**STATE OF NEW JERSEY**
**BOARD OF PUBLIC UTILITIES**

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| **I/M/O THE PETITION OF PUBLIC SERVICE ELECTRIC & GAS COMPANY FOR APPROVAL OF THE ENERGY STRONG PROGRAM** | ) ) ) ) | **BPU Docket Nos. EO13020155 and GO13020156** |

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# SUPPLEMENTAL TESTIMONY OF DAVID E. DISMUKES, PH.D. ON BEHALF OF THE DIVISION OF RATE COUNSEL

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**Dated: January 10, 2014**

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**ON BEHALF OF THE**

**NEW JERSEY DIVISION OF RATE COUNSEL**

**BPU DOCKET NO. EO13020155 and GO13020156**

## I. Introduction

**Q. WOULD YOU PLEASE STATE YOUR NAME AND BUSINESS ADDRESS?**

A. My name is David E. Dismukes. My business address is 5800 One Perkins Place Drive, Suite 5-F, Baton Rouge, Louisiana, 70808. I am the same person that prepared and pre-filed direct expert testimony on the behalf of the New Jersey Division of Rate Counsel ("Rate Counsel") on October 28, 2013.

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

A. I have been asked by Rate Counsel to provide an expert opinion to the Board of Public Utilities ("BPU" or "Board") on the report prepared by the Brattle Group, on the behalf of Public Service Electric & Gas Company ("PSE&G" or "the Company"), to estimate the program benefits associated with the Company's Energy Strong ("ES") proposal. The Brattle Group report is entitled *Analysis of Benefits: PSE&G's Energy Strong Program*, dated October 7, 2013 (hereafter "Brattle Report" or "the Report") and was provided to the Parties as a supplement to the Company's Response to RCR-ECON-5. It is my understanding that the Brattle Report is being sponsored through the rebuttal testimony of Dr. Peter S. Fox-Penner, one of the authors of the study. Dr. Fox-

Penner has also provided this report as Schedule PFP-ES-2 to his rebuttal testimony dated November 27, 2013.

**Q. ARE THERE ANY OTHER RATE COUNSEL WITNESSES ADDRESSING THE BRATTLE REPORT?**

A. Yes. Mr. Charles Salamone, an electrical engineering expert for Rate Counsel, who also pre-filed direct expert testimony on October 28, 2013, will be providing supplemental testimony addressing many of the engineering inputs utilized by the Brattle Group in the preparation of its analysis.

**Q. HAVE YOU PREPARED ANY SCHEDULES IN SUPPORT OF YOUR SUPPLEMENTAL TESTIMONY AND RECOMMENDATIONS?**

A. Yes. I have prepared nine schedules in support of my supplemental testimony that were prepared by me or under my direct supervision.

**Q. HOW IS THE REMAINDER OF YOUR SUPPLEMENTAL TESTIMONY ORGANIZED?**

A. My testimony is organized into the following sections:

- Section II: Summary of Recommendations
- Section III: Brattle Report Overview
- Section IV: The Brattle Report Break-Even Analysis is Inappropriate
  - Benefits Will Evolve Over a Very Long Time Period
  - Fails to Discount Program Benefits Over Time
- Section V: The NGD Analysis Shortcomings
  - NGD Benefits Timing and Discounting Issues
  - Flaws in Estimates of Benefits of Natural Gas ES Investments
  - Residential Price Elasticities of Natural Gas Demand

- Maximum Prices
- Overstated Commercial and Industrial Program Benefits

- Section VI: Conclusions and Recommendations

## II. Summary of Recommendations

**Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.**

A. I recommend that the Board reject the use of the Brattle Report, and its findings, in making a decision regarding the net economic impacts associated with the Company's ES proposal. The Report suffers from a number of important flaws that cause it to substantially over-estimate the outage duration-related benefits of the Company's ES proposal.

**Q. HAVE YOU CHANGED YOUR EARLIER-OFFERED EXPERT OPINION AS A RESULT OF YOUR REVIEW AND ANALYSIS OF THE BRATTLE REPORT?**

A. No. I continue to recommend that the Board find the Company's ES proposal to not be in the public interest. The costs continue to outweigh the benefits associated with the proposed ES investments for both electric distribution ("ED") and natural gas distribution ("NGD") service.

## III. Brattle Report Overview

**Q. PLEASE EXPLAIN THE BRATTLE REPORT'S PURPOSE.**

A. The Brattle Group was asked by PSE&G to estimate the benefits associated with the Company's proposed ES investments.[1] It is important to note that the Company made its ES filing before the Board in February 2013 and had failed to provide parties any type of cost-benefit analysis associated with its report until early October 2013. The

[1] Rebuttal Testimony, Dr. Peter S. Fox-Penner, Schedule PFP-ES-2, p. vi. ("Brattle Report")

Company appears to have not contracted with the Brattle Group to conduct this study until April 19, 2013, close to two months after the Company filed its ES proposal.[2]

**Q. IS THE COMPANY'S REPORT A TRUE COST-BENEFIT ANALYSIS?**

A. No, and I will address the methodological differences between the Brattle Group approach and traditional cost-benefit analysis ("CBA") later in my testimony. However, even by its own admission, the Brattle Report notes that its estimation methods differ since they are based upon what is referred to as a "break-even analysis" ("BEA") which differs from a traditional CBA.[3] According to the Dr. Fox-Penner, the BEA methodology was utilized to estimate the magnitude and duration of a storm-related event needed to bring ES program costs and benefits into alignment.[4] Dr. Fox-Penner, the Report's primary author, considers the BEA to be a more complete approach relative to a CBA analysis since: (1) the BEA does not require the quantification of public and non-market benefits; (2) the ES program "prevent[s] outcomes for which the community as a whole is highly risk-averse;"[5] and (3) the BEA does not require the discounting of benefits based on the timing and frequency of severe weather events.[6]

**Q. DOES THE REPORT'S DISCUSSION OF "SYSTEM-WIDE OUTAGE" REQUIRE THE COMPANY'S ENTIRE SYSTEM TO EXPERIENCE LOSS OF SERVICE?**

A. No. The Report's use of the term "system-wide outage" is specific to its ES proposal and the reduction of a particular set of customer outage durations that are

[2] Company's Response to RCR-G-POL-118.
[3] Rebuttal Testimony, Dr. Peter S. Fox-Penner, p. 9:25-28 and p. 10:1-5.
[4] Rebuttal Testimony, Dr. Peter S. Fox-Penner, 4:16-19.
[5] Rebuttal Testimony, Dr. Peter S. Fox-Penner, 8:21-22.
[6] Rebuttal Testimony, Dr. Peter S. Fox-Penner, 8:19-24

associated with the Company's definition of a major storm event.[7] These outage durations can be examined on either an individual or cumulative weather-event basis.

**Q. WHAT ARE THE BREAK-EVEN RESULTS FOR THE COMPANY'S ED PROGRAMS?**

A. The Brattle Report estimates that the Company's electric ES program investments will lead to a positive break-even cost-benefit outcome (i.e., benefits are equal to costs) if a "system-wide" storm-related outage lasts 3.08 days.[8] The Company estimates that the ES program improvements would result in approximately 15.3 million customer-hours of avoided outage over an assumed 24-hour "system-wide outage." This implies that the estimated avoided outage duration for a 3.08-day "system-wide outage" would be approximately 47.12 million customer-hours.[9] In other words, the Report concludes that the Company's electric ratepayers will break even from the proposed ES program if the Company's electric ES program investments mitigate approximately 47.12 million customer-hours of future storm-related outages.[10]

**Q. WHAT ARE THE BREAK-EVEN RESULTS FOR THE COMPANY'S NGD PROGRAMS?**

A. The Brattle Report estimates that the Company's natural gas ES program investments will lead to a positive break-even cost-benefit outcome if all of the 664,927 customers that the Company expects to be affected by those investments avoid a cumulative 7.08 days of major-storm related outages.[11] This is equivalent to 113

[7] Rebuttal Testimony, Dr. Peter S Fox-Penner, 11:22 to 12:20.
[8] Brattle Report, p. x.
[9] *See,* Brattle Report, p. x; 47.12 million customer-hours equals 3.08 days multiplied by 15.3 million customer-hours per day.
[10] *See,* Brattle Report, p. x.
[11] Brattle Report, p. 80.

million customer-hours of avoided outage duration.[12] In other words, the Company's natural gas ratepayers will break even from the proposed natural gas ES program if the Company's natural gas ES program investments mitigate approximately 113 million customer hours of future storm-related outages.[13]

## IV. The Brattle Report Break-Even Analysis is Inappropriate

**Q. DID YOU OFFER ANY PRELIMINARY OPINIONS ABOUT THE BRATTLE REPORT IN YOUR PRE-FILED DIRECT TESTIMONY?**

A. Yes, I offered two preliminary opinions about the Brattle Report findings in my pre-filed direct testimony. First, I recommended that the Board be wary of any study that purports to support the cost-effectiveness of a policy proposal four months after that policy proposal has been made.[14] Second, I noted in my direct testimony that the Brattle Report, by its own admission, is not a CBA-based approach, but one based upon what is referred to as a BEA-based approach. I noted that the Brattle Report's BEA approach effectively "assumes that if there were a 100 percent guarantee that a major weather-related event like Hurricane Sandy were to happen again in the future, with unprecedented customer outage levels, i.e. tens of thousands of customers out for multiple days, then the cost of the NGD proposals included in the Energy Strong proposal will 'break-even' with its benefits."[15]

**Q. DID THE BRATTLE REPORT'S PRIMARY AUTHOR TAKE ISSUE WITH ANY OF YOUR PRELIMINARY CONCLUSIONS?**

[12] *See* Brattle Report, pp. 77, 79; 113 million customer-hours equals 170 hours (7.08 days multiplied by 24 hours in a day) multiplied by 664,927 customers.
[13] *See,* Brattle Report, pp. 77, 79.
[14] Direct Testimony, Dr. David E. Dismukes, 45:7-8.
[15] Direct Testimony, Dr. David E. Dismukes, 45:12-16.

