New Jersey Board of Public Utilities

New Jersey Clean Energy Program

Protocols to Measure Resource Savings

Revisions to
December 2009 Protocols

September 2010

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New Jersey Clean Energy Program
Protocols to Measure Resource Savings

Introduction

These protocols have been developed to measure resource savings, including electric energy capacity, natural gas, and other resource savings, and to measure electric energy and capacity from renewable energy and distributed generation systems. Specific protocols for determination of the resource savings or generation from each program are presented for each eligible measure and technology.

These protocols use measured and customer data as input values in industry-accepted algorithms. The data and input values for the algorithms come from the program application forms or from standard values. The standard input values are based on the recent impact evaluations and best available measured or industry data applicable for the New Jersey programs when impact evaluations are not available.

Purpose

These protocols were developed for the purpose of determining energy and resource savings for technologies and measures supported by New Jersey's Clean Energy Program. The protocols will be updated from time to time to reflect the addition of new programs, modifications to existing programs, and the results of future program evaluations. The protocols will be used consistently statewide to assess program impacts and calculate energy and resource savings to:

1. Report to the Board on program performance
2. Provide inputs for planning and cost-effectiveness calculations
3. Calculate lost margin revenue recovery (as approved by the BPU)
4. Provide information to regulators and program administrators for determining eligibility for administrative performance incentives (to the extent that such incentives are approved by the BPU)
5. Assess the environmental benefits of program implementation

Resource savings to be measured include electric energy (kWh) and capacity (kW) savings, natural gas savings (therms), and savings of other resources (oil, propane, water, and maintenance), where applicable. In turn, these resource savings will be used to determine avoided environmental emissions. The Protocols are also utilized to support preliminary estimates of the electric energy and capacity from renewable energy and distributed generation systems and the associated environmental benefits. Note, however, that renewable energy protocols are different from those required for REC certification in the state of New Jersey.

The protocols in this document focus on the determination of the per unit savings for the energy efficiency measures, and the per unit generation for the renewable energy or distributed generation measures, included in the current programs approved by the Board. The number of adopted units to which these per unit savings or avoided generation apply are captured in the program tracking and reporting process, supported by market assessments for some programs. The unit count will reflect the direct participation and, through market assessments, the number of units due to market effects in comparison to a baseline level of adoptions. 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.

The outputs of the Protocols are used to support:

- Regulatory Reporting
- Cost Effectiveness Analysis
- Program Evaluation
- Performance Incentives for the Market Managers

These Protocols provide the methods to measure per unit savings for program tracking and reporting. An annual evaluation plan prepared by the Center for Energy, Economic and Environmental Policy (CEEEP) outlines the plans for assessing markets including program progress in transforming markets, and to update key assumptions used in the Protocols to assess program energy impacts. Reporting provides formats and definitions to be used to document program expenditures, participation rates, and program impacts, including energy and resource savings. The program tracking systems, that support program evaluation and reporting, will track and record the number of units adopted due to the program, and assist in documenting the resource savings using the per unit savings values in the Protocols. Cost benefit analyses prepared by CEEEP and other evaluation contractors assesses the impact of programs, including market effects, and their relationship to costs in a multi-year analysis.

Types of Protocols

In general, energy and demand savings will be measured using measured and customer data as input values in algorithms in the protocols, tracking systems, and information from the program application forms, worksheets, and field tools.

The following table summarizes the spectrum of protocols and approaches to be used for measuring energy and resource savings. No one protocol approach will serve all programs and measures.

Summary of Protocols and Approaches

Type of Measure	Type of Protocol	General Approach	Examples
1. Standard prescriptive measures	Standard formula and standard input values	Number of installed units times standard savings/unit	Residential lighting (number of units installed times standard savings/unit)
2. Measures with important variations in one or more input values (e.g., delta watts, efficiency level, capacity, load, etc.)	Standard formula with one or more site-specific input values	Standard formula in the protocols with one or more input values coming from the application form, worksheet, or field tool (e.g., delta watts, efficiency levels, unit capacity, site-specific load)	Some prescriptive lighting measures (delta watts on the application form times standard operating hours in the protocols) Residential Electric HVAC (change in efficiency level times site-specific capacity times standard operating hours) Field screening tools that use site-specific input values Customer On-Site Renewable Energy
3. Custom or site-specific measures, or measures in complex comprehensive jobs	Site-specific analysis	Greater degree of site-specific analysis, either in the number of site-specific input values, or in the use of special engineering algorithms, including building simulation programs	Custom Industrial process Complex comprehensive jobs (P4P) CHP

Three or four systems will work together to ensure accurate data on a given measure:

1. The application form that the customer or customer's agent submits with basic information.
2. Application worksheets and field tools with more detailed site-specific data, input values, and calculations (for some programs).

3. Program tracking systems that compile data and may do some calculations.
4. Protocols that contain algorithms and rely on standard or site-specific input values based on measured data. Parts or all of the protocols may ultimately be implemented within the tracking system, the application forms and worksheets, and the field tools.

Algorithms

The algorithms that have been developed to calculate the energy and or demand savings are driven by a change in efficiency level for the installed measure compared to a baseline level of efficiency. This change in efficiency is reflected in both demand and energy savings for electric measures and energy savings for gas. Following are the basic algorithms.

Electric Demand Savings = $\Delta kW = kW_{baseline} - kW_{energy\ efficient\ measure}$

Electric Energy Savings = ΔkW X EFLH

Electric Peak Coincident Demand Savings = ΔkW X Coincidence Factor

Gas Energy Savings = $\Delta Btuh$ X EFLH

Where:

EFLH = Equivalent Full Load Hours of operation for the installed measure. Total annual energy use (kWh) of an end use over a range of operating conditions divided by the connected full load of the end use in kW.

$\Delta Btuh = Btuh_{baseline\ input} - Btuh_{energy\ efficient\ measure\ input}$

Other resource savings will be calculated as appropriate.

Specific algorithms for each of the program measures may incorporate additional factors to reflect specific conditions associated with a program or measure. This may include factors to account for coincidence of multiple installations, or interaction between different measures.

When building simulation software programs are used to develop savings estimates for several measures in a comprehensive project, as in the Pay for Performance Program, the specific algorithms used are inherent in the software and account for interaction among measures by design. Detailed Simulation Guidelines have been developed for the Pay for Performance Program and are included in the Pay for Performance Program Guidelines. These Guidelines should be followed when building simulation is used to develop savings estimates. As stated in the Guidelines, simulation software must be compliant with ASHRAE 90.1 2004 Section 11 or Appendix G.

Data and Input Values

The input values and algorithms in the protocols and on the program application forms are based on the best available and applicable data for the New Jersey programs. The input values for the algorithms come from the program application forms or from standard values based on measured or industry data.

Many input values, including site-specific data, come directly from the program application forms, worksheets, and field tools. Site-specific data on the application forms are used for measures with important variations in one or more input values (e.g., delta watts, efficiency level, capacity, etc.).

Standard input values are based on the best available measured or industry data, including metered data, measured data from prior evaluations (applied prospectively), field data and program results, and standards from industry associations. The standard values for most commercial and industrial measures are based on recent impact evaluations of New Jersey Programs.
For the standard input assumptions for which metered or measured data were not available, the input values (e.g., delta watts, delta efficiency, equipment capacity, operating hours, coincidence factors) were based on the best available industry data or standards. These input values were based on a review of literature from various industry organizations, equipment manufacturers, and suppliers.

For larger, comprehensive projects, as in the Pay the Performance Program, measurement and verification (M&V) protocols are followed to better estimate site-specific energy use for the pre- and post-retrofit conditions. Guidelines for developing an M&V plan and protocols to follow for conducting M&V are included in the Pay for Performance Program Guidelines, available on the NJ Office of Clean Energy website at www.njcleanenergy.com. These guidelines and protocols should be followed when M&V is conducted to determine energy use for either the pre- or post-retrofit period.

Program evaluation will be used to assess key data and input values to either confirm that current values should continue to be used or update the values going forward.

Baseline Estimates

For most efficiency programs and measures, the Δ kW, Δ kWh, and gas energy savings values are based on the energy use of standard new products vs. the high efficiency products promoted through the programs. The approach used for the new programs encourages residential and business consumers to purchase and install high efficiency equipment vs. new standard efficiency equipment. The baseline estimates used in the protocols are documented in the baseline studies or other market information. Baselines will be updated to reflect changing codes, practices and market transformation effects.

For the Direct Install and Low Income programs, some Δ kW, Δ kWh, and gas energy savings values are based on high efficiency equipment versus existing equipment, where the programs specifically target early retirement or upgrades that would not otherwise occur. Protocols for the Direct Install Program include degradation tables to calculate the efficiency of the replaced unit.

The Pay for Performance Program is a comprehensive program that requires participants to implement energy efficiency improvements that will achieve a minimum of 15% reduction in total source energy consumption. Due to the building simulation and measurement and verification (M&V) requirements associated with this Program, the baseline is the existing energy consumption of the facility, as reported through the U.S. EPA's Portfolio Manager benchmarking software.

Renewable energy and distributed generation program protocols assume that any electric energy or capacity produced by a renewable energy or distributed generation system displaces electric energy and capacity from the PJM grid.

Resource Savings in Current and Future Program Years

The Protocols support tracking and reporting the following categories of energy and resource savings:

1. Savings or generation from installations that were completed in the program year and prior program years due to the program's direct participation and documented market effects.
2. Savings or generation from program participant future adoptions due to program commitments.
3. Savings or generation from future adoptions due to market effects.

Prospective Application of the Protocols

The protocols will be applied prospectively. The input values are from the program application forms and standard input values (based on measured data including metered data and evaluation results). The protocols will be updated periodically based on evaluation results and available data, and then applied prospectively for future program years.

Resource Savings

Electric

Protocols have been developed to determine the electric energy and coincident peak demand savings.

Annual Electric energy savings are calculated and then allocated separately by season (summer and winter) and time of day (on-peak and off-peak). Summer coincident peak demand savings are calculated using a demand savings protocol for each measure that includes a coincidence factor. Application of this coincidence factor converts the demand savings of the measure, which may not occur at time of system peak, to demand savings that is expected to occur during the Summer On-Peak period. These periods for energy savings and coincident peak demand savings are defined as:

	Energy Savings	Coincident Peak Demand Savings
Summer	May through September	June through August

Winter	October through April	NA
On Peak (Monday - Friday)	8:00 a.m. to 8:00 p.m.	12:00 p.m. to 8:00 p.m.
Off Peak (Weekends and Holidays)	8:00 p.m. to 8:00 a.m.	NA

The time periods for energy savings and coincident peak demand savings were chosen to best fit the seasonal avoided cost patterns for electric energy and capacity that were used for the energy efficiency program cost effectiveness purposes. For energy, the summer period May through September was selected based on the pattern of avoided costs for energy at the PJM level. In order to keep the complexity of the process for calculating energy savings benefits to a reasonable level by using two time periods, the knee periods for spring and fall were split approximately evenly between the summer and winter periods.

For capacity, the summer period June through August was selected to match the highest avoided costs time period for capacity. The experience in PJM and New Jersey has been that nearly all system peak events occur during these three months. Coincidence factors are used to calculate energy efficiency factors on peak demand. Renewable energy and distributed generation systems are assumed to be operating coincident with the PJM system peak. This assumption will be assessed in the impact evaluation.

Natural Gas

Protocols have been developed to determine the natural gas energy savings on a seasonal basis. The seasonal periods are defined as:

Summer - April through September
Winter - October through March

The time periods for gas savings were chosen to best fit the seasonal avoided gas cost pattern that was used for calculating energy efficiency program benefits for cost effectiveness purposes. However, given the changing seasonal cost patterns for gas supply, different time periods may be more appropriate to reflect a current outlook for the seasonal pattern, if any, at the time that the avoided cost benefits are calculated. The seasonal factors used in the following protocols that correspond to the above time periods reflect either base load or heating load usage. In the case of base load, one twelfth of the annual use is allocated to each month. In the case of heating load, the usage is prorated to each month based on the number of normal degree-days in each month. This approach makes it relatively easy to calculate new seasonal factors to best match different avoided cost patterns.

Other Resources

Some of the energy savings measures also result in environmental benefits and the saving of other resources. Environmental impacts are quantified based on statewide conversion factors supplied by the NJDEP for electric, gas and oil energy savings. Where identifiable and quantifiable these other key resource savings, such as oil, will be estimated. Oil and propane savings are the major resources that have been identified. If other resources are significantly impacted, they will be included in the resource savings estimates.

Post-Implementation Review

Program administrators will review application forms and tracking systems for all measures and conduct field inspections on a sample of installations. For some programs and jobs (e.g., custom, large process, large and complex comprehensive design), post-installation review and on-site verification of a sample of application forms and installations will be used to ensure the reliability of site-specific savings estimates.

Adjustments to Energy and Resource Savings

Coincidence with Electric System Peak

Coincidence factors are used to reflect the portion of the connected load savings or generation that is coincident with the electric system peak.

Measure Retention and Persistence of Savings

The combined effect of measure retention and persistence is the ability of installed measures to maintain the initial level of energy savings or generation over the measure life. Measure retention and persistence effects were accounted for in the metered data that were based on C&I installations over an eight-year period. As a result, some protocols incorporate retention and persistence effects in the other input values. For other measures, if the measure is subject to a reduction in savings or generation over time, the reduction in retention or persistence is accounted for using factors in the calculation of resource savings (e.g., in-service rates for residential lighting measures, degradation of photovoltaic systems).

Interaction of Energy Savings

Interaction of energy savings is accounted for in certain programs as appropriate. For all other programs and measures, interaction of energy savings is zero.

For the Residential New Construction program, the interaction of energy savings is accounted for in the home energy rating tool that compares the efficient building to the baseline or reference building and calculates savings.

For the Commercial and Industrial Efficient Construction program, the energy savings for lighting is increased by an amount specified in the protocol to account for HVAC interaction. For commercial and industrial custom measures, interaction where relevant is accounted for in the site-specific analysis. In the Pay for Performance Program, interaction is addressed by the building simulation software program.

Calculation of the Value of Resource Savings

The calculation of the value of the resources saved is not part of the protocols. The protocols are limited to the determination of the per unit resource savings in physical terms.

In order to calculate the value of the energy savings for reporting and other purposes, the energy savings are determined at the customer level and then increased by the amount of the transmission and distribution losses to reflect the energy savings at the system level. The energy savings at the system level are then multiplied by the appropriate avoided costs to calculate the value of the benefits.

System Savings = (Savings at Customer) X (T&D Loss Factor)

Value of Resource Savings = (System Savings) X (System Avoided Costs + Environmental Adder) + (Value of Other Resource Savings)

The value of the benefits for a particular measure will also include the value of the water, oil, maintenance and other resource savings where appropriate. Maintenance savings will be estimated in annual dollars levelized over the life of the measure.

Transmission and Distribution System Losses

The protocols calculate the energy savings at the customer level. These savings need to be increased by the amount of transmission and distribution system losses in order to determine the energy savings at the system level. The following loss factors multiplied by the savings calculated from the protocols will result in savings at the supply level.

Electric Loss Factor

The electric loss factor applied to savings at the customer meter is 1.11 for both energy and demand. The electric system loss factor was developed to be applicable to statewide programs. Therefore, average system losses at the margin based on PJM data were utilized. This reflects a mix of different losses that occur related to delivery at different voltage levels. The 1.11 factor used for both energy and capacity is a weighted average loss factor and was adopted by consensus.

Gas Loss Factor

The gas loss factor is 1.0. The gas system does not have losses in the same sense that the electric system does. All of the gas gets from the "city gate" (delivery point to the distribution system) to the point of use except for unaccounted for gas (such as theft), gas lost due to system leakage or loss of gas that is purged when necessary to make system repairs. Since none of these types of "losses" is affected by a decrease in gas use due to energy efficiency at the customer, there are no losses for which to make any adjustment. Therefore, a system loss factor of 1.0 is appropriate for gas energy efficiency savings.

These electric and gas loss factors reflect losses at the margin and are a consensus of the electric and gas utilities.

Calculation of Clean Air Impacts

The amount of air emission reductions resulting from the energy savings are calculated using the energy savings at the system level and multiplying them by factors developed by the New Jersey Department of Environmental Protection (NJDEP).

System average air emissions reduction factors provided by the NJDEP are:

Electric Emissions Factors

Emissions Product	Jan 2001-June 2002	July 2003-Present
CO_2	1.1 lbs per kWh saved	1,520 lbs per MWh saved
NO_x	6.42 lbs per metric ton of CO_2 saved	2.8 lbs per MWh saved
SO_2	10.26 lbs per metric ton of CO_2 saved	6.5 lbs per MWh saved
Hg	0.00005 lbs per metric ton of CO_2 saved	0.0000356 lbs per MWh saved

Gas Emissions Factors

Emissions Product	Jan 2001-June 2002	July 2003-Present
CO_2	NA	11.7 lbs per therm saved
NO_x	NA	0.0092 lbs per therm saved

All factors are provided by the NJ Department of Environmental Protection and are on an average system basis. They will be updated as new factors become available.

Measure Lives

Measure lives are provided in Appendix A for informational purposes and for use in other applications such as reporting lifetime savings or in benefit cost studies that span more than one year. The Pay for Performance Program uses the measure lives as included in Appendix A to determine measure-level and project-level cost effectiveness.

Protocols for Program Measures

The following pages present measure-specific protocols.

Residential Electric HVAC

Protocols

The measurement plan for residential high efficiency cooling and heating equipment is based on algorithms that determine a central air conditioner's or heat pump's cooling/heating energy use and peak demand. Input data is based both on fixed assumptions and data supplied from the high efficiency equipment rebate application form. The algorithms also include the calculation of additional energy and demand savings due to the required proper sizing of high efficiency units.

The savings will be allocated to summer/winter and on-peak/off-peak time periods based on load shapes from measured data and industry sources. The allocation factors are documented below in the input value table.

The protocols applicable for this program measure the energy savings directly related to the more efficient hardware installation. Estimates of energy savings due to the proper sizing of the equipment are also included.

The following is an explanation of the algorithms used and the nature and source of all required input data.

<u>Algorithms</u>

Central Air Conditioner (A/C) & Air Source Heat Pump (ASHP)

Cooling Energy Consumption and Peak Demand Savings – Central A/C & ASHP (High Efficiency Equipment Only)

Energy Impact (kWh) = $CAPY/1000 \times (1/SEER_b - 1/SEER_q) \times EFLH_c$

Peak Demand Impact (kW) = $CAPY/1000 \times (1/EER_b - 1/EER_q) \times CF$

Heating Energy Savings – ASHP

Energy Impact (kWh) = $CAPY/1000 \times (1/HSPF_b - 1/HSPF_q) \times EFLH_h$

Cooling Energy Savings for Proper Sizing and QIV

$kWh_p = kWh_q * ESF$

Cooling Demand Savings for Proper Sizing and QIV

$kW_p = kW_q * DSF$

Cooling Energy Consumption and Demand Savings – Central A/C & ASHP (During Existing System Maintenance)

Energy Impact (kWh) = $((CAPY/(1000 \times SEERm)) \times EFLH_c) \times MF$

Peak Demand Impact (kW) $=((CAPY/(1000 \times EERm)) \times CF) \times MF$

Cooling Energy Consumption and Demand Savings– Central A/C & ASHP (Duct Sealing)

Energy Impact (kWh) = $(CAPY/(1000 \times SEERq)) \times EFLH_c \times DuctSF$

Peak Demand Impact (kW) = $((CAPY/(1000 \times EERq)) \times CF) \times DuctSF$

Ground Source Heat Pumps (GSHP)

Cooling Energy (kWh) Savings = $CAPY/1000 \times (1/SEER_b - (1/(EER_g \times GSER))) \times EFLH_c$

Heating Energy (kWh) Savings = $CAPY/1000 \times (1/HSPF_b - (1/(COP_g \times GSOP))) \times EFLH_h$

Peak Demand Impact (kW) = $CAPY/1000 \times (1/EER_b - (1/(EER_g \times GSPK))) \times CF$

GSHP Desuperheater

Energy (kWh) Savings = EDSH

Peak Demand Impact (kW) = PDSH

Furnace High Efficiency Fan

Heating Energy (kWh) Savings = $((CAPY_q \times EFLH_{HT})/100{,}000$ BTU/therm$) \times FFS_{HT}$

Cooling Energy (kWh) Savings = FFS_{CL}

Solar Domestic Hot Water (augmenting electric resistance DHW)

Heating Energy (kWh) Savings = $ESav_{SDHW}$

Peak Demand Impact (kW) = $DSav_{SDHW} \times CF_{SDHW}$

Heat Pump Hot Water (HPHW)

Heating Energy (kWh) Savings = $ESav_{HPHW}$

Peak Demand Impact (kW) = $DSav_{HPHW} \times CF_{HPHW}$

Definition of Terms

CAPY = The cooling capacity (output) of the central air conditioner or heat pump being installed. This data is obtained from the Application Form based on the model number.

$SEER_b$ = The Seasonal Energy Efficiency Ratio of the Baseline Unit.

$SEER_q$ = The Seasonal Energy Efficiency Ratio of the qualifying unit being installed. This data is obtained from the Application Form based on the model number.

$SEER_m$ = The Seasonal Energy Efficiency Ratio of the Unit receiving maintenance

EER_b = The Energy Efficiency Ratio of the Baseline Unit.

EER_q = The Energy Efficiency Ratio of the unit being installed. This data is obtained from the Application Form based on the model number.

EER_g = The EER of the ground source heat pump being installed. Note that EERs of GSHPs are measured differently than EERs of air source heat pumps (focusing on entering water temperatures rather than ambient air temperatures). The equivalent SEER of a GSHP can be estimated by multiplying EER_g by 1.02.

GSER = The factor to determine the SEER of a GSHP based on its EER_g.

EFLH = The Equivalent Full Load Hours of operation for the average unit.

ESF = The Energy Savings Factor or the assumed saving due to proper sizing and proper installation.

MF = The Maintenance Factor or assumed savings due to completing recommended maintenance on installed cooling equipment

DuctSF = The Duct Sealing Factor or the assumed savings due to proper sealing of all cooling ducts

CF = The coincidence factor which equates the installed unit's connected load to its demand at time of system peak.

DSF = The Demand Savings Factor or the assumed peak demand capacity saved due to proper sizing and proper installation.

$HSPF_b$ = The Heating Seasonal Performance Factor of the Baseline Unit.

$HSPF_q$ = The Heating Seasonal Performance Factor of the unit being installed. This data is obtained from the Application Form.

COP_g = Coefficient of Performance. This is a measure of the efficiency of a heat pump.

GSOP = The factor to determine the HSPF of a GSHP based on its COP_g.

GSPK = The factor to convert EER_g to the equivalent EER of an air conditioner to enable comparisons to the baseline unit.

EDSH = Assumed savings per desuperheater.

PDSH = Assumed peak demand savings per desuperheater.

$ESav_{SDHW}$ = Assumed energy savings per installed solar domestic hot water system with electric resistance heater backup.

$DSav_{SDHW}$ = Assumed demand savings per installed solar domestic hot water system with electric resistance heater backup.

$CAPYY_q$ = Output capacity of the qualifying heating unit in BTUs/hour

$EFLH_{HT}$ = The Equivalent Full Load Hours of operation for the average heating unit

FFS_{HT} = Furnace fan savings (heating mode)

FFS_{CL} = Furnace fan savings (cooling mode)

kWh_p = Annual kWh due to proper sizing

kWh_q = Annual kWh usage post-program

kW_p = Annual kW due to proper sizing

kW_q = Annual kW usage post-program

$ESav_{HPHW}$ = Assumed energy savings per installed heat pump hot water.

$DSav_{HPHW}$ = Assumed demand savings per installed heat pump hot water.

The 1000 used in the denominator is used to convert watts to kilowatts.

