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Final Report on the Clean Energy/ Air Quality Integration Initiative Pilot Project of the U.S. Department of Energy's Mid-Atlantic Regional Office

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Preface

This final report and its underlying analysis were developed through a collaboration between Debra Jacobson, professorial lecturer in law, George Washington University Law School and president, DJ Consulting LLC; Peter O'Connor, project manager**,** Global Environment & Technology Foundation; Dr. Colin High, vice president, Resource Systems Group; and John Brown, project leader for State and Local Initiatives, National Renewable Energy Laboratory. Dr. High and Messrs. O'Connor and Brown were responsible for the technical analysis, and Ms. Jacobson took the lead in the policy and legal analysis. For purposes of this report, these four individuals are referred to as the "project team." This work was conducted with the financial support of the U.S. Department of Energy (DOE). This report has been revised since hard copies were distributed.

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Acronyms

CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CEP	Clean Energy Program
CFL	compact fluorescent light
C&I	commercial and industrial
CHP	combined heat and power
CO_2	carbon dioxide
CORE	New Jersey Customer On-Site Renewable Energy Program
DOE	U.S. Department of Energy
EE	Energy Efficiency
EPA	U.S. Environmental Protection Agency
kWh	kilowatt-hour
HVAC	heating, ventilation, and air conditioning
MARO	U.S. Department of Energy Mid-Atlantic Regional Office
MWh	megawatt-hour
NO_x	nitrogen oxides
NJ BPU	New Jersey Board of Public Utilities
NJ CEP	New Jersey Clean Energy Program
NJ DEP	New Jersey Department of Environmental Protection
NREL	National Renewable Energy Laboratory
OTC	Ozone Transport Commission
PV	photovoltaic
RE	renewable energy
REC	Renewable Energy Credit
RGGI	Regional Greenhouse Gas Initiative
SIP	State Implementation Plan
SREC	Solar Renewable Energy Certificate
STAC	State Technologies Advancement Collaborative

Executive Summary

DOE, in cooperation with EPA, in Fiscal Year 2005 initiated the Clean Energy/Air Quality Integration Initiative to facilitate state efforts to improve air quality and increase the use of renewable energy (RE) and energy efficiency (EE) technologies. The initiative also seeks to facilitate the development of new state policies to further these objectives. This report summarizes the results of one of the four pilot projects supported by the initiative in FY 2005—the Mid-Atlantic Regional Office (MARO) pilot project.

The MARO pilot project represents the first effort in the country to seek to obtain credit under a Clean Air Act (CAA) State Implementation Plan (SIP) for nitrogen oxide (NO_x) emission reductions. This project came about because of state-funded incentive programs and projects for RE and EE.[1] Specifically, the pilot project focuses on the New Jersey (NJ) SIP and efforts to facilitate attainment of the new, 8-hour ozone standard under CAA by implementing selected categories of RE and EE programs and projects funded by the New Jersey Clean Energy Program (NJ CEP) of the New Jersey Board of Public Utilities (NJ BPU).[2] The project is significant because of the broad scope of the RE and EE programs and projects considered, including: (1) EE projects in new construction and retrofits of commercial and industrial (C&I) and residential buildings and schools (36,000 projects); (2) Energy Star® air-conditioning (50,000 units) and lighting (3.5 million units); (3) high-efficiency central air-conditioning (50,000 units) and ground source heat pumps (1,000 units); and (4) solar photovoltaic projects (344 systems that total 2.5 MW).

During the pilot project, the project team refined and expanded an analytical framework developed by NJ BPU and the New Jersey Department of Environmental Protection (NJ DEP) and conducted its own extensive analysis. The team's analysis, which employed conservative assumptions, indicates that a subset of RE and EE measures implemented under the NJ CEP in 2002, 2003, and 2004 would result in the reduction of at least 240 tons of NO_x emissions during the summer season of 2005 alone, based on summer electricity savings and RE generation of approximately 320,000 megawatt-hours (MWh).[3] Based on the expected continuation and growth of the NJ CEP, NO_x emission reductions that result from that program and from private investments will likely exceed the current incentive allowance cap of 410 tons annually by 2007.

Preliminary estimates of potential NO_x reductions during the summer ozone season of 2012 are 480−950 tons, depending on the specific assumptions that are used for program growth, duration

[1] In May 2005, EPA approved the first-ever SIP credit for an RE measure in a SIP. This approval involved a wind purchase included in a revised SIP that was developed by the State of Maryland to meet the 1-hour ozone standard, 70 Fed. Reg. 24987 (May 12, 2005). Although this wind purchase was precedent setting, it involved only RE and did not include EE measures. It also did not involve state programs to provide financial incentives, such as rebates, to spur RE and EE use.
[2] EPA is expected to require states to submit revised SIPs to meet the 8-hour ozone standard by June 2007, and New Jersey plans to identify its planned control measures by 2006.
[3] This number includes savings from measures actually implemented through 2004. Other measures are "committed" to or under development.

of measures, and changes in the electricity grid.[4] This analytical foundation also can be applied to estimate annual NO_x emission reductions for the period 2008 to 2013 for the NJ SIP for fine particulate matter. It also can be applied to determine carbon dioxide (CO_2) emission reductions for New Jersey's participation in the Regional Greenhouse Gas Initiative (RGGI).

The project expanded methodologies to evaluate: (1) the amount of electricity savings; (2) the summer component of the electricity savings; and (3) the NO_x emission reductions.[5] Also, approaches were developed to integrate various elements of the federal and state regulatory framework to ensure that RE and EE programs result in real emission reductions.[6] Moreover, the analytical and policy framework developed during the pilot project provides many valuable lessons to other states, including Pennsylvania and New York—two states with direct involvement in MARO's initial pilot project.[7] During the course of the project, the project team resolved challenges in estimating reductions in emissions of NO_x, a pollutant that is subject to emissions trading (cap and trade) regulations in New Jersey and most eastern states. Thus, the team needed to integrate elements of: (1) EPA's requirements for crediting NO_x emission reductions in SIPs; and (2) the implementation of New Jersey regulations that govern NO_x emissions trading, including provisions to establish an RE and EE set-aside of NO_x allowances for the summer ozone season.

The work accomplished during the pilot project has already proven useful to other states in developing new NO_x emissions trading programs that are required under EPA's Clean Air Interstate Rule.[8] Such work should help states achieve the full air quality benefits of their RE and EE programs.[9]

This report contains a detailed list of "lessons learned" that other states can replicate. The pilot project has facilitated the resolution of numerous analytical and policy issues, and provides direction for other states to follow.

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[4] See pp. 13−17 (infra).
[5] The basic methodology for determining energy savings, the NJ Clean Energy Protocols, is attached as Appendix 3. Modifications and expansions are detailed on pp. 27−30 of this report.
[6] See pp. 20−27 (infra).
[7] Originally, the Mid-Atlantic pilot project was expected to include New Jersey, New York, and Pennsylvania and would parallel a separate State Technologies Advancement Collaborative (STAC) project that focused on regulatory barriers faced by distributed generation in the mid-Atlantic States. Following delays by outside parties in the issuance of the contract for the STAC project and the Request for Proposals associated with this project, MARO decided to revise the scope of the pilot project.
[8] 70 Fed. Reg. 25162 et seq. (May 12, 2005).
[9] New Jersey has regulatory advantages that facilitated the integration of clean energy and air quality goals that some other states may not possess. For example, New Jersey is one of only seven states that have adopted an EERE set-aside in their NO_x emission trading regulations, and New Jersey's regulations contain a stipulated allocation rate that aided the conversion of energy savings into emission reductions. Lessons from the New Jersey experience that are relevant to other states are addressed in substantial detail in the final section of this report, titled "Lessons Learned."

1.0 Background

1.1 EPA Guidance Documents that Affect Energy Efficiency and Renewable Energy

In 2004, the U.S. Environmental Protection Agency (EPA) issued two important guidance documents to encourage innovative air pollution control measures, including renewable energy (RE) and energy efficiency (EE). EPA issued the first guidance document titled, *Guidance on State Implementation Plan (SIP) Credits for Emission Reduction Measures from Electric-sector Energy Efficiency and Renewable Energy Measures* in August 2004.[10] The purpose of this guidance is to "promote the testing of promising new pollution reduction strategies, such as energy efficiency and renewable energy, within the air quality planning process."[11]

Highlights: Findings, Issues, and Lessons Learned

- The U.S. Department of Energy (DOE) Mid-Atlantic Regional Office (MARO) pilot project represents the first effort in the country to seek to obtain credit under a Clean Air Act State Implementation Plan (CAA SIP) for nitrogen oxide (NO_x) emission reductions that result from state-funded incentive programs and projects for renewable energy (RE) energy efficiency (EE).
- Preliminary estimates of NO_x reductions during the 2009 summer ozone season in New Jersey that result from the New Jersey Clean Energy Program (NJ CEP) are 370−560 tons. By 2012, NO_x reductions are expected to be 480−950 tons.
- A state with a NO_x emissions trading program will not be able to claim NO_x emission reduction credit in its SIP to meet the 8-hour ozone standard unless several criteria are met. In most cases, two of the key criteria include: (1) adopting regulations under the Clean Air Interstate Rule (CAIR) that allocate a percentage of NO_x allowances to support RE/EE measures; and (2) retiring allowances to ensure that the emission reductions are surplus.
- Most of the procedures developed by New Jersey and the pilot project to convert RE generation and EE savings into emission reduction estimates will be replicable in other states. These procedures allow NO_x emission reductions from RE/EE measures to be estimated with a relatively small investment.

[10] U.S. Environmental Protection Agency, *Guidance on State Implementation Plan (SIP) Credits for Emission Reduction Measures from Electric-sector Energy Efficiency and Renewable Energy Measures*, August 2004 (hereinafter cited as *EPA SIP Guidance*). This document, the September 2004 voluntary measures guidance, and other documents are available at www.epa.gov/cleanenergy/stateandlocal/guidance.htm.
[11] *EPA SIP Guidance*, p. 1.

EPA issued the second guidance document titled, *Incorporating Voluntary and Emerging Measures in a State Implementation Plan (SIP)*, in September 2004. The purpose of this guidance is to facilitate efforts by state and local governments to include nontraditional control measures in their SIPs.

The major purpose of the two guidance documents is to assist areas of the country that are facing challenges in meeting air quality standards. EPA has designated 474 counties or portions of counties as nonattainment areas for the 8-hour ozone standard and 225 counties or portions of counties as nonattainment areas for fine particulate matter.[12]

1.2 Clean Energy/Air Quality Integration Initiative

DOE established the Clean Energy/Air Quality Integration Initiative in late 2004 after the two EPA guidance documents were issued. This DOE initiative was undertaken in cooperation with EPA, several energy and environmental organizations,[13] and the National Renewable Energy Laboratory (NREL). Its purpose was "to demonstrate how state energy and environmental officials can work together on energy efficiency and renewable energy technologies and policies that improve air quality while they address energy goals."[14] DOE designated four of its Regional Offices to develop pilot projects to pursue clean energy/air quality integration in the first phase of this initiative. This report summarizes the results of the pilot project in MARO.

The MARO pilot project represents the first effort in the country to seek to obtain credit under a Clean Air Act (CAA) SIP for nitrogen oxide (NO_x) emission reductions that result from state-funded incentive programs and projects for both RE and EE. Specifically, the pilot project focuses on the New Jersey (NJ) SIP and efforts to facilitate attainment of the new, 8-hour ozone standard under CAA through SIP credit for selected categories of RE and EE programs and projects funded by the Clean Energy Program (CEP) of the NJ Board of Public Utilities (BPU). The project is significant because of the broad scope of the RE and EE programs and projects considered, including: (1) EE projects in new construction and retrofits of commercial and industrial (C&I) and residential buildings and schools (36,000 projects); (2) Energy Star® air-conditioning (50,000 units) and lighting (3.5 million units); (3) high-efficiency central air-conditioning (50,000 units) and ground-source heat pumps (1,000 units); and (4) solar photovoltaic (PV) projects (344 systems that total 2.5 MW).[15]

1.3 New Jersey Clean Energy Program

The current NJ CEP began in 2001. It is funded by a "societal benefits charge" of more than \$100 million annually,[16] and includes a wide range of RE and EE programs and projects across

[12] U.S. Environmental Protection Agency, *Green Book for Nonattainment Areas*. See http://www.epa.gov/oar/oaqps/greenbk/. Figures are from the October 5, 2005 update.
[13] These organizations include the National Association of State Energy Officials, the Environmental Council of the States, and the Global Environment & Technology Foundation.
[14] DOE fact sheet, "Integration Pilots: Improving Air Quality through Energy Efficiency and Renewable Energy Technologies," 2004.
[15] See infra.
[16] Actual program expenditures were \$100 million in 2002, \$98 million in 2003, and \$108 million in 2004. Funding increased to \$140 million for 2004 and 2005 and is expected to increase to \$235 million by 2008.

the state. New Jersey is one of nearly 20 states that fund energy incentive programs under a systems benefit charge. The New Jersey "societal benefits charge" is about 3 mills/kWh, of which NJ CEP receives about 1 mill/kWh.[17] Growth in electricity savings[18] has increased 70% from 2002 to 2003 and 14% from 2003 to 2004, to outpace growth in expenditures. Because these RE and EE improvements are long lasting, New Jersey will see a cumulative benefit, as measures implemented in previous years continue to save or generate energy.

