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Cost-Benefit Analysis of the NJCEP Energy Efficiency Programs:

FY2017 Retrospective and FY2019 Summary Reports

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I. Summary

The Rutgers Center for Green Building (RCGB) of the Edward J. Bloustein School of Planning and Public Policy was asked by the New Jersey Board of Public Utilities (NJBPU) to conduct a cost-benefit analysis of the FY2017 residential, commercial and industrial New Jersey Clean Energy Program (NJCEP) energy efficiency programs. Non-energy impacts, such as reductions in water usage and improved health and safety, are not accounted for in these analyses but will appear in a separate report. The NJCEP Energy Efficiency programs available to New Jersey residential, commercial and industrial customers in FY2017 are listed in Table 1. Recommendations for potential improvements to NJCEPs CBA methodology appear in Appendix A.

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 EB
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 for the cost-benefit analysis: Participant Cost Test, Program Administration Cost Test, Ratepayer Impact Measure Test, Total Resource Cost Test and Societal Cost Test.[1] These are defined below as per the national Standard Practice Manual (NSPM)[2].

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 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, including 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.

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

[2] 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

Ratepayer Impact Measure Test: 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 between participants and non-participants 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. The RIM test measures what happens to customer bills or rates due to changes in revenues and operating costs caused by the program. 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.

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, such as increased consumption of other fuels, increased O&M costs, other fuel savings, water savings, and participant O&M savings.

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; costs such as 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.

It is assumed that wholesale electricity prices account for the national sulfur dioxide and nitrogen oxide allowance programs. As New Jersey is in the process of rejoining 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) or the full cost of weatherization and insulation products. The mix of measure types for each program is reported by TRC from the IMS system. When possible, the measure incremental cost from EnerNOC's New Jersey Market Potential[3] study in 2012 is used. Otherwise, incremental costs from NEEP's 2017 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

[3] EnerNOC Utility Solutions, "New Jersey Energy Efficiency Market Potential Assessment", October 2012.
[4] NEEP Mid-Atlantic Technical Reference Manual V7 (May 2017)
https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V7_FINAL.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

were mainly taken from data that was received from Rockland Electric on their Low Income Direct Install program in 2016. 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 were computed using a list of measures that were installed under the program as well. To increase accuracy of the CBA, RCGB will request 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: The number of years that an energy efficient product will accrue energy savings. The measure life of each program was calculated using the same method as the incremental cost, using data from the New Jersey Protocols.[8] For the measures where data is not available in the Protocols, RCGB used EnerNOC's Market Potential study, NEEP's Mid-Atlantic TRM, and the TRMs from Minnesota and Michigan.

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	NJCEP Annual Report	EnerNOC/ NEEP	NJ Protocols/EnerNOC/NEEP/EIA	TRC IMS & NJCEP Program Documents	RCGB was able to determine the specific measures that were eligible for rebates through the program website and thus were able to calculate incremental costs.
Comfort Partners	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP	Rockland Electric	TRC IMS & NJCEP Program Documents	
EE Products	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP	NJ Protocols	TRC IMS & NJCEP Program Documents	
Home Performance with Energy Star	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP	NJ Protocols/NEEP/ EIA/EnerNOC	TRC IMS & NJCEP Program Documents	
Residential New Construction	NJCEP Annual Report	NJCEP Annual Report	Energy Star	NJ Protocols		
Commercial & Industrial						
C&I New Construction	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP/MI/MN	NJ Protocols/ EnerNOC/ NEEP/MI/MN	TRC IMS	For C&I programs the specific measures that were eligible for rebates were
C&I Retrofit	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP/MI/MN	NJ Protocols/ EnerNOC/ NEEP/MI/MN	TRC IMS	

[7] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs January 1, 2017-December 31, 2019 http://mn.gov/commerce-stat/pdfs/mn-trm-v2.0-041616.pdf

[8] NJCEP. New Jersey Clean Energy Program Protocols to Measure Resource Savings. (December 2007).

Direct Install	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP/MI/MN	NJ Protocols/ EnerNOC/ NEEP/MI/MN	TRC IMS	not provided.
Pay for Performance	NJCEP Annual Report	NJCEP Annual Report	EnerNOC/ NEEP/MI/MN	NJ Protocols/ EnerNOC/ NEEP/MI/MN	TRC IMS	
Large Energy Users Program	NJCEP Annual Report	NJCEP Annual Report	Used minimum project cost	NJ Protocols/ EnerNOC/ NEEP/MI/MN	TRC IMS	

The Clean Energy Program reports include installed, committed and total savings for all programs. For the purposes of the 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 were also 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 FY2017 energy efficiency programs are presented in Table 3 and Table 4.