A summary of the input values and their data sources follows:

Residential Electric HVAC

Component	Type	Value	Sources
CAPY	Variable		Rebate Application
$SEER_b$	Fixed	Baseline = 13	1
$SEER_q$	Variable		Rebate Application
$SEER_m$	Fixed	10	15
EER_b	Fixed	Baseline = 11.3	2
EER_q	Fixed	= (11.3/13) X $SEER_q$	2
EER_g	Variable		Rebate Application
EER_m	Fixed	8.69	19
GSER	Fixed	1.02	3
EFLH	Fixed	Cooling = 600 Hours Heating = 965Hours	4
ESF	Fixed	9.2%	22
DSF	Fixed	9.2%	22
kWh_q	Variable		Rebate Application
kW_q	Variable		Rebate Application
MF	Fixed	10%	20
DuctSF	Fixed	18%	14
CF	Fixed	70%	6
DSF	Fixed	2.9%	7
$HSPF_b$	Fixed	Baseline = 7.7	8
$HSPF_q$	Variable		Rebate Application
COP_g	Variable		Rebate Application
GSOP	Fixed	3.413	9
GSPK	Fixed	0.8416	10
EDSH	Fixed	1842 kWh	11
PDSH	Fixed	0.34 kW	12
$ESav_{SDHW}$	Fixed	3100 kWh	21
$DSav_{SDHW}$	Fixed	0.426 kW	21

Component	Type	Value	Sources
CF_{SDHW}	Fixed	20%	21
$ESav_{HPHW}$	Fixed	2662 kW	23
$DSav_{HPHW}$	Fixed	0.25 kW	24
CF_{HPHW}	Fixed	70%	24
Cooling - CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 64.9% Summer/Off-Peak 35.1% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Cooling – ASHP Time Period Allocation Factors	Fixed	Summer/On-Peak 59.8% Summer/Off-Peak 40.2% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Cooling – GSHP Time Period Allocation Factors	Fixed	Summer/On-Peak 51.7% Summer/Off-Peak 48.3% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Heating – ASHP & GSHP Time Period Allocation Factors	Fixed	Summer/On-Peak 0.0% Summer/Off-Peak 0.0% Winter/On-Peak 47.9% Winter/Off-Peak 52.1%	13
GSHP Desuperheater Time Period Allocation Factors	Fixed	Summer/On-Peak 4.5% Summer/Off-Peak 4.2% Winter/On-Peak 43.7% Winter/Off-Peak 47.6%	13
SDHW Time Period Allocation Factors	Fixed	Summer/On-Peak 27.0% Summer/Off-Peak 15.0% Winter/On-Peak 42.0% Winter/Off-Peak 17.0%	21
$Capy_q$	Variable		Rebate Application
$EFLH_{HT}$	Fixed	965 hours	16
FFS_{HT}	Fixed	0.5 kWh	17
FFS_{CL}	Fixed	105 kWh	18

Sources:

1. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
2. Average EER for SEER 13 units.
3. VEIC estimate. Extrapolation of manufacturer data.
4. VEIC estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.
5. Xenergy, "New Jersey Residential HVAC Baseline Study", (Xenergy, Washington, D.C., November 16, 2001).
6. Based on an analysis of 6 different utilities by Proctor Engineering.

7. Xenergy, “New Jersey Residential HVAC Baseline Study”, (Xenergy, Washington, D.C., November 16, 2001)
8. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
9. Engineering calculation, HSPF/COP=3.413
10. VEIC Estimate. Extrapolation of manufacturer data.
11. VEIC estimate, based on PEPCo assumptions.
12. VEIC estimate, based on PEPCo assumptions.
13. Time period allocation factors used in cost-effectiveness analysis.
14. Northeast Energy Efficiency Partnerships, Inc., “Benefits of HVAC Contractor Training”, (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01
15. Minimum Federal Standard for new Central Air Conditioners between 1990 and 2006
16. NJ utility analysis of heating customers, annual gas heating usage
17. Scott Pigg (Energy Center of Wisconsin), “Electricity Use by New Furnaces: A Wisconsin Field Study”, Technical Report 230-1, October 2003.
18. Ibid., p. 34. ARI charts suggest there are about 20% more full load cooling hours in NJ than southern WI. Thus, average cooling savings in NJ are estimated at 95 to 115
19. The same EER to SEER ratio used for SEER 13 units applied to SEER 10 units. EER_m = (11.3/13) * 10
20. VEIC estimate. Conservatively assumes less savings than for QIV because of the retrofit context
21. Energy savings are estimated based on 2008 SRCC OG300 ratings for a typical 2 panel system with solar storage tank in Newark, NJ with electric DHW backup. Demand savings are estimated based on an estimated electric DHW demand of 2.13kW with 20% CF. Loadshape and coincidence factors were developed by VEIC from ASHRAE hot water hourly consumption and NREL Red Book insulation data.
22. KEMA, *NJ Clean Energy Program Energy Impact Evaluation Protocol Review*. 2009.
23. ENERGY STAR® Residential Water Heaters: Final Criteria Analysis, 2008 using conservative assumptions and values for annual EF (2.0) based upon minimum energy star criteria.
24. VEIC Estimate based upon range derived from FEMP Federal Technology Alert: S9508031.3a (http://www1.eere.energy.gov/femp/pdfs/FTA_res_heat_pump.pdf)

Residential Gas HVAC

Protocols

The following two algorithms detail savings for gas heating and water heating equipment. They are to be used to determine gas energy savings between baseline standard units and the high efficiency units promoted in the program. The input values are based on data on typical customers supplied by the gas utilities, an analysis by the Federal Energy Management Program (FEMP), and customer information on the application form, confirmed with manufacturer data. The energy values are in therms.

Space Heaters

<u>Algorithms</u>

Gas Savings = [($Capy_q$/$AFUE_b$) – ($Capy_q$/ $AFUE_q$)] * EFLH / 100,000 BTUs/therm

Low Income Gas Savings = [($Capy_q$/$AFUE_{LI}$) – ($Capy_q$/ $AFUE_q$)] * EFLH / 100,000 BTUs/therm

Gas Savings due to duct sealing = (CAP_{avg} $AFUE_{avg}$) * EFLH * ($DuctSF_h$/100,000 BTUs/therm)

Average Heating Use (therms) = (Cap_{avg} / $AFUE_{avg}$) * EFLH / 100,000 BTUs/therm

EFLH = Average Heating Use * $AFUE_{avg}$* 100,000 BTUs/therm) / Cap_{avg}

Oil Savings for a qualifiying boiler = OsavBOILER

Oil Savings for a qualifying furnace = OsavFURNACE

<u>Definition of Variables</u>

$Capy_q$ = Output capacity of qualifying unit output in BTUs/hour

$Capy_t$ = Output capacity of the typical heating unit output in Btus/hour

$Capy_{avg}$ = Output capacity of the average heating unit output in Btus/hour

EFLH = The Equivalent Full Load Hours of operation for the average unit.

$DuctSF_h$ = The Duct Sealing Factor or the assumed savings due to proper sealing of all heating ducts

$AFUE_{avg}$ = Annual Fuel Utilization Efficiency of the average furnace or boiler

$AFUE_q$ = Annual Fuel Utilization Efficiency of the qualifying baseline furnace or boiler

$AFUE_b$ = Annual Fuel Utilization Efficiency of the baseline furnace or boiler

$AFUE_{LI}$ = Annual Fuel Utilization Efficiency of the Low Income Program replaced furnace or boiler.

Average Heating Usage = The weighted average annual heating usage (therms) of typical New Jersey heating customers

OsavBOILER = Per unit energy (MMBTU) savings for a qualifying oil-fired boiler

OsavFURNACE = Per unit energy (MMBTU) savings for a qualifying oil-fired furnace

Space Heating

Component	Type	Value	Source
$Capy_q$	Variable		Application
$Capy_t$	Fixed	$CAPY_Q$	1
$DuctSF_h$	Fixed	13%	5
$AFUE_{avg}$	Variable		Application
$AFUE_q$	Variable		Application
$AFUE_b$	Fixed	Gas Furnaces: 80% Gas Boilers: 83%	2
$AFUE_{LI}$	Variable		Application or utility estimates
EFLH[1]	Fixed	965 hours	3
Avg. Heating Usage	Fixed	860 therms	5
Time Period Allocation Factors	Fixed	Summer = 12% Winter = 88%	4
OsavBOILER[2]	Fixed	5.2	7
OsavFURNACE	Fixed	5.2	7

Sources:

1. NJ Residential HVAC Baseline Study
2. Based on the quantity of models available by efficiency ratings as listed in the April 2003 Gamma Consumers Directory of Certified Efficiency Ratings.
3. NJ utility analysis of heating customers, annual gas heating usage
4. Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.
5. Northeast Energy Efficiency Partnerships, Inc., "Benefits of HVAC Contractor Training", (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01

[1] Residential Gas Measures ELFH are subject to change barring the results of impact evaluations.
[2] For 2010 the State Energy Efficiency Appliance Rebate Program provided by the US DOE allows the NJCEP program to support incentives for oil and propane equipment. The savings for this equipment can be found in this section of the protocols.

6. KEMA, *NJ Clean Energy Program Energy Impact Evaluation Protocol Review*. 2009.
7. Savings derived from US DOE estimates for the SEEARP (EPA Savings Calculator. Assumes default values but without Programmable Thermostat)

Water Heaters

Algorithms

Gas Savings = ((EF_q – EF_b)/EF_q) X Baseline Water Heater Usage

Gas Savings (Solar DHW) = GsavSHW

Definition of Variables

EF_q = Energy factor of the qualifying energy efficient water heater.

EF_b = 0.67 – (0.0019 * Gallons of Capacity)

Baseline Water Heater Usage = Annual usage of the baseline water heater, in therms.

GsavSHW = Gas savings, in therms, for a solar hot water installation augmented by a new gas hot water heater.

Water Heaters

Component	Type	Value	Source
EF_q	Variable		Application Form, confirmed with Manufacturer Data
EF_b	Variable		Application Form, confirmed with Manufacturer Data
Baseline Water Heater Usage	Fixed	180 therms	2
Time Period Allocation Factors	Fixed	Summer = 50% Winter = 50%	3
GsavSHW	Fixed	130.27	4

Sources:

1. Federal EPACT Standard for a 40 gallon gas water heater. Calculated as 0.62 – (0.0019 X gallons of capacity).
2. KEMA. *NJ Clean Energy Program Energy Impact Evaluation Protocol Review. 2009.*
3. Prorated based on 6 months in the summer period and 6 months in the winter period.
4. Savings derived from US DOE estimates for the SEEARP (ENERGY STAR® Residential Water Heaters: Final Criteria Analysis)

Residential Low Income Program

Protocols

The Protocols set out below are applicable to both the Comfort Partners component of the Low-income Program currently implemented by the State's electric and gas utilities and the Weatherization Assistance component of the Low-income Program implemented by the New Jersey Department of Community Affairs (DCA).

The savings protocols for the low-income program are based upon estimated per unit installed savings. In some cases, such as lighting and refrigerators, the savings per unit estimate is based on direct observation or monitoring of the existing equipment being replaced. For other measures, for example air sealing and insulation, the protocols calculation is based on an average % savings of pre-treatment consumption.

Base Load Measures

Efficient Lighting

Savings from installation of screw-in CFLs, high performance fixtures and fluorescent torchieres are based on a straightforward algorithm that calculates the difference between existing and new wattage, and the average daily hours of usage for the lighting unit being replaced.

<u>Algorithm</u>

Compact Fluorescent Screw In Lamp

Electricity Impact (kWh) = $((CFL_{watts}) \text{ X } (CFL_{hours} \text{ X } 365))/1000$

Peak Demand Impact (kW) = $(CFL_{watts}) \text{ X Light CF}$

Efficient Fixtures

Electricity Impact (kWh) = $((Fixt_{watts}) \text{ X } (Fixt_{hours} \text{ X } 365))/1000$

Peak Demand Impact (kW) = $(Fixt_{watts}) \text{ X Light CF}$

Efficient Torchieres

Electricity Impact (kWh) = $((Torch_{watts}) \text{ X } (Torch_{hours} \text{ X } 365))/1000$

Peak Demand Impact (kW) = $(Torch_{watts}) \text{ X Light CF}$

Hot Water Conservation Measures

The protocols savings estimates are based on an average package of domestic hot water measures typically installed by low-income programs.

Algorithm

Electricity Impact (kWh) = HW_{eavg}

Gas Savings (MMBtu) = HW_{gavg}

Peak Demand Impact (kW) = HW_{watts} X HW CF

Water Savings (gallons) = WS

Efficient Refrigerators

The eligibility for refrigerator replacement is determined by comparing monitored consumption for the existing refrigerator with the rated consumption of the eligible replacement. Estimated savings are directly calculated based on the difference between these two values. Note that in the case where an under-utilized or unneeded refrigerator unit is removed, and no replacement is installed, the Ref_{new} term of the equation will be zero.

Algorithm

Electricity Impact (kWh) = $Ref_{old} – Ref_{new}$

Peak Demand Impact (kW) = $(Ref_{old} – Ref_{new})$ *(Ref DF)

Space Conditioning Measures

When available, gas heat measure savings will be based on heating use. If only total gas use is known, heating use will be estimated as total use less 300 therms.

Air Sealing

It is assumed that air sealing is the first priority among candidate space conditioning measures. Expected percentage savings is based on previous experiences with measured savings from similar programs. Note there are no summer coincident electric peak demand savings estimated at this time.

Algorithm

Electricity Impact (kWh) = ESC_{pre} X 0.05

MMBtu savings = (GHpre X 0.05)

Furnace/Boiler Replacement

Quantification of savings due to furnace and boiler replacements implemented under the low-income program will be based on the algorithms presented in the Residential Gas HVAC section of these Protocols.

Duct Sealing and Repair

The second priority for homes with either Central Air Conditioning (CAC) or some other form of ducted distribution of electric space conditioning (electric furnace, gas furnace or heat pump) is ensuring integrity and effectiveness of the ducted distribution system.

<u>Algorithm</u>

With CAC

Electricity Impact (kWh) = $(ECool_{pre})$ X 0.10

Peak Demand Impact (kW) = $(Ecool_{pre}$ X 0.10) / EFLH X AC CF

MMBtu savings = (GHpre X 0.02)

No CAC

Electricity Impact (kWh) = $(ESC_{pre}$.) X 0.02

MMBtu savings = (GHpre X 0.02)

Insulation Up-Grades

For savings calculations, it is assumed that any applicable air sealing and duct sealing/repair have been done, thereby reducing the space conditioning load, before consideration of upgrading insulation. Attic insulation savings are then projected on the basis of the "new" load. Gas savings are somewhat greater, as homes with gas heat generally have less insulation.

<u>Algorithm</u>

Electricity Impact (kWh) = (ESC_{pre}) X 0.08

MMBtu savings = GH_{pre} X 0.13

Thermostat Replacement

Thermostats are eligible for consideration as an electric space conditioning measure only after the first three priority items. Savings projections are based on a conservative 3% of the "new" load after installation of any of the top three priority measures.

<u>Algorithm</u>

Electricity Impact (kWh) = (ESC_{pre}) X 0.03

MMBtu savings = $(GH_{pre}$ X 0.03)

Heating and Cooling Equipment Maintenance Repair/Replacement

Savings projections for heat pump charge and air flow correction. Protocol savings account for shell measures having been installed that reduce the pre-existing load.

Algorithm

Electricity Impact (kWh) = (ESC_{pre}) X 0.17

Peak Demand Impact (kW) = (Capy/EER X 1000) X HP CF X DSF

Other "Custom" Measures

In addition to the typical measures for which savings algorithms have been developed, it is assumed that there will be niche opportunities that should be identified and addressed. The savings for these custom measures will be reported based on the individual calculations supplied with the reporting. As necessary the program working group will develop specific guidelines for frequent custom measures for use in reporting and contractor tracking.

Definition of Terms

CFL_{watts} = Average watts replaced for a CFL installation.

CFL_{hours} = Average daily burn time for CFL replacements.

$Fixt_{watts}$ = Average watts replaced for an efficient fixture installation.

$Fixt_{hours}$ = Average daily burn time for CFL replacements.

$Torch_{watts}$ = Average watts replaced for a Torchiere replacement.

$Torch_{hours}$ = Average daily burn time for a Torchiere replacements.

Light CF = Summer demand coincidence factor for all lighting measures. Currently fixed at 5%.

HW_{eavg} = Average electricity savings from typical electric hot water measure package.

HW_{gavg} = Average natural gas savings from typical electric hot water measure package.

HW_{watts} = Connected load reduction for typical hot water efficiency measures

HW CF = Summer demand coincidence factor for electric hot water measure package. Currently fixed at 75%.

Ref_{old} = Annual energy consumption of existing refrigerator based on on-site monitoring.

Ref_{new} = Rated annual energy consumption of the new refrigerator.

Ref DF = kW /kWh of savings. Refrigerator demand savings factor.

Ref CF = Summer demand coincidence factor for refrigeration. Currently 100%, diversity accounted for in the Ref DF factor.

ESC_{pre} = Pre-treatment electric space conditioning consumption.

$ECool_{pre}$ = Pre-treatment electric cooling consumption.

EFLH = Equivalent full load hours of operation for the average unit. This value is currently fixed at 650 hours.

AC CF = Summer demand coincidence factor for air conditioning. Currently 85%.

Capy = Capacity of Heat Pump in Btuh

EER = Energy Efficiency Ratio of average heat pump receiving charge and air flow service. Fixed at 9.2

HP CF = Summer demand coincidence factor for heat pump. Currently fixed at 70%.

DSF = Demand savings factor for charge and air flow correction. Currently fixed at 7%.

GC_{pre} = Pre treatment gas consumption.

GH_{pre} = Pre treatment gas space heat consumption (=.GC_{pre} less 300 therms if only total gas use is known.

WS = Water Savings associated with water conservation measures. Currently fixed at 3,640 gallons per year per home receiving low flow showerheads, plus 730 gallons saved per year aerator installed.

Residential Low Income

Component	**Type**	**Value**	**Sources**
CFL_{Watts}	Fixed	42 Watts	1
CFL_{Hours}	Fixed	2.5 hours	1
$Fixt_{Watts}$	Fixed	100-120 Watts	1
$Fixt_{Hours}$	Fixed	3.5 hours	1
$Torch_{Watts}$	Fixed	245 Watts	1
$Torch_{Hours}$	Fixed	3.5 hours	1
Light CF	Fixed	5%	2
Elec. Water Heating Savings	Fixed	178 kWh	3
Gas Water Heating	Fixed	1.01 MMBTU	3

Component	Type	Value	Sources
Savings			
WS Water Savings	Fixed	3,640 gal/year per home receiving low flow shower heads, plus 1,460 gal/year per home receiving aerators.	12
HW_{watts}	Fixed	0.022 kW	4
HW CF	Fixed	75%	4
Ref_{old}	Variable		Contractor Tracking
Ref_{new}	Variable		Contractor Tracking and Manufacturer data
Ref DF	Fixed	0.000139 kW/kWh savings	5
RefCF	Fixed	100%	6
ESC_{pre}	Variable		7
$Ecool_{pre}$	Variable		7
ELFH	Fixed	650 hours	8
AC CF	Fixed	85%	4
Capy	Fixed	33,000 Btu/hr	1
EER	Fixed	11.3	8
HP CF	Fixed	70%	9
DSF	Fixed	7%	10
GC_{pre}	Variable		7
GH_{pre}	Variable		7
Time Period Allocation Factors - Electric	Fixed	Summer/On-Peak 21% Summer/Off-Peak 22% Winter/On-Peak 28% Winter/Off-Peak 29%	11
Time Period Allocation Factors - Gas	Fixed	Heating: Summer 12% Winter 88% Non-Heating: Summer 50% Winter 50%	13

Sources/Notes:

1. Working group expected averages for product specific measures.
2. Efficiency Vermont Reference Manual – average for lighting products.
3. Experience with average hot water measure savings from low income and direct install programs.
4. VEIC estimate.

5. UI Refrigerator Load Data profile, .16 kW (5pm July) and 1,147 kWh annual consumption.
6. Diversity accounted for by Ref DF.
7. Billing histories and (for electricity) contractor calculations based on program procedures for estimating space conditioning and cooling consumption.
8. Average EER for SEER 13 units.
9. Analysis of data from 6 utilities by Proctor Engineering
10. From Neme, Proctor and Nadel, 1999.
11. These allocations may change with actual penetration numbers are available.
12. VEIC estimate, assuming 1 GPM reduction for 14 five minute showers per week for shower heads, and 4 gallons saved per day for aerators.
13. Heating: Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.
    Non-Heating: Prorated based on 6 months in the summer period and 6 months in the winter period.

Residential New Construction Program

Protocols

Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment, and Duct Sealing

Energy savings due to improvements in Residential New Construction will be a direct output of accredited Home Energy Ratings (HERS) software that meets the applicable Mortgage Industry National Home Energy Rating System Standards. REM/Rate is cited as example of an accredited software which has a module that compares the energy characteristics of the energy efficient home to the baseline/reference home and calculates savings.

The system peak electric demand savings will be calculated from the software output with the following savings algorithms, which are based on compliance and certification of the energy efficient home to the EPA's ENERGY STAR for New Homes program standard:

Peak demand of the baseline home = (PL_b X OF_b) / ($SEER_b$ X BLEER X 1,000)

Peak demand of the qualifying home = (PL_q X OF_q) / (EER_q X 1,000)

Coincident system peak electric demand savings = (Peak demand of the baseline home – Peak demand of the qualifying home) X CF

<u>Definition of Terms</u>

PL_b = Peak load of the baseline home in Btuh.

OF_b = The oversizing factor for the HVAC unit in the baseline home.

$SEER_b$ = The Seasonal Energy Efficiency Ratio of the baseline unit.

BLEER = Factor to convert baseline $SEER_b$ to EER_b.

PL_q = The actual predicted peak load for the program qualifying home constructed, in Btuh.

OF_q = The oversizing factor for the HVAC unit in the program qualifying home.

EER_q = The EER associated with the HVAC system in the qualifying home.

CF = The coincidence factor which equates the installed HVAC system's demand to its demand at time of system peak.

In July 2002 energy code changes took place with the adoption of MEC 95. This code change affects baselines for variables used in the protocols. Therefore, to reflect these changes, tables and or values are identified as needed for installations completed during 2001 through March

2003 and for installations completed in April 2003 through the present. The application of the code changes to completions starting in April allows for the time lag between when the permits are issued and a when a home would reasonably be expected to be completed.

A summary of the input values and their data sources follows:

Applicable to building completions from April 2003 to present

Component	Type	Value	Sources
PL_b	Variable		1
OF_b	Fixed	1.6	2
$SEER_b$	Fixed	13	3
BLEER	Fixed	0.92	4
PL_q	Variable		Software Output
OF_q	Fixed	1.15	5
EER_q	Variable		Program Application
CF	Fixed	0.70	6

Sources:

1. Calculation of peak load of baseline home from the home energy rating tool, based on the reference home energy characteristics.
2. PSE&G 1997 Residential New Construction baseline study.
3. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200
4. Engineering calculation.
5. Program guideline for qualifying home.
6. Based on an analysis of six different utilities by Proctor Engineering.

Lighting and Appliances

Quantification of additional saving due to the addition of high efficiency lighting and clothes washers will be based on the algorithms presented for these appliances in the Energy Star Lighting Protocols and the Energy Star Appliances Protocols, respectively. These protocols are found in the Energy Star Products Program.

Ventilation Equipment

Additional energy savings of 175 kWh and peak demand saving of 60 Watts will be added to the output of the home energy rating software to account for the installation of high efficiency ventilation equipment. These values are based on a baseline fan of 80 Watts and an efficient fan of 20 Watts running for 8 hours per day.

The following table describes the characteristics of the three reference homes.

New Jersey ENERGY STAR Homes
REMRate User Defined Reference Homes -- Applicable to building completions from April 2003 to present -- Reflects MEC 95

Data Point	Single and Multiple Family Except as Noted.		
Active Solar	None		
Ceiling Insulation	U=0.031 (1)		
Radiant Barrier	None		
Rim/Band Joist	U=0.141 Type A-1, U=0.215 Type A-2 (1)		
Exterior Walls - Wood	U=0.141 Type A-1, U=0.215 Type A-2 (1)		
Exterior Walls - Steel	U=0.141 Type A-1, U=0.215 Type A-2 (1)		
Foundation Walls	U=0.99		
Doors	U=0.141 Type A-1, U=0.215 Type A-2 (1)		
Windows	U=0.141 Type A-1, U=0.215 Type A-2 (1), No SHGC req.		
Glass Doors	U=0.141 Type A-1, U=0.215 Type A-2 (1), No SHGC req.		
Skylights	U=0.031 (1), No SHGC req.		
Floor over Garage	U=0.050 (1)		
Floor over Unheated Basement	U=0.050 (1)		
Floor over Crawlspace	U=0.050 (1)		
Floor over Outdoor Air	U=0.031 (1)		
Unheated Slab on Grade	R-0 edge/R-4.3 under		
Heated Slab on Grade	R-0 edge/R-6.4 under		
Air Infiltration Rate	0.51 ACH winter/0.51 ACH summer		
Duct Leakage	No Observable Duct Leakage		
Mechanical Ventilation	None		
Lights and Appliances	Use Default		
Setback Thermostat	Yes for heating, no for cooling		
Heating Efficiency			
Furnace	80% AFUE (3)		
Boiler	80% AFUE		
Combo Water Heater	76% AFUE (recovery efficiency)		
Air Source Heat Pump	6.8 HSPF		

Data Point	Single and Multiple Family Except as Noted.		
Geothermal Heat Pump	Open not modeled, 3.0 COP closed		
PTAC / PTHP	Not differentiated from air source HP		
Cooling Efficiency			
Central Air Conditioning	13.0 SEER		
Air Source Heat Pump	13.0 SEER		
Geothermal Heat Pump	3.4 COP (11.6 EER)		
PTAC / PTHP	Not differentiated from central AC		
Window Air Conditioners	Not differentiated from central AC		
Domestic WH Efficiency			
Electric	0.86 EF (4)		
Natural Gas	0.53 EF (4)		
Water Heater Tank Insulation	None		
Duct Insulation	N/A		

Notes:

(1) Varies with heating degree-days ("HHD"). Above value reflects 5000 HDD average for New Jersey.
U values represent total wall system U value, including all components (i.e., clear wall, windows, doors).
Type A-1 - Detached one and two family dwellings.
Type A-2 - All other residential buildings, three stories in height or less.

(2) Closest approximation to MEC 95 requirements given the limitations of REM/Rate UDRH scripting language.

(3) MEC 95 minimum requirement is 78 AFUE. However, 80 AFUE is adopted for New Jersey based on typical minimum availability and practice.

(4) Size dependent. 50 gallon assumed.

