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## M E M O

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**DATE:** September 5, 2017  
**UPDATE:** October 11, 2017, October 18, 2017  
**TO:** Frank Felder, Rutgers; Anne-Marie McShea, NJ BPU; Tom Rooney, TRC  
**FROM:** Kerri-Ann Richard, ERS  
**RE:** NJCEP Protocols – Comparative Measure Life Study and Summary of Measure Changes to NJCEP Protocols

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The following memo presents the findings of a comparative measure life study ERS completed as part of our review of the NJCEP Protocols to Measure Resource Savings (the Protocols) dated June 29, 2016. The results of the study were used as an update to Appendix A of the Protocols. In addition, this memo presents summary tables that outline changes made to individual measures during the review. As part of the summary, we present the estimated impact to the savings due to the changes made within the individual measures.

### **COMPARATIVE MEASURE LIFE STUDY**

ERS completed a comparative study of measure lives as presented in Appendix A of the Protocols. The measure lives in the Protocols are dated April 2012 and do not include documented references as to how they were evaluated and selected. In order to update the measure lives as part of our review, we compared the values in the Protocols to similar regional technical reference manuals (TRMs) from Massachusetts, New York, Pennsylvania, and NEEP Mid-Atlantic.

Our proposed changes to the measure lives presented in the Protocols were based on the following:

- 1) If the value listed in the Protocols was within a similar range to those of the other TRMs, no change was recommended.
- 2) If the value listed in the Protocols was out of range of those in the other TRMs, and multiple TRMs had values listed, we recommended an increase or decrease in value to the average of the other TRMs.

- 3) If there was no value listed in the Protocols, we recommended a set value based on an average of the other TRMs.
- 4) If the measure was no longer active in 2017, the measure live was not reviewed and there was no change made to the value.

The table below presents a summary of the measure lives and our recommended changes. These changes are reflected in the updated Appendix A of the Protocols.

### Comparative Study of Measure Lives

End Use	NJ	NEEP	NY	MA	PA	Proposed Change
<b>Residential Sector</b>						
<b>Lighting End Use</b>						
CFL	5	7		7	6.2	Increase to 7
LED	15	18	15	17	14	Increase to 16
<b>HVAC End Use</b>						
Central air conditioner (CAC)	15		15	15	14	None
CAC QIV	15			18	14	None
Air source heat pump (ASHP)	15	18	15	14	12	None
Mini-split (AC or HP)	15	18		18	15	Increase to 17
Ground source heat pumps (GSHP)	20	25	20	19	30	None
Furnace high efficiency fan	NA	18	18	18		Set at 18
Heat pump hot water (HPHW)	NA	13	10	10	10	Set at 10
Furnaces	20	18	18	18		Decrease to 18
Boilers	20	18	24	20		None
Combination boilers	NA			19		Set to 19
Boiler reset controls	7	18	15	15		Increase to 16
Heating and cooling equipment maintenance repair/replacement	7					None
Thermostat replacement	5					None
<b>Hot Water End Use</b>						
Storage water heaters	10	13	15	11		Increase to 13
Instantaneous water heaters	NA		20	19		Set to 19
<b>Building Shell End Use</b>						
Air sealing	30	15			15	Decrease to 15
Duct sealing and repair	15	20				None
Insulation upgrades	30	25			15	Decrease to 20
<b>Appliances/Electronics End Use</b>						
ES refrigerator	12	12	17	12	12	None
ES freezer	11			12	12	None
ES dishwasher	10			10	10	None
ES clothes washer	11	11		12	11	None
ES RAC	10	12	10	9	9	None
ES Air Purifier	9	Inactive 2017, Not Reviewed				None
ES Set Top Box	4	Inactive 2017, Not Reviewed				None
ES Sound Bar	10	Inactive 2017, Not Reviewed				None
Advanced power strips	4	4	4	5	5	None
ES clothes dryer	12	14		12	13	None
Refrigerator/freezer retirement	8		5	12	8	None

