

ATTACHMENT – EDH-3

Public Service Electric and Gas Company
Case Name: EE 2017
Docket No(s): EO17030196

Response to Discovery Request: RCR-EE-0014
Date of Response: 5/11/2017
Witness: McCormick, Courtney
Gabel Associates' Cost Benefit Analysis

Question:

Regarding the cost-benefit analysis described in Paragraph 29, p11 of the Company's Petition:

- a. Please provide documents relevant to the selection of Gabel Associates, including the Request for Proposals (if any) and Gabel Associates' proposal for services.
- b. Please provide all instructions provided by the company to Gabel Associates regarding its implementation of the cost-benefit analysis.
- c. Please provide any and all documents, presentations, and meeting notes reflecting the cost-benefit study results provided by Gabel Associates.
- d. Please provide documentation in support of the per-customer and per-measure savings assumptions, including kWh, kW, and therms, made in the Cost-Benefit analysis. If the documents are readily available on the internet, it is sufficient to provide complete identifying information along with internet links to the relevant documents. If not, please provide copies of the documents.

Attachments Provided Herewith: 2

RCR-EE_0014_Gabel Proposal to PSEG.pdf

RCR-EE_0014_Overview of Gabel Methods Employed for EE 2017 Program - 3.14.17.docx

Response:

- a. Attached is the Gabel Associates' proposal for services titled, "Gabel Proposal to PSEG.pdf".
- b. Gabel Associates was instructed to develop the cost benefit analyses to support the EE 2017 filing using the formulas set out in the "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects." Gabel Associates was also instructed to fully brief and coordinate with PSE&G staff on the various assumptions that were included in the cost benefit analyses.
- c. The overall cost benefit study results were provided in Schedule MCM-EE17-11. In addition, a report providing an overview of the assumptions and methodology used by Gabel Associates was also provided and is being provided as an attachment, please see the response to d. below.
- d. A complete overview of the methodology used by Gabel Associates to complete the Cost Benefit Analysis is provided as an attachment titled, "Overview of Gabel Methods Employed for EE 2017 Program 3.14.17.docx". This document includes all assumptions used, including all of the assumptions that were used to identify energy savings assumptions.



Assumptions and Methods Employed to Compute Savings and Cost Benefit Ratios for the PSE&G EE 2017 Program

Gabel Associates, Inc

March 14, 2017

Gabel Associates (Gabel) was retained by Public Service Electric & Gas Company (PSE&G) to assist in analyzing the individual energy efficiency (EE) sub-programs contained in PSE&G's petition to the New Jersey Board of Public Utilities (BPU) for approval to implement PSE&G's EE 2017 Program.

In particular, Gabel assisted in estimating savings related to all the sub-programs and calculating the cost benefit ratios to evaluate the merits of each sub-program.

This report summarizes the methodology, calculations, and assumptions used in this analysis. Specifically, the following four analytical elements are reviewed:

- 1) Smart Thermostat Sub-Program Assumptions
- 2) Data Analytics Sub-Program Assumptions
- 3) Sub-Program Savings Calculation Assumptions
- 4) Cost Benefit Ratio Test Calculation Assumptions

The Cost-Benefit Ratio tests are detailed in Schedule MCM-EE17-11 of M. Courtney McCormick's Direct Testimony in support of the PSE&G EE 2017 Program filing.

1. Smart Thermostat Sub-Program Assumptions

PSE&G is proposing a program in which residential customers can purchase smart thermostats, such as the Nest or EcoBee thermostat, for a reduced cost via a direct rebate. In addition, PSE&G will offer customers the ability to access interest free on-bill repayment to further support the dissemination of smart thermostats throughout its territory.

Smart thermostats use controls and sensors, as well as imbedded logic to reduce air conditioning and heating costs for customers by monitoring usage, occupancy, and temperature preference patterns to optimize the efficiency of air conditioning and heating equipment.