New Jersey ENERGY STAR Homes
REMRate User Defined Reference Homes -- Applicable to building completions from January 2008 to present

Data Point	Single and Multiple Family Except as Noted.		
Domestic WH Efficiency Electric Natural Gas	 EF = 0.97 - (0.00132 * gallons) (1) EF = 0.67 - (0.0019 * gallons) (1)		

Notes:

(1) Federal Government standard for calculating EF

ENERGY STAR Products Program

ENERGY STAR Appliances, ENERGY STAR Lighting, ENERGY STAR Windows, and ENERGY STAR Audit

ENERGY STAR Appliances

Protocols

The general form of the equation for the ENERGY STAR Appliance Program measure savings algorithms is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the protocols will be multiplied by the number of appliance units. The number of units will be determined using market assessments and market tracking. Some of these market tracking mechanisms are under development. Per unit savings estimates are derived primarily from a 2000 Market Update Report by RLW for National Grid's appliance program and from previous NEEP screening tool assumptions (clothes washers).

Note that the pre-July 2001 refrigerator measure has been deleted given the timing of program implementation. As no field results are expected until July 2001, there was no need to quantify savings relative to the pre-July 2001 efficiency standards improvement for refrigerators.

ENERGY STAR Refrigerators

Electricity Impact (kWh) = $ESav_{REF}$

Demand Impact (kW) = $DSav_{REF}$ x CF_{REF}

ENERGY STAR Refrigerators – CEE Tier 2

Electricity Impact (kWh) = $ESav_{REF2}$

Demand Impact (kW) = $DSav_{REF2}$ x CF_{REF}

ENERGY STAR Clothes Washers (MEF of 1.8 to 2.19)

Electricity Impact (kWh) = $ESav_{CW}$

Demand Impact (kW) = $DSav_{CW}$ x CF_{CW}

Gas Impact (Therms) = $EGSav_{CW}$

Water Impact (gallons) = $WSav_{CW}$

ENERGY STAR Clothes Washers – Tier 3 (MEF of 2.20 or greater)

Electricity Impact (kWh) = $ESav_{CW3}$

Demand Impact (kW) = $DSav_{CW3}$ x CF_{CW}

Gas Impact (Therms) = $GSav_{CW3}$

Water Impact (gallons) = $WSav_{CW3}$

ENERGY STAR Dishwashers

Electricity Impact (kWh) = $ESav_{DW}$

Demand Impact (kW) = $DSav_{REF}$ x CF_{DW}

Gas Impact (MMBtu) = $EGSav_{DW}$

Water Impact (gallons) = $WSav_{DW}$

ENERGY STAR Dishwashers CEE Tier 1)

Electricity Impact (kWh) = $ESav_{DW1}$

Demand Impact (kW) = $DSav_{DW1}$ x CF_{DW}

Gas Impact (MMBtu) = $GSav_{DW1}$

Water Impact (gallons) = $WSav_{DW1}$

ENERGY STAR Dehumidifiers

Electricity Impact (kWh) = $ESav_{DH}$

Demand Impact (kW) = $DSav_{DH}$ x CF_{DH}

ENERGY STAR Room Air Conditioners

Electricity Impact (kWh) = $ESav_{RAC}$

Demand Impact (kW) = $DSav_{RAC}$ x CF_{RAC}

ENERGY STAR Televisions – CEE Tier 2 (15% > E-Star Tier 1)

Electricity Impact (kWh) = $ESav_{TV}$

Demand Impact (kW) = $DSav_{TV}$ x CF_{TV}

ENERGY STAR Set Top Boxes
Electricity Impact (kWh) = $ESav_{STB}$

Demand Impact (kW) = $DSav_{STB}$ x CF_{STB}

ENERGY STAR Desktop Computers
Electricity Impact (kWh) = $ESav_{CMP}$

Demand Impact (kW) = $DSav_{CMP}$ x CF_{CMP}

ENERGY STAR LCD Monitor – (25% > E-Star Tier 2)
Electricity Impact (kWh) = $ESav_{MON}$

Demand Impact (kW) = $DSav_{MON}$ x CF_{MON}

Efficient Pool Pumps – (Two speed or variable speed)
Electricity Impact (kWh) = $ESav_{PP}$

Demand Impact (kW) = $DSav_{PP}$ x CF_{PP}

Pool Pump Timers
Electricity Impact (kWh) = $ESav_{PPT}$

Demand Impact (kW) = $DSav_{PPT}$ x CF_{PPT}

Definition of Terms

$ESav_{REF}$ = Electricity savings per purchased ENERGY STAR refrigerator.

$DSav_{REF}$ = Summer demand savings per purchased ENERGY STAR refrigerator.

$ESav_{REF2}$ = Electricity savings per purchased ENERGY STAR refrigerator – CEE Tier 2.

$DSav_{REF2}$ = Summer demand savings per purchased ENERGY STAR refrigerator – CEE Tier 2.

$ESav_{CW}$ = Electricity savings per purchased ENERGY STAR clothes washer.

$DSav_{CW}$ = Summer demand savings per purchased ENERGY STAR clothes washer.

$GSav_{CW}$ = Gas savings per purchased clothes washer

$WSav_{CW}$ = Water savings per purchased clothes washer.

$ESav_{CW3}$ = Electricity savings per purchased ENERGY STAR clothes washer - Tier 3

$DSav_{CW3}$ = Summer demand savings per purchased ENERGY STAR clothes washer - Tier 3

$GSav_{CW3}$ = Gas savings per purchased ENERGY STAR clothes washer - Tier 3

$WSav_{CW3}$ = Water savings per purchased ENERGY STAR clothes washer – Tier 3

$ESav_{DW}$ = Electricity savings per purchased ENERGY STAR dishwasher.

$DSav_{DW}$ = Summer demand savings per purchased ENERGY STAR dishwasher.

$GSav_{DW}$ = Gas savings per purchased ENERGY STAR dishwasher

$Wsav_{DW}$ = Water savings per purchased ENERGY STAR dishwasher.

$ESav_{DW1}$ = Electricity savings per purchased ENERGY STAR dishwasher – CEE Tier 1

$DSav_{DW1}$ = Summer demand savings per purchased ENERGY STAR dishwasher – CEE Tier 1

$GSav_{DW1}$ = Gas savings per purchased ENERGY STAR dishwasher – CEE Tier 1

$Wsav_{DW1}$ = Water savings per purchased ENERGY STAR dishwasher – CEE Tier 1

$ESav_{DH}$ = Electricity savings per purchased ENERGY STAR dehumidifier

$DSav_{DH}$ = Summer demand savings per purchased ENERGY STAR dehumidifier

$ESav_{RAC}$ = Electricity savings per purchased ENERGY STAR room AC.

$DSav_{RAC}$ = Summer demand savings per purchased ENERGY STAR room AC.

$ESav_{TV}$ = Electricity savings per purchased ENERGY STAR TV meeting CEE Tier 2.

$DSav_{TV}$ = Summer demand savings per purchased ENERGY STAR TV meeting CEE Tier 2.

$ESav_{STB}$ = Electricity savings per purchased ENERGY STAR set top box.

$DSav_{STB}$ = Summer demand savings per purchased ENERGY STAR set top box.

$ESav_{CMP}$ = Electricity savings per purchased ENERGY STAR computer.

$DSav_{CMP}$ = Summer demand savings per purchased ENERGY STAR computer.

$ESav_{MON}$ = Electricity savings per purchased ENERGY STAR monitor exceeding Tier 2 by 15%.

$DSav_{MON}$ = Summer demand savings per purchased ENERGY STAR monitor exceeding Tier 2 by 15%.

$ESav_{PP}$ = Electricity savings per purchased efficient pool pump (Two speed or variable speed).

$DSav_{PP}$ = Summer demand savings per purchased pool pump (Two speed or variable speed).

$ESav_{PPT}$ = Electricity savings per purchased pool pump timer.

$DSav_{PPT}$ = Summer demand savings per purchased pool pump timer.

CF_{REF}, CF_{CW}, CF_{DW}, CF_{DH}, CF_{RAC}, CF_{TV}, CF_{STB}, CF_{CMP}, CF_{MON}, CF_{PP}, CF_{PPT} = Summer demand coincidence factor. The coincidence of average appliance demand to summer system peak equals 1 for demand impacts for all appliances reflecting embedded coincidence in the DSav factor except for room air conditioners where the CF is 58%.

ENERGY STAR Appliances

Component	Type	Value	Sources
$ESav_{REF}$	Fixed	105 kWh	1
$DSav_{REF}$	Fixed	0.0120 kW	1
$ESav_{REF2}$	Fixed	131 kWh	16
$DSav_{REF2}$	Fixed	0.0150 kW	16
REF Time Period Allocation Factors	Fixed	Summer/On-Peak 20.9% Summer/Off-Peak 21.7% Winter/On-Peak 28.0% Winter/Off-Peak 29.4%	2
$ESav_{CW}$	Fixed	90 kWh	17
$Gsav_{CW}$	Fixed	5.23 therms	17
$DSav_{CW}$	Fixed	0.0119 kW	17
$WSav_{CW}$	Fixed	6,846 gallons	17
$ESav_{CW3}$	Fixed	128 kWh	3
$Gsav_{CW3}$	Fixed	9.00 therms	3
$DSav_{CW3}$	Fixed	0.0170 kW	3
$WSav_{CW3}$	Fixed	9433 gallons	3
CW Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 24.5% Summer/Off-Peak 12.8% Winter/On-Peak 41.7% Winter/Off-Peak 21.0%	2
CW Gas Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	
$ESav_{DW}$	Fixed	45 kWh	4
$Gsav_{DW}$	Fixed	1.35 therms	4

Component	Type	Value	Sources
$DSav_{DW}$	Fixed	0.0123	4
$Wsav_{DW}$	Fixed	402 gallons	4
$ESav_{DW1}$	Fixed	53 kWh	18
$Gsav_{DW1}$	Fixed	1.56 therms	18
$DSav_{DW1}$	Fixed	0.0145 kW	18
$Wsav_{DW1}$	Fixed	497 gallons	18
DW Electricity Time Period Allocation Factors	Fixed	19.8%, 21.8%, 27.8%, 30.6%	2
DW Gas Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	8
$ESav_{DH}$	Fixed	71 kWh	9
$DSav_{DH}$	Fixed	.0098 kW	10
$ESav_{RAC}$	Fixed	56.4 kWh	5
$DSav_{RAC}$	Fixed	0.1018 kW	6
$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{DH}, CF_{RAC}	Fixed	1.0, 1.0, 1.0, 1.0, 0.58	7
$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{DH}, CF_{TV}, $CF_{STB,}$ $CF_{CMP,}$ $CF_{MON,}$ CF_{RAC}	Fixed	1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 0.58	7
RAC Time Period Allocation Factors	Fixed	65.1%, 34.9%, 0.0%, 0.0%	2
$ESav_{TV}$	Fixed	146 kWh	11
$DSav_{TV}$	Fixed	.0160 kW	11
TV Time Period Allocation Factors	Fixed	Summer/On-Peak 24.5% Summer/Off-Peak 9.0% Winter/On-Peak 48.0% Winter/Off-Peak 18.5%	11
$ESav_{STB}$	Fixed	94 kWh	12
$DSav_{STB}$	Fixed	0.0107 kW	12
STB Time Period Allocation Factors	Fixed	Summer/On-Peak 16.6% Summer/Off-Peak 16.8% Winter/On-Peak 32.5% Winter/Off-Peak 34.1%	12
$ESav_{CMP\ -}$	Fixed	87 kWh	13
$DSav_{CMP}$	Fixed	.0039 kW	13
CMP Time Period Allocation Factors	Fixed	Summer/On-Peak 16.9% Summer/Off-Peak 16.4% Winter/On-Peak 33.8% Winter/Off-Peak 32.9%	13
$ESav_{MON}$	Fixed	43 kWh	14
$DSav_{MON}$	Fixed	.0075 kW	14

Component	Type	Value	Sources
MON Time Period Allocation Factors	Fixed	Summer/On-Peak 16.9% Summer/Off-Peak 16.4% Winter/On-Peak 33.8% Winter/Off-Peak 32.9%	14
$ESav_{PP}$	Fixed	1,235 kWh	15
$DSav_{PP}$	Fixed	.74 kW	15
PP Time Period Allocation Factors	Fixed	Summer/On-Peak 65% Summer/Off-Peak 35% Winter/On-Peak 0% Winter/Off-Peak 0%	15
$ESav_{PPT}$	Fixed	1,006 kWh	15
$DSav_{PPT}$	Fixed	.124 kW	15
PPT Time Period Allocation Factors	Fixed	Summer/On-Peak 23% Summer/Off-Peak 77% Winter/On-Peak 0% Winter/Off-Peak 0%	15

Sources:

1. Energy Star refrigerator Savings are derived from US Department of Energy estimates for the State Energy Efficient Appliance Rebate Program. Demand savings are estimated based on a flat 8760 hours of use during the year.
2. Time period allocation factors used in cost-effectiveness analysis. From residential appliance load shapes.
3. Energy and water savings based on Consortium for Energy Efficiency estimates. Assumes 75% of participants have gas water heating and 60% have gas drying (the balance being electric). Demand savings derived using NEEP screening clothes washer load shape
4. Energy Star dishwasher savings are derived from US Department of Energy estimates for the State Energy Efficient Appliance Rebate Program. Demand savings derived using dishwasher load shape.
5. Energy and demand savings from engineering estimate based on 600 hours of use. Based on delta watts for ENERGY STAR and non-ENERGY STAR units in five different size (cooling capacity) categories. Category weights from LBNL *Technical Support Document for ENERGY STAR Conservation Standards for Room Air Conditioners*.
6. Average demand savings based on engineering estimate.
7. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.
8. Prorated based on 6 months in the summer period and 6 months in the winter period.
9. Energy Star Dehumidifier Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). A weighted average based on the distribution of available ENERGY STAR products was used to determine savings.
10. Conservatively assumes same kW/kWh ratio as Refrigerators
11. Demand savings for TVs are derived from a comparison of an average of a 2007 US EPA data set and a January 2009 Energy star approved list. Energy savings are calculated based on hourly usage patterns defined in the US EPA 2007 revised TV specification.

12. Baseline energy savings for set top boxes is based on recent evaluation by Marbek / Ecos for BC Hydro, Feasibility Assessment of Canadian ENERGY STAR Set-Top Box Promotion Program (2009). On average, demand savings are the same for both Active and Standby states and is based on 8760 hours usage.
13. Energy savings for efficient computers is developed from an updated EPA data set (2008) accompanying the release of Version 5.0 ENERGY STAR Specification for Computers. Demand savings are calculated based on average power consumption in the idle (on) state.
14. Energy and demand savings for ultra efficient LCD monitors is based on a submittal to the California Energy Commission, Docket 07-AAER-3. Loadshape and coincidence factors are adopted from the efficient computer measure.
15. Energy and demand savings for efficient pool pumps are calculated based on California Energy Commission performance curves for two speed and variable speed pool pumps. Timers and Pool Pumps assume continued operation from June 1st to Sept 15th.
16. Refrigerator savings for CEE Tier 2 are derived from a 5% increase in performance over the US Department of Energy estimates for an ENERGY STAR unit in the State Energy Efficient Appliance Rebate Program.
17. Energy Star clothes washer savings are derived from US Department of Energy estimates for the State Energy Efficient Appliance Rebate Program. Demand savings derived using NEEP screening clothes washer load shape.
18. Energy Star clothes washer savings are derived from US Department of Energy estimates for the State Energy Efficient Appliance Rebate Program. Demand savings derived using dishwasher load shape.

Residential ENERGY STAR Lighting

Protocols

Savings from installation of screw-in ENERGY STAR CFLs, ENERGY STAR fluorescent torchieres, ENERGY STAR indoor fixtures and ENERGY STAR outdoor fixtures are based on a straightforward algorithm that calculates the difference between existing and new wattage, and the average daily hours of usage for the lighting unit being replaced. An "in-service" rate is used to reflect the fact that not all lighting products purchased are actually installed.

The general form of the equation for the ENERGY STAR or other high efficiency lighting energy savings algorithm is:

Number of Units X Savings per Unit

Per unit savings estimates are derived primarily from a 2004 Nexus Market Research report evaluating similar retail lighting programs in New England (MA, RI and VT). Per unit savings will decrease for CFLs in operation after 2012 due to the effects of federal minimum efficiency standards for incandescent lighting. Because CFLs typically have rated lifespans of 6-8000 hours (5-7 years) and incandescent light bulbs are rated at 1000 hours (1 year), after 2013 there will be less of a difference between CFLs in service and the incandescents that they would have been replacing.

ENERGY STAR CFL Bulbs

Energy Savings (kWh) = $(\Delta kW/1000) * CFL_{hours} * 365 * ISR_{cfl}$

Demand Savings (kW) = $(\Delta kW/1000) * CF$

ENERGY STAR Torchieres

Electricity Impact (kWh) = $((Torch_{watts} \text{ X } (Torch_{hours} \text{ X } 365))/1000) \text{ X } ISR_{Torch}$

Peak Demand Impact (kW) = $(Torch_{watts})$ X Light CF

ENERGY STAR Indoor Fixture

Electricity Impact (kWh) = $((IF_{watts} \text{ X } (IF_{hours} \text{ X } 365))/1000) \text{ X } ISR_{IF}$

Peak Demand Impact (kW) = (IF_{watts}) X Light CF

ENERGY STAR Outdoor Fixture

Electricity Impact (kWh) = $((OF_{watts} \text{ X } (OF_{hours} \text{ X } 365))/1000) \text{ X } ISR_{OF}$

Peak Demand Impact (kW) = (OF_{watts}) X Light CF

ENERGY STAR LED Recessed Downlights

Energy Savings (kWh) = $((LED_{DWN\text{-}watts} / 1000) \times LED_{Hours} \times 365 \times ISR_{LED}$

Demand Savings (kW) = $(LED_{DWN\text{-}watts} / 1000) * CF$

Definition of Terms

ΔW = Average difference in watts between baseline and ENERGY STAR CFL

CFL_{hours} = Average hours of use per day per CFL

CF = Summer demand coincidence factor for ligthing

ISR_{CFL} = In-service rate per CFL

$Torch_{watts}$ = Average delta watts per purchased ENERGY STAR torchiere

$Torch_{hours}$ = Average hours of use per day per torchiere

ISR_{Torch} = In-service rate per Torchier

IF_{watts} = Average delta watts per purchased ENERGY STAR Indoor Fixture

IF_{hours} = Average hours of use per day per Indoor Fixture

ISR_{IF} = In-service rate per Indoor Fixture

OF_{watts} = Average delta watts per purchased ENERGY STAR Outdoor Fixture

OF_{hours} = Average hours of use per day per Outdoor Fixture

ISR_{OF} = In-service rate per Outdoor Fixture

Light CF = Summer demand coincidence factor for lighting.

$LED_{DWN\text{-}watts}$ = Average delta watts per purchased LED recessed downlight

LED_{hours} = Average hours of use per day per LED recessed downlight

ISR_{LED} = In-service rate per LED recessed downlight

ENERGY STAR Lighting

Component	Type	Value	Sources
ΔW	Fixed	48.5	5
CFL_{hours}	Fixed	2.8	6
ISR_{CFL}	Fixed	83.4%	5
CF	Fixed	9.9 %	4
$Torch_{watts}$	Fixed	115.8	1
$Torch_{hours}$	Fixed	3.0	2
ISR_{Torch}	Fixed	83%	3
IF_{watts}	Fixed	48.7	1
IF_{hours}	Fixed	2.6	2
ISR_{IF}	Fixed	95%	3
OF_{watts}	Fixed	94.7	1
OF_{hours}	Fixed	4.5	2
ISR_{OF}	Fixed	87%	3
Light CF	Fixed	5%	4
$LED_{DWN\text{-}watts}$	Fixed	53.9	7

Component	Type	Value	Sources
LED_{hours}	Fixed	2.8	6
ISR_{LED}	Fixed	100%	7

Sources:

1. Nexus Market Research, "Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs", Final Report, October 1, 2004, p. 43 (Table 4-9)
2. US Department of Energy, Energy Star Calculator.
3. Ibid., p. 42 (Table 4-7). These values reflect both actual installations and the % of units planned to be installed within a year from the logged sample. The logged % is used because the adjusted values (i.e to account for differences between logging and telephone survey samples) were not available for both installs and planned installs. However, this seems appropriate because the the % actual installed in the logged sample from this table is essentially identical to the % after adjusting for differences between the logged group and the telephone sample (p. 100, Table 9-3).
4. RLW Analytics, "Development of Common Demand Impacts for Energy Efficiency Measures/Programs for the ISO Forward Capacity Market (FCM)", prepared for the New England State Program Working Group (SPWG), March 25, 2007, p. IV.
5. KEMA, *NJ Clean Energy Program Energy Impact Evaluation Protocol Review*. 2009.
6. RLW Analytics, *New England Residential Lighting Markdown Impact Evaluation*, January 20, 2009.
7. For determining demand savings the baseline was adopted from 2009 KEMA evaluation and represents the replacement of a 65W BR30 downlight and high efficiency is the average of ENERGY STAR qualified downlights (11/10/2009) with lighting output exceeding 475 lumens. Due to the high incremental cost and limited market availability of products, the higher ISR reflects the assumption that every LED downlight purchased is directed towards immediate use.

ENERGY STAR Windows

Protocols

The general form of the equation for the ENERGY STAR or other high efficiency windows energy savings algorithms is:

Square Feet of Window Area X Savings per Square Foot

To determine resource savings, the per square foot estimates in the protocols will be multiplied by the number of square feet of window area. The number of square feet of window area will be determined using market assessments and market tracking. Some of these market tracking mechanisms are under development. The per unit energy and demand savings estimates are based on prior building simulations of windows.

ENERGY STAR Windows

Savings estimates for ENERGY STAR Windows are based on modeling a typical 2,500 square foot home using REM Rate, the home energy rating tool. Savings are per square foot of qualifying window area. Savings will vary based on heating and cooling system type and fuel. These fuel and HVAC system market shares will need to be estimated from prior market research efforts or from future program evaluation results.

<u>Heat Pump</u>

Electricity Impact (kWh) = $ESav_{HP}$

Demand Impact (kW) = $DSav_{HP}$ x CF

<u>Gas Heat/CAC</u>

Electricity Impact (kWh) = $ESav_{GAS/CAC}$

Demand Impact (kW) = $DSav_{CAC}$ x CF

Gas Impact (therms) = $GSav_{GAS}$

<u>Gas Heat/No CAC</u>

Electricity Impact (kWh) = $ESav_{GAS/NOCAC}$

Demand Impact (kW) = $DSav_{NOCAC}$ x CF

Gas Impact (therms) = $GSav_{GAS}$

<u>Oil Heat/CAC</u>

Electricity Impact (kWh) = $ESav_{OIL/CAC}$

Demand Impact (kW) = $DSav_{CAC}$ x CF

Oil Impact (MMBtu) = $OSav_{OIL}$

<u>Oil Heat/No CAC</u>

Electricity Impact (kWh) = $ESav_{OIL/NOCAC}$

Demand Impact (kW) = $DSav_{NOCAC}$ x CF

Oil Impact (MMBtu) = $OSav_{OIL}$

Electric Heat/CAC

Electricity Impact (kWh) = $ESav_{RES/CAC}$

Demand Impact (kW) = $DSav_{CAC}$ x CF

Electric Heat/No CAC

Electricity Impact (kWh) = $ESav_{RES/NOCAC}$

Demand Impact (kW) = $DSav_{NOCAC}$ x CF

Definition of Terms

$ESav_{HP}$ = Electricity savings (heating and cooling) with heat pump installed.

$ESav_{GAS/CAC}$ = Electricity savings with gas heating and central AC installed.

$ESav_{GAS/NOCAC}$ = Electricity savings with gas heating and no central AC installed.

$ESav_{OIL/CAC}$ = Electricity savings with oil heating and central AC installed.

$ESav_{OIL/NOCAC}$ = Electricity savings with oil heating and no central AC installed.

$ESav_{RES/CAC}$ = Electricity savings with electric resistance heating and central AC installed.

$ESav_{RES/NOCAC}$ = Electricity savings with electric resistance heating and no central AC installed.

$DSav_{HP}$ = Summer demand savings with heat pump installed.

$DSav_{CAC}$ = Summer demand savings with central AC installed.

$DSav_{NOCAC}$ = Summer demand savings with no central AC installed.

CF = System peak demand coincidence factor. Coincidence of building cooling demand to summer system peak.

$GSav_{GAS}$ = Gas savings with gas heating installed.

$OSav_{OIL}$ = Oil savings with oil heating installed.