A. Yes. Dr. Fox-Penner asserts that I have "somehow interpreted the break-even outage duration provided in the Brattle Report to reflect the duration of a single outage that would need to occur with 100% certainty in order for PSE&G's Energy Strong investment to be cost justified."[16] Dr. Fox-Penner offers an alternative explanation and notes that the Report's findings do not require a major storm event to happen with 100 percent certainty in the near future, but instead, could be met through a series of smaller-scale storms across a longer period of time.[17]

**Q. DO YOU AGREE WITH DR. FOX-PENNER'S CRITICISM?**

A. No. Dr. Fox-Penner's rebuttal simply states that electric and gas outages could occur over time and the results are not contingent upon the known (or estimated) occurrence of a storm like Sandy occurring again in the future. This rebuttal is simply a distinction without a difference. In order for the Brattle Report's BEA estimates to "balance," the cumulative total of avoided outages still has to equal approximately 47.12 million customer-hours for its proposed ES program and approximately 113 million customer hours for its proposed NGD program; whether these avoided outages occur all at once, or across a longer period of time, is immaterial so long as the avoided outages occur at some point with 100 percent certainty. If actual cumulative electric outage durations that are avoided from this smaller set of major storm events sums to something less than 47.12 million customer-hours, then the electric ES investments will be less than cost-effective. Likewise, if actual avoided cumulative natural gas outages are something less than 113 million customer-hours, the natural gas ES investments will be less than cost-effective.

[16] Rebuttal Testimony, Dr. Peter S. Fox-Penner, p. 12:24-27.
[17] Rebuttal Testimony, Dr. Peter S. Fox-Penner, p. 2:19-22.

**Q. DO DR. FOX-PENNER'S CRITICISMS CHANGE YOUR VIEW?**

A. No. While Dr. Fox-Penner may claim that the intent of the Brattle Report was to examine the cumulative valuation of outages over an extended period of time, his underlying BEA assumptions and mathematical calculations do not reflect this intent. If Dr. Fox-Penner's rebuttal assertions were accurate, then his underlying cumulative benefits calculations (value of avoided outages) should have been estimated, or simulated, across a set of smaller individual avoided storm outages across time and then discounted in order to arrive at his "break-even" number of outage days. His calculations, as I will discuss later in my testimony, make no such adjustment and instead assume that all customer benefits of the ES program accrue immediately and instantaneously, before the ES program investments have even begun. This results in overstated cumulative ES program benefits, thereby artificially lowering the "break-even" number of outage-days required to justify the proposed ES investments.

**Q. ARE THERE ANY OTHER SPECIFIC PROBLEMS ASSOCIATED WITH THE BRATTLE REPORT'S BEA METHODS?**

A. Yes. The BEA included in the Brattle Report suffers from a number of specific problems that result in overstatement of the cumulative benefits of the Company's proposed ES investments. For instance:

- The BEA fails to put an adequate perspective upon the time period over which the estimated avoided outages will likely materialize. While a "three-day electric outage" may not seem very large, the break-even point, as reflected in the Brattle Report's actual calculations, is in million customer-hours of avoided outage durations. As explained below, it will likely take an extended period of time for

these avoided outages to arise when assessed against PSEG's actual historical experience of major storm–related (not normal) electrical outages.

- The BEA does not appropriately discount the value of the outage benefits over time.

### A. Benefits will Evolve Over a Very Long Time Period

**Q. CAN YOU GENERALLY EXPLAIN HOW THE BRATTLE REPORT ESTIMATES THE VALUE OF THE AVOIDED OUTAGES ASSOCIATED WITH THE COMPANY'S PROPOSED ES PROGRAMS?**

A. Yes. The value of these avoided storm-related outages are simply the product of (1) the unit value of the lost load and (2) the avoided storm-related outage durations associated with the Company's proposed ES programs.[18] Two points are important to highlight in this calculation. First, the Company's ES programs are not designed to address normally-occurring storm-related outages, but only those associated with making the system more resilient against major events like Superstorm Sandy.[19] In fact, the Company notes that the storm-related emphasis of its proposed ES programs is what differentiates these from its normally-occurring reliability-related investments.[20] Second, the Company notes that the ES programs are not designed to eliminate all outages resulting from major storm events, but only to reduce their severity by reducing the duration of those storm-related impacts.[21] So the Brattle Report's avoided outage

[18] Brattle Report, p. 17.
[19] Direct Testimony, Jorge L. Cardenas, p. 2:46 to 3:48.
[20] Company's Response to S-PSEG-ES-1.
[21] Company's Petition, ¶3; "It is not possible to completely eliminate power outages. Outages will undoubtedly occur when falling trees and limbs knock down power lines, but the full implementation of the proposed investments will reduce the frequency of such outages and enable PSE&G to restore service more quickly than would otherwise occur."

valuation estimates should be interpreted as the ratepayer value of reducing the duration of outages associated with only severe storms events.

**Q. CAN YOU PROVIDE AN EXAMPLE?**

A. Yes. Assume that there are a group of residential customers that currently would experience 100 minutes of lost service during an unspecified weather event. Let's also assume that a utility program is designed such that the program is expected to reduce this storm-related outage duration by 25 minutes, i.e., by 25 percent. These residential customers will likely still experience storm-related outages (when major storms arise), but the impact of those outages, as measured by outage duration, are estimated to be reduced. The total benefits to these hypothetical residential customers will be a function of (a) how frequently these major storm events arise and (b) the severity of the major storm-related outages when they occur. Total ratepayer benefits will increase as future major storm-related events increase in frequency or severity.

**Q. CAN YOU EXPLAIN HOW THE COMPANY'S BREAK-EVEN RESULTS RELATE TO STORM-RELATED OUTAGES?**

A. Yes. As stated previously, the Report estimates that the Company's electric ES program investments will lead to a positive break-even outcome for a "system-wide" storm-related outage lasting 3.08 days, while the Company's natural gas ES program investment will lead to a positive break-even outcome for a "system-wide" storm-related outage lasting 7.08 days.[22] This calculation, however, is not based on avoided outages to the Company's entire electric and natural gas system.[23] Instead, the Report estimates electric benefits as being based on the proposed electrical ES program

[22] Brattle Report, p. xv.
[23] Brattle Report, Table III-11, p. 57.

reducing 15.3 million customer-hours per day, or roughly only 30 percent of what a hypothetical outage to the Company's entire system would entail.[24] Similarly, the Report estimates natural gas benefits as being based on the proposed natural gas ES program affecting 664,937 customers[25] – roughly 37.6 percent of the Company's 2012 natural gas customer count.[26]

**Q. HAVE YOU PREPARED A SCHEDULE THAT HELPS TO ILLUSTRATE THE NATURE OF THESE AVOIDED MAJOR-EVENT OUTAGES?**

A. Yes. Schedule DED-S-1 presents annual customer outage durations for PSE&G. The first column of this schedule shows historical annual hours of customer interruptions excluding Major Outage Events ("MOE"). The second column shows the same information with the inclusion of outage data associated with MOEs. The third column shows the difference between outage duration data associated with MOE and without; in other words, outage statistics associated with only major storm events. The schedule shows that that there are some years with no major storm-related events (or storm-related electric outages), whereas there are several others where there have been significant storm-related outages. The high level of outages in 2012, for instance, is associated with electric outages resulting from Superstorm Sandy. On average, PSE&G has experienced 21.03 million customer-hours of major storm-related electric outages per year, including the 2012 activity, and 5.67 million customer-hours of major storm-related electric outages per year, excluding 2012 activity. The Company's ES proposal attempts to reduce this major storm-related peak by, on average, some 30

[24] Brattle Report, p. x.
[25] Brattle Report, p. 77.
[26] *See*, Brattle Report, p. 1.

percent.[27] The forth column of DED-S-1 shows the interruptions avoided if historical storm event impacts were reduced by 30 percent.

**Q. HOW DOES THIS ILLUSTRATION RELATE TO DR. FOX-PENNER'S ESTIMATED BREAK-EVEN POINTS?**

A. Dr. Fox-Penner's testimony implies that it will only take approximately 3.08 days of major storm-related outages for ratepayers to break even on the Company's electric ES program. However, this break-even point is based upon reductions in major storm-related durations for large numbers of customers, not normal outage durations. Avoiding approximately 47.12 million customer-hours of future storm-related outages will not occur overnight, but, instead, will take many years to arise.

**Q. GIVEN THESE HISTORIC TRENDS, HOW LONG WILL IT TAKE TO AVOID THREE FULL DAYS OF SEVERE WEATHER-RELATED ELECTRIC OUTAGES?**

A. It will take 7.5 years to make the program cost-effective if the comparison is made with historic data that includes Superstorm Sandy. In other words, if the Company's historic major storm-related outages are summed, then it will take approximately seven years of major event outages to make the ES ED program cost effective. That estimate of customer effectiveness increases to 27.5 years if the electric outage duration information associated with Superstorm Sandy (2012 data) is excluded.

**Q. HAVE YOU CONDUCTED A SIMILAR ANALYSIS FOR THE COMPANY'S NGD PROGRAMS?**

A. Yes. The Company's analysis found that the proposed NGD programs do not provide value to customers until total cumulative outages sum to around 113 million

[27] *See*, Brattle Report, p. x.

customer-hours.[28] However, over the past 30 years, the Company has only experienced six weather events which have caused significant "impacts" to the Company's natural gas distribution system.[29] Excluding Tropical Storm Floyd (September 1999), for which reliable data is unavailable, the Company reports that 33,758 NGD customers have lost service due to storms.[30] This equates to only 0.14 hours of storm-related natural gas service interruptions per customer per year due to storm impacts,[31] assuming that each storm-related NGD outage lasts four days.[32] Based on these statistics, it would take over 453 years for the Company's proposed NGD programs to "break-even," even if the proposed improvements are successful in completely insulating the Company's natural gas distribution system from any effects of severe storm events.

