New Jersey Clean Energy Program

Protocols to Measure Resource Savings

Revisions to
September 2004 Protocols

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New Jersey's Clean Energy Program Protocols

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New Jersey Clean Energy Program
Protocols to Measure Resource Savings

Introduction

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

These protocols use measured and customer data as input values in industry-accepted algorithms. The data and input values for the algorithms come from the program application forms or from standard values. The standard input values are based on the 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 on program performance
2. Provide inputs for planning and cost-effectiveness calculations
3. Calculate lost margin revenue recovery
4. Provide information to regulators and program administrators for determining eligibility for administrative performance incentives (to the extent that such incentives are approved by the BPU)
5. Assess the environmental benefits of program implementation

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

The protocols in this document focus on the determination of the per unit savings for the energy efficiency measures, and the per unit generation for the renewable energy or distributed generation measures, included in the current programs approved by the Board. The number of adopted units to which these per unit savings or avoided generation apply are captured in the program tracking and reporting process, supported by market assessments for some programs. The unit count will reflect the direct participation and, through market assessments, the number of units due to market effects in comparison to a baseline level of adoptions. 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 for program tracking and reporting. An annual evaluation plan prepared by the Center for Energy, Economic and Environmental Policy (CEEEP) outlines the plans for assessing markets including program progress in transforming markets, and to update key assumptions used in the Protocols to assess program energy impacts. Reporting provides formats and definitions to be used to document program expenditures, participation rates, and program impacts, including energy and resource savings. The program tracking systems, that support program evaluation and reporting, will track and record the number of units adopted due to the program, and assist in documenting the resource savings using the per unit savings values in the Protocols. Cost benefit analyses prepared by CEEEP and other evaluation contractors assesses the impact of programs, including market effects, and their relationship to costs in a multi-year analysis.

Types of Protocols

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

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

[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.

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

Electric Energy Savings = ΔkW X EFLH

Electric Peak Coincident Demand Savings = ΔkW X Coincidence Factor

Gas Energy Savings = $\Delta Btuh$ X EFLH

Where:

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

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

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 prior 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.

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:

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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.

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.

The only exceptions to prospective application of the protocols are (1) utility review of tracking systems and any necessary adjustments after the end of the program year and prior to the completion of the annual report for that year, and (2) adjustments due to review and on-site verification of custom measures and large comprehensive jobs, also to be completed before the submission of the annual report for that year.

Resource Savings

Electric

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

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

	Energy Savings	Coincident Peak Demand Savings
Summer	May through September	June through August
Winter	October through April	NA
On Peak (Monday - Friday)	8:00 a.m. to 8:00 p.m.	12:00 p.m. to 8:00 p.m.
Off Peak (Weekends and Holidays)	8:00 p.m. to 8:00 a.m.	NA

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

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

Natural Gas

Protocols have been developed to determine the natural gas energy savings on a seasonal basis. The 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, gas and oil 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 administrators will review application forms and tracking systems for all measures and conduct field inspections on a sample of installations. For some programs and jobs (e.g., custom, large process, large and complex comprehensive design), post-installation review and on-site verification of a sample of application forms and installations will be used to ensure the reliability of site-specific savings estimates.

Adjustments to Energy and Resource Savings

Coincidence with Electric System Peak

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

Measure Retention and Persistence of Savings

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

Interaction of Energy Savings

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

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

For the Commercial and Industrial Efficient Construction program, the energy savings for lighting is increased by an amount specified in the protocol to account for HVAC interaction.

For commercial and industrial custom measures, interaction where relevant is accounted for in the site-specific analysis.

Calculation of the Value of Resource Savings

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

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

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

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

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

Transmission and Distribution System Losses

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

Electric Loss Factor

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

Gas Loss Factor

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

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

Calculation of Clean Air Impacts

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

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

Electric Emissions Factors

Emissions Product	Jan 2001-June 2002	July 2003-Present
CO_2	1.1 lbs per kWh	1,520 lbs per MWh

	saved	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.