ENERGY STAR Windows

Component	Type	Value	Sources
$ESav_{HP}$	Fixed	2.2395 kWh	1
HP Time Period Allocation Factors	Fixed	Summer/On-Peak 10% Summer/Off-Peak 7% Winter/On-Peak 40% Winter/Off-Peak 44%	2
$ESav_{GAS/CAC}$	Fixed	0.2462 kWh	1
Gas/CAC Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 65% Summer/Off-Peak 35% Winter/On-Peak 0% Winter/Off-Peak 0%	2
$ESav_{GAS/NOCAC}$	Fixed	0.00 kWh	1
Gas/No CAC Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2
Gas Heating Gas Time Period Allocation Factors	Fixed	Summer = 12% Winter = 88%	4
$ESav_{OIL/CAC}$	Fixed	0.2462 kWh	1
Oil/CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 65% Summer/Off-Peak 35% Winter/On-Peak 0% Winter/Off-Peak 0%	2
$ESav_{OIL/NOCAC}$	Fixed	0.00 kWh	1
Oil/No CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2
$ESav_{RES/CAC}$	Fixed	4.0 kWh	1
Res/CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 10% Summer/Off-Peak 7% Winter/On-Peak 40% Winter/Off-Peak 44%	2
$ESav_{RES/NOCAC}$	Fixed	3.97 kWh	1
Res/No CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2
$DSav_{HP}$	Fixed	0.000602 kW	1
$DSav_{CAC}$	Fixed	0.000602 kW	1
$DSav_{NOCAC}$	Fixed	0.00 kW	1
$GSav_{GAS}$	Fixed	0.169 therms	1
$OSav_{OIL}$	Fixed	0.0169 MMBtu	1

Component	Type	Value	Sources
CF	Fixed	0.75	3

Sources:

1. From REMRATE Modeling of a typical 2,500 sq. ft. NJ home. Savings expressed on a per sq. ft. of window area basis. New Brunswick climate data.
2. Time period allocation factors used in cost-effectiveness analysis.
3. Based on reduction in peak cooling load.
4. Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.

Home Energy Reporting System

Protocols

The purpose of the program is to provide information and tools that residential customers can use to make decisions about what actions to take to improve energy efficiency in their homes. The information is mailed in reports separately and soon after a utility's regular bill to create a neighbor-to-neighbor comparison where homes of similar size are compared to each other, as well as targeting energy saving tips to individuals.

Home Energy Reporting System

Gas Savings (Therms) = $GSav_{HERS}$

Component	Type	Value	Sources
$Gsav_{HERS}$	Fixed	13.1 therms	1

Sources:

1. The average natural gas savings from similar program offered to Pudget Sound Energy customers. (Reference: Evidence from Two Large Field Experiments that Peer Comparison Feedback Can Reduce Residential Energy Usage, Ayres, 2009)

Refrigerator/Freezer Retirement Program

Protocols

The general form of the equation for the Refigerator/Freezer Retirement Program savings algorithm is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the protocols will be multiplied by the number of appliance units.

Unit savings are the product of average fridge/freezer consumption (gross annual savings), and a net to gross ratio that adjusts for both free ridership and the portion of retired units that are replaced with more efficient new units.

Algorithm

Electricity Impact (kWh) = $ESav_{RetFridge}$ * NTG

Demand Impact (kW) = $DSav_{RetFridge}$ x $CF_{RetFridge}$

Definition of Terms

$ESav_{RetFridge}$ = Gross annual energy savings per unit retired appliance

NTG = Net-to-Gross Adjustment factor.

$DSav_{RetFridge}$ = Summer demand savings per retired refrigerator/freezer

$CF_{RetFridge}$ = Summer demand coincidence factor.

REFRIGERATOR/FREEZER RECYCLING

Component	Type	Value	Sources
$ESav_{RetFridge}$	Fixed	1,728 kWh	1
NTG	Fixed	55%	2
$DSav_{RetFridge}$	Fixed	.2376 kW	3
$CF_{RetFridge}$	Fixed	1	4

Sources:

1. The average power consumption of units retired under similar recent programs:
   a. Fort Collins Utilities, February 2005. Refrigerator and Freezer Recycling Program 2004 Evaluation Report.
   b. Midwest Energy Efficiency Alliance, 2005. 2005 Missouri Energy Star Refrigerator Rebate and Recycling Program Final Report
   c. Pacific Gas and Electric, 2007. PGE ARP 2006-2008 Climate Change Impacts Model (spreadsheet)
   d. Quantec, Aug 2005. Evaluation of the Utah Refrigerator and Freezer Recycling Program (Draft Final Report).
   e. CPUC DEER website, http://eega.cpuc.ca.gov/deer/measure.asp?s=1&c=2&sc=7&m=389059
   f. Snohomish PUD, February 2007. 2006 Refrigerator/Freezer Recycling Program Evaluation.
   g. Ontario Energy Board, 2006. Total Resource Cost Guide.
2. The average net to gross ratios estimated for several recent programs
   a. Fort Collins Utilities, February 2005. Refrigerator and Freezer Recycling Program 2004 Evaluation Report.
   b. SCE, 2001. The Multi-Megawatt Refrigerator/Freezer Recycling Summer Initiative Program Final Report.
   c. Pacific Gas and Electric, 2007. PGE ARP 2006-2008 Climate Change Impacts Model (spreadsheet)
   d. Quantec, Aug 2005. Evaluation of the Utah Refrigerator and Freezer Recycling Program (Draft Final Report).
   e. Snohomish PUD, February 2007. 2006 Refrigerator/Freezer Recycling Program Evaluation.
   f. Ontario Energy Board, 2006. Total Resource Cost Guide.
3. Applied the kW to kWh ratio derived from Refrigerator savings in the ENERGY STAR Appliances Program.
4. Coincidence factor already embedded in summer peak demand reduction estimates

Home Performance with ENERGY STAR Program

In order to implement Home Performance with Energy Star, there are various standards a program implementer must adhere to in order to deliver the program. The program implementer must use software that meets a national standard for savings calculations from whole-house approaches such as home performance. The software the program implementer uses must adhere to at least one of the following standards:

- A software tool whose performance has passed testing according to the National Renewable Energy Laboratory's HERS BESTEST software energy simulation testing protocol.[3]
- Software approved by the US Department of Energy's Weatherization Assistance Program.[4]
- RESNET approved rating software.[5]

There are numerous software packages that comply with these standards. Some examples of the software packages are REM/Rate, EnergyGauge, TREAT, and HomeCheck. The HomeCheck software is described below as an example of a software that can be used to determine if a home qualifies for Home Performance with Energy Star.

HomeCheck Software Example

The following section provides a description of the HomeCheck software, which is designed to enable an energy auditor to collect information about a customer's site, and, based on what is found through the energy audit, recommend energy savings measures and demonstrate the costs and savings associated with those recommendations. The HomeCheck software is also used to estimate the energy savings that are reported for this program. The HomeCheck software is described here as an example only of how the various software packages work.

These protocols incorporate the HomeCheck software by reference which will be utilized for estimating energy savings for the Home Performance with Energy Star Program. The Board intends to assess the savings reported from time to time and will make adjustments as necessary. The following is a summary of the HomeCheck software:
The HomeCheck software was designed to streamline the delivery of energy efficiency programs. The software provides the energy efficiency specialist with an easy-to-use guide for data collection, site and HVAC testing protocols, eligible efficiency measures, and estimated energy savings. The software is designed to enable an auditor to collect information about customers' sites and then, based on what he/she finds through the audit, recommend energy-saving measures, demonstrate the costs and savings associated with those recommendations. It

[3] A new standard for BESTEST is currently being developed. The existing 1995 standard can be found at http://www.nrel.gov/docs/legosti/fy96/7332a.pdf .
[4] A listing of the approved software available at http://www.waptac.org/si.asp?id=736 .
[5] A listing of the approved software available at http://resnet.us .

also enables an auditor/technician to track the delivery of services and installation of measures at a site.

This software is a part of an end-to-end solution for delivering high-volume retrofit programs, covering administrative functions such as customer relationship management, inspection scheduling, sub-contractor arranging, invoicing and reporting. The range of existing components of the site that can be assessed for potential upgrades is extensive and incorporates potential modifications to almost all energy using aspects of the home. The incorporation of building shell, equipment, distribution systems, lighting, appliances, diagnostic testing and indoor air quality represents a very broad and comprehensive ability to view the needs of a home.

The software is designed to combine two approaches to assessing energy savings opportunities at the site. One is a measure specific energy loss calculation, identifying the change in use of BTU's achieved by modifying a component of the site. Second, is the correlation between energy savings from various building improvements, and existing energy use patterns at a site. The use of both calculated savings and the analysis of existing energy use patterns, when possible, provides the most accurate prescription of the impact of changes at the site for an existing customer considering improvements on a retrofit basis.

This software is not designed to provide a load calculation for new equipment or a HERS rating to compare a site to a standard reference site. It is designed to guide facilities in planning improvements at the site with the goal of improved economics, comfort and safety. The software calculates various economic evaluations such as first year savings, simple payback, measure life cost-effectiveness, and Savings-to-Investment ratio (SIR).

Site-Level Parameters and Calculations

There are a number of calculations and methodologies that apply across measures and form the basis for calculating savings potentials at a site.

Heating Degree Days and Cooling Degree Hours

Heat transfer calculations depend fundamentally on the temperature difference between inside and outside temperature. This temperature difference is often summarized on a seasonal basis using fixed heating degree-days (HDD) and cooling degree-hours CDH). The standard reference temperature for calculating HDD (the outside temperature at which the heating system is required), for example, has historically been 65°F. Modern houses have larger internal gains and more efficient thermal building envelopes than houses did when the 65°F standard was developed, leading to lower effective reference temperatures. This fact has been recognized in ASHRAE Fundamentals, which provides a variable-based degree-day method for calculating energy usage. CSG's Building Model calculates both HDD and CDH based on the specific characteristics and location of the site being treated.

Building Loads, Other Parameters, and the Building Model

Some are of the opinion that, in practice, detailed building load simulation tools are quite limited in their potential to improve upon simpler approaches due to their reliance on many factors that are not measurable or known, as well as limitations to the actual models themselves. Key to these limitations is the Human Factor (e.g., sleeping with the windows open; extensive use of high-volume extractor fans, etc.) that is virtually impossible to model. As such, the basic concept behind the model was to develop a series of location specific lookup tables that would take the place of performing hourly calculations while allowing the model to perform for any location. The data in these tables would then be used along with a minimum set of technical data to calculate heating and cooling building loads.

In summary, the model uses:

- Lookup tables for various parameters that contain the following values for each of the 239 TMY2 weather stations:
    - Various heating and cooling infiltration factors
    - Heating degree days and heating hours for a temperature range of 40 to 72°F
    - Cooling degree hours and cooling hours for a temperature range of 68 to 84°F
    - Heating and cooling season solar gain factors

- Simple engineering algorithms based on accepted thermodynamic principles, adjusted to reflect known errors, the latest research and measured results
- Heating season iterative calculations to account for the feedback loop between conditioned hours, degree days, average "system on" indoor and outdoor temperatures and the building
- The thermal behavior of homes is complex and commonly accepted algorithms will on occasion predict unreasonably high savings, HomeCheck uses a proprietary methodology to identify and adjust these cases. This methodology imposes limits on savings projected by industry standard calculations, to account for interactivities and other factors that are difficult to model. These limits are based on measured experience in a wide variety of actual installations.

Usage Analysis

The estimation of robust building loads through the modeling of a building is not always reliable. Thus, in addition to modeling the building, HomeCheck calculates a normalized annual consumption for heating and cooling, calculated from actual fuel consumption and weather data using a Seasonal Swing methodology. This methodology uses historic local weather data and site-specific usage to calculate heating and cooling loads. The methodology uses 30-year weather data to determine spring and fall shoulder periods when no heating or cooling is likely to be in use. The entered billing history is broken out into daily fuel consumption, and these daily consumption data along with the shoulder periods is used to calculate base load usage, and summer and winter seasonal swing fuel consumption.

Multiple HVAC Systems

HVAC system and distribution seasonal efficiencies are used in all thermal shell measure algorithms. HVAC system and distribution seasonal efficiencies and thermostat load reduction adjustments are used when calculating the effect of interactivity between mechanical and architectural measures. If a site has multiple HVAC systems, weighted average seasonal efficiencies and thermostat load reduction adjustments are calculated based on the relative contributions (in terms of percent of total load) of each system.

Multiple Heating Fuels

It is not unusual to find homes with multiple HVAC systems using different fuel types. In these cases it is necessary to aggregate the NACs for all fuel sources for use in shell savings algorithms. This is achieved by assigning a percentage contribution to total NAC for each system, converting this into BTU's, and aggregating the result. Estimated first year savings for thermal shell measures are then disaggregated into the component fuel types based on the pre-retrofit relative contributions of fuel types.

Interactivity

To account for interactivity between architectural and mechanical measures, HomeCheck employs the following methodology, in order:

- Non interacted first year savings are calculated for each individual measure
- Non-interacted SIR (RawSIR) is calculated for each measure
- Measures are ranked in descending order of RawSIR
- Starting with the most cost-effective measure (as defined by RawSIR), first year savings are adjusted for each measure as follows:
    - Mechanical measures (such as thermostats, HVAC system upgrades or distribution system upgrades) are adjusted to account for the load reduction from measures with a higher RawSIR
    - Architectural measures are adjusted to account for overall HVAC system efficiency changes and thermostat load reduction changes. Architectural measures with a higher RawSIR than that of HVAC system measures are calculated using the existing efficiencies. Those with RawSIR's lower than that of heating equipment use the new heating efficiencies.
- Interacted SIR is then calculated for each measure, along with cumulative SIR for the entire job.
- All measures are then re-ranked in descending order of SIR
- The process is repeated, replacing RawSIR with SIR until the order of measures does not change

Lighting

Quantification of additional saving due to the addition of high efficiency lighting will be based on the algorithms presented for these appliances in the Energy Star Lighting Protocols found in the Energy Star Products Program.

Energy Use Feedback Devices

For homes with an energy use feedback device installed, a fixed annual electric savings of 320 kWh is estimated. These savings estimates are based on the following study: Mountain D, 2006, "The Impact of Real-Time Feedback on Residential Electricity Consumption: The Hydro One Pilot," Mountain Economic Consulting and Associated Inc., Ontario.

- Savings have been adjusted to account for the percentage of homes with non-electric space heating and/or non-electric DHW vs. homes with electric space heating and/or electric DHW.

The following grid outlines the savings observed in the Mountain study by fuel type and the correlating estimated NJ population of that fuel type.

	Reduction in electricity consumption per Mountain Study	NJ Population
Non-electric water heating and non-electric space heating	5.1%	70%
Homes with electric water heating and non-electric space heating	16.7%	20%
Homes with electric space heating and electric water heating	1.2%	10%

Savings were further adjusted by a 50% conservatism adjustment factor until more NJ specific data has been gathered.

Commercial and Industrial Energy Efficient Construction

C&I Electric Protocols

Baselines and Code Changes

In general, efficiency baselines are designed to reflect current market practices - typically, the higher of applicable codes or the minimum efficiency of available new equipment - and are updated periodically to reflect upgrades in code or information from evaluation results. There are exceptions to this approach, as in the Direct Install program (see below).

Baseline data reflect ASHRAE 90.1 1999 for program commitments made prior to December 31, 2007 and ASHRAE 90.1 2004 for commitments starting on January 1, 2008..

Building Shell

Building shell measures identified in an approved Local Government Energy Audit (or equivalent) are eligible for program incentives for a limited time through ARRA funding. Savings for these measures will vary from project to project based on factors such as building size, existing levels of insulation and infiltration levels. As a result, energy savings for these installed building shell measures will be taken from what is provided in the approved Audit.

Performance Lighting

For new construction and entire facility rehabilitation projects, savings are calculated by comparing lighting power density of fixture being installed to the baseline power densities from ASHRAE 90.1 2004.

Lighting equipment includes fluorescent fixtures, ballasts, compact fluorescent fixtures, exit signs, LED fixtures, and metal halide lamps. The measurement of energy savings is based on algorithms with measurement of key variables (i.e., Coincidence Factor and Operating Hours) through end-use metering data accumulated from a large sample of participating facilities from 1995 through 1999.

Algorithms

Demand Savings = ΔkW X CF X (1+IF)

Energy Savings = ΔkW X EFLH X (1+IF)

$\Delta kW = (LPD_{base} – LPD_{inst}) \times SF$

Definition of Variables

ΔkW = Change in connected load from baseline to efficient lighting level.

LPD_{base} = Baseline lighting power density in Watt per square foot of space floor area, based on ASHRAE 90.1 Table 9.6.1 (Space-by-Space Method)

LPD_{inst} = Lighting power density of installed fixtures, equal to the sum of installed fixture wattage divided by floor area of the space where the fixtures are installed. Wattage of installed fixtures is based on table at http://www.sce.com/NR/rdonlyres/FC51087D-2848-42DF-A52A-BDBA1A09BF8D/0/SCE_B_StandardFixtureWatts010108.pdf.

SF = space floor area, Square Foot

CF = Coincidence Factor

EFLH = Equivalent Full Load Hours

IF = Interactive Factor

Lighting Verification Summary

Component	Type	Value	Source
ΔkW	Fixed	See Lighting Wattage Table derived from the California SPC Table: http://www.sce.com/NR/rdonlyres/FC51087D-2848-42DF-A52A-BDBA1A09BF8D/0/SCE_B_StandardFixtureWatts010108.pdf And Formula Above.	• 1 • Baseline LPD from ASHRAE 90.1-2004 Table 9.6.1 • Installed LPD, space type and floor area from customer application.
CF	Fixed	See Lighting Table by BuildingType	2
IF	Fixed	See Lighting Table by Building Type	3
EFLH	Fixed	See Lighting Table by Building Type	4

Lighting Wattage Table

Fixture Type Installed	Fixture Installed	kW/Fixture
Fluorescent - 1 L STD T-8	17 W (1) 2' T-8 Lamp	0.017
Fluorescent - 1 L STD T-8	25 W (1) 3' T-8 Lamp	0.023
Fluorescent - 1 L STD T-8	32 W (1) 4' T-8 Lamp	0.030
Fluorescent - 1 L STD T-8	40 W (1) 5' T-8 Lamp	0.035
Fluorescent - 1 L STD T-8	59 W (1) 8' T-8 Lamp	0.057
Fluorescent - 2 L STD T-8	17 W (2) 2' T-8 Lamp	0.032
Fluorescent - 2 L STD T-8	25 W (2) 3' T-8 Lamp	0.045
Fluorescent - 2 L STD T-8	32 W (2) 4' T-8 Lamp	0.056
Fluorescent - 2 L STD T-8	40 W (2) 5' T-8 Lamp	0.070
Fluorescent - 2 L STD T-8	59 W (2) 8' T-8 Lamp	0.109
Fluorescent - 3 L STD T-8	17 W (3) 2' T-8 Lamp	0.050
Fluorescent - 3 L STD T-8	25 W (3) 3' T-8 Lamp	0.070
Fluorescent - 3 L STD T-8	32 W (3) 4' T-8 Lamp	0.086
Fluorescent - 3 L STD T-8	40 W (3) 5' T-8 Lamp	0.106
Fluorescent - 3 L STD T-8	59 W (3) 8' T-8 Lamp	0.167
Fluorescent - 4 L STD T-8	17 W (4) 2' T-8 Lamp	0.065
Fluorescent - 4 L STD T-8	25 W (4) 3' T-8 Lamp	0.088
Fluorescent - 4 L STD T-8	32 W (4) 4' T-8 Lamp	0.111
Fluorescent - 4 L STD T-8	40 W (4) 5' T-8 Lamp	0.134
Fluorescent - 4 L STD T-8	59 W (4) 8' T-8 Lamp	0.219
Fluorescent - 5 L STD T-8	32 W (5) 4' T-8 Lamp	0.148
Fluorescent - 6 L STD T-8	32 W (6) 4' T-8 Lamp	0.172
Fluorescent - 6 L STD T-8	59 W (6) 8' T-8 Lamp	0.328
Fluorescent - 8 L STD T-8	32 W (8) 4' T-8 Lamp	0.217
Fluorescent - 1 L T-8 U-Tube	32 W (1) U-Tube T-8 Lamp	0.032
Fluorescent - 2 L T-8 U-Tube	32 W (2) U-Tube T-8 Lamp	0.059
Fluorescent - 3 L T-8 U-Tube	32 W (3) U-Tube T-8 Lamp	0.089
Fluorescent - 1 L STD T-5	14 W (1) 2' T-5 Lamp	0.018
Fluorescent - 1 L STD T-5	21 W (1) 3' T-5 Lamp	0.025
Fluorescent - 1 L STD T-5	28 W (1) 4' T-5 Lamp	0.033
Fluorescent - 1 L STD T-5	35 W (1) 5' T-5 Lamp	0.040
Fluorescent - 1 L STD T-5	14 W (2) 2' T-5 Lamp	0.034
Fluorescent - 2 L STD T-5	21 W (2) 3' T-5 Lamp	0.048
Fluorescent - 2 L STD T-5	28 W (2) 4' T-5 Lamp	0.064
Fluorescent - 2 L STD T-5	35 W (2) 5' T-5 Lamp	0.078
Fluorescent - 2 L STD T-5	14 W (3) 2' T-5 Lamp	0.052
Fluorescent - 2 L STD T-5	21 W (3) 3' T-5 Lamp	0.073
Fluorescent - 3 L STD T-5	28 W (3) 4' T-5 Lamp	0.097
Fluorescent - 3 L STD T-5	35 W (3) 5' T-5 Lamp	0.118

Fluorescent - 3 L STD T-5	14 W (4) 2' T-5 Lamp	0.068
Fluorescent - 3 L STD T-5	21 W (4) 3' T-5 Lamp	0.096
Fluorescent - 3 L STD T-5	28 W (4) 4' T-5 Lamp	0.128
Fluorescent - 4 L STD T-5	35 W (4) 5' T-5 Lamp	0.156
Fluorescent - 4 L STD T-5	28 W (6) 4' T-5 Lamp	0.192
Fluorescent - 4 L STD T-5	35 W (6) 5' T-5 Lamp	0.234
Fluorescent - 4 L STD T-5	28 W (8) 4' T-5 Lamp	0.256
Fluorescent - T-5 HO	24 W (1) 2' T-5/HO Lamp	0.027
Fluorescent - T-5 HO	38 W (1) 3' T-5/HO Lamp	0.042
Fluorescent - T-5 HO	54 W (1) 4' T-5/HO Lamp	0.0605
Fluorescent - T-5 HO	80 W (1) 5' T-5/HO Lamp	0.089
Fluorescent - T-5 HO	24 W (2) 2' T-5/HO Lamp	0.052
Fluorescent - T-5 HO	38 W (2) 3' T-5/HO Lamp	0.085
Fluorescent - T-5 HO	54 W (2) 4' T-5/HO Lamp	0.117
Fluorescent - T-5 HO	24 W (3) 2' T-5/HO Lamp	0.079
Fluorescent - T-5 HO	38 W (3) 3' T-5/HO Lamp	0.127
Fluorescent - T-5 HO	54 W (3) 4' T-5/HO Lamp	0.179
Fluorescent - T-5 HO	24 W (4) 2' T-5/HO Lamp	0.104
Fluorescent - T-5 HO	38 W (4) 3' T-5/HO Lamp	0.17
Fluorescent - T-5 HO	54 W (4) 4' T-5/HO Lamp	0.234
Fluorescent - T-5 HO	38 W (6) 3' T-5/HO Lamp	0.255
Fluorescent - T-5 HO	54 W (6) 4' T-5/HO Lamp	0.351
Fluorescent - T-5 HO	38 W (8) 3' T-5/HO Lamp	0.34
Fluorescent - T-5 HO	54 W (8) 4' T-5/HO Lamp	0.468
Fluorescent - T-8 HO	32 W (1) 4' T-8/HO Lamp	0.0345
Fluorescent - T-8 HO	32 W (2) 4' T-8/HO Lamp	0.0675
Fluorescent - T-8 HO	32 W (3) 4' T-8/HO Lamp	0.0955
Fluorescent - T-8 HO	32 W (4) 4' T-8/HO Lamp	0.135
Fluorescent - T-8 HO	32 W (5) 4' T-8/HO Lamp	0.163
Fluorescent - T-8 HO	32 W (6) 4' T-8/HO Lamp	0.191
Fluorescent - T-8 HO	32 W (8) 4' T-8/HO Lamp	0.27
Fluorescent - T-8 HO	86 W (1) 8' T-8/HO Lamp	0.08
Fluorescent - T-8 HO	86 W (2) 8' T-8/HO Lamp	0.16
Fluorescent - T-8 HO	86 W (4) 8' T-8/HO Lamp	0.32
Metal Halide (non Pulse Start), 1 L	32 W (1) Metal Halide	0.043
Metal Halide (non Pulse Start), 1 L	50 W (1) Metal Halide	0.072
Metal Halide (non Pulse Start), 1 L	70 W (1) Metal Halide	0.095
Metal Halide (non Pulse Start), 1 L	100 W (1) Metal Halide	0.128
Metal Halide (non Pulse Start), 1 L	150 W (1) Metal Halide	0.19
Metal Halide (non Pulse Start), 1 L	175 W (1) Metal Halide	0.215
Metal Halide (non Pulse Start), 1 L	250 W (1) Metal Halide	0.295