Table 3: FY2017 Residential Programs

	Low Income	HVAC	EE Products	New Construction	Home Performance
Participant	$10,571,271	$15,878,449	$408,540,732	$6,773,790	$27,864,529
Ratio	1.4	2.0	4.8	1.5	5.3
Program Administration	($25,777,840)	$1,424,880	$90,024,372	$8,370,917	($13,361,729)
Ratio	0.1	1.1	4.2	2.1	0.3
Ratepayer Impact Measure	($29,806,393)	($3,728,060)	($146,981,049)	$3,326,272	($17,905,934)
Ratio	0.1	0.7	0.4	1.3	0.3
Total Resource	($25,461,353)	($6,607,970)	$6,464,619	$49,680	($2,865,160)
Ratio	0.1	0.6	1.1	1.0	0.7
Social Cost	($23,694,698)	($5,371,850)	$121,569,593	$2,089,379	($1,421,486)
Ratio	0.2	0.7	2.1	1.1	0.9

Table 4: FY 2017 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	$17,173,546	$248,352,577	$30,495,564	$ 30,035,922	$13,372,549	$75,416,392
Ratio	10.4	15.5	9.7	9.1	1.8	63.8
Program Administration	$5,364,737	$76,662,933	$2,247,074	$ 7,168,708	$8,649,844	$18,221,346
Ratio	3.3	4.1	1.2	2.1	2.2	3.1
Ratepayer Impac Measur	($2,565,074)	($33,850,749)	($8,899,599)	$ (3,553,082)	($1,112,836)	($7,819,022)
Ratio	0.8	0.7	0.6	0.8	0.9	0.8
Total Resource	$4,801,698	$80,663,818	$6,888,613	$8,212,487	($1,781,600)	$24,611,141
Ratio	2.6	4.9	2.5	2.5	0.9	12.0
Social Cost	$9,965,610	$153,006,761	$14,024,937	$ 14,656,828	$4,468,836	$40,137,558
Ratio	4.4	8.4	4.0	3.7	1.3	19.0

A comparison of 2006 through 2017[9] participant and total resource cost test CBA results 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 savings and budget in the Home Performance program, and exclusion of propane fuel switching from program savings. Additionally, the Program Manager has been able to provide more data on installed measures in recent years, which has improved the accuracy of the CBA results (particularly in the Residential sector).

Table 5: Participant Cost Test Ratios (2006-2017)

	2006	2007	2008	2009	2010	2011	2013[10]	2014	2015	2016	2017
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
HVAC	4.3	5.1	7.4	3.4	3.4	3.1	2.1	1.4	2.1	2.4	2.0
HPwES				1.4	4.7	4.3	2.5	2.4	5.8	7.0	5.3
EE Products	1.6	1.8	4.3	10.3	8.4	4.8	6.5	4.0	4.2	5.9	4.8
New Construction	3.1	3.2	4.0	2.7	2.5	2.4	3.0	3.0	2.4	2.9	1.5
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
Retrofit	8.1	3.7	7.5	5.0	6.7	9.0	1.3	43.6	7.1	4.5	15.5
Schools	5.2	7.7	4.0	4.1							
Direct Install					4.0	9.2	3.5		5.4	5.1	9.7

[9] 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.

[10] 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.

Pay for Performance EB									4.3	3.0	9.1
Pay for Performance NC									0.8	3.8	1.8
LEUP									11.9	12.3	63.8*

Table 6: Total Resource Cost Test Ratios (2006-2017)

	2006	2007	2008	2009	2010	2011	2013[11]	2014	2015	2016	2017
Residential Programs											
Low Income[12]			9.7	0.4	0.3	0.4	0.3	0.3	0.1	0.1	0.1
HVAC	2.7	3.5	4.1	1.8	1.1	0.9	0.7	0.4	0.6	2.4	0.6
HPwES			0.2	0.5	0.4	0.7	0.4	0.5	0.7	1.0	0.7
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
New Construction	1.5	1.5	2.2	1.5	1.0	0.9	1.2	1.2	5.6	1.0	1.0
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
Retrofit	5.0	1.7	4.7	3.3	3.7	6.2	0.6	10.3	2.0	1.2	4.9
Schools	3.1	3.1	2.3	2.7							
Direct Install					1.5	3.8	1.2		1.5	1.2	2.5
Pay for Performance EB									1.4	1.2	2.5
Pay for Performance NC									0.4	1.4	0.9
LEUP									2.6	3.4	12.0*

*Please note that the BC ratio 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.

IV. FY2019 Prospective Cost Benefit Analysis

TRC and RCGB have worked together during FY2018 to validate the CBA results from ePLAN and CBA spreadsheets each team uses respectively. Additionally, RCGB provided input data and assumptions to TRC for use in the FY2019 prospective cost benefit analyses. TRC utilized ePLAN software to conduct associated CBAs.

Appendix A: Recommendations for Potential Improvements to Benefit-Cost Data and Methodology

There are two key areas in which more detailed program data might improve the accuracy of the benefit-cost ratios estimated for NJCEP Energy Efficiency Programs. On the cost side, more detailed descriptions of incentivized measures would allow for more accurate determination and assignment of incremental costs. On the benefit side, avoided cost (energy savings) data on a per-measure, rather than per-program basis would allow for calculation and discounting of benefits (energy savings) over individual measure lifetimes. This could eliminate potential distortions that can arise from the use of average lifetimes and aggregate energy savings at the program level. It is our understanding that the ePLAN platform may substantially address these concerns. More detailed explanations of these issues are provided below.