Program	Measure Life (Years) Electric	Measure Life (Years) 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 Electric HVAC

Protocols

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

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

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

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

<u>Algorithms</u>

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

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

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

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

Heating Energy Savings – ASHP

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

Cooling Energy Consumption and Demand Savings – Central A/C & ASHP (Proper Sizing)

Energy Impact (kWh) = (CAPY/($SEER_q$ X 1000)) X EFLH X PSF

Peak Demand Impact (kW) = ((CAPY/(EER_q X 1000)) X CF) X PSF

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

Energy Impact (kWh) = (((CAPY/(1000 X SEERq)) X EFLH) X (1-PSF) X QIF

Peak Demand Impact (kW) = ((CAPY/(1000 X EERq)) X CF) X (1-PSF) X QIF

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

Energy Impact (kWh) = ((CAPY/(1000 X SEERm)) X EFLH) X MF

Peak Demand Impact (kW) =((CAPY/(1000 X EERm)) X CF) X MF

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

Energy Impact (kWh) = (CAPY/(1000 X SEERq)) X EFLH X DuctSF

Peak Demand Impact (kW) = ((CAPY/(1000 X EERq)) X CF) X DuctSF

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

Peak Demand Impact (kW) = CAPY/1000 X (1/EER_b – (1/(EER_g X GSPK))) X CF

GSHP Desuperheater

Energy (kWh) Savings = EDSH

Peak Demand Impact (kW) = PDSH

Furnace High Efficiency Fan

Heating Energy (kWh) Savings = (($Capy_t$ X $EFLH_{HT}$)/100,000 BTU/therm) X FFS_{HT}

Cooling Energy (kWh) Savings = FFS_{CL}

<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.

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

EER_b = The Energy Efficiency Ratio of the Baseline Unit.

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

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

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

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

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

PSF = The Proper Sizing Factor or the assumed savings due to proper sizing of cooling equipment

QIF = The Quality Installation factor or assumed savings due to a verified quality installation of cooling equipment

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

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

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

DSF = The Demand 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.

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

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

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

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

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

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

Residential Electric HVAC

Component	**Type**	**Value**	**Sources**
CAPY	Variable		Rebate Application
$SEER_b$	Fixed	Baseline = 13	1
$SEER_q$	Variable		Rebate Application
$SEER_m$	Fixed	10	15
EER_b	Fixed	Baseline = 11.3	2
EER_q	Fixed	= (11.3/13) X $SEER_q$	2
EER_g	Variable		Rebate Application
EER_m	Fixed	8.69	19
GSER	Fixed	1.02	3
EFLH	Fixed	Cooling = 600 Hours Heating = 2250 Hours	4
ESF	Fixed	2.9%	5
PSF	Fixed	5%	14
QIF	Fixed	15%	14

Component	Type	Value	Sources
MF	Fixed	10%	20
DuctSF	Fixed	18%	14
CF	Fixed	70%	6
DSF	Fixed	2.9%	7
$HSPF_b$	Fixed	Baseline = 7.7	8
$HSPF_q$	Variable		Rebate Application
COP_g	Variable		Rebate Application
GSOP	Fixed	3.413	9
GSPK	Fixed	0.8416	10
EDSH	Fixed	1842 kWh	11
PDSH	Fixed	0.34 kW	12
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
$Capy_q$	Variable		Rebate Application
$EFLH_{HT}$	Fixed	965 hours	16
FFS_{HT}	Fixed	0.5 kWh	17
FFS_{CL}	Fixed	105 kWh	18

Sources:

1. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
2. Average EER for SEER 13 units.
3. VEIC estimate. Extrapolation of manufacturer data.
4. VEIC estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.
5. Xenergy, "New Jersey Residential HVAC Baseline Study", (Xenergy, Washington, D.C., November 16, 2001).
6. Based on an analysis of 6 different utilities by Proctor Engineering.
7. Xenergy, "New Jersey Residential HVAC Baseline Study", (Xenergy, Washington, D.C., November 16, 2001)
8. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
9. Engineering calculation, HSPF/COP=3.413
10. VEIC Estimate. Extrapolation of manufacturer data.
11. VEIC estimate, based on PEPCo assumptions.
12. VEIC estimate, based on PEPCo assumptions.
13. Time period allocation factors used in cost-effectiveness analysis.
14. Northeast Energy Efficiency Partnerships, Inc., "Benefits of HVAC Contractor Training", (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01
15. Minimum Federal Standard for new Central Air Conditioners between 1990 and 2006
16. NJ utility analysis of heating customers, annual gas heating usage
17. Scott Pigg (Energy Center of Wisconsin), "Electricity Use by New Furnaces: A Wisconsin Field Study", Technical Report 230-1, October 2003.
18. Ibid., p. 34. ARI charts suggest there are about 20% more full load cooling hours in NJ than southern WI. Thus, average cooling savings in NJ are estimated at 95 to 115
19. The same EER to SEER ratio used for SEER 13 units applied to SEER 10 units. EER_m = (11.3/13) * 10
20. VEIC estimate. Conservatively assumes less savings than for QIV because of the retrofit context

Residential Gas HVAC

Protocols

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

Space Heaters

Algorithms

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

Gas Savings due to duct sealing = $CAPY_t$ * EFLH * ($DuctSF_h$/100,000)

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

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

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

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

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

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

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

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

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

Average 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
$DuctSF_h$	Fixed	13%	5
$AFUE_q$	Variable		Application Form, confirmed with Manufacturer Data
$AFUE_b$	Fixed	Furnaces: 80% Boilers: 83%	2
EFLH[3]	Fixed	965 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.
5. Northeast Energy Efficiency Partnerships, Inc., “Benefits of HVAC Contractor Training”, (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01

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

[3] Residential Gas Measures ELFH are subject to change barring the results of impact evaluations.

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.

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.

Algorithm

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.

Algorithm

Electricity Impact (kWh) = HW_{eavg}

Gas Savings (MMBtu) = HW_{gavg}

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

Water Savings (gallons) = WS

Efficient Refrigerators

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

Algorithm

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

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

Space Conditioning Measures

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

Air Sealing

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

Algorithm

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

MMBtu savings = (GHpre X 0.05)

Furnace/Boiler Replacement

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

Duct Sealing and Repair

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

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 0.02

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

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

MMBtu savings = GH_{pre} X 0.13

Thermostat Replacement

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

Algorithm

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

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

Heating and Cooling Equipment Maintenance Repair/Replacement

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

Algorithm

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

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

Other "Custom" Measures

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

Definition of Terms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Capy = Capacity of Heat Pump in Btuh

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

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

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

GC_{pre} = Pre treatment gas consumption.

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

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

Residential Low Income

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

Component	Type	Value	Sources
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
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 lighting and clothes washers will be based on the algorithms presented for these appliances in the Energy Star Lighting Protocols and the Energy Star Appliances Protocols, respectively. These protocols are found in the Energy Star Products Program.

Ventilation Equipment

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

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

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

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

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

Notes:

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

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

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

(4) Size dependent. 50 gallon assumed.

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

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

Notes:

(1) Federal Government standard for calculating EF

ENERGY STAR Products Program

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

ENERGY STAR Appliances

Protocols

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

Number of Units X Savings per Unit

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

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

ENERGY STAR Refrigerators

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

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

ENERGY STAR Clothes Washers – Tier 2 (MEF of 2.00 to 2.19)

Electricity Impact (kWh) = $ESav_{CW2}$

Demand Impact (kW) = $DSav_{CW2}$ x CF_{CW}

Gas Impact (Therms) = $EGSav_{CW2}$

Water Impact (gallons) = $WSav_{CW2}$

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

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

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

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

ENERGY STAR Dishwashers

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

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

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

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

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

ENERGY STAR Dehumidifiers

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

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

ENERGY STAR Room Air Conditioners

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

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

Definition of Terms

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

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

$ESav_{CW2}$ = Electricity savings per purchased ENERGY STAR clothes washer – Tier 2.