To determine the value and viability of such a program, current publicly available market data on savings resulting from the installation of smart thermostats in the residential space was evaluated, leading to the development of a model to calculate the individual and overall energy savings which may be realized as a result of a Smart Thermostat sub-program offering from PSE&G. Based upon this research, it was



determined that residential users of smart thermostats generally realize 9.0% to 23.0% electric savings on cooling, and 5.0% to 23.0% savings of natural gas for heating. The chart below summarizes the compiled studies which provided information on savings from smart thermostats:

Study	Location	Electric	Natural Gas
Nest Avg	National Study	17.5%	9.6%
Nest -High	National Study	19.6%	12.5%
Nest - Low	National Study	15.4%	6.7%
Nest-Avg	Single Thermostats	15.5%	11.0%
Cadmus - Avg	Nest Tstat in Indiana	13.9%	12.5%
Cadmus - Low	Nest Tstat in Indiana	9.0%	11.0%
Cadmus - High	Nest Tstat in Indiana	19.0%	14.0%
Ecobee - Avg	Texas and Oregon Combined	20.0%	23.0%
T: Ecobee	Texas	23.0%	21.0%
O: Ecobee	Oregon	14.0%	17.0%
Honeywell		19.0%	5.0%
NIPSCO - Avg	Nest	16.1%	13.4%
NIPSCO - Low	Nest	10.0%	11.0%
NIPSCO - High	Nest	22.0%	16.0%
U.S. DOE High			15.0%
U.S. DOE Low			5.0%
Nest	Oregon	12.0%	
Max		23.0%	23.0%
Min		9.0%	5.0%
Average		16.4%	12.7%

Based upon the data collected and summarized in the chart above, it was decided the average of the available data should be used as the basis for electric cooling and natural gas heating savings in the model. Therefore, the Smart Thermostats model assumed that customers would reduce electric cooling costs by 16.4% and natural gas heating costs by 12.7%

It should be noted that these savings figures are based upon electric cooling and natural gas heating requirements. In order to determine the overall electric and natural gas savings, Gabel applied these savings percentages to the percentage of electricity used for cooling purposes, and the percentage of natural gas used for heating purposes. These percentages were provided by PSE&G based upon an internal study of actual customer usage patterns, and were assumed to be 26.1% of electric for cooling and 75.1% of natural gas for heating. Therefore, the assumed overall savings used in the model was calculated to be 4.29% of electric usage, and 9.56% of natural gas usage.

Total customer electric usage, natural gas usage, equipment costs, installation costs, and rebate value were all provided by PSE&G and incorporated into the model. Those assumptions, as well as other assumptions used in the model can be found on the 'Assumptions' tab of the Smart Thermostats model, which is titled: "WP-MCM-EE17-2B.xlsx" and was submitted as an electronic work paper with the EE 2017 Program filing.

2. Data Analytics Sub-Program Assumptions

PSE&G is proposing a data analytics program in which customers will be provided periodic updates regarding their energy usage, with the intention, based on similar programs implemented around the country, that this knowledge will result in customers voluntarily reducing electric and natural gas consumption. The Data Analytics program will have no direct cost to participants, and will provide customers with a periodic review and analysis of electric and natural gas consumption for a term of two years.

These types of data analytic programs enlist a third-party vendor to collect and analyze the monthly electric and natural gas consumption patterns of customers, and provide customized Home Energy Reports (HER) which allow residents to understand their usage patterns, and often also include comparisons of neighbors and similar types of households for customers to use as a benchmark to compare their own usage patterns.

To determine the value and viability of such a program, current publicly available market data on savings resulting from previously implemented data analytics and HER programs within the residential space was evaluated leading to the development of a model to calculate the individual and overall energy savings which may be realized as a result of a Data Analytics sub-program offering from PSE&G. The primary resource used in this analysis was a white paper published by Cadmus titled “Long-Run Savings and Cost-Effectiveness of Home Energy Report Programs” conducted in Winter 2014/2015¹. This report compiled and studied data from a number of existing HER programs to assess the viability of such programs.

Based upon the findings of the Cadmus report, savings typically range between 1.5% and 2.5% of energy usage. Note that these studies did not differentiate between electric and natural gas savings for customers. Cadmus discussed the “post-treatment” savings of these programs, which found that savings do not immediately disappear upon termination of HERs, and there is generally a “savings decay” period which can range between one and ten years. The report also explored the “ramp-up” in savings which occurs in HER programs. In essence, full behavioral change as a result of receiving HERs is not achieved immediately, and typically takes two to three years to reach its full effect.