Metal Halide (non Pulse Start), 1 L	400 W (1) Metal Halide	0.458
Metal Halide (non Pulse Start), 1 L	750 W (1) Metal Halide	0.85
Metal Halide (non Pulse Start), 1 L	1000 W (1) Metal Halide	1.08
Metal Halide (non Pulse Start), 1 L	1500 W (1) Metal Halide	1.61
Metal Halide (non Pulse Start), 2 L	400 W (2) Metal Halide	0.916
Pulse Start Metal Halide	150 W - Pulse Start Metal Halide	0.185
Pulse Start Metal Halide	175 W - Pulse Start Metal Halide	0.208
Pulse Start Metal Halide	200 W - Pulse Start Metal Halide	0.235
Pulse Start Metal Halide	250 W - Pulse Start Metal Halide	0.288
Pulse Start Metal Halide	300 W - Pulse Start Metal Halide	0.342
Pulse Start Metal Halide	320 W - Pulse Start Metal Halide	0.368
Pulse Start Metal Halide	350 W - Pulse Start Metal Halide	0.4
Pulse Start Metal Halide	400 W - Pulse Start Metal Halide	0.45
Pulse Start Metal Halide	750 W - Pulse Start Metal Halide	0.815
Pulse Start Metal Halide	1000 W - Pulse Start Metal Halide	1.075
LED Exit Sign	Light Emitting Diode, (1) 2 W, Single Sided	0.006
LED Exit Sign	Light Emitting Diode, (2) 2 W, Dual Sided	0.009
CFL - Twin Tube	1 Lamp, 32 W	0.034
CFL - Twin Tube	1 Lamp, 40 W	0.043
CFL - Twin Tube	2 Lamp, 32 W	0.062
CFL - Twin Tube	2 Lamp, 40 W	0.072
CFL - Twin Tube	3 Lamp, 40 W	0.105
CFL - Twin Tube	6 Lamp, 32 W	0.186
CFL - Quad Tude	1 Lamp, 13 W	0.015
CFL - Quad Tude	1 Lamp, 18 W	0.020
CFL - Quad Tude	1 Lamp, 26 W	0.027
CFL - Quad Tude	2 Lamp, 13 W	0.028
CFL - Quad Tude	2 Lamp, 18 W	0.038
CFL - Quad Tude	2 Lamp, 26 W	0.050
CFL - Quad Tude	6 Lamp, 26 W	0.150
CFL - Screw-in	7 W	0.007
CFL - Screw-in	9 W	0.009
CFL - Screw-in	11 W	0.011
CFL - Screw-in	13 W	0.013
CFL - Screw-in	15 W	0.015
CFL - Screw-in	16 W	0.016
CFL - Screw-in	17 W	0.017
CFL - Screw-in	18 W	0.018
CFL - Screw-in	20 W	0.02
CFL - Screw-in	23 W	0.023
CFL - Screw-in	25 W	0.025

CFL - Screw-in	28 W	0.028
Mercury Vapor	40 W, 1 Lamp	0.05
Mercury Vapor	50 W, 1 Lamp	0.074
Mercury Vapor	75 W, 1 Lamp	0.093
Mercury Vapor	100 W, 1 Lamp	0.125
Mercury Vapor	175 W, 1 Lamp	0.205
Mercury Vapor	250 W, 1 Lamp	0.29
Mercury Vapor	400 W, 1 Lamp	0.455
Mercury Vapor	700 W, 1 Lamp	0.78
Mercury Vapor	1000 W, 1 Lamp	1.075
Mercury Vapor	400 W, 2 Lamp	0.91
High Pressure Sodium	35 W	0.046
High Pressure Sodium	50 W	0.066
High Pressure Sodium	70 W	0.095
High Pressure Sodium	100 W	0.138
High Pressure Sodium	150 W	0.188
High Pressure Sodium	200 W	0.25
High Pressure Sodium	250 W	0.295
High Pressure Sodium	310 W	0.365
High Pressure Sodium	360 W	0.414
High Pressure Sodium	400 W	0.465
High Pressure Sodium	1000 W	1.1
Halogen Incandescent	42 W, 1 Lamp	0.042
Halogen Incandescent	45 W, 1 Lamp	0.045
Halogen Incandescent	50 W, 1 Lamp	0.055
Halogen Incandescent	52 W, 1 Lamp	0.052
Halogen Incandescent	55 W, 1 Lamp	0.055
Halogen Incandescent	60 W, 1 Lamp	0.060
Halogen Incandescent	72 W, 1 Lamp	0.072
Halogen Incandescent	75 W, 1 Lamp	0.075
Halogen Incandescent	90 W, 1 Lamp	0.090
Halogen Incandescent	100 W, 1 Lamp	0.100
Halogen Incandescent	150 W, 1 Lamp	0.150
Halogen Incandescent	300 W, 1 Lamp	0.300
Halogen Incandescent	500 W, 1 Lamp	0.500
Halogen Incandescent	45 W, 2 Lamp	0.090
Halogen Incandescent	50 W, 2 Lamp	0.100
Halogen Incandescent	55 W, 2 Lamp	0.110
Halogen Incandescent	75 W, 2 Lamp	0.150
Halogen Incandescent	90 W, 2 Lamp	0.180
Halogen Incandescent	150 W, 2 Lamp	0.300

Incandescent, 1 L	15 W, 1 Lamp	0.015
Incandescent, 1 L	20 W, 1 Lamp	0.02
Incandescent, 1 L	25 W, 1 Lamp	0.025
Incandescent, 1 L	34 W, 1 Lamp	0.034
Incandescent, 1 L	36 W, 1 Lamp	0.036
Incandescent, 1 L	40 W, 1 Lamp	0.04
Incandescent, 1 L	42 W, 1 Lamp	0.042
Incandescent, 1 L	45 W, 1 Lamp	0.045
Incandescent, 1 L	50 W, 1 Lamp	0.05
Incandescent, 1 L	52 W, 1 Lamp	0.052
Incandescent, 1 L	54 W, 1 Lamp	0.054
Incandescent, 1 L	55 W, 1 Lamp	0.055
Incandescent, 1 L	60 W, 1 Lamp	0.06
Incandescent, 1 L	65 W, 1 Lamp	0.065
Incandescent, 1 L	67 W, 1 Lamp	0.067
Incandescent, 1 L	69 W, 1 Lamp	0.069
Incandescent, 1 L	72 W, 1 Lamp	0.072
Incandescent, 1 L	75 W, 1 Lamp	0.075
Incandescent, 1 L	80 W, 1 Lamp	0.08
Incandescent, 1 L	85 W, 1 Lamp	0.085
Incandescent, 1 L	90 W, 1 Lamp	0.09
Incandescent, 1 L	93 W, 1 Lamp	0.093
Incandescent, 1 L	95 W, 1 Lamp	0.095
Incandescent, 1 L	120 W, 1 Lamp	0.12
Incandescent, 1 L	125 W, 1 Lamp	0.125
Incandescent, 1 L	135 W, 1 Lamp	0.135
Incandescent, 1 L	150 W, 1 Lamp	0.15
Incandescent, 1 L	170 W, 1 Lamp	0.17
Incandescent, 1 L	200 W, 1 Lamp	0.2
Incandescent, 1 L	250 W, 1 Lamp	0.25
Incandescent, 1 L	300 W, 1 Lamp	0.3
Incandescent, 1 L	400 W, 1 Lamp	0.4
Incandescent, 1 L	448 W, 1 Lamp	0.448
Incandescent, 1 L	500 W, 1 Lamp	0.5
Incandescent, 1 L	750 W, 1 Lamp	0.75
Incandescent, 1 L	1000 W, 1 Lamp	1
Incandescent, 1 L	1500 W, 1 Lamp	1.5
Incandescent, 1 L	2000 W, 1 Lamp	2
Incandescent, 2 L	15 W, 2 Lamp	0.03
Incandescent, 2 L	20 W, 2 Lamp	0.04
Incandescent, 2 L	25 W, 2 Lamp	0.05

Incandescent, 2 L	34 W, 2 Lamp	0.068
Incandescent, 2 L	40 W, 2 Lamp	0.08
Incandescent, 2 L	50 W, 2 Lamp	0.1
Incandescent, 2 L	52 W, 2 Lamp	0.104
Incandescent, 2 L	54 W, 2 Lamp	0.108
Incandescent, 2 L	55 W, 2 Lamp	0.11
Incandescent, 2 L	60 W, 2 Lamp	0.12
Incandescent, 2 L	65 W, 2 Lamp	0.13
Incandescent, 2 L	67 W, 2 Lamp	0.134
Incandescent, 2 L	75 W, 2 Lamp	0.15
Incandescent, 2 L	90 W, 2 Lamp	0.18
Incandescent, 2 L	95 W, 2 Lamp	0.19
Incandescent, 2 L	100 W, 2 Lamp	0.2
Incandescent, 2 L	120 W, 2 Lamp	0.24
Incandescent, 2 L	135 W, 2 Lamp	0.27
Incandescent, 2 L	150 W, 2 Lamp	0.3
Incandescent, 2 L	200 W, 2 Lamp	0.4
Incandescent, 3 L	60 W, 3 Lamp	0.18
Incandescent, 3 L	67 W, 3 Lamp	0.201
Incandescent, 3 L	75 W, 3 Lamp	0.225
Incandescent, 3 L	90 W, 3 Lamp	0.27
Incandescent, 3 L	100 W, 3 Lamp	0.3
Incandescent, 4 L	25 W, 4 Lamp	0.1
Incandescent, 4 L	60 W, 4 Lamp	0.24
Incandescent, 4 L	75 W, 4 Lamp	0.3
Incandescent, 4 L	100 W, 4 Lamp	0.4
Incandescent, 5 L	60 W, 5 Lamp	0.3
Incandescent, 5 L	100 W, 5 Lamp	0.5
Induction	40 W	0.045
Induction	50 W	0.055
Induction	55 W	0.060
Induction	80 W	0.085
Induction	85 W	0.090
Induction	150 W	0.155
Induction	165 W	0.170
LED Strips, Center Strip	38 W, 5'	0.038
LED Strips, Center Strip	46 W, 6'	0.046
LED Strips, End Strip	19 W, 5'	0.019
LED Strips, End Strip	23 W, 6'	0.023
Low Bay LED	85 W	0.085

Lighting by Building Type

Building Type	EFLH	CF	IF
Education – Primary School	1,440	0.57	0.15
Education – Secondary School	2,305	0.57	0.15
Education – Community College	3,792	0.64	0.15
Education – University	3,073	0.64	0.15
Grocery	5,824	0.88	0.13
Medical – Hospital	8,736	0.72	0.18
Medical – Clinic	4,212	0.72	0.18
Lodging Hotel (Guest Rooms)	1,145	0.67	0.14
Lodging Motel	8,736	1.00	0.14
Manufacturing – Light Industrial	4,290	0.63	0.04
Office- Large	2,808	0.68	0.17
Office-Small	2,808	0.68	0.17
Restaurant – Sit-Down	4,368	0.76	0.15
Restaurant – Fast-Food	6,188	0.76	0.15
Retail – 3-Story Large	4,259	0.78	0.11
Retail – Single-Story Large	4,368	0.78	0.11
Retail – Small	4,004	0.78	0.11
Storage Conditioned	4,290	0.69	0.06
Storage Heated or Unconditioned	4,290	0.69	0.00
Warehouse	3,900	0.69	0.06
Average = Miscellaneous	4,242	0.72	0.13

Sources:

1. California Standard Performance Contracting Program
2. RLW Analytics, *Coincident Factor Study, Residential and Commercial & Industrial Lighting Measures*, 2007.
3. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*", March 1, 1999
4. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*", March 1, 1999
5. KEMA. *New Jersey's Clean Energy Program Energy Impact Evaluation and Protocol Review*. 2009.

Prescriptive Lighting

This is a fixture replacement program for existing commercial customers that is targeted at facilities performing efficiency upgrades to their lighting systems.

The baseline is existing T-12 fixtures with energy efficient lamps and magnetic ballast.

The baseline for compact fluorescent is that the fixture replaced was 4 times the wattage of the replacement compact fluorescent.

New fixtures and technologies available after publication will be periodically updated. Baselines will be established based on the guidelines noted below.

Algorithms

Demand Savings =(ΔkW) X (CF) X (1+ IF)

Energy Savings = (ΔkW) X (1 + IF) X (EFLH)

> ΔkW=(Number of fixtures installed X baseline wattage for new fixture) – (number of replaced fixtures X wattage from table)

For LED strip fixtures, the following protocols will be applied to account for the lighting and refrigeration energy savings associated with this measure.

Algorithms

Demand Savings = (ΔkW) X (CF) X (1+ IF) X (1 + (0.28 X Eff))

Energy Savings = (ΔkW) X (1 + IF) X EFLH X (1 + (0.28 X Eff))

Definition of Variables

ΔkW = Change in connected load from baseline to efficient lighting level.

CF = Coincidence Factor

EFLH = Equivalent Full Load Hours

IF = Interactive Factor

0.28 = Conversion from kW to tons (Refrigeration)

Eff = Efficiency of typical refrigeration system in kW/ton

Prescriptive Lighting for Commercial Customers

Component	Type	Value	Source
ΔkW	Fixed	See Lighting Wattage Table derived from California SPC Table at: (http://www.sce.com/NR/rdonlyres/FC51087D-2848-42DF-A52A-BDBA1A09BF8D/0/SCE_B_StandardFixtureWatts010108.pdf)	1
CF	Fixed	See Lighting Table by Building in Performance Lighting Section Above	2
EFLH	Fixed	See Lighting Table by Building in Performance Lighting Section Above	3
IF	Fixed	See Lighting Table by Building Type in Performance Lighting Section Abovce	4
Eff	Fixed	1.6	5

Sources:

1. California Standard Performance Contracting Program
2. RLW Analytics, *Coincident Factor Study, Residential and Commercial & Industrial Lighting Measures*, 2007.
3. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*", March 1, 1999
4. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*", March 1, 1999
5. Select Energy Services, Inc. *Cooler Control Measure Impact Spreadsheet User's Manual*. 2004.

Lighting Controls

Lighting controls include occupancy sensors, daylight dimmer systems, and occupancy controlled hi-low controls for fluorescent, and HID fixtures. The measurement of energy savings is based on algorithms with key variables (i.e., coincidence factor, equivalent full load hours) provided through existing end-use metering of a sample of facilities or from other utility programs with experience with these measures (i.e., % of annual lighting energy saved by lighting control). For lighting controls, the baseline is a manual switch, based on the findings of the New Jersey Commercial Energy Efficient Construction Baseline Study.

Algorithms

Demand Savings = kW_c X SVG X CF X (1+ IF)

Energy Savings = kW_c X SVG X EFLH X (1+IF)

Definition of Variables

SVG = % of annual lighting energy saved by lighting control; refer to table by control type

kW_c = kW lighting load connected to control

IF = Interactive Factor – This applies to C&I interior lighting only. This represents the secondary demand and energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage. This value will be fixed at 5%.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's peak window.

EFLH = Equivalent full load hours.

Lighting Controls

Component	Type	Value	Source
kW_c	Variable	Load connected to control	Application
SVG	Fixed	Occupancy Sensor, Controlled Hi-Low Fluorescent Control and controlled HID = 30% Daylight Dimmer System=50%	See sources below
CF	Fixed	See Lighting Table by Building in Performance Lighting Section Above	1
EFLH	Fixed	See Lighting Table by Building in Performance Lighting Section Above	2
IF	Fixed	See Lighting Table by Building in Performance Lighting Section Above	3

Sources:

1. RLW Analytics, *Coincident Factor Study, Residential and Commercial & Industrial Lighting Measures*, 2007.
2. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*", March 1, 1999

3. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*", March 1, 1999

Motors

For premium efficiency motors 1-200 HP.

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) X CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables

ΔkW = kW Savings at full load

HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.

LF = Load Factor, percent of full load at typical operating condition

IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD

η_{base} = Efficiency of the baseline motor

η_{prem} = Efficiency of the energy-efficient motor

HRS = Annual operating hours

CF = Coincidence Factor

Motors

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
hp_{base}	Fixed	EPACT Baseline Efficiency Table	EPACT Directory
hp_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

EPAct Baseline Motor Efficiency Table

Motor Horsepower	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	0.8	0.8	0.825	0.825	na	0.755
1.5	0.84	0.855	0.84	0.84	0.825	0.825
2	0.855	0.865	0.84	0.84	0.84	0.84
3	0.865	0.875	0.865	0.875	0.84	0.855
5	0.875	0.875	0.875	0.875	0.855	0.875
7.5	0.885	0.895	0.885	0.895	0.875	0.885
10	0.9002	0.895	0.895	0.895	0.885	0.895
15	0.902	0.902	0.91	0.91	0.895	0.902
20	0.91	0.902	0.91	0.91	0.902	0.902
25	0.917	0.917	0.917	0.924	0.91	0.91
30	0.924	0.917	0.924	0.924	0.91	0.91
40	0.93	0.93	0.93	0.93	0.917	0.917
50	0.93	0.93	0.93	0.93	0.924	0.924
60	0.936	0.936	0.936	0.936	0.93	0.93
75	0.936	0.936	0.941	0.941	0.93	0.93
100	0.941	0.941	0.941	0.945	0.93	0.936
125	0.941	0.941	0.945	0.945	0.936	0.945
150	0.945	0.95	0.95	0.95	0.936	0.945
200	0.945	0.95	0.95	0.95	0.945	0.95

*Note: For the Direct Install Program, different baseline efficiency values are used.

NEMA Premium Motor Efficiency Table

Motor Horsepower	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	0.825	0.825	0.855	0.855	0.77	0.77
1.5	0.865	0.875	0.865	0.865	0.84	0.84
2	0.875	0.885	0.865	0.865	0.855	0.855
3	0.885	0.895	0.895	0.895	0.855	0.865
5	0.895	0.895	0.895	0.895	0.865	0.885
7.5	0.902	0.91	0.91	0.917	0.885	0.895
10	0.917	0.91	0.917	0.917	0.895	0.902
15	0.917	0.917	0.93	0.924	0.902	0.91
20	0.924	0.917	0.93	0.93	0.91	0.91
25	0.93	0.93	0.936	0.936	0.917	0.917
30	0.936	0.93	0.941	0.936	0.917	0.917
40	0.941	0.941	0.941	0.941	0.924	0.924
50	0.941	0.941	0.945	0.945	0.93	0.93
60	0.945	0.945	0.95	0.95	0.936	0.936
75	0.945	0.945	0.95	0.954	0.936	0.936
100	0.95	0.95	0.954	0.954	0.936	0.941
100	0.95	0.95	0.954	0.954	0.941	0.95
150	0.954	0.958	0.958	0.958	0.941	0.95
200	0.954	0.958	0.958	0.962	0.95	0.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Electronically Commutated Motors for Refrigeration

This measure is applicable to existing walk-in, multi-deck and free standing coolers and freezers with shaded pole or permanent split capacitor (PSC) motors. These fractional horsepower motors are significantly more efficient than mechanically commutated, brushed motors, particularly at low speeds or partial load. By employing variable-speed technology, EC motors are able to optimize fan speeds for changing load requirements. Because these motors are brushless and utilize DC power, losses due to friction and phase shifting are eliminated. Calculations of savings for this measure take into account both the increased efficiency of the motor as well as the reduction in refrigeration load due to motor heat loss.

EC Motor retrofits in Walk-in Coolers and Freezers

Algorithms

Gross kWh Savings = $kWh\ Savings_{EF}$ + $kWh\ Savings_{RH}$

$kWh\ Savings_{EF}$ = $((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * PF_{EF}$ * Operating Hours * LR65%

$kWh\ Savings_{RH}$ = $kWh\ Savings_{EF} * 0.28 * 1.6$

Definition of Variables

$kWh\ Savings_{EF}$ = Savings due to Evaporator Fan Motors being replaced

$kWh\ Savings_{RH}$ = Savings due to reduced heat from Evaporator Fans

$Amps_{EF}$ = Nameplate Amps of Evaporator Fan

$Volts_{EF}$ = Nameplate Volts of Evaporator Fan

$Phase_{EF}$ = Phase of Evaporator Fan

PF_{EF} = Evaporator Fan Power Factor

Operating Hours = Annual operating hours if Evaporator Fan Control

LR = Percent reduction of load by replacing motors

0.28 = Conversion from kW to tons (Refrigeration)

1.6 = Efficiency of typical refrigeration system in kW/ton

Case Motor Replacement

Algorithms

Gross kWh Savings = $kWh\ Savings_{CM}$ + $kWh\ Savings_{RH}$

$kWh\ Savings_{CM}$ = kW * ER * RT8,500

$kWh\ Savings_{RH}$ = $kWh\ Savings_{EF} * 0.28 * Eff$

Definition of Variables

$kWh\ Savings_{CM}$= Savings due to Case Motors being replaced

$kWh\ Savings_{RH}$ = Savings due to reduced heat from Case Motors kW = Metered load of Case Motors

ER = Energy reduction if a motor is being replaced

RT = Average runtime of Case Motors

0.28 = Conversion from kW to tons (Refrigeration)

Eff = Efficiency of typical refrigeration system in kW/ton

ECM Fraction HP Motors

Component	Type	Value	Source
$Amps_{EF}$	Variable	Nameplate/Manufacturer Spec. Sheet	Application
$Volts_{EF}$	Variable	Nameplate/Manufacturer Spec. Sheet	Application
$Phase_{EF}$	Variable	Nameplate/Manufacturer Spec. Sheet	Application
PF_{EF}	Fixed	0.55	1
Operating Hours	Fixed	Not Installed = 8,760 Installed = 5,600	
LR	Fixed	65%	2
ER	Fixed	Shaded Pole Motor Replaced = 53% PSC Motor Replaced = 29%	3
RT	Fixed	8500	
Eff	Fixed	1.6	

Sources:

1. Select Energy Services, Inc. *Cooler Control Measure Impact Spreadsheet User's Manual.* 2004.
2. This value is an estimate by NRM based on several pre and post meter readings of installations. This is supported by RLW report for National Grid, "Small Business Services, Custom Measure Impact Evaluation", March 23, 2007.
3. Based on numerous pre and post-meterings conducted by NRM.

Electric HVAC Systems

The measurement of energy and demand savings for C/I Efficient HVAC program for Room AC, Central AC, and air cooled DX is based on algorithms. (Includes split systems, air to air heat pumps, packaged terminal systems, water source heat pumps, central DX AC systems, ground water or ground source heat pumps)

Algorithms

Air Conditioning Algorithms:

Demand Savings = (BtuH/1000) X ($1/EER_b$-$1/EER_q$) X CF

Energy Savings = (BtuH/1000) X ($1/EER_b$-$1/EER_q$) X EFLH

Heat Pump Algorithms

Energy Savings-Cooling = ($BtuH_c$/1000) X ($1/EER_b$-$1/EER_q$) X $EFLH_c$

Energy Savings-Heating = $BtuH_h$/1000 X(((1/COP_b X 3.412)-(1/COP_q X 3.412))/ $EFLH_h$

Where $_c$ is for cooling and $_h$ is for heating.

Definition of Variables

BtuH = Cooling capacity in Btu/Hour – This value comes from ARI/AHRI or AHAM rating or manufacturer data.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pump verification summary table. For units < 65,000, SEER and HSPF/3.412 should be used for cooling and heating savings, respectively.

COP_q = Coefficient of Performance of the High Efficiency unit – This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000, SEER and HSPF/3.412 should be used for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value will be based on existing measured usage and determined as the average number of operating hours during the peak window period.

EFLH = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off peak periods. This value will be determined by existing measured data of kWh during the period divided by kW at design conditions.

HVAC and Heat Pumps

Component	Type	Value	Source
BtuH	Variable	ARI/AHRI or AHAM or Manufacturer Data	Application
EER_b	Variable	See Table below	Collaborative agreement and C/I baseline study
EER_q	Variable	ARI/AHRI or AHAM Values	Application

Component	Type	Value	Source
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	HVAC 1,131 HP cooling 381 HP heating 800	JCP&L metered data[6]

HVAC Baseline Table

Equipment Type	Baseline = ASHRAE Std. 90.1 - 2004
Unitary HVAC/Split Systems, Air Cooled · <=5.4 tons: · >5.4 to 11.25 tons · >11.25 to 20 tons .> 21 to 63 tons >63 Tons	 13 SEER 10.1 EER 9.5 EER 9.3 EER 9.0 EER
Air-Air Heat Pump Systems · <=5.4 tons: · >5.4 to 11.25 tons · >11.25 to 20 tons .>= 21	 13 SEER 9.9 EER 9.1 EER 8.8 EER
Package Terminal Systems < 0.74 tons .75 – 1 ton > 1 ton	 12.5-(0.213*BTUHc/1000)
Water Source Heat Pumps All Capacities	 12.0 EER
GWSHPs Open and Closed Loop All Capacities	 16.2 EER

Baseline heat pump efficiency in heating mode must be based on ASHRAE 90.1-2004 table 6.8.1 B

Dual Enthalpy Economizers

Algorithms

Energy Savings (kWh) = OTF*SF*Cap/Eff

Demand Savings (kW) = Savings/Operating Hours

Definition of Variables

OTF = Operational Testing Factor

[6] Results reflect metered use from 1995 – 1999.

SF = Approximate savings factor based on regional temperature bin data (assume 4576 for equipment under 5.4 tons where a fixed damper is assumed for the baseline and 3318 for larger equipment where a dry bulb economizer is assumed for the baseline). (Units for savings factor are in kWh x rated EER per ton of cooling or kWh*EER/Ton)

Cap = Capacity of connected cooling load (tons)

Eff = Cooling equipment energy efficiency ratio (EER)

Operating Hours = 4,438 = Approximate number of economizer operating hours

Dual Enthalpy Economizers

Component	Type	Value	Source
OTF	Fixed	1.0 when operational testing is performed, 0.8 otherwise	
SF		4576 for equipment under 5.4 tons, 3318 otherwise	1
Cap	Variable		Application
Eff	Variable		Application
Operating Hours	Fixed	4,438	2

Sources:

1. DOE-2 Simulation Modeling
2. ClimateQuest Economizer Savings Calculator

Electric Chillers

The measurement of energy and demand savings for C/I Chillers program is based on algorithms with key variables (i.e., kW/ton, Coincidence Factor, Equivalent Full Load Hours) measured through existing end-use metering of a sample of facilities.