The project team focused on programs and projects completed under the NJ CEP in 2002, 2003, and 2004 in the following specific categories:

1.3.1 Residential Energy Efficiency

- *Comfort Partners Low-Income Customers Program* – This program improves EE in the homes of low-income customers and includes a pilot program, implemented in 2004, for weatherizing the homes of senior citizens. Projects can include a wide range of EE measures such as lighting, appliances, insulation, and duct sealing and repair. Program expenditures were $14.3 million in 2004. From 2002 through 2004, the program made improvements in more than 19,000 homes.
- *NJ Energy Star Homes* – This program works with residential builders to ensure that new homes are built to New Jersey Energy Star® standards, which exceed the standards of the national Energy Star program. Homes must use at least 30% less energy than homes built to the model national energy code and must be located in a "smart growth" area. Nearly 13,000 such homes were built between 2002 and 2004; in 2004, qualified homes represented 16% of all new homes in New Jersey. Program expenditures were $21.7 million in 2004.
- *Cool Advantage and Warm Advantage* – This program focuses on energy-efficient cooling and heating equipment. Program expenditures were $15.6 million in 2004. Between 2002 and 2004, the program led to the installation of more than 50,000 high-efficiency central air conditioners and more than 1,000 high-efficiency heat pumps.[19]
- *New Jersey for Energy Star* – This program promotes the use of Energy Star appliances and other products. The largest component of this program promotes compact fluorescent lights (CFLs) and other efficient residential lighting fixtures; more than 3.5 million units have been sold (commercial lighting is a separate program). Another element of this program provides rebates for high-efficiency room air conditioners; nearly 50,000 units were sold through 2004. In addition, New Jersey added a new component to this program in 2004 that promotes energy-efficient clothes washers. Lighting represented 97.8% of the electricity savings from 2004 projects in this category. In 2004, program expenditures totaled $8.4 million.

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[17] See Atlantic City Electric tariff, effective July 1, 2005. The benefits charge may vary from year to year, according to the NJ CEP funding levels set by the NJ BPU.

[18] The program also implements several measures that can reduce natural gas demand and emissions. However, since our analysis focuses only on electricity savings, we have avoided use of the term *energy savings* to clarify that our analysis does not include natural gas savings.

[19] The program also funds furnaces and water heaters. These programs provide natural gas savings rather than electricity savings and are not included in our analysis.

1.3.2 Commercial and Industrial Energy Efficiency

New Jersey SmartStart Buildings – This program includes all C&I EE programs, grouped into three categories: (1) C&I new construction ($3.9 million in 2004), (2) C&I retrofits ($22.7 million in 2004), and (3) new school construction and retrofits ($3.1 million in 2004). Measures may include lighting, motors, traffic signals, heat pumps, chillers, variable frequency drives, and other improvements. This program conducted more than 17,000 projects between 2002 and 2004.

1.3.3 Renewable Energy

Customer On-Site Renewable Energy (CORE) is the only RE program in New Jersey that has achieved energy generation to date. The project team's analysis focused on the PV component of this program. Though other renewable technologies such as wind and biogas have been installed, available data are insufficient for the project team to determine the resulting generation or emission reductions. Three hundred forty-four PV systems were installed under the program from mid-2003 through 2004, with an aggregate capacity of 2.5 MW.[20] This capacity represents five to six acres of PV panels.

1.3.4 New Jersey NO_x Cap-and-Trade Program

Pursuant to the 1990 Amendments to CAA, EPA issued the NO_x SIP Call, which required certain states to issue regulations that impose limits (a cap) on NO_x emissions. The regulations also established a NO_x emissions trading program to, among other things, reduce the cost of implementation to electric utilities.

In response to the NO_x SIP Call, New Jersey issued NO_x budget regulations[21] that included several components, such as an incentive reserve for RE and EE.[22] The New Jersey Department of Environmental Protection (NJ DEP) has incorporated the total emissions cap under its NO_x budget regulations into its attainment demonstration for the 1-hour ozone standard.

The New Jersey incentive reserve set aside 410 NO_x allowances that could be claimed by customers who saved electricity and owners and operators of RE projects. These incentive allowances can be traded or sold as an inducement to encourage RE and EE measures.[23] A project owner or energy customer can also "retire" such allowances, which will reduce the total emissions cap and help the state attain the ozone standard.

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[20] See Appendix 2 for a complete list of CORE projects during this period.

[21] NJAC 7:27-31 et seq.

[22] NJAC 7:27-31.8.

[23] Art Diem and Debra Jacobson, *Options for New Jersey to Obtain and Retire Allowances in Order to Obtain SIP Credit for Energy Efficiency and Renewable Energy Measures*, April 14, 2005, p. 4. Since its inception, the EERE incentive allowance pool has been undersubscribed in New Jersey, and the owners and operators of most of the projects subsidized through the NJ CEP have not yet applied for allowances under the Incentive Reserve. One of the major reasons for the limited use of the reserve appears to be that most small individual projects, such as small PV arrays and small EE projects, are not large enough to meet eligibility requirements for allowances on their own, and only one company has effectively pursued aggregation of projects to overcome this hurdle. Most projects involve emission reductions far below one ton, and allowances are only granted in one-ton increments. Discussion with Tom McNevin, NJ DEP, May 2005.

Under EPA's Clean Air Interstate Rule (CAIR), issued in the spring of 2005, NJ DEP is required to issue new NO_x cap-and-trade regulations to replace its NO_x SIP Call regulations for electric generating units.[24] NJ DEP has not yet developed these new regulations, which will govern NO_x emission trading in New Jersey for the 2009 ozone season and thereafter. Therefore, the state has not yet announced its plans for allowance allocation under the new rules, including any decision on the continuation of its RE/EE incentive allowance.

[24] 70 Fed. Reg. 25290 (May 12, 2005).

2.0 Energy Savings and Emissions Reduction Quantification Methodology

2.1 Energy Efficiency

The project team refined and expanded methodologies that were developed by the NJ CEP to estimate NO_x emission reductions during the summer ozone season that result from measures implemented under the NJ CEP. This methodology:

1. Calculates the annual electricity savings resulting from the energy efficiency measures.
2. Estimates the electricity savings during the summer ozone season.
3. Calculates the NO_x emission reductions during the summer ozone season.
4. Estimates the current electricity savings and ozone season NO_x emission reductions of previously implemented projects.

The project team relied on calculations that were conducted by the NJ CEP for step 1; step 2 involved applying a summer season "allocation factor" to the estimate of annual electricity savings, and step 3 required that a "conversion factor" be applied to convert summer electricity savings into summer emission reductions. During this process, we identified step 4, and we employed a "degradation factor" to determine this quantity. Details of the analysis follow.

2.1.1 Annual Electricity Savings

The first step—the calculation of annual electricity savings—was based on the official protocols developed by the NJ CEP.[25] New Jersey has directed extensive effort into data tracking and estimating the electricity savings of various installed EE measures. For each type of technology, the protocols spell out the methodology used to estimate annual electricity savings. This approach is used in the program's annual reports and in periodic cost-benefit analyses.

Thus, under the New Jersey energy saving protocols, electricity savings are not measured directly for each piece of equipment, but are calculated based on the characteristics of the installed technology. This approach greatly simplifies the data tracking and measurement procedure. The protocols compare a piece of equipment, such as a CFL, an Energy Star air conditioner, or a highly efficient industrial motor, to the average new model of that type and size. The protocols also take into account the typical hours of operation of that type of equipment at a specified facility (school, C&I, or residential). The savings stipulated by the protocols are based on almost 10 years of direct measurement.

For example, a CFL installed at a residential location is assumed to save 42 watts compared to a standard new light bulb,[26] and to provide these savings for 2.5 hours/day. Thus, each CFL is

[25] New Jersey Clean Energy Program, *Protocols to Measure Resource Savings*, September 2004. See Appendix 3 for a more detailed explanation.

[26] This figure is based on a minimum electricity saving of 66% for Energy Star CFLs (as specified in the Energy Star labeling requirement), combined with NJ CEP assumptions about the typical wattage of incandescent bulbs replaced. The protocols indicate that this figure can be adjusted as the NJ CEP obtains better information.

assumed to save 38 kWh/year at the customer side, and 42 kWh of generation.[27] For the Energy Star homes program, home energy rating software is used to evaluate energy savings for each building constructed.[28]

The value of the New Jersey protocols is that they eliminate the need for tracking electricity savings for each piece of equipment and greatly simplify the energy savings estimation process. Such an approach would be unnecessarily burdensome in most cases. However, individual tracking may be a valid approach where there are only a few instances of a technology, or where the energy generation or savings of individual units are particularly large.

2.1.2 Summer Season Electricity Savings

The second step—estimating summer ozone season electricity savings—is derived from "summer season allocation factors" specified by the protocols. In its annual reports, the NJ CEP uses the summer season allocation factors to determine the cost savings associated with various EE measures. This allocation is required because electricity tends to cost more in the summer. The summer season, as defined by the allocation factors, runs from May 1 through September 30, matching the ozone season. The project team used the allocation factors to identify NO_x emission reductions during the summer ozone season when such factors were available.

In some cases the New Jersey protocols do not provide allocation factors, and the project team used other resources to identify the fraction of electricity savings that occurs during the summer season. In particular, the team employed allocation factors provided in the Emission Reduction Workbook developed for the Ozone Transport Commission (OTC).[29] Factors listed in the *OTC Emission Reduction Workbook* are well established and accepted by industry practitioners.

2.1.3 Baselines

A baseline must be determined to establish electricity savings from EE programs. New Jersey officials, as well as our own project team, measured the electricity savings of the New Jersey EE programs against a "business-as-usual" baseline case that assumes the program was not implemented. For example, these baseline methodologies quantify the electricity savings benefit of a new high-efficiency air-conditioning system by comparing this system to the average new system of that size that conforms to current applicable codes and standards.

The New Jersey and pilot team methodologies are consistent with the standard methods for computing baselines for electricity savings. Such methods do not compare the new system to the previous system or to the average system, but rather to current standard technology. If, for example, a building consumes 4000 MWh/year less than before the energy-efficient equipment was installed, this amount is not used as the total savings.

Improved technology and standards dictate that some degree of energy savings improvement must be used to determine the baseline. Models used by the Energy Information Administration

[27] Assumed transmission and distribution losses are 11%, according to the protocols.
[28] This approach will be required in other states, as it is required by the Energy Star homes program.
[29] The *OTC Emission Reduction Workbook 2.1*, Synapse Energy Economics, 2001. The allocation factors used for the NJ CEP's cost-benefit analysis could not be directly employed in certain cases. However, they did confirm the accuracy of other resources, such as the *OTC Emission Reduction Workbook*.

and other energy experts assume that old equipment will wear out and be replaced by newer and more efficient equipment. Under these models, the installation of a typical new system is considered business as usual and not surplus energy savings, even if the new system results in some savings from the previous levels of electricity consumption. Some degree of improvement is already incorporated into projections used to develop SIPs.

A second component of the baseline determination involves identifying the impact of the electricity savings. If New Jersey did not implement its EE programs, additional electricity generation would be necessary to meet the increased load. Therefore, the type of technology that would have been used to meet this additional load needs to be projected. As recommended by EPA, the pilot team looked at the direct and immediate impact on fossil fuel plants.[30]

Modified Excerpts from
New Jersey Clean Energy Program Protocols to Measure Resource Savings

Basic Methodology

Electric Demand Savings = $\Delta kW = kW_{baseline} - kW_{energy\ efficient\ measure}$
Electric Energy Savings = $\Delta kW \times EFLH$
EFLH = Equivalent Full Load Hours of operation for the installed measure.
Electric Peak Coincident Demand Savings = $\Delta kW \times$ Coincidence Factor

Electric Loss Factor:
The electric loss factor applied to savings at the customer meter is 1.11 for both energy and demand. The electric system loss factor was developed to be applicable to statewide programs. Therefore, New Jersey used average system losses at the margin, based on PJM grid data (referes to the PJM Interconnection region, which includes New Jersey, Pennsylvania, Maryland, and neighboring states). This approach reflects a mix of losses that occur relative to delivery at various voltage levels. The 1.11 factor used for both energy and capacity is a weighted average loss factor and was adopted by consensus.

Example: Central Air Conditioner

Energy Impact (kWh) = $CAPY/1000 \times (1/SEER_b - (1/SEER_q \times (1\text{-}ESF)) \times EFLH$
CAPY = Cooling capacity (output) of system
$SEER_b$ = The Seasonal Energy Efficiency Ratio of the Baseline Unit (set at 10).
$SEER_q$ = The Seasonal Energy Efficiency Ratio of the qualifying unit installed. These data are obtained from the application form based on the model number.
ESF = The Energy Sizing Factor or the assumed saving that results from proper sizing and installation (set at 17%).
EFLH = Equivalent Full Load Hours of operation for the installed measure (set at 600 hours for cooling).

Note: This text is based on the September 2004 New Jersey Protocol document and has been modified for illustrative purposes. A complete detailed list of the New Jersey energy-saving protocols may be found in Appendix 3 and at www.njcleanenergy.com/media/Protocols.pdf.

[30] A large and lasting EE program might defer the need for new power plants. However, this consideration is beyond the scope of the analysis required by EPA.

2.1.4 Avoided Emissions Rate and Tons NO_x Avoided

The third step in the energy savings and emission reduction quantification methodology is to determine the NO_x emission reductions that are achieved for a given electricity saving. Under the New Jersey NO_x emission trading regulations, this conversion factor is specified as 1.5 lb for each megawatt-hour of energy savings (1.5 lb/MWh). Under the regulations, this conversion factor is fixed even if the actual emission reductions are greater than this amount.[31] Therefore, the actual avoided emissions need to meet or exceed the stipulated emission reductions.

2.1.5 Degradation Factor

When calculating the ongoing electricity savings from projects installed in previous years, the team decided that employing a degradation factor would be conservative and useful. The degradation factor accounts for some changes that may occur to an EE improvement: (1) equipment deteriorates over time, especially if maintenance is inadequate; (2) some equipment may be removed before the end of its useful life; and (3) a degradation factor can offer a substitute for estimating the lifetime effectiveness for specific types of efficiency measures.

Our calculations include a degradation factor of 15%/year for EE measures. For example, energy savings from 2004 measures are credited fully in 2005, but at 85% of their previous value in each successive year. To be conservative, a high figure is used as a placeholder until more precise calculations are conducted. Though using a single overall factor to all measures simplifies the calculation process, using different factors for different types of measures may be more accurate.[32]

2.2 Renewable Energy

For RE generation,[33] the methodology for calculating the annual and summer ozone season avoided NO_x emissions consists of three steps:

1. Calculate the annual and summer ozone season electricity generation of the renewable source.
2. Estimate the annual and summer ozone season NO_x emission reductions.
3. Estimate the electricity generation and NO_x reductions of previously implemented projects.

Thus, the emission reductions that result from RE are easier to quantify than those that result from EE. The baseline is simply the case in which the project was not implemented. The business as usual scenario assumes a negligible amount of RE and does not include projects that are implemented as a result of the NJ CEP. Therefore, all RE generation that is implemented through the NJ CEP is surplus and not included in the baseline.

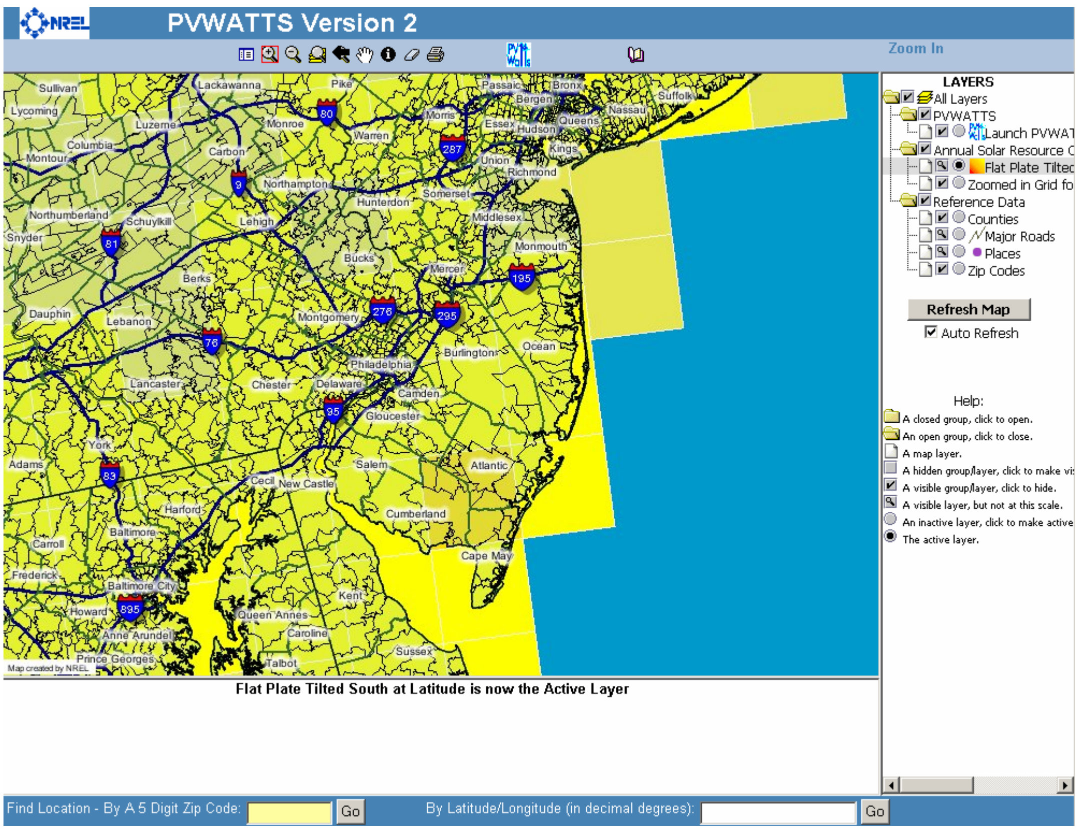
[31] N.J.A.C. 7:27-31.7(e)3.i.
[32] Examining varying degradation factors is beyond the scope of this initial pilot project.
[33] The New Jersey regulations limit claims for incentive allowances to equipment that commenced operation in 1992 and thereafter and that generates electricity through one of the following “environmentally beneficial techniques”: (1) Generation through the burning of landfill gas or digester gas; (2) generation by a fuel cell; (3) generation using solar energy or wind power; or (4) generation through another environmentally beneficial technique approved by DEP. N.J.A.C. 7:27-31.8(c)

2.2.1 Annual and Summer Season Renewable Energy Generation

The first step is to calculate the annual and summer season electricity generation of the renewable source. The project team employed standard methodologies to estimate annual and summer season energy generation from PV projects based on the rated installed capacity.

The annual and summer ozone season electricity generation for the 344 completed solar projects supported by the CORE program was calculated with the PVWATTS model (see Figure 1),[34] which was developed by NREL. NREL developed this model to provide a calculator for estimating the monthly generation of specified PV units on a per-kilowatt basis of installed capacity. With this tool, annual and monthly generation are provided simultaneously, so identification of annual and summer season energy production can be considered in a single step. The calculation is based on measurements of incident solar radiation recorded at observation stations in all 50 states.

PV Watts



PVWATTS calculates electrical energy produced by a grid-connected photovoltaic (PV) system. Researchers at the National Renewable Energy Laboratory developed PVWATTS to permit non-experts to quickly obtain performance estimates for grid-connected PV systems within the United States and its territories. The grid cells indicate solar resource in kWh/m^2/day.

Figure 1. PVWATTS model

[34] PVWATTS program version 2, NREL. http://mapserve1.nrel.gov/website/PVWATTSLITE/viewer.htm.

Because New Jersey is relatively small on a geographic scale (compared to Florida or California), the project team used a representative factor based on examination of three areas across the state to apply the PVWATTS model to New Jersey. The PV systems were grouped into 21 categories according to orientation and inclination. For example, the largest group (by capacity) consisted of systems that are oriented generally southward (160°−220°) at a tilt of 30°−39°. This group was modeled as orientation of 180° (south) and an inclination of 35°. The second-largest group consisted of systems with an inclination less than 10°; these were modeled as flat-roof systems (which, in fact, most were).[35]

We calculated an average annual generation rate of 1,191 kWh/kW of installed capacity for the New Jersey solar PV projects.[36] The generation rate for the five-month ozone season is 597 kWh/kW of installed capacity. The total annual generation from the solar electric capacity of 2,521 kW is 3,003 MWh and the ozone season generation is 1,505 MWh.

2.2.2 Avoided Emissions Rate and Tons NO_x Avoided

A solar electric system produces no direct emissions. Moreover, solar electric displaces emissions from fossil fuel generating sources such as natural gas or coal-fired generation. As with EE measures, the New Jersey NO_x regulations stipulate the allocation of incentive reserve allowances at a rate of 1.5 lb/MWh. This rate is applied to all nonemitting RE systems.

2.2.3 Degradation Factor

Similar to EE, when calculating the ongoing renewable generation from previous years, the team decided that a degradation factor should be applied. The actual deterioration of solar panels can be quite small: well-maintained systems may experience output declines of less than 1%/year. However, systems that are not well maintained may be shaded, soiled, or have inverter failures or other problems. For this analysis, we used a degradation factor of 5%/year for solar PV systems. As with EE, this is a conservative factor that accounts for deterioration and system failures, and obviates the need for a fixed system lifetime.

A degradation factor of 5%/year implies that, by the end of 2012, the systems installed in 2004 will be, on average, at two-thirds of their original capacity. Some systems will have failed or been removed, but many will still be operating at almost their original capacity. NJ CEP conducts quality assurance tests through a random routine inspection of 10% of the larger (10 kW or greater) systems by comparing the estimated energy production with the inverter display. This sampling is conducted as part of the state's Solar Renewable Energy Certificate (SREC) trading system. These data could be used in the future to more precisely estimate the actual degradation factor. These refined estimates might provide the basis for a lower degradation factor.

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[35] For variations and the uncertainties associated with the weather data and the model used to model the PV performance, future months and years may be encountered where the actual PV performance is less than or greater than the values shown in the table. The variations may be as much as 40% for individual months and up to 20% for individual years. Compared to long-term performance over many years, the values in the table are accurate to within 10%−12%. The model also assumes a standard combined default factor of 0.77 for inefficiencies in conversions from DC power to AC power.

[36] The category with the highest annual generation included south-facing systems of 30°−39° inclination; these were deemed to have an annual generation of 1,263 kWh/DC kW.

3.0 Analysis and Results

3.1 Energy Efficiency

Our findings indicate that the efficiency measures installed pursuant to the NJ CEP in calendar years 2002, 2003, and 2004 should result in electricity savings for the summer of 2005 of approximately 320,000 MWh. Using the conversion factor specified in the New Jersey emissions trading regulations of 1.5 lb/MWh, this electricity saving translates into emission reductions of 240 tons of NO_x.

3.2 Renewable Energy

Our analysis indicates that the solar electric projects installed under the CORE program in 2003 and 2004 generated 1,505 MWh during the summer ozone season of 2005. Based on the stipulated conversion factor in the New Jersey regulations, this generation accounted for emission reductions of approximately 1.13 tons of NO_x during the 2005 summer ozone season.[37]

3.3 Summary Analysis

Table 1 illustrates the electricity savings, renewable generation, and avoided NO_x emissions for the 2005 ozone season. It includes the savings from measures implemented in 2002 through 2004 with a 15% annual degradation factor for EE and a 5% annual degradation factor for RE.

Table 1. Summary of 2005 Energy Savings, RE Generation, and Avoided NO_x Emissions

	2005 Summer MWh	**2005 Summer NO_x (tons)**
Residential HVAC		
Central Air-Conditioning	38,457	28.84
Heat Pumps	407	0.31
Residential New Construction	4,715	3.54
Room Air-Conditioning	2,594	1.95
Lighting	63,464	47.60
Clothes Washers	276	0.21
Comfort Partners	6,733	5.05
C&I New Construction	62,794	47.10
C&I Retrofit	136,034	102.03
New School Construction and Retrofit	6,019	4.51
Combined Heat & Power	N/A	N/A
Total Energy Efficiency	321,493	241
Renewable Energy		
Solar Electric	1,505	1.13
Wind	TBD*	TBD*
Fuel Cells	TBD*	TBD*
Landfill Gas	TBD*	TBD*
Total Renewable Energy	1,505	1.13
TOTAL	**322,998**	**242**

* See discussion of analytical issues and data gaps on pages 27−31, infra.

[37] If a power plant dispatch study were conducted, the actual displacement of NO_x emissions might be calculated at a higher rate.

Although we have stated avoided emissions in tons per summer ozone season, SIP submissions to EPA to implement the ozone standard generally present NO_x emissions avoided in tons/day. The 242 tons is equivalent to 1.6 tons/day.[38]

3.4 Preliminary Projection of NO_x Emission Reductions from 2007 through 2012

If NJ DEP includes NO_x emission reductions that result from the NJ CEP in its SIP for the 8-hour ozone standard, the agency will be required to project such reductions for the summer ozone season for the period 2007 through 2009 to demonstrate attainment of the ozone standard in 2010. The project team has not conducted a detailed analysis of the projected emission reductions for this period. However, we have developed preliminary projections based on the methodology and analysis conducted to date. We used the following assumptions to estimate NO_x emission reductions for the summer ozone seasons from 2007 through 2012[39]:

- The determination of the baseline for this analysis was limited only to the specific NJ CEP programs that were covered in our analysis of emission reductions for the 2005 ozone season.[40]
- Estimates provided by the NJ CEP for future years project a growth of 20%/year for EE programs and 40%/year for RE programs. These projections are based on a New Jersey goal of a 10% increase in energy savings per dollar invested and annual increases in funding of approximately 10% for EE and 30% for RE.[41]
- The fraction of summer electricity savings remains at 46.38% of annual savings, and the fraction of summer PV generation remains at 50.13% of annual PV generation.
- The actual avoided emissions rate is 1.85 lb/MWh in 2004 and is projected to be 1.65 lb/MWh in 2005 and 2006, 1.24 lb/MWh in 2007, and 0.97 lb/MWh in 2008. This rate is estimated to decrease by 5%/year after 2008; the credited value will be the lesser of the actual rate or the stipulated rate of 1.5 lb/MWh.[42] The annual degradation factor is 15% for EE and 5% for RE, which reflects the relatively short lifetimes of many EE measures such as lighting, which accounts for a significant fraction of savings; and renovation or remodeling may also reduce EE measures.

To illustrate the sensitivity of our assumptions, four alternative scenarios are presented for comparison:

Base Case Scenario: Table 2 summarizes avoided NO_x emissions under the assumptions presented earlier:

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[38] Total emission reductions during the summer ozone season in tons can be converted into tons/day by dividing by 153 (the number of days in the summer season).

[39] Although EPA is expected to require data for 2007 to 2009 only, the project team has provided projected scenarios through 2012 for informational purposes.

[40] See pp. 2−3, supra.

[41] The EE budget grows 43% over 2004 to 2008, and the RE budget grows 129% over that time. Program effectiveness per dollar has increased by more than 10% from 2002 to 2004.

[42] Estimated rates for 2004 to 2008 were provided by NJ DEP. These emission rates represent the generation-weighted average emissions rate for all NO_x budget units in New Jersey; that is, all fossil fuel units greater than 15 MW. An analysis for 2009 may be necessary for SIP crediting, and may need to account for the impacts of CAIR.

Table 2. Avoided NO_x Emissions

Year	Summer Electricity Savings (MWh)	Credited NO_x Rate (lb/MWh)	Credited NO_x Emissions (tons)
2005	322,999	1.50	242
2006	459,635	1.50	345
2007	613,387	1.24	380
2008	789,413	0.97	383
2009	993,723	0.92	458
2010	1,233,412	0.88	540
2011	1,516,942	0.83	631
2012	1,854,483	0.79	733

First Alternative Scenario − Low Growth: Table 3 shows the avoided emissions with the program electricity savings growing only as fast as the program budget, rather than the higher rates assumed in the base case scenario. All other assumptions are the same as the base case.

Table 3. Avoided Emissions with Program Electricity Savings Level with Program Budget

Year	Summer Electricity Savings (MWh)	Credited NO_x Rate (lb/MWh)	Credited NO_x Emissions (tons)
2005	322,999	1.50	242
2006	444,249	1.50	333
2007	564,845	1.24	350
2008	686,788	0.97	333
2009	812,013	0.92	374
2010	942,436	0.88	413
2011	1,080,005	0.83	449
2012	1,226,749	0.79	485

This scenario illustrates the impact of the state's goal for the NJ CEP of improving energy saved per dollar invested by 10%/year. If that goal is not met, and energy savings grow only as fast as the program budget, avoided emissions in 2012 are one-third less than they are in the base case.

Second Alternative Scenario − Sustained Measures: Table 4 shows the avoided emissions with the degradation factors set at 5%/year for EE and 2.5%/year for RE instead of 15% and 5%, respectively. All other assumptions are the same as the base case.

Table 4. Avoided Emissions with Degradation Factors at 5% per Year

Year	Summer Electricity Savings (MWh)	Credited NO_x Rate (lb/MWh)	Credited NO_x Emissions (tons)
2005	350,334	1.50	263
2006	517,790	1.50	388
2007	714,334	1.24	443
2008	946,181	0.97	459
2009	1,220,841	0.92	563
2010	1,547,405	0.88	677
2011	1,936,894	0.83	805
2012	2,402,698	0.79	949

This scenario shows avoided emissions in 2012 that are nearly one-third higher than those in the base case. The lower degradation factors are reasonable (and in fact conservative) for systems that are properly maintained and monitored.[43] NJ CEP can ensure a higher level of avoided emissions in future years by demonstrating the continued performance of previously implemented RE/EE measures. C&I facilities that benefit from EE improvements through NJ CEP should be encouraged to take steps to ensure the continued performance of their new systems.

Third Alternative Scenario − Clean Grid: Table 5 shows the avoided emissions with the actual avoided emissions rate falling by 10%/year instead of 5%/year after 2008. All other assumptions are the same as the base case.

Table 5. Avoided Emissions with Actual Avoided Emissions Rate Falling by 10% per Year

Year	Summer Electricity Savings (MWh)	Credited NO_x Rate (lb/MWh)	Credited NO_x Emissions (tons)
2005	322,999	1.50	242
2006	459,635	1.50	345
2007	613,387	1.24	380
2008	789,413	0.97	383
2009	993,723	0.87	434
2010	1,233,412	0.79	485
2011	1,516,942	0.71	536
2012	1,854,483	0.64	590

Expedited reductions in NO_x emission rates from power plants would lower the amount of NO_x avoided by RE and EE measures. However, many power plants have already implemented the most cost-effective pollution controls available and have less room for improvement. NJ DEP considers that the reduction in NO_x emission rates will probably slow after 2008.

Fourth Alternative Scenario – Full Renewable Energy: Table 6 shows the impact of New Jersey meeting its RE goals by 2012. These goals are 300 MW of RE, including 90 MW of PV. The non-PV RE is assumed to be 50% wind and 50% biomass (landfill gas, possibly in fuel cells), with a wind capacity factor of 35%, a wind seasonal allocation factor of 40%, a biomass capacity factor of 75%, and a biomass seasonal allocation factor of 45%.[44] This case involves considerable speculation about the performance of wind and biomass systems.

If met, New Jersey's RE goal would lead to a significant reduction in emissions by 2012, primarily because of the non-PV RE component, which attains a larger capacity and a higher capacity factor than PV.

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[43] See G. Kats, A. Rosenfeld, T. McIntosh, and S. McGaraghan, *Energy Efficiency as a Commodity: The Emergence of an Efficiency Secondary Market for Savings in Commercial Buildings*, Published in ACEEE 1997 Summer Study, Part I, Panel 2.

[44] Only the avoided electricity generation emissions, not the direct emissions, are considered for biomass. This would be the case when the biomass emissions equal the avoided flaring emissions.

Table 6. Impact of New Jersey Meeting Its Renewable Goals by 2012

Year	Summer Electricity Savings (MWh)	Credited NO_x Rate (lb/MWh)	Credited NO_x Emissions (tons)
2005	322,999	1.50	242
2006	477,500	1.50	358
2007	655,576	1.24	406
2008	865,085	0.97	420
2009	1,115,850	0.92	514
2010	1,420,342	0.88	622
2011	1,794,610	0.83	746
2012	2,259,530	0.79	893

Figure 2 shows the NO_x emission reductions achieved by each component of the NJ CEP: EE, PV systems, and other RE.

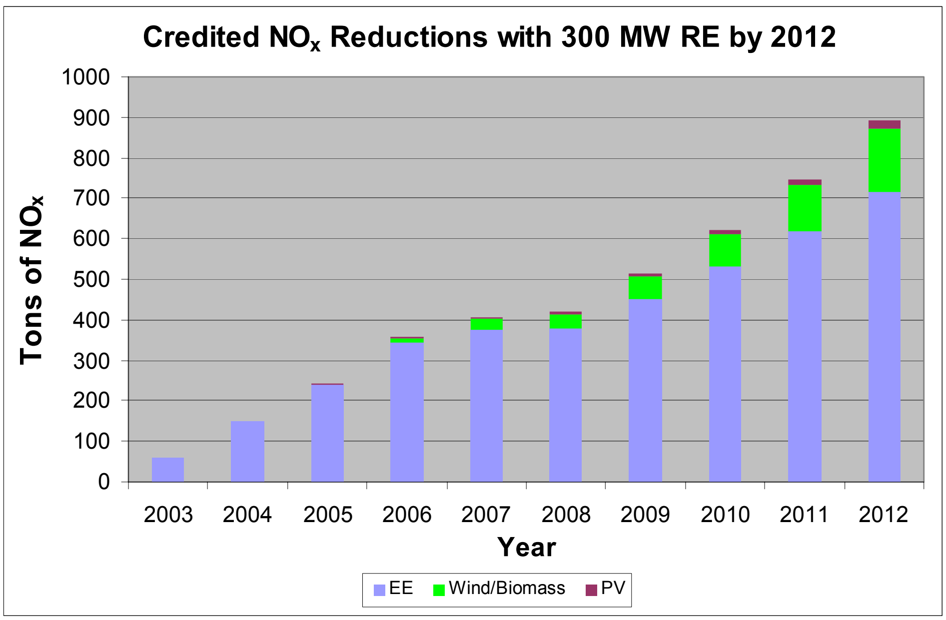

Figure 2. Credited NO_x Reductions with 300 MW RE by 2012

Summary of Scenarios: Varying each of these assumptions leads to markedly different results. The projection of the avoided NO_x emissions rate under each alternative assumption is particularly important. Because of these differences, NJ DEP should consider an analysis of the projected summer season NO_x rate of dispatchable fossil fuel electric generation facilities. Also, demonstrating the sustained performance of previously implemented EERE measures and continued improvements in the cost effectiveness of the NJ CEP will be important.

Figure 3 illustrates NO_x credited to NJ CEP:

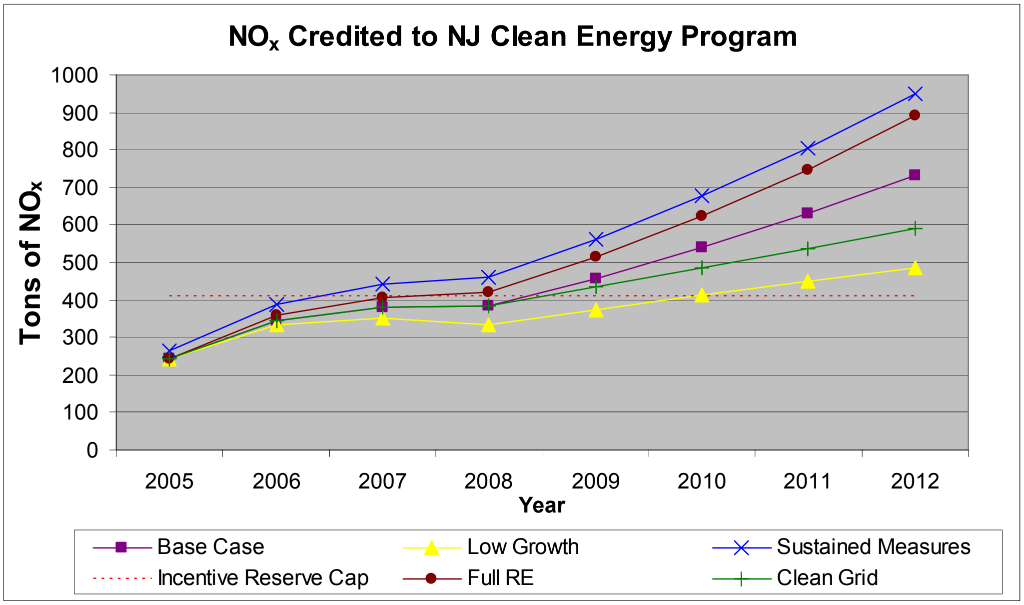

Figure 3. NO_x Credited to NJ CEP

A rapid decrease in the avoided NO_x rate causes avoided emissions to level off or decline slightly from 2007 to 2008. In most scenarios, avoided emissions consistently approach or exceed 400 tons/year, and in some cases, they double that level. When non-BPU claimants to allowances are included,[45] the current Incentive Allowance Reserve of 410 tons is likely to be oversubscribed in most years of the program.[46] One possible option available to NJ DEP is to transfer unused allowances from the Growth/New Source Reserve to the Incentive Allowance Reserve.[47] NJ DEP has indicated that the Growth/New Source Reserve is unlikely to be fully utilized.

[45] The DEP issued 47 incentive allowances to private parties in 2004.

[46] The limit of 410 tons per season is set forth in New Jersey Administrative Code, Title 7, Chapter 27, Subchapter 31.7, Part(d)ii. See www.state.nj.us/dep/aqm/Sub31v2004-04-05.htm.

[47] The New Jersey NO_x budget regulations allocate 820 allowances into this reserve from 2004 to 2008. NJAC 7:27-31.7(d)(1). New Jersey has not yet issued regulations to implement the EPA's CAIR, and New Jersey's CAIR rule will determine the size of any new source allocations for 2009 and thereafter.

4.0 Policy Issues

4.1 Interface between State Implementation Planning Process and State Cap-and-Trade Regulations

One of the major challenges of this pilot project was to develop an approach to ensure that RE and EE programs result in real reductions in emissions of NO_x, a pollutant that is subject to emissions trading (cap-and-trade) regulations in New Jersey and most eastern states. The SIP process under CAA Section 110 is the mechanism to account for emission reductions.[48] Under EPA's 2004 guidance, states can receive emission reduction credit in their SIPs for RE and EE measures that reduce NO_x emissions and help achieve the 8-hour ozone health standard, under specified circumstances.[49]

Currently, states in the eastern United States have caps on NO_x emissions from electric generating units (EGUs) through regulations that implement EPA's NO_x SIP Call. Beginning in 2009, these caps in 28 states and the District of Columbia will be governed by new regulations that are being developed by the states that implement EPA's new CAIR.[50] As a result, credit for RE and EE projects must be provided in a way that avoids double counting. According to EPA's Guidance, the states will need to ensure that the emissions trading cap for NO_x and the number of allowances allocated to fossil-fuel generators are reduced commensurate with the level of emission reductions that result from EERE projects and programs.

This can be accomplished in one of two ways:

- **Baseline Approach** − Incorporates the estimated effect that the RE and EE programs have on emissions within the projected emissions inventory baseline and provides a corresponding decrease in the emissions cap. This decrease in the emissions cap to account for the RE and EE programs can be accomplished by issuing CAIR regulations that adjust the EPA-established state cap at the outset through an attainment reserve, public health reserve, or similar mechanism.

- **Control Measures Approach** − Incorporates emission reductions from individual control measures such as a regional wind purchase or solar programs in schools (or as part of a voluntary bundle of control measures), and provides a corresponding decrease in the emissions cap. The decrease in the cap can be accomplished by retiring allowances that have been allocated to RE and EE projects through a set-aside or output-based regulations issued under the state's NO_x budget or CAIR regulations.

According to guidance issued by EPA in August 2004, both approaches are acceptable.[51] Of course, under any approach, the state's SIP will require approval by the relevant EPA Regional Office (Region II with respect to New Jersey).

[48] 42 U.S.C. 7410 (2005).
[49] EPA SIP Guidance.
[50] 70 Fed. Reg. 25162 (May 12, 2005).
[51] EPA SIP Guidance, pp. 13–14.

In other words, to achieve SIP credit under either approach, the state must either omit a certain fraction of allowances from distribution (thereby lowering the NO_x emissions cap at the outset) or require the retirement of any such allowances allocated to EERE owners and operators. Otherwise, the emissions would be allowed within the trading program and could be double counted.[52]

The justification for EPA's approach is that EERE activities are unlikely to result in emission reductions of a capped pollutant, particularly in the near term, unless the state lowers the cap directly or retires allowances (the authorization to emit a ton of NO_x) to account for the reduction in demand from fossil fuel generators caused by the EERE measures. According to EPA, the cap-and-trade program allows the same emissions from fossil fuel-fired generation, no matter how much generation these sources are called upon to meet demand. EPA is concerned that fossil fuel generators are likely to take the allowances made available when coal, natural gas, or oil generation is displaced by RE and EE measures and either use such allowances or sell them to other generators. This results in the continued emissions of NO_x at the capped amount and the failure to provide surplus emission reductions.

As EPA states in its Guidance:

> Cap and trade programs are enforced through the issuance of a limited number of allowances (authorizations to emit) that are equal to the emissions cap. Through trading and banking of these allowances, individual sources can vary their emissions as long as the aggregate emissions for all sources do not exceed the allowances issued. By limiting total mass emissions for the category of sources, cap and trade programs automatically account for any action that reduces emissions, including energy efficiency and renewable energy.[53]

Under the base case scenario for the NJ CEP, NJ DEP could lower the NO_x emissions cap by 520 allowances on average for the summer ozone season from 2007 through 2012, which is equivalent to an average emission reduction of 3.4 tons of NO_x per summer day. Because NJ CEP will increase the market for RE and EE and the integration pilot will raise the visibility of the Incentive Allowance Reserve, private parties will probably claim additional allowances.

4.2 Claims for New Jersey Incentive Allowances

Under its current emissions trading regulations, New Jersey has included a set-aside of NO_x allowances for certain RE and EE activities.[54] This is called the "incentive allowance" pool and

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[52] Id., p. 18.
[53] Id. p. 9.
[54] Under the incentive allowance regulations, the following two categories of entities are specifically listed as eligible to submit an annual claim for allowances: (1) New Jersey electricity consumers who reduce electricity consumption by implementing an EE measure initiated in 1992 or thereafter (subject to certain additional conditions); and (2) owners and operators of equipment that commenced operation after 1992 that generates electricity through certain environmentally beneficial techniques defined as generation by burning of landfill gas or digester gas, fuel cell, solar energy or wind power, or equipment that generates electricity by another environmentally beneficial technique approved by the DEP. N.J. 7:27-31.8.

is distributed at the rate of 1.5 lb/MWh with a current cap of 410 allowances.[55] If the incentive allowance pool is oversubscribed, these allowances are distributed pro-rata.[56] Under current NO_x budget regulations, unused allowances can be transferred from the Growth/New Source Reserve, thereby increasing the number of incentive allowances distributed. However, the adequacy of the post-2008 allowances for RE and EE will depend on the specifics of the NJ CAIR regulations, which have not yet been issued.

4.3 Developing SIP Control Measures that Meet EPA Requirements

If a state proceeds with a SIP to seek approval of individual control measures for RE and EE, it will need to demonstrate to EPA that its emission reductions will be surplus, quantifiable, enforceable, and permanent.[57]

4.3.1 Surplus Requirement

EPA notes in its SIP Guidance that "the surplus requirement is especially important in areas subject to a cap and trade program."[58] However, the Guidance emphasizes that:

> One acceptable way of achieving additional emission reductions from energy efficiency and renewable energy measures in the presence of a cap and trade program is through the *retirement of allowances* commensurate to the emissions expected to be reduced by the energy efficiency measures. The retirement of allowances provides some level of assurance that the energy efficiency measures will achieve emission reductions that are *surplus* to the emission reductions under the cap and trade program.[59] (emphasis added)

As a result of this guidance, NJ BPU and DEP have worked together under this pilot project to plan an approach for retiring allowances that are obtained by BPU under the incentive allowance program. This should provide a key element to help meet the surplus requirement.

In addition, if emission reductions from RE and other measures are included in individual control measures, they cannot be included in the baseline emissions inventory for a SIP to meet the 8-hour ozone standard. This element is crucial to ensure that emission reductions are not double counted and that they are surplus and have not been otherwise relied on to meet air quality attainment requirements.

The regulations do not directly authorize the issuance of allowances to an entity that aggregates allowances on behalf of energy-saving electric consumers or owners or operators of environmentally beneficial techniques. However, the regulatory history of the regulation, contained in the NO_x Budget Rule Adoption Document (government response to comment 123), indicates that "the rules adopted herein do not preclude the submittal of a claim on behalf of the owner or operator of [a] project eligible for submitting a claim. Neither do the rules preclude aggregating several different projects into a single claim."

In addition, a precedent has been established for the award of allowances from the incentive reserve to an energy services company named SYCOM on behalf of its clients who contracted for EE projects.

[55] N.J.A.C. 7:27–31.7(e).1. In 2004, applicants claimed 47 of the 410 incentive allowances (NJ DEP).
[56] N.J.A.C. 7:27–31.7(e)3.iv.
[57] EPA SIP Guidance, pp. 4–7.
[58] Id., p. 5.
[59] Id., p. 10.

4.3.2 Quantifiable Requirement

Another key component of EPA's regulations and SIP Credit Guidance is a demonstration that the NO_x emission reductions that result from the NJ CEP are quantifiable. During the course of the pilot project, EPA officials advised informally that this test might be simplified because of the stipulation of the New Jersey regulations that fossil fuel emissions are displaced by RE and EE at a rate of 1.5 lb/MWh. EPA officials have indicated that some basic analysis should be conducted to demonstrate that the avoided emissions associated with the displaced fossil fuel generation are no less than the presumed rate of 1.5 lb/MWh.

The project team evaluated several methodologies to support the quantifiable requirement and to demonstrate that the avoided emissions were in fact greater than 1.5 lb/MWh. The team determined that the best methodology available for the purposes of the pilot project was to estimate the generation-weighted average NO_x rate of New Jersey fossil fuel plants. This methodology would provide a reasonable approximation of the marginal emissions rate without the time and expense of a complete grid system dispatch analysis.

The analysis included only facilities that were fossil fuel powered for their primary source of input energy, including those that burn coal, natural gas, and petroleum fuels. Under this generation-weighted approach, the estimated avoided emissions are driven by facilities that contribute the most generation to the system.

Initially the primary data source for this methodology was EPA's eGRID database 2002, which was last updated with emission rates from 2000.[60] However, the mix of fossil fuel generating facilities in New Jersey has changed significantly since 2000. As a result, the project team used more recent estimates, provided by NJ DEP, of NO_x emission rates for 2003 to 2008.[61] These rates represent the generation-weighted average of NO_x budget units in the state; they include all fossil fuel generating plants with a capacity greater than 15 MW. These and other methodologies are discussed in greater detail in Appendix 4.

Under the New Jersey regulations, RE generation uses the same 1.5 lb/MWh rate for avoided NO_x emissions as EE. This rate is fully applicable for zero-emission renewable sources such as solar electric generation.[62]

4.3.3 Enforceabity Requirement

If a state pursues SIP credit for RE and EE projects as individual control measures, it must also meet the enforceability test under EPA's voluntary measures policy.[63] RE and EE measures

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[60] The project team initially relied on data from the U.S. Energy Information Administration and EPA (the Emissions & Generation Integrated Database or eGRID).

[61] Tom McNevin, Bureau Air Quality Planning, NJ DEP, personal communication, September 2005.

[62] In comparison, certain RE sources such as landfill gas systems not only produce electricity but also produce some NO_x emissions of their own and reduce emissions that would be produced by the alternative disposal of that landfill gas (typically flaring). In such cases, the net avoided emissions—the emissions produced by the landfill gas engine minus the sum of 1.5 lb/MWh (for the avoided generation of fossil fuel-fired electricity and the emissions that would be produced from flaring the landfill gas) must be calculated.

[63] See EPA's, "Incorporating Voluntary and Emerging Measures in a SIP," September 2004 for the voluntary measures policy. Such EERE measures would need to meet all applicable requirements of the voluntary measures policy (hereinafter cited as Voluntary and Emerging Measures Policy). See www.epa.gov/ttn/oarpg/tl/pgm.html.

typically result in emission reductions at fossil fuel generating plants located some distance from the RE or EE activities. Although such measures are not enforceable against the direct emitting sources, they are enforceable against the entities such as state and local governments that undertake such activities.[64]

If a SIP revision is approved under the voluntary measures policy, a state is responsible to ensure that the reductions credited in the SIP are made. The state would need to make an enforceable SIP commitment to monitor, assess, and report on the emission reductions that result from the voluntary measure, and remedy any shortfalls from forecasted emission reductions in a timely manner. For voluntary and emerging measures that cover stationary sources, a presumptive limit of 6% of the total reductions is needed to meet any requirements related to attainment or maintenance of the air quality standards or reasonable further progress or rate of progress, as described in the policy.[65] A separate limit of 3% applies to voluntary mobile source programs. Thus, there is a presumptive 9% limit on the inclusion of voluntary and emerging measures in a SIP, although a state may seek case-by-case EPA approval of a higher limit.[66]

Recently, EPA issued a new guidance document on incorporating bundled measures in a SIP,[67] which should facilitate efforts by states to meet the enforceability requirement with voluntary SIP control measures. As stated in EPA's transmittal memorandum to regional air directors:

> The guidance supports the development of additional emissions reductions from innovative approaches by describing how States can identify individual voluntary and emerging measures and "bundle" them into a single SIP submission. The emissions reductions for each measure in the bundle would be quantified and, after applying an appropriate discount factor for uncertainty, the total reductions would be summed together in the SIP submission. After SIP approval, each individual measure would be implemented according to its schedule in the SIP. It is the performance of the entire bundle (the sum of emissions reductions from all the measures in the bundle) that is considered for SIP evaluation purposes, not the effectiveness of any individual measure.

In other words, by grouping a set of voluntary control measures into a bundle, the state minimizes the chance that it will experience a shortfall later when the effectiveness of the measures is evaluated. By averaging the contribution of multiple measures, overperformance of some measures will likely compensate for underperformance of others.

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[64] See EPA SIP Guidance, pp. 5–7.
[65] Ibid.
[66] EPA,Voluntary and Emerging Measures Policy, p. 9.
[67] Memorandum from Stephen D. Page, director, Office of Air Quality Planning and Standards, EPA, and Margo Tsirigotis Oge, director, Office of Transportation and Air Quality, EPA, to Air Division Directors, "Guidance on Incorporating Bundled Measures in a State Implementation Plan," August 16, 2005. See www.epa.gov/ttn/oarpg/t1pgm.html.

4.3.4 Permanence Requirement

EPA's SIP Guidance requires that a control measure "should be permanent throughout the term for which the credit is granted unless it is replaced by another measure or the State demonstrates in a SIP revision that the emission reductions from the measure are no longer needed to meet applicable requirements." The guidance emphasizes that the emission reductions will qualify as meeting the permanence test even if the emission reductions change over time or vary from season to season.[68]

Thus, NO_x emission reductions that result from the BPU's CEP will satisfy the permanence test even if the reductions from efficiency measures decline over time or the RE generation varies from one season to another. However, New Jersey will need to ensure that the estimated emission reductions are delivered.

One way states have sought to address the fact that the impact of emission reductions from RE and EE measures is often variable during the term of the SIP is through the bundled measures approach addressed earlier. Maryland incorporated this creative approach in its SIP revision to meet the 1-hour ozone standard,[69] and this example was showcased by EPA at its 2004 Air Innovations Conference.[70]

4.4 The Purpose and Uses of Allowances

The initial purpose of the New Jersey incentive allowance for EE and EE (and similar NO_x allowance set-asides adopted by six other states)[71] was to provide a financial incentive to entities that adopt such pollution prevention projects. Thus, issuance of such allowances to RE and EE developers was designed to offset the cost of installing such projects and spur increased use.

In the past few years, state officials have recognized that the reduction of the NO_x emissions cap (either through a direct reduction at the outset or by retiring NO_x allowances) is a prerequisite to SIP credit in a state with a NO_x cap-and-trade program. As stated previously,[72] RE and EE activities are unlikely to result in emission reductions of a capped pollutant unless the state lowers the EPA-established cap directly or retires allowances to account for the reduction in demand from fossil fuel generators that results from the RE and EE measures.

During the pilot project, participants discussed their interest in ensuring that two goals—spurring increased EERE development and achieving improved air quality—could be accomplished. For example, an approach that balances both goals might allow applicants for NO_x allowances to either sell or retire such allowances.

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[68] EPA SIP Guidance, p. 7.
[69] See 70 Fed. Reg. 24987 (May 12, 2005) for final EPA approval of the voluntary bundle and www.mwcog.org/committee/committee/archives.asp?COMMITTEE_ID=14 (February 19, 2004) for the detailed SIP revisions, Chapter 7, pp. 77−-81 and Appendix J, J-71-76.
[70] www.epa.gov/ttnmain1/airinnovations/aiconf.2004.html Presentation by Brian Hug, Maryland Department of Environmental Protection.
[71] These states are Maryland, New York, Massachusetts, Indiana, Ohio, and Missouri.
[72] See p. 18, infra.

A recent presentation by Kevin Rackstraw of Clipper Wind Energy has underscored the monetary value in the Renewable Energy Credit (REC) market of NO_x allowances awarded to RE generators under a well-structured allowance allocation program.[73] According to Mr. Rackstraw, this monetary value accrues in the REC market with the retirement of NO_x allowances, and can greatly enhance financing opportunities.[74]

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[73] It is important to recognize the difference between the RECs and emission trading markets that involve NO_x allowances. In essence, RECs and allowances are two separate trading currencies. However, energy marketers have begun to recognize that the value of a REC can be increased if the REC is sold in conjunction with an allowance that can be retired because this REC will then ensure emission reduction of the capped pollutant.

[74] See the Web site of the American Wind Energy Association for a copy of this presentation. www.awea.org/seminars/past_events.html.

5.0 Analytical Issues

5.1 Energy Efficiency

During this project, the team worked to resolve analytical challenges in a number of areas. These challenges included estimating the electricity savings, the summer season electricity savings, and the emission reductions.

In many cases, the reporting mechanisms established by the NJ CEP resolved important issues. In other cases, experts from NJ BPU and NJ DEP were able to clarify key points. However, the project team sometimes had to refine and expand the methodologies.

One of the major challenges was the estimation of summer season energy savings. This factor is essential because the current ozone regulations focus on NO_x emissions during the summer ozone season.[75]

The seasonal allocation factors applied by the Clean Energy Protocols form a sound methodological tool and were applied by the project team, where available. The NJ CEP seasonal factors generally agree with the findings of other analyses, such as the *OTC Emission Reduction Workbook*. These allocation factors are particularly appropriate for consumer products and appliances such as light bulbs and clothes washers.

However, NJ CEP could not provide data on seasonal load profiles for every category of energy-saving measure considered by the project team. For example, the Clean Energy Protocols include "custom measures" as a catch-all category that encompasses any type of measure not detailed elsewhere. In such cases, the Clean Energy Protocols allocate savings evenly across the year. This specific set of seasonal allocation factors is acceptable but not preferable.[76] NJ CEP recognizes this limitation, noting that "[t]hese allocations may change [when] actual penetration numbers are available."[77]

In addition, the annual and quarterly reports currently prepared by the NJ CEP do not provide sufficient detail on C&I EE improvements that are necessary to estimate summer season energy savings. The reports provide aggregated data on C&I electricity savings combined with information on the number, but not the size of electricity savings or of specific measures such as motors, chillers, or lighting controls. Unfortunately, many types of C&I measures have significantly different seasonal load profiles that have result in varying summer season electricity savings.

In this situation, the project team employed the *OTC Workbook* seasonal allocation factors specified for "Commercial Comprehensive New Construction Design." This approach was selected because this category includes a range of efficiency measures. Based on this factor, we

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[75] EPA's new regulations under CAIR, issued in May 2005, focus on both summer season and annual NO_x emissions. 70 Fed. Reg. 25162.

[76] Because electricity use for most loads is either summer peaking (as for HVAC) or equal year-round (as for office computers), assuming equal year-round energy savings is unlikely to overstate summer energy savings.

[77] *Protocols to Measure Resource Savings*, Appendix 3, p. 27.

assumed that 43% of C&I energy savings occurred during the summer season. For some types of commercial measures, such as the 364 high-efficiency electrical chillers and heating, ventilation, and air-conditioning (HVAC) systems installed in 2004, summer season savings are expected to be much higher. For other types of commercial measures, such as the 358 motors installed, summer season savings could be slightly lower (the *OTC Workbook* suggests that industrial motors achieve 39% of their savings in the summer season).

NJ CEP has access to data on C&I energy savings by type of measure through the utilities. [78] In future years, the program will have the data readily available. NJ CEP could conduct an analysis to determine whether the project team's estimated allocation factors are reasonable. A significant overrepresentation or underrepresentation of measures with high seasonal variability, such as HVAC systems, could lead to revisions of the projected emission reductions.

Another area of uncertainty that the project team confronted was the definition of HVAC." NJ CEP provided data on the number of units that were categorized as central air-conditioning or heat pumps, as well as the annual electricity savings that result from HVAC as a whole. However, NJ CEP did not provide the project team with information in its database on the relative size of these units, or on the summer season electricity savings for the heat pumps. These data are important because some heat pumps save electricity during the winter.

In an effort to address these information gaps, the project team applied the following assumptions:

- Each measure saved the same amount of energy per unit, so the fraction of electricity savings attributable to central air conditioning was the same as the fraction of units that were central air conditioners.[79]
- Half the heat pumps were air-source and half were ground-source (affects peak versus off-peak calculations).
- Each heat pump achieved half of its annual electricity savings in the summer.

Our analysis is not significantly affected by these assumptions because the number of central air conditioners was 50 times greater than the number of heat pumps.

Another analytical challenge arose because the New Jersey protocols did not specify how to allocate electricity savings by season for Energy Star homes in the Residential New Construction program. We applied the allocation factors specified under the Comfort Partners Low Income Customers program because that program also focuses on whole-home energy efficiency

[78] In this and other instances, NJ CEP had access to more extensive data but could not provide the data to the project team because of confidentiality concerns. With appropriate confidentiality agreements, such information might be used in a future analysis.

[79] In 2004, there were 16,986 CAC units and 339 heat pumps, saving 15,499 MWh of electricity. If electricity savings are proportional to the number of units, CAC savings are 15,196 MWh and heat pump savings are 303 MWh. Information on the capacity of units installed was not available; a directional bias, such as heat pumps tending to have larger capacity than CAC units, would produce slightly different results.

improvement.[80] For Energy Star homes, employing energy modeling software to generate an estimate of summer and annual electricity savings would be preferable and not burdensome.

New School Construction & Retrofit was another area of interest that lacked data. Some schools could be closed during most of the summer season and thus be a marginal source of summer season electricity savings. However, we were informed that many schools in New Jersey, particularly new schools or those that were renovated during the program, would continue to be used during the summer for a variety of programs. We therefore assessed schools according to the *OTC Workbook* factor for Commercial Comprehensive New Construction Design.

The project team also identified analytical challenges that will need to be addressed with respect to combined heat and power (CHP) projects. At the time of our review, no CHP systems had been installed under the NJ CEP, but several had been approved for funding. When New Jersey officials begin to evaluate potential NO_x emission reductions from CHP, they will need to address the following issues:

- CHP projects usually result in some additional emissions of NO_x, which have to be measured or calculated, to determine the net emission reductions.
- The energy savings are variable, depending on season and the allocation of the energy savings between electricity and process heat.

We recommend that New Jersey officials develop a data collection and analysis protocol to facilitate analysis of the CHP technology.

5.2 Degradation Factor

The Clean Energy Protocols include assumed system lifetimes. In many cases, New Jersey officials have accounted for system degradation by shortening the estimated system lifetimes or adjusting the deemed energy savings. We recommend using an annual degradation factor rather than fixed lifetimes to better reflect degradation in the near term.

An annual degradation factor also helps to account for the fact that some equipment is removed before the end of its useful life. Commercial buildings may be renovated, or new tenants may override the high-efficiency lighting or HVAC controls.

5.3 Renewable Energy

The RE analysis encountered numerous challenges, including limitations on available data and the need to supplement the New Jersey data with additional data sources. In analyzing solar electric generation, the project team supplemented the data provided by NJ CEP with a model developed by NREL to estimate electricity generation from the solar PV systems. Since no metered data were readily available to us for any of the solar generation funded under the CORE

[80] This factor allocates the electricity savings as follows: summer/on-peak 21%; summer/off-peak 22%; winter/on-peak 28%; and winter/off-peak 29%. Because electricity consumption in New Jersey peaks during the summer season, and because the summer season (May−September) takes up 42% of the year, we consider it conservative to allocate 43% of the energy savings to the summer period.

program, the project team employed the PVWATTS Version 2 Tool to meet this need.[81] The PVWATTS calculation was based on typical solar radiation from a location in south-central New Jersey. Other locations were examined as well: the highest resource location in the state showed summer generation as 4% higher; the lowest resource location showed summer generation as 4% lower.

NJ CEP collects data through a sampling process of PV systems that are 10 kW or larger for SREC trading. The program is considering a more active remote-reading approach to encompass a broader range of systems. Comparing the projected summer production from our analysis with the observed summer production from the NJ CEP sampling would be advantageous.

The team also employed the PVWATTS default factors to allow for power to be converted from DC to AC. This tool requires information about the direction of orientation and angle of tilt for the PV system considered. NJ CEP requires applicants to provide this information to receive a rebate, and tracks this information in a database. Because there were 344 systems, the project team grouped systems into categories of orientation and inclination to facilitate use of the PV WATTS tool. System orientation and inclination have a greater impact for year-round than for summer generation.

NJ CEP data were insufficient to provide a reasonable estimate of electricity generation and NO_x emission reductions during the summer ozone season in 2005 from a wind project and two biomass (landfill gas) projects funded by the agency. For the wind project, the location, height, and type of equipment are critical to estimating ozone season generation. Actual records of generation are preferred for making this determination, and were not available to us. The importance of these site-specific protocols will increase as additional wind projects come on line.

Estimating the electric generation from landfill gas projects also requires site-specific data, which were not available to the project team. Actual generation is almost always metered, and those data could be made available in the program records. Landfill gas combustion emits significant direct NO_x emissions, which must be compared to the emissions that are avoided when flaring is eliminated.[82] This comparative analysis could not be performed because the emission rates from the specific combustion systems were not available to the project team. In projecting future emissions from landfill gas, the rate of decline in landfill gas releases from the specific landfills over time need to be forecast.

The data available to the project team on the fuel cell projects funded by the NJ CEP were insufficient to estimate the 2005 generation and to determine whether such projects qualified as RE sources. The second problem has been resolved. NJ CEP has indicated that: "After a program modification in early 2004, only sustainably-fueled (landfill gas) fuel cells are eligible for rebates."[83] Generation records and technology-specific data also will be required to estimate generation and net avoided emissions of fuel cell projects.

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[81] See p. 10 (infra).
[82] We understand that private companies have sought allowances for certain landfill gas projects. How they resolved these analytical issues is unclear.
[83] *New Jersey Clean Energy Programs Report*, submitted to the New Jersey Board of Public Utilities, May 6, 2005, p. 30.

6.0 Lessons Learned

The MARO pilot project provides numerous lessons learned about emissions trading programs that are applicable to other states. These lessons involve issues of regulatory policy as well as methodological approaches.

First, the project underscores the importance of the state regulatory framework that governs NO_x emissions trading. If state regulations limit the allocation of allowances to only fossil fuel-fired generating units, the state and local government agencies will be precluded, for all practical purposes, from obtaining SIP credit for RE or EE purchases or development. In other words, unless the state's NO_x trading regulations provide a pool of allowances to reward RE and EE development or purchases and provide a mechanism for lowering the total cap of allowances, an important market driver and revenue stream for RE and EE will be lost.

State focus on NO_x allocation regulations is particularly timely. EPA's new CAIR requires most states in the ozone transport region to submit to EPA enforceable plans by September 2006 for complying with the CAIR requirements. The new CAIR requirements will replace the state regulations under the NO_x SIP Call for electric generating units and will govern NO_x allowance allocation in 2009 and thereafter for such units.

The pilot project underscored several regulatory options that provide a pool of NO_x allowances to encourage EERE measures. These options include:

- Allocate a percentage of NO_x allowances into a so-called RE and EE set-aside to encourage RE and EE measures.
- Allocate a percentage of NO_x allowance into a so-called attainment/public health reserve.
- Allocate allowances to all sources on an output basis (tons of emissions reduction per MWh) instead of a heat-input basis (used currently in most states and which covers only electric generators that burn fossil fuels).
- Allocate allowances to new sources on an output-basis.[84]

A recent document prepared by the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO) highlights these options.[85]

In addition, lessons learned from RE and EE set-aside regulations under the NO_x SIP Call are helpful in crafting new CAIR rules for NO_x trading. These lessons are highlighted in an EPA draft report titled *State Set-Aside Programs for Energy Efficiency and Renewable Energy*

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[84] This approach was adopted by the National Association of State Regulatory Commissioners in a resolution in the summer of 2004. This approach can encompass energy efficiency if a conversion factor is specified in the regulation.

[85] "Alternative NO_x Allowance Allocation Language for the Clean Air Interstate Rule," August, 2005. See www.4cleanair.org/Bluestein-cairallocation-final.pdf.

Projects Under the NO_x Budget Trading Program: A Review of Programs in Indiana, Maryland, Massachusetts, Missouri, New Jersey, New York, and Ohio.[86]

The pilot project and these two recent reports underscore several important provisions that states should consider including in new CAIR rules that provide allowances to spur EERE. These provisions include:

- Authority for a developer and the state to aggregate small projects in an application for allowance allocation. For example, small solar PV projects alone will not qualify for allowances since such projects result in emission reductions far lower than one ton (the minimum allocation in most states). If project aggregation authority is not provided in the state rules, the RE and EE set-aside will likely be underused.

- Authority for a state energy office that administers incentive programs to apply for allowances relating to state-funded clean energy projects for owners and operators who have not applied on their own behalf. The state energy office could then retire these allowances to obtain SIP credit.

The pilot project highlights various methodological approaches that can facilitate the implementation of state regulations to reward RE and EE. Other states can benefit from employing some or all of the methodologies developed by the NJ CEP (and refined and expanded by the pilot project) to determine the emission reductions achieved by RE and EE measures. New Jersey's clean energy protocols and incentive allowance regulations allow NO_x emission reductions to be estimated with a relatively small investment.[87]

States may want to consider the following specific methodological approaches in their CAIR regulations to facilitate the integration of energy and air quality goals:

- Employ protocols with stipulated electricity savings to assess the benefits of specific EE measures and use the New Jersey clean energy protocols as a starting point. Some variables may need to be adjusted, depending on the specific state and region (e.g., the assumed equivalent full load hours of operation of an air-conditioning unit), but the equations included in the protocols appear to be sound and transferable.

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[86] EPA, Climate Protection Partnerships Division, Office of Atmospheric Programs, Office of Air and Radiation, EPA Document No. 430-R-03-005, September 2005, available at http://www.epa.gov/cleanenergy/pdf/eere_rpt.pdf.

[87] When using a simplified approach, such as that employed by the pilot project, be conservative in assumptions and default values.

States may alternatively follow an approach developed by the Texas Energy Systems Laboratory (in partnership with EPA) that is more detailed and includes more in-depth analysis. This latter approach may result in a greater emission reductions credit but at a much higher cost. This methodology, which identifies county-level emissions impacts of RE/EE measures based on the county in which the measure was implemented, is both possible and necessary in a statewith regions that are not subject to NO_x caps. (*Emissions & Energy Calculator* (eCalc), Energy Systems Laboratory, Texas A&M University. See http://ecalc.tamu.edu/.)

- Employ a stipulated avoided emissions rate (lb/MWh) for RE and EE measures that is based on the generation-weighted average NO_x emissions rate of the relevant region's variable dispatch fossil fuel plants.
    - The CAIR regulations could require that the state update this stipulated allocation rate periodically to reflect changes in the composition of the fuel mix and control technologies. (This approach would significantly reduce the resources required to analyze specific facilities.)
    - In addition, the state's CAIR regulations could, if adequate evidence is presented, grant the state air agency authority to approve a higher allocation rate than the stipulated amount. (This approach allows parties who are responsible for developing large RE or EE projects to devote greater resources and claim higher actual emissions reductions.)

- Include seasonal allocation factors that define assumed electricity savings for specific types of measures in state protocols.

- Seek to fulfill the requirements for Energy Star ratings for residential construction and renovation and employ Energy Star energy modeling for home EE improvements. This approach can ascertain the likely effect of a combination of efficiency measures and will help promote the Energy Star brand.

- Determine electricity savings for specific measures by comparison to a typical new system for that load, and define the reference system in protocols. Determine electricity savings for comprehensive building improvements through energy modeling with an energy code as a reference.

- Examine the state's emission inventory and SIP and identify any assumptions about RE and EE that are already in the inventory. If the state intends to rely on RE/EE measures for SIP credit, it must ensure those measures are surplus to those included in the baseline.

This appendix outlines the methodology used in developing an estimate of the potential NO_x emission reductions from selected categories of the New Jersey Clean Energy Program. Excel workbooks were the primary calculation tool used in this process. The NJ Clean Energy Protocols and NREL's PVWATTS tool provided key inputs.

More detailed information can be obtained from Peter O'Connor, Global Environment & Technology Foundation, at pete.oconnor@getf.org.

1. Assessment of 2005 Electricity Savings and Emission Reductions from Selected Categories of the NJ Clean Energy Program

	2005 Electricity Savings (MWh)								
	2002 Projects		2003 Projects		2004 Projects	Summer Fraction		2005 Summer	2005 Summer
	Original	Discounted	Original	Discounted	Original	On-Peak	Off-Peak	MWh	NOx (tons)
Residential HVAC	15,703	11,345	14,621	12,428	15,499				
CAC	15,373	11,107	14,299	12,154	15,196	64.9%	35.1%	38,457	28.84
Heat Pumps	330	238	322	273	303	28.0%	22.0%	407	0.31
Residential New Construction	3,262	2,357	4,773	4,057	4,551	21.0%	22.0%	4,715	3.54
Room Air Conditioning	0	0	1,432	1,217	1,377	65.1%	34.9%	2,594	1.95
Lighting	0	0	61,630	52,386	95,206	21.0%	22.0%	63,464	47.60
Clothes Washers	0	0	0	0	740	24.5%	12.8%	276	0.21
Comfort Partners	5,196	3,754	5,774	4,908	6,995	21.0%	22.0%	6,733	5.05
C&I New Construction	144,635	104,499	11,760	9,996	31,538	24.0%	19.0%	62,794	47.10
C&I Retrofit	0	0	179,679	152,727	163,631	24.0%	19.0%	136,034	102.03
New School Construction & Retrofit	0	0	5,908	5,022	8,975	24.0%	19.0%	6,019	4.51
EE Subtotal	168,796	**121,955**	285,577	**242,740**	**328,512**			**321,493**	**241.12**
PV	0	0	0	0	3,003			1,505	1.13
Total	168,796	**121,955**	285,577	**242,740**	**331,515**			**322,999**	**242.25**

EE Degradation Factor	15%
RE Degradation Factor	5%

EE Summer Fraction	46.3777%
PV Summer Fraction	50.1321%

This table illustrates the overall electricity savings for 2005 resulting from selected categories of the NJCEP implemented from 2002 through 2004. The table also includes the summer electricity savings and summer NO_x emission reductions resulting from these project categories. The base figures are the annual electricity savings resulting from each category of measure, as identified in the quarterly reports of the New Jersey Board of Public Utilities on the Clean Energy Program. The annual electricity savings from the energy efficiency projects of 2002 are multiplied by the square of (1-degradation factor), or 0.7225. The savings from the 2003 projects are multiplied by (1-degradation factor), or 0.85. The savings from the 2004 projects are fully credited for the summer of 2005. The total annual savings (the sum of the 2004 value and the discounted 2002 and 2003 values) are then multiplied by the sum of the summer season allocation factors. For example, clothes washers are assumed to achieve 24.5%[1] of their annual energy savings in the summer peak period and 12.8% of their annual energy savings in the summer off-peak period, for a total of 37.3% of their annual savings in the summer.

For PV systems, the discount factors are not applied (all systems are assumed to have been installed in 2004), and the allocation factor is based on the input of specific system characteristics into NREL's PVWATTS tool. This tool calculates the monthly output of systems based on size, location, and orientation. A flat-roof PV system will generate 56.1% of its annual electricity during the May to September period, whereas a south-facing system at 45° tilt will generate only 45.5% of its annual electricity in that time period (but about 15% more than the flat-roof system over the course of the year).

Summer electricity savings were derived on a measure-specific basis, using the allocation factors from the NJ Clean Energy Protocols or using appropriate surrogates (such as the OTC Emission Reduction Workbook or PVWATTS). The combination of energy efficiency measures implemented in 2002 to 2004 have a weighted seasonal allocation factor of 46.38%. This factor is used for energy efficiency measures implemented in future years, as the exact combination of measures to be implemented is not known at this time. The PV systems installed have a weighted seasonal allocation factor of 50.13%, with generation of 1505.455 MWh per summer (May-September) and 3002.979 MWh per year.

NO_x emission reductions for 2005 are generated using the allowance allocation factor of 1.5 lbs/MWh. See Appendix 4 for our analysis establishing that 2005 emission reductions will likely exceed this value.

2. Projection of Future NO_x Emission Reductions and Sensitivity Analysis

Step 1: Defining the Scenarios

Base Case	EE	PV
Program Growth	20%	40%
Degradation Factor	15%	5%
Grid Improvement	5%	5%

Low Growth	EE	RE
Program Growth	10%	30%
Degradation Factor	15%	5%
Grid Improvement	5%	5%

Continued Savings	EE	RE
Program Growth	20%	40%
Degradation Factor	5%	2.5%
Grid Improvement	5%	5%

Clean Grid	EE	PV
Program Growth	20%	40%
Degradation Factor	15%	5%
Grid Improvement	10%	10%

Full RE	EE	RE
Program Growth	20%	41%
Degradation Factor	15%	5%
Grid Improvement	5%	5%

These tables establish the variables for the analysis of future NO_x emission reductions. The four scenarios other than the "Base Case" serve to illustrate the sensitivity of the analysis to the various assumptions. "Grid Improvement" refers to decreases in the avoided NO_x rate after 2008; rates through 2008 were identified by NJ DEP.

[1] We consider our results to be accurate to no more than two significant figures. However, in order to reduce rounding errors, we carry forward up to seven digits in our calculations, only rounding off the final result.

Step 2: Identifying Annual Electricity Savings and Generation

EE MWh	**Year of Savings**									
Year of Project	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2002	168,796	143,477	121,955	103,662	88,113	74,896	63,661	54,112	45,995	39,096
2003		285,577	242,740	206,329	175,380	149,073	126,712	107,705	91,549	77,817
2004			328,512	279,235	237,350	201,747	171,485	145,763	123,898	105,313
2005				394,214	335,082	284,820	242,097	205,782	174,915	148,678
2006					473,057	402,099	341,784	290,516	246,939	209,898
2007						567,669	482,518	410,141	348,620	296,327
2008							681,202	579,022	492,169	418,343
2009								817,443	694,827	590,603
2010									980,932	833,792
2011										1,177,118
	168,796	*429,054*	*693,208*	*983,441*	*1,308,982*	*1,680,303*	*2,109,460*	*2,610,484*	*3,199,843*	*3,896,985*
PV MWh										
Year of Project	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2002	0	0	0	0	0	0	0	0	0	0
2003		0	0	0	0	0	0	0	0	0
2004			3,003	2,853	2,710	2,575	2,446	2,324	2,207	2,097
2005				4,204	3,994	3,794	3,605	3,424	3,253	3,090
2006					5,886	5,592	5,312	5,046	4,794	4,554
2007						8,240	7,828	7,437	7,065	6,712
2008							11,536	10,960	10,412	9,891
2009								16,151	15,343	14,576
2010									22,611	21,481
2011										31,656
	0	*0*	*3,003*	*7,057*	*12,590*	*20,201*	*30,727*	*45,342*	*65,686*	*94,057*

These tables illustrate the annual electricity savings or generation achieved by the energy efficiency measures and photovoltaic systems. The shaded boxes illustrate the most recent measures implemented. The unshaded boxes represent continuing electricity savings from measures previously implemented, and reflect the degradation factor (in the base case, 15% for energy efficiency, 5% for photovoltaic systems).

The savings from the most recent projects increase each year according to the growth factor for each scenario. For example, New Jersey expects that the budget for energy efficiency programs will grow by about 10% each year and that the cost-effectiveness of the program will grow by about 10%. Therefore, these tables include energy efficiency program growth of about 20% per year in the base case. The 2006 electricity savings from the 2005 energy efficiency projects are 20% larger than the 2005 savings from 2004 energy efficiency projects.

Steps 3 and 4: Identifying Summer Electricity Savings or Generation and Identifying Summer NO_x Emission Reductions

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EE Summer Fraction	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767
PV Summer Fraction	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321
Summer Energy Savings (MWh)	78,284	198,985	322,999	459,635	613,387	789,413	993,723	1,233,412	1,516,942	1,854,483
Projected NO_x rate (lb/MWh)	1.85	1.85	1.65	1.65	1.24	0.97	0.92	0.88	0.83	0.79
Credited NO_x rate	1.50	1.50	1.50	1.50	1.24	0.97	0.92	0.88	0.83	0.79
Credited NO_x Emissions (tons)	59	149	242	345	380	383	458	540	631	733

These tables translate the identified annual electricity savings and generation into summer season savings and generation, as well as NO_x emission reductions. First, the summer season allocation factors are applied. For energy efficiency, we multiply annual energy savings by the summer fraction of 2005 annual electricity savings (from measures implemented in 2002 to 2004). For photovoltaic systems, we multiply annual generation by the summer fraction identified by the PVWATTS tool for the systems in the CORE database (this accounts for orientation and inclination).

Then, the identified summer energy savings and generation are multiplied by the credited NO_x emissions rate. The rate applied is the lesser of 1.5 lbs/MWh or the projected NO_x emissions rate. The projected NO_x emissions rate for 2003-2008 is based on data provided by NJ DEP; for 2009-2012, it is the previous year's rate decreased by the "grid improvement" factor. For the base case, this factor is 5% per year. *New Jersey will need to conduct an analysis of the likely impact of CAIR and other regulations to more accurately project the relevant NO_x emission factors.*

PVWatts Methodology

Bin	Orientation			Tilt			Summer Generation			Annual Generation		Summer
	Min	Max	Assumed	Min	Max	Assumed	kWh/kW	kW	kWh	kWh/kW	kWh	Ratio
1	Any	Any	**0**	0	9	**0**	605	361.38	218,635	1079	389,929	56%
2	80	120	**100**	10	19	**15**	598	29.465	17,620	1091	32,146	55%
3	121	160	**140**	10	19	**15**	616	35.748	22,021	1176	42,040	52%
4	161	200	**180**	10	19	**15**	626	90.218	56,476	1209	109,074	52%
5	201	240	**220**	10	19	**15**	618	42.549	26,295	1172	49,867	53%
6	241	280	**260**	10	19	**15**	599	11.326	6,784	1084	12,277	55%
7	80	120	**100**	20	29	**25**	578	54.572	31,543	1071	58,447	54%
8	121	160	**140**	20	29	**25**	606	176.498	106,958	1203	212,327	50%
9	161	200	**180**	20	29	**25**	620	309.574	191,936	1253	387,896	49%
10	201	240	**220**	20	29	**25**	611	133.653	81,662	1197	159,983	51%
11	241	280	**260**	20	29	**25**	582	40.28	23,443	1061	42,737	55%
12	80	120	**100**	30	39	**35**	551	18.562	10,228	1035	19,212	53%
13	121	160	**140**	30	39	**35**	587	113.235	66,469	1201	135,995	49%
14	161	200	**180**	30	39	**35**	596	698.99	416,598	1263	882,824	47%
15	201	240	**220**	30	39	**35**	588	125.419	73,746	1192	149,499	49%
16	241	280	**260**	30	39	**35**	555	63.552	35,271	1023	65,014	54%
17	80	120	**100**	40	49	**45**	516	9.135	4,714	983	8,980	52%
18	121	160	**140**	40	49	**45**	554	52.39	29,024	1173	61,453	47%
19	161	200	**180**	40	49	**45**	563	82.963	46,708	1241	102,957	45%
20	201	240	**220**	40	49	**45**	556	56.265	31,283	1162	65,380	48%
21	241	280	**260**	40	49	**45**	522	15.404	8,041	970	14,942	54%
Total								2521.178	1,505,455		3,002,979	50.1321%

This table illustrates the process used to identify the generation from the PV systems in the state's CORE database. There were a total of 344 systems with a total capacity of 2,521.178 kW (see Appendix 2). The project team considered that it would be unnecessarily burdensome to evaluate every single system through PVWATTS, and determined that such a detailed evaluation would provide only limited value (with any change being relegated to non-significant digits in the final analysis). Therefore, the PV projects were grouped according to orientation and inclination. The project team evaluated a model 1-kW system for each group in PVWATTS to identify the annual and summer (May to September) kWh/kW ratio. The summer ratio was multiplied by the capacity within that "bin" to give the summer generation for that bin. The total summer generation was found to be 3,002.979 MWh per year for the projects in the CORE database.

The project team evaluated three different locations in New Jersey using PVWATTS. The two outlying locations had 4% higher and 4% lower summer generation than the mid-range location. We therefore modeled all systems as if located at the mid-range location. The initial assumption that all PV systems were flat-roof would have overestimated the summer generation by about 1.3% (but underestimated annual generation). Since that 1.3% error is only about 30 pounds of NO_x for 2005, even this rough breakdown by orientation and inclination is unnecessary. Similarly, any error caused by the assumption of a single representative location is also negligible.

Scenario: Full Renewable Energy Goal Met

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EE Summer Fraction	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767	0.4637767
PV Summer Fraction	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321	0.501321
Other RE Summer Fraction	0.434091	0.434091	0.434091	0.434091	0.434091	0.434091	0.434091	0.434091	0.434091	0.434091
Summer Energy Savings (MWh)	78,284	198,985	322,999	477,500	655,576	865,085	1,115,850	1,420,342	1,794,610	2,259,530
Projected NO_x rate (lb/MWh)	1.85	1.85	1.65	1.65	1.24	0.97	0.92	0.88	0.83	0.79
Credited NO_x rate	1.50	1.50	1.50	1.50	1.24	0.97	0.92	0.88	0.83	0.79
Credited NO_x Emissions (tons)	59	149	242	358	406	420	514	622	746	893
EE	59	149	241	342	376	378	451	530	617	714
Wind/Biomass	0	0	0	13	26	37	56	82	115	159
PV	0	0	1	3	4	5	7	10	14	19

	2005	2006	2007	2008	2009	2010	2011	2012
PV installed in previous year (kW)	2,521	3,555	5,014	7,071	9,972	14,063	19,833	27,970
Cumulative PV at beginning of year (kW)	2,521	6,076	11,090	18,161	28,133	42,197	62,030	90,000
Effective PV at beginning of year (kW)	2,521	5,950	10,667	17,204	26,316	39,064	56,944	82,067
Other RE installed in previous year (kW)		8,535	12,036	16,975	23,939	33,760	47,611	67,144
Cumulative other RE at beginning of year (kW)		8,535	20,571	37,546	61,484	95,244	142,855	210,000
Effective other RE at beginning of year (kW)		8,535	20,144	36,112	58,245	89,093	132,249	192,781
Wind MWh		13,084	30,881	55,359	89,289	136,579	202,738	295,533
Biomass MWh		28,037	66,174	118,627	191,334	292,669	434,438	633,285
Summer MWh		17,850	42,131	75,526	121,816	186,333	276,592	403,192

The "Full RE" scenario has several differences from other analyses. It assumes that New Jersey meets its goals of 90 MW of PV and 210 MW of other renewable energy by the end of 2011. The "program growth" rate for renewable energy in this case is actually 41%, selected to allow the cumulative installed capacity of PV to grow from 2.521 MW through 2004 (CORE program only) to 90 MW by the end of 2011. New Jersey would need to install 8.535 MW of non-PV renewable energy in 2005 to achieve a cumulative 210 MW installed by the end of 2011 with a 41% growth rate. For purposes of this analysis, we assume that installation and growth rate to occur.

Assumptions for "Full RE" case

Fraction of Wind	50%
Fraction of Biomass	50%
Wind Capacity Factor	35%
Wind Summer Fraction	40%
Biomass Capacity Factor	75%
Biomass Summer Fraction	45%
Overall Summer Fraction	43.41%

"Program growth" applies to the capacity of renewable energy systems as well as their annual generation, assuming that new systems will have the same capacity factor as current systems. "Effective PV at beginning of year" is the previous year's effective capacity times the degradation factor plus the most recent capacity additions. The same methodology is used for other renewable energy. Assumptions about the installed non-PV renewable energy are indicated in the table above. These give an effective summer allocation factor. Emission reductions for EE, PV, and other RE are calculated separately by multiplying together the annual generation, the summer allocation factor, and the credited NO_x rate. Biomass electricity, which in New Jersey typically consists of landfill gas energy projects, was assumed to have no net NO_x emissions. Direct emissions were assumed to be equal to the avoided flaring emissions. This is not always the case; however, if NJCEP wishes to achieve the maximum possible emission reductions, it will focus its efforts on landfill gas systems that produce fewer NO_x emissions, such as microturbines or fuel cells.

Appendix 2
NJCEP CORE Program
PV Systems Installed 2003-2004

City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Barnegat Light	08006	0.925	Sharp	185	185	5	Sharp	Sunvista 3500	0.93	215	11	Complete
Barnegat Light	08006	0.925	Sharp	185	185	5	Sharp	Sunvista 3500	0.93	125	25	Complete
Barnegat Light	08006	0.925	Sharp	185	185	5	Sharp	Sunvista 3500	0.93	305	25	Complete
Budd Lake	07828	1.336	Sharp	ND-167U1	167	8	SMA	SunnyBoy1100U	0.93	280	15	Complete
Montclair	07042	1.43	Evergreen Solar	EC-110	110	13	SMA America	Sunny Boy 1800U	0.944	162	40	Complete
Rumson	07760	1.665	Sharp	NT-S5EIU	185	9	SMA America	SMA-2500	0.94	170	30	Complete
Pennington	08534	1.8	BP Solar	BP3150	150	12	Sharp	JH-3500U	0.94	160	35	Complete
Blairstown	07825	1.84	Evergreen Solar	EC-115	115	16	SMA-America	SB2500U	0.944	170	35	Check Request
Sea Bright	07760	1.92	BP Solar	BP3160	160	12	SMA	1800U	0.94	270	30	Complete
Atlantic City	08401	2.1	BP Solar	BP3150	150	14	SMA America	Sunny Boy 1800U	0.94	157.5	30	Complete
Atlantic City	08401	2.1	BP Solar	BP3150	150	14	SMA America	Sunny Boy 1800U	0.94	157.5	30	Complete
Atlantic City	08401	2.1	BP Solar	BP3150	150	14	SMA America	Sunny Boy 1800U	0.94	157.5	30	Complete
Atlantic City	08401	2.1	BP Solar	BP-3150	150	14	SMA America	Sunny Boy 1800U	0.935	157.5	30	Complete
Atlantic City	08401	2.1	BP Solar	BP3150	150	14	SMA America	Sunny Boy 1800U	0.94	157.5	30	Complete
Atlantic City	08401	2.1	BP Solar	BP3150	150	14	SMA America	Sunny Boy 1800U	0.94	157.5	30	Complete
Neptune	07753	2.16	Astropower	AP 120	120	18	SMA America	SWR 2500U	0.94	270	30	Complete
Brielle	08730	2.24	BP Solar	BP 3160	160	14	SMA	1800U	0.93	225	8	Complete
Farmingdale	07727	2.24	BP Solar	BP3160B	160	14	Fronius	IG3000	0.94	180	30	Complete
Bradley Beach	07720	2.31		GE PV 165	165	14	SMA	Sunny Boy2500	0.94	90	45	Complete
Blairstown	07825	2.31	Evergreen Solar	EC-110	110	21	SMA America	SB2500U	0.944	140	40	Complete
Bordentown	08505	2.338	Kyocera	KC167G	167	14	SMA	SunnyBoy2500U	0.94	210	35	Complete
Southampton	08088	2.4	Astropower	AP100	100	24	SMA	2500U	0.94	175	25	Complete
Newton	07860	2.4	Astropower	AP 110	120	20	Trace	4024 SW	0.95	190	40	Complete
Stockton	08559	2.475		GE165	165	15	SMA	SB2500	0.94	180	35	Complete
Chatham	07928	2.56	BP Solar	BP3160	160	16	Outback	GVFX3648	0.9	225	35	Complete
Trenton		2.625	Sharp	Sharp 175-NT-R5eiu	175	15	Sunvista Sharp	JH-3500-U	0.924	160	30	Complete
Trenton		2.625	Sharp	Sharp 175-NT-R5eiu	175	15	Sunvista Sharp	JH-3500-U	0.924	160	30	Complete
Newark	07107	2.64	Astropower	AP120	120	22	SMA America	SMA2500W	0.94	145	10	Complete
High Bar Harbor	08008	2.64		165	165	16	Fronius	IG3000	0.94	150	27	Complete
Millstone	08844	2.64	Evergreen Solar	EC-110	110	24	Sunny Boy	SWR 2500U	0.941	180	20	Complete
Hewitt	07421	2.64	Evergreen Solar	EC-110	110	24	SMA America	SB2500U	0.944	172	40	Complete
Peneala Park	08008	2.7	BP Solar	SX150S	150	18	SMA America	Sunny Boy 2500U	0.941	135	22	Complete
Wanague	07465	2.75	Evergreen Solar	EC-110	110	25	SMA America	Sunny Boy 2500U	0.941	120	10	Complete
West Orange	07052	2.75	Evergreen Solar	EC-110	110	24	SMA America	Sunny Boy 2500U	0.944	122	40	Complete
Flemington	08822	2.76	Evergreen Solar	EC115	115	24	SMA	SB2500U	0.94	195	20	Complete
High Bridge	08829	2.76	Evergreen Solar	EC-115	115	24	SMA	SB2500U	0.94	210	42	Complete
Woodcliff Lake	07677	2.88	BP Solar	BP3160	160	18	SMA	1800U	0.93	135	25	Complete

Appendix 2
NJCEP CORE Program
PV Systems Installed 2003-2004

City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Oakland	07436	2.88	Astropower	AP120	120	24	SMA America	2500U	0.941	180	20	Complete
Vineland	08360	2.88	Astropower	AP120	120	24	Sunny Boy	SMA2500W	0.941	200	25	Complete
Edgewater	07020	2.88	BP Solar	BP3160	160	18	SMA	2500U	0.93	220	25	Complete
Hillsborough	08844	2.88	Astropower	AP 120	120	24	Trace	SW 5548 W/GTI	0.96	180	35	Complete
Pennsville	08070	2.88	Astropower	AP120	120	24	SMA America	SMA 2500	0.941	180	30	Inspected
Cape May	08210	2.88	Astropower	AP120	120	24	SMA America	SWR2500U	0.941	250	30	Complete
Brigantine	08203	2.96	Sharp	NT-185U	185	16	SMA	2500U	0.94	215	30	Complete
Atlantic City	08401	2.96	Sharp	NT-185U1	185	16	SMA	SWR-2500U	0.94	150	45	Complete
Atlantic City	08401	2.96	Sharp	NT-185U1	185	16	SMA	SWR-2500U	0.94	150	45	Complete
Atlantic City	08401	2.96	Sharp	NT-185U1	185	16	SMA	SWR-2500U	0.94	150	45	Complete
Barnegat Light	08006	2.97	Sharp	165	165	18	Sunny Boy	SMA2500W	0.941	215	25	Complete
Manville	08835	3	Shell	SP150PC	150	20	SMA America	2500U	0.944	100	18	Complete
Avon by the Sea	07717	3	BP Solar	BP3150	150	20	SMA	Sunny Boy 2500U	0.94	200	15	Complete
Barnegat Light	08006	3	BP Solar	BP SX 150	150	20	Sunny Boy	SMA2500W	0.941	220	16	Inspected
Southampton	08088	3	BP Solar	BP3150	150	20	Sunny Boy	SMA 2500U	0.93	145	25	Complete
Howell	07731	3	BP Solar	BP150	150	20	SMA	SunnyBoy2500U	0.94	148	22	Complete
Barnegat Light	08006	3	BP Solar	BP150	150	20	Sunny Boy	SMA 2500	0.941	130	25	Complete
Beach Haven Terr.	08008	3	BP Solar	SMA 2500	150	20	Sunny Boy	SMA 2500	0.93	215	28	Complete
High Bar Harbor	08008	3	BP Solar	150	150	20	Sunny Boy	2500	0.93	230	23	Complete
High Bar Harbor	08008	3	BP Solar	BP5X	