Accordingly, based upon the HER programs discussed in the report and the recommendations made by Cadmus, the Data Analytics model assumed that customers would reduce electric and natural gas costs by 1.5% total as a result of the sub-program. However, the 1.5% would be staged over a two-year period to account for the delay in behavior changes from customers. Accordingly, customers ramped up to only 75% of the total savings after year 1, and then received 100% savings in year two. In addition, following the culmination of the program, the savings would decay at an annual rate of 20% per year (which equates to increasing loss of savings in years 3 through 7).

Total customer electric usage, natural gas usage, third party data analysis and HER costs were all provided by PSE&G and incorporated into the model. PSE&G also indicated that all program costs would be borne by PSE&G, and customers would not be subject to any program related costs. Those

¹ http://www.cadmusgroup.com/wp-content/uploads/2014/11/Cadmus_Home_Energy_Reports_Winter2014.pdf

assumptions, as well as other assumptions used in the model can be found on the 'Assumptions' tab of the Data Analytics model, which is titled: "WP-MCM-EE17-2C.xlsx" and was submitted as an electronic work paper with the EE 2017 Program filing.

3. Sub-Program Savings Calculation Assumptions

To calculate the wholesale electric and natural gas, electric capacity, electric transmission & distribution, customer retail, and emissions savings related to each of the sub-programs, Gabel constructed a model that would incorporate outputs from each of the sub-program models and compute the necessary metrics for determining these values.

Key variables used to calculate each of the necessary metrics used in the savings calculations are summarized in the sections below:

a. Wholesale Electric Savings

Wholesale electric savings occur because the programs will reduce the overall amount of electricity purchased and delivered through PJM in the PSEG zone. Sub-programs which reduce electric consumption directly reduce the amount of electricity which must be purchased in wholesale markets. The value of these savings is computed as the cost of the avoided purchases – in other words, the market price for electricity.

To calculate the value of the market price of electricity, congestion-adjusted current energy market forwards for PJM-Western Hub, the most liquidly traded zone in PJM, to account for the differential between PJM Western Hub and PSEG zone, were used. These congestion-adjusted forwards were then forecast using Energy Information Administration (EIA) 2017 Annual Energy Outlook² reference case for the Reliability First Corporation – East region electricity generation escalations³ to determine the long-term wholesale electric forecast. The following chart details the annual average, as well as on and off peak electric prices for summer and non-summer periods used in the model to compute wholesale electric savings in dollars per megawatt hour (\$/MWh). It also provides the compound annual growth rate (CAGR) for each portion of the forecast.

Year	Average Price	Summer Peak	Summer Off-Peak	Non-Summer Peak	Non-Summer Off-Peak
2017	\$31.66	\$39.96	\$25.45	\$35.45	\$27.45
2018	\$32.36	\$37.90	\$22.55	\$38.84	\$28.74
2019	\$35.59	\$41.68	\$24.80	\$42.71	\$31.61
2020	\$37.91	\$44.40	\$26.42	\$45.50	\$33.67
2021	\$40.17	\$47.05	\$27.99	\$48.21	\$35.67
2022	\$42.00	\$49.18	\$29.26	\$50.40	\$37.29
2023	\$43.77	\$51.26	\$30.50	\$52.53	\$38.87

² <http://www.eia.gov/outlooks/aeo/>

³ <http://www.eia.gov/outlooks/aeo/data/browser/#/?id=62-AEO2017®ion=3-9&cases=ref2017&start=2015&end=2050&f=A&linechart=ref2017-d120816a.126-62-AEO2017.3-9&map=&ctype=linechart&sourcekey=0>

