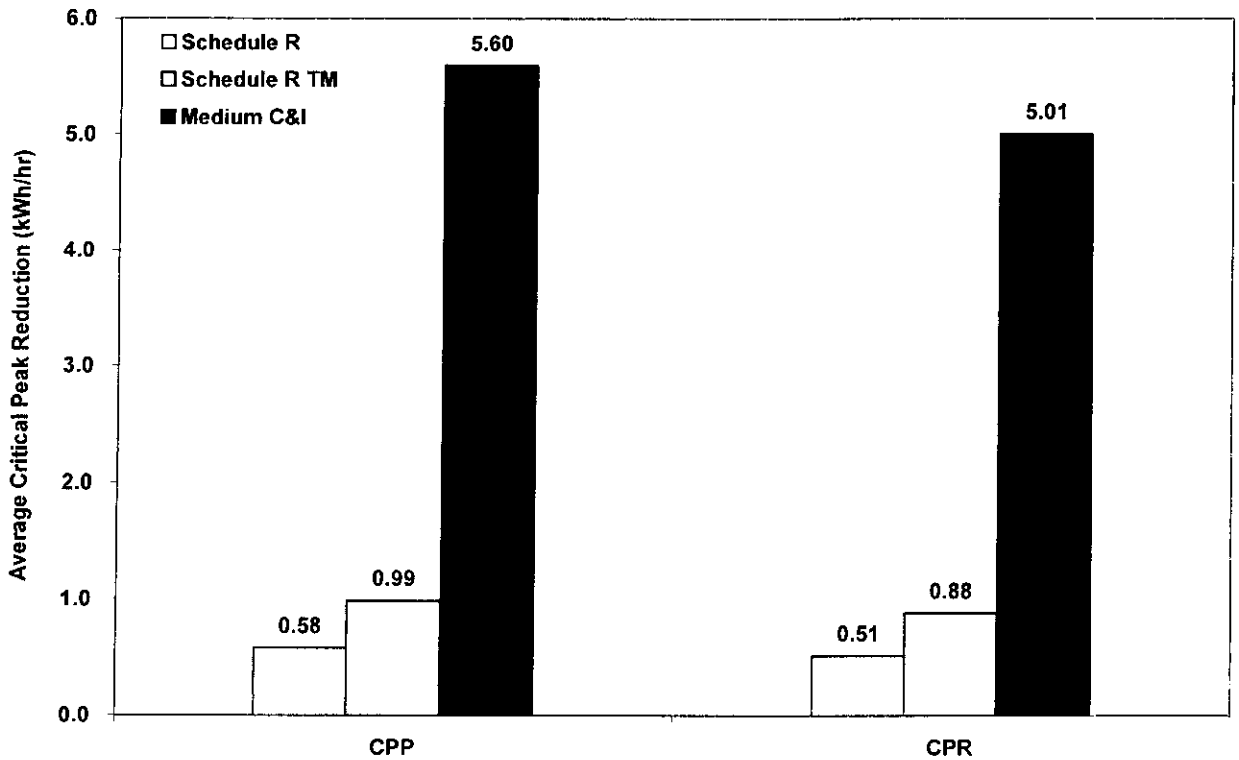
Introduced as:
DPL/PEPCO __ EXHIBIT AF-8

Exhibit AF-8. Expected Average Customer Demand Response Resulting from Dynamic Pricing in Pepco MD (kWh/hr)