$DSav_{CW2}$ = Summer demand savings per purchased ENERGY STAR clothes washer – Tier 2.

$GSav_{CW2}$ = Gas savings per purchased clothes washer - Tier 2

$WSav_{CW2}$ = Water savings per purchased clothes washer – Tier 2.

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

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

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

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

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

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

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

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

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

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

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

CF_{REF}, CF_{CW}, CF_{DW}, CF_{DH}, 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	91 kWh	1
$DSav_{REF}$	Fixed	0.0125 kW	1
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
$ESav_{CW2}$	Fixed	111 kWh	3
$Gsav_{CW2}$	Fixed	7.94 therms	3
$DSav_{CW2}$	Fixed	0.0147 kW	3
$WSav_{CW2}$	Fixed	7,693 gallons	3
$ESav_{CW3}$	Fixed	128 kWh	3
$Gsav_{CW3}$	Fixed	9.00 therms	3
$DSav_{CW3}$	Fixed	0.0170 kW	3
$WSav_{CW3}$	Fixed	9433 gallons	3
CW Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 24.5% Summer/Off-Peak 12.8% Winter/On-Peak 41.7% Winter/Off-Peak 21.0%	2
CW Gas Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	

Component	Type	Value	Sources
$ESav_{DW}$	Fixed	82 kWh	4
$Gsav_{DW}$	Fixed	0.0754 kW	4
$Osav_{DW}$	Fixed	1.0	4
$DSav_{DW}$	Fixed	0.0225	4
$Wsav_{DW}$	Fixed	159 gallons	4
DW Electricity Time Period Allocation Factors	Fixed	19.8%, 21.8%, 27.8%, 30.6%	2
DW Gas Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	8
$ESav_{DH}$	Fixed	71 kWh	9
$DSav_{DH}$	Fixed	.0098 kW	10
$ESav_{RAC}$	Fixed	56.4 kWh	5
$DSav_{RAC}$	Fixed	0.1018 kW	6
$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{DH}, CF_{RAC}	Fixed	1.0, 1.0, 1.0, 1.0, 0.58	7
RAC Time Period Allocation Factors	Fixed	65.1%, 34.9%, 0.0%, 0.0%	2

Sources:

1. Energy Star Refrigerator Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). Demand savings derived using refrigerator load shape.
2. Time period allocation factors used in cost-effectiveness analysis. From residential appliance load shapes.
3. Energy and water savings based on Consortium for Energy Efficiency estimates. Assumes 75% of participants have gas water heating and 60% have gas drying (the balance being electric). Demand savings derived using NEEP screening clothes washer load shape
4. Energy 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.
5. Energy and demand savings from engineering estimate based on 600 hours of use. Based on delta watts for ENERGY STAR and non-ENERGY STAR units in five different size (cooling capacity) categories. Category weights from LBNL *Technical Support Document for ENERGY STAR Conservation Standards for Room Air Conditioners*.
6. Average demand savings based on engineering estimate.
7. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.
8. Prorated based on 6 months in the summer period and 6 months in the winter period.
9. Energy Star Dehumidifier Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). A weighted average based on the distribution of available ENERGY STAR products was used to determine savings.
10. Conservatively assumes same kW/kWh ratio as Refrigerators

Residential ENERGY STAR Lighting

Protocols

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

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

Number of Units X Savings per Unit

Per unit savings estimates are derived primarily from a 2004 Nexus Market Research report evaluating similar retail lighting programs in New England (MA, RI and VT)

<u>ENERGY STAR CFL Bulbs</u>

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

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

<u>ENERGY STAR Torchieres</u>

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

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

<u>ENERGY STAR Indoor Fixture</u>

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

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

<u>ENERGY STAR Outdoor Fixture</u>

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

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

Definition of Terms

CFL_{watts} = Average delta watts per purchased ENERGY STAR CFL

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

ISR_{CFL} = In-service rate per CFL

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

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

ISR_{Torch} = In-service rate per Torchier

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

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

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

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

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

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

Light CF = Summer demand coincidence factor.