2024	\$46.04	\$53.92	\$32.08	\$55.25	\$40.88
2025	\$48.70	\$57.04	\$33.94	\$58.45	\$43.25
2026	\$52.90	\$61.95	\$36.86	\$63.48	\$46.97
2027	\$55.47	\$64.96	\$38.65	\$66.57	\$49.26
2028	\$57.94	\$67.86	\$40.37	\$69.54	\$51.45
2029	\$59.15	\$69.27	\$41.22	\$70.99	\$52.53
2030	\$62.05	\$72.67	\$43.24	\$74.47	\$55.10
2031	\$63.35	\$74.19	\$44.14	\$76.02	\$56.25
2032	\$64.72	\$75.80	\$45.10	\$77.67	\$57.47
2033	\$65.06	\$76.19	\$45.33	\$78.08	\$57.77
2034	\$65.47	\$76.67	\$45.62	\$78.57	\$58.14
2035	\$67.79	\$79.38	\$47.23	\$81.35	\$60.19
2036	\$69.72	\$81.65	\$48.58	\$83.67	\$61.91
2037	\$70.75	\$82.85	\$49.30	\$84.90	\$62.82
2038	\$72.37	\$84.76	\$50.43	\$86.85	\$64.27
2039	\$73.48	\$86.05	\$51.20	\$88.18	\$65.25
2040	\$73.65	\$86.25	\$51.32	\$88.39	\$65.40
CAGR	3.74%	3.40%	3.10%	4.05%	3.85%

It should be noted that the model used monthly forwards and pricing to determine wholesale electric savings; however, annual values were provided above for purposes of illustration in this report.

b. Wholesale Natural Gas Savings

Similar to wholesale electric savings, wholesale natural gas savings occur as result of reduced natural gas purchases caused by the programs. Sub-programs which reduce natural gas consumption directly reduce the amount of natural gas which must be purchased by PSE&G customers. The value of these savings is computed as the cost of the avoided purchases, in other words, the market price for natural gas.

To calculate the value of the market price of natural gas, Gabel collected current Henry Hub natural gas commodity prices, as well as current Transco Zone 6 NY and Tetco M3 basis differentials to determine the basis adder used for interstate transportation of natural gas. The summation of the Henry Hub natural gas commodity forwards with the interstate transport basis equals the cost of gas to PSE&G's city-gate. Based upon our understanding of PSE&G's gas delivery system, it was assumed that 60% of the gas would be delivered via Transco's pipeline at Z6 NY, while 40% would be delivered via Tetco's pipeline at M3. These prices were then escalated based upon EIA's 2017 Annual Energy Outlook reference case escalation for Henry Hub natural gas⁴. The follow chart details the annual natural gas prices used in the model to compute wholesale natural gas savings in dollars per million british thermal units (\$/MMBtu). It also provides the CAGR for each portion of the forecast.

Year	Average	Summer	Winter
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⁴ <http://www.eia.gov/outlooks/aeo/data/browser/#/?id=13-AEO2017®ion=0-0&cases=ref2017&start=2015&end=2050&f=A&linechart=ref2017-d120816a.59-13-AEO2017&ctype=linechart&sourcekey=0>

	Price	Price	Price
2017	\$3.51	\$2.76	\$5.02
2018	\$3.58	\$2.50	\$5.73
2019	\$4.17	\$3.08	\$6.36
2020	\$4.77	\$3.65	\$7.00
2021	\$4.75	\$3.63	\$6.98
2022	\$4.71	\$3.60	\$6.94
2023	\$4.83	\$3.71	\$7.07
2024	\$5.06	\$3.92	\$7.32
2025	\$5.25	\$4.11	\$7.54
2026	\$5.50	\$4.34	\$7.82
2027	\$5.74	\$4.57	\$8.08
2028	\$5.98	\$4.80	\$8.35
2029	\$6.22	\$5.02	\$8.61
2030	\$6.39	\$5.18	\$8.81
2031	\$6.64	\$5.42	\$9.08
2032	\$6.77	\$5.54	\$9.23
2033	\$6.80	\$5.57	\$9.26
2034	\$6.89	\$5.66	\$9.36
2035	\$7.12	\$5.88	\$9.62
2036	\$7.22	\$5.97	\$9.73
2037	\$7.35	\$6.09	\$9.87
2038	\$7.45	\$6.19	\$9.98
2039	\$7.62	\$6.35	\$10.18
2040	\$7.74	\$6.46	\$10.31
CAGR	3.50%	3.77%	3.18%