Algorithms

For IPLV:

Demand Savings = Tons PDC X $(IPLV_b - IPLV_q)$

Energy Savings = Tons X EFLH X $(IPLV_b - IPLV_q)$

For FLV:

Demand Savings = Tons PDC X $(FLV_b - FLV_q)$

Energy Savings = Tons X EFLH X $(FLV_b - FLV_q)$

Definition of Variables

Tons = Rated equipment cooling capacity

EFLH = Equivalent Full Load Hours – This represents a measure of chiller use by season determined by measured kWh during the period divided by kW at design conditions from JCP&L measurement data.

PDC = Peak Duty Cycle: fraction of time the compressor runs during peak hours

$IPLV_b$ = Integrated Part Load Value of baseline equipment, kW/Ton. The efficiency the chiller under partial-load conditions.

$IPLV_q$ = Integrated Part Load Value of qualifying equipment, kW/Ton. The efficiency the chiller under partial-load conditions.

FLV_b = Full Load Value of baseline equipment, kW/Ton. The efficiency the chiller under full-load conditions.

FLV_q = Full Load Value of qualifying equipment, kW/Ton. The efficiency the chiller under full-load conditions.

Electric Chillers

Component	Type	Situation	Value	Source
$IPLV_b$ (kW/ton)	Fixed	Air Cooled with Condenser (All)	1.153	ASHRAE 90.1-2004
		Air Cooled w/o Condenser (All)	1.019	
		Water Cooled, reciprocating	0.696	ASHRAE 90.1-2004
		Water Cooled (<150 tons)	0.676	ASHRAE 90.1-2004
		Water Cooled (151 to 300 tons)	0.628	
		Water Cooled, screw/scroll (>300 tons)	0.572	ASHRAE 90.1-2004
		Water Cooled, centrifugal (<150 tons)	0.670	ASHRAE 90.1-2004
		Water Cooled, centrifugal (>=150 tons to 300 tons)	0.596	ASHRAE 90.1-2004
		Water Cooled, centrifugal >300 tons)	0.549	ASHRAE 90.1-2004
FLV_b (kW/ton)	Fixed	Air Cooled with Condenser (All)	1.256	ASHRAE 90.1-2004
		Air Cooled w/o Condenser (All)	1.135	
		Water Cooled, reciprocating	0.837	ASHRAE 90.1-2004
		Water Cooled (<150 tons)	0.790	ASHRAE 90.1-2004
		Water Cooled (151 to 300 tons)	0.718	
		Water Cooled, screw/scroll (>300 tons)	0.639	ASHRAE 90.1-2004
		Water Cooled, centrifugal (<150 tons)	0.7034	ASHRAE 90.1-2004
		Water Cooled, centrifugal (>=150 tons to 300 tons)	0.634	ASHRAE 90.1-2004
		Water Cooled, centrifugal >300 tons)	0.577	ASHRAE 90.1-2004
Tons	Variable	All	Varies	From Application
$IPLV_q$ (kW/ton)	Variable	All	Varies	From Application (per ARI Std. 550/590)
PDC	Fixed	All	67%	Engineering Estimate
EFLH	Fixed	All	1,360	California DEER

Variable Frequency Drives

The measurement of energy and demand savings for C/I Variable Frequency Drive for VFD applications is for HVAC fans and water pumps only. VFD applications for other than this use should follow the custom path.

<u>Algorithms</u>

Energy Savings (kWh) = $0.746*HP*HRS*(ESF/\eta_{motor})$

Demand Savings (kW) = $0.746*HP*(DSF/\eta_{motor})$

Definitions of Variables

HP = nameplate motor horsepower or manufacturer spec. sheet per application

η_{motor} = Motor efficiency at the peak load. Motor efficiency varies with load. At low loads relative to the rated hp (usually below 50%) efficiency often drops dramatically.

ESF = Energy Savings Factor. The energy savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions.

DSF = Demand Savings Factor. The demand savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions

HRS = annual operating hours

Variable Frequency Drives

Component	**Type**	**Value**	**Source**
Motor HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
η_{motor}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Connecticut Light and Power
DSF	Variable	See Table Below	Connecticut Light and Power
HRS	Variable	>2,000	Application

VFD Savings Factors

Component	Energy Savings Factor, ESF	Demand Savings Factor, DSF
Airfoil/Backward Inclined Fans	0.475	0.448
Forward Curved Fans	0.240	0.216
Chilled Water Pumps	0.580	0.201

Air Compressors with Variable Frequency Drives

The measurement of energy and demand savings for variable frequency drive (VFD) air compressors.

Algorithms

Energy Savings (kWh) = HRS*(Maximum kW/HP Savings)*Motor HP

Demand Savings (kW) = PDC*(Maximum kW/HP Savings)*Motor HP

Maximum kW/HP Savings = Percent Energy Savings * (0.746r / EFF_b)

<u>Definitions of Variables</u>

HRS = Annual compressor runtime (hours) from application.

PDC = Peak Duty Cycle: fraction of time the compressor runs during peak hours

EEF_b = Efficiency of the industry standard compressor at average load

0.746 = kW to HP conversion factor

Air Compressors with VFDs

Component	**Type**	**Value**	**Source**
Motor HP	Variable	Nameplate	Application
Maximum kW/HP Savings	Fixed	0.274	Calculated
PDC	Fixed	0.865	1
HRS	Fixed	4957	2
Percent Energy Savings	Fixed	22%	3
EEF_b	Fixed	0.60	3

Sources:

1. Aspen Systems Corporation, *Prescriptive Variable Speed Drive Incentive Program Support for Industrial Air Compressors*, June 20, 2005.
2. Xenergy, *Assessment of the Market for Compressed Air Efficiency Systems*. 2001.
3. ACEEE, *Modeling and Simulation of Air Compressor Energy Use*. 2005.

C&I Construction Gas Protocols

For measures installed as part of the Direct Install program, different baselines will be utilized to estimate savings as defined further in the Direct Install section of these Protocols.

The following fuel conversions will be used to calculate energy savings for propane and oil equipment for all eligible C&I programs including C&I Construction, Direct Install, and Pay for Performance.

1 therm of gas = 1.087 gal of propane = 0.721 gal of #2 oil

1 therm = 100,000 Btu
1 gal of propane = 92,000 Btu
1 gal of #2 oil = 138,700 Btu

Gas Chillers

The measurement of energy savings for C&I gas fired chillers and chiller heaters is based on algorithms with key variables (i.e., Equivalent Full Load Hours, Vacuum Boiler Efficiency, Input Rating, Coincidence Factor) provided by manufacturer data or measured through existing end-use metering of a sample of facilities.

Algorithms

Winter Gas Savings = $(VBE_q – BE_b)/VBE_q$ X IR X EFLH

Electric Demand Savings = Tons X $(kW/Ton_b – kW/Ton_{gc})$ X CF

Electric Energy Savings = Tons X $(kW/Ton_b – kW/Ton_{gc})$ X EFLH

Summer Gas Usage (MMBtu) = MMBtu Output Capacity / COP X EFLH

Net Energy Savings = Electric Energy Savings + Winter Gas Savings – Summer Gas Usage

Definition of Terms

VBE_q = Vacuum Boiler Efficiency

BE_b = Efficiency of the baseline gas boiler

IR = Input Rating = Therms/hour

Tons = The capacity of the chiller (in tons) at site design conditions accepted by the program.

kW/Ton_b = The baseline efficiency for electric chillers, as shown in the Gas Chiller Verification Summary table below.

kW/Ton_{gc} = Parasitic electrical requirement for gas chiller.

COP = Efficiency of the gas chiller

MMBtu Output Capacity = Cooling Capacity of gas chiller in MMBtu.

CF = Coincidence Factor. This value represents the percentage of the total load that is on during electric system peak.

EFLH = Equivalent Full Load Hours. This represents a measure of chiller use by season.

Gas Chillers

Component	Type	Value	Source
VBE_q	Variable		Rebate Application or Manufacturer Data
BE_b	Fixed	75%	ASHRAE 90.1-2004
IR	Variable		Rebate Application or Manufacturer Data
Tons	Variable		Rebate Application
MMBtu	Variable		Rebate Application
kW/Ton_b	Fixed	<100 tones 1.25 kW/ton **100 to < 150 tons** 0.703 kW/ton **150 to <300 tons:** 0.634 kW/Ton **300 tons or more:** 0.577 kW/ton	Collaborative agreement and C/I baseline study Assumes new electric chiller baseline using air cooled unit for chillers less than 100 tons;water cooled for chillers greater than 100 tons
kW/Ton_{gc}	Variable		Manufacturer Data
COP	Variable		Manufacturer Data

Component	Type	Value	Source
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L Measured data[7]

Variable data will be captured on the application form or from manufacturer's data sheets and collaborative/utility studies.

For certain fixed components, studies and surveys developed by the utilities in the State or based on a review of manufacturer's data, other utilities, regulatory commissions or consultants' reports will be used to update the values for future filings.

Gas Fired Desiccants

Protocols to be developed.

Gas Booster Water Heaters

C&I gas booster water heaters are substitutes for electric water heaters. The measurement of energy savings is based on engineering algorithms with key variables (i.e., Input Rating Coincidence Factor, Equivalent Full Load Hours) provided by manufacturer data or measured through existing end-use metering of a sample of facilities.

Algorithms

Demand Savings (kW) = IR X EFF/3412 X CF

Energy Savings (kWh) = IR X EFF/3412 X EFLH

Gas Usage Increase = IR X EFLH

Net Energy Savings = Electric Energy Savings – Gas Usage Increase
(Calculated in MMBtu)

Definition of Variables

IR = Input Rating in Btuh

EFF = Efficiency

CF = Coincidence Factor

EFLH = Equivalent Full Load Hours

[7] Results reflect metered use from 1995 – 1999.

The 3412 used in the denominator is used to convert Btus to kWh.

Gas Booster Water Heaters

Component	Type	Value	Source
IR	Variable		Application Form or Manufacturer Data
CF	Fixed	30%	Summit Blue
EFLH	Fixed	1,000	PSE&G
EF	Variable		Application Form or Manufacturer Data

Water Heaters

This prescriptive measure targets solely the use of smaller-scale domestic water heaters (50 gallons or less per unit) in all commercial facilities. Larger gas water heaters are treated under the custom measure path. The measurement of energy savings for C&I gas water heaters is based on algorithms with key variables (i.e., energy factor) provided by manufacturer data.

<u>Algorithms</u>

Gas Savings = ((EFF_q – EFF_b)/EFF_q) X Energy Use Density X (Area/1000)

<u>Definition of Variables</u>

EFF_q = Efficiency of the qualifying energy efficient water heater.

EFF_b = Efficiency of the baseline water heater.

Area = Square feet served by the water heater

Water Heaters

Component	Type	Value	Source
EFF_q	Variable		Application
EFF_b	Fixed	<50 gal or <75,000 Btu/h: EF >50 gal or >75,000 Btu/h: TE EF = Energy Factor TE = Thermal Efficiency	From ASHRAE 90.1 2004
Energy Use Density	Variable	See Table Below	1
Fluid Capacity	Variable		Application
Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	

Energy Use Density Lookup Table

Building Type	Energy Use Density (kBtu/1000 sf/yr)
Education	5.2
Food Sales	3.2
Food Service	40.0
Health Care	28.9
- Inpatient	39.4
- Outpatient	3.5
Lodging	29.2
Retail (Other Than Mall)	1.0
Office	1.6
Public Assembly	0.9
Public Order and Safety	15.1
Religious Worship	0.9
Service	0.9
Warehouse and Storage	0.7
Other	1.7

Sources

1. Energy Information Administration, *Commercial Building Energy Consumption Survey*. 2003.

Furnaces and Boilers

This prescriptive measure targets the use of smaller-scale boilers (less than or equal to 4000 MBH) and furnaces (no size limitation) in all commercial facilities. Larger sized boilers are treated under the custom measure path. The measurement of energy savings for C&I gas fired furnaces and boilers is based on algorithms with key variables (i.e. Annual Fuel Utilization Efficiency, capacity of the furnace, EFLH) provided by manufacturer data or utility data. Savings are calculated for four zones throughout the state by heating degree days and for twelve different building types.

Infrared Heaters

Opportunities to target replacement of existing unit heater equipment with gas infrared heating an available measure under the Direct Install Program.

<u>Algorithms</u>

$$\text{Gas Savings} = \left[\frac{(0.8 \times CAPY_{in} \times HDD_{mod} \times 24)}{\Delta T \times 100{,}000}\right] \times \left(\frac{1}{AFUE_b} - \frac{1}{AFUE_q}\right)$$

Definition of Variables

0.8 = Oversize factor of standard boiler or furnace, equivalent to 25% of capacity

$AFUE_q$ = Annual Fuel Utilization Efficiency of the qualifying energy efficient furnace or boiler

$AFUE_b$ = Annual Fuel Utilization Efficiency of the baseline furnace or boiler

For projects where infrared heater(s) are proposed as a measure:
$AFUE_b$ = Annual Fuel Utilization Efficiency of the baseline unit heater(s)

$CAPY_{in}$ = Capacity of the furnace or boiler in Btu/hour

HDD_{mod} = HDD by zone and building type

ΔT = design temperature difference, with balance temperatures = 65° F and outdoor temperature in table below

Furnaces and Boilers

Component	Type	Value	Source
$AFUE_q$	Variable		Application
$AFUE_b$	Fixed	Furnaces: 78% Boilers: 80% Infrared: 78%	EPACT Standard for furnaces and boilers
$CAPY_{in}$	Variable		Application
ΔT	Variable	See Table Below	1
HDD_{mod}	Fixed	See Table Below	1

Sources:
1. KEMA, *Smartstart Program Protocol Review*. 2009.

Adjusted Heating Degree Days by Building Type

Building Type	Heating Energy Density (kBtu/sf)	Degree Day Adjustment Factor	Atlantic City (HDD)	Newark (HDD)	Philadelphia (HDD)	Monticello (HDD)
Education	29.5	0.55	2792	2783	2655	3886
Food Sales	35.6	0.66	3369	3359	3204	4689
Food Service	39.0	0.73	3691	3680	3510	5137
Health Care	53.6	1.00	5073	5057	4824	7060
Lodging	15.0	0.28	1420	1415	1350	1976
Retail	29.3	0.55	2773	2764	2637	3859
Office	28.1	0.52	2660	2651	2529	3701
Public Assembly	33.8	0.63	3199	3189	3042	4452
Public Order/Safety	24.1	0.45	2281	2274	2169	3174
Religious Worship	29.1	0.54	2754	2745	2619	3833
Service	47.8	0.89	4524	4510	4302	6296
Warehouse/Storage	20.2	0.38	1912	1906	1818	2661

Heating Degree Days and Outdoor Design Temperature by Zone

Weather Station	HDD	Outdoor Design Temperature (F)
Atlantic City	5073	13
Newark	5057	14
Philadelphia, PA	4824	15
Monticello, NY	7060	8

Compressed Air System Optimization

Protocols

Compressed Air Systems

The energy and peak demand savings due to Compressed Air Optimization measures will be based on an a site-specific engineering analysis completed for each participating site. The engineering analysis will determine what increase in efficiency will be realized through program participation. This will be compared to the site-specific baseline condition to estimate savings.

Combined Heat and Power (CHP) Program

Protocols

The measurement of energy and demand savings for Combined Heat and Power (CHP) systems is based primarily on the characteristics of the individual CHP systems subject to the general principles set out below. The majority of the inputs used to estimate energy and demand impacts of CHP systems will be drawn from individual project applications.

CHP systems typically use fossil fuels to generate electricity that displaces electric generation from other sources. Therefore, the electricity generated from a CHP system should not be reported as either electric energy savings or renewable energy generation. Alternatively, electric generation and capacity from CHP systems should be reported as Distributed Generation (DG) separate from energy savings and renewable energy generation. However, any waste heat recaptured and utilized should be reported as energy savings as, discussed below.

Distributed Generation

Electric Generation (MWh) = Estimated annual and lifetime electric generation in MWh provided on the project application, as adjusted during the project review and approval process.

Electric Demand (kW) = Electric capacity of the CHP system in kW provided on the project application, as adjusted during the project review and approval process.

Energy Savings

Gas Energy Savings: Gas savings should be reported on a consistent basis by all applicants as the reduction in fuel related to the recapture of thermal energy (e.g., reduction in boiler gas associated with the recapture of waste heat from the CHP engine or turbine)

Electric Energy Savings: Electric energy savings should be reported only in cases where the recapture of thermal energy from the CHP system is used to drive an absorption chiller that would displace electricity previously consumed for cooling.

Emission Reductions

For many CHP applications there can be substantial emission benefits due to the superior emission rates of many new CHP engines and turbines as compared to the average emission rate of electric generation units on the margin of the grid. However, CHP engines and turbines produce emissions, which should be offset against the displaced emissions from the electricity that would have been generated by the grid.[8]

The New Jersey Department of Environmental Protection (DEP) has provided the BPU with emission factors that are used to calculate the emission savings from energy efficiency and renewable energy projects. These factors should be used to calculate the base emission factors

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[8] Summit Blue, Draft Energy Efficiency Market Assessment of New Jersey Clean Energy Program, Book III, Page 196, May 26, 2006

which the CHP system emission factors would be compared to. The emissions from the CHP system would be subtracted from the base emissions to determine the net emission changes as follows:

Base Emission Factors

DEP Emissions Reduction Factors for electric programs are as follows:

- CO_2 (Carbon Dioxide) emissions are reduced by 1,520 lbs. per MWh saved
- NO_x (Nitric Oxide) emission reductions are 2.8 lbs. per MWh saved
- SO_2 (Sulfur Dioxide) emission reductions are 6.5 lbs. per MWh saved
- Hg (Mercury) emission reductions are 0.0000356 lbs. per MWh saved

CHP Emission Reduction Algorithms

CO2 ER (lbs) = (1,520 * MWh) – (CHP CO2EF *MWh)
NOx ER (lbs) = (2.8 * MWh) – (CHP NOxEF *MWh)
SO2 ER (lbs) = (6.5 * MWh) – (CHP SO2EF *MWh)
HG ER (lbs) = (0.0000356 * MWh) – (CHP HGEF *MWh)

Definitions
ER = Emission reductions in pounds
CHP EF = the emission factors of the CHP system in pounds per MWh for each type of emission
MWh = the estimated annual and lifetime generation from the CHP system

Emission reductions from any CHP system energy savings, as discussed above, would be treated the same as any other energy savings reported.

Pay for Performance Program

Protocols

The Pay for Performance Program is a comprehensive program targeted at existing commercial and industrial buildings that have an average annual demand of 200 kW or greater. Participants in the Pay for Performance Program are required to identify and implement energy efficiency improvements that will achieve a minimum of 15% reduction in total source energy consumption.

In order for a project to qualify for incentives under the Pay for Performance Program, the Partner must create a whole-building simulation, as described in detail in the Simulation Guidelines section of the Pay for Performance Program Guidelines. The primary source for developing the Simulation Guidelines is ASHRAE Guideline 14. The requirements are meant to facilitate consistent modeling among modelers, establish modeling guidelines for measures that ASHRAE 90.1 leaves to the Rating Authority to determine, and ensure that these modeling results are used to drive energy-efficient design from the beginning of the design process. Savings estimates calculated by the simulation software and included in the final approved Energy Reduction Plan will be applied to the Pay for Performance program.

Modeling Software Requirements
Simulation software must be compliant with ASHRAE 90.1 2004 Section 11 or Appendix G. Examples of allowed tools include eQUEST, HAP, EnergyPlus, Trane Trace, DOE 2.1. Approval for use in LEED and Federal Tax Deductions for Commercial Buildings program may serve as the proxy to demonstrate compliance with the requirement.

If the approved simulation tool used for the project cannot adequately model a design, material, or device, then the energy savings associated with this component may be calculated using an external calculation method (custom spreadsheets, proprietary software, or thermodynamically-similar component model) that can approximate the expected performance of the particular component that cannot be modeled explicitly in the approved software tool. The resulting savings may then be subtracted from the usage projected by post-retrofit model. External calculation methods must include detailed documentation and require prior approval by the Market Manager.

Baseline Conditions
Due to the building simulation and measurement and verification (M&V) requirements associated with this Program, the baseline is the existing energy consumption of the facility, as reported through the U.S. EPA's Portfolio Manager benchmarking software.

Measurement & Verification Guidelines
A building-specific metering plan is a required component of each Energy Reduction Plan. The Metering Plan should follow the M&V Guidelines (Appendix A) and shall be included in Section VI of the Energy Reduction Plan. The Metering Plan must, in general, address the following for each measure and building:

1. How will the post-retrofit usage be measured or otherwise determined and how will that relate to the pre-construction conditions/equipment?
2. What factors or variables affect energy consumption of both baseline and post-retrofit conditions (e.g. outside and indoor air temperature, humidity, occupancy, operating hours)?
3. How will these factors/variables be measured and used to adjust the baseline or post-retrofit energy usage, if necessary, so savings can be determined?

The options and methods used for measurement and verification in the Pay for Performance Program are adopted from those defined in the 2002 International Performance Measurement and Verifications Protocol (IPMVP) and the 2008 Federal Energy Management Program (FEMP) M&V Guideline version 3.0. Of the four basic options are outlined in the IPMVP, Option D must be followed for all projects in the Pay for Performance Program. M&V protocols for Options A and B may be used as guidelines for data collection. All metering results will be used to calibrate the simulation model. Option C is not applicable for the Program.

Option A – Partially Measured Retrofit Isolation: Savings are predicted using engineering or statistical methods that do not involve long-term measurement. This option will generally be accepted only where other methods are not cost effective and the savings are very predictable and reliable.

Option B – Retrofit Isolation: Involves short-term or continuous metering during the performance period to determine energy consumption. Measurements are usually taken at the device or system level.

Option C – Whole Facility: Involves (1) comparing monthly billing data recorded for the whole building or project site by a utility meter or sub-meters, before and after project installation, and (2) analyzing that data to account for any variables, such as weather or occupancy levels. Energy savings can be determined once the variables are recognized and adjusted to match pre-installation conditions.

<u>Option D – Calibrated Simulation</u>: Involves using software to create a simulated model of a building based on blueprints and site surveys. The model is calibrated by comparing it with billing or end-use monitored data. Models of the project are typically constructed for (1) the existing base case, and (2) a case with the energy measures installed.

Direct Install Program

Protocols

This section identifies the protocols for all measures proposed under the Direct Install Program. This section includes protocols for measures that are not included in other sections of the Protocols. In addition, for several of the where Direct Install Protocols uses algorithms and inputs from the "Commercial and Industrial Energy Efficient Construction" section of the Protocols, different equipment baselines will be used to reflect the Direct Install includes early retirement. Baseline equipment efficiency shown in this section is an estimate of existing equipment efficiency rather than currently available standard efficiency.

Electric HVAC Systems

Replacement of existing electric HVAC equipment with high efficiency units is a proposed measure under the Direct Install Program. (See C&I Construction Electric HVAC Systems Protocols). The savings protocol will be the same as previously stated in this document with the exception of the assumption for baseline efficiency. For the Direct Install program, the following values will be used for the variable identified as EER_b. These age-based efficiencies are used in estimating savings associated with the Direct Install Program because as an early replacement program, equipment is replaced as a direct result of the program.

Default Values for Mechanical System Efficiencies – Age-Based

System	Units	Pre-1960	1960-1969	1970-1974	1975-1983	1984-1987	1988-1991	1992-present
Unitary HVAC / Split Systems								
<= 5.4 tons	SEER	5.0	6.1	6.5	7.4	8.7	9.4	10
5.4 - 11.25 tons	EER	3.9	4.7	5.1	5.7	6.8	7.3	7.8
11.25 - 20 tons	EER	3.7	4.5	4.8	5.4	6.4	6.9	7.3
Air-Air Heat Pump Systems								
<= 5.4 tons	SEER	5.0	6.1	6.5	7.4	8.7	9.4	10
5.4 - 11.25 tons	EER	3.8	4.6	5.0	5.6	6.6	7.2	7.6
Packaged Terminal Systems								
< 0.74 tons	EER	5.0	6.1	6.1	6.7	7.7	8.1	8.5
0.75 - 1 ton	EER	4.8	5.9	5.9	6.4	7.4	7.8	8.2
> 1 ton	EER	4.7	5.7	5.7	6.3	7.2	7.6	7.9
Water Source Heat Pumps								
All Capacities	EER	5.9	7.2	7.2	7.9	9.1	9.5	10

Source: Based on the 2006 Mortgage Industry National Home Energy Ratings Systems Standards, Table 303.7.1(3) Default Values for Mechanical System Efficiencies (Age-based), RESNET.

Motors

Replacement of existing motors with high efficiency units is a proposed measure under the Direct Install Program. (See C&I Construction Motors Protocols). The savings protocol will be the same as previously stated in this document with the exception of the assumption for baseline efficiency. For the Direct Install program, the following values will be used for the variable identified as η_{base}. These efficiencies are used in estimating savings associated with the Direct Install Program because as an early replacement program, equipment is replaced as a direct result of the program.

