New Jersey Clean Energy Collaborative

Protocols to Measure Resource Savings

July 9, 2001

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Introduction

These protocols have been developed to measure resource savings, including energy, capacity, and other resource savings. Specific protocols for determination of the resource savings 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 the GPUE Shared Savings Program. 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.

Purpose

These protocols were developed for the purpose of determining energy and resource savings for the programs approved by Board Order dated March 9, 2001 and subsequently described in a Program Compliance Filing made on April 9, 2001 in the Comprehensive Resources Analysis (CRA) of Energy Programs proceeding, Docket Nos. EX99050347, EO99050348, EO99050349, EO99050350, EO99050351, GO99050352, GO99050353, and GO99050354. These 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 in this document focus on the determination of the per unit savings for the energy efficiency measures included in the programs in the April 9, 2001 Program Compliance Filing. The number of adopted units to which these per unit savings 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.

The following four attachments to Supplement 1 to the April 9, 2001 Program Compliance Filing present inter-related plans and analyses to support regulatory reporting, measure energy and resource savings, assess program cost effectiveness and environmental benefits, and track and evaluate program implementation:

- Attachment 1 - Energy and Economic Assessment of Energy Efficiency Programs (Cost Effectiveness)
- Attachment 2 - Protocols to Measure Resource Savings
- Attachment 3 - Program Evaluation Plan
- Attachment 4 - Regulatory Reporting
- Attachment 5 - Performance Incentives

The protocols (Attachment 2) provide the methods to measure per unit savings for program tracking and reporting. The Evaluation Plan (Attachment 3) outlines the plans for assessing markets and program progress in transforming markets, and to update key assumptions used in the protocols to assess program energy savings. Reporting (Attachment 4) 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. The Energy and Economic Assessment of Energy Efficiency Programs (Cost Effectiveness) (Attachment 1) presents the projected impacts of programs, including market effects, and their relationship to costs in a multi-year analysis. The assumptions and methods used in these statewide analyses are consistent and integrated (e.g., the same per unit savings were used to project program savings, to assess program cost-effectiveness and environmental benefits, and to set savings goals for program performance incentives).

Types of Protocols

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

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

Summary of Protocols and Approaches

Type of Measure	Type of Protocol	General Approach	Examples
1. Standard prescriptive measures	Standard formula and standard input values	Number of installed units times standard savings/unit	Residential lighting (number of units installed times standard savings/unit)
2. Measures with important variations in one or more input values (e.g., delta watts, efficiency level, capacity, load, etc.)	Standard formula with one or more site-specific input values	Standard formula in the protocols with one or more input values coming from the application form, worksheet, or field tool (e.g., delta watts, efficiency levels, unit capacity, site-specific load)	Some prescriptive lighting measures (delta watts on the application form times standard operating hours in the protocols) Residential Electric HVAC (change in efficiency level times site-specific capacity times standard operating hours) Field screening tools that use site-specific input values
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

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.

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 and two years of metered data for lighting. 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 collaborative stipulated to (or "deemed") certain input values (e.g., delta watts, delta efficiency, equipment capacity, operating hours, coincidence factors) 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 programs the Δ kW and 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. 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.

Resource Savings in Current and Future Program Years

The New Jersey Collaborative has agreed to track and report the following categories of energy and resource savings:

1. Savings 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 from program participant future adoptions due to program commitments.

3. Savings 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 demand savings. Current energy savings and billed demand savings are calculated monthly for the purpose of lost margin revenue recovery. The electric energy savings are tracked by voltage level and rate schedules. Calculated electric energy and demand savings are determined separately by season (summer and winter) and time of day (on-peak and off-peak), and summed on an annual basis. These periods are defined as:

	Energy Savings	Demand Savings
Summer	May through September	June through August
Winter	October through April	September through May
On-Peak	8:00 a.m. to 8:00 p.m.	12:00 p.m. to 8:00 p.m.
Off-Peak	8:00 p.m. to 8:00 a.m.	8:00 p.m. to 12 p.m.

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

Other Resources

Some of the energy savings measures also result in the saving of other resources. Where identifiable and quantifiable these other resource savings 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

Utilities 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 System Peak

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

Measure Retention and Persistence of Savings

The combined effect of measure retention and persistence is the ability of installed measures to maintain the initial level of energy savings 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 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).

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 electric loss factor applied to savings at the customer meter is 1.11 for both energy and demand. Similarly the gas loss factor is 1.0. These 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:

- CO_2 - 1.1 lbs per kWh saved
- NO_X - 6.42 lbs per metric ton of CO_2 reductions
- SO_2 - 10.26 lbs per metric ton of CO_2 reductions
- Hg - 0.00005 lbs per metric ton of CO_2 reductions
  All factors are on an average system basis and will be updated as new factors become available.

Protocols for Program Measures

The following pages present measure-specific protocols organized by each program.

Residential Electric HVAC Program

Overview

This program aims to improve the efficiency of new central air conditioners and heat pumps. It promotes both the sale of high efficiency equipment and improvements in sizing and installation practices that affect operating efficiency. The long-term goal is to transform the market to one in which quality installations of high efficiency equipment are commonplace. To achieve this goal, the program must overcome a number of important market barriers. Key among these are: (1) split incentives (between builders and homebuyers and between owners and renters); (2) consumers lack of information on the benefits (both energy and non-energy) of efficient equipment and quality installations; (3) lack of training for HVAC contractors on key installation issues and approaches to "selling" efficiency; and (4) consumers inability to differentiate between good work and poor work or between quality contractors/technicians and those less skilled. The program employs several key strategies to overcome these barriers:

1. Substantial incentives for the sale or purchase of high efficiency equipment for which documentation of proper sizing and installation is provided;
2. Aggressive consumer marketing campaign on key elements & benefits of efficiency;
3. Direct marketing to HVAC distributors and contractors through "circuit riders";
4. Training of HVAC contractors on key elements of quality installations;
5. ENERGY STAR sales training for contractors (i.e. on how to sell efficiency);
6. Promotion of HVAC technician certification; and
7. Promotion of significant increases in minimum federal efficiency standards.

Protocols

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

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

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

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

Algorithms

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

Cooling Energy Consumption and Peak Demand Savings – Central A/C & ASHP

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

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

Heating Energy Savings – ASHP

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

Ground Source Heat Pumps (GSHP)

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

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

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

GSHP Desuperheater

Energy (kWh) Savings = EDSH

Peak Demand Impact (kW) = PDSH

Definition of Terms

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

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

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

EER_b = The Energy Efficiency Ratio of the Baseline Unit.

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

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

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

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

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

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

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

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

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

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

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

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

EDSH = Assumed savings per desuperheater.

PDSH = Assumed peak demand savings per desuperheater.