It should be noted that the model used monthly forwards and pricing to determine wholesale natural gas savings; however, annual values were provided above for purposes of illustration in this report.

c. Electric Capacity Savings

Electric capacity savings result from the reduced electric load in the PSEG zone. PSEG is obligated to purchase capacity in annual Reliability Pricing Model (RPM) auctions three years in advance of its delivery to assure adequate generation is available to match load within PSE&G's territory. Sub-programs which reduce the overall capacity obligation of the PSEG zone have a direct impact on the amount of required capacity, and therefore can claim the offset capacity requirements as savings accrued as a result of the program.

Because the PJM load forecast for a delivery year is set prior to the Base Residual Auction (BRA) three years ahead of a delivery year, and subsequently updated in Incremental Auctions (IA) leading up to a delivery year, capacity savings were delayed by one year from the commencement of energy savings to account for the lag in incorporating load reductions into the load forecast for a delivery year.

In addition, capacity obligations are generally set during the five peak summer hours, and therefore the capacity reduction for each sub-program was set every June equal to the minimum savings calculated during the June through August period in the year prior.

The following chart summarizes the capacity price forecast used in the model to determine capacity savings in dollars per MW-day (\$/MW-day). It also provides the CAGR for the forecast.

Year	Capacity Price
2017	\$219.00
2018	\$215.00
2019	\$225.42
2020	\$119.77
2021	\$150.00
2022	\$157.50
2023	\$165.38
2024	\$173.64
2025	\$182.33
2026	\$191.44
2027	\$201.01
2028	\$206.04
2029	\$211.19
2030	\$216.47
2031	\$221.88
2032	\$227.43
2033	\$233.12
2034	\$238.94
2035	\$244.92
2036	\$251.04
2037	\$257.32
2038	\$263.75
2039	\$270.34
2040	\$277.10
CAGR	1.03%

The capacity forecast used known capacity clearing prices through the 2019/2020 delivery year, and forecasted values thereafter.

d. Electric Transmission & Distribution Savings

Electric Transmission & Distribution (T&D) savings occurs when PSE&G diminishes the total cost of maintaining the transmission and distribution infrastructure used to serve its customers as a result of reduced or flattened load.

Gabel used the precedent used in past filings to set the value of avoided electric T&D charges. This value was sourced from the “Draft Energy Efficiency Cost-Benefit Analysis Avoided Cost Assumptions”

produced by the Center for Energy, Economic and Environmental Policy (CEEP) of the Edward J. Bloustein School of Planning and Public Policy at Rutgers University.⁵

e. Retail Electric Savings

Electric retail savings represent the direct savings customers realize by installing measures through the sub-programs. To calculate retail electric savings, Gabel modeled each of the applicable electric rate classes based upon the rates in PSE&G’s Tariff for Electric Service⁶, and calculated the total cost which would be offset as a result of the sub-programs. This method results in a “price to compare” type analysis, as only portions of the tariff which would be offset as a result of the sub-programs are included in the analysis. By way of example, customers will not offset any of the monthly fixed Service Charge, so that avoiding that charge was not included in the retail electric savings analysis.

As stated, rates were set based upon PSE&G’s BPU approved Tariff for Electric Service, and were escalated, by rate component, to account for separate escalation rates for distribution and supply charges. Distribution and other tariff riders were escalated at 1.5% annually, while supply charges for customers receiving Basic Generation Service (BGS) Residential and Small Commercial Pricing (RSCP) supply were escalated based upon a weighted average of the wholesale electric forecast, the capacity forecast, and a transmission escalation rate of 1.5% annually. For customers BGS Commercial and Industrial Energy Pricing (CIEP) service, supply charges were based upon the actual escalations for the supply components listed above.

The chart below details the annual realized retail supply savings by rate class, in dollars per kilowatt hour (\$/kWh).