End Use	NJ	NEEP	NY	MA	PA	Proposed Change
<b>Commercial Sector</b>						
<b>Lighting End Use</b>						
Performance lighting	15	15	NA	15		None
Prescriptive lighting	15		NA	14		None
Refrigerated case LED lights	NA	8	6	13	8	Set to 9
Specialty LED fixtures (signage)	NA				15	Set at 15
Lighting controls	18	10	8	9	8	Decrease to 9
<b>HVAC End Use</b>						
Electronically commutated motors for refrigeration	NA	15	15	15		Set to 15
Electric HVAC systems	15	16	15	15	15	None
Fuel use economizers	15					None
Dual enthalpy economizers	10	10	10	7	10	None
Occupancy controlled thermostats	NA			10	15	Set to 13
Electric chillers	25	23	20	23	20	Decrease to 22
Gas chillers	25					None
Gas fired desiccants	NA					None
Prescriptive boilers	25	20	20	25		Decrease to 22
Prescriptive furnaces	20	18	20	18		None
Commercial Small Motors (1-10 HP)	20	Inactive 2017, Not Reviewed				None
Commercial Small Motors (11-75 HP)	20	Inactive 2017, Not Reviewed				None
Commercial Small Motors (76-200 HP)	20	Inactive 2017, Not Reviewed				None
Small Commercial Gas Boiler	20	Inactive 2017, Not Reviewed				None
Infrared heaters	17		17	17		None
Electronic fuel use economizers	15					None
Programmable thermostats	NA		11	15	11	Set to 12
Demand-controlled ventilation using CO <sub>2</sub> sensors	NA		10	10		Set to 10
Boiler reset controls	7	18	15	15		Increase to 16
<b>VFDs End Use</b>						
Variable frequency drives	15	15	15	14		None
New and retrofitted kitchen hoods with variable frequency drives	NA				15	Set at 15
<b>Refrigeration End Use</b>						
Energy efficient glass doors on vertical open refrigerated cases	12				12	None
Aluminum night covers	4	5	5	10	5	Increase to 6
Walk-in cooler/freezer evaporator fan control	10	10	16	10	15	Increase to 13
Cooler and freezer door heater control	10	12	12	10	12	None
Electric defrost control	NA			10	10	Set to 10
Novelty cooler shutoff	NA		5	10		Set to 5
Vending machine controls	NA			5	5	Set to 5
<b>Food Service Equipment End Use</b>						
Electric and gas combination oven/steamer	10	12	12	12	12	Increase to 12

End Use	NJ	NEEP	NY	MA	PA	Proposed Change
Electric and gas convection ovens, gas conveyor and rack ovens, steamers, fryers, and griddles	12	12	12	12		None
Insulated food holding cabinets	NA	12		12		Set to 12
Commercial dishwashers	NA			15		Set to 15
Commercial refrigerators and freezers	NA		12			Set to 12
Commercial ice machines	NA			8	10	Set to 9
<b>Hot Water End Use</b>						
Gas booster water heaters	NA					None
Tank style (storage) water heaters	10		15	13		Increase to 14
Instantaneous gas water heaters	NA		20	20		Set to 20
Low flow faucet aerators and showerheads	NA		10	7	10	Set to 9
Low flow pre-rinse spray valves	NA	5	5		5	Set to 5
Pipe insulation	NA		11	15		Set to 13
<b>Combined Heat &amp; Power Program</b>						
Fuel cell	20					Decrease to 5
Combustion gas turbine	NA					Set to 17
IC small <= 200 KW*	NA					Set to 17
IC large > 200 KW*	NA					Set to 20
Micro turbine	NA					Set to 15
Steam turbine	NA					Set to 25

## SUMMARY OF CHANGES TO THE PROTOCOLS

The following tables summarize the changes that were made to individual measures during our review of the Protocols. The tables are listed by NJCEP program within the Protocols. In addition, the tables outline the estimated impact to the savings due to the changes within the individual measures.

### Introduction

The Introduction section of the Protocols remains generally intact from the prior version. As one key takeaway, ERS noted the Protocols do not account for a net-to-gross (NTG) savings calculation to account for freeridership (FR) and spillovers (SO), stating, “The protocols report gross savings and generation only. Free riders and free drivers are not addressed in these Protocols. Further research in this area is planned.” A recent memo from Center for Energy, Economic and Environmental Policy (CEEPP) found that future NJCEEP Protocols should include FR and SO (including market effects<sup>1</sup>. ERS agrees with the findings from the CEEPP review, and recommends future versions of the Protocols take into account NTG savings adjustments.

<sup>1</sup> CEEPP, Estimation of Freeridership and Spillovers (Free Drivers) in NJCEP Protocols, October 6, 2017.

Additional modifications and recommendations to the introduction section are noted in the table below.

