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Cost-Benefit Analysis of the NJCEP Energy Efficiency Programs:

FY2018 Retrospective Summary Report

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I. Summary

The Rutgers Center for Green Building (RCGB) of the Edward J. Bloustein School of Planning and Public Policy is contracted by the New Jersey Board of Public Utilities (NJBPU) to conduct cost-benefit analysis of the FY2018 residential, commercial and industrial New Jersey Clean Energy Program (NJCEP) energy efficiency programs. The NJCEP Energy Efficiency programs available to New Jersey residential, commercial and industrial customers in FY2018 are listed in Table 1.

There are three major changes currently underway that will affect future program evaluation. First, the utilities in New Jersey are taking over administration of a large portion of the Energy Efficiency programs. As a result of this change, future program evaluation with be conducted/overseen by a Statewide Evaluator. Second, the Board has approved a NJ Cost Test as a primary test, which will be used to assess the programs beginning in FY21. The NJ Cost Test will fulfill the Clean Energy Act's requirements to consider more extensively economic and environmental factors, ensure universal access to EE, and serve the needs of low-income communities.[1] This FY2018 analysis is based on the five standard cost tests defined by the National Standard Practice Manual (NSPM). Finally, the NJ Cost Test Board Order lays out new methodologies and assumptions for the calculation of Avoided Costs. This CBA, and the Avoided Costs presented in Appendix A, do not yet use this updated methodology.

Table 1: NJCEP Energy Efficiency Programs

Residential	Commercial & Industrial
Residential HVAC	C&I New Construction
Residential New Construction	C&I Retrofit
Comfort Partners	Direct Install
EE Products	Pay-for-Performance
Home Performance with Energy Star	Pay-for-Performance New Construction
	Large Energy Users Program

II. Cost-Benefit Tests: Definitions and Data Sources

Five costs tests are utilized in this cost-benefit analysis: Participant Cost Test, Program Administration Cost Test, Ratepayer Impact Measure Test, Total Resource Cost Test and Societal Cost Test.[2] These are defined below as per the National Standard Practice Manual (NSPM)[3].

Participant Cost Test: The measure of the quantifiable benefits and costs to the customer attributed to participation in a program. The participant benefits are equal to the sum of any participant incentives paid, any reductions in bills, and any federal or state tax deductions or credits. Participant costs include any out-of-pocket costs associated with the program.

Program Administrator Cost Test: Referred to as the Utility Cost Test in the NSPM, the purpose is to indicate whether the benefits of an EE resource will exceed its costs from the perspective of only the utility system. The PACT includes all costs and benefits that affect the operation of the utility system and the provision of electric and gas services to customers. The test includes all costs that the utility must

[1] *See* In re the Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO19010040 (Order dated June 10, 2020) ("June 10, 2020 Order"), p. 3.

[2] California Standard Practice Manual. Economic Analysis of Demand-Side Programs and Projects. (October 2001).

[3] National Efficiency Screening Project, "National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources", Spring 2017. https://nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf

recover from customers, including financial incentives for efficiency measures, efficiency program costs, and efficiency portfolio costs. The benefits include all utility system costs that are avoided by the EE resource, such as avoided energy costs, avoided generation capacity costs, avoided reserves, price suppression effects, avoided transmission costs, avoided distribution costs, avoided ancillary services costs, avoided T&D line losses, avoided environmental compliance costs, avoided RPS compliance costs, avoided credit and collection costs, and the value of reductions in risk and/or increases in system reliability. The current CBA conducted by RCGB does not include all of these costs and benefits; Avoided reserves, price suppression effects, avoided ancillary services costs, avoided environmental compliance costs (rather than Social Cost of Carbon), avoided RPS compliance costs, avoided credit and collection costs, and the value of reductions in risk and/or increases in system reliability currently are excluded from the CBA. Generally, they have been excluded due to lack of data or research into relevant values for New Jersey. Some of these, such as environmental compliance costs, ancillary services, and low income adders, will be included in the NJ Cost Test.

Ratepayer Impact Measure Test: This test assesses equity between participants and non-participants by measuring how changes in programmatic revenues and operating costs impact customer rates and bills. The benefits equal the savings from avoided supply costs, including the reduction in capacity costs for periods when load has been reduced and the increase in revenues for periods in which load has increased. The costs are the program costs incurred by administration of the program, the incentives paid to the participant, decreased revenues for any periods in which load has been decreased and increased supply costs for any periods when load has increased. The NSPM indicates that the RIM test should not be used for the purpose of determining which efficiency resources are cost-effective since it is a test of equity rather than of cost-effectiveness. RCGB will consider removing the RIM test from the CBA in future years after consultation with BPU and TRC staff.

Total Resource Cost Test: The TRC evaluates cost-effectiveness of EE investment as a resource and compares it with other demand-side and supply-side resources. It evaluates EE from the combined perspective of the utility system and participants. Thus, this test includes all impacts of the PACT, plus all impacts on the program participants. The costs include all costs described above for the PACT, plus any costs incurred by the program participant, including financial cost to purchase efficiency measures; increased consumption of other fuels; increased O&M costs; and participant non-financial costs. The benefits include all benefits described above for the PACT, plus any resources and benefits experienced by the program participant, including other fuel savings, water savings, participant O&M savings, and all other participant non-resource benefits. The current CBA conducted by RCGB does not include all of these costs; increased consumption of other fuels, increased O&M costs, other fuel savings, water savings, and participant O&M savings are excluded. Some of these, such as avoided fuel costs, will be included in the NJ Cost Test.

Societal Cost Test: The SCT attempts to quantify the change in the total resource costs to society as a whole rather than only to the utility and its ratepayers. The SCT should account for all costs that are incurred to acquire the EE resource. This includes all costs described above for the TRC test, plus any costs incurred by society, including environmental costs and reduced economic development. Benefits include all benefits described above for the TRC test plus any benefits experienced by society, including low-income community benefits, environmental benefits, economic development benefits, and reduced health care costs. The current CBA conducted by RCGB does not include all of these costs; reduced economic development, low-income community benefits, environmental benefits (except for Social Cost of Carbon), economic development benefits, and reduced health care costs are excluded. Many of these are included in the NJ Cost Test.