### B. The Report Fails to Discount Benefits Over Time

**Q. WHAT DO YOU MEAN BY DISCOUNTING?**

A. Discounting is a common technique used in economics and finance that adjusts for the fact that a dollar today does not have the same value as a dollar in the future.[33] Discounting is an important component of project evaluation when costs and benefits span many years and in some instances (like the ES proposal), decades. Failure to appropriately discount costs and/or benefits can lead to erroneous conclusions about

[28] Brattle Report, p. vii.
[29] Company's Response to RCR-G-POL-51.
[30] Company's Response to RCR-G-POL-51, Tables; and Brattle Report, p. 72.
[31] Note that the calculations here are on terms of only 12 years due to the unreliability of data associated with Tropical Storm Floyd. As Tropical Storm Floyd is the only weather event to have a significant impact on the Company's natural gas distribution system during the years 1983 to 2000, it can be reasonably assumed that this estimate overstates annual interruptions to the Company's natural gas system due to storm events.
[32] Four days is reported by the Company as the average duration of a natural gas service outage due to water intrusion. See the Company's Response to S-PSEG-ES-46.
[33] Danthine, Jean-Pierre and John B. Donaldson. Intermediate Financial Theory. Second Edition. Chapter 2.

investment profitability (from either a public or private investment perspective). To see this, consider the following scenario. Suppose you are offered two financial options. The first option is for a $1,000 cash payment today and the other option is for the same $1,000, but in five years from now. Typical individuals, who are risk averse, will take the $1,000 today instead of the option for payment in the future due to (a) the uncertainty associated with the future payment and (b) the fact that a dollar today is not worth a dollar in the future. Even if you do not actually intend to use the money for five years, you still have the ability to invest the money and earn a rate of return on that investment. The rate of return on the investment is what you forgo if you simply take $1,000 in the future without some form of additional financial compensation.

**Q. CAN DISCOUNTING BE AN IMPORTANT COMPONENT OF PROGRAM EVALUATION?**

A. Yes. Discounting is necessary in comparing the costs and benefits on an apples-to-apples basis when evaluating the costs and benefits of a program that occur over a multiple-year period. Any analysis conducted without discounting both the costs and the benefits is incomplete and will have significantly biased and incorrect results.

**Q. DOES THE BRATTLE REPORT PROPERLY DISCOUNT BOTH THE COSTS AND THE BENEFITS THAT ARE ANTICIPATED TO OCCUR OVER TIME AS A RESULT OF THE ES PROGRAM?**

A. No. The Brattle Report discounts future program investment costs, but it does not discount the value of anticipated future program benefits. The Report uses the Company's Weighted Average Cost of Capital ("WACC") of 7.01 percent[34] to discount program costs, but does nothing to discount program benefits, essentially assuming that

[34] *See,* Direct Testimony, Stephen Swetz, 3:6-16.

the dollar value of benefits that will arise in the future are worth the same amount to ratepayers as if they had occurred today. The Report specifically notes:

> In comparing benefits to costs, we adopt the following simplified approach: We use the current year as the basis for estimating benefits associated with PSE&G's Electric ES sub-program investments. We compare the resulting benefits to the PV [present value] of investment costs.[35]

Discounting costs, while leaving benefits undiscounted, results in a direct, immediate, and obvious bias in program evaluation results.

**Q. DID THE BRATTLE REPORT COMMENT ON WHY THE ANALYSIS WAS DEVELOPED IN SUCH A BIASED FASHION?**

A. Yes. The Report justifies comparing the current year benefits and the present value of investment costs by arguing that discounting benefits would not substantially affect the Report's conclusions. In a footnote, the Report develops a side analysis that purportedly shows why this is the case. As explained in the footnote, the Report could have "project[ed] a path of future benefits (which would grow over time), yet discount[ed] these future benefits to 2013 dollars…." The footnote concludes that, by using a zero discount rate for future benefits, the Report either overstates or slightly understates the outage durations required to justify the program investments.

**Q. DO YOU HAVE ANY ISSUES WITH THE SIDE ANALYSIS THAT PURPORTS TO JUSTIFY THE REPORT'S FAILURE TO DISCOUNT ES PROGRAM BENEFITS?**

A. Yes, there are at least three problems associated with this side analysis that purports to show that discounting ES program benefits is unimportant. First, the Report's side analysis has been calculated in error since it only examines benefits for the first ten years of the program, not over the life of the ES distribution assets being put

[35] Brattle Report, p. 63 fn. 40, *Emphasis added*.

into place.[36] Since the effects of discounting increases over time, examining only near-term effects understates the total effect the Report's lack of discounting benefits has on end results. Second, the Report's side analysis assumes that the full benefits of the program begin immediately, even before construction of these programs has been completed, or in some instances, even started. Third, the Report's side analysis is highly biased because it fails to discounts cost and benefits on a comparable basis.

**Q. LET'S FOCUS ON YOUR FIRST CRITIQUE. HOW DOES THE REPORT'S 10-YEAR BENEFITS ASSUMPTION IMPACT ITS CONCLUSIONS?**

A. The Report's side analysis suggests that discounting really doesn't have that big of an impact on reducing overall program benefits. Further, the Report implies that, if anything, discounting results in program benefit under-estimation, not over-estimation, since a commonly used social discount rate based on the U.S. Treasury Real Long-Term Rate is lower than the projected growth rate of benefits.[37] Both conclusions are in error and only arise because of the incorrect methods used by the Report in developing its side analysis estimates.

**Q. WILL THE TIMING OF THESE BENEFITS IMPACT THE REPORT'S SIDE ANALYSIS?**

A. Yes, and changing this input will reduce the benefits estimated in the Report's side analysis considerably. The Company only calculates benefits for a 10-year period, not the full 40-year asset life associated with the Company's proposed ED investments. The Report's side analysis is inconsistent with both the life of the assets (or the period over which these assets are anticipated to deliver ratepayer benefits), as well as the

[36] Company's Response to RCR-G-POL-114, Attachment "Discounting.xlsx."
[37] Brattle Report, p. 63, fn. 40.

Company's own rate impact analysis which uses a 40-year period for calculating annual rate impacts.

**Q. LET'S FOCUS ON YOUR SECOND CRITIQUE. DO YOU AGREE WITH THE REPORT'S ASSUMPTION THAT PROGRAM BENEFITS WILL ARISE IMMEDIATELY (I.E., IN 2014)?**

A. No. The Brattle Report's side analysis that purports to show benefits discounting is unimportant makes the erroneous assumption that program benefits will start from day one of the program. In other words, the Report's side analysis assumes 100 percent of all program benefits will start in 2014 despite the fact that the ES program is designed around investments incrementally completed over a 10-year period.[38] This is implausible: there is likely no way that program resiliency benefits can begin before the programs are completed and in service. This error biases the Report's side analysis that presumes to show that discounting is unimportant.

**Q. NOW LET'S FOCUS ON YOUR THIRD CRITIQUE. WOULD YOU PLEASE EXPLAIN THE IMPROPERLY APPLIED RATES USED IN THE SIDE ANALYSIS TO DISCOUNT BENEFITS?**

A. The side analysis presents two calculations. The first "projects a path of future benefits" which are assumed to grow in value over time at a 2.8 percent annual escalation rate. This 2.8 percent rate is based on the Congressional Budget Office's projections of annualized real Gross Domestic Product growth rates. These escalated values are then discounted back to their purported present value based on a "social discount rate" of 1.01 percent, based on the U.S. Treasury Real Long-Term Rate.[39]

[38] Company's Petition, ¶10.
[39] Brattle Report, p.63, fn. 40.

Since the 1.01 percent discount rate is lower than the 2.8 percent escalation rate, the calculated present value of the benefits is actually higher than that produced by the report's "zero percent" discounting, thus leading to the conclusion that the avoided outage durations required for ratepayers to break even are actually less than estimated in the Report's main analysis. As an alternative, the side analysis includes a similar calculation using the same 2.8 percent escalation rate, but with a slightly higher "social" discount rate of 4 percent. This alternative calculation results in lower, but not substantially lower, benefit values than presented in the Report's main analysis.[40]

**Q, PLEASE EXPLAIN WHY THIS IS IMPROPER.**

A. There are two reasons. The first is that it is improper to apply a "social" discount rate to the ES program benefit. The second is that it is improper to apply different discount rates to program costs and program benefits. The proper discount rate to apply to ES program benefits is the same 7.01 percent that is used in the Report's main analysis to discount program costs.

**Q. TURNING TO THE FIRST REASON, WHAT IS A "SOCIAL" DISCOUNT RATE?**

A. A social discount rate is used in analysis of public policies which provide future benefits that are largely public in nature, known as "societal goods" or "public goods." These public goods are often paid for by one group of citizens, but enjoyed by all. Examples of such benefits traditionally recognized as public goods include clean air and clean water or national defense.

[40] Id.

**Q. DO YOU AGREE THAT THE ES PROGRAM REPRESENTS A "SOCIETAL GOOD" AND THUS SHOULD BE EVALUATED USING A LOWER "SOCIETAL" DISCOUNT RATE?**

A. No. The resiliency investments being offered by the Company are to improve the specific quality of service during extreme storm events.[41] These investments are not public goods: ratepayers are partners in this process and will be asked to pay considerably for these potential resiliency improvements. As noted several times earlier, the Company has offered this program to improve its distribution service during severe weather events. PSE&G ratepayers (customers) are the ones that are designed to benefit from this program, not society overall or the customers of New Jersey's other electric distribution companies.

**Q. ARE YOU SAYING THERE WON'T BE ANY POSITIVE "EXTERNALITIES"[42] CREATED BY THE ES PROGRAM?**

A. No, but the fact that the program creates a positive externality is not an appropriate reason for the use of incorrect project evaluation methods. Stated another way, the fact that the ES program may create a limited form of externalities is not justification for evaluating the entire program as a public good. While these externalities may be important, it is still the fact that the overwhelming majority of the program's benefits are likely to accrue to the Company's ratepayers. The more appropriate approach would be to examine the direct costs and benefits associated with the program, and then consider any additional "externalities" outside, or in addition to, this

[41] Direct Testimony, Jorge L. Cardenas, 2:46 to 2:48: "In response to this heightened storm activity, PSE&G proposes investments to work towards improving our ability to withstand and recover from severe storms."