### Introduction

Recommendations	Section	Changes to Measures	Savings Impact (%)
General edits	T&D Losses	<ul style="list-style-type: none"> <li>Updated values</li> </ul>	Not applicable
Removed	Post-Implementation Review	<ul style="list-style-type: none"> <li>No longer part of program</li> </ul>	Not applicable
	Measure Retention and Persistence	<ul style="list-style-type: none"> <li>Not used in Protocols</li> <li>Recommend reviewing and adding as part of future Protocols maintenance reviews</li> </ul>	Not applicable
Addition	Net-to-Gross	<ul style="list-style-type: none"> <li>Recommend adding as part of future Protocols maintenance reviews</li> <li>See CEEEP memo</li> </ul>	Not applicable
	Protocols Revision History	<ul style="list-style-type: none"> <li>Added table to track revision history</li> </ul>	Not applicable

### Program: Residential Electric HVAC

Recommendations	Measures	Changes to Measures	Savings Impact (%)
General edits	AC ASHP GSHP Furnace fan	<ul style="list-style-type: none"> <li>Changed CAPY to tons to be more specific with units</li> <li>Baseline IECC 2015</li> <li>EFLH based on NYC TRM</li> </ul>	Decrease savings 10%–25%: Heating EFLH decrease Increase savings 5%-12%: Cooling EFLH increase
Measure to remain, but flagged as: Inactive 2017, Not Reviewed	GSHP desuperheater	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable
	Solar domestic HW	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable
	DWHR	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable
	Combi boiler	<ul style="list-style-type: none"> <li>Moved to Residential Gas HVAC</li> </ul>	Not applicable

### Program: Residential Gas HVAC

Recommendations	Measures	Changes to Measure	Savings Impact (%)
General edits		<ul style="list-style-type: none"> <li>Split out space heating and water heating measures into separate measures</li> <li>Updated baseline to IECC 2015</li> <li>Updated EFLH based on KEMA 2009</li> </ul>	

Recommendations	Measures	Changes to Measure	Savings Impact (%)
Added/updated	Furnaces	<ul style="list-style-type: none"> <li>New measure now separate from boilers with updated variables and assumptions</li> <li>Measure to include NC/EUL/ROF</li> </ul>	Decrease savings 10%–25%: Heating EFLH decrease
	Boilers	<ul style="list-style-type: none"> <li>Removed steam boiler (no longer incented)</li> <li>New measure now separate from furnaces with updated variables and assumptions</li> <li>Measure to include NC/EUL/ROF</li> </ul>	Decrease savings 10%–25%: Heating EFLH decrease
	Combi boiler	<ul style="list-style-type: none"> <li>Created specific measure with updated variables and assumptions</li> <li>Measure to include NC/EUL/ROF</li> </ul>	Increase savings by 3%: Net increase between space and water heading measures
	Boiler reset controls (added)	<ul style="list-style-type: none"> <li>New measure in Protocols based on program data</li> </ul>	Not applicable
	Storage water heater	<ul style="list-style-type: none"> <li>Created specific measure with updated variables and assumptions</li> <li>Changed EF to UEF</li> </ul>	Increase savings 25%–30%: Baseline water heater usage increased from 18 to 23.6 MMBtu/yr
Added/updated	Instantaneous water heater	<ul style="list-style-type: none"> <li>Created specific measure with updated variables and assumptions</li> <li>Changed EF to UEF</li> </ul>	Increase savings 25%–30%: Baseline water heater usage increased from 18 to 23.6 MMBtu/yr

### Program: Residential Low Income

The Residential Low Income section remains intact from the prior version of the Protocols. Some of the algorithms for the specific measures are different from those in the Residential Electric and Gas Programs. Since the underlying engineering relationships driving savings are the same regardless of whether the measure is for a market rate and low income applicant, the algorithms typically should be the same as well. Variable values may differ between market rate and low income.

There may be practical reasons that necessitate using different algorithms and approaches. If not, ERS recommends using common algorithms.

### Program: Residential New Construction

Recommendations	Measures	Notes on Measure	Savings Impact (%)
General edits		<ul style="list-style-type: none"> <li>Program guide does not specify homes permitted prior to March 21, 2006 <ul style="list-style-type: none"> <li><a href="http://www.njcleanenergy.com/files/file/Program%20Guide_RNC_FINAL.pdf">http://www.njcleanenergy.com/files/file/Program%20Guide_RNC_FINAL.pdf</a></li> </ul> </li> <li>Program guide specifies three standards: <ul style="list-style-type: none"> <li>IECC 2015</li> <li>Energy Star v3.1</li> <li>Zero Energy Ready Home</li> </ul> </li> </ul>	Not applicable

Recommendations	Measures	Notes on Measure	Savings Impact (%)
		<ul style="list-style-type: none"> <li>Tables removed as savings are calculated with modelling software</li> </ul>	