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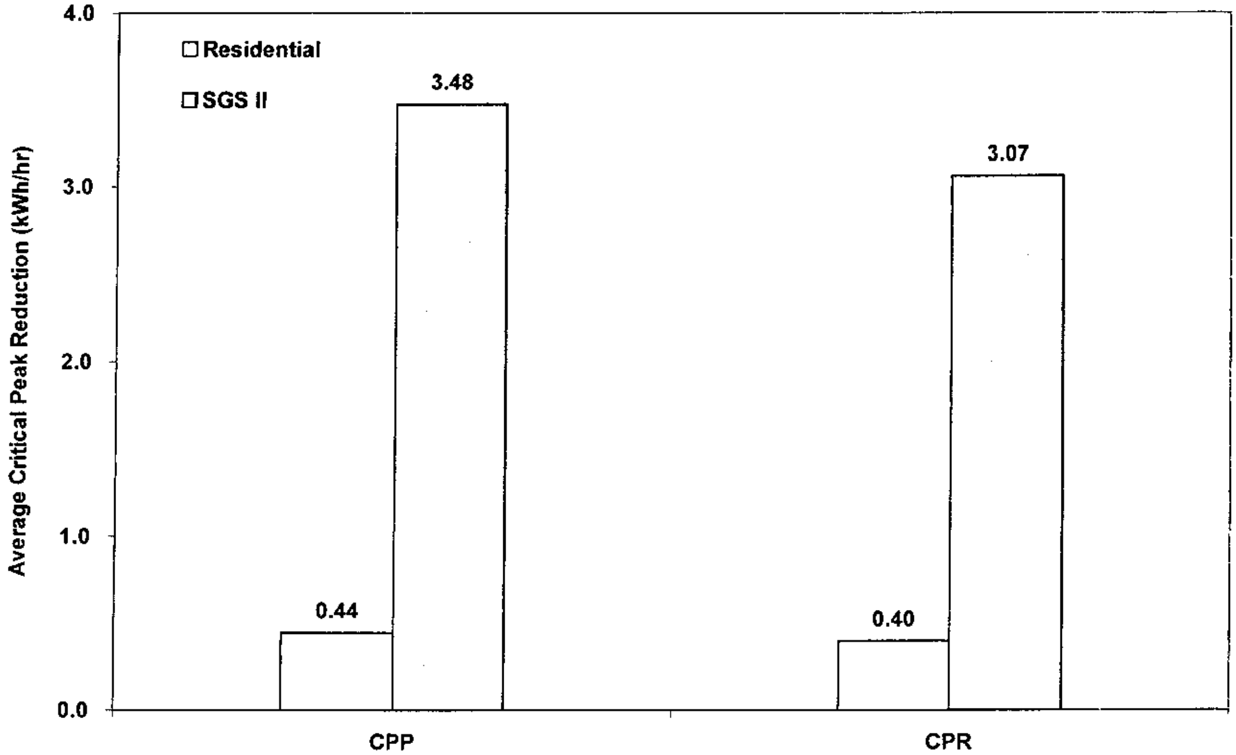
Introduced as:
DPL/PEPCO __ EXHIBIT AF-9

Exhibit AF-9. Expected Average Customer Demand Response Resulting from Dynamic Pricing in Delmarva MD (kWh/hr)



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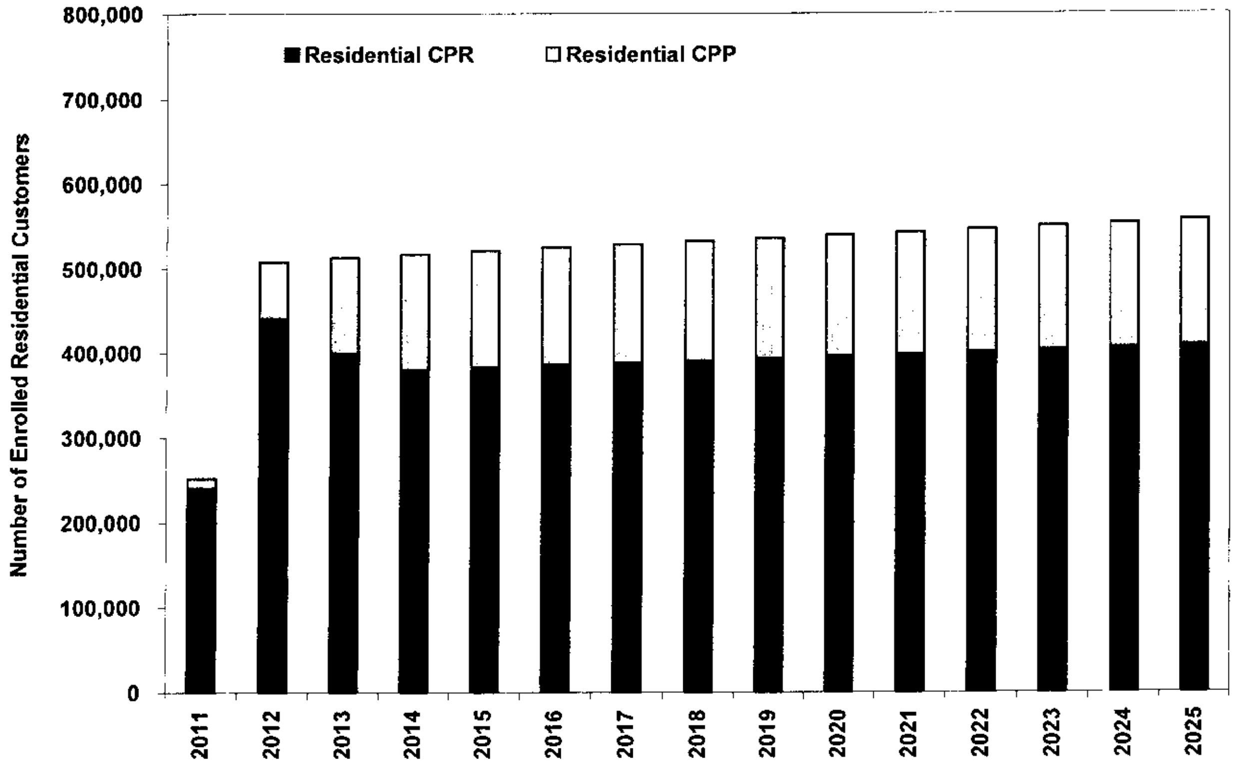
Introduced as:
DPL/PEPCO __ EXHIBIT AF-10