[42] A positive externality is a benefit to parties which do not incur the costs of the program.

analysis. This external benefit approach is similar to the one I provided in my direct testimony analyzing the reduced methane emissions associated with the NGD component of the Company's ES proposal.[43]

**Q. HAVE ANY REGULATORY COMMISSIONS RECOGNIZED THE IMPROPRIETY OF USING SOCIETAL DISCOUNT RATES IN EVALUATING UTILITY CAPITAL INVESTMENTS AND PROGRAMS?**

A. Yes. In 2012, the Illinois Commerce Commission ("ICC") took issue with a CBA provided by Commonwealth Edison Company ("ComEd") related to its Advanced Metering Infrastructure ("AMI") proposal. The ICC found ComEd's use of a societal discount rate equal to 3.087 percent discount rate "dubious," noting that the rate is at the low end of a reasonable range of discount rates, and did not reflect customers' cost of capital since it was based on a risk-free return on government bonds.[44] Furthermore, the ICC felt that from a ratepayer perspective, the proposed AMI investment was not "risk-free," since there were no guarantees that the Company's assumptions would hold true or that even the meters being installed would remain in service as long as expected by the Company.[45]

**Q. WOULD YOU PLEASE EXPLAIN WHY COSTS AND BENEFITS SHOULD BE DISCOUNTED AT THE SAME RATES?**

A. Yes. Program evaluation results will be biased if costs and benefits are not discounted on the same (or uniform) basis. Non-uniform discounting essentially assesses one discount rate to program costs and a different discount rate to program

[43] Direct Testimony, David E. Dismukes, 47:8 to 48:20 and Schedule DED-25.
[44] Commonwealth Edison Company Petition for Statutory Approval of a Smart Grid Advanced Metering Infrastructure Deployment Plan pursuant to Section 16-108.6 of the Public Utilities Act, Illinois Commerce Commission Docket, 12-0298, p. 30.
[45] Id.

benefits. Using these non-uniform discount rates can lead to significant program evaluation biases which was pointed out in a 1982 publication prepared by the Rand Corporation under grant from the U.S. Department of Health and Human Services.[46] Specifically, the non-uniform discounting of costs and benefits typically implies that a program can always appear more cost-effective by simply postponing the project into the future. In other words, if costs are discounted, and benefits are not, it is always more cost-effective to delay the project by one (or multiple) years since (a) costs will be lower in the future and (b) benefits will be unaffected. The Rand Corporation shows, through a series of mathematical proofs, that a CBA is only meaningful under the circumstance where costs and benefits are discounted on a uniform (i.e., equal) basis.[47]

**Q. HAVE OTHER FEDERAL AGENCIES RECOGNIZED THE PROBLEMS ASSOCIATED WITH MIS-MATCHING DISCOUNT RATES BETWEEN COSTS AND BENEFITS?**

A. Yes. In September 2011, the U.S. Environmental Protection Agency ("EPA") submitted a series of questions to 12 economists, including one Nobel Laureate,[48] concerning how future benefits and costs of EPA regulations should be appropriately discounted. One question dealt with the potential to add the present value of benefits and costs calculated using one set of discount rates to other benefits and costs calculated using different discount rates. The panel's opinion was clear:

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[46] Keeler, Emmett B. and Shan Cretin (June 1982), "Discounting of Nonmonetary Effects," Rand Corporation for The U.S. Department of Health and Human Service.

[47] Keeler, Emmett B. and Shan Cretin (June 1982), "Discounting of Nonmonetary Effects," Rand Corporation for The U.S. Department of Health and Human Service, pp. 6-7.

[48] Kenneth J. Arrow, "1972 Nobel Laureate in Economic Sciences;" *see*, http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1972/index.html?sess=030e4a51daa1ba961189994c195efe1b.

> Our answer to Question 3 is simple: it is clearly inappropriate to discount benefits and/or costs occurring in the same year to the present using different discount rates.[49]

A 2010 manual published by the National Center for Environmental Economics at the EPA is perhaps more succinct, stating simply: "In all cases social benefits and costs should be discounted in the same manner."[50]

**Q. ARE THE DISCOUNT RATES OF 1.01 PERCENT AND 4 PERCENT DOWNWARDLY BIASED?**

A. Yes. Both discount rates referenced in the Brattle Report are already very low particularly when compared to those used by Federal executive agencies and the ones used by the Board in assessing the performance of energy efficiency programs included in the New Jersey Clean Energy Program.

**Q. PLEASE EXPLAIN THE CBA DISCOUNT RATE USED BY FEDERAL EXECUTIVE AGENCIES.**

A. Beginning in 1992, and periodically updated since, the White House Office of Management and Budget ("OMB") publishes Circular No. A-94, which sets guidelines and specific discount rates to be applied to all CBAs performed by executive agencies. Section 8(b)1 of the current circular orders all executive agencies to report net present value using a real discount rate of seven percent,[51] an estimate of the average before-tax rate of return to private capital in the U.S. economy.[52] When examining the effects of regulation that do not fall exclusively or primarily on the allocation of capital, such as the effect on private consumption due to higher consumer prices for goods and

[49] Arrow et. al. (December 2012), "How Should Benefits and Costs be Discounted in an Intergenerational Context: The Views of an Expert Panel," Resources for the Future, p. 6.
[50] "Guidelines for Preparing Economic Analyses" (December 17, 2010), National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, p. 6-20.
[51] Office of Management and Budget, Circular No. A-94 Revised, Section 8(b)1 (October 29, 1992).
[52] Office of Management and Budget, Circular No. A-4, p. 33 (September 17, 2003).

services, the OMB may use a lower three percent "societal" discount rate, based on the real, inflation adjusted, returns to a 10-year Treasury note since 1973.[53] It is important to note that OMB's use of a lower three percent "societal" discount rate in some instances is net of inflation. Thus, using the Company's assumed escalation, i.e. inflation, rate of 2.8 percent, this is equivalent to a 5.8 percent nominal societal discount rate.

**Q. WHAT IS THE DISCOUNT RATE PREVIOUSLY USED BY THE BOARD IN ASSESSING ENERGY EFFICIENCY PROGRAMS?**

A. In October 2012, the Center for Energy, Economic and Environmental Policy ("CEEEP") at Rutgers University published the results of its retrospective CBA of the New Jersey Clean Energy Program Energy Efficiency Programs. The CEEEP study used an eight percent nominal discount rate to discount the value of future benefits from the Clean Energy Program offerings.[54]

**Q. DO YOU HAVE ANY OTHER COMMENTS REGARDING THE USE OF A SOCIETAL DISCOUNT RATE TO DISCOUNT THE VALUE OF THE ES PROGRAM BENEFITS?**

A. As explained above, all benefits and costs included in a CBA should be discounted using the same rate. Further, the use of societal discount rates are generally inappropriate for use in evaluating the cost-effectiveness (or cost-benefit) of a distribution investment program of this nature. However, if the Board is inclined to use a societal discount rate to evaluate the Company's ES proposal, then I recommend, as an

[53] Office of Management and Budget, Circular No. A-4, pp. 33-34 (September 17, 2003).
[54] "Cost-Benefit Analysis of the New Jersey Clean Energy Program Energy Efficiency Programs: 2011 Retrospective & 2012 Prospective Summary Report" (October 2012), Center for Energy, Economics & Environmental Policy, p. 5.

alternative, that the use of this societal discount rate be extended to the analysis of all benefits and costs associated with the program including those associated with the ES program's rate impacts. In considering this alternative, the Board should bear in mind that the lower discount rate will have a substantial impact on the estimated costs of the program from a ratepayer perspective. The "costs" of the ES program for ratepayers are the rate impacts that are incurred to support the program investments. If the "benefits" (i.e., value of the avoided outages) are evaluated using a societal discount rate, then the "costs" (i.e., rate impacts) should also use this same discount factor. The use of the Brattle Report's 1.01 percent societal discount rate, and the Company's rate impact analysis, suggests a total rate impact of over $1.783 billion (present value).

**Q. HAVE YOU ANALYZED THE EFFECT ON THE REPORT'S SIDE ANALYSIS IF BENEFITS WERE EXAMINED OVER A MORE REALISTIC 40-YEAR PERIOD?**

A. Yes. Spreading these benefits out over a longer period of time, and then discounting them, will result in considerably changed program benefits, contrary to the Report's arguments. Correcting for the Report's error of only analyzing 10 years of benefits as opposed to 40 years shows that use of a 1.01 and 4 percent discount rate with an internal escalation rate of 2.8 percent leads to an increase in benefits by 26 percent,[55] and a decrease in benefits by 31 percent relative to using the Report's undiscounted results.[56] As stated earlier, since the effects of discounting increase over time, examining a shorter time frame significantly understates the effects that an appropriate discount factor, or even an inappropriate discount factor, has on end results.

[55] Company's Response to RCR-G-POL-114, Attachment "Discounting Revised.xlsx."
[56] Id.

**Q. HAVE YOU ANALYZED THE EFFECT OF THE REPORT'S SIDE ANALYSIS ASSUMPTION THAT 100 PERCENT OF ALL BENEFITS WILL ACCRUE THE FIRST YEAR OF IMPLEMENTATION?**

A. Yes. Changing the assumption to have all program benefits start in the year in which construction is complete under a 1.01 and 4 percent discount rate with an internal escalation rate of 2.8 percent leads to an increase in benefits by 17 percent,[57] and a decrease in benefits by 62 percent[58] relative to using the Report's undiscounted results. Again, this error biases the Report's side analysis that aims to show that discounting is unimportant.

## V. NGD Analysis Shortcomings

**Q. DO YOU HAVE ANY ADDITIONAL COMMENTS THAT APPLY TO BRATTLE'S "BREAK-EVEN" ANALYSIS OF THE NATURAL GAS ES INVESTMENTS?**

A. Yes. I have additional comments on two subjects: (1) the timing/discounting issues discussed above as they apply to the expected benefits of the natural gas ES investments and (2) flaws in the methods used to estimate the value of the natural gas related benefits.