Motor HP	***Baseline Efficiency***
1	***0.75***
1.5	***0.775***
2	***0.80***
3	***0.825***
5	***0.84***
7.5	***0.845***
10	***0.85***

Source: Opportunities for Energy Savings in the Residential and Commercial Sectors with High-Efficiency Electric Motors, US DOE, 1999, Figure 4-4, page 4-5.

Variable Frequency Drives

Installation of variable frequency motor drive systems is a proposed measure under the Direct Install Program. (See C&I Construction Motors Protocols). Because there is no baseline assumption included in the protocols for this measure, the savings protocol will be exactly the same as previously stated in this document.

Refrigeration Measures

Walk-in Cooler/Freezer Evaporator Fan Control

This measure is applicable to existing walk-in coolers and freezers that have evaporator fans which run continuously. The measure adds a control system feature to automatically shut off evaporator fans when the cooler's thermostat is not calling for cooling. The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein. These savings take into account evaporator fan shut off and associated savings as a result of less heat being introduced into the walk-in, as well as the savings from the compressor, which is now being controlled through electronic temperature control.

Several case studies have been performed that verify the accuracy of these savings. The algorithms below are based on field-tested approximations of energy savings realized through installation of National Resource Management Inc. (NRM)'s Cooltrol® energy management system. [1]

Algorithms

Gross kWh Savings = $kWh\ Savings_{EF} + kWh\ Savings_{RH} + kWh\ Savings_{EC}$

$kWh\ Savings EF = ((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * 8{,}760 * 35.52\%$

$kWh\ Savings RH = kWh\ Savings_{EF} * 0.28 * 1.6$

$kWh\ Savings EC = (((Amps_{CP} * Volts_{CP} * (Phase_{CP})^{1/2})/1000) * 0.85 * ((35\% * WH) + (55\% * NWH)) * 5\%) + (((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * 8{,}760 * 35.52\% * 5\%)$

$\text{Gross kW Savings} = ((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * D$

Definition of Variables

$kWh\ Savings_{EF}$ = Savings due to Evaporator Fan being off
$kWh\ Savings_{RH}$ = Savings due to reduced heat from Evaporator Fans
$kWh\ Savings_{EC}$ = Savings due to the electronic controls on compressor and evaporator
$Amps_{EF}$ = Nameplate Amps of Evaporator Fan
$Volts_{EF}$ = Nameplate Volts of Evaporator Fan
$Phase_{EF}$ = Phase of Evaporator Fan
0.55 = Evaporator Fan Motor power factor.
8,760 = Annual Operating Hours
35.52% = Percent of time Evaporator Fan is turned off. [2]
0.28 = Conversion from kW to tons (Refrigeration).
1.6 = Efficiency of typical refrigeration system in kW/ton.[3]
$Amps_{CP}$ = Nameplate Amps of Compressor
$Volts_{CP}$ = Nameplate Volts of Compressor
$Phase_{CP}$ = Phase of Compressor
0.85 = Compressor power factor.
35% = Compressor duty cycle during winter months (estimated)
WH = Compressor hours during winter months (2,195)
55% = Compressor duty cycle during non-winter months (estimated)
NWH = Compressor hours during non-winter months (6,565)
5% = Reduced run time of Compressor and Evaporator due to electronic controls.[4]
D = Diversity Factor or 0.228[5]

Notes

(1) Several case studies related to NRM's Cooltrol system can be found at: http://www.nrminc.com/national_resource_management_case_studies_cooltrol_cooler_control_systems.html
(2) This value is an estimate by NRM based on hundreds of downloads of hours of use data from the electronic controller. It is an 'average' savings number and has been validated through several 3rd Party Impact Evaluation Studies including study performed by HEC, "Analysis of Walk-in Cooler Air Economizers", Page 22, Table 9, October 10, 2000 for National Grid.
(3) Select Energy Services, Inc. *Cooler Control Measure Impact Spreadsheet User's Manual.* 2004.
(4) This percentage has been collaborated by several utility sponsored 3rd Party studies including study conducted by Select Energy Services for NSTAR, March 9, 2004.

(5) Based on the report "Savings from Walk-In Cooler Air Economizers and Evaporator Fan Controls", HEC, June 28, 1996.

Cooler and Freezer Door Heater Control

This measure is applicable to existing walk-in coolers and freezers that have continuously operating electric heaters on the doors to prevent condensation formation. This measure adds a control system feature to shut off the door heaters when the humidity level is low enough such that condensation will not occur if the heaters are off. This is performed by measuring the ambient humidity and temperature of the store, calculating the dewpoint, and using PWM (pulse width modulation) to control the anti-sweat heaters based on specific algorithms for freezer doors. The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein.

Several case studies have been performed that verify the accuracy of these savings. The algorithms below are based on field-tested approximations of energy savings realized through installation of National Resource Management Inc. (NRM)'s Cooltrol® energy management system.[1]

Low Temperature (Freezer) Door Heater Control

Algorithms

kWh Savings = $(kW_{DH} * 8{,}760) – ((40\% * kW_{DH} * 4{,}000) + (65\% * kW_{DH} * 4{,}760))$

kW Savings = $kW_{DH} * 46\% * 75\%$

Definition of Variables

kW_{DH} = Total demand (kW) of the freezer door heaters, based on nameplate volts and amps.
8,760 = Annual run hours of Freezer Door Heater before controls.
40% = Percent of total run power of door heaters with controls providing maximum reduction.[2]
4,000 = Number of hours door heaters run at 40% power.
65% = Percent of total run power of door heaters with controls providing minimum reduction.[2]
4,760 = Number of hours door heaters run at 65% power.
46% = Freezer Door Heater off time.[3]
75% = Adjustment factor to account for diversity and coincidence at peak demand time.[2]

Medium Temperature (Cooler) Door Heater Control

Algorithms

kWh Savings = (kW_{DH} * 8,760) – (60% * kW_{DH} * 3,760)

kW Savings = kW_{DH} * 74% * 75%

Definition of Variables

kW_{DH} = Total demand (kW) of the cooler door heaters, based on nameplate volts and amps.
8,760 = Annual run hours of Cooler Door Heater before controls.
60% = Percent of total run power of door heaters with controls providing minimum reduction.[2]
3,760 = Number of hours door heaters run at 60% power.
74% = Cooler Door Heater off time.[3]
75% = Adjustment factor to account for diversity and coincidence at peak demand time.[2]

Notes

(1) Several case studies related to NRM's Cooltrol system can be found at: http://www.nrminc.com/national_resource_management_case_studies_cooltrol_cooler_control_systems.html
(2) Estimated by NRM based on their experience of monitoring the equipment at various sites.
(3) This value is an estimate by National Resource Management based on hundreds of downloads of hours of use data from Door Heater controllers. This supported by 3rd Party Analysis conducted by Select Energy for NSTAR, "Cooler Control Measure Impact Spreadsheet Users' Manual", Page 5, March 9, 2004.

Aluminum Night Covers

This measure is applicable to existing open-type refrigerated display cases where considerable heat is lost through an opening that is directly exposed to ambient air. These retractable aluminum woven fabric covers provide a barrier between the contents of the case and the outside environment. They are employed during non-business hours to significantly reduce heat loss from these cases when contents need not be visible.

Savings approximations are based on the report, "Effects of the Low Emissivity Shields on performance and Power use of a refrigerated display case", by Southern California Edison, August 8, 1997. Southern California Edison (SCE) conducted this test at its state-of-the-art Refrigeration Technology and Test Center (RTTC), located in Irwindale, CA. The RTTC's sophisticated instrumentation and data acquisition system provided detailed tracking of the refrigeration system's critical temperature and pressure points during the test period. These readings were then utilized to quantify various heat transfer and power related parameters within the refrigeration cycle. The results of SCE's test focused on three typical scenarios found mostly in supermarkets: low, medium and high temperature cases.

Algorithms

kWh Savings = W * H * F

Definition of Variables

W = Width of protected opening in ft.
H = Hours per year covers are in place
F = Savings factor based on case temperature:
Low temperature (-35F to -5F) F = 0.1 kW/ft
Medium temperature (0F to 30F) F = 0.06 kW/ft
High temperature (35F to 55F) F = 0.04 kW/ft

Electric Defrost Control

This measure is applicable to existing evaporator fans with a traditional electric defrost mechanism. This control system overrides defrost of evaporator fans when unnecessary, reducing annual energy consumption. The estimates for savings take into account savings from reduced defrosts as well as the reduction in heat gain from the defrost process.

Independent Testing was performed by Intertek Testing Service on a Walk-in Freezer that was retrofitted with Smart Electric Defrost capability. A baseline of 28 electric defrosts per week were established as the baseline for a two week period without the Smart Electric Defrost capability. With Smart Electric Defrost capability an average skip rate of 43.64% was observed for the following two week period.

Algorithms

Gross kWh Savings = $kWh\ Savings_{Defrost} + kWh\ Savings_{RH}$

$kWh\ Savings_{Defrost} = KW_{Defrost} * 0.667 * 4 * 365 * 35\%$

$kWh\ Savings_{RH} = kWh\ Savings_{Defrost} * 0.28 * 1.6$

Definition of Variables

$kWh\ Savings_{Defrost}$ = Savings due to reduction of defrosts
$kWh\ Savings_{RH}$ = Savings due to reduction in refrigeration load
$KW_{Defrost}$ = Nameplate Load of Electric Defrost
0.667 = Average Length of Electric Defrost in hours
4 = Average Number of Electric Defrosts per day
365 = Number of Days in Year
35% = Average Number of Defrosts that will be eliminated in year
0.28 = Conversion from kW to tons (Refrigeration)
1.6 = Efficiency of typical refrigeration system in kW/ton[1]

(1) Select Energy Services, Inc. *Cooler Control Measure Impact Spreadsheet User's Manual.* 2004.

LED Lighting for Coolers and Freezers

This measure is applicable to existing walk-in and reach-in coolers and freezers with non-LED lighting. LED lighting is not only more efficient, but also provides higher quality lighting for cooler and freezer displays as they are more suited for cold environments. In addition, LEDs have a longer operating life than fluorescents in cooler and freezer applications, which results in reduced life cycle costs. The estimated savings for this measure take into account both reduced wattage of replacement lighting and reduced refrigeration load from lighting heat loss.

Algorithms

kWh Savings = $(((Watts_B - Watts_{LED})/1000) * H) * (1 + (0.28 * 1.6))$

kW Savings = $((Watts_B - Watts_{LED})/1000) * (1 + (0.28 * 1.6))$

Definition of Variables

$Watts_B$ = Baseline Lighting Wattage
$Watts_{LED}$ = LED Lighting Wattage
1000 = Conversion from W to kW
H = Lighting Operating Hours
0.28 = Conversion from kW to tons (Refrigeration)
1.6 = Efficiency of typical refrigeration system in kW/ton[9]

Novelty Cooler Shutoff

This measure is applicable to existing reach-in novelty coolers which run continuously. The measure adds a control system feature to automatically shut off novelty coolers based on pre-set store operating hours. Based on programmed hours, the control mechanism shuts off the cooler at end of business, and begins operation on reduced cycles. Regular operation begins the following day an hour before start of business. The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein.

Several case studies have been performed that verify the accuracy of these savings. The algorithms below are based on field-tested approximations of energy savings realized through installation of National Resource Management Inc. (NRM)'s Cooltrol® energy management system. [1]

[9] Select Energy Services, Inc. *Cooler Control Measure Impact Spreadsheet User's Manual*. 2004.

Algorithms

kWh Savings = $(((Amps_{NC} * Volts_{NC} * (Phase_{NC})^{1/2})/1000) * 0.85) * ((0.45 * ((CH - 1) * 91)) + (0.5 * ((CH - 1) * 274)))$

Definition of Variables

$Amps_{NC}$ = Nameplate Amps of Novelty Cooler
$Volts_{NC}$ = Nameplate Volts of Novelty Cooler
$Phase_{NC}$ = Phase of Novelty Cooler
0.85 = Novelty Cooler power factor[2]
0.45 = Duty cycle during winter month nights[3]
CH = Closed Store hours
91 = Number of days in winter months
0.5 = Duty cycle during non-winter month nights[3]
274 = Number of days in non-winter months

Notes

(1) Several case studies related to NRM's Cooltrol system can be found at: http://www.nrminc.com/national_resource_management_case_studies_cooltrol_cooler_control_systems.html
(2) Estimated by NRM based on their experience of monitoring the equipment at various sites.
(3) Duty Cycles are consistent with 3rd Party study done by Select Energy for NSTAR"Cooler Control Measure Impact Spreadsheet Users' Manual", page 5, March 9, 2004.

Gas Space and Water Heating Measures

Gas Furnaces and Boilers

Replacement of existing gas furnaces and boilers with gas high efficiency units is a proposed measure under the Direct Install Program. (See C&I Construction Gas Protocols). The savings protocol will be the same as previously stated in this document with the exception of the assumption for baseline efficiency. For the Direct Install program, the following values will be used for the variable identified as $AFUE_b$. These age-based efficiencies are used in estimating savings associated with the Direct Install Program because as an early replacement program, equipment is replaced as a direct result of the program.

Default Values for Mechanical System Efficiencies – Age-Based

System	*Units*	*Pre-1960*	*1960-1969*	*1970-1974*	*1975-1983*	*1984-1987*	*1988-1991*	*1992-present*
Gas Furnace	***AFUE***	***0.60***	***0.60***	***0.65***	***0.68***	***0.68***	***0.76***	***0.78***
Gas Boiler	***AFUE***	***0.60***	***0.60***	***0.65***	***0.65***	***0.70***	***0.77***	***0.80***
Oil Furnace or Boiler	***AFUE***	***0.60***	***0.65***	***0.72***	***0.75***	***0.80***	***0.80***	***0.80***

Source: 2006 Mortgage Industry National Home Energy Ratings Systems Standards, Table 303.7.1(3) Default Values for Mechanical System Efficiencies (Age-based), RESNET.

Gas Infrared Heating

Replacement of existing atmospherically vented heating with gas infrared heating is an available measure under the Direct Install Program. (See C&I Construction Gas Protocols). The savings protocol will be the same as previously stated in this document with the exception of the assumption for baseline efficiency. For the Direct Install program, a value of **0.63** will be used for the variable identified as $AFUE_b$. This age-based efficiency is used in estimating savings associated with the Direct Install Program because as an early replacement program, equipment is replaced as a direct result of the program.

Source: Unit Heaters Deserve Attention For Commercial Programs, Sachs, Harvey M., April 2003, Report Number A031

Gas Water Heating

Replacement of existing gas furnaces and boilers with gas high efficiency units is a proposed measure under the Direct Install Program. (See C&I Construction Gas Protocols). The savings protocol will be the same as previously stated in this document with the exception of the assumption for baseline efficiency. For the Direct Install program, the following values will be used for the variable identified as EFF_b. These age-based efficiencies are used in estimating savings associated with the Direct Install Program because as an early replacement program, equipment is replaced as a direct result of the program.

Default Values for Water Heating System Efficiencies – Age-Based

System	*Units*	*Pre-1960*	*1960-1969*	*1970-1974*	*1975-1983*	*1984-1987*	*1988-1991*	*1992-present*
Gas Storage	***EF***	***0.47***	***0.47***	***0.47***	***0.49***	***0.55***	***0.55***	***0.56***
Oil Storage	***EF***	***0.47***	***0.47***	***0.47***	***0.48***	***0.49***	***0.54***	***0.56***
Gas/Oil >50 gal, >75 kBtuh	T_e	***0.65***	***0.65***	***0.65***	***0.68***	***0.76***	***0.76***	***0.77***

Source: 2006 Mortgage Industry National Home Energy Ratings Systems Standards, Table 303.7.1(3) Default Values for Mechanical System Efficiencies (Age-based), RESNET.

Food Service Measures

Electric and Gas Fryers

Energy efficient electric or natural gas fryers and vat fryers utilized in commercial food service applications which have performance rated in accordance with ASTM Standard Test Method 1361-F or 2144-F for small and large vat fryers respectively. The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein.

Algorithms

Savings = $(D*((P*E*(1/EFF_b - 1/EFFq)) + (I_b*(H-(P/Cap_b)) – I_q*(H-(P/Cap_q))))/C$

Definition of Variables

Savings = gross customer annual energy savings for the measure in ΔkWh for electric fryer, or ΔMMBTU for gas fryer.
D = Operating days per year
P = Average production per day (lb/day) (assume 150)
E = Energy to Food (Btu/lb) (assume 570)
EFF_b = Heavy Load Efficiency of Baseline Unit
EFF_q = Heavy Load Efficiency of Qualifying Unit
I_b = Idle Energy Rate of Baseline Unit (Btu/hr)
I_q = Idle Energy Rate of Qualifying Unit (Btu/hr)
H = Operating hours per day (assume 12)
Cap_b = Production Capacity of Baseline Unit (lb/hr)
Cap_q = Production Capacity of Qualifying Unit (lb/hr)
C = Conversion Factor (3,412 Btu/kWh or 1,000,000 Btu/MMBtu)

Baseline Condition

Electric fryers: $EFF_b = 0.75$
$I_b = 3583$ Btu/hr
$Cap_b = 65$ lb/hr
Gas fryers: $EFF_b = 0.35$
$I_b = 14000$ Btu/hr
$Cap_b = 60$ lb/hr

Measure Cost and Incentive Amount

The standardized cost and incentive amounts for this measure will be based on contractor bids in response to the forthcoming RFP planned for issuance in April 2009.

Source:

Savings algorithm, baseline values, assumed values and lifetimes developed from information on the Food Service Technology Center program's website, www.fishnick.com, by Fisher-Nickel, Inc. and funded by California utility customers and administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission.

Electric and Gas Steamers

Energy efficient electric or natural gas steamers utilized in commercial food service applications which have performance rated in accordance with ASTM Standard Test Method 1484-F. The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein.

Algorithms

Savings = $(D*((P*E*(1/EFF_b - 1/EFFq)) + (I_b*(H-(P/Cap_b)) – I_q*(H-(P/Cap_q))))/C$

Definitions

Savings = gross customer annual energy savings for the measure in ΔkWh for electric steamer or ΔMMBTU for gas steamer.

D = Operating days per year

P = Average production per day (lb/day) (assume 100)

E = Energy to Food (Btu/lb) (assume 105)

EFF_b = Heavy Load Efficiency of Baseline Unit

EFF_q = Heavy Load Efficiency of Qualifying Unit

I_b = Idle Energy Rate of Baseline Unit (Btu/hr)

I_q = Idle Energy Rate of Qualifying Unit (Btu/hr)

H = Operating hours per day (assume 12)

Cap_b = Production Capacity of Baseline Unit (lb/hr)

Cap_q = Production Capacity of Qualifying Unit (lb/hr)

C = Conversion Factor (3,412 Btu/kWh or 1,000,000 Btu/MMBtu)

Baseline Condition

Electric steamers:	EFF_b = 0.26
	I_b = 3412 Btu/hr
	Cap_b = 70 lb/hr
Gas steamers:	EFF_b = 0.15
	I_b = 11000 Btu/hr
	Cap_b = 65 lb/hr

Measure Cost and Incentive Amount

The standardized cost and incentive amounts for this measure will be based on contractor bids in response to the forthcoming RFP planned for issuance in April 2009.

Source

Savings algorithm, baseline values, assumed values and lifetimes developed from information on the Food Service Technology Center program's website, www.fishnick.com, by Fisher-Nickel, Inc. and funded by California utility customers and administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission**.**

Electric and Gas Griddles

Energy efficient electric or natural gas griddles utilized in commercial food service applications which have performance rated in accordance with ASTM Standard Test Method 1275-F. The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein.

Algorithms

Savings = $(D*((P*E*(1/EFF_b - 1/EFFq)) + (I_b*(H-(P/Cap_b)) - I_q*(H-(P/Cap_q))))/C$

Definition of Variables

Savings = gross customer annual energy savings for the measure in ΔkWh for electric griddle or ΔMMBTU for gas griddle.

D = Operating days per year

P = Average production per day (lb/day) (assume 100)

E = Energy to Food (Btu/lb) (assume 475)

EFF_b = Heavy Load Efficiency of Baseline Unit

EFF_q = Heavy Load Efficiency of Qualifying Unit

I_b = Idle Energy Rate of Baseline Unit (Btu/hr)

I_q = Idle Energy Rate of Qualifying Unit (Btu/hr)

H = Operating hours per day (assume 12)

Cap_b = Production Capacity of Baseline Unit (lb/hr)

Cap_q = Production Capacity of Qualifying Unit (lb/hr)

C = Conversion Factor (3,412 Btu/kWh or 1,000,000 Btu/MMBtu)

Baseline Condition

Electric griddles: $EFF_b = 0.60$
$I_b = 8189$ Btu/hr
$Cap_b = 35$ lb/hr

Gas griddles: $EFF_b = 0.30$
$I_b = 21000$ Btu/hr
$Cap_b = 25$ lb/hr

Measure Cost and Incentive Amount

The standardized cost and incentive amounts for this measure will be based on contractor bids in response to the forthcoming RFP planned for issuance in April 2009.

Source

Savings algorithm, baseline values, assumed values and lifetimes developed from information on the Food Service Technology Center program's website, www.fishnick.com, by Fisher-Nickel, Inc. and funded by California utility customers and administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission.

Electric and Gas Ovens

Energy efficient electric or natural gas ovens of the following listed types utilized in commercial food service applications which have performance rated in accordance with the listed ASTM standards:

- Electric combination and convection ovens – ASTM 1639-F
- Gas combination, convection – ASTM 1639-F
- Gas conveyor and rack ovens – ASTM 1817-F

The measurement of energy savings for this measure is based on algorithms with key variables provided by manufacturer data or prescribed herein.

<u>Algorithms</u>

Savings = $(D*((P*E*(1/EFF_b - 1/EFFq)) + (I_b*(H-(P/Cap_b)) – I_q*(H-(P/Cap_q))))/C$

<u>Definitions</u>

Savings = gross customer annual energy savings for the measure in ΔkWh for electric oven or ΔMMBTU for gas oven.

D = Operating days per year

P = Average production per day (lb/day)

- Electric Combination Ovens = 200
- Gas Combination Ovens = 200
- Electric Convection Ovens = 100
- Gas Convection Ovens = 100
- Gas Conveyor Ovens = 300
- Gas Rack Ovens = 1200

E = Energy to Food (Btu/lb) (assume 250)

EFF_b = Heavy Load Efficiency of Baseline Unit

EFF_q = Heavy Load Efficiency of Qualifying Unit

I_b = Idle Energy Rate of Baseline Unit (Btu/hr)

I_q = Idle Energy Rate of Qualifying Unit (Btu/hr)

H = Operating hours per day (assume 12)

Cap_b = Production Capacity of Baseline Unit (lb/hr)

Cap_q = Production Capacity of Qualifying Unit (lb/hr)

C = Conversion Factor (3,412 Btu/kWh or 1,000,000 Btu/MMBtu)

<u>Baseline Condition from which savings are calculated</u>

Electric Combination Ovens:	EFF_b = 0.44
	I_b = 25590 Btu/hr
	Cap_b = 80 lb/hr
Gas Combination Ovens:	EFF_b = 0..35
	I_b = 28000 Btu/hr
	Cap_b = 80 lb/hr

Electric Convection Ovens:	$EFF_b = 0.65$ $I_b = 6824$ Btu/hr $Cap_b = 70$ lb/hr
Gas Convection Ovens:	$EFF_b = 0.30$ $I_b = 18000$ Btu/hr $Cap_b = 70$ lb/hr
Gas Conveyor Ovens:	$EFF_b = 0.20$ $I_b = 70000$ Btu/hr $Cap_b = 215$ lb/hr
Gas Rack Ovens:	$EFF_b = 0.30$ $I_b = 65000$ Btu/hr $Cap_b = 250$ lb/hr

Measure Cost and Incentive Amount

The standardized cost and incentive amounts for this measure will be based on contractor bids in response to the forthcoming RFP planned for issuance in April 2009.

Source:

Savings algorithm, baseline values, assumed values and lifetimes developed from information on the Food Service Technology Center program's website, www.fishnick.com, by Fisher-Nickel, Inc. and funded by California utility customers and administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission.

Occupancy Controlled Thermostats

The program has received a large amount of custom electric applications for the installation of Occupancy Controlled Thermostats in hotels, motels, and, most recently, university dormitories. Due to the number of applications, consistent incentive amounts ($75 per thermostat) and predictable savings of the technology TRC recommends that a prescriptive application be created for this technology.

Standard practice today is thermostats which are manually controlled by occupants to regulate temperature within a facility. An occupancy controlled thermostat is a thermostat paired with a sensor and/or door detector to identify movement and determine if a room is occupied or unoccupied. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e. programmed setpoint). If a pre-programmed time frame elapses (i.e. 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g, setback setpoint or off) until occupancy is sensed again. This type of thermostat is often used in hotels to conserve energy.

The occupancy controlled thermostat reduces the consumption of electricity and/or gas by requiring less heating and/or cooling when a room or a facility is vacant or unoccupied.