ENERGY STAR Lighting

Component	Type	Value	Sources
CFL_{watts}	Fixed	48.7	1
CFL_{hours}	Fixed	3.4	2
ISR_{CFL}	Fixed	84%	3
$Torch_{watts}$	Fixed	115.8	1
$Torch_{hours}$	Fixed	3.0	2
ISR_{Torch}	Fixed	83%	3
IF_{watts}	Fixed	48.7	1
IF_{hours}	Fixed	2.6	2
ISR_{IF}	Fixed	95%	3
OF_{watts}	Fixed	94.7	1
OF_{hours}	Fixed	4.5	2

Component	Type	Value	Sources
ISR_{OF}	Fixed	87%	3
Light CF	Fixed	5%	4

Sources:

1. Nexus Market Research, "Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs", Final Report, October 1, 2004, p. 43 (Table 4-9)
2. Ibid., p. 104 (Table 9-7). This table adjusts for differences between logged sample and the much larger telephone survey sample and should, therefore, have less bias.
3. Ibid., p. 42 (Table 4-7). These values reflect both actual installations and the % of units planned to be installed within a year from the logged sample. The logged % is used because the adjusted values (i.e to account for differences between logging and telephone survey samples) were not available for both installs and planned installs. However, this seems appropriate because the the % actual installed in the logged sample from this table is essentially identical to the % after adjusting for differences between the logged group and the telephone sample (p. 100, Table 9-3).
4. RLW Analytics, "Development of Common Demand Impacts for Energy Efficiency Measures/Programs for the ISO Forward Capacity Market (FCM)", prepared for the New England State Program Working Group (SPWG), March 25, 2007, p. IV.

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.

Heat Pump

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

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

Gas Heat/CAC

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

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

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

Gas Heat/No CAC

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

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

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

Oil Heat/CAC

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

<u>Definition of Terms</u>

$ESav_{HP}$ = 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

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

Refigerator/Freezer Retirement Program

Protocols

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

Number of Units X Savings per Unit

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

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

Algorithm

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

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

Definition of Terms

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

NTG = Net-to-Gross Adjustment factor.

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

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

REFRIGERATOR/FREEZER RECYCLING

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

Sources:

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

Home Performance with ENERGY STAR Program

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)[4]. 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. 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.

[4] 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 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

Lighting

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

Blue Line Innovations – PowerCost Monitor™

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

- Savings have been adjusted to account for the percentage of homes with non-electric space heating and/or non-electric DHW vs. homes with electric space heating and/or electric DHW. The following grid outlines the savings observed in the Mountain study by fuel type and the correlating estimated NJ population of that fuel type.

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

Homes with electric space heating and electric water heating	1.2%	10%

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

Commercial and Industrial Energy Efficient Construction

C&I Electric Protocols

Baselines and Code Changes

All baselines are designed to reflect current market practices 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 1999 for program commitments made prior to December 31, 2007 and ASHRAE 90.1 2004 for commitments starting on January 1, 2008..

Lighting Equipment

For new construction and entire facility rehabilitation projects, savings are calculated using market-driven assumptions that presume a decision to upgrade the lighting system from an industry standard system. For existing 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, LED fixtures, and metal halide lamps. The measurement of energy savings is based on algorithms with measurement of key variables (i.e., Coincidence Factor and Operating Hours) through end-use metering data accumulated from a large sample of participating facilities from 1995 through 1999.

<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 to calculate program savings.

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 .08]	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.