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

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

Residential Electric HVAC

Component	**Type**	**Value**	**Sources**
CAPY	Variable		Rebate Application
$SEER_b$	Fixed	Baseline = 10	1
$SEER_q$	Variable		Rebate Application
EER_b	Fixed	Baseline = 9.2	2
EER_q	Variable		Rebate Application
EER_g	Variable		Rebate Application
GSER	Fixed	1.02	3
EFLH	Fixed	Cooling = 600 Hours Heating = 2250 Hours	4
ESF	Fixed	17%	5
CF	Fixed	70%	6
DSF	Fixed	7%	7
$HSPF_b$	Fixed	Baseline = 6.8	8
$HSPF_q$	Variable		Rebate Application
COP_g	Variable		Rebate Application
GSOP	Fixed	3.413	9
GSPK	Fixed	0.8416	10
EDSH	Fixed	1842 kWh	11
PDSH	Fixed	0.34 kW	12

Component	Type	Value	Sources
Cooling - CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 64.9% Summer/Off-Peak 35.1% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Cooling – ASHP Time Period Allocation Factors	Fixed	Summer/On-Peak 59.8% Summer/Off-Peak 40.2% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Cooling – GSHP Time Period Allocation Factors	Fixed	Summer/On-Peak 51.7% Summer/Off-Peak 48.3% Winter/On-Peak 0% Winter/Off-Peak 0%	13
Heating – ASHP & GSHP Time Period Allocation Factors	Fixed	Summer/On-Peak 0.0% Summer/Off-Peak 0.0% Winter/On-Peak 47.9% Winter/Off-Peak 52.1%	13
GSHP Desuperheater Time Period Allocation Factors	Fixed	Summer/On-Peak 4.5% Summer/Off-Peak 4.2% Winter/On-Peak 43.7% Winter/Off-Peak 47.6%	13

Sources:

1. Federal minimum SEER is 10.0 and national data confirms that this is predominately the unit installed without intervention.
2. Analysis of ARI data.
3. VEIC estimate. Extrapolation of manufacturer data.
4. VEIC estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.
5. From Neme, Proctor and Nadel, 1999.
6. Based on an analysis of 6 different utilities by Proctor Engineering.
7. From Neme, Proctor and Nadel, 1999.
8. Federal minimum HSPF is 6.8.
9. Engineering calculation, HSPF/COP=3.413
10. VEIC Estimate. Extrapolation of manufacturer data.
11. VEIC estimate, based on PEPCo assumptions.
12. VEIC estimate, based on PEPCo assumptions.
13. Time period allocation factors used in cost-effectiveness analysis.

Residential Gas HVAC Program

Overview

This program aims to improve the efficiency of new gas heating systems, primarily by promoting the sale and purchase of ENERGY STAR furnaces and boilers. It may also promote the sale and purchase of high efficiency gas water heaters. The long-term goal is to transform the market to one in which high efficiency equipment becomes the market standard. The program must overcome several market barriers to achieve this goal. Key among these are: (1) consumers lack of information on the magnitude of the benefits of efficiency; (2) HVAC contractors lack of skill/tools for "selling" efficiency; (3) split incentives (both between builders and homebuyers and between owners and renters; and (4) higher costs related, in part, to lower sales volumes for high efficiency equipment. The program employs several key strategies to address these barriers:

1. Substantial incentives for the sale and purchase of ENERGY STAR-rated heating equipment and high efficiency water heaters, steadily declining over time as the program places greater emphasis on marketing;
2. Aggressive consumer marketing campaign on the benefits of efficiency;
3. Direct marketing to HVAC distributors and contractors;
4. ENERGY STAR sales training for contractors (i.e., on how to sell efficiency); and
5. Promotion of significant increases in minimum federal efficiency standards.

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. These energy efficiency measures can also be found in the current Residential New Construction program; similar gas measures are found in the C&I construction program. The energy values are in therms.

Space Heaters

Algorithms

Gas Savings = $Capy_q/Capy_t$ X $((AFUE_q - AFUE_b)/AFUE_q)$ X Baseline Heating Usage

Definition of Variables

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

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

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

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

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

Space Heating

Component	Type	Value	Source
$Capy_q$	Variable		Application Form, confirmed with Manufacturer Data
$Capy_t$	Fixed	80,000	1
$AFUE_q$	Variable		Application Form, confirmed with Manufacturer Data
$AFUE_b$	Fixed	Furnaces: 78% Boilers: 80%	2
Baseline Heating Usage	Fixed	965 therms	3
Time Period Allocation Factors	Fixed	Summer = TBD Winter = TBD	4

Sources:

1. NJ utility analysis of heating customers, typical output capacity.
2. Minimum Federal Standards for Furnaces and Boilers.
3. NJ utility analysis of heating customers, annual gas heating usage.
4. Time period allocation factors used in the cost-effectiveness analysis. To be derived.

<u>Algorithms</u>

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 = Energy factor of the baseline water heater.

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

Water Heaters

Component	Type	Value	Source
EF_q	Variable		Application Form, confirmed with Manufacturer Data
EF_b	Fixed	.544	1
Baseline Water Heater Usage	Fixed	277	2
Time Period Allocation Factors	Fixed	Summer = TBD Winter = TBD	3

Sources:

1. Federal EPACT Standard for a 40 gallon gas water heater. Calculated as 0.62 – (0.0019 X gallons of capacity).
2. DOE/FEMP website. http://www.eren.doe.gov/femp/pro
3. Time period allocation factors used in the cost-effectiveness analysis. To be derived.

Residential Energy Star Windows Program

Overview

This program promotes the sale and purchase of ENERGY STAR rated windows. The long-term goal is to transform the market to one in which ENERGY STAR windows becomes the market standard. The program employs several key strategies to accomplish this goal:

1. A consumer marketing campaign promoting ENERGY STAR windows – integrated to the extent appropriate with marketing of other New Jersey programs promoting ENERGY STAR products (i.e. Appliances, Lighting, and New Homes);
2. Sales training and marketing support to retailers and contractors selling ENERGY STAR windows;
3. Outreach to regional window industry representatives to encourage labeling and promotion of ENERGY STAR windows;
4. Facilitating consumer access to financing for the purchase of ENERGY STAR windows; and
5. Support (as appropriate) for up-grading state code and minimum federal efficiency standards.

