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New Jersey Board of Public Utilities
Office of Clean Energy

New Jersey's Clean Energy Program

Protocols to Measure Resource Savings

Draft Revisions to September 2004 Protocols

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New Jersey's Clean Energy Program Protocols

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New Jersey's Clean Energy Program
Protocols to Measure Resource Savings

Introduction

These protocols have been developed to measure resource savings, including electric energy and 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 best available measured or industry data applicable for the New Jersey programs.

The standard values for most commercial and industrial (C&I) measures are supported by end use metering for key parameters for a sample of facilities and circuits, based on the metered data from past programs. These C&I standard values are based on five years of data for most measures and two years of data for lighting.

Some electric and gas input values were derived from a review of literature from various industry organizations, equipment manufacturers, and suppliers. These input values are updated to reflect changes in code, federal standards and recent program evaluations.

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 of Public Utilities (the Board) on program performance
2. Provide inputs for planning and cost-effectiveness calculations
3. Calculate lost margin revenue recovery (to the extent that lost margin revenue recovery is approved by the Board)
4. Provide information to regulators and program administrators for determining eligibility for performance incentives (to the extent that such incentives are approved by the Board)
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 measure electric energy and capacity from renewable energy and distributed generation systems and the associated environmental benefits.

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 distributes generation measures, included in the current programs approved by the Board. The number of adopted units to which these per unit savings or 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. Free riders and free drivers will be captured implicitly on a net basis through this approach to counting adoption of units. Further, the net of free riders and free drivers are assumed to be zero in the counting of units from direct program participation.[1]

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 or generation 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 assess 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, or renewable or distributed generation, will be estimated 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.

[1] Net impacts, including free riders and free drivers, will be assessed as part of an impact evaluation of the programs anticipated to commence in early 2007.

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 (site specific capacity times standard MWh per kW factor)
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	Custom Industrial process Complex comprehensive jobs 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 = ΔkW = $kW_{baseline} - kW_{energy\ efficient\ measure}$

Electric Energy Savings = ΔkW X EFLH

Electric Peak Coincident Demand Savings = ΔkW X Coincidence Factor

Gas Energy Savings = ΔBtuh X EFLH

Where:

EFLH = Equivalent Full Load Hours of operation for the installed measure.

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

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.

The algorithms for renewable energy and distributed generation systems are driven by installed capacity and assumed capacity factors. For renewable energy systems standard capacity factors are utilized. For example, for photovoltaic systems the protocols estimate that approximately 1,200 kWh of electricity is generated per year per kW of installed capacity. Capacity factors for distributed generation systems are based upon individual project operating assumptions.

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 evaluations (applied prospectively), field data and program results, and standards from industry associations. The standard values for most commercial and industrial measures are supported by end use metering for key parameters for a sample of facilities and circuits. These standard values are based on five years of metered data for most measures[2]. Data that were metered over that time period are from measures that were installed over an eight-year period. Many input values are based on program evaluations of prior New Jersey programs or similar programs in other regions.

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.

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 and Δ kWh values are based on the energy use of standard new products vs. the high efficiency products promoted through the programs. This baseline may be different than the baseline estimates used in previous programs such as the Standard Offer in which the baseline assumptions were based on either the existing equipment for retrofits or current code or practice for new construction. 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.

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[2] Values for lighting, air conditioners, chillers, and motors are based on measured usage from a large sample of participants from 1995 through 1999. Values for heat pumps reflect metered usage from 1996 through 1998, and variable speed drives reflect metered usage from 1995 through 1998.

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	8:00 p.m. to 8:00	NA

and Holidays)	a.m.	

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. 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 gas energy savings are tracked by rate schedule. 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 and gas energy savings. Where identifiable and quantifiable these other key resource savings, such as water, will be estimated. Water, oil, propane and maintenance 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 managers 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 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 or generation (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.

Calculation of the Value of Resource Savings

The calculation of the value of the resources saved is not part of this 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. For regulatory reporting, the following are the average lives that relate lifetime savings to annual savings for each program reporting savings.

	Measure Life (Years)	
Program	Electric	Gas
Residential HVAC	15	20
Residential Low Income	16	20
Energy Star Homes	20	20

C&I Construction	15	15
Customer Sited Generation		
PV	20	
Wind	15	
Fuel Cell		10

Protocols for Program Measures

The following pages present measure-specific protocols.

Residential HVAC Program: Electric Measures

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 and installation 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 and improved installation practices 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

Energy Impact (kWh) = CAPY/1000 X (1/$SEER_b$ – (1/$SEER_q$ X (1-ESF))) X EFLH

Peak Demand Impact (kW) = CAPY/1000 X (1/EER_b – (1/EER_q X (1-DSF))) X CF

Heating Energy Savings – ASHP

Energy Impact (kWh) = CAPY/1000 X (1/$HSPF_b$ – (1/$HSPF_q$ X (1-ESF))) X EFLH

Ground Source Heat Pumps (GSHP)

Cooling Energy (kWh) Savings = CAPY/1000 X (1/$SEER_b$ – (1/EER_g X GSER)) X EFLH

Heating Energy (kWh) Savings = CAPY/1000 X (1/$HSPF_b$ – (1/COP_g X GSOP)) X EFLH

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

GSHP Desuperheater

$$\text{Energy (kWh) Savings} = EDSH$$

$$\text{Peak Demand Impact (kW)} = PDSH$$

<u>Definition of Terms</u>

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.

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 Sizing Factor or the assumed saving due to proper sizing and proper installation.

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

DSF = The Demand Sizing 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.

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
EER_b	Fixed	Baseline = 11.3	2
EER_q	Variable		Rebate Application
EER_g	Variable		Rebate Application
GSER	Fixed	1.02	3
EFLH	Fixed	Cooling = 600 Hours Heating = 2250 Hours	4
ESF	Fixed	2.9%	5
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

Component	Type	Value	Sources
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

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.