### A. NGD Benefits Timing and Discounting Issues

**Q. HOW DO THE BEA TIMING/DISCOUNTING PROBLEMS YOU IDENTIFIED EARLIER IMPACT THE REPORT'S NGD BENEFIT ESTIMATES?**

[57] Based upon a 40-year ED asset life comparable to the Company's rate impact analysis and a 1.01 percent discount rate.
[58] Based upon a 40 year ED asset life comparable to the Company's rate impact analysis and a 4 percent discount rate.

A. Earlier I noted that there were two important timing/discounting problems associated with the Brattle Report's BEA methodologies that include (1) a failure to put the "break-even" outage day estimates into perspective and (2) a failure to appropriately discount program costs and benefits on equal terms. With regard to the natural gas investments, these problems are essentially irrelevant because of the unlikelihood that the "break-even" levels of avoided outages will ever be reached. As I explained above, the Company's historic natural gas outage information associated with major storms over the past 30 years[59] does not even approach a fraction of the full seven days of outage for the approximately 665,000 customers[60] that would be affected by the natural gas ES investments. Since the outage durations necessary to make the Company's NGD program cost effective are unlikely to happen, there is likely no way the NGD component of the ES program can ever approach this "break even" point, irrespective of the rates used to discount costs and benefits.

**B. Flaws in Estimates of Benefits of Natural Gas ES Investments**

**Q. PLEASE SUMMARIZE THE FLAWS YOU FOUND IN THE BRATTLE REPORT'S ESTIMATES OF THE VALUE OF THE BENEFITS THAT WOULD RESULT FROM AVOIDED NATURAL GAS OUTAGES.**

A. The Brattle Report utilizes differing methods to estimate the avoided natural gas outage benefits for residential and commercial and industrial ("C&I") customers. Residential customer benefits are developed using a method that first estimates the loss in "consumer surplus" associated with one day's loss of natural gas service. C&I benefits are developed in a similar fashion but estimates the "value added" lost from

[59] Company's Response to RCR-G-POL-51.
[60] Brattle Report, pp. 77, 79.

one day's loss of natural gas service rather than lost consumer surplus. The Report estimates the value of lost residential customer service at an average of $53 per customer-day and lost C&I customer service at an average of $1,775 per customer-day.[61] These estimates are used to support the Report's conclusion that the equivalent of 7.08 days of avoided outages for the approximately 665,000 customers affected by the natural gas ES investments would be needed to produce the approximately $905 million in ratepayer benefits required for ratepayers to break even on the ES NGD program.[62] The Report's estimates of the value of lost natural gas service are substantially overstated for both residential and C&I customers, as I explain below.

**Q. TURNING FIRST TO THE ESTIMATED VALUE OF LOST RESIDENTIAL GAS SERVICE, PLEASE EXPLAIN WHAT IS MEANT BY "CONSUMER SURPLUS."**

A. Consumer surplus is the difference between a buyer's "reservation price" and the price that is actually paid[63] where the buyer's reservation price is the highest price that the buyer would be willing to pay for the good or service.[64] Schedule DED-S-2 provides a standard consumer surplus representation. A linear, downward-sloping demand curve, labelled D, is provided on the chart. Consumer surplus is shown on the chart as the triangular area under the demand curve measuring the difference between a buyer's reservation price and the going market price and quantity demanded. Assume that this chart is an example of the residential demand for natural gas service. Then, under the Brattle Report's estimation framework, a major storm-related natural gas outage would

[61] Brattle Report, p. 77-79.
[62] Brattle Report, Table IV-8, p. 79.
[63] Robert H. Frank and Ben S. Bernanke. Principles of Macroeconomics. *5e.,* p. 85.
[64] Robert H. Frank and Ben S. Bernanke. Principles of Macroeconomics. *5e.,* p. 66.

eliminate the consumer surplus (triangular area) that would have arisen if the natural gas service were available.

**Q. HOW DID THE BRATTLE REPORT DEVELOP ITS RESIDENTIAL CUSTOMER NATURAL GAS CONSUMER SURPLUS ESTIMATE?**

A. In order to estimate the residential consumer surplus, the Report first estimates a type of demand curve known as a constant (price) elasticity demand curve.[65] A constant (price) elasticity demand curve has the property that for a given percent change in price, the percent change in quantity demanded will be constant over differing price-quantity combinations. The Report estimates separate demand curves for each month in order to estimate total annual residential consumer surplus.

**Q. DOES THE REPORT UTILIZE ANY ASSUMPTIONS IN DEVELOPING THIS CONSTANT ELASTICITY DEMAND CURVE?**

A. Yes. The Report estimates a demand curve based on three important assumptions that include: (1) an assumed price elasticity of demand of -0.1;[66] (2) an assumed maximum price that any consumer would be willing to pay; and (3) an equilibrium monthly observed price and quantity. These three assumptions lead to the earlier-referenced consumer surplus loss estimate of $53 per residential gas customer per day.[67]

**Q. DO ANY OF THESE MODELING ASSUMPTIONS SKEW THE REPORT'S RESIDENTIAL NGD BENEFIT ESTIMATES?**

A. Yes. Two of these assumptions in particular (the assumed price elasticity of demand and the maximum natural gas service price) lead to a very substantial over-

[65] Brattle Report, Figure II-4, p. 21.
[66] Brattle Report, p. 26.
[67] Brattle Report, p. xiii.

estimate of lost residential consumer surplus in the event of a NGD service outage, and consequently over-estimates the total residential consumer benefits from the proposed ES NGD investments. The Report uses an assumed price elasticity of natural gas demand that is inconsistent with a large number of estimates included in the academic literature. This is an important assumption since, as will be shown in greater detail later, the Report's estimated residential natural gas consumer surplus is highly dependent upon the price elasticity of demand assumption. Second, the method used in the Report to develop its reservation prices for the winter months leads to consumer surplus results that are inconsistent with economic theory, due to a combination of an apparent modeling error and unrealistically high assumed maximum price. As discussed below, using the same methodology for the winter months as was used for the summer would substantially decrease the Report's estimated consumer surplus.

### C. Residential Price Elasticities of Natural Gas Demand

**Q. PLEASE EXPLAIN WHAT YOU MEAN BY A PRICE ELASTICITY OF NATURAL GAS DEMAND?**

A. The price elasticity of demand is defined as the percent change in the quantity demanded of a good or service relative to a percent change in the price of that good or service.[68] The Report uses an assumed price elasticity of demand of -0.10.[69] This means that a one percent increase in the price of natural gas will lead to a one-tenth of one percent decrease in the quantity demanded of natural gas service. Goods or services with an estimated price elasticity of demand of between 0.0 and 1.0, in absolute value, are often characterized as having very low price responsiveness, or

[68] Walter Nicholson, Intermediate Microeconomics and Its Application. 5e. pp. 121-123.
[69] Brattle Report, p. 26.

being relatively price "inelastic." Those goods or services with an estimated price elasticity of demand that is greater than 1.0, in absolute value, are typically said to be relatively price responsive, or price "elastic." The Report's use of a -0.10 price elasticity of demand assumes an exceptionally unresponsive, or price "inelastic," level of residential natural gas demand. In other words, the Report assumes that natural gas customers would be willing to pay relatively high prices to avoid or reduce the durations of natural gas outages.

**Q. WHAT IS THE SOURCE OR BASIS FOR THE REPORT'S PRICE ELASTICITY ASSUMPTION?**

A. The Report bases its assumption on the results of a working paper published by the United States Association for Energy Economics ("USAEE") in 2009.[70]

**Q. IS IT REASONABLE TO USE A SINGLE WORKING PAPER FOR AN ASSUMPTION OF THIS NATURE?**

A. No, particularly given the importance and sensitivity of the price elasticity assumption to the overall consumer surplus estimates. It would be more appropriate to conduct a broad survey of the literature and develop an average or appropriate range based on prior-reported estimates. Schedule DED-S-3 provides a list of major articles estimating the price elasticity of demand for natural gas service. Empirical estimates of the short-run elasticity of demand for natural gas in the United States range from very inelastic, -0.08, to -0.82, almost unitary elastic. In other words, estimates suggest that a 10 percent increase in natural gas prices is estimated to decrease demand by as low as 1 percent to as high as 8.2 percent. The average short-run price elasticity of demand for residential natural gas service included in this survey is -0.24. A price elasticity of

[70] Brattle Report, p. 26, fn. 25.

demand of -0.10 is on the lower end of the range of reasonableness suggested by the overall literature.

### D. Maximum Prices

**Q. YOU MENTIONED PREVIOUSLY THAT THE REPORT CONSIDERS ASSUMED MAXIMUM PRICES IN DEVELOPING ITS CONSUMER SURPLUS ESTIMATES. PLEASE EXPLAIN THE ROLE OF ASSUMED MAXIMUM PRICES IN THE REPORT'S ANALYSIS.**

A. The Brattle Report uses assumed maximum prices as "limit prices" to constrain the results of the constant elasticity demand curve utilized in the Report.[71] An important property of the constant elasticity demand curve is that it is asymptotic to the price ("P") axis. Geometrically, a curve that is "asymptotic" to the P axis will move close to the P axis but never actually touch or intersect that axis. This means, from an economics perspective, that there are some consumers that are willing to pay an infinite amount for the good or service in question, which here is natural gas service. This is not a reasonable assumption since there is likely no customer or set of natural gas customers willing to pay an infinite amount of money for natural gas service, so the Brattle Report utilizes a "limit price" (maximum price) to constrain the demand function to the axis making it "non-asymptotic" or "non-infinite." The "limit price" is essentially the highest total per unit price that a consumer is willing to pay for natural gas service.[72] An illustration of an asymptotic demand curve, as well as a demand curve with a limit price, has been provided in Schedule DED-S-4.

[71] Brattle Report, Figure II-4, p. 21.
[72] Brattle Report, p. 25.