Protocols

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

Square Feet of Window Area X Savings per Square Foot

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

ENERGY STAR Windows

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

<u>Heat Pump</u>

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

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

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

Definition of Terms

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

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

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

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

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

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

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

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

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

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

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

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

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

ENERGY STAR Windows

Component	Type	Value	Sources
$ESav_{HP}$	Fixed	2.2395 kWh	1
HP Time Period Allocation Factors	Fixed	10%, 7%, 40%, 44%	2
$ESav_{GAS/CAC}$	Fixed	0.2462 kWh	1
Gas/CAC Electricity	Fixed	65%, 35%, 0%, 0%	2

Component	Type	Value	Sources
Time Period Allocation Factors			
$ESav_{GAS/NOCAC}$	Fixed	0.00 kWh	1
Gas/No CAC Electricity Time Period Allocation Factors	Fixed	3%, 3%, 45%, 49%	2
Gas Heating Gas Time Period Allocation Factors	Fixed	TBD	2
$ESav_{OIL/CAC}$	Fixed	0.2462 kWh	1
Oil/CAC Time Period Allocation Factors	Fixed	65%, 35%, 0%, 0%	2
$ESav_{OIL/NOCAC}$	Fixed	0.00 kWh	1
Oil/No CAC Time Period Allocation Factors	Fixed	3%, 3%, 45%, 49%	2
$ESav_{RES/CAC}$	Fixed	4.0 kWh	1
Res/CAC Time Period Allocation Factors	Fixed	10%, 7%, 40%, 44%	2
$ESav_{RES/NOCAC}$	Fixed	3.97 kWh	1
Res/No CAC Time Period Allocation Factors	Fixed	3%, 3%, 45%, 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.

Residential Low Income Program

Overview

This program is designed to improve energy affordability for low-income households. To achieve this objective, it must overcome several market barriers. Key among these are: (1) lack of information on either how to improve efficiency or the benefits of efficiency; (2) low income customers do not have the capital necessary to upgrade efficiency or even, in many cases, keep up with regular bills; (3) low income customers are the least likely target of market-based residential service providers due to perceptions of less capital, credit risk and/or high transaction costs; and (4) split incentives between renters and landlords. The Program will address these barriers through:

1. Direct installation of all cost-effective energy efficiency measures (addressing all fuels);
2. Comprehensive, personalized customer energy education and counseling; and
3. Arrearage forgiveness for participants who agree to payment plans.

Protocols

The savings protocols for the low-income program are based upon estimated per unit installed savings. In some cases, such as lighting and refrigerators, the savings per unit estimate is based on direct observation or monitoring of the existing equipment being replaced. For other measures, for example air sealing and insulation, the protocols calculation is based on an average % savings of pre-treatment consumption. The protocols for space heating measures take account of an assumed priority order for installation, and the non-additive nature of individual measures. Further, (for protocol reporting only) the cumulative savings from space conditioning measures is capped at 10% of pre-treatment electric consumption and 15% of pre-treatment natural gas consumption.

Base Load Measures

Efficient Lighting

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

<u>Algorithm</u>

Compact Fluorescent Screw In Lamp

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

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

Efficient Fixtures

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

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

Efficient Torchieres

Electricity Impact (kWh) = $((Torch_{watts})$ X $(Torch_{hours}$ 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

Efficient Refrigerators

The eligibility for refrigerator replacement is determined by a 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

Savings from individual space conditioning measures are affected by any other measures that also are being installed; i.e., such savings are not cumulative. Further, technical reasons dictate prioritizing certain measures over others. The savings algorithms for all space conditioning measures accommodate these considerations by presuming a fixed sequence of measure installation for the purpose of projecting savings.

Air Sealing for Electric Heat

It is assumed that, for electric heat customers, 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 peak demand savings estimated at this time.

Algorithm

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

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 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

No CAC

Electricity Impact (kWh) = (ESC_{pre} X 0.95) X 0.02

Insulation Up-Grades for Electric Heat

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.

Algorithm

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

Thermostat for Electric Heat

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

Algorithm

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

Heating and Cooling Equipment Maintenance Repair/Replacement

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

Algorithm

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

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

Total Space Conditioning Electric Savings

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

Algorithm

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

Typical Fossil Fuel Heat Measure

Fossil fuel heated houses typically have more substantial opportunities for space conditioning savings than electrically heated houses. Further, there are greater opportunities for interaction between measure types. For these reasons, the savings projection for fossil fuel heated houses are based on the total package of measures chosen for installation based on the site-specific characteristics. For protocol reporting these savings estimates will be capped at 15% of total pre-treatment consumption.

Algorithm

$$\text{Maximum MMBtu savings} = (GC_{pre} \times 0.15)$$

Other "Custom" Measures

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

Definition of Terms

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

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

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

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

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

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

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

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

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

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

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

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

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

Ref DF = kW /kWh of savings.

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.

Residential Low Income

Component	Type	Value	Sources
CFL_{Watts}	Fixed	42 Watts	1
CFL_{Hours}	Fixed	2.5 hours	1
$Fixt_{Watts}$	Fixed	90 Watts	1
$Fixt_{Hours}$	Fixed	3.5 hours	1
$Torch_{Watts}$	Fixed	245 Watts	1
$Torch_{Hours}$	Fixed	3.5 hours	1
Light CF	Fixed	5%	2
Elec. Water Heating Savings	Fixed	178 kWh	3
Gas Water Heating Savings	Fixed	1.01 MMBTU	3
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	.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

Component	Type	Value	Sources
Capy	Fixed	33,000 Btu/hr	1
EER	Fixed	9.2	8
HP CF	Fixed	70%	9
DSF	Fixed	7%	10
GC_{pre}	Variable		7
Time Period Allocation Factors	Fixed	Summer/On-Peak 21% Summer/Off-Peak 22% Winter/On-Peak 28% Winter/Off-Peak 29%	11

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. Analysis of ARI data
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.

Residential New Construction Program

Overview

This program is designed to increase the efficiency of residential new construction, with the long term goal of transforming the market to one in which all new homes are built at least as efficiently as the current ENERGY STAR homes standard. There are a number of market barriers to efficiency investments in new construction. Key among these are: (1) split incentives (i.e. builders who make design decisions will not pay the energy bills associated with those decisions); (2) lack of information on the benefits of efficiency (on the part of consumers, builders, lenders, appraisers, realtors and others); (3) limited technical skills to address key elements of efficiency; and (4) inability of consumers, lenders, appraisers and others to differentiate between efficient and standard homes. The program will employ several key strategies to overcome these barriers:

1. Marketing assistance to builders of efficient homes (promoting ENERGY STAR label);
2. Technical assistance to builders and their subcontractors;
3. Home energy ratings and ENERGY STAR certification to qualified homes;
4. Incentives to builders to construct homes to program standards;
5. Support to the Department of Community Affairs to foster the development of market-based mechanisms to facilitate market transformation, including a uniform statewide energy rating system, accreditation of raters, development of preferential mortgage products for efficient homes; and
6. Technical support/training on residential energy code updates and implementation.

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 = $(PL_b \text{ X } OF_b) / (SEER_b \text{ X BLEER X } 1{,}000)$

Peak demand of the qualifying home = $(PL_q \text{ X } OF_q) / (EER_q \text{ X } 1{,}000)$

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

Definition Of Terms

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.