Residential HVAC Program: Gas Measures

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

Algorithms

Gas Savings = ($Capy_t$/$AFUE_b$ - $Capy_q$/ $AFUE_q$) * ELFH / 100,000 BTUs/therm

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

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

Definition of Variables

$Capy_q$ = Actual output capacity of the qualifying heating system in Btus/hour

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

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

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

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

Space Heating

Component	Type	Value	Source
$Capy_q$	Variable		Application Form, confirmed with Manufacturer Data
$Capy_t$	Fixed	91,000	1
$AFUE_q$	Variable		Application Form, confirmed with Manufacturer Data
$AFUE_b$	Fixed	Furnaces: 80%	2

Component	Type	Value	Source
		Boilers: 83%	
ELFH	Fixed	593 hours	3
Time Period Allocation Factors	Fixed	Summer = 12% Winter = 88%	4

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.

Water Heaters

Algorithms

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

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.

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	212	2
Time Period Allocation Factors	Fixed	Summer = 50% Winter = 50%	3

Sources:

1. Federal EPACT Standard for a 40 gallon gas water heater. Calculated as 0.62 – (0.0019 X gallons of capacity).

2. Federal Register, Vol. 66, No. 11, Wednesday, January 17, 2001/Rules and Regulations, p. 4474-4497.
3. Prorated based on 6 months in the summer period and 6 months in the winter period.

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. The protocols for space heating measures were established considering the non-additive nature of individual measures. Further, (for protocol reporting only) the cumulative savings from space conditioning measures is capped at 10% of pre-treatment electric space conditioning consumption and 15% of pre-treatment natural gas space conditioning 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}) X Light CF

Efficient Fixtures

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

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

Efficient Torchieres

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

Peak Demand Impact (kW) = $(Torch_{watts})$ 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.

<u>Algorithm</u>

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.

<u>Algorithm</u>

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

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

Space Conditioning Measures

Savings from individual space conditioning measures are affected by any other measures that also are being installed; i.e., such savings are not cumulative. Further, technical reasons dictate prioritizing certain measures over others. The savings algorithms for all space conditioning measures accommodate these considerations by presuming a fixed sequence of measure installation for the purpose of projecting savings and by limiting total estimated electric space conditioning savings to 10% of electric space conditioning pre-treatment usage. Fossil fuel heated houses typically have more substantial opportunities for space conditioning savings than electrically heated houses. Further, there are greater opportunities for interaction between measure types. For protocol reporting, these savings estimates will be capped at 15% of pre-treatment space heating consumption. 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.

Algorithm

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 0.95) 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.

Algorithm

$$\text{Electricity Impact (kWh)} = (ESC_{pre} \text{ X } 0.93) \text{ X } 0.08$$

$$\text{MMBtu savings} = GH_{pre} \text{ X } 0.13$$

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.

Algorithm

$$\text{Electricity Impact (kWh)} = (ESC_{pre} \text{ X } 0.85) \text{ X } 0.03$$

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

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

$$\text{Electricity Impact (kWh)} = (ESC_{pre} \text{ X } 0.93) \text{ X } 0.17$$

$$\text{Peak Demand Impact (kW)} = (\text{Capy/EER X } 1000) \text{ X HP CF X DSF}$$

Total Space Conditioning Savings

As noted, for protocol reporting the total electric savings from all space conditioning measures are presumed to not exceed 10% of the pre-treatment consumption, and gas savings are presumed to not exceed 15% of pre-treatment space heating consumption.

Algorithm

$$\text{Maximum Electricity Impact (kWh)} \leq (ESC_{pre} \text{ X } 0.10)$$

$$\text{Maximum MMBtu savings} = (GH_{pre} \text{ X } 0.15)$$

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 1,460 gallons saved per year per home receiving aerators.

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 Savings	Fixed	1.01 MMBTU	3
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

Component	Type	Value	Sources
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

The energy savings due to the Residential New Construction Program will be a direct output of the home energy rating software. This software 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 algorithms then applied:

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 January 2001 through March 2003

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		REM 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.

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		REM 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 light fixtures 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.

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 January 2001 through March 2003

Data Point	Single Family	Multiple Single Family	Multifamily
Active Solar	None	None	None
Ceiling Insulation	R-30	R-30	R-30
Radiant Barrier	None	None	None
Rim/Band Joist	R-13	R-13	R-13
Exterior Walls - Wood	R-13	R-13	R-13
Exterior Walls - Steel	R-7 effective	R-7 effective	R-7 effective
Foundation Walls	R-0	R-0	R-0
Doors	**R-2.6**	**R-2.6**	**R-2.6**
Windows	U=0.50, SHGC=0.60	U=0.50, SHGC=0.60	U=0.50, SHGC=0.60
Glass Doors	U=0.50, SHGC=0.60	U=0.50, SHGC=0.60	U=0.50, SHGC=0.60
Skylights	U=0.50, SHGC=0.60	U=0.50, SHGC=0.60	U=0.50, SHGC=0.60
Floor over Garage	*R-19*	*R-19*	*R-19*
Floor over Unheated Basement	*R-0*	*R-0*	*R-0*
Floor over Crawlspace	*R-19*	*R-19*	*R-19*
Floor over Outdoor Air	*R-19*	*R-19*	*R-19*
Unheated Slab on Grade	*R-0 edge/R-5 under*	*R-0 edge/R-5 under*	*R-0 edge/R-5 under*
Heated Slab on Grade	*R-0 edge/R-7 under*	*R-0 edge/R-7 under*	*R-0 edge/R-7 under*
Air Infiltration Rate	0.56 ACH winter/0.28 ACH summer	0.56 ACH winter/0.28 ACH summer	0.56 ACH winter/0.28 ACH summer
Duct Leakage	*Observable Duct Leakage*	*Observable Duct Leakage*	*Observable Duct Leakage*
Mechanical Ventilation	*None*	*None*	*None*
Lights and Appliances	*Use Default*	*Use Default*	*Use Default*
Setback Thermostat	*Yes*	No	No
Heating Efficiency			
Furnace	80% AFUE	80% AFUE	80% AFUE
Boiler	**80% AFUE**	**80% AFUE**	**80% AFUE**
Combo Water Heater	*76% AFUE (recovery efficiency)*	*76% AFUE (recovery efficiency)*	*76% AFUE (recovery efficiency)*
Air Source Heat Pump	**7.7 HSPF**	**7.7 HSPF**	**7.7 HSPF**
Geothermal Heat Pump	**2.8 COP open/3.0 COP closed**	**2.8 COP open/3.0 COP closed**	**2.8 COP open/3.0 COP closed**