Algorithms

Cooling Energy Savings (kWh) = $(((T_c*(H+5)+S_c*(168-(H+5)))/168)$ $T_c)*(P_c*Cap_{hp}*12*EFLH_c/EER_{hp})$

Heating Energy Savings (kWh) = $(((T_h*(H+5)+S_h*(168-(H+5)))/168)-$ $T_h)*(P_h*Cap_{hp}*12*EFLH_h/EER_{hp})$

Heating Energy Savings (Therms) = $(T_h-(T_h*(H+5)+S_h*(168-$ $(H+5)))/168)*(P_h*Cap_h*EFLH_h/AFUE_h/100{,}000)$

Definition of Variables

T_h = Heating Season Facility Temp. (°F)
T_c = Cooling Season Facility Temp. (°F)
S_h = Heating Season Setback Temp. (°F)
S_c = Cooling Season Setup Temp. (°F)
H = Weekly Occupied Hours
Cap_{hp} = Connected load capacity of heat pump/AC (Tons) – Provided on Application.
Cap_h = Connected heating load capacity (Btu/hr) – Provided on Application.
$EFLH_c$ = Equivalent full load cooling hours
$EFLH_h$ = Equivalent full load heating hours
P_h = Heating season percent savings per degree setback
P_c = Cooling season percent savings per degree setup
$AFUE_h$ = Heating equipment efficiency – Provided on Application.
EER_{hp} = Heat pump/AC equipment efficiency – Provided on Application
12 = Conversion factor from Tons to kBtu/hr to acquire consumption in kWh.
168 = Hours per week.
5 = Assumed weekly hours for setback/setup adjustment period (based on 1 setback/setup per day, 5 days per week).

Occupancy Controlled Thermostats

Component	Type	Value	Source
T_h	Variable		Application
T_c	Variable		Application
S_h	Fixed	T_h-5°	
S_c	Fixed	T_c+5°	
H	Variable		Application; Default of 56 hrs/week
Cap_{hp}	Variable		Application
Cap_h	Variable		Application
$EFLH_c$	Fixed	381	1
$EFLH_h$	Fixed	900	PSE&G
P_h	Fixed	3%	2

Component	Type	Value	Source
P_c	Fixed	6%	2
$AFUE_h$	Variable		Application
EER_{hp}	Variable		Application

Sources:

1. JCP&L metered data from 1995-1999
2. ENERGY STAR Products website

Dual Enthalpy Economizers

Dual enthalpy economizers are used to control a ventilation system's outside air intake in order to reduce a facility's total cooling load. An economizer monitors the outside air to ensure that its temperature (sensible heat) and humidity (latent heat) are low enough to utilize outside air to provide cooling in place of the cooling system's compressor. This reduces the demand on the cooling system, lowering its usage hours, saving energy.

The measurement of energy savings associated with dual enthalpy economizers is based on algorithms with key variables provided through DOE-2 simulation modeling and ClimateQuest's economizer savings calculator. Savings are calculated per ton of connected cooling load. The baseline conditions are fixed damper for equipment under 5.4 tons and dry bulb economizer otherwise.

<u>Algorithms</u>

Energy Savings (kWh) = OTF*SF*Cap/Eff

Demand Savings (kW) = Savings/Operating Hours

<u>Definition of Variables</u>

OTF = Operational Testing Factor

SF = Approximate savings factor based on regional temperature bin data (assume 4576 for equipment under 5.4 tons where a fixed damper is assumed for the baseline and 3318 for larger equipment where a dry bulb economizer is assumed for the baseline). (Units for savings factor are in kWh x rated EER per ton of cooling or kWh*EER/Ton)

Cap = Capacity of connected cooling load (tons)

Eff = Cooling equipment energy efficiency ratio (EER)

Operating Hours = 4,438 = Approximate number of economizer operating hours

Duel Enthalpy Economizers

Component	Type	Value	Source
OTF	Fixed	1.0 when operational testing is performed, 0.8 otherwise	
SF		4576 for equipment under 5.4 tons, 3318 otherwise	1
Cap	Variable		Application
Eff	Variable		Application
Operating Hours	Fixed	4,438	2

Sources:

3. DOE-2 Simulation Modeling
4. ClimateQuest Economizer Savings Calculator

Low Flow Devices

Low flow showerheads, faucet aerators and pre-rinse spray valves save water heating energy by reducing the total flow rate from water sources.

The measurement of energy savings associated with low flow devices is based on algorithms with key variables provided through Fisher-Nickel's Life Cycle cost calculators.

Algorithms

Savings = N x (60 x H x D x (F_{base} – F_{eff}) x 8.33 x DT x (1/Eff)/ C

Definition of Variables

60 = Conversion from hours to minutes

N = Number of fixtures

H = Hours per day of device usage

D = Days per year of facility operation

F_{base} = Baseline device flow rate (gal/m)

F_{eff} = Low flow device flow rate (gal/m)

8.33 = Heat content of water (Btu/gal/°F)

DT = Difference in temperature (°F) between cold intake and output

Eff = Percent efficiency of water heating equipment

C = Conversion factor from Btu to Therms or kWh (100,000 for gas water heating (Therms), 3,413 for electric water heating (kWh))

Low Flow Devices

Component	Type	Value	Source
N	Variable		Application
H	Fixed	3 for pre-rinse spray valves	1
H	Fixed	20 minutes for showerheads 30 minutes for aerators	2
D	Variable		Application
F_{base}	Variable		Application
F_{eff}	Variable	Max of 1.0 gpm for lavatory aerators, 2.2 for kitchen aerators and 2.0 gpm for showerheads per EPA's Water Sense Label	Application
DT	Fixed	50°F for showerheads and faucet aerators, 70°F for pre-rinse spray valves	1
Eff	Variable	default of 80% for gas water heaters and 95% for electric water heaters	Application

Sources:

1. Fisher-Nickel Life Cycle cost calculator
2. FEMP Cost Calculator located at http://www1.eere.energy.gov/femp/technologies/eep_faucets_showerheads_calc.html

Demand Control Ventilation Using CO_2 Sensors

Demand control ventilation (DCV) monitors indoor air CO_2 content as a result of occupancy production levels and uses this data to regulate the amount of outdoor air that is permitted for ventilation. In order to ensure adequate air quality, standard ventilation systems permit outside air based on estimated occupancy levels in CFM/occupant. However, during low occupancy hours, the space may become over ventilated due to decreased CO_2 levels. This air must be conditioned and, therefore, unnecessary ventilation results in wasted energy. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual CO_2 levels, saving energy. DCV is most suited for facilities where occupancy levels are known to fluctuate considerably.

The measurement of energy savings associated with DCV is based on hours of operation, occupancy schedule, return air enthalpy, return air dry bulb temperature, system air flow, outside air reduction, cooling system efficiency, and other factors. As a conservative simplification of complex algorithms, DCV is assumed to save 5% of total facility HVAC load in appropriate building types based on FEMP DCV documentation.

Algorithms

Electric Savings (kWh) = $0.05*HVAC_E$

Gas Savings (Therms) = $0.05*HVAC_G$

Definition of Variables

$HVAC_E$ = Total electric HVAC consumption (kWh)

$HVAC_G$ = Total gas HVAC consumption (Therms)

Demand Control Ventilation Using CO_2 Sensors

Component	Type	Value	Source
$HVAC_E$	Variable		Application
$HVAC_G$	Variable		Application

Pipe Insulation

Un-insulated hot water carrying pipes lose considerable heat to outside air due to high thermal conductivity. In order to reduce this heat loss, pipes can be covered with a layer of fiberglass insulation, which will reduce source heating demand, resulting in significant energy savings.

The measurement of energy savings associated with pipe insulation is based on the length of the supply pipe, pipe diameter, relative thermal conductivity of bare and insulated piping and the temperature difference between supplied water and outside air temperature as indicated in the EPRI report referenced below. The baseline case is un-insulated copper pipe and the default proposed case is 0.5" of fiberglass insulation.

Algorithms

Energy Savings (kWh) = $(L*(HLC_{base}-HLC_{ee})/C)*\Delta T*8{,}760$

Definition of Variables

L = Length of pipe from water heating source to hot water application (ft)

HLC_{base} = Pipe heat loss coefficient by pipe diameter (baseline) (Btu/hr-°F-ft)

HLC_{ee} = Pipe heat loss coefficient by pipe diameter (proposed) (Btu/hr-°F-ft)
C = Conversion from Btu to kWh or Therms (3,413 for kWh (Electric Water Heating), 100,000 for Therms (Gas Water Heating)

ΔT = Average temperature difference between supplied water and outside air temperature (°F)

8,760 = Hours per year

Pipe Insulation

Component	Type	Value	Source
L	Variable		Application
HLC_{base}	Fixed	See Table Below	
HLC_{ee}	Fixed	See Table Below	
ΔT	Variable	Default is 65°F	EPRI Study

Pipe Heat Loss Coefficient Table

Pipe Diam. (in.)	HLC_{base}	HLC_{ee}
0.75	0.43	0.25
1.00	0.54	0.29
1.25	0.64	0.33
1.50	0.76	0.36
2.00	0.94	0.42
2.50	1.00	0.48
3.00	1.30	0.56
4.00	1.70	0.69

Source: Engineering Methods for Estimating the Impacts of Demand-Side Management Programs, Volume 2, EPRI, 1993

Cool Cities Program

Protocol

CITYgreen's energy conservation study utilizes methods developed by Jill Mahon of AMERICAN FORESTS, interpolated from research by Dr. Greg McPherson of the USDA Forest Service. The program estimates the energy conservation benefits of trees resulting from direct shading of residential buildings.

Trees are most effective when located to shade air conditioners, windows, or walls and when located on the side of the home receiving the most solar exposure in addition to other criteria. In many parts of the country the west side is most valuable, followed by the east and the south, although this ranking can change based on geographical considerations.

CITYgreen assigns each tree an energy rating, 1 through 5, based on location characteristics listed above and information about tree size and shape. For example, in many parts of the country, a large tree located near the west side of a building and shading an air conditioner or window would be assigned a maximum energy rating.

Each tree then is assumed to reduce a home's annual energy bill by a percentage associated with energy rank, which varies based on the climate being studied. The percentage savings produced by each tree around a home are multiplied by a home's average annual cooling cost ($600.00 for New Jersey). CITYgreen adds the results together to produce the savings per home, which are in turn summed to estimate savings per site.

Methodology

The measurement plan for tree plantings for reducing energy use by shading communities is based on a randomly selected sample study area in each of the selected neighborhoods where trees were planted. A sample study area in the planted neighborhood is used due to the large volume of field data needed to calculate energy savings over time for the tree plantings. In the sample study area, averages are created to extrapolate savings over the planted areas within a municipality.

The sample study area is a single location randomly selected, which includes over 10% of the initial planting area within each municipality. The data within that sample study area are collected to run a growth model and then a tree energy savings model year by year after the initial year's calculations. Currently the best fitting model for modeling the tree planting energy savings over the Cool Cities Initiative planting areas is CITYgreen 5.4.

The program assigns an energy rating (0= No Savings, 5= Maximum Savings) to each tree that has been field verified and inventoried based on the following criteria:

- Distance from residential building structure
- Orientation to the building

- Ability to shade a window and/or an air conditioner

CITYgreen incorporates research from eleven cities distributed across the United States. Users are asked to identify their region of the United States; the program uses data from the nearest of those eleven cities. If data is available from more than one city within the region, the user is asked to identify which is closest to the project location.

The user is prompted to enter the annual cooling cost ($600 for NJ). Multipliers associated with each energy rating (representing percent energy use-reduction) are assigned to each tree. Each home's annual energy use is multiplied by each associated tree's multiplier to produce an estimate of dollar and kilowatt savings per household, not including inflation.

Multipliers used in CITYgreen were interpolated from "Modeling Benefits and Costs of Community Tree Planting in 12 U.S. Cities" and "Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project."

Dr. McPherson's research found that a second tree located in an optimal location provides about 2/3 as much savings as the first. Therefore, when more than one tree is assigned a rating of 5 for a given home, only one tree is assumed to provide the full benefits: the rest are assumed to provide 2/3 of the equivalent of a number 5 energy rating.

CITYgreen's tree growth model was developed by AMERICAN FORESTS. The program "grows" the tree trunk diameter at breast-height (DBH), the tree height, and the tree canopy according to species and year of growth selected. CITYgreen also considers the area of the country your projection is in, since trees grow at different rates in different parts of the country. Currently modeling has been with Northeast setting. The program uses the following method, derived from Nowak, Susinni, Stevens, and Luley, to estimate growth:

Tree Growth Rate	Trunk DBH (Inches/Year)	Height (Inches/Year)
Slow-Growing Trees	0.1	1.0
Medium-Growing Trees	0.25	1.5
Fast-Growing Trees	0.5	3.0

The height change is determined by multiplying the number of growth years by the height growth rate assigned to the species. The tree trunk diameter (DBH) changes are projected by adding the existing DBH (inches) to the number of growth years multiplied by the DBH growth rate assigned to the species.

A growth factor was derived for individual tree species based on the DBH and canopy area trends taken from AMERICAN FORESTS' composite tree species database of more than 13,000 trees. This growth factor is multiplied by the calculated tree trunk DBH growth for each species to estimate projected canopy radius and canopy area in square feet. By looking at the largest inventoried specimen from each species, a maximum potential growth has been determined for nearly all tree species in the CITYgreen species database. The canopy growth factor is based on a linear regression of canopy radius divided by tree trunk DBH.

To accumulate the energy savings, the energy savings model runs for one year. Then the growth model runs for one year and then the energy savings model runs for one year on the new growth projection, repeating this process for 30 years of growth. The process gives 31 year of savings, because the first year was before one year's growth.

The 31 years of energy savings are summed for the study area. To determine the energy savings over all the planting areas within a municipality, a ratio relationship is used between area and total savings.

Calculation for total energy savings

TES/SAMES = TPA/SA

(SAMES) TES/SAMES = (SAMES) TPA/SA

TES = (SAMES) TPA/SA

TES – Total Energy Savings
SAMES – Sample Area Modeled Energy Savings
SA – Sample Area
TPA – Total Planting Area

Definition of Terms

Air conditioning unit – Any air conditioner unit below three stories

Average annual cooling cost – The average amount of energy used in one year to cool a home. Currently the Cool Cities Initiative is using $600 per annual cooling cost.

Diameter at breast-height (DBH) – A standard measurement of the diameter of a tree trunk at 4.5 feet above the ground.

Initial planting area – The area that was first planted in a municipality.

Municipality – The controlling governing body of a selected area. This would be a city, town, township, borough, or village.

Window – A three-foot by four-foot window under three stories. If a window is much larger than this it is counted as two, for example a four-foot by six-foot window counts as two windows.

Year of growth – The projected growth in one year's time.

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Customer On-Site Renewable Energy Program (CORE) and Renewable Energy Incentive Program (REIP)

Protocols

The energy and demand impacts for customer sited generation systems participating in the CORE program are based on algorithms that estimate each systems annual energy production and coincident peak capacity production. Input data are based on fixed assumptions, engineering estimates and data supplied from the program's technical worksheets and inspection forms. The reported generation will be based on as installed conditions, as verified by site inspection documentation.

For solar electric generation, an industry standard calculation tool (PVWATTS from the National Renewable Energy Laboratory) is used for estimating PV system annual outputs.

For wind installations estimated annual energy output is calculated using approved wind resource data maps, wind speed at proposed hub height, and approved annual estimated power curves for each turbine.

For fuel cell and sustainable biomass projects the protocols include recommended formats but the energy and peak capacity for each project will be estimated on a case by case basis. This level of flexibility allows for the use of more detailed case specific engineering data in the protocol reporting.

For all technicalities, the customer sited generation protocols report the gross electrical generation from the system. Therefore, for example, the estimates for production from sustainable biomass projects do not account for estimated consumption of the applicable biomass fuel.

The following is an explanation of the algorithms used and the nature and source of all required input data.

<u>Algorithms</u>

Photovoltaic Systems

PVWATTS (Version 1) is used to estimate the energy generated by photovoltaic systems. PVWATTS was developed and is available through the Renewable Resource Data Center (RReDC). The RReDC is supported by the National Center for Photovoltaics (NCPV) and managed by the Department of Energy's Office of Energy Efficiency and Renewable Energy. The RReDC is maintained by the Distributed Energy Resources Center of the National Renewable Energy Laboratory. The subroutines used to calculate the energy generation are based on information developed by Sandia National Laboratories. PVWATTS is available through the RReDC website, http://rredc.nrel.gov/solar/codes_algs/PVWATTS/. Note that program generation algorithms have used Version 1 of PVWATTS.

The following input values are used by PVWATTS to estimate average annual energy production. These are collected and/or are available for each PV project on the PV technical worksheet and inspection documentation.

- System Rated Output (AC output based on DC output at Standard Rating Conditions and default DC/AC ratings)
- Fixed, Single or Double Axis Tracking
- Array Tilt angle (for fixed axis only)
- Array Azimuth (for fixed axis only)
- Weather data (based on closest weather station data for Version 1)

The Peak demand impact for photovoltaic systems is estimated separately from the annual energy output. Summer and winter peak impacts are based on research conducted by Richard Perez, of SUNY Albany, (http://www.nrel.gov/ncpv/documents/pv_util.html). The estimated summer effective load carrying capacity (ELCC) for New Jersey is 60% to 70%. A value of 65% is adopted for these protocols.

Summer Peak Impact (kW) = System Rated Output * Summer Effective Load Carrying Capacity (ELCC).

Winter Peak Impact (kW) = System Rated Output * Winter Effective Load Carrying Capacity (WELCC).

A summary of the input values and their data sources follows:

Photovoltaic Systems

Component	Type	Value	Sources
System Rated Output (SRO)	Variable		Application Technical Worksheet, and inspection documentation
Fixed, Single, Double Axis tracking	Variable		Application Technical Worksheet, and inspection documentation
Array Tilt	Variable		Application Technical Worksheet, and inspection documentation
Azimuth Angle	Variable		Application Technical Worksheet, and inspection documentation
Weather Data	Variable	City, State – four sites will be used (Wilkes Barre PA, Newark NJ, Philadelphia PA, and Atlantic City,	Application Technical Worksheet – Version 2 if adopted provides average resource data based on 40 km square grid.

Component	Type	Value	Sources
		NJ	
ELCC	Fixed	65%	(http://www.nrel.gov/ncpv/documents/pv_util.html)
WELCC	Fixed	8%	Monitored system data from White Plains NY

Wind Systems

Estimated annual energy output for wind systems will be based on the program's method for calculating the Expected Performance Based Buy-down for system rebates. These calculations are derived from industry data resources and calculation methods. Currently there is a lack of data on the peak impact of small wind systems in New Jersey and an estimate of 0% will be used. This value will be updated if supporting data are identified.

Annual Energy Output (kWh) is a function of:

- Average annual wind speed (using one of three approved wind resource maps) at 50 meters for the proposed site
- The proposed hub height for the turbine
- An approved annual energy output curve for each turbine

Data summary of the input values and their data sources follows:

Wind Systems

Component	Type	Value	Sources
Average annual wind speed at 50 meters (m/s) or (mph)	Variable		Application Technical Worksheet, verified by checking against approved wind resource maps
Turbine hub height as installed	Variable		Application Technical Worksheet, verified by inspection documentation
Annual energy output power curve for proposed turbine	Variable look up based on wind speed and hub height at each location		Annual energy output power curves based on manufacturer's published data. Values checked against industry experience and acceptance for use in other jurisdictions.
Summer Peak Impact	Fixed	0%	Data on peak impact not available at this time
Winter Peak Impact	Fixed	0%	Data on peak impact not available at this time

Sustainable Biomass

Estimated annual energy output and peak impacts for sustainable biomass systems will be based on case specific engineering estimates and manufacturer data.

SREC-Only Program

The measurement of energy and demand impacts for photovoltaic systems participating in the SREC-Only program is based on the rules and protocols for metering, reporting and verification in N.J.A.C. 14:8-2.9. For systems less than 10 kW, the methods used in the CORE section about for estimating each system's annual energy production and coincident peak capacity production are acceptable. For systems greater than 10 kW must submit megawatt-hour production of electrical energy. Reported generation will be based on as installed conditions, as verified by site inspection documentation.

Renewable Energy Program: Grid Connected

Energy savings/generation for projects installed pursuant to the Renewable Energy Program: Grid Connected will be determined on a case-by-case basis based on the information provided by project applicants, and inspection data for verification of as- installed conditions. The reported savings for each project participant in the REDI will be calculated and presented for review by the Office of Clean Energy.

Appendix A
Measure Lives

NEW JERSEY STATEWIDE ENERGY-EFFICIENCY PROGRAMS
Measure Lives Used in Cost-Effectiveness Screening
July 2001

PROGRAM/Measure	Measure Life
Residential Programs	
Energy Star Appliances	
ES Refrigerator post 2001	17
ES Refrigerator 2001	17
ES Dishwasher	13
ES Clotheswasher	20
ES Dehumidifier	11
ES RAC	10
Energy Star Lighting	
CFL	6.4
Recessed Can Fluourescent Fixture	20
torchiere residential	10
Fixtures Other	20
Energy Star Windows	
WIN-heat pump	20
WIN-gas heat/CAC	20
WIN-gas No CAC	20
Win-elec No AC	20
Win-elec AC	20
Refrigerator/Freezer Retirement	
Refrigerator/Freezer retirement	8
Residential New Construction	
SF gas w/CAC	20
SF gas w/o CAC	20
SF oil w/CAC	20
SF all electric	20
TH gas w/CAC	20
TH gas w/o CAC	20
TH oil w/CAC	20
TH all electric	20
MF gas w/AC	20
MF gas w/o AC	20
MF oil w/CAC	20
MF all electric	20
ES Clotheswasher	20
Recessed Can Fluor Fixture	20
Fixtures Other	20
Efficient Ventilation Fans w/Timer	10

PROGRAM/Measure	Measure Life
Residential Electric HVAC	
CAC 13	15
CAC 14	15
ASHP 13	15
ASHP 14	15
CAC proper sizing/install	15
CAC QIV	15
CAC Maintenance	7
CAC duct sealing	15
ASHP proper sizing/install	15
E-Star T-stat (CAC)	15
E-star T-stat (HP)	15
GSHP	30
CAC 15	15
ASHP 15	15
Residential Gas HVAC	
High Efficiency Furnace	20
High Efficiency Boiler	20
High Efficiency Gas DHW	10
E-Star T-stat	15
Low-Income Program	
Air sealing electric heat	17
Duct Leak Fossil Heat & CAC	15
typical fossil fuel heat	17
typical electric DHW pkg	10
typical fossil fuel DHW pkg	10
screw-in CFLs	6.4
high-performance fixtures	20
fluorescent torchieres	10
TF 14	20
TF 16	20
TF 18	20
SS 20	20
TF 21	20
SS 22	20
TF 25	20
audit fees	20
Attic Insulation- ESH	17
Duct Leak - ESH	15
T-Stat- ESH	5
HP charge air flow	8
electric arrears reduction	1
gas arrears reduction	1
Home Performance with ENERGY STAR	
Blue Line Innovations – PowerCost MonitorTM	5

Non-Residential Programs

C&I Construction

PROGRAM/Measure	Measure Life
Commercial Lighting — New	15
Commercial Lighting — Remodel/Replacement	15
Commercial Custom — New	18*
Commercial Chiller Optimization	18
Commercial Unitary HVAC — New - Tier 1	15
Commercial Unitary HVAC — Replacement - Tier 1	15
Commercial Unitary HVAC — New - Tier 2	15
Commercial Unitary HVAC — Replacement Tier 2	15
Commercial Chillers — New	25
Commercial Chillers — Replacement	25
Commercial Small Motors (1-10 HP) — New or Replacement	20
Commercial Medium Motors (11-75 HP) — New or Replacement	20
Commercial Large Motors (76-200 HP) — New or Replacement	20
Commercial VSDs — New	15
Commercial VSDs — Retrofit	15
Commercial Comprehensive New Construction Design	18
Commercial Custom — Replacement	18
Industrial Lighting — New	15
Industrial Lighting — Remodel/Replacement	15
Industrial Unitary HVAC — New - Tier 1	15
Industrial Unitary HVAC — Replacement - Tier 1	15
Industrial Unitary HVAC — New - Tier 2	15
Industrial Unitary HVAC — Replacement Tier 2	15
Industrial Chillers — New	25
Industrial Chillers — Replacement	25
Industrial Small Motors (1-10 HP) — New or Replacement	20
Industrial Medium Motors (11-75 HP) — New or Replacement	20
Industrial Large Motors (76-200 HP) — New or Replacement	20
Industrial VSDs — New	15
Industrial VSDs — Retrofit	15
Industrial Custom — Non-Process	18*
Industrial Custom — Process	10*
Small Commercial Gas Furnace — New or Replacement	20
Infrared Heating	17
Small Commercial Gas Boiler — New or Replacement	20
Small Commercial Gas DHW — New or Replacement	10
C&I Gas Absorption Chiller — New or Replacement	25
C&I Gas Custom — New or Replacement (Engine Driven Chiller)	25*
C&I Gas Custom — New or Replacement (Gas Efficiency Measures)	18*
Building O&M	
O&M savings	3
Compressed Air	
Compressed Air (GWh participant)	8
Refrigeration	
Evaporator Fan Control	10
Cooler and Freezer Door Heater Control	10
Polyethylene Strip Curtains	4
Food Service	
Fryers	12

PROGRAM/Measure	Measure Life
Steamers	10
Griddles	12
Ovens	12

* For custom applications, projects will be evaluated upon industry/manufacturer data but not to exceed value in above table unless authorized by the Market Manager. Reported savings will be calculated per measure life indicated in this table.