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

Component	Type	Value	Sources
PL_b	Variable		1
OF_b	Fixed	1.6	2
$SEER_b$	Fixed	10	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 minimum SEER is 10.0 and national data suggests that this is predominately the unit installed without intervention.
4. Engineering calculation.

5. Program guideline for qualifying home.
6. Based on an analysis of six different utilities by Proctor Engineering.

Lighting and Appliances

Quantification of additional saving due to the addition of high efficiency light fixtures and clothes washers will be based on the algorithms presented for these appliances in the Energy Star Lighting Protocols and the Energy Star Appliances Protocols, respectively.

Ventilation Equipment

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

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

New Jersey ENERGY STAR Homes
REMRate User Defined Reference Homes

Data Point	Single Family	Multiple Single Family	Multifamily
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	**5.4 HSPF**	**5.4 HSPF**	**5.4 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**
PTAC / PTHP	*3.0 COP*	*3.0 COP*	*3.0 COP*

Residential Retrofit Program

Overview

This program will provide to interested customers information on energy use and energy efficiency. This will be accomplished in two ways. First the utilities will provide sophisticated software tools to help customers assess both the efficiency of their energy use and opportunities for improving efficiency. These tools will be available through the Internet and via mail (in response to phone or mail inquiries). Accommodations will be made for those customers who are not able to use computer-based tools. Second, the utilities will operate call centers that attempt to answer consumer questions on energy efficiency issues and refer them to other relevant efficiency Programs.

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 CRA programs. These savings are captured in the measured savings for those programs. The savings produced by this program that are not captured in other CRA programs would be difficult to isolate and relatively expensive to measure.

Residential ENERGY STAR Lighting Program

Overview

This program will seek to transform specific components of residential lighting markets, focusing particularly on fixtures, through a comprehensive and coordinated set of market interventions. The long-term objective of the Program is to develop a self-sustaining market presence for ENERGY STAR lighting products. The Program must overcome several market barriers to achieve this goal. Key among these are: (1) lack of consumer awareness of the benefits of efficient lighting technologies; (2) some poor experience with early generations of efficient lighting; (3) limited availability of high quality, aesthetically appealing, efficient products (particularly fixtures); (4) lack of shelf space for screw-in (CFL) products in retail outlets at which many consumers buy bulbs (e.g. supermarkets); (5) higher first cost; and (6) inability of consumers to differentiate between efficient and inefficient products. This Program employs several key strategies to address these barriers:

1. Marketing and brand awareness promoting ENERGY STAR lighting products – integrated to the extent appropriate with marketing of other New Jersey Programs promoting ENERGY STAR products (i.e. Appliances, Windows and New Homes);
2. Retail sales training & point of sale materials (for both fixtures and screw-ins);
3. Design competition for ENERGY STAR lighting fixtures (coordinated with national or regional activity);
4. Participation in bulk procurement activities for specific fixtures such as high efficiency recessed cans; and
5. Development and marketing to builders of high efficiency fixture packages for new construction and major retrofit applications.

In addition, the utilities may provide both incentives for efficient fixtures and consumer mail order catalogs.

Protocols

The general form of the equation for the ENERGY STAR Lighting 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 units of lighting product. The number of units 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 primarily on prior program evaluation results.

ENERGY STAR Lighting

Savings estimates are on a per unit (bulb or fixture) basis and are derived primarily from lighting program evaluation results and program tracking information from New England lighting programs.

ENERGY STAR CFL Bulbs

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

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

ENERGY STAR Torchieres

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

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

ENERGY STAR Recessed Cans

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

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

ENERGY STAR Fixtures (Other)

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

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

Definition of Terms

$ESav_{BULBS}$ = Electricity savings per purchased ENERGY STAR bulb.

$DSav_{BULBS}$ = Summer demand savings per purchased ENERGY STAR bulb.

$ESav_{TORCH}$ = Electricity savings per purchased ENERGY STAR torchiere.

$DSav_{TORCH}$ = Summer demand savings per purchased ENERGY STAR torchiere.

$ESav_{CAN}$ = Electricity savings per purchased ENERGY STAR recessed can.

$DSav_{CAN}$ = Summer demand savings per purchased ENERGY STAR recessed can.

$ESav_{FIXT}$ = Electricity savings per purchased ENERGY STAR fixture.

$DSav_{FIXT}$ = Summer demand savings per purchased ENERGY STAR fixture.

CF_{BULBS}, CF_{TORCH}, CF_{CAN}, CF_{FIXT} = Summer demand coincidence factor. Coincidence of average lighting demand to summer system peak.

ENERGY STAR Lighting

Component	Type	Value	Sources
$ESav_{BULBS}$	Fixed	61 kWh	1
$DSav_{BULBS}$	Fixed	0.0548 kW	1
$ESav_{TORCH}$	Fixed	287 kWh	2
$DSav_{TORCH}$	Fixed	0.243 kW	2
$ESav_{CAN}$	Fixed	89 kWh	3
$DSav_{CAN}$	Fixed	0.0754 kW	3
$ESav_{FIXT}$	Fixed	89 kWh	3
$DSav_{FIXT}$	Fixed	0.0754 kW	3
CF_{BULBS}, CF_{TORCH}, CF_{CAN}, CF_{FIXT}	Fixed	0.05	4
Time Period Allocation Factors	Fixed	22%, 15%, 37%, 26%	5

Sources:

1. Average demand reduction of 0.0548 x 0.9 in service rate x 1,241 hours of use per yr. Consistent with 1999 XENERGY market study and EVT analysis (in service rate).
2. Estimated average 0.243 kW reduction (300W halogen lamp replaced by 57W CFL lamp/ballast) x 0.95 in service rate x 1,241 hours of use per yr. Consistent with results from EVT torchiere turn-in data and other EVT analysis (in service rate).
3. Average demand reduction of 0.0754 x 0.95 in service rate x 1,241 hours of use per yr. Consistent with 1999 XENERGY market study and EVT analysis (in service rate).
4. VEIC estimate.
5. Time period allocation factors used in cost-effectiveness analysis. From residential lighting load shapes.

Residential ENERGY STAR Appliance Program

Overview

This program promotes the sale and purchase of ENERGY STAR appliances primarily through marketing, consumer education and related activities. The long-term goal will be to transform the appliance market to one in which efficient products become the market standard. Experience in other parts of the country suggests that the Program will have to overcome several market barriers to achieve this goal. Key among these are: (1) lack of consumer awareness on the benefits of efficient models; (2) inability of consumers to differentiate efficient from inefficient products; (3) limited availability of efficient models in key retail outlets; (4) lack of retailer understanding of the efficiency, its benefits and how to "sell" it; and (5) higher first costs. The Program will employ several strategies to address these barriers:

1. Consumer education on the benefits of ENERGY STAR appliances;
2. Marketing to raise the market visibility of these products, focusing particularly on promotion of the ENERGY STAR brand – integrated with ENERGY STAR marketing in other product areas (e.g. Lighting, Windows and New Homes) to the extent appropriate;
3. Retail sales training and point of sale materials to help sales people more easily and effectively identify and market the benefits of efficient products; and
4. Support (as appropriate) for up grading minimum federal appliance efficiency standards.