**Q. HOW DOES THE BRATTLE REPORT ESTIMATE THIS "LIMIT" OR MAXIMUM NATURAL GAS SERVICE PRICE FOR THE WINTER MONTHS?**

A. The Report makes an assumption for this limit price that is based upon the authors' estimate of what they believe a household would be willing to pay to avoid a natural gas service outage. During the winter heating season, the Brattle Report estimates that households would be willing to pay $163 per family, per day of outage,[73] which is based upon one-half the average temporary food and lodging cost for an average-sized New Jersey household.[74] This limit can be converted to a natural gas equivalent maximum price of $92.8 per therm (or $928/MMBtu) across all winter months or 92 times the average winter retail natural gas price.

**Q. HOW DOES THE REPORT ESTIMATE THIS LIMIT PRICE DURING THE SUMMER MONTHS?**

A. The Report utilizes a different methodology to estimate the summer month limit or maximum price. This method takes a linear approximation of the constant elasticity curve and simply algebraically solves for the intercept or maximum price. A linear curve, which is a straight line, does not move "asymptotically" to the P axis, so this mathematical derivation is relatively straightforward. The Report estimates a maximum average summer month price of $13.2 per therm (or $132/MMBtu).

**Q. IS THE REPORT'S METHODOLOGY FOR ESTIMATING THE WINTER MONTH MAXIMUM PRICE REASONABLE?**

A. The Report's method of basing a household's maximum willingness to pay as the cost of lodging and food outside of the home is arbitrary, unnecessary, and likely

[73] Brattle Report, p. 27.
[74] Id.

overstates the true maximum price that a customer is willing to pay to avoid a natural gas service outage. The estimated limit prices are at levels that are simply unbelievable. The differences between the winter and summer months is likely one of the primary sources of this implausibility. Schedule DED-S-5 provides a table that shows the Report's estimated limit price and limit quantities for each month during a year. As I noted earlier, the limit prices are the maximum prices a household would be willing to pay to avoid a natural gas service outage; whereas, the limit quantity is the amount of gas that the Report estimates will be purchased at this limit price level. The bottom three rows average the limit prices and limit quantities over the winter months, summer months, and entire year. The estimated limit price during the heating months is almost $93 per therm ($930/MMBtu) or approximately 92 times the average equilibrium price of gas during the heating months from the Report's calculations. Equally implausible is the fact that the Report estimates that 127.6 million therms (12.76 million MMBTu) of natural gas (the "limit quantity") would likely be purchased at this astronomically high limit price. In other words, the Brattle Report estimates that over 70 percent of New Jersey residential households (or over 1.46 million households)[75] would be willing to pay up to $1.18 billion, or over $805 per household, to simply avoid one full day of natural gas service outage.

**Q. IS THERE ANY REASON WHY WINTER AND SUMMER MONTH LIMIT PRICE METHODOLOGIES SHOULD DIFFER?**

A. No. The Report could have easily used the same linear extrapolation approach for the winter months that was used for the summer months to produce results that are

[75] *See*, Company's Response to RCR-G-POL-114, Attachment "NG_Res_Value.xlsx"; there is assumed to be 2,092,314 households in New Jersey.

(a) less unreasonable and (b) more consistent with economic theory. Schedule DED-S-6 presents monthly consumer surplus estimates using two different methodologies. As illustrated in Schedule DED-S-6, simply estimating the limit price in the heating months using the same linearized demand curve methodology used in the summer months decreases the estimated consumer surplus substantially. Specifically, the estimated consumer surplus in January decreases from $114.60 per customer per day using the Company's original assumptions to $26.94 by changing this one assumption of the model. This is a decrease of over 75 percent.

**Q. HAVE YOU ESTIMATED THE RESULTS OF THE MODEL IF BOTH THE LIMIT PRICE IS CHANGED AS WELL AS THE UNDERLYING PRICE ELASTICITY OF DEMAND?**

A. Yes. These results are presented in Schedule DED-S-7. The consumer surplus estimates in this schedule utilize the study survey average price elasticity of -0.24 and results in an estimated consumer surplus per customer per day which is substantially less than the Company's estimates. The average consumer surplus per customer per day decreases from the original estimate of $53.49 to $4.85. This is a decrease of over 91 percent.

**Q. ARE THERE ANY OTHER FLAWS IN THE MODEL USED TO ESTIMATE CUSTOMER SURPLUSES FOR THE WINTER MONTHS?**

A. Yes. The mathematical calculations used to develop the winter month, consumer surplus estimates appear to be in error. This apparent error leads to consumer surplus results that are inconsistent with economic theory. These results are illustrated in Schedule DED-S-8, which shows the estimated consumer surplus for (a) the

Company's original elasticity of -0.10 and (b) the study survey average of -0.24 (included in Schedule DED-S-3). The table shows that the impact of the differing price elasticity assumptions on the consumer surplus estimates vary by month. For the winter heating months,[76] increasing the assumed price elasticity demand (in absolute value) results in an increase in estimated residential consumer surplus by some $6.06 per customer per day. This outcome is inconsistent with economic theory: consumer surplus should decrease, not increase, as demand becomes more price elastic. The effects of the error are compounded by the Report's use of an unreasonably high maximum price assumed for the winter months. A lower maximum price would constrain the model's results so as to make the flaw less apparent.

**Q. CAN YOU EXPLAIN IN MORE DETAIL WHY THIS RESULT IS INCONSISTENT WITH ECONOMIC THEORY?**

A. Yes. DED-S-9 considers two demand curves: one being relatively more elastic than the other. The more elastic demand curve is the one that shows the larger percent change in quantity demanded relative to the percent change in price. Here the demand curve labelled $D_1$ is more elastic than the demand curve labelled $D_2$. The graphical representation of consumer surplus under each demand curve is shown as A (for demand curve $D_1$) and B (for demand curve $D_2$). As it can clearly be seen, the consumer surplus associated with the more *inelastic* demand curve ($D_2$) is larger than the consumer surplus associated with the more *elastic* demand curve ($D_1$). The Brattle Report's model, however, shows the exact opposite, yielding results that show consumer surplus actually increasing as demand becomes more elastic in the winter months.

[76] Brattle Report, p. 27; defined as November through March.

**Q. DOES THIS RESULT ARISE IN THE REPORT'S SUMMER MONTHS ESTIMATES?**

A. No. While the Report's summer consumer surplus estimates have other flaws, at least the magnitude and direction of the consumer surplus results move in a fashion more consistent with theory.[77] For October, the month in which Superstorm Sandy occurred, the estimated CS actually decreases from a level of $10.56 per customer per day to $4.06 per customer per day by simply changing the price elasticity of demand from -0.10 to -0.24 a rather dramatic reduction in estimated consumer surplus and the per customer benefits associated with the Company's ES NGD proposal.

### E. Overstated Commercial and Industrial Program Benefits

**Q. CAN YOU EXPLAIN HOW THE REPORT ESTIMATES C&I CUSTOMER BENEFITS?**

A. The Report utilizes what it defines as the lost "value added" associated with interrupted C&I loads. "Value added" is defined as the the market value of a given industry's goods or services less the cost of the inputs used to produce that good or service.[78] Over the entire economy, value added is the sum of the economic value created by all firms in the economy. Value added is one component of Input-Output modeling and is mathematically calculated as the sum of employee compensation, proprietary income, other property type income, and taxes on production and imports.[79] The Report estimates that the average value added for the Company's natural gas C&I customers is $1,775 per day. Thus, if these C&I customers lose gas service for a day, the New Jersey economy will lose approximately $1,775 per day per C&I customer.

[77] Brattle Report, p. 27; defined as April through October.
[78] Robert H. Frank and Ben S. Bernanke. Principles of Macroeconomics. *5e.* p. 101.
[79] IMPLAN software.

**Q. DO YOU FIND THE COMPANY'S METHODOLOGY FOR ESTIMATING VALUE ADDED REASONABLE?**

A. No. The Company's analysis assumes 100 percent of the value added for the C&I customers impacted by an outage is permanently lost. This assumption is not reasonable. To see this, consider an industrial firm that manufactures 100 units of output per day to meet the demand of its customers located not only in New Jersey, but in other parts of the U.S. If the firm has to shut down for a day due to the unavailability of natural gas service, 100 percent of that decreased economic activity is likely not permanently lost. A more likely scenario is that the firm will have to increase production in the days, weeks, and potentially even years after the event in order to make up for this lost production. In addition, there is also a good possibility that economic activity could, for some limited period of time, increase to levels higher than pre-storm-related normals given regional restoration activities, the influx of private insurance, and federal assistance funds, among other sources of capital and economic activity. This is not to suggest that major disasters are economic "boons" to regional economies, but the net longer-run economic impact that these disasters can have on a state or regional economy is often difficult to quantify, and while longer-run steady state economic activity could, in theory, fall below prior-storm levels, it is likely that those steady-state reductions are nowhere near the 100 percent reduction in value added assumed in the Brattle Report analysis.

**Q. HAS EMPIRICAL RESEARCH CONFIRMED THAT FIRMS DO NOT SEE A 100 PERCENT DECREASE IN ECONOMIC ACTIVITY RESULTING FROM EXOGENOUS DISASTERS?**

A. Yes, this concept has been researched in academic literature and is referred to as the concept of economic resilience. Specifically, economic resilience refers to the inherent ability and adaptive responses individual businesses and regional markets have to avoid potential losses.[80] Research conducted following the 1994 Northridge Earthquake found that although 8.3 percent of area electricity service was lost for a day, direct output losses attributable to the outage amounted to only 1.9 percent of a single day's output in Los Angeles County, meaning that direct economic resilience to this natural disaster was 77.1 percent.[81] Subsequent research into the Northridge Earthquake found similarly high resilience factors of 95 and 79.3 percent.[82] A more recent study examining resilience in the aftermath of the September 11, 2001, attacks on the World Trade Center found that direct business interruptions losses were about 72 percent lower than they would have been if all tenants in the World Trade Center area of lower Manhattan had gone out of business. This means that about 72 percent of economic activity was preserved as businesses relocated within the New York City Metropolitan area.[83]

## VI. Conclusions and Recommendations

**Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.**

A. I recommend that the Board reject the use of the Brattle Report, and its findings, in making a decision regarding the net economic impacts associated with the

[80] *See* Rose, Adam and Shu-Yi Liao (2005), "Modeling Regional Economic Resilience to Disasters: A Computable General Equilibrium Analysis of Water Service Disruptions," Journal of Regional Science, Vol. 45:1, pp. 75-112; *See also*, Rose, Adam (November 1, 2009), "Economic Resilience to Disasters," CREATE Research Archive, pp. 8-9.
[81] Rose, Adam (November 1, 2009), "Economic Resilience to Disasters," CREATE Research Archive, p. 25.
[82] Rose, Adam (November 1, 2009), "Economic Resilience to Disasters," CREATE Research Archive, p. 25.
[83] Rose, Adam (November 1, 2009), "Economic Resilience to Disasters," CREATE Research Archive, p. 26.