Currently, it is assumed that wholesale electricity prices account for the national sulfur dioxide and nitrogen oxide allowance programs. As New Jersey has rejoined the Regional Greenhouse Gas Initiative carbon dioxide program, a relevant discussion point is whether CO2 prices are internalized in wholesale

electricity prices. Currently, the Social Cost of Carbon is being used in the Societal Cost Test. Federal tax credits are not included.

Incremental Costs: Incremental cost is the additional cost of purchasing an energy efficient product instead of a standard product (for new installations), or the cost of high efficiency equipment versus existing equipment (for retrofit or "early-retirement" programs. The mix of measure types for each program is reported by TRC from the IMS system. When possible, the measure incremental cost from NEEP's 2018 Mid-Atlantic TRM[4], EIA 2018[5], Michigan's TRM[6], or Minnesota's TRM[7] are used. In the case of Comfort Partners, incremental costs were taken mainly from data that was received from Rockland Electric on their Low Income Direct Install program in 2016 as well as the above sources. The Residential HVAC, Low Income, Home Performance with Energy Star, and EE Products incremental costs were estimated based on the weighted average of the number of measures actually installed under the programs. Specific measure types installed under the Residential programs are determined from the program information published on the NJCEP website. The C&I program participant costs also were computed using a list of measures that were installed under the program. To increase accuracy of the CBA, RCGB would need specific data on types of measures installed under the C&I programs (i.e. specific types of light fixtures, models or size of refrigerators, tonnage of furnaces, etc.). For the Large Energy Users Program, RCGB used the minimum project cost eligible to participate in the program as the incremental cost ($200,000) because not enough measure level detail was available to calculate an incremental cost.

Measure Lives: This refers to the number of years that an energy efficient product will accrue energy savings. The measure life of each program was calculated by dividing the lifetime electricity savings reported in the New Jersey's Clean Energy Program Report 4QFY18 Final Report[8] by the annual electricity savings and by dividing the lifetime natural gas savings by the annual natural gas savings and averaging the two values.

Table 2: Sources of Data Inputs into CBAs

	Energy Savings	Program Costs	Incremental Costs	Measure Lives	Mix of Measures	Notes
Residential						
Residential HVAC	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/MA[9]	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS & NJCEP Program Documents	RCGB was able to determine the specific measures that were eligible for rebates through the program website and thus was able to calculate incremental costs.
Comfort Partners	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/Rockland Electric	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS & NJCEP Program Documents	
EE Products	NJCEP Annual Report	TRC IMS	NEEP/EIA	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS & NJCEP Program Documents	

[4] NEEP Mid-Atlantic Technical Reference Manual V8 (May 2018)
https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V8_0.pdf
[5] Updated Buildings Sector Appliance and Equipment Costs and Efficiencies April 2018
https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/full.pdf
[6] Michigan Energy Measures Database https://www.michigan.gov/mpsc/0,4639,7-159-52495_55129---,00.html
[7] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs V2.1 January 1, 2018-December 31, 2018 http://mn.gov/commerce-stat/pdfs/mn-trm-v2.1.pdf
[8] https://njcleanenergy.com/files/file/FINAL%20REPORT%20-%204QFY18.pdf
[9] Navigant Water Heating, Boiler, and Furnace Cost
Study (RES 19) April 2018http://ma-eeac.org/wordpress/wp-content/uploads/RES19_Task5_FinalReport_v3.0_clean.pdf

Home Performance with Energy Star	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/Rockland Electric	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS & NJCEP Program Documents	
Residential New Construction	NJCEP Annual Report	TRC IMS	Energy Star	NJCEP Annual Report Lifetime/Annual Savings		
Commercial & Industrial						
C&I New Construction	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/MI/MN	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS	For C&I programs the specific measures that were eligible for rebates were not provided.
C&I Retrofit	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/MI/MN	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS	
Direct Install	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/MI/MN	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS	
Pay for Performance	NJCEP Annual Report	TRC IMS	EnerNOC/ NEEP/MI/MN	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS	
Large Energy Users Program	NJCEP Annual Report	TRC IMS	Used minimum project cost	NJCEP Annual Report Lifetime/Annual Savings	TRC IMS	

The Clean Energy Program reports include installed, committed, and total savings for all programs. For purposes of cost-benefit analysis, only the installed savings were used. Energy savings and budget data were reported for the total program, but calculations to determine per unit cost and savings also were made. Table 2 shows the data sources used for energy savings, administrative and incremental costs, mix of measures, incremental cost, and measure lives. RCGB is not able to obtain data on the specific types of measures that are being installed under the C&I programs (i.e., particular models or the efficiency levels).

III. Cost-benefit Analysis Results

The CBA results for the FY2018 energy efficiency programs are presented in Table 3 and Table 4. The C&I Programs, with the exception of Pay for Performance New Construction have Benefit-cost ratios (BCRs) for the TRC test above 1.0, meaning that their benefits are larger than their costs. For Pay for Performance New Construction, the incremental cost of the program would need to be reduced by about one-third for the benefit-cost ratio to be 1.0 (from a current assumed incremental cost of $330,000 to $227,000).

The TRC results for the Residential Programs are all below 1.0, except for the EE Products program. The results for the Societal Cost Test are all closer to 1.0, showing the potential importance of including non-energy benefits in capturing all of the costs and benefits that a program incurs.