Protocols

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

Number of Units X Savings per Unit

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

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

ENERGY STAR Refrigerators

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

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

ENERGY STAR Clothes Washers

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

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

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

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

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

ENERGY STAR Dishwashers

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

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

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

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

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

ENERGY STAR Room Air Conditioners

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

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

Definition of Terms

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

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

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

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

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

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

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

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

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

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

$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{RAC} = Summer demand coincidence factor. Coincidence of average appliance demand to summer system peak.

ENERGY STAR Appliances

Component	Type	Value	Sources
$ESav_{REF}$	Fixed	48 kWh	1
$DSav_{REF}$	Fixed	0.0066 kW	1
REF Time Period Allocation Factors	Fixed	20.9%, 21.7%, 28.0%, 29.4%	2
$ESav_{CW}$	Fixed	201 kWh	3
$Gsav_{CW}$	Fixed	10.6 therms	3
$Osav_{CW}$	Fixed	1.06 MMBtu	3
$DSav_{CW}$	Fixed	0.0267 kW	3
$WSav_{CW}$	Fixed	4,915 gallons	4
CW Electricity Time Period Allocation Factors	Fixed	24.5%, 12.8%, 41.7%, 21.0%	2
CW Gas Time Period Allocation Factors	Fixed	TBD	
$ESav_{DW}$	Fixed	82 kWh	5
$Gsav_{DW}$	Fixed	0.0754 kW	5
$Osav_{DW}$	Fixed	1.0	5
$DSav_{DW}$	Fixed	0.0225	5
$Wsav_{DW}$	Fixed	159 gallons	5
DW Electricity Time Period Allocation Factors	Fixed	19.8%, 21.8%, 27.8%, 30.6%	2

Component	Type	Value	Sources
DW Gas Time Period Allocation Factors	Fixed	TBD	
$ESav_{RAC}$	Fixed	56.4 kWh	6
$DSav_{RAC}$	Fixed	0.1018 kW	7
$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{RAC}	Fixed	1.0, 1.0, 1.0, 0.58	8
RAC Time Period Allocation Factors	Fixed	65.1%, 34.9%, 0.0%, 0.0%	2

Sources:

1. Electricity savings from RLW ENERGY STAR Market Update for National Grid. June 2000. Difference is for a post-7/1/2001 fed standards unit. Demand savings derived using refrigerator load shape.
2. Time period allocation factors used in cost-effectiveness analysis. From residential appliance load shapes.
3. Energy savings estimates consistent with prior NEEP screening. Demand savings derived using clothes washer load shape.
4. Clothes washer water savings from RLW Market Update.
5. Energy and water savings from RLW Market Update. Assumes 37% electric hot water market share and 63% gas hot water market share. Demand savings derived using dishwasher load shape.
6. Energy and demand savings from engineering estimate based on 600 hours of use. Based on delta watts for ENERGY STAR and non-ENERGY STAR units in five different size (cooling capacity) categories. Category weights from LBNL *Technical Support Document for ENERGY STAR Conservation Standards for Room Air Conditioners*.
7. Average demand savings based on engineering estimate.
8. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.

Commercial and Industrial Energy Efficient Construction Program

Overview

This program is designed to: a) capture lost opportunity energy efficiency savings that occur during customer-initiated construction events (i.e., when customers normally construct buildings or buy equipment); b) achieve market transformation by helping customers, designers and specifiers to make energy efficient equipment specification, building/system design, and commissioning standard practice; c) stimulate small customer investments in energy efficiency measures; and d) lay the groundwork for an upgrade to New Jersey's commercial building code.

This program is designed to address key market barriers to efficient building construction and design on the part of developers, designers, engineers, and contractors including: unfamiliarity or uncertainty with energy efficient building technologies and designs; bias toward first cost versus operating costs; compressed time schedules for design and construction; aversion to perceived risk-taking, despite the proven reliability of efficient technologies and designs; incentive structures and priorities for engineers, designers and contractors which are at variance with efficiency considerations.

The program will employ the following key strategies to accomplish this goal:

1. Program emphasis on customer-initiated construction and equipment replacement events;
2. Coordinated and consistent marketing to commercial and industrial customers, especially large and centralized players, such as national/regional accounts, major developers, etc.;
3. Consistent efficiency and incentive levels for efficient electric and gas equipment and design practices;
4. Prescriptive incentives for pre-identified efficiency equipment and custom measure incentives for more complex and aggressive measures;
5. Design support/technical assistance to developers and their contractors for new construction and renovation projects;
6. Specialized technical assistance for small commercial customers and educational institutions.
7. Specialized program paths for markets with unique opportunities for energy savings and market transformation.
8. Technical support for commercial energy code updates, and marketplace training in energy code requirements.

C&I Electric Protocols

Lighting Equipment

Lighting equipment includes fluorescent fixtures, ballasts, compact fluorescent fixtures, exit signs, and metal halide lamps. The verification method is based on algorithms with measurement of key variables (i.e., Coincidence Factor and Operating Hours) through end-use metering data accumulated over the last eight years of sampling of participating facilities. All baselines are a 30 percent improvement from ASHRAE 90.1-1989 uniform lighting power allowance in watts per square foot by building space type. When the ASHRAE 90.1-1999 becomes effective within the State, then ASHRAE 90.1-1999 will become the baseline.

Algorithms

Demand Savings = ΔkW X CF X (1+IF)

Energy Savings = ΔkW X EFLH X (1+IF)

ΔkW is calculated from example worksheet below:

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

Code and Program Limits						
A	B	C	D	E	F	G
Building Type or Space Activity	Gross Lighted Area (sf)	Unit Lighting Power Allowance (Watts/sf)	Lighting Power Allowance (W) [B x C]	Program Limit (Watts/sf) [C x .07]	Lighting Power Limit (W) [B x E]	Composite Program Limit [sum F / sum B]
#1Dorm Bed/Study	42,752	1.40	59,853	0.98	41,897	
#2Dorm Bath	7,936	1.20	9,523	0.84	6,666	
#3Stairs	9,216	0.60	5,530	0.42	3,871	
	59,904		74,906		52,434	0.875299145
Installed Lighting Levels						
H	I	J	K	L	M	
Space ID	Luminaire Tag # if applicable	Luminaire Description	Number of Luminaires	Watts per Luminaire	Connected Watts [K x L]	
#1		32w T8	384	27	10,368	
#1&2		26W plt	128	61	7,808	
#1&#2		26w Quad	192	27	5,184	
#3		26w plt	24	27	648	
#3		13w plc	16	30	480	
	Other Wattage not applicable listed below				9,600	
			744		34,088	
N. Composite Connected Watts/Square Foot [sum M / sum B]				0.57		

Definition of Variables

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. (30 percent better than ASHRAE 90.1-1989 by area) - Watts/Sq.Ft. (qualified equipment by same area))*Area Sq.Ft./1000 (see table above).

There is a lighting table used and updated by all electric utilities 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 by the State in measuring energy and demand savings. Electric utilities, 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 GPU 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 GPUE 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	Based on Standard Wattage Tables and Verified watts/sqft		ASHRAE 90.1 1989 Better by 30%
CF	Fixed	Large Office*	65%	GPU metered data
		Large Retail	81%	GPU metered data
		Large Schools	41%	GPU metered data
		Large All Other	63%	GPU metered data
		All Hospitals	67%	GPU metered data
		All Other Office	71%	GPU metered data
		All Other Retail	84%	GPU metered data
		Other Schools	40%	GPU metered data
		All Other	69%	GPU metered data

Component	Type	Value		Source
		Industrial	71%	Cost effectiveness study
		Continuous	90%	Estimate
IF	Fixed	5%		Impact of lighting watt reduction on air-conditioning load used in previous lighting savings.
EFLH	Fixed	Large Office	3309	GPU metered data
		Large Retail	5291	GPU metered data
		Large Schools	2289	GPU metered data
		Large All Other	3677	GPU metered data
		All Hospitals	4439	GPU metered data
		All Other Office	2864	GPU metered data
		All Other Retail	4490	GPU metered data
		Other Schools	2628	GPU metered data
		All Other	2864	GPU metered data
		Industrial	4818	Cost effectiveness study
		Continuous	7000	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

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

Prescriptive Lighting for Small Commercial Customers

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

- Existing small commercial and industrial <= 50 kW connected load
- New/renovated/change-of-use small commercial and industrial <= 10,000 s.f. of conditioned space

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

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

<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 Small Commercial Customers

Component	Type	Value	Source
ΔkW	Fixed	1 lamp 42 watts 2 lamp 73 watts 3 lamp 105 watts 4 lamp 146 watts	From NJ lighting tables
CF	Fixed	Average of the small retail and office from lighting verification summary table, 77.5%.	GPUE metered data
EFLH	Fixed	Average of small retail and office from lighting verification summary 3,677.	GPUE metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 21% Summer/Off-Peak 22% Winter/On-Peak 28% Winter/Off-Peak 29%	

Lighting Controls

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

Algorithms

Demand Savings = kW_c X SVG X CF

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

Definition of Variables

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

kW_c = kW lighting load connected to control

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

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

EFLH = Equivalent full load hours.

Lighting Controls

Component	Type	Value	Source
kW_c	Variable	Load connected to control	Application
SVG	Fixed*	Occupancy Sensor, Controlled Hi-Low Fluorescent Control and controlled HID = 30% Daylight Dimmer System=50%	See sources below*
CF	Fixed	By building type and size see lighting verification summary table	Assumes same as GPUE metered data
EFLH	Fixed	By building type and size see lighting verification summary table	GPUE metered data

Component	Type	Value	Source
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:

$$\Delta kW = HP*0.7456 \text{ X } (1/\eta_b - 1/\eta_q)$$

Demand Savings = (ΔkW) X CF

Energy Savings = (ΔkW)*EFLH

Motors

Component	Type	Value	Source
Motor kW	Variable	Based on horsepower and efficiency	Application
EFLH	Fixed	Commercial 2,502 Industrial 4,599	GPUE metered data and PSEG audit data for industrial
Efficiency - EFF $_b$	Fixed	Comparable EPACT Motor	From EPACT directory
Efficiency - EFF $_q$	Variable	Nameplate	Application
CF	Fixed	35%	GPUE metered data

Component	Type	Value	Source
Time Period Allocation Factors	Fixed	Summer/On-Peak 25% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 23%	

HVAC Systems

The verification plan 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)

<u>Algorithms</u>

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.

<u>Definition of Variables</u>

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	Unitary HVAC/Split Systems* · <=5.4 tons: **10 SEER** · >5.4 to 11.25 tons **8.9 EER** · >11.25 to 30 tons **8.5 EER** Air-Air Heat Pump Systems* · <=5.4 tons: **6.8 HSPF/10.0 SEER** · >5.4 to 11.25 tons **8.9 EER** · >11.25 to 30 tons **8.5 EER** Package Terminal Systems **9 EER** Water Source Heat Pumps <=30 tons* **10.5 EER** >30 tons **10.5 EER** Central DX AC Systems · >30 to 63 tons **8.5** · > 63 tons **8.5** GWSHPs **11 EER**	Collaborative agreement and C/I baseline study
EER_q	Variable	ARI or AHAM Values	Application
CF	Fixed	67%	Engineering estimate

Component	Type	Value	Source
EFLH	Fixed	HVAC 1,131 HP cooling 381 HP heating 800	GPUE metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	
Time Period Allocation Factors	Fixed	Summer/On-Peak 0% Summer/Off-Peak 0% Winter/On-Peak 41% Winter/Off-Peak 58%	

Electric Chillers

The verification plan 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 GPUE 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 GPUE measurement data.

Electric Chillers

Component	Type	Value	Source
Tons	Variable	From Rebate Application	
kW/ton_b	Fixed	**Water Cooled Chillers (<70 tons)** **kW/Ton** *Baseline* ***0.93*** **Water Cooled Chillers (70 to <150 tons)** **kW/Ton** *Baseline* ***0.86*** **Water Cooled Chillers (150 to <300 tons)** **kW/Ton** *Baseline* ***0.72*** **Water Cooled Chillers (=>300 tons)** **kW/Ton** *Baseline* ***0.64*** **Air Cooled Chillers (<150 tons)** **kW/Ton** *Baseline* ***1.30*** **Air Cooled Chillers (+150 tons)** **kW/Ton** *Baseline* ***1.30***	Collaborative agreement and C/I baseline study
KW/ton_q	Variable	ARI Standards 550/590-Latest edition	Application
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	GPUE metered data
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 verification plan 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.

Algorithms

Energy Savings = Motor HP X kWh/motor HP

There are no Demand Savings for VFD's

Definitions of Variables

Motor Horsepower – This value comes from the nameplate of the motor.

Variable Frequency Drives

Component	Type	Value	Source
Motor Horsepower	Variable	Nameplate	Application
kWh/motor HP	Fixed	1,653 for VAV air handler systems. 1,360 for chilled water pumps.	GPUE metered data fo: VFD's and chillers.
Time Period Allocation Factors	Fixed	Summer/On-Peak 22% Summer/Off-Peak 10% Winter/On-Peak 47% Winter/Off-Peak 21%	

C&I Construction Gas Protocols

Gas Chillers

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

Algorithms

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

Summer Electric Savings = Electric Demand Savings + Electric Energy Savings

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

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

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

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

Definition of Terms

VBE_q = Vacuum Boiler Efficiency

BE_b = Efficiency of the baseline gas boiler

IR = Input Rating = Therms/hour

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

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

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

COP = Efficiency of the gas chiller

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

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

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

Gas Chillers

Component	Type	Value	Source
VBE_q	Variable		Rebate Application or Manufacturer Data
BE_b	Fixed	75%	ASHRAE 90.1
IR	Variable		Rebate Application or Manufacturer Data
Tons	Variable		Rebate Application
MMBtu	Variable		Rebate Application
kW/Ton_b	Fixed	<100 tons 1.30kW/Ton	Collaborative agreement and C/I

Component	Type	Value	Source
		100 to 150 tons 0.86 kW/ton 150 to <300 tons: 0.72 kW/Ton =>300 tons: 0.64 kW/ton	baseline study Air cooled less than 100 tons; Water cooled greater than 100 tons
kW/Ton_{gc}	Variable		Manufacturer Data
COP	Variable		Manufacturer Data
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	GPUE Measured data
Time Period Allocation Factors	Fixed	Summer = TBD Winter = TBD	Cost-effectiveness

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

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

Gas Fired Desiccants

Protocols to be developed.

Gas Booster Water Heaters

C&I gas booster water heaters are substitutes for electric water heaters. The verification plan 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 EF/3412 X CF

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

Gas Usage Increase = IR X EFLH

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

Definition of Variables

IR = Input Rating in Btuh

EF = Efficiency

CF = Coincidence Factor

EFLH = Equivalent Full Load Hours

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

Gas Booster Water Heaters

Component	Type	Value	Source
IR	Variable		Application Form or Manufacturer Data
CF	Fixed	50%	GPUE Metered Data
EFLH	Fixed	1,000	PSE&G
EF	Variable		Application Form or Manufacturer Data
Time Period Allocation Factors	Fixed	Summer = TBD Winter = TBD	Cost-effectiveness

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 verification plan 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 0.62 – (0.0019 X 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	.544	Federal EPACT Standard
Baseline Usage	Fixed	277	DOE/FEMP website http://www.eren.doe.gov/femp/pro
Time Period Allocation Factors	Fixed	Summer = TBD Winter = TBD	Cost-effectiveness

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 verification plan 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 = TBD Winter = TBD	Cost-effectiveness

Commercial and Industrial Building Operation & Maintenance Program

Overview

The goal of this program is to create sustainable, market-driven improvements in the resource efficiency of operation and maintenance practices in existing commercial buildings and industrial facilities served by New Jersey utilities. The objectives of the Program are to build market awareness and demand for resource efficient building O&M practices, build the capability for the implementation of such practices, and increase the use of resource efficient O&M in buildings.

Market barriers which this Program addresses include: 1) limited customer awareness of the benefits of resource-efficient O&M, 2) limited customer data to track energy costs, 3) limited customer management attention to these issues, 4) absence of efficiency in most O&M service contracts 5) lack of clear standards for O&M-related products and services which improve efficiency, 6) internal structural and financial issues within customer organizations, and 7) the immature developmental state of some products to help achieve building O&M.

The Program initially employs three key strategies to address these barriers:

1. Conduct expanded baseline research for and on-going tracking of O&M activity in New Jersey's commercial sector.
2. Depending on the findings of ongoing research, develop and establish an ongoing Program for building operator training and certification in resource efficient O&M practices.
3. Test market intervention initiatives that help customers increase the resource efficiency of their O&M activities in buildings.

Protocols

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

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

Algorithms

Electric Savings
Energy Impact (kWh) = PYEL X ESF

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

Gas Savings
Energy Savings (Therms) = PYGL X GSF

Definition of Variables

PYEL = Participants previous years electric energy use.

PYGL = Participants previous years gas energy use.

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

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

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

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

A summary of the data sources and fixed values follows:

C&I Building O&M

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

Source Notes:

1. EFLH: Equivalent Full Load Hours of 3900 is based on a typical NJ load profile from the NJ 2000 Forecast.

2. CF: Coincidence Factor of 0.875 is based on the average of 85% for commercial customers and 90% for industrial customers.
3. ESF: Electric Savings Factor of 10% of pre-participation facility load is based on a review of multiple O&M improvement programs.
4. GSF: Gas Savings Factor of 7% of pre-participation facility load is based on a review of multiple O&M improvement programs.

Compressed Air System Optimization Program

Overview

The goals of this program are to 1) capture significant energy savings from compressed air system optimization in industrial facilities, and 2) progressively create market conditions whereby independent businesses can build a sustainable market to address these opportunities. The expectation is that the market can be transformed to the point where utility incentives are not necessary for optimization of systems over 300 HP within a four year period. Market transformation for smaller systems, and the ability to discontinue utility technical assistance, is a less certain outcome.

Market barriers include 1) limited customer awareness of compressed air costs, opportunities for savings, and production related benefits, 2) lack of management focus on compressed air, 3) significant front-end study costs, 4) a limited number of vendors who promote system efficiency, and 5) limited credibility of vendors and approaches for system optimization. However, the return on investment and ancillary benefits from system improvements are very attractive.

1. The utilities conducted customer and contractor Compressed Air Challenge training last year. Based on this experience, additional training will be continued in 2001; however, a wider a variety of training models, including Compressed Air Challenge and vendor-conducted workshops, will be pursued.
2. As the pool of trained customers expands, the Program will shift its emphasis from training to engaging these customers in follow-through with compressed air audits and actual projects. Therefore, the 2001 Program will focus on developing potential studies, leading to projects.
3. PSE&G completed a market assessment of compressed air optimization potential in its service territory last year and will focus its efforts on audits and actual projects in 2001.
4. For GPU, audit goals are predicated on the results of an assessment of compressed air Program potential in their service territory. Based on the results of this study, the Market Transformation Plan will be revised accordingly.
5. The results of this early experience will be shared with Conectiv and RECo (each of which is assumed to have very small compressed air potential, due to the demographics of their service territories) so that the Program can grow out to a seamless statewide offering in 2002.
6. Case studies of compressed air optimization, emphasizing bottom-line impacts of energy and non-energy benefits, will be developed by the utilities.

Protocols

Compressed Air Systems

The energy and peak demand savings due to the Compressed Air Optimization Program will be based on 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.

Residential Air Conditioning Cycling Load Control Program

Overview

Through the Residential Air Conditioning Cycling Load Control Program, certain utilities (i.e., GPU Energy, PSE&G, and Conectiv) will continue to use air conditioner cycling strategies to provide capacity relief on days of system peak. By using radio-activated relays, system operators will selectively cycle air conditioning equipment through a variety of operating strategies, which are designed to optimize system load and lower the peak demand while minimizing the impact on the customer. The short duration of such load cycling periods (generally fifteen (15) minutes of each half-hour when activated) minimizes the impact of the cycling on the customer's comfort.

In the PSE&G program, radio receiver switches have been installed on more than 141,315 central air conditioners, heat pumps (or in the thermostats which control them), and qualifying water heaters (when accompanied by a central air conditioner or heat pump).

GPU Energy has been offering this service to eligible customers since 1992 and to date has over 66,000 outdoor units installed and over 18,600 thermostat load control receivers installed under DSM programs.

Conectiv has over 24,000 active participants in the program and has installed radio receiver switches on more than 33,000 central air conditioners, heat pumps, and water heaters.

The utilities agree that load control programs are not to be expanded under the SBC.

Protocols

Each company has individually assessed the peak reductions of this program utilizing methodologies acceptable for PJM contractual and reporting purposes. Those same impacts will be used to report the peak savings for this program.

School Energy Efficiency and Renewable Energy Education Program

Overview

Through the School Energy Efficiency & Renewable Education Program, certain utilities (i.e., GPU Energy and PSE&G) will make available to learning institutions select resources and support for energy efficiency and renewable education initiatives (e.g., grants, materials, curriculum content, teacher instruction and services). These initiatives will instill values and awareness in students - the next generation of consumers and suppliers - and increase their families' awareness through homework and "what kids bring home".

By making the School Energy Efficiency & Renewable initiatives available to learning institutions, supported programs will help to minimize future market barriers and help address current awareness barriers in students' families related to energy efficiency and renewable options specifically by:

1. Introducing new technologies, services, or behaviors;
2. Increasing exposure to existing efficient technologies, services, or behaviors;
3. Discouraging use of inefficient technologies, and services; and
4. Encouraging good conservation habits.

Protocols

No protocol was developed to measure energy savings for this program, because the program purpose is to instill values and awareness as students that will inform their decisions about energy use as the next generation of consumers and buyers. A secondary purpose is to increase their families' awareness through homework and family involvement in helping the children. Isolating the energy savings as a result of this program would require tracking behavior of these young participants ten or more years in the future. Actions that children's parents take as a result of this program are likely to be reflected in measure installations or market effects that are covered in other CRA programs. These savings are captured in the measured savings for those programs. The savings produced by this program that are not captured in other CRA programs would be difficult to isolate and relatively expensive to measure.

Customer-Sited Clean Generation

Overview

The Customer-Sited Clean Generation (CSCG) Program addresses new markets, technologies and paradigms for electric power generation. Key elements of the program include: 1) direct incentives, 2) consumer education and marketing, 3) streamlining of interconnection requirements, 4) infrastructure development (e.g. training and certification for system installers), and 5) support for the development (as needed) of consumer-friendly financing for CSCG technologies.

Protocols

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

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

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

All of the CSCG protocols report the gross energy production from the customer sited clean generation system. The protocols for fuel cell installations account for estimated natural gas consumption. Sustainable biomass projects account for estimated consumption of the applicable biomass fuel.

In support of the protocol estimates, we will install sub-metering to measure the gross output of the clean energy generating systems, using metering equipment recording 15 minute intervals, and for a minimum of 12 months.

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

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

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

Algorithms

Photovoltaic Systems

To estimate the energy generated by photovoltaic systems we will use PVWatts. 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. PV Watt is available through the RReDC website, http://rredc.nrel.gov/solar/codes_algs/PVWATTS/.

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

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

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

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

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

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

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

Photovoltaic Systems

Component	Type	Value	Sources
System Rated Output (SRO)	Variable		Application Technical Worksheet
Fixed, Single, Double Axis tracking	Variable		Application Technical Worksheet
Array Tilt	Variable		Application Technical Worksheet
Azimuth Angle	Variable		Application Technical Worksheet
Weather Data	Variable	City, State – four sites will be used (Wilkes Barre PA, Newark NJ, Philadelphia PA, and Atlantic City, NJ	Application Technical Worksheet
ELCC	Fixed	65%	(http://www.nrel.gov/ncpv/documents/pv_util.html)
WELCC	Fixed	8%	Monitored system data from White Plains NY

Wind Systems

Estimated annual energy output for wind systems will be based on an industry data table. Currently we lack data on the peak impact of small wind systems in New Jersey and an estimate of 0% will be used. This value will be updated if supporting data are identified.

Annual Energy Output (kWh) is a function of:

Average annual wind speed at hub height,
Rotor diameter,
Total system efficiency

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

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

Wind Systems

Component	Type	Value	Sources
Average annual wind speed at hub height (m/s) or (mph)	Variable		Application Technical Worksheet
Rotor diameter in meters or feet	Variable		Application Technical Worksheet
Typical System Efficiency	Fixed for each wind speed / rotor diameter combination	Ranges from 12% to 30%	Gipe, (1993). Appendix E-1 Table on Estimate Annual Energy Output. Efficiencies based on published data.
Summer Peak Impact	Fixed	0%	Data on peak impact not available at this time
Winter Peak Impact	Fixed	0%	Data on peak impact not available at this time

Fuel Cells

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

Total Annual Energy = Average Electric Output + Average Thermal Energy Recovered

Data collected for the protocol estimation for each fuel cell project will include the following.

Fuel Cells

Component	Type	Value	Sources
Rated Continuous Peak Output (AC)	Variable		Manufacturer Specifications – Application Technical Worksheet
Rated Fuel Input at Peak Output (MMBTU/hr)	Variable		Manufacturer Specifications – Application Technical Worksheet
Average annual Electric Output	Variable		Project specific based on estimated duty cycle
Average annual thermal energy	Variable		Project specific based on estimated duty cycle

Component	Type	Value	Sources
recovery			
Annual fuel consumption (MMBTU)	Variable		Project specific based on estimated duty cycle
Average total system efficiency	Variable		Project specific based on manufacturer specifications and estimated operating parameters.
Summer Peak Impact	Variable		Project specific based on estimated duty cycle.
Winter Peak Impact	Variable		Project specific based on estimated duty cycle.

Sustainable Biomass

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

Data Point	Single Family	Multiple Single Family	Multifamily
Cooling Efficiency			
Central Air Conditioning	8.0 SEER	8.0 SEER	8.0 SEER
Air Source Heat Pump	8.0 SEER	8.0 SEER	8.0 SEER
Geothermal Heat Pump	**11.0 EER open/12.0 EER closed**	**11.0 EER open/12.0 EER closed**	**11.0 EER open/12.0 EER closed**
PTAC / PTHP	*9.5 EER*	*9.5 EER*	*9.5 EER*
Window Air Conditioners	**8.5 EER**	**8.5 EER**	**8.5 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.