Data Point	**Single Family**	**Multiple Single Family**	**Multifamily**
PTAC / PTHP	*3.0 COP*	*3.0 COP*	*3.0 COP*
Cooling Efficiency			
Central Air Conditioning	13.0 SEER	13.0 SEER	13.0 SEER
Air Source Heat Pump	13.0 SEER	13.0 SEER	13.0 SEER
Geothermal Heat Pump	**11.3 EER open/12.0 EER closed**	**11.3 EER open/12.0 EER closed**	**11.3 EER open/12.0 EER closed**
PTAC / PTHP	*9.5 EER*	*9.5 EER*	*9.5 EER*
Window Air Conditioners	**11.3 EER**	**11.3 EER**	**11.3 EER**
Domestic WH Efficiency			
Electric	**0.88 EF**	**0.88 EF**	**0.88 EF**
Natural Gas	0.53 EF	0.53 EF	0.53 EF
Water Heater Tank Insulation	*None*	*None*	*None*
Duct Insulation	R-4.8	R-4.8	R-4.8

Data points listed in normal type have been obtained from the Incentive Analysis Assumptions for the associated building type.
Data points listed in **bold** have been obtained from the New Jersey Energy Star Homes Operations Manual.
Data points listed in *italics* were not identified in the Incentive Analysis or the Operations Manual. Values were assigned by MaGrann Associates.
An asterisk (*) indicates the value is more stringent than code.

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.

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 Clothes Washers

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

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

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

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

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

ENERGY STAR Dishwashers

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

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

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

Oil Impact (MMBtu) = $Osav_{DW}$

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

ENERGY STAR Room Air Conditioners

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

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

Definition of Terms

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

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

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

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

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

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

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

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

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

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

$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{RAC} = 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	48 kWh	1
$DSav_{REF}$	Fixed	0.0066 kW	1

Component	Type	Value	Sources
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	201 kWh	3
$Gsav_{CW}$	Fixed	10.6 therms	3
$Osav_{CW}$	Fixed	1.06 MMBtu	3
$DSav_{CW}$	Fixed	0.0267 kW	3
$WSav_{CW}$	Fixed	4,915 gallons	4
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	82 kWh	5
$Gsav_{DW}$	Fixed	0.0754 kW	5
$Osav_{DW}$	Fixed	1.0	5
$DSav_{DW}$	Fixed	0.0225	5
$Wsav_{DW}$	Fixed	159 gallons	5
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%	9
$ESav_{RAC}$	Fixed	56.4 kWh	6
$DSav_{RAC}$	Fixed	0.1018 kW	7
$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{RAC}	Fixed	1.0, 1.0, 1.0, 0.58	8
RAC Time Period Allocation Factors	Fixed	65.1%, 34.9%, 0.0%, 0.0%	2

Sources:

1. Electricity savings from RLW ENERGY STAR Market Update for National Grid. June 2000. Difference is for a post-7/1/2001 fed standards unit. Demand savings derived using refrigerator load shape.
2. Time period allocation factors used in cost-effectiveness analysis. From residential appliance load shapes.
3. Energy savings estimates consistent with prior NEEP screening. Demand savings derived using clothes washer load shape.
4. Clothes washer water savings from RLW Market Update.

5. Energy and water savings from RLW Market Update. Assumes 37% electric hot water market share and 63% gas hot water market share. Demand savings derived using dishwasher load shape.
6. 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*.
7. Average demand savings based on engineering estimate.
8. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.
9. Prorated based on 6 months in the summer period and 6 months in the winter period.

Residential ENERGY STAR Lighting

Protocols

See the protocols for efficient lighting savings under the Residential Low Income Program.

<u>ENERGY STAR CFL Bulbs</u>

Same as Compact Fluorescent Screw In Lamp.

<u>ENERGY STAR Torchieres</u>

Same as Efficient Torchieres

<u>ENERGY STAR Recessed Cans</u>

Same as Efficient Fixtures.

<u>ENERGY STAR Fixtures(Other)</u>

Same as Efficient Fixtures.

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) = $OSav_{OIL}$

Oil Heat/No CAC

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

Component	Type	Value	Sources
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
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.

ENERGY STAR Audit

Protocols

No protocol was developed to measure energy savings for this program. 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. Many measure installations that are likely to produce significant energy savings are covered in other programs. These savings are captured in the measured savings for those programs. The savings produced by this program that are not captured in other programs would be difficult to isolate and relatively expensive to measure.

Home Performance with ENERGY STAR Program

Protocols

Conservation Services Group (CSG) implements the Home Performance with Energy Star Program in New Jersey and in several other states. CSG has developed proprietary software known as HomeCheck 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.

CSG has provided a description of the methods and inputs utilized in the HomeCheck software to estimate energy savings. CSG has also provided a copy of an evaluation report prepared by Nexant which assessed the energy savings from participants in the Home Performance with Energy Star Program managed by the New York State Energy Research and Development Authority (NYSERDA)[3]. The report concluded that the savings estimated by HomeCheck and reported to NYSERDA were in general agreement with the savings estimates that resulted from the evaluation.

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 which was provided by CSG:
CSG's 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 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.

[3] M&V Evaluation, Home Performance with Energy Star Program, Final Report, Prepared for the New York State Energy Research and Development Authority, Nexant, June 2005.

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

CSG is 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 CSG's 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, CSG's 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

Commercial and Industrial Energy Efficient Construction Program

C&I Electric Protocols

Baselines and Code Changes

All baselines are designed to reflect an improvement over market practice defined by baselines, which are generally the higher of code or available equipment, that are updated periodically to reflect upgrades in code, or information from evaluation results.

Baseline data reflect ASHRAE 90.1 1989 for program commitments made prior to July 16, 2002 and ASHRAE 90.1 1999 for commitments starting on July 16, 2002.