Table 3: FY2018 Residential Programs

	Low Income	HVAC	EE Products	New Construction	Home Performance
Participant	$27,368,204	$14,816,309	$24,782,962	$16,740,907	$28,447,385
Ratio	2.6	3.0	8.2	2.9	5.5
Program Administration	($14,376,620)	$1,105,237	($1,052,037)	($960,191)	($11,185,912)
Ratio	0.4	1.2	0.9	0.9	0.4
Ratepayer Impact Measure	($19,893,600)	($2,756,652)	($11,515,907)	($6,881,966)	($16,007,073)
Ratio	0.3	0.7	0.4	0.6	0.3
Total Resource	($11,987,619)	($1,733,028)	$524,410	($2,557,114)	($2,058,295)
Ratio	0.4	0.8	1.1	0.8	0.8
Social Cost	($11,179,768)	($1,167,656)	$3,398,559	($1,176,226)	($1,187,071)
Ratio	0.5	0.9	1.5	0.9	0.9

Table 4: FY 2018 Commercial and Industrial Programs

	C&I New Construction	C&I Retrofit	Direct Install	Pay for Performance	P4P NC	LEUP Inc Cost assumes $200k min proj cost
Participant	$6,713,693	$216,965,049	$89,962,929	$59,827,548	$7,368,888	$11,934,122
Ratio	15.5	12.9	8.3	3.7	1.5	5.6
Program Administration	$1,785,336	$73,955,340	$8,821,683	$21,097,796	$5,624,814	$734,322
Ratio	2.2	4.0	1.3	3.1	2.1	1.2
Ratepayer Impac Measur	($1,318,356)	($26,809,652)	($23,370,676)	($3,525,284)	($2,087,852)	($4,734,020)
Ratio	0.7	0.8	0.6	0.9	0.8	0.5
Total Resource	$1,795,177	$76,661,620	$22,427,197	$7,486,626	($4,407,467)	$802,060
Ratio	2.2	4.5	2.7	1.3	0.7	1.2
Social Cost	$3,014,825	$115,891,955	$34,346,908	$15,565,397	($1,482,462)	$2,920,757
Ratio	3.0	6.3	3.5	1.7	0.9	1.8

A time series of results of the participant and total resource costs tests 2006 through 2018[10] are presented in Tables 5 and 6. Numerous updates over the years regarding model inputs and assumptions have an impact on the CBA results, making a direct comparison between years challenging. Illustratively, there have been changes in incentive levels and measures, such as inclusion of Tier 1 audit and air sealing in the Home Performance program and inclusion of propane fuel switching from program savings. Additionally, the Program Manager has been able to provide more data on installed measures in recent

[10] In 2012/13 the NJCEP changed from Calendar year reporting to Fiscal year, the result of which is that 2006-12 are reported as CY and 2013-17 are reported as FY.

years, which has improved the accuracy of the CBA results (particularly in the Residential sector). There is no definitive trend one way or the other over the past few years in the BCRs.

Table 5: Participant Cost Test Ratios (2006-2018)

	2006	2007	2008	2009	2010	2011	2013[11]	2014	2015	2016	2017	2018
Residential Programs												
Low Income	N/A	N/A	N/A	N/A	N/A	N/A	2.0	2.5	1.1	1.0	1.4	2.6
HVAC	4.3	5.1	7.4	3.4	3.4	3.1	2.1	1.4	2.1	2.4	2.0	3.0
HPwES				1.4	4.7	4.3	2.5	2.4	5.8	7.0	5.3	5.5
EE Products	1.6	1.8	4.3	10.3	8.4	4.8	6.5	4.0	4.2	5.9	4.8	8.2
New Construction	3.1	3.2	4.0	2.7	2.5	2.4	3.0	3.0	2.4	2.9	1.5	2.9
Commercial & Industrial Programs												
CHP	1.6	7.3	1.2	8.2	1.9							
New Construction	14.7	11.9	20.1	13.3	15.7	12.0	9.4	1.9	44.8	14.7	10.4	15.5
Retrofit	8.1	3.7	7.5	5.0	6.7	9.0	1.3	43.6	7.1	4.5	15.5	12.9
Schools	5.2	7.7	4.0	4.1								
Direct Install					4.0	9.2	3.5		5.4	5.1	9.7	8.3
Pay for Performance EB									4.3	3.0	9.1	3.7
Pay for Performance NC									0.8	3.8	1.8	1.5
LEUP									11.9	12.3	63.8*	5.6*

Table 6: Total Resource Cost Test Ratios (2006-2018)

	2006	2007	2008	2009	2010	2011	2013[12]	2014	2015	2016	2017	2018
Residential Programs												
Low Income[13]			9.7	0.4	0.3	0.4	0.3	0.3	0.1	0.1	0.1	0.4
HVAC	2.7	3.5	4.1	1.8	1.1	0.9	0.7	0.4	0.6	2.4	0.6	0.8
HPwES			0.2	0.5	0.4	0.7	0.4	0.5	0.7	1.0	0.7	0.8
Energy Star Products	0.5	1.9	1.9	4.7	3.0	1.4	2.1	1.5	1.0	0.9	1.1	1.1
New Construction	1.5	1.5	2.2	1.5	1.0	0.9	1.2	1.2	5.6	1.0	1.0	0.8
Commercial & Industrial Programs												
CHP	1.1	7.5	1.4		0.8							
New Construction	8.6	5.1	10.1	7.9	6.8	5.3	2.3	0.3	5.5	2.1	2.6	2.2
Retrofit	5.0	1.7	4.7	3.3	3.7	6.2	0.6	10.3	2.0	1.2	4.9	4.5
Schools	3.1	3.1	2.3	2.7								
Direct Install					1.5	3.8	1.2		1.5	1.2	2.5	2.7
Pay for Performance EB									1.4	1.2	2.5	1.3
Pay for Performance NC									0.4	1.4	0.9	0.7
LEUP									2.6	3.4	12.0*	1.2*

*Please note that the BCR for the Large Energy User Program is likely substantially less than the values reported in this table due to RCGB's usage of the minimum project cost as an incremental cost.