Year	Residential	General Lighting and Power	Large Power and Lighting – Secondary	Large Power and Lighting – Primary	High Tension Service – Sub-Transmission
2017					
2018	\$0.174	\$0.093	\$0.092		
2019	\$0.182	\$0.106	\$0.105		
2020	\$0.178	\$0.117	\$0.114	\$0.069	\$0.062
2021	\$0.183	\$0.133	\$0.123	\$0.079	\$0.071
2022	\$0.191	\$0.145	\$0.135	\$0.099	\$0.099
2023	\$0.198	\$0.150	\$0.144	\$0.122	\$0.130
2024	\$0.204	\$0.156	\$0.151	\$0.132	\$0.144
2025	\$0.213	\$0.164	\$0.159	\$0.138	\$0.152
2026	\$0.222	\$0.172	\$0.168	\$0.146	\$0.163
2027	\$0.230	\$0.180	\$0.175	\$0.151	\$0.170
2028	\$0.236	\$0.186	\$0.181	\$0.156	\$0.177
2029	\$0.242	\$0.191	\$0.186	\$0.160	\$0.182
2030	\$0.249	\$0.196	\$0.192	\$0.165	\$0.189
2031	\$0.253	\$0.201	\$0.197	\$0.169	\$0.193
2032	\$0.258	\$0.204	\$0.200	\$0.172	\$0.197

⁵ <http://www.njcleanenergy.com/files/file/Library/Market%20Research/AvoidedCost20131.pdf>

⁶ https://pseg.com/family/pseandg/tariffs/electric/pdf/electric_tariff.pdf

2033	\$0.261	\$0.208	\$0.203	\$0.174	\$0.198
2034	\$0.266	\$0.237	\$0.211	\$0.176	\$0.200
2035	\$0.272	\$0.348	\$0.224	\$0.181	\$0.206
2036	\$0.281	\$0.511	\$0.243	\$0.185	\$0.212
2037			\$0.241	\$0.189	\$0.215
2038			\$0.246	\$0.192	\$0.220
2039			\$0.256	\$0.204	\$0.236
2040			\$0.375	\$0.360	\$0.475
CAGR	2.84%	3.31%	3.48%	3.64%	4.30%

It should be noted that the model used monthly forwards and pricing to determine retail electric savings; however, annual values were provided for purposes of illustration in this report. In addition, the rates above represent realized annual rates; therefore, the unitized rates will not match the arithmetic average rate for all PSE&G customers in each of the listed rate classes, especially during program ramp-up and ramp-down (where applicable), because of the monthly distribution of savings in individual sub-programs. An additional factor which effects some of the rate classes is the capacity factor (i.e. the relationship between the demand offset and the energy consumption offset) of the measures and equipment installed with each sub-program. Blank years represent periods which did not accrue any retail electric savings. The CAGR is calculated as the growth rate between 2023 and 2033 to omit partial years of production from sub-programs, which result in fluctuations of the calculated realized rate and escalation rate.

f. Retail Natural Gas Savings

Natural Gas retail savings represent the direct savings customers realize by installing measures through the sub-programs. To calculate retail natural gas savings, each of the applicable natural gas rate classes based upon the rates in PSE&G’s Tariff for Gas Service⁷, were modeled to calculate the total cost which would be offset as a result of the subprograms. This method results in a “price to compare” type analysis, as only portions of the tariff which would be offset as a result of the sub-programs are included in the analysis. By way of example, customers will not offset any of the monthly fixed Service Charge, so that charge was not included in the offset retail natural gas savings analysis.

As stated, rates were set based upon PSE&G’s BPU approved Tariff for Gas Service, and were escalated, by rate component, to account for separate escalation rates for distribution and supply charges. Distribution and other tariff riders were escalated at 1.5% annually, while supply charges were escalated based upon the wholesale natural gas forecast.

The chart below details the annual realized retail supply savings by rate class, in dollars per therm (\$/therm).