Lighting Equipment

With the exception of small commercial lighting, and T-5 and T-8 fixtures replacing HID, 250 watt or greater T-12 fluorescent, or 250 watt or greater incandescent fixtures, savings are calculated using market-driven assumptions for new construction, renovation, remodeling, or equipment replacement that presume a decision to upgrade the lighting system. For small commercial lighting, the most efficient T-12 lamp and magnetic ballast fixture serves as the baseline. For T-5 and T-8 fixtures replacing HID, 250 watt or greater T-12 fluorescent, or 250 watt or greater incandescent fixtures savings are calculated referencing pre-existing connected lighting load.

Lighting equipment includes fluorescent fixtures, ballasts, compact fluorescent fixtures, exit signs, 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.

<u>Algorithms</u>

Demand Savings = ΔkW X CF X (1+IF)

Energy Savings = ΔkW X EFLH X (1+IF)

ΔkW is calculated from example worksheet below (For T-5 and T-8 fixtures replacing HID, 250 watt or greater T-12 fluorescent, or 250 watt or greater incandescent fixtures ΔkW is calculated using the formula below):

This worksheet is an example and does not represent that present stage of improvement to the worksheets presently being used and updated in the field.

Code and Program Limits

A	B	C	D	E	F	G
Building Type or Space Activity	Gross Lighted Area (sf)	Unit Lighting Power Allowance (Watts/sf)	Lighting Power Allowance (W) [B x C]	Program Limit (Watts/sf) [C x .07]	Lighting Power Limit (W) [B x E]	Composite Program Limit [sum F / sum B]
#1Dorm Bed/Study	42,752	1.40	59,853	0.98	41,897	
#2Dorm Bath	7,936	1.20	9,523	0.84	6,666	
#3Stairs	9,216	0.60	5,530	0.42	3,871	
	59,904		74,906		52,434	0.875299145

Installed Lighting Levels

H	I	J	K	L	M
Space ID	Luminaire Tag # if applicable	Luminaire Description	Number of Luminaires	Watts per Luminaire	Connected Watts [K x L]
#1		32w T8	384	27	10,368
#1&2		26W plt	128	61	7,808
#1&#2		26w Quad	192	27	5,184
#3		26w plt	24	27	648
#3		13w plc	16	30	480
	Other Wattage not applicable listed below				9,600
			744		34,088

N. Composite Connected Watts/Square Foot [sum M / sum B] 0.57

<u>Definition of Variables</u>

ΔkW = Change in connected load from baseline to efficient lighting level. The baseline value is expressed in watts/square foot calculated as: (Watts/Sq.Ft. - Watts/Sq.Ft. (qualified equipment by same area))*Area Sq.Ft./1000 (see table above).

There is a lighting table used that is to be periodically updated by the program administrator(s) in the State that shows standardized values of fixture wattages for common lighting systems. These tables are based on evaluations of several manufacturers' wattage ratings for a given fixture type, and have been used in measuring energy and demand savings. The program administrator(s), in a cooperative effort will be responsible for the lighting tables.

For T-5 and T-8 fixtures replacing HID, 250 watt or greater T-12 fluorescent, or 250 watt or greater incandescent fixtures ΔkW = Change in connected load from pre-existing lighting to efficient lighting level calculated as: (Pre-existing watts per fixture * number of fixtures – New lighting watts per fixture * number of fixtures)

CF = Coincidence Factor – This value represents the percentage of the total lighting connected load which is on during electric system's Peak Window. The Peak Window covers the time period from 12 noon to 8 p.m. These values are based on measured usage in the JCP&L service territory.

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%.

EFLH = Equivalent Full Load Hours – This represents the annual operating hours and is computed based on JCP&L metered data and divided into Large (facilities with over 50 kW of reduced load) and other size and building types.

Lighting Verification Summary

Component	Type	Value	Source
ΔkW	Fixed	Change in connected load from baseline.	• Installed load is based on standard wattage tables and verified watts/sq.ft. • For commitments prior to 7/16/2002, baseline is 30% better than ASHRAE 90.1 1989 by space. • For commitments after 7/16/2002, baseline is *5* percent better than ASHRAE 90.1-*1999* by space.
CF	Fixed	Large Office* 65% Large Retail 81% Large Schools 41% Large All Other 63% All Hospitals 67% All Other Office 71% All Other Retail 84% Other Schools 40% All Other 69% Industrial 71% Continuous 90%	JCP&L metered data[4] Cost effectiveness study Estimate

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

Component	Type	Value	Source
IF	Fixed	5%	Impact of lighting watt reduction on air-conditioning load used in previous lighting savings.
EFLH	Fixed	Large Office 3309 Large Retail 5291 Large Schools 2289 Large All Other 3677 All Hospitals 4439 All Other Office 2864 All Other Retail 4490 Other Schools 2628 All Other 2864 Industrial 4818 Continuous 7000	JCP&L metered data[5] Cost effectiveness study Estimate
Time Period Allocation Factors	Fixed	Summer/On-Peak 26% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 22%	

* For facility with greater than 50kW reduction in load.
** For facilities that operate at or near 24 hours, 7 days per week.

Traffic Signals (data from NJDOT)

Traffic Signals

Type of Fixture	kW Reduced	EFLH Total	Summer on-peak	Summer off-peak	Winter on-peak	Winter off-peak
8" red	0.052	5257	636	1125	1246	2250
12" red	0.120	5257	636	1125	1246	2250
8" green	0.051	3066	371	656	727	1312
12"green	0.117	3066	371	656	727	1312

Pedestrian Walk Sign 8" or 12", kW reduced = 0.068, kWh per year = 550.

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

Coincidence factor for demand savings = 60% for red and 35% for green.

Prescriptive Lighting for Small Commercial Customers

This is a fixture replacement program for new and existing small commercial customers which is targeted at facilities the following facilities:

- Existing small commercial and industrial (up to 50 kW average twelve month metered demand through 2001, up to 75 kW average twelve month metered demand beginning 1/1/2002)
- New/renovated/change-of-use small commercial and industrial <= 10,000 s.f. of conditioned space

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.