[11] 2006 through 2011 are reported on a calendar year basis. 2013 represents a shift to Energy year and covers the period of January 1, 2012 through June 30, 2013.

[12] Ibid.

[13] The Low Income values for 2006 through 2008 were initially calculated using an incorrect incremental cost and will be updated in the future to reflect a corrected value.

Appendix A: FY2018 Avoided Costs

Energy Efficiency Benefit-Cost Analysis Avoided Cost Assumptions for 2018 BCA

Technical Memo

June 2021

This memo provides the inputs and methods utilized to update the avoided cost assumptions for integration into cost-benefit analyses of the New Jersey Clean Energy Program (NJCEP).

Please note that there are three major changes currently underway that will affect future program evaluation. First, the utilities in New Jersey are taking over administration of a large portion of the Energy Efficiency programs. As a result of this change, future program evaluation with be conducted/overseen by a Statewide Evaluator. Second, the Board has approved a NJ Cost Test as a primary test, which will be used to assess the programs beginning in FY21. The NJ Cost Test will fulfill the Clean Energy Act's requirements to consider more extensively economic and environmental factors, ensure universal access to EE, and serve the needs of low-income communities.[14] Finally, the NJ Cost Test Board Order lays out new methodologies and assumptions for the calculation of Avoided Costs. This CBA, and the Avoided Costs presented in Appendix A, do not yet use this updated methodology.

Benefit-Cost Analysis of Energy Efficiency Programs

Benefit-Cost Analysis (BCA) is a tool that compares the monetized costs and benefits of energy efficiency measures, programs and portfolios. Utilized by program managers and regulators as a formal decision-making tool, BCA assists in determining which measures, programs or portfolios should be adopted, continued or altered in some fashion.

To achieve the most value, BCA should be integrated into both program planning and evaluation.[15] Program design should reflect BCA assumptions in order for BCA results to be meaningful. Program evaluations also should align with BCA assumptions; program impact evaluations are needed to assess the actual savings.[16]

Any BCA undertaking requires numerous assumptions and a consistent approach in the level of detail afforded the assumptions. There is a tradeoff between time and effort and the additional accuracy that may result from a more extensive, detailed analysis. Additionally, both costs and benefits need to be properly accounted for. In this analysis, all assumptions are transparently derived from independent and publicly

[14] *See* In re the Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO19010040 (Order dated June 10, 2020) ("June 10, 2020 Order"), p. 3.

[15] The 2017 Evaluation Plan is posted at http://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an . It is currently being updated for 2018.

[16] The last impact evaluations were conducted in 2009. See http://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an

available sources.[17] The spreadsheet BCA tool employed by RCGB uses nominal dollars, unless otherwise stated, and adjusts assumptions for inflation as appropriate. [18]

Currently, NJCEP BCAs are calculated, based on standard industry practices, using a spreadsheet tool developed by the Center for Energy, Economic, and Environmental Policy (CEEEP) and now maintained by Rutgers Center for Green Building. The Clean Energy Program recently moved to a BCA modeling platform that is widely used in the industry and across multiple jurisdictions called e-Plan. RCGB will run the CEEEP model and e-Plan in parallel this year to ensure the robustness of the new tool.

Updates Since Last Version

RCGB has made several changes to this document since the last version:

- Removed Wholesale/Resale Propane and Heating Oil from Table 5 because they are applicable only to very large commercial customers;
- Recommended a Social Discount Rate for use in the Societal Cost Test;
- Updated Distribution Line Loss Factor and Natural Gas Loss Factor; and
- Escalated Avoided Electricity T&D value to 2018$

I. Electricity Prices

Retail Electricity Prices: Historic 2018 U.S. Energy Information Administration (EIA) New Jersey retail electricity prices[19] were escalated using an annual price growth rate derived from the *EIA Annual Energy Outlook 2019* for the Mid-Atlantic region[20]. On average, the annual growth rate was about 2.9%. The NJ Clean Energy Programs do not distinguish between commercial and industrial sectors, therefore the commercial and industrial prices were averaged based on historic 2017 New Jersey retail electricity sales. Retail electricity prices reported to EIA include the Societal Benefits Charge (SBC)[21] and the 6.875% Sales and Use Tax.

Wholesale Electricity Prices: Historic 2018 New Jersey wholesale electric prices from PJM Data Miner 2 were escalated based on the annual percent change in the *EIA 2019 Annual Energy Outlook* using the Reliability First Corporation/East Electricity Generation Prices.[22] The annual percent change was, on average, about 1.4%. The seasonal peak and off-peak factors were derived using historic 2018 PJM LMP data.[23] Summer is defined as May through September, winter is defined as October through April, on-peak is defined as Monday through Friday 8am-8pm (hour beginning or HB), and off-peak is defined as Monday-Friday 8pm-8am (HB) and weekends and holiday.

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[17] For previously used avoided cost assumptions please visit http://ceeep.rutgers.edu/publications/.

[18] *Nominal prices*, sometimes referred to as *current dollar prices*, measure the dollar value of a product or service at the time it was produced. In contrast, *real prices* are adjusted for inflation. See https://www.stlouisfed.org/publications/inside-the-vault/fall-2007/nominal-vs-real-oil-prices.

[19] https://www.eia.gov/electricity/data/browser/#/topic/7?agg=0,1&geo=g004&endsec=u&linechart=ELEC.PRICE.US-ALL.A&columnchart=ELEC.PRICE.US-ALL.A&map=ELEC.PRICE.US-ALL.A&freq=A&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin=

[20] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2019&region=1-2&cases=ref2019&start=2017&end=2050&f=A&linechart=~~~~ref2019-d111618a.73-3-&map=&sourcekey=0

[21] The Societal Benefits Charge for electric customers of 3.6% for residential and 4.8% for C&I is included in the retail prices reported to EIA by the utilities.