Exhibit AF-10. Forecast of Total Residential Dynamic Pricing Enrollment in Maryland Jurisdictions



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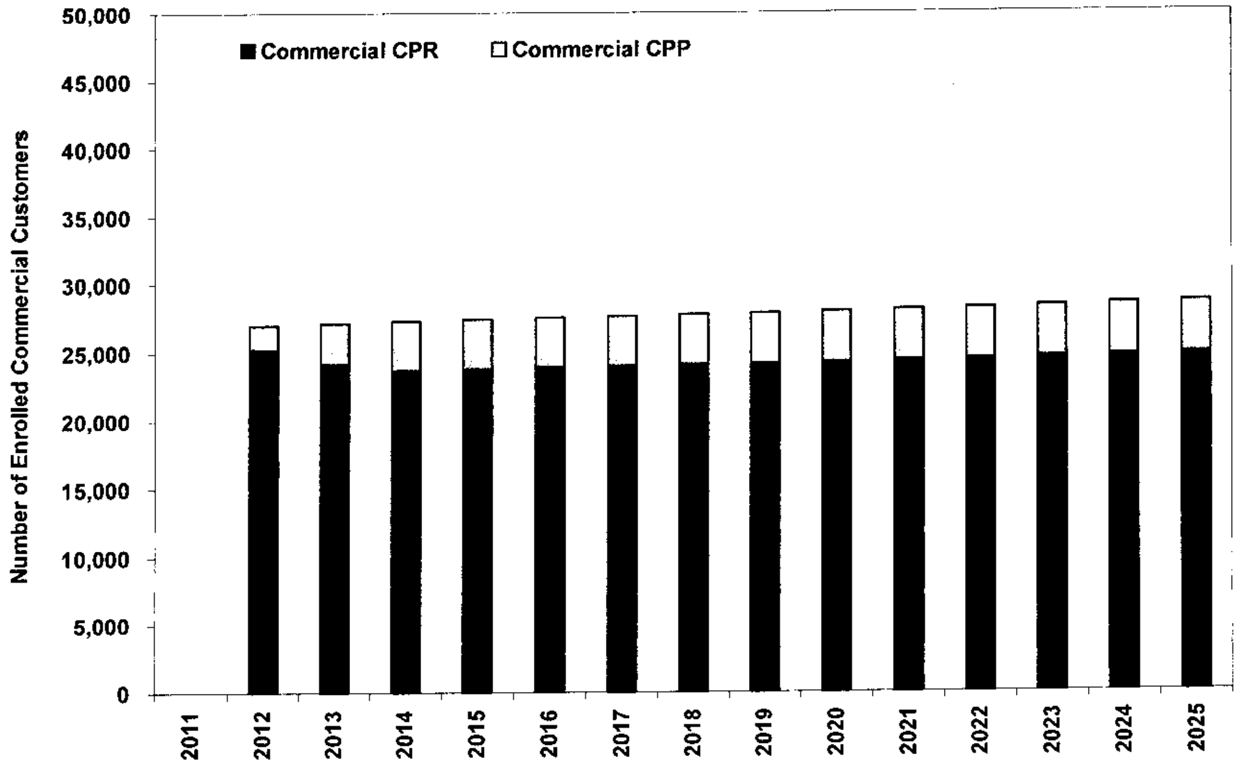
Introduced as:
DPL/PEPCO __ EXHIBIT AF-11

Exhibit AF-11. Forecast of Total C&I Dynamic Pricing Enrollment in PHI Maryland Jurisdictions



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Introduced as:
DPL/PEPCO __ EXHIBIT AF-12

Exhibit AF-12. System-Wide Peak Demand Reductions Attributable to Dynamic Pricing and AMI