Company's ES proposal. The Report suffers from a number of important flaws that cause it to substantially over-estimate the outage duration-related benefits of the Company's ES proposal.

**Q. HAVE YOU CHANGED YOUR EARLIER-OFFERED EXPERT OPINION AS A RESULT OF YOUR REVIEW AND ANALYSIS OF THE BRATTLE REPORT?**

A. No. I continue to recommend that the Board find the Company's ES proposal to not be in the public interest. The costs continue to outweigh the benefits associated with the proposed ES investments for both electric distribution ("ED") and natural gas distribution ("NGD") service.

**Q. DOES THIS CONCLUDE YOUR SUPPLEMENTAL TESTIMONY FILED ON JANUARY 10, 2014?**

A. Yes. However, I reserve the right to supplement my testimony if any updated or additional information becomes available during the course of this proceeding.

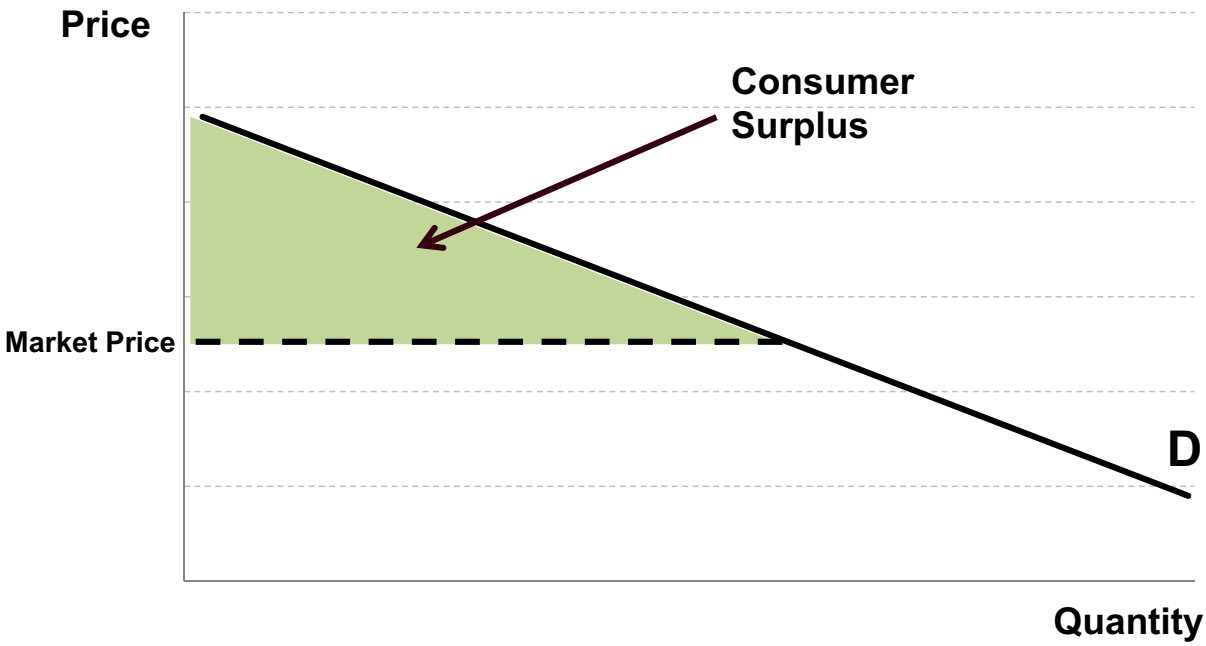
# SCHEDULUES DED-S-1 THROUGH DED-S-9

# Public Service Electric & Gas Historic Interruption Statistics With and Without Major Outage Events ("MOE")

| | Total Hours of Customer Interruptions | | MOE Customer Interruptions | 30 Percent Reduction |
|---|---|---|---|---|
| | Without MOE | With MOE | | |
| | - (Million Customer-Hours) - | | -- (Million Customer-Hours) -- | |
| 2003 | 1.76 | 1.76 | 0.00 | 0.00 |
| 2004 | 1.58 | 1.58 | 0.00 | 0.00 |
| 2005 | 1.63 | 2.37 | 0.74 | 0.22 |
| 2006 | 1.64 | 4.59 | 2.96 | 0.89 |
| 2007 | 1.81 | 2.40 | 0.59 | 0.18 |
| 2008 | 1.66 | 5.14 | 3.48 | 1.05 |
| 2009 | 1.56 | 1.87 | 0.32 | 0.09 |
| 2010 | 2.09 | 13.53 | 11.44 | 3.43 |
| 2011 | 2.03 | 33.52 | 31.49 | 9.45 |
| 2012 | 1.61 | 160.93 | 159.32 | 47.80 |
| **Average per Year (including 2012):** | | | **21.03** | **6.31** |
| **Average per Year (excluding 2012):** | | | **5.67** | **1.70** |

Source: Company's Response to RCR-E-124.

## Illustrative Representation of Consumer Surplus



# Major Articles Estimating the Price Elasticity of Demand



| Study/Author | Year | Short-Run Price Elasticity | Study Average |
|---|---|---|---|
| Lavin & Dale | 2011 | -0.11<br>-0.41<br>-0.15 | -0.22 |
| Bernstein and Madlener | 2011 | -0.04<br>-0.23 | -0.14 |
| Davis and Muehlegger | 2010 | -0.28 | -0.28 |
| Joutz & Trost | 2007 | -0.10 | -0.10 |
| Bernstein and Griffin | 2005 | -0.12<br>-0.13<br>0.00 | -0.08 |
| Maddala et al | 1997 | -0.09<br>-0.18 | -0.13 |
| Huntington | 1992 | -0.82 | -0.82 |
| Lin, Chen, and Chatov | 1987 | -0.15 | -0.15 |
| Beierlein, Dunn and McConnon | 1981 | -0.23<br>-0.24<br>-0.35 | -0.27 |

# Major Articles Estimating the Price Elasticity of Demand



## Study References

Lavin, Felipe Vasquez and Larry Dale, "The Impact of Price on Residential Demand for Electricity and Natural Gas," Climate Change, 2011, 109, S171–S189.

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Davis, Lucas W. and Erich Muehlegger, "Do Americans Consumer Too Little Natural Gas? An Empirical Test of Marginal Cost Pricing," RAND Journal of Economics, Winter 2010, 41 (4), 791–810.

Joutz, Fredrick and Robert T. Trost, "Consumer Response to Natural Gas Prices," Prepared for the American Gas Association, March 2007.

Bernstein, Mark A. and James Griffin, "Regional Differences in the Price-Elasticity of Demand for Energy," RAND Corporation - Prepared for the National Renewable Energy Laboratory, 2005.

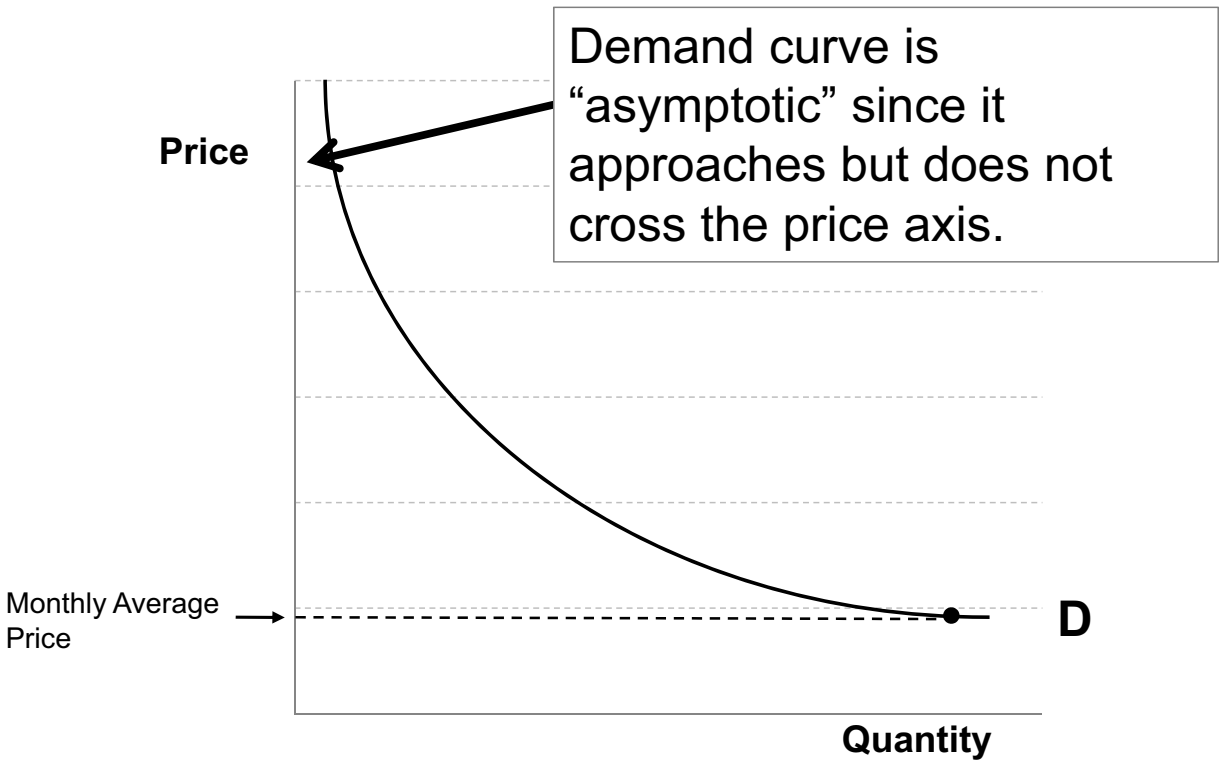
Maddala, G. S., Robert P. Trost, Hongyi Li, and Frederick Joutz, "Estimation of Short-Run and Long-Run Elasticities of Energy Demand From Panel Data Using Shrinkage Estimators," Journal of Business Economic Statistics, 1997, 15 (1), 90–100.