[22] Wholesale electricity prices are not weather normalized. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=62-AEO2019&region=3-9&cases=ref2019&start=2017&end=2050&f=A&linechart=ref2019-d111618a.130-62-AEO2019.3-9&map=&ctype=linechart&sourcekey=0

[23] http://www.pjm.com/markets-and-operations/energy.aspx

Table 1: Retail Electricity Prices and Wholesale Energy Prices (Nominal Dollars)

	Retail ($/kWh)		Wholesale Energy ($/MWh)				
	Residential	Weighted Avg. C&I	Average Price	Summer Peak	Summer Off-Peak	Non-Summer Peak	Non-Summer Off-Peak
2018	$0.15	$0.12	$28.03	$33.33	$21.22	$33.28	$27.22
2019	$0.16	$0.12	$28.35	$33.72	$21.46	$33.66	$27.53
2020	$0.17	$0.12	$23.20	$27.60	$17.57	$27.55	$22.53
2021	$0.17	$0.13	$23.31	$27.72	$17.65	$27.67	$22.63
2022	$0.18	$0.13	$23.50	$27.95	$17.79	$27.90	$22.82
2023	$0.19	$0.13	$24.09	$28.65	$18.24	$28.60	$23.39
2024	$0.20	$0.14	$26.65	$31.70	$20.18	$31.64	$25.88
2025	$0.20	$0.15	$27.68	$32.93	$20.96	$32.87	$26.88
2026	$0.21	$0.15	$28.53	$33.93	$21.60	$33.87	$27.70
2027	$0.22	$0.16	$29.11	$34.63	$22.04	$34.57	$28.27
2028	$0.23	$0.16	$29.76	$35.40	$22.53	$35.34	$28.90
2029	$0.23	$0.17	$30.22	$35.94	$22.88	$35.88	$29.34
2030	$0.24	$0.17	$30.69	$36.50	$23.23	$36.44	$29.80
2031	$0.24	$0.18	$31.25	$37.17	$23.66	$37.11	$30.35
2032	$0.25	$0.18	$32.31	$38.43	$24.47	$38.37	$31.38
2033	$0.26	$0.19	$33.35	$39.67	$25.25	$39.60	$32.39
2034	$0.27	$0.19	$34.22	$40.70	$25.91	$40.63	$33.23
2035	$0.27	$0.20	$34.84	$41.44	$26.38	$41.36	$33.83
2036	$0.28	$0.21	$35.76	$42.53	$27.08	$42.46	$34.73
2037	$0.29	$0.21	$37.04	$44.06	$28.05	$43.98	$35.97
2038	$0.29	$0.22	$37.86	$45.02	$28.66	$44.94	$36.76
2039	$0.30	$0.22	$38.59	$45.89	$29.22	$45.81	$37.47
2040	$0.30	$0.22	$38.38	$45.64	$29.06	$45.56	$37.27

Ancillary Services Prices: Ancillary services include regulation, scheduling, dispatch and system control, reactive power, and synchronized reserves, and their cost in 2018 was $1.05/MWh.[24] The cost of ancillary reserves are added to wholesale electricity prices.

Capacity Prices: New Jersey Utility PJM Reliability Pricing Model (RPM) prices for the four electric utilities (AE, JCP&L, PSE&G and RECO) for 2010 to 2021 were weighted by each utility's historic 2018 peak load[25] to estimate an average New Jersey capacity price. From 2022 to 2040, the capacity prices were escalated based on the EIA projected annual change in U.S. GDP Chain-type Price Index, which is reported in Table 6. PJM's Forecast Pool Requirement (FPR) is provided in Table 3; the FPR is a multiplier that converts load values into capacity obligation.[26] To calculate avoided capacity benefits, the peak savings are multiplied by the numbers in Table 2 and again by the numbers in Table 3.

[24] Monitoring Analytics, LLC, 2018 State of the Market Report, p. 436 (Table 10-4), http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2018/2018q2-som-pjm.pdf

[25] Downloaded from Data Miner 2 https://dataminer2.pjm.com/feed/hrl_load_metered/definition

[26] 2018 PJM Reserve Requirement Study, October 10, 2018, PJM Staff, p. 9 for FPR values and p. 40 for definition of FPR. https://www.pjm.com/-/media/committees-groups/committees/pc/20181011/20181011-item-06b-2018-pjm-reserve-requirement-study-draft.ashx

Table 2: Capacity Price (Nominal $/kW-year)

	$/kW- year
2018	$73.46
2019	$58.65
2020	$57.94
2021	$68.42
2022	$70.16
2023	$71.89
2024	$73.60
2025	$75.29
2026	$77.00
2027	$78.75
2028	$80.52
2029	$82.31
2030	$84.09
2031	$85.90
2032	$87.77
2033	$89.69
2034	$91.65
2035	$93.68
2036	$95.78
2037	$97.93
2038	$100.12
2039	$102.37
2040	$104.68

Table 3: PJM Forecast Pool Requirements

Delivery Year Period	Forecast Pool Requirement (FPR)
2018/2019	1.0905
2019/2020	1.0896
2020/2021	1.0898
2021/2022*	1.0898

*Assume 2021/2022 FPR for years 2023 and later.

II. Natural Gas Prices

Retail Natural Gas Prices: Historic 2018 EIA New Jersey retail natural gas prices[27] were escalated using an annual growth rate derived from the Mid-Atlantic Region *EIA Annual Energy Outlook 2019* natural gas price forecasts[28]. On average, the annual growth rate was about 3.2%. Retail natural gas prices reported to EIA include the Societal Benefits Charge (SBC)[29] and the 6.875% Sales and Use Tax.