More Detailed Descriptions of Measures

Historically, the Program Manager has provided Rutgers with counts of measures subsidized under NJCEP Energy Efficiency Programs at a highly aggregated level of measure description. More detailed descriptions of implemented measures would improve the accuracy of the incremental cost calculations

[11] Ibid.

[12] 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.

for each program. Generalized and/or aggregated measure descriptions can potentially result in errors in the assignment and calculation of incremental costs, and thus in mis-estimation of program benefit-cost ratios. For example, a common measure listed for commercial and industrial programs is "Fluorescent Fixtures." The program application for Performance Lighting indicates a $30 per fixture cap for eligible fixtures, including certain T5 and T8 fluorescent lighting fixtures; however, no detail on the types or sizes of fixtures receiving incentives is provided with the count of "Fluorescent Fixtures" provided by TRC. According to the Michigan Energy Measure Database, one of several Technical Resource Manuals used as references for incremental costs of energy efficiency measures, incremental costs for T8 fluorescent fixtures can range from $19 to $72, depending on size and other features. In such cases, Rutgers' practice to date has been to use an average of values or a measure-specific value that falls near the midpoint of the range. This year, the C&I New Construction Program provided incentives for 2,189 Fluorescent Fixtures. These were valued at $45.38 based on one of the examples in the Michigan Energy Measure Database that is roughly equal to the average of the lowest and highest values for the measure ($45.50). If the actual incremental cost of all the fixtures based on their specific features were at the low ($19) or high ($72) of the range, use of the mid-range estimate ($45.38) would either overestimate the total incremental cost by about $58,000 (58%) or underestimate it by about $58,000 (37%).

	Low Cost Variant	Mid-Range (used)	High Cost Variant
Incremental Cost Per Measure	19.00	45.38	72.00
Total Cost (2,189 measures)	41,591	99,337	157,608
Difference from Mid-Range	-57,746	-	58,271
Percent Difference Over/Under Estimate if Mid-Range is Used	-58.1%	-	37.0%

This issue is even more pronounced in the case of measures that are even vaguer in their description, such as "Other Lighting," "Custom Electric" or "Custom Gas." In the 2017 Large Energy Users Program data, there are five categories of measure (11 total measures) to which we were able to assign incremental costs totaling just over $11,000. There are also nine "Custom Electric" measures and two "Custom Gas" measures to which we were unable to assign values in the absence of additional project detail. Participant energy savings benefits over the 14-year weighted average measure life for the program are estimated at over $73 million and incentive payments for LEUP measures in 2017 totaled $7.6 million. Program parameters - including a $200,000 minimum contribution by participants into the NJCEP Fund and a maximum incentive limit calculated as the lesser of $4 million, 75% of total project costs, 90% of the entity's prior year contribution to the NJCEP fund or $0.33/projected kWh saved – indicate that the $11,000 incremental cost figure is incorrect. However, without specific information on these custom measures, we are unable to properly estimate total incremental cost values for the program. This results in an overestimated benefit-cost ratio of 60.9 for the Participant Cost Test, in which we used the $200,000 minimum project cost per participant as a proxy for incremental costs. This ratio would be over 6,000 if only the $11,000 in known incremental costs were used.

Avoided Costs, Measure Life and Discounted Lifetime Benefits

Currently, the Energy Savings Report issued by the Program Manager provides total annual energy savings at the program level, as opposed to the measure level. Allocation of energy savings by measure could substantially improve the reliability of the benefit-cost ratio calculations. Aggregation of avoided costs at the program level presents challenges for accurate estimation of benefits, in that it can distort the calculated net present value of benefits. This distortion results from the fact that annual energy savings

are given as the total first-year aggregate savings for a given program. RCGB was recently given energy savings data from the Information Management System (IMS) at the measure level. An initial analysis of the Pay for Performance Existing Buildings Program showed that using program level savings and measure lives (as opposed to conducting a measure level CBA) overestimates total costs by between 25% and 50%, depending on the cost test. This overestimate is a result of the fact that in the program level analysis, the total savings are assumed to reoccur annually (i.e., for all program measures) over a program life calculated as the weighted average of measure lives weighted by the number of measures of each type. For Pay for Performance, this resulted in MWh savings of 169,960 for the measure level analysis and 207,097 for the program level analysis. As a result, the energy savings of measures with actual duration shorter than the weighted average will be over-counted, while the savings of measures with actual duration longer than the weighted average will be undercounted. In the case of Pay for Performance, this resulted in an over-estimate of the value of the energy savings benefits of the program. RCGB and BPU staff will discuss whether CBAs should be performed at the program level or measure level CBAs.