### Program: ENERGY STAR Products – Appliances

Recommendations	Measures	Changes to Measure	Savings Impact (%)
Measure to remain, but flagged as: Inactive 2017, Not Reviewed	Room AC Tier I and II Room air purifier Soundbar Set top boxes Freezers	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable
Clarification	Power strip	<ul style="list-style-type: none"> <li>Measure installed in 2016 but not listed on NJCEP website</li> </ul>	Not applicable/needs clarification

### Program: ENERGY STAR Products – Lighting

Recommendations	Measures	Changes to Measure	Savings Impact (%)
General edits		<ul style="list-style-type: none"> <li>Simplified algorithm across all fixtures/bulbs</li> <li>Decrease in hours of operation</li> <li>Increased interactive energy effects with HVAC</li> <li>Interactive electric impacts' coincidence factor is lower</li> <li>Lower controls savings factor</li> </ul>	Decrease peak demand savings 30%: Lower coincidence factor
Added	Specialty LED	<ul style="list-style-type: none"> <li>Rope, sign, etc.</li> </ul>	Not applicable

### Program: Appliance Recycling

Recommendations	Measures	Changes to Measure	Savings Impact (%)
General edits		<ul style="list-style-type: none"> <li>Updated reference links</li> </ul>	Not applicable

### Program: HPwES

Recommendations	Measures	Changes to Measure	Savings Impact (%)
General edits		<ul style="list-style-type: none"> <li>Clarified baseline statement</li> <li>Updated reference links</li> </ul>	Not applicable

### Program: HERS

Recommendations	Measures	Changes to Measure	Savings Impact (%)
Remove		<ul style="list-style-type: none"> <li>No longer a program</li> </ul>	Not applicable

### Program: C&I Electric

Recommendations	Measures	Changes to Measure	Savings Impact (%)
Updated/Lighting	Performance lighting Prescriptive lighting Refrigerated case lighting	<ul style="list-style-type: none"> <li>Simplified algorithm across all fixtures/bulbs</li> <li>Decrease in hours of operation</li> </ul>	Decrease peak demand savings 30%: Lower coincidence factor  Decrease controls savings 20%–40%: Lower savings factor

Recommendations	Measures	Changes to Measure	Savings Impact (%)
	Specialty LED Lighting controls	<ul style="list-style-type: none"> <li>Increased interactive energy effects with HVAC</li> <li>Interactive electric impacts</li> <li>Coincidence factor is lower</li> <li>Lower controls savings factor</li> </ul>	
Updated/ECM	ECM refrigeration	<ul style="list-style-type: none"> <li>No changes</li> </ul>	Not applicable
Updated/Electric HVAC	All	<ul style="list-style-type: none"> <li>Used tons to be more specific with units</li> <li>Measure to include NC/EUL/ROF</li> <li>Updated baseline to ASHRAE Std. 90.1 - 2013</li> <li>EFLH based on NYTRM for NYC</li> <li>CF decreased</li> </ul>	<p>Decrease peak demand savings 25%: CF decreases from 67% to 50%</p> <p>Unable to estimate due to EFLH values which vary according to building type</p>
Updated/Economizers and Controls	Dual enthalpy economizers	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> </ul>	<p>Methods and variables are too different for direct effect estimation.</p> <p>Decrease kW savings to zero</p>
	Occupancy controlled thermostats	<ul style="list-style-type: none"> <li>Moved from Direct Install Program</li> </ul>	Not applicable
Updated/Chillers		<ul style="list-style-type: none"> <li>Used tons to be more specific with units</li> <li>Measure to include NC/EUL/ROF</li> <li>Updated baseline to ASHRAE Std. 90.1 - 2013</li> <li>Updated EFLH based on NYTRM for NYC</li> </ul>	<p>Existing buildings now must meet ASHRAE 2013</p> <p>Estimate decrease in savings 11%–20%: Decreased EFLH</p>
Updated/VFDs	VFD VFD on air compressors VFD on kitchen hoods	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> </ul>	Methods and variables are too different for direct effect estimation.
Updated/Refrigeration	EE doors/covers and controls	<ul style="list-style-type: none"> <li>Moved from Direct Install</li> <li>Updated algorithms/assumptions/sources</li> </ul>	Decrease savings 35-38%: Updated study deemed savings
Measure to remain, but flagged as: Inactive 2017, Not Reviewed	Motors	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable
Additional Study	FUE for AC or refrigeration	<ul style="list-style-type: none"> <li>Unable to find a better source for savings</li> <li>Requires additional study</li> </ul>	Not applicable/requires additional study

### Program: Commercial Food Service

Recommendations	Measures	Changes to measure	Savings Impact (%)
Updated measures	All	<ul style="list-style-type: none"> <li>Moved from Direct Install</li> </ul>	Not applicable