Wholesale (Henry Hub) Natural Gas Prices: Wholesale natural gas prices are taken from the EIA Annual Energy Outlook 2019[30]. The winter and summer prices were derived from the 1994 to 2018

[27] https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SNJ_a.htm
[28] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2019&region=1-2&cases=ref2019&start=2017&end=2050&f=A&linechart=~~~~ref2019-d111618a.73-3-&map=&sourcekey=0
[29] The Societal Benefits Charge for natural gas customers of 4.1% for residential and 5.0% for C&I is included in the retail prices.
[30] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=13-AEO2019&sourcekey=0

historic average ratio of summer and winter prices to Henry Hub[31]. The summer average ratio was 97.3% and the winter average ratio was 102.7%. With the continued development of shale natural gas in Pennsylvania, using a Mid-Atlantic regional wholesale hub for natural gas may be appropriate going forward. RCGB is tracking this issue. In addition to the wholesale price at the well head, one would want to add the fixed costs of the pipeline, storage, and peaking resources that deliver gas into the local distribution system, the variable costs to transport gas by pipeline and cycle gas through storage and peaking facilities, and the cost of delivering gas through the gas distribution system to be equivalent to the retail natural gas price.

Table 4: Retail and Wholesale Natural Gas Prices (Nominal $/MMBtu)

	Retail Prices			Henry Hub Wholesale Prices		
	Residential	Commercial	Industrial	Average Price	Summer	Winter
2018	$8.82	$8.74	$7.79	2.99	$2.91	$3.07
2019	$8.68	$8.46	$8.08	3.10	$3.02	$3.19
2020	$9.33	$9.00	$8.28	3.25	$3.16	$3.34
2021	$9.81	$9.51	$8.28	3.24	$3.15	$3.33
2022	$10.38	$10.14	$8.47	3.33	$3.24	$3.42
2023	$11.06	$10.89	$8.84	3.56	$3.46	$3.65
2024	$11.74	$11.66	$9.26	3.84	$3.74	$3.95
2025	$12.21	$12.14	$9.79	4.20	$4.09	$4.32
2026	$12.57	$12.48	$10.08	4.39	$4.27	$4.51
2027	$12.91	$12.78	$10.30	4.52	$4.39	$4.64
2028	$13.26	$13.10	$10.62	4.72	$4.59	$4.85
2029	$13.59	$13.40	$10.83	4.84	$4.71	$4.98
2030	$13.94	$13.72	$11.12	5.00	$4.86	$5.14
2031	$14.27	$14.02	$11.34	5.09	$4.95	$5.23
2032	$14.70	$14.44	$11.85	5.38	$5.23	$5.53
2033	$15.14	$14.87	$12.23	5.58	$5.43	$5.73
2034	$15.52	$15.23	$12.55	5.77	$5.61	$5.92
2035	$15.93	$15.61	$12.90	5.95	$5.79	$6.12
2036	$16.36	$16.01	$13.34	6.20	$6.03	$6.37
2037	$16.82	$16.47	$13.72	6.37	$6.20	$6.55
2038	$17.23	$16.83	$14.02	6.53	$6.35	$6.71
2039	$17.67	$17.24	$14.39	6.71	$6.53	$6.90
2040	$18.14	$17.69	$14.85	6.96	$6.77	$7.15

III. Propane and Heating Oil Prices

Propane Prices: Historic 2018 EIA New Jersey residential propane prices[32] were escalated using an annual growth rate derived from the Mid-Atlantic Region *EIA Annual Energy Outlook 2019* propane price forecasts[33] (Residential Prices). EIA defines Residential Propane Prices as the price charged for home delivery of consumer grade propane intended for use in space heating, cooking, or hot water heaters in

[31] https://www.eia.gov/dnav/ng/hist/rngc1m.htm
[32] https://www.eia.gov/dnav/pet/pet_pri_wfr_dcus_sNJ_w.htm
[33] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2019&region=1-2&cases=ref2019&start=2017&end=2050&f=A&linechart=ref2019-d111618a.3-3-AEO2019.1-2&map=ref2019-d111618a.4-3-AEO2019.1-2&sourcekey=0

residences. Propane prices initially were presented as weekly averages during the period of January to March and October to December[34] and were averaged to develop an annual price. On average, the annual growth rate was about 3.3% for the residential prices and 2.9% for the prices for all users. In addition, RCGB added the 6.875% Sales and Use Tax.[35]

Heating Oil Prices: Historic 2018 EIA New Jersey residential heating oil prices were escalated using an annual growth rate derived from the Mid-Atlantic Region *EIA Annual Energy Outlook 2019* heating oil price forecast (Residential Prices)[36]. EIA defines Residential Heating Oil as the price charged for home delivery of No.2 heating oil, exclusive of any discounts such as those for prompt cash payment. Heating oil prices were presented as weekly averages from January to March and October to December and were averaged to develop an annual price. On average, the annual growth rate was about 5.3% for the residential prices and 4.9% for the prices for all users. In addition, RCGB added the 6.875% Sales and Use Tax.[37]

Table 5: Residential Propane and Heating Oil Prices (Nominal $/Gallon)

	Propane Residential	Heating Oil Residential
2018	$3.84	$3.29
2019	$4.39	$3.46
2020	$4.82	$3.65
2021	$5.19	$3.81
2022	$5.56	$3.96
2023	$5.89	$4.16
2024	$6.24	$4.45
2025	$6.59	$4.64
2026	$6.94	$4.82
2027	$7.25	$5.06
2028	$7.54	$5.21
2029	$7.80	$5.41
2030	$8.03	$5.57
2031	$8.24	$5.73
2032	$8.48	$5.92
2033	$8.75	$6.12
2034	$9.02	$6.26
2035	$9.29	$6.45
2036	$9.58	$6.68
2037	$9.86	$6.81
2038	$10.14	$7.00
2039	$10.41	$7.20
2040	$10.70	$7.40

[34]RCGB used weekly Wholesale/Resale propane prices from the Central Atlantic region from October to December 2018 because the data was not reported for New Jersey. The Central Atlantic region includes NJ, MD, NY, and PA. All other data was for NJ.
[35] Based upon communications with the U.S. EIA, RCGB assumes that EIA does not include the 6.875% sales and use tax because it is unclear whether utiilties include the sales tax when submitting this data to the EIA.
[36] https://www.eia.gov/dnav/pet/pet_pri_wfr_dcus_sNJ_w.htm
[37] Based upon communications with the U.S. EIA, RCGB assumes that EIA does not include the 6.875% sales and use tax because it is unclear whether utiilties include the sales tax when submitting this data to the EIA.