Huntington, Hillard G., "U.S. Natural Gas Markets: A Structural Model Comparison," Journal of Policy Modeling, 1992, 14 (1), 12–39.

Lin, Winston T., Yueh H. Chen, and Robert Chatov, "The Demand for Natural Gas, Electricity and Heating Oil in the United States," Resources and Energy, 1987, 9, 233–258.

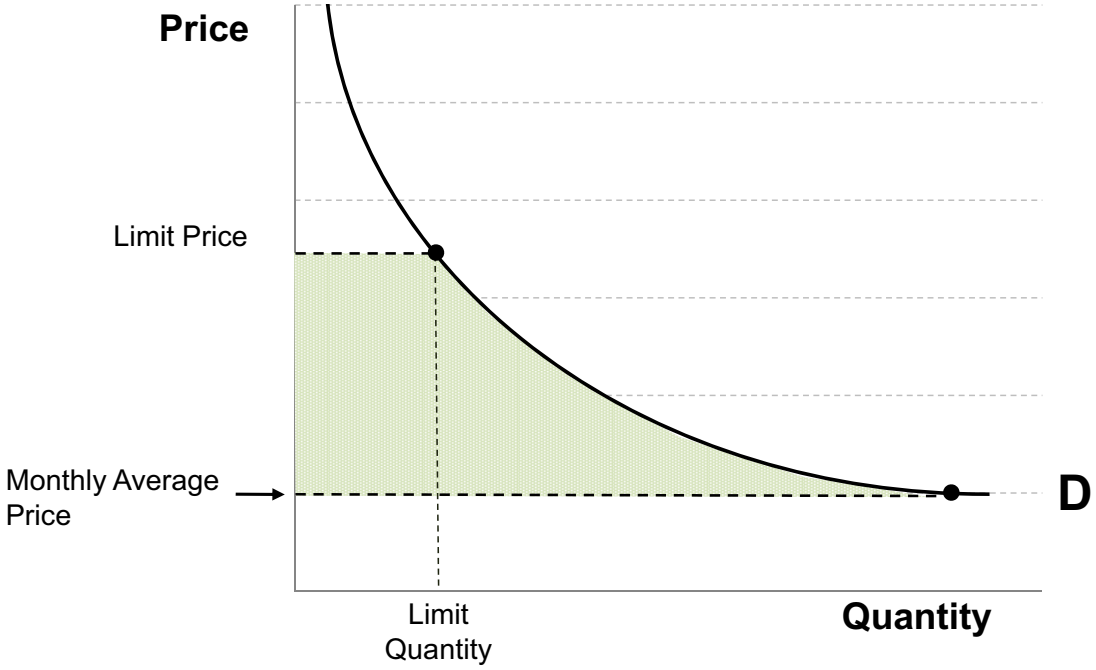
Beierlein, James G., James W. Dunn, and Jr. James C. McConnor, "The De-mand for Electricity and Natural Gas In the Northeastern United States," The Review of Economics and Statistics, August 1981, 63 (3), 403–408.

## Illustration of an Asymptotic Demand Curve




Source: Brattle Report.

## Illustration of an Demand Curve With a Limit Price




Source: Brattle Report.

# Monthly Limit Prices and Quantities from Brattle Report



| | PSE&G Analysis | | PSE&G Analysis | |
|---|---|---|---|---|
| | Equilibrium Price $/Therm | Equilibrium Quantity Therms | Limit Price $/Therm | Limit Quantity Therms |
| January | $ 1.05 | 300,250,720 | $ 52.17 | 203,202,864 |
| February | $ 1.06 | 217,271,910 | $ 66.70 | 143,561,449 |
| March | $ 0.98 | 188,426,810 | $ 88.20 | 120,195,418 |
| April | $ 1.07 | 96,123,720 | $ 11.73 | 75,629,512 |
| May | $ 1.15 | 48,101,790 | $ 12.65 | 37,846,170 |
| June | $ 1.22 | 37,536,710 | $ 13.39 | 29,533,641 |
| July | $ 1.25 | 34,029,360 | $ 13.77 | 26,774,075 |
| August | $ 1.31 | 28,673,110 | $ 14.45 | 22,559,816 |
| September | $ 1.28 | 30,221,020 | $ 14.03 | 23,777,698 |
| October | $ 1.15 | 53,961,710 | $ 12.62 | 42,456,723 |
| November | $ 1.06 | 107,917,290 | $ 156.62 | 65,504,579 |
| December | $ 0.88 | 169,704,530 | $ 100.33 | 105,663,147 |
| Heating Month Average | $ 1.01 | 196,714,252 | $ 92.81 | 127,625,491 |
| Non-Heating Month Average | $ 1.20 | 46,949,631 | $ 13.23 | 36,939,662 |
| Annual Average | $ 1.12 | 109,351,557 | $ 46.39 | 74,725,424 |

Source: Brattle Report.

## Alternative Monthly Consumer Surplus Estimates Under Alternative Limit Prices



| | PSE&G Analysis ($/customer/day) [a] | Alternative Estimates: Adjusted Pmax ($/customer/day) [b] | Alternative Estimates: Difference ($/customer/day) [c]=[a]-[b] | Alternative Estimates: Difference (Percent) [c]/[a] |
|---|---|---|---|---|
| January | $ 114.60 | $ 26.94 | $ 87.66 | 76.5% |
| February | $ 115.28 | $ 19.61 | $ 95.68 | 83.0% |
| March | $ 116.05 | $ 15.81 | $ 100.24 | 86.4% |
| April | $ 18.06 | $ 18.06 | $ - | 0.0% |
| May | $ 9.43 | $ 9.43 | $ - | 0.0% |
| June | $ 8.05 | $ 8.05 | $ - | 0.0% |
| July | $ 7.27 | $ 7.27 | $ (0.00) | 0.0% |
| August | $ 6.42 | $ 6.42 | $ 0.00 | 0.0% |
| September | $ 6.80 | $ 6.80 | $ - | 0.0% |
| October | $ 10.56 | $ 10.56 | $ 0.00 | 0.0% |
| November | $ 116.80 | $ 9.78 | $ 107.01 | 91.6% |
| December | $ 116.46 | $ 12.72 | $ 103.74 | 89.1% |
| **Annual** | $ 53.49 | $ 12.62 | $ 40.87 | 76.4% |

Source: Brattle Report.

# Alternative Monthly Consumer Surplus Estimates Under Alternative Elasticities



| | PSE&G Analysis | Alternative Estimates | | | |
|---|---|---|---|---|---|
| | Adjusted Consumer Surplus Elasticty = -0.1 ($/customer/day) [a] | Adjusted Consumer Surplus Elasticity = -0.24 ($/customer/day) [b] | Adjusted Pmax and Elasticity = -0.24 ($/customer/day) [c] | Difference ($/customer/day) [a]-[c]=[d] | Difference (Percent) [d]/[a] |
| January | $ 114.60 | $ 135.71 | $ 10.35 | $ 104.25 | 91.0% |
| February | $ 115.28 | $ 136.52 | $ 7.53 | $ 107.75 | 93.5% |
| March | $ 116.05 | $ 137.43 | $ 6.08 | $ 109.98 | 94.8% |
| April | $ 18.06 | $ 6.94 | $ 6.94 | $ 11.12 | 61.6% |
| May | $ 9.43 | $ 3.63 | $ 3.63 | $ 5.81 | 61.6% |
| June | $ 8.05 | $ 3.09 | $ 3.09 | $ 4.96 | 61.6% |
| July | $ 7.27 | $ 2.79 | $ 2.79 | $ 4.47 | 61.6% |
| August | $ 6.42 | $ 2.47 | $ 2.47 | $ 3.96 | 61.6% |
| September | $ 6.80 | $ 2.61 | $ 2.61 | $ 4.18 | 61.6% |
| October | $ 10.56 | $ 4.06 | $ 4.06 | $ 6.50 | 61.6% |
| November | $ 116.80 | $ 138.31 | $ 3.76 | $ 113.04 | 96.8% |
| December | $ 116.46 | $ 137.91 | $ 4.89 | $ 111.57 | 95.8% |
| **Annual** | $ 53.49 | $ 58.89 | $ 4.85 | $ 48.64 | 90.9% |

Source: Brattle Report.

## Effect of Adjusted Consumer Surplus



| | PSE&G Analysis Adjusted Consumer Surplus Elasticity = -0.1 ($/customer/day) | Alternative Estimate Consumer Surplus Elasticity = -0.24 ($/customer/day) |
|---|---|---|
| January | $ 114.60 | $ 135.71 |
| February | $ 115.28 | $ 136.52 |
| March | $ 116.05 | $ 137.43 |
| April | $ 18.06 | $ 6.94 |
| May | $ 9.43 | $ 3.63 |
| June | $ 8.05 | $ 3.09 |
| July | $ 7.27 | $ 2.79 |
| August | $ 6.42 | $ 2.47 |
| September | $ 6.80 | $ 2.61 |
| October | $ 10.56 | $ 4.06 |
| November | $ 116.80 | $ 138.31 |
| December | $ 116.46 | $ 137.91 |
| **Annual** | $ 53.49 | $ 58.89 |

Source: Brattle Report.

**Illustration of Consumer Surplus Under Different Demand Curves**



$D_2$ is more inelastic than $D_1$ and results in greater consumer surplus (i.e. B>A).