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 12/31/2007, baseline is 20% better than ASHRAE 90.1 1999 by space. • For commitments after 1/1/2008, baseline is *5* percent better than ASHRAE 90.1-*2004* 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[5] Cost effectiveness study (All Other) Estimate (Industrial)
IF	Fixed	5%	Impact of lighting watt reduction on air-conditioning load used in previous lighting savings.

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

Component	Type	Value	Source
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[6] 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.

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

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

Prescriptive Lighting

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

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

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

<u>Algorithms</u>

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 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[7]
EFLH	Fixed	Average of small retail and office from lighting verification summary 3,677.	JCP&L metered data
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

This table will be updated periodically to include new fixtures and technologies available after table publication. Baselines will be established based on the guidelines noted above.

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

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
Low Bay LED 85 W for 250 Metal Halide	LBLD	85	248	163
Low Bay LED 85 W for 2LHO T-8	LBLF	85	118	33

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.

<u>Algorithms</u>

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

Algorithms

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

Definition of Variables

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[8] 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 Motor	From EPACT 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%	

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

		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[9]
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 - 2004
Unitary HVAC/Split Systems · <=5.4 tons: · >5.4 to 11.25 tons · >11.25 to 30 tons .> 21 to 30 tons	 13 SEER 10.1 EER 9.5 EER 9.3 EER
Air-Air Heat Pump Systems · <=5.4 tons: · >5.4 to 11.25 tons · >11.25 to 20 tons .>= 21 to 30 tons	 13 SEER 9.9 EER 9.1 EER 9.0 EER
Package Terminal Systems < 0.74 tons .75 – 1 ton > 1 ton	 10.6 EER 10.2 EER 9.9 EER

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

Equipment Type	Baseline = ASHRAE Std. 90.1 - 2004
Water Source Heat Pumps All Capacities	12.0 EER
Central DX AC Systems All Capacities	11.0 EER
GWSHPs Open and Closed Loop All Capacities	16.2 EER

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 (=<150 tons)** *Baseline:………….. 0.703 kW/Ton* **Water Cooled Chillers (151 to <300 tons)** *Baseline:………….. 0.634 kW/Ton* **Water Cooled Chillers (>301 tons)** *Baseline:………….. 0.577 kW/Ton* **Air Cooled Chillers (<150 tons)** *Baseline:………….. 1.256 kW/Ton*	ASHRAE 90.1 2004
kW/ton$_q$	Variable	ARI Standards 550/590-Latest edition	Application
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L metered data[10]
Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	

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 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

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

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[11] and chillers[12].
RLF	Variable	Dependent on HP and peak running load	
η_{motor}	Variable	Nameplate or manufacturer specs	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	Applicatoin

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

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.

Algorithms

Energy Savings (kWh) = 774*HP

Demand Savings (kW) = 0.129*HP

Coincident Peak Demand Savings (kW) = 0.106*HP

Definitions of Variables

HP = nameplate motor horsepower

Air Compressors with VFDs

Component	**Type**	**Value**	**Source**
Motor HP	Variable	Nameplate	Application
kWh/motor HP	Fixed	774	Aspen Systems Study[13]
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%	

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

C&I Construction Gas Protocols

Gas Chillers

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

<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	**> 150 tons** 0.703 kW/ton **150 to <300 tons:** 0.634 kW/Ton **300 tons or more:** 0.577 kW/ton	Collaborative agreement and C/I baseline study Assumes new electric chiller baseline using air cooled unit for chillers less than 100 tons;water cooled for chillers greater than 100 tons
kW/Ton_{gc}	Variable		Manufacturer Data
COP	Variable		Manufacturer Data
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L Measured data[14]
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.

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.

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

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.

<u>Algorithms</u>

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)

<u>Definition of Variables</u>

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
EF	Variable		Application Form or Manufacturer Data

Component	Type	Value	Source
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.

Algorithms

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

Definition of Variables

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

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.

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.