Year	Residential	General	Large Volume
2017			
2018	\$0.81	\$0.70	\$0.47

⁷ https://pseg.com/family/pseandg/tariffs/gas/pdf/gas_tariff.pdf

2019	\$0.85	\$0.87	\$0.49
2020	\$0.89	\$0.87	\$0.65
2021	\$0.91	\$0.91	\$0.73
2022	\$0.91	\$0.95	\$0.80
2023	\$0.93	\$0.97	\$0.82
2024	\$0.96	\$1.00	\$0.85
2025	\$0.99	\$1.02	\$0.87
2026	\$1.02	\$1.06	\$0.91
2027	\$1.05	\$1.09	\$0.94
2028	\$1.09	\$1.12	\$0.97
2029	\$1.11	\$1.16	\$1.00
2030	\$1.14	\$1.18	\$1.02
2031		\$1.21	\$1.05
2032		\$1.23	\$1.07
2033		\$1.24	\$1.08
2034		\$1.26	\$1.09
2035		\$1.29	\$1.12
2036		\$1.31	\$1.13
2037		\$1.33	\$1.15
2038		\$1.34	\$1.17
2039		\$1.37	\$1.21
2040		\$1.39	\$1.26
CAGR	2.84%	3.31%	3.48%

It should be noted that the model used monthly forwards and pricing to determine retail natural gas savings; however, annual values were provided above for purposes of illustration in this report. In addition, the rates above represent realized annual rates; therefore, the unitized rates will not match the arithmetic average rate for all PSE&G customers in each of the listed rate classes, especially during program ramp-up and ramp-down (where applicable), because of the monthly distribution of savings in individual sub-programs. Blank years represent periods which did not accrue any retail natural gas savings. The CAGR for residential service is calculated as the growth rate between 2020 and 2030, while the CAGR for general and large volume service is calculated between 2023 and 2033, to omit partial years of production from sub-programs, which result in fluctuations of the calculated realized rate and escalation rate.

g. Emissions Savings

Emissions savings represent a societal benefit due to the environmental offset associated with using less electricity and natural gas. The values assumed for emissions savings are based upon the BPU's New Jersey Clean Energy Program Protocols to Measure Resource Savings for fiscal year 2017⁸. The emissions factors provided in the protocols are based upon New Jersey Department of Environmental Protection (NJDEP) figures for average system emissions savings.

⁸http://www.njcleanenergy.com/files/file/NJCEP%20Protocols%20to%20Measure%20Resource%20Savings%20FY17_FINAL.pdf

The following chart summarizes the emissions rates for avoided electricity in pounds per MWh (lbs/MWh), metric tons per MWh (mt/MWh), and dollars per kWh (\$/kWh).

Year	lbs/MWh	mt/MWh	\$/kWh
SO ₂	2.21	0.0010	\$0.0499
NO _x	0.95	0.0004	\$0.0031
CO ₂	1,111.79	0.5043	\$0.0077

Emission costs were based upon EPA costs, and were escalated at 1.5% annually.

The following chart summarizes the emissions rates for avoided natural gas in pounds per therm (lbs/therm), metric tons per therm (mt/therm), and dollars per therm (\$/therm).

Year	lbs/therm	mt/therm	\$/therm
NO _x	0.0092	0.000004	\$ 0.0297
CO ₂	11.7	0.0053	\$ 0.0805

h. Losses

When delivering electricity or natural gas to customers a factor which must be accounted for is losses during the transmission and delivery process. Therefore, reductions in the amount of electricity or natural gas delivered will result in avoided losses as well.

However, avoided losses are not applied to all calculations. Values which must account for losses include: wholesale electric and natural gas savings and capacity savings. However, retail electric and natural gas savings are calculated at the customer level, and therefore, there are no losses to avoid, as customers only pay for electricity and natural gas that passes through their meter.

Electricity losses can be split into two distinct parts, delivery and transmission. Delivery losses are experienced on PSE&G's distribution system, while transmission losses are experienced prior to the distribution system, on the transmission lines overseen by PJM. In addition, distribution losses occur at different factors depending on the voltage of delivery. The below chart summarizes the avoided distribution losses at each voltage level, as well as the avoided PJM transmission losses.

Category	Loss Factor (%)
Offset Electric Secondary Distribution Line Losses	8.15%
Offset Electric Primary Distribution Line Losses	5.40%
Offset Electric Sub-Transmission Line Losses	3.03%
Offset Electric Mean PJM Marginal Line Losses	0.77%

The distribution and PJM transmission losses are summed together to determine the total avoided losses for a customer. Each of these values are sourced from PSE&G's Tariff for Electric Service and adjusted to calculate for avoided losses.