IV. Environmental Externalities.

Forecasted Carbon Dioxide (CO_2) Social Cost: Values for the Social Cost of Carbon were taken from the U.S. Government Interagency Working Group on Social Cost of Carbon.[38] Values were reported in 2007$/metric ton, and were converted to nominal dollars using the EIA projected U.S. GDP Price Index[39]. The study presented three values for the social cost of carbon, using a discount rate of 2.5%, 3%, and 5%. The scenario using a discount rate of 3% is presented in Table 6.

Table 6: Social Cost of Carbon (Nominal $/metric ton) and U.S. GDP Chain-type Price Index

	Social Cost of CO_2	GDP Chain-type Price Index
2018	$43.55	1.16
2019	$45.74	1.19
2020	$48.15	1.22
2021	$49.43	1.25
2022	$51.90	1.28
2023	$54.42	1.31
2024	$56.97	1.34
2025	$59.58	1.38
2026	$62.26	1.41
2027	$65.03	1.44
2028	$67.87	1.47
2029	$69.38	1.50
2030	$72.33	1.54
2031	$75.36	1.57
2032	$78.51	1.60
2033	$81.77	1.64
2034	$85.14	1.67
2035	$88.64	1.71
2036	$92.27	1.75
2037	$96.02	1.79
2038	$99.89	1.83
2039	$103.90	1.87
2040	$108.05	1.91

Environmental Externality Benefits: Avoided CO2 emission savings are calculated by multiplying the Social Cost of carbon in Table 6 by CO2 emissions savings (MWh conserved multiplied by the CO2 emissions factor in Table 8).

PJM Marginal Units: Table 7 shows the type of fuel used by marginal resources in the PJM Real-Time Energy Market[40] in 2018. Please note that the category "Other" includes nuclear.

[38] EPA Fact Sheet, "Social Cost of Carbon", August 2016. https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

[39] *Energy Information Administration. Annual Energy Outlook 2018. http://www.eia.gov/outlooks/aeo/data/browser/#/?id=18-AEO2018&cases=ref2017&sourcekey=0*. 2005=1.0

[40] Monitoring Analytics, LLC, 2019 State of the Market Report, Section 3 – Energy Market, pg. 169.

Table 7: 2018 (Jan-June) PJM Marginal Units

Fuel Type	% on the Margin
Coal	27.3%
Gas	69.6%
Oil	0.51%
Wind	1.98%
Other	0.59%
Municipal Waste	0%

Power Plant Emission Rates: Power plant emission rates for CO_2, NO_x, and SO_x are shown in Table 8. Emission rates are in pounds per MWh and were calculated by dividing 2018 EIA Annual Emissions by source[41] for NJ by 2018 EIA Annual Generation for NJ by source[42]. The NJ DEP estimated in October 2014 that the emission rate for mercury is 2.11 mg/MWh for electricity. Note that energy efficiency displaces some renewables given that the Renewable Portfolio Standard (RPS) is a percentage of electricity retail sales. This displacement should be accounted for when calculating emission reductions due to energy efficiency.

Table 8: Power Plant Emission Rates (lbs/MWh)

	CO_2	NO_x	SO_x
Coal	2,884	1.8	2.2
Natural Gas	918	0.2	0
Oil	1,683	1.3	7.4
Weighted Avg	**985**	**0.26**	**0.14**

V. Other Assumptions

Discount Rate: Discount rates are used to convert future economic values into present day dollars. A nominal discount rate of 7% is currently used for all 5 cost tests.[43] The utility cost of capital should be used for utility specific cost-benefit analyses of energy efficiency programs. For the social discount rate, RCGB recommends using the 20 year Treasury Bond Rate from OMB Circular A-94[44] (currently 3.5% for analyses done for 2019 and 2.8% for analyses done for 2018) which is the value used by the Federal Government.s This is similar to Minnesota's Societal Discount Rate, which uses the US Treasury 20 year constant maturity rate[45] and Iowa's use of 12-month average of the 10-year Treasury note and 30-year Treasury bond.[46] If this recommendation is adopted, the above 7% discount rate will continue to be used for the PCT, UCT, RIM, and TRC.

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https://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2019/2019q2-som-pjm-sec3.pdf

[41] https://www.eia.gov/electricity/data/state/emission_annual.xls

[42] https://www.eia.gov/electricity/data/state/annual_generation_state.xls

[43] This is the weighted average cost of capital (cost of capital or WACC) for PSE&G https://nj.pseg.com/aboutpseg/regulatorypage/-/media/86A2603B2DB04B9FAA1B6AB1ABF1631E.ashx . RCGB found a range of possible discount rate values from publicly available documents. The most recent OMB circular on cost-benefit analysis is using a nominal discount rate of 1.8% (10 years) and 2.2% (20 years) https://www.gpo.gov/fdsys/granule/FR-2018-02-08/2018-02520 while the WACC for JCP&L is 7.47% https://www.firstenergycorp.com/content/dam/customer/OpCoHome/files/JCPLRegulatory/07-13-2018-JCPL-reliability-plus-filing.pdf (page 416)

[44] https://www.whitehouse.gov/wp-content/uploads/2018/12/M-19-05.pdf

[45] https://www.synapse-energy.com/sites/default/files/Minnesota-NSPM-Report-17-094.pdf

[46] https://efs.iowa.gov/cs/groups/external/documents/docket/mdax/nze4/~edisp/1718374.xls