Direct Install Program

The Direct Install Program is designed to install prescriptive equipment in small commercial and industrial facilities. All equipment installed under this program will utilize equipment for which the existing energy savings protocols can be utilized.

Pay for Performance Program

The Pay for Performance Program is designed for large projects with custom energy savings calculations. These savings calculations are developed during the modeling of the specific Pay for Performance Project and confirmed in the Measurement and Verification Methodology presented and approved as part of the project application. The Measurement and Verification protocols will follow the International Performance Measurement and Verification Protocol (IPMVP). The savings approved in the project application utilizing the IPMVP, and confirmed at the project post installation inspection will be the basis of reported energy savings for the project.

Combined Heat and Power (CHP) Program

Protocols

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

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

Distributed Generation

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

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

Energy Savings

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

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

Emission Reductions

For many CHP applications there can be substantial emission benefits due to the superior emission rates of many new CHP engines and turbines as compared to the average emission rate of electric generation units on the margin of the grid. However, CHP engines and turbines produce emissions, which should be offset against the displaced emissions from the electricity that would have been generated by the grid.[15]

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

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

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.

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Customer On-Site Renewable Energy Program (CORE)

Protocols

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

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

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

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

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

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

<u>Algorithms</u>

Photovoltaic Systems

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

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

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

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

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

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

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

Photovoltaic Systems

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

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

Wind Systems

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

Annual Energy Output (kWh) is a function of:

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

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

Wind Systems

Component	Type	Value	Sources
Average annual wind speed at 50 meters (m/s) or (mph)	Variable		Application Technical Worksheet, verified by checking against approved wind resource maps
Turbine hub height as installed	Variable		Application Technical Worksheet, verified by inspection documentation
Annual energy output power curve for proposed turbine	Variable look up based on wind speed and hub height at each location		Annual energy output power curves based on manufacturer's published data. Values checked against industry experience and acceptance for use in other jurisdictions.
Summer Peak Impact	Fixed	0%	Data on peak impact not available at this time
Winter Peak Impact	Fixed	0%	Data on peak impact not available at this time

Sustainable Biomass

Estimated annual energy output and peak impacts for sustainable biomass systems will be based on case specific engineering estimates and manufacturer data.

SREC-Only Pilot

The measurement of energy and demand impacts for photovoltaic systems participating in the SREC-Only pilot will be based on the rules and protocols for metering, reporting and verification that are expected to be developed in 2008. Prior to formal adoption of these rules and protocols, methods similar to those identified above will be used to estimate each systems annual energy production and coincident peak capacity production. Reported generation will be based on as installed conditions, as verified by site inspection documentation.

Renewable Energy Development Initiative

Energy savings/generation for projects installed pursuant to the Renewable Energy Development Initiative will be determined on a case-by-case basis based on the information provided by project applicants, and inspection data for verification of as- installed conditions. The reported savings for each project participant in the REDI will be calculated and presented for review by the Office of Clean Energy.

Appendix A
Measure Lives

NEW JERSEY STATEWIDE ENERGY-EFFICIENCY PROGRAMS
Measure Lives Used in Cost-Effectiveness Screening
July 2001

PROGRAM/Measure	Measure Life
Residential Programs	
Energy Star Appliances	
ES Refrigerator post 2001	17
ES Refrigerator 2001	17
ES Dishwasher	13
ES Clotheswasher	20
ES Dehumidifier	11
ES RAC	10
Energy Star Lighting	
CFL	6.4
Recessed Can Fluourescent Fixture	20
torchiere residential	10
Fixtures Other	20
Energy Star Windows	
WIN-heat pump	20
WIN-gas heat/CAC	20
WIN-gas No CAC	20
Win-elec No AC	20
Win-elec AC	20
Refrigerator/Freezer Retirement	
Refrigerator/Freezer retirement	8
Residential New Construction	
SF gas w/CAC	20
SF gas w/o CAC	20
SF oil w/CAC	20
SF all electric	20
TH gas w/CAC	20
TH gas w/o CAC	20
TH oil w/CAC	20
TH all electric	20
MF gas w/AC	20
MF gas w/o AC	20
MF oil w/CAC	20
MF all electric	20
ES Clotheswasher	20
Recessed Can Fluor Fixture	20
Fixtures Other	20
Efficient Ventilation Fans w/Timer	10