Algorithms

Demand Savings = ΔkW X CF

Energy Savings = ΔkW X EFLH

> ΔkW=Number of fixtures installed X (baseline wattage for fixture type(from above baseline))-number of replaced fixtures X (wattage from table)

Prescriptive Lighting for Small Commercial Customers

Component	Type	Value	Source
ΔkW	Fixed	See Prescriptive Lighting Savings Table (below)	From NJ lighting tables
CF	Fixed	Average of the small retail and office from lighting verification summary table, 77.5%.	JCP&L metered data[6]
EFLH	Fixed	Average of small retail and office from lighting verification summary 3,677.	JCP&L metered data

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

Component	Type	Value	Source
Time Period Allocation Factors	Fixed	Summer/On-Peak 21% Summer/Off-Peak 22% Winter/On-Peak 28% Winter/Off-Peak 29%	

Prescriptive Lighting Savings Table

Fixture Type	Type	New Watts (w/fixture)	Baseline (w/fixture)	Savings (w/fixture)
COMPACT FLUORESCENT (2) 11W CF/HW	CFL2	26	104	78
COMPACT FLUORESCENT (2) 13W CF/HW	CFL2	30	120	90
COMPACT FLUORESCENT (2) 18W CF/HW	CFL2	36	144	108
COMPACT FLUORESCENT (2) 18W QD/ELEC	CFL2	38	152	114
COMPACT FLUORESCENT (3) 18W	CFL2	54	225	171
COMPACT FLUORESCENT (2) 26W CF/HW	CFL2	53	212	159
COMPACT FLUORESCENT (2) 26W QD/ELEC	CFL2	54	216	162
COMPACT FLUORESCENT (2) 5W CF/HW	CFL2	14	56	42
COMPACT FLUORESCENT (2) 7W CF/HW	CFL2	18	72	54
COMPACT FLUORESCENT (2) 9W CF/HW	CFL2	22	88	66
COMPACT FLUORESCENT 11W CF/HW	CFL1	13	52	39
COMPACT FLUORESCENT 13W CF/HW	CFL1	15	60	45
COMPACT FLUORESCENT 18W CF/HW	CFL1	19	76	57
COMPACT FLUORESCENT 18W QD/ELEC	CFL1	22	88	66
COMPACT FLUORESCENT 20W CF/HW	CFL1	22	88	66
COMPACT FLUORESCENT 22W QD/ELEC	CFL1	26	104	78
COMPACT FLUORESCENT 26W CF/HW	CFL1	28	112	84
COMPACT FLUORESCENT 26W QD/ELEC	CFL1	27	108	81
COMPACT FLUORESCENT 28W CF/HW	CFL1	30	120	90
COMPACT FLUORESCENT 32W CF/HW	CFL1	34	136	102
COMPACT FLUORESCENT 36W CF/HW	CFL1	41	164	123
COMPACT FLUORESCENT 40W CF/HW	CFL1	45	180	135
COMPACT FLUORESCENT (2) 40W CF/HW	CFL2	71	180	109
COMPACT FLUORESCENT 5W CF/HW	CFL1	7	28	21
COMPACT FLUORESCENT 7W CF/HW	CFL1	10	40	30
COMPACT FLUORESCENT 9W CF/HW	CFL1	11	44	33
Low Bay T-5 2L FP54/T5/Elec/Ho	LOBA	117	250	133
Low Bay T-5 3L FP54/T5/Elec/Ho	LOBA	179	290	111
Low Bay T-5 4L FP54/T5/Elec/Ho	LOBA	234	409	175
Low Bay T-5 6L FP54/T5/Elec/Ho	LOBA	351	992	641
Low Bay T-8 2L4	LOBA	55	73	18
Low Bay T-8 2L8	LOBA	118	158	40
Low Bay T-8 3L4	LOBA	79	105	26
Low Bay T-8 4L4	LOBA	110	146	36
Low Bay T-8 4L8	LOBA	233	316	83
Low Bay T-8 6L4	LOBA	224	454	230
High Bay T-5 3L FP54/T5/Elec/Ho	HIBA	179	290	111

Fixture Type	Type	New Watts (w/fixture)	Baseline (w/fixture)	Savings (w/fixture)
High Bay T-5 4L FP54/T5/Elec/Ho	HIBA	234	409	175
High Bay T-5 6L FP54/T5/Elec/Ho	HIBA	351	992	641
High Bay T-8 8L4 FP54/T5/Elec/Ho	HIBA	468	1080	612
High Bay T-8 3L4	HIBA	79	105	26
High Bay T-8 4L4	HIBA	110	146	36
High Bay T-8 4L8	HIBA	233	316	83
High Bay T-8 6L4	HIBA	224	454	230
High Efficiency Fluorescent 1L2 (1) FO17T8/Elec	HEF	18	32	14
High Efficiency Fluorescent 1L2 (2) FO17T8/Elec	HEF	34	56	22
High Efficiency Fluorescent 1L2 (3) FO17T8/Elec	HEF	50	78	28
High Efficiency Fluorescent 1L2 (4) FO17T8/Elec	HEF	62	112	50
High Efficiency Fluorescent 1L3 (1) FO25T8/Elec	HEF	30	46	16
High Efficiency Fluorescent 1L3 (2) FO25T8/Elec	HEF	48	80	32
High Efficiency Fluorescent 1L3 (3) FO25T8/Elec	HEF	68	126	58
High Efficiency Fluorescent 1L3 (4) FO25T8/Elec	HEF	90	160	70
High Efficiency Fluorescent T-5 3L FP54/T5/Elec/Ho	HEF	179	290	111
High Efficiency Fluorescent T-5 4L FP54/T5/Elec/Ho	HEF	234	409	175
High Efficiency Fluorescent T-5 6L FP54/T5/Elec/Ho	HEF	351	992	641
High Efficiency Fluorescent T-8 1L4	HEF	28	42	14
High Efficiency Fluorescent T-8 1L8	HEF	67	78	11
High Efficiency Fluorescent T-8 2L2	HEF	62	94	32
High Efficiency Fluorescent T-8 2L4	HEF	55	73	18
High Efficiency Fluorescent T-8 2L8	HEF	118	158	40
High Efficiency Fluorescent T-8 3L4	HEF	79	105	26
High Efficiency Fluorescent T-8 4L4	HEF	110	146	36
High Efficiency Fluorescent T-8 4L8	HEF	233	316	83
LED Exit Sign	EXIT	20	18	2
PULSE START METAL HALIDE 1000 W	PSMH	1075	1080	5
PULSE START METAL HALIDE 150 W	PSMH	185	200	15
PULSE START METAL HALIDE 175 W	PSMH	208	285	77
PULSE START METAL HALIDE 200 W	PSMH	235	285	50
PULSE START METAL HALIDE 250 W	PSMH	288	454	166
PULSE START METAL HALIDE 300 W	PSMH	342	454	112
PULSE START METAL HALIDE 320 W	PSMH	368	454	86
PULSE START METAL HALIDE 350 W	PSMH	400	454	54
PULSE START METAL HALIDE 400 W	PSMH	450	454	4
PULSE START METAL HALIDE 750 W	PSMH	815	1075	260