Natural Gas losses are only accounted for on the PSE&G distribution system, and are the same regardless of the type of customer or delivery. The below chart summarizes the avoided losses factor accounted for in the model.

Category	Loss Factor (%)
Offset Natural Gas Losses	0.96%

The natural gas avoided losses factor is based upon the losses accounted for in PSE&G's FERC Form 2 filing for 2015 included in PSE&G's Annual Report to the BPU⁹.

i. Taxes

Many of the savings must also be adjusted to account for avoided taxes. For example, retail customer bills account for sales and use tax on every rate. As a result of participating in the sub-programs, customers will reduce their electric and natural gas usage, and therefore will avoid tax payments and produce additional savings for customers.

New Jersey recently amended its tax code to reduce the sales and use tax rate applied to transactions within the state. Beginning January 1, 2017, New Jersey's sales and use tax rate was reduced to 6.875%. On January 1, 2018, New Jersey's sales and use tax rate will further decline to 6.625%.

4. Cost Benefit Ratio Test Calculation Assumptions

Each sub-program was evaluated and graded based upon a number of industry standard testing protocols through the use of five Cost-Benefit tests. The formulae for these tests are set out in the California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects¹⁰. To calculate these tests, Gabel followed the precedents utilized by the BPU in previous filings from PSE&G, and consistent with the California Standard Practice Manual.

The five tests used to evaluate the sub-programs were:

- Total Resource Cost Test (TRC)
- Participant Cost Tests (PCT)
- Program Administrator Cost Test (PAC)
- Ratepayer Impact Measure Test (RIM)
- Societal Cost Test (SCT)

Each test listed above accounts for separate factors and is meant to measure a sub-program based upon a different scale. The equations for each of the cost-benefit tests is summarized below. Each test computes the quotient of the applicable benefits over the applicable costs. Sub-programs with a result above 1.0 signify an investment where benefits exceed costs.

Total Resource Cost Test Ratio

$$= \frac{(Avoided\ Supply\ Costs) + (Avoided\ Capacity\ Costs) + (Avoided\ T\&D\ costs)}{(Participant\ Costs) + (Program\ Admin\ Costs) + (Program\ Investment\ Costs)}$$

⁹ [https://pseg.com/family/pseandg/BPU annual reports/BPU annual reports/2015 BPU Annual Report.pdf](https://pseg.com/family/pseandg/BPU_annual_reports/BPU_annual_reports/2015_BPU_Annual_Report.pdf)

¹⁰ [http://www.cpuc.ca.gov/uploadedFiles/CPUC Public Website/Content/Utilities and Industries/Energy - Electricity and Natural Gas/CPUC STANDARD PRACTICE MANUAL.pdf](http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf)

Participant Cost Test Ratio

$$= \frac{(Participant\ Benefits)}{(Participant\ Costs)}$$

Program Administrator Cost Test Ratio

$$= \frac{(Avoided\ Supply\ Costs) + (Avoided\ Capacity\ Costs) + (Avoided\ T\&D\ costs)}{(Program\ Admin\ Costs) + (Program\ Investment\ Costs) + (Program\ Incentive\ Costs)}$$

Ratepayer Impact Measure Test Ratio

$$= \frac{(Avoided\ Supply\ Costs) + (Avoided\ Capacity\ Costs) + (Avoided\ T\&D\ costs) + (Utility\ Revenue\ Gained)}{(Program\ Admin\ Costs) + (Program\ Investment\ Costs) + (Program\ Incentive\ Costs) + (Utility\ Costs)}$$

Societal Cost Test Ratio

$$= \frac{(Avoided\ Supply\ Costs) + (Avoided\ Capacity\ Costs) + (Avoided\ T\&D\ costs) + (Lifetime\ Emissions\ Savings)}{(Participant\ Costs) + (Program\ Admin\ Costs) + (Program\ Investment\ Costs)}$$

Each component of the above listed tests is based upon the lifetime present value of the component. Present value was calculated monthly, and used a discount rate of 6.32%. The discount rate was calculated based upon the currently approved PSE&G weighted average cost of capital (WACC).