Table 9: Line Loss Factors by Utility and Rate Class

	PSEG[47]	ACE[48]	RE[49]
Residential	5.8327%	7.149%	7.987%
General Lighting & Power	5.8327%	7.149%	7.987%
Large Power & Lighting (Secondary)	5.8327%	7.149%	7.987%
Large Power & Lighting (Primary)	3.3153%	4.345%	5.641%

Avoided Electric and Natural Gas Losses: Marginal transmission line losses are incorporated by PJM as a component of the LMP (Locational Marginal Price). Distribution loss factors represent the average distribution system line losses for primary and secondary distribution voltage deliveries. Table 9 shows distribution line loss factors by utility and rate class in New Jersey. Additionally, RCGB calculated distribution line loss factors using Direct Use Sales and Losses as reported for New Jersey by EIA[50]. The 10 year average line loss was 5.8% and the 20 year average line loss was 6.6%. Unless an analysis for a specific utility region is being undertaken, RCGB recommends using the 20 year average of 6.6%.

Marginal distribution system losses are assumed to be approximately 1.5 times average losses.[51] PJM wholesale energy prices include marginal transmission losses. Electric utilities report distribution losses on their respective webpages.[52] Distribution marginal line loss rate multiplier for avoided energy (kWh) is 9.9% (i.e. 1.5 times the 6.6% portion of T&D losses that are assumed).

PSE&G uses a natural gas loss factor of 2%[53] and South Jersey Gas uses a natural gas loss factor of 1.43%[54]. RCGB recommends the usage of 2% for natural gas loss factor, unless the analysis is utility region specific in which case the utility specific value should be used.

Avoided Electric Transmission and Distribution (T&D): RCGB recommends using the average avoided electric T&D estimated in the 2014 Mendota Group study and that a comprehensive avoided T&D study be conducted in the near future. The average avoided electric T&D of $66.03 (2012$) is escalated using the GDP Chain-type Price Index reported in Table 6 to a value of $$72.61 (2018$). An

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47 https://nj.myaccount.pseg.com/myservicepublic/energychoiceandthirdpartysuppliers/-/media/DC015CE6B7554368AAB1AC15C502BD40.ashx

48 https://www.atlanticcityelectric.com/DoingBusinessWithUs/Pages/ClassLoadProfile.aspx

49 https://www.oru.com/_external/orurates/documents/energysuppliers/thirdpartysuppagreement.pdf

50 https://www.eia.gov/electricity/state/newjersey/xls/nj.xlsx

51 See RAP's 2011 *Valuing the Contribution of Energy Efficiency to Avoid Marginal Line Losses and Reserve Requirements* p. 5, http://www.raponline.org/wp-content/uploads/2016/05/rap-lazar-eeandlinelosses-2011-08-17.pdf . ICF's 2005 *Avoided Energy Supply Costs in New England* https://www9.nationalgridus.com/masselectric/non_html/avoided-cost-study.pdf p. 100 (Exhibit 3-6) suggests a ration of 1.25 for New England.

52 PSEG: https://www.pseg.com/business/energy_choice/third_party/rate_class.jsp
Orange Rockland: https://www.oru.com/documents/tariffsandregulatorydocuments/ny/electrictariff/electricGI31.pdf
Atlantic City: http://www.pepcoholdings.com/about-us/do-business-with-phi/energy-suppliers/retail-energy-suppliers/new-jersey/registered-suppliers/settlement-informaton/class-load-profile-information/
JCP&L: https://www.firstenergycorp.com/content/dam/supplierservices/files/interval-data/JC%20Loss%20Factors.pdf

53 https://nj.pseg.com/aboutpseg/regulatorypage/-/media/062F22BB0BD74392B34E4E477DD6BA9B.ashx

54 https://southjerseygas.com/SJG/media/pdf/SJG-2018_2019-USF_Lifeline-Annual-Filing.pdf

evaluation of both what New Jersey-specific avoided T&D costs are and whether actual T&D investments have been avoided because of EE should be performed.
Previously, in 2012, EnerNOC recommended that the NJCEP use an Avoided Electric T&D cost of $30/kW-yr.[55]

Non-Energy Benefits and Costs: Non-energy benefits and costs, typically referred to as non-energy benefits, include additional benefits and costs that occur due to energy efficiency measures. CEEEP conducted a review of studies on this topic[56] and RCGB has updated this review and has suggested the inclusion of several NEBs to BPU. Non-energy benefits were discussed extensively as part of the EM&V stakeholder process and are further being discussed as part of the development of a primary cost test for New Jersey. Non-energy benefits that were reviewed include Carbon adders, other environmental adders (such as NOx, SO2, Hg, etc), Risk adders, Low-income adders, other participant adders (e.g. to address comfort, building durability, health and safety, operation and maintenance, improved business productivity, and other participant NEBs), and other societal adders (e.g. to address public health, economic development and other societal NEBs). Non-energy benefits and costs presently are not tabulated in the New Jersey Technical Energy Protocol, with the exception of the Social Cost of Carbon.

Administrative Costs: The administrative costs considered as part of the Energy Efficiency program include program administration, program development, marketing and sales costs, training, rebates and direct incentives, rebate processing, inspections, evaluation and quality control. Administrative costs should be included at the appropriate level of analysis based upon the type of administrative costs. For instance, costs associated with marketing a program should be included in that program's BCA but not assigned to the BCA at the measure level. Administrative costs that are for a portfolio should be included in the portfolio BCA. Administrative costs should also include those of relevant BPU Staff.

BPU Overhead Costs: The associated BPU staff and overhead costs currently are not included in the administrative costs for the NJCEP EE programs. Further consideration should be given as to whether and how to include these costs in the future.

[55] http://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-po
[56] Freed, M. & Felder, F. (2017). Non-energy benefits: Workhorse or unicorn of energy efficiency programs? *The Electricity Journal*, 30(1), 43-46.