Lighting Controls

Lighting controls include occupancy sensors, daylight dimmer systems, and occupancy controlled hi-low controls for fluorescent, and HID controls. 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

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	By building type and size see lighting verification summary table	Assumes same as JCP&L metered data
EFLH	Fixed	By building type and size see lighting verification summary table	JCP&L metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 26% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 22%	

Sources:

- Northeast Utilities, *Determination of Energy Savings Document*, 1992
- Levine, M., Geller, H., Koomey, J., Nadel S., Price, L., "Electricity Energy Use Efficiency: Experience with Technologies, Markets and Policies" ACEEE, 1992

- Lighting control savings fractions consistent with current programs offered by National Grid, Northeast Utilities, Long Island Power Authority, NYSERDA, and Energy Efficient Vermont.

Motors

<u>Algorithms</u>

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * [(hp_{base} * RLF_{base})/\eta_{base} - (hp_{ee} * RLF_{ee})/\eta_{ee}]$$

Demand Savings = (ΔkW) X CF

Energy Savings = (ΔkW)*EFLH

<u>Definition of Variables</u>

hp_{base} = Rated horsepower of the baseline motor

hp_{ee} = Rate horsepower of the energy-efficient motor

RLF_{base} = Rated load factor of the baseline motor

RLF_{ee} = Rated load factor of the energy-efficient motor

η_{base} = Efficiency of the baseline motor

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

Motors

Component	**Type**	**Value**	**Source**
Motor kW	Variable	Based on horsepower and efficiency	Application
EFLH	Fixed	Commercial 2,502 Industrial 4,599	JCP&L metered data[7] and PSEG audit data for industrial
hp_{base}	Fixed	Comparable EPACT Motor	EPACT Directory
hp_{ee}	Variable	Nameplate	Application
RLF_{base}	Fixed	0.70-0.80	Industry Data
RLF_{ee}	Variable	Nameplate	Application
Efficiency – η_{base}	Fixed	Comparable EPACT	From EPACT

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

		Motor	directory.
Efficiency - η_{ee}	Variable	Nameplate	Application
CF	Fixed	35%	JCP&L metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 25% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 23%	

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/EER_b-1/EER_q) X $EFLH_h$

Where c is for cooling and h is for heating.

Definition of Variables

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

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

EER_q = Efficiency rating of the High Efficiency unit – This value comes from the ARI or AHAM directories or manufacturer data. For units < 65,000, SEER and HSPF 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 or AHAM or Manufacturer Data	Application
EER_b	Variable	See Table below	Collaborative agreement and C/I baseline study
EER_q	Variable	ARI or AHAM Values	Application
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	HVAC 1,131 HP cooling 381 HP heating 800	JCP&L metered data[8]
Cooling Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	
Heating Time Period Allocation Factors	Fixed	Summer/On-Peak 0% Summer/Off-Peak 0% Winter/On-Peak 41% Winter/Off-Peak 58%	

HVAC Baseline Table

Equipment Type	Baseline	ASHRAE Std. 90.1 – 1989	ASHRAE Std. 90.1 – 1999
Unitary HVAC/Split Systems			
· <=5.4 tons:	13 SEER	13 SEER	13 SEER
· >5.4 to 11.25 tons	8.9 EER	8.9 EER	10.3 EER
· >11.25 to 30 tons	8.5 EER	8.5 EER up to 20 tons 8.2 EER above 30 tons	9.7 EER up to 20 tons 9.7 EER above 30 tons

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

Equipment Type	Baseline	ASHRAE Std. 90.1 – 1989	ASHRAE Std. 90.1 – 1999
Air-Air Heat Pump Systems · <=5.4 tons: · >5.4 to 11.25 tons · >11.25 to 30 tons	 6.8 HSPF & 13.0 SEER 8.9 EER 8.5 EER	 13 SEER 8.9 EER 8.5 EER up to 20 tons 8.2 EER above 30 tons	 13 SEER 10.1 EER 9.3 EER up to 20 tons 9.0 EER above 30 tons
Package Terminal Systems	9 EER	10 – [0.91 * cap/1000]	10.9 – [0.213 * cap/1000] EER
Water Source Heat Pumps <=30 tons >30 tons	 10.5 EER 10.5 EER	up to 5.4 tons– 9.3 EER >5.4 Tons 10.5 10.5 EER	up to 5.4 tons– 12.0 EER >5.4 Tons 12.0 EER 12.0 EER
Central DX AC Systems · >30 to 63 tons · > 63 tons	8.5 EER 8.5 EER	8.5 EER 8.2 EER	9.5 EER 9.5 EER
GWSHPs	11 EER		3.1 COP

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

Demand Savings = Tons X (kW/ton_b – kW/ton_q) X CF

Energy Savings = Tons X (kW/ton_b – kW/ton_q) X EFLH

Definition of Variables

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

kW/ton_b = This data is the baseline and is found in the Chiller verification summary table.

kW/ton_q = This is the manufacturer data and equipment ratings in accordance with ARI Standard 550/590 latest edition.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system’s Peak Window derived from JCP&L metered data.

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.

Electric Chillers

Component	Type	Value	Source
Tons	Variable	From Rebate Application	
kW/ton$_b$	Fixed	**Water Cooled Chillers (<70 tons)** *Baseline:…………… 0.79 kW/Ton* *ASHRAE Std 90.1-1999…..0.84 kW/Ton* **Water Cooled Chillers (70 to <150 tons)** *Baseline:…………… 0.79 kW/Ton* *ASHRAE Std 90.1-1999…..0.84 kW/Ton* **Water Cooled Chillers (150 to <300 tons)** *Baseline:…………… 0.718 kW/Ton* *ASHRAE Std 90.1-1999…..0.718 kW/Ton* **Water Cooled Chillers (=>300 tons)** *Baseline:…………… 0.639 kW/Ton* *ASHRAE Std 90.1-1999…..0.639 kW/Ton* **Air Cooled Chillers (<150 tons)** *Baseline:…………… 1.256 kW/Ton* *ASHRAE Std 90.1-1999….1.256 kW/Ton* **Air Cooled Chillers (+150 tons)** *Baseline:…………… 1.256 kW/Ton* *ASHRAE Std 90.1-1999…..1.256 kW/Ton*	Collaborative agreement, C/I baseline study, E-Cube Inc. Study, May 2003
kW/ton$_q$	Variable	ARI Standards 550/590-Latest edition	Application
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L metered data[9]
Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	

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

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 consultant's reports will be used to update the values for future filings.

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) = $0.746*HP*RLF/\eta_{motor}*ESF*FLH_{base}$

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

<u>Definitions of Variables</u>

HP = nameplate motor horsepower

RLF = Rated Load Factor. This is the ratio of the peak running load to the nameplate rating of the motor

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

ESF = Energy Savings Factor. The energy savings factor is equal to $1 - FLH_{asd}/FLH_{base}$. This factor can also be computed according to fan and pump laws assuming an average flow reduction and a cubic relationship between flow rate reduction and power draw savings

FLH_{asd} = Full Load Hours of the fan/pump with the VSD

FLH_{base} = Full Load Hours of the fan/pump with baseline drive

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

$DSF = 1 - (kW_{asd}/kW_{base})_{peak}$

kW_{asd} = peak demand of the motor under the variable control conditions

kW_{base} = peak demand of the motor under the base operating conditions

Variable Frequency Drives

Component	Type	Value	Source
Motor HP	Variable	Nameplate	Application
kWh/motor HP	Fixed	1,653 for VAV air handler systems. 1,360 for chilled water pumps.	JCP&L metered data for VFD's[10] and chillers[11].
RLF	Variable	Dependent on HP and peak running load	
η_{motor}	Variable	Nameplate	Application
ESF	Variable	Dependent on full load of base and VFD	
FLH_{asd}	Variable	Nameplate	Application
FLH_{base}	Fixed		Manufacturer Data
DSF	Variable	Dependent on base and variable peak demand	
kW_{asd}	Variable	Nameplate	Application
kW_{base}	Fixed		Manufacturer Data
Time Period Allocation Factors	Fixed	Summer/On-Peak 22% Summer/Off-Peak 10% Winter/On-Peak 47% Winter/Off-Peak 21%	

Air Compressors with Variable Frequency Drives

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

<u>Algorithms</u>

Energy Savings (kWh) = 774*HP

Demand Savings (kW) = 0.129*HP

Coincident Peak Demand Savings (kW) = 0.106*HP

<u>Definitions of Variables</u>

HP = nameplate motor horsepower

Air Compressors with VFDs

[10] Results reflect metered use from 1995 – 1998.
[11] Results reflect metered use from 1995 – 1999.

Component	Type	Value	Source
Motor HP	Variable	Nameplate	Application
kWh/motor HP	Fixed	774	Aspen Systems Study[12]
kW/motor HP	Fixed	0.129	Aspen Systems Study
Coincident Peak kW/motor HP	Fixed	0.106	Aspen Systems Study
Time Period Allocation Factors	Fixed	Summer/On-Peak 28% Summer/Off-Peak 39% Winter/On-Peak 14% Winter/Off-Peak 19%	

[12] Aspen Systems Corporation, Prescriptive Variable Speed Drive Incentive Development Support for Industrial Air Compressors, Executive Summary, June 20, 2005

Gas Chillers

The 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.

<u>Algorithms</u>

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

<u>Definition of Terms</u>

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
IR	Variable		Rebate Application or Manufacturer Data
Tons	Variable		Rebate Application
MMBtu	Variable		Rebate Application
kW/Ton_b	Fixed	**<100 tons** 0.79kW/Ton **100 to 150 tons** 0.79 kW/ton **150 to <300 tons:** 0.718 kW/Ton **300 tons or more:** 0.639 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
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L Measured data[13]
Electric Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	

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

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

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

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	27-32%	Summit Blue
EFLH	Fixed	1,000	PSE&G

Component	Type	Value	Source
EF	Variable		Application Form or Manufacturer Data
Electric Time Period Allocation Factors	Fixed	*Requires additional research*	

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 = $((EF_q - EF_b)/EF_q)$ X Baseline Usage

<u>Definition of Variables</u>

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

EF_b = Energy factor of the baseline water heater. Calculated as 0.67 – 0.0019 * gallons of capacity). Based on a 40 gallon water heater.

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

Water Heaters

Component	Type	Value	Source
EF_q	Variable		Application Form or Manufacturer Data
EF_b	Fixed	0.544	Federal EPACT Standard
Baseline Usage	Fixed	254	DOE/FEMP website http://www.eren.doe.gov/femp/pro
Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	1

1. Prorated based on 6 months in the summer period and 6 months in the winter period.

Furnaces and Boilers

This prescriptive measure targets the use of smaller-scale boilers (less than or equal to 1500 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.

Algorithms

Gas Savings = (($AFUE_q$ – $AFUE_b$)/$AFUE_q$) X CAPY X EFLH

Definition of Variables

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

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

CAPY = Capacity of the furnace or boiler in therms/hour

EFLH = Equivalent full load heating hours

Furnaces and Boilers

Component	Type	Value	Source
$AFUE_q$	Variable		Application Form or Manufacturer Data
$AFUE_b$	Fixed	Furnaces: 78% Boilers: 80%	EPACT Standard for furnaces and boilers
CAPY	Variable		Application Form or Manufacturer Data
EFLH	Fixed	900	PSE&G
Time Period Allocation Factors	Fixed	Summer 12% Winter 88%	1

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.

Building Operation & Maintenance

Protocols

The measurement of energy and demand savings for the building O&M program is based on saving a fixed percent of a building electric and gas load through the performance of various O&M improvement activities. It will be necessary to collect a facilities prior year electric and gas usage for input to the equations.

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

Algorithms

Electric Savings

Energy Impact (kWh) = PYEL X ESF

Peak Demand Impact (kW) = (Energy Impact / EFLH) X CF

Gas Savings

Energy Savings (Therms) = PYGL X GSF

Definition of Variables

PYEL = Participants previous years electric energy use.

PYGL = Participants previous years gas energy use.

EFLH = The equivalent full load hours of operation for the average commercial or industrial establishment in New Jersey.

CF = The coincidence factor for the average commercial or industrial establishment in New Jersey.

ESF = Electric savings factor as a % of facility load prior to program participation.

GSF = Gas savings factor as a % of facility load prior to program participation.

A summary of the data sources and fixed values follows:

C&I Building O&M

Component	Type	Value	Sources
PYEL	Variable		Customer Application
PYGL	Variable		Customer

Component	Type	Value	Sources
			Application
EFLH	Fixed	3900	1
CF	Fixed	0.875	2
ESF	Fixed	10%	3
GSF	Fixed	7%	4

Source Notes:

1. EFLH: Equivalent Full Load Hours of 3900 is based on a typical NJ load profile from the NJ 2000 Forecast.
2. CF: Coincidence Factor of 0.875 is based on the average of 85% for commercial customers and 90% for industrial customers.
3. ESF: Electric Savings Factor of 10% of pre-participation facility load is based on a review of multiple O&M improvement programs.
4. GSF: Gas Savings Factor of 7% of pre-participation facility load is based on a review of multiple O&M improvement programs.

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 current 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 process.

Electric Demand (kW) = Electric capacity of the CHP system in kW provided on the project application, as adjusted during the project review 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.[14]

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

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 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
- NOx (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.

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.

References

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2. Energy Information Administration. "Method for Calculating Carbon Sequestration by Trees in Urban and Suburban Settings," Voluntary Reporting of Greenhouse Gases, September 1996. Washington, DC: U.S. Department of Energy.

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Customer On-Site Renewable Energy Program (CORE)

Protocols

The measurement of energy and demand impacts for customer sited generation systems is based on algorithms that estimate each systems annual energy production and coincident peak capacity production. Input data is based on fixed assumptions, engineering estimates and data supplied from the program's technical worksheets and rebate application forms. An industry standard calculation tool (PVWATTS from the National Renewable Energy Laboratory) will be used for estimating PV system annual outputs.

For wind installations estimated annual energy output is calculated using industry data table and inputs on average wind speed at hub height, rotor diameter and typical system efficiencies for wind speed/rotor diameter combinations.

For 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.

All of the customer sited generation protocols report the gross energy production from the generation system. Sustainable biomass projects account for estimated consumption of the applicable biomass fuel.

In support of the protocol estimates, sub-metering must be installed to measure the gross output of the generating systems capable of recording at 15 minute intervals for a minimum of 12 months.

<u>Sub-Metering Samples Size by technology:</u>

- 50% of first 30 installations
- 10% above 30 Installations
- Not to exceed 100

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

Algorithms

Photovoltaic Systems

PVWATTS will be 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/.

The following input values are used by PVWATTS to estimate average annual energy production, and are collected for each PV project on the PV technical worksheet and rebate application.

Annual Energy Production (kWh) calculated by PVWATTS is a function of:

- System Rated Output (AC output at Standard Rating Conditions)
- Fixed, Single or Double Axis Tracking
- Array Tilt angle (for fixed axis only)
- Array Azimuth (for fixed axis only)
- Weather data (based on City and State)

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
Fixed, Single,	Variable		Application Technical

Component	Type	Value	Sources
Double Axis tracking			Worksheet
Array Tilt	Variable		Application Technical Worksheet
Azimuth Angle	Variable		Application Technical Worksheet
Weather Data	Variable	City, State – four sites will be used (Wilkes Barre PA, Newark NJ, Philadelphia PA, and Atlantic City, NJ	Application Technical Worksheet
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 an industry data table. 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 at hub height
- Rotor diameter
- Total system efficiency

The Estimated Annual Energy Output data table is drawn from Gipe, Paul (1993), Wind Power for Home and Business, Chelsea Green Publishing Company. A spreadsheet with the values in this table is attached.

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

Wind Systems

Component	Type	Value	Sources
Average annual wind speed at hub height (m/s) or (mph)	Variable		Application Technical Worksheet
Rotor diameter in	Variable		Application Technical

Component	Type	Value	Sources
meters or feet			Worksheet
Typical System Efficiency	Fixed for each wind speed / rotor diameter combination	Ranges from 12% to 30%	Gipe, (1993). Appendix E-1 Table on Estimate Annual Energy Output. Efficiencies based on published data.
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.

Renewable Energy Grants and Financing Program

Energy savings/generation for projects installed pursuant to the Renewable Energy Grants and Financing Program will be determined on a case-by-case basis based on the information provided by project applicants as reviewed by the Office of Clean Energy.

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 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
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
Residential Electric HVAC	
CAC 13	15
CAC 14	15
ASHP 13	15

PROGRAM/Measure	Measure Life
ASHP 14	15
CAC proper sizing/install	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
Non-Residential Programs	
C&I Construction	
Air Compressors with VFDs	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

PROGRAM/Measure	Measure Life
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
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
CHP	15
Compressed Air	
Compressed Air (GWh participant)	8