PROGRAM/Measure	Measure Life
Residential Electric HVAC	
CAC 13	15
CAC 14	15
ASHP 13	15
ASHP 14	15
CAC proper sizing/install	15
CAC QIV	15
CAC Maintenance	7
CAC duct sealing	15
ASHP proper sizing/install	15
E-Star T-stat (CAC)	15
E-star T-stat (HP)	15
GSHP	30
CAC 15	15
ASHP 15	15
Residential Gas HVAC	
High Efficiency Furnace	20
High Efficiency Boiler	20
High Efficiency Gas DHW	10
E-Star T-stat	15
Low-Income Program	
Air sealing electric heat	17
Duct Leak Fossil Heat & CAC	15
typical fossil fuel heat	17
typical electric DHW pkg	10
typical fossil fuel DHW pkg	10
screw-in CFLs	6.4
high-performance fixtures	20
fluorescent torchieres	10
TF 14	20
TF 16	20
TF 18	20
SS 20	20
TF 21	20
SS 22	20
TF 25	20
audit fees	20
Attic Insulation- ESH	17
Duct Leak - ESH	15
T-Stat- ESH	5
HP charge air flow	8
electric arrears reduction	1
gas arrears reduction	1
Home Performance with ENERGY STAR	
Blue Line Innovations – PowerCost MonitorTM	5

Non-Residential Programs

C&I Construction

PROGRAM/Measure	Measure Life
Commercial Lighting — New	15
Commercial Lighting — Remodel/Replacement	15
Commercial Custom — New	18
Commercial Chiller Optimization	18
Commercial Unitary HVAC — New - Tier 1	15
Commercial Unitary HVAC — Replacement - Tier 1	15
Commercial Unitary HVAC — New - Tier 2	15
Commercial Unitary HVAC — Replacement Tier 2	15
Commercial Chillers — New	25
Commercial Chillers — Replacement	25
Commercial Small Motors (1-10 HP) — New or Replacement	20
Commercial Medium Motors (11-75 HP) — New or Replacement	20
Commercial Large Motors (76-200 HP) — New or Replacement	20
Commercial VSDs — New	15
Commercial VSDs — Retrofit	15
Commercial Comprehensive New Construction Design	18
Commercial Custom — Replacement	18
Industrial Lighting — New	15
Industrial Lighting — Remodel/Replacement	15
Industrial Unitary HVAC — New - Tier 1	15
Industrial Unitary HVAC — Replacement - Tier 1	15
Industrial Unitary HVAC — New - Tier 2	15
Industrial Unitary HVAC — Replacement Tier 2	15
Industrial Chillers — New	25
Industrial Chillers — Replacement	25
Industrial Small Motors (1-10 HP) — New or Replacement	20
Industrial Medium Motors (11-75 HP) — New or Replacement	20
Industrial Large Motors (76-200 HP) — New or Replacement	20
Industrial VSDs — New	15
Industrial VSDs — Retrofit	15
Industrial Custom — Non-Process	18
Industrial Custom — Process	10
Small Commercial Gas Furnace — New or Replacement	20
Small Commercial Gas Boiler — New or Replacement	20
Small Commercial Gas DHW — New or Replacement	10
C&I Gas Absorption Chiller — New or Replacement	25
C&I Gas Custom — New or Replacement (Engine Driven Chiller)	25
C&I Gas Custom — New or Replacement (Gas Efficiency Measures)	18
Building O&M	
O&M savings	3
Compressed Air	
Compressed Air (GWh participant)	8