Recommendations	Measures	Changes to measure	Savings Impact (%)
Added	Ice machines Refrigerators/freezers Dishwashers	<ul style="list-style-type: none"> <li>Moved from Commercial Electric</li> </ul>	Not applicable

### Program: C&I Gas

Recommendations	Measures	Changes to Measure	Savings Impact (%)
Updated/Chillers-Desiccants		<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> </ul>	Unable to estimate energy savings change, as EFLH values vary according to building type
Updated /Water Heating	Booster	<ul style="list-style-type: none"> <li>No changes</li> </ul>	Not applicable
	Tank style	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> <li>Updated Energy Use Density Table</li> <li>Updated storage and standby losses</li> </ul>	Unable to estimate due to EUD values which vary according to building type
	Instantaneous	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> <li>Updated Energy Use Density Table</li> <li>Updated storage and standby losses</li> </ul>	Unable to estimate due to EUD values which vary according to building type
Updated /Space Heating	Prescriptive boilers	<ul style="list-style-type: none"> <li>Measure to include NC/EUL/ROF</li> <li>Updated baseline to ASHRAE Std. 90.1 - 2013</li> </ul>	Existing buildings now must meet ASHRAE 2013
	Prescriptive furnaces	<ul style="list-style-type: none"> <li>Measure to include NC/EUL/ROF</li> <li>Updated baseline ASHRAE Std. 90.1 - 2013</li> </ul>	Existing buildings now must meet ASHRAE 2013
	Infrared heaters	<ul style="list-style-type: none"> <li>Deemed savings based on NYTRM</li> </ul>	Methods and variables are too different for direct effect estimation.
Updated/Economizers	Fuel use economizer for boilers and furnace	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources based on MTAC study</li> </ul>	Decrease savings 69%: Updated study

### Program: CHP/Fuel Cell

Recommendations	Measures	Changes to measure	Savings Impact (%)
Updated		<ul style="list-style-type: none"> <li>Renamed from DER to CHP</li> <li>Added NREL Protocol to capture energy savings</li> <li>Updated algorithms/assumptions/sources</li> </ul>	Not applicable. Savings are too custom.

**Program: P4P**

Recommendations	Measures	Changes to measure	Savings Impact (%)
No updates			Not applicable

**Program: Direct Install**

Recommendations	Measures	Changes to measure	Savings Impact (%)
Updated	Electric HVAC Gas space heating (boilers and furnaces) Gas water heating	<ul style="list-style-type: none"> <li>Updated baseline to ASHRAE Std. 90.1 - 2007</li> </ul>	Decrease savings 20%–40%: New baseline
Updated	VFD Refrigeration Dual enthalpy economizers Fuel use economizers Lighting and lighting controls	<ul style="list-style-type: none"> <li>These measures are all described in the C&amp;I EE Construction Program and are referenced back to those sections.</li> </ul>	See C&I measures
Updated	Low-flow devices	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> <li>Separated pre-rinse nozzles</li> </ul>	Methods and variables are too different for direct effect estimation.
Updated	DCV	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> </ul>	Methods and variables are too different for direct effect estimation.
Updated	Pipe insulation	<ul style="list-style-type: none"> <li>Updated algorithms/assumptions/sources</li> </ul>	Increase savings by 100%: Updated change in temperature ( $\Delta T$ )
Added	Programmable thermostats	<ul style="list-style-type: none"> <li>New protocols based on installation volume</li> </ul>	Unable to estimate/new measures
	Boiler reset controls	<ul style="list-style-type: none"> <li>Missing from the Protocols</li> </ul>	Not applicable
	Vending machine controls	<ul style="list-style-type: none"> <li>Missing from the Protocols</li> </ul>	Not applicable
Measure to remain, but flagged as: Inactive 2017, Not Reviewed	Motors	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable
	Small commercial boilers	<ul style="list-style-type: none"> <li>Inactive 2017, Not Reviewed</li> </ul>	Not applicable

**Program: C&I Large Energy Users**

Recommendations	Measures	Changes to measure	Savings Impact (%)
No updates			Not applicable

**Program: C&I Customer Tailored EE Pilot Program**

Recommendations	Measures	Changes to measure	Savings Impact (%)
No updates			Not applicable

**Program: Renewable Energy Program**

<b>Recommendations</b>	<b>Measures</b>	<b>Changes to measure</b>	<b>Savings Impact (%)</b>
Updates		<ul style="list-style-type: none"><li>• Solar and electric storage no longer apply</li><li>• SRP Protocol remains</li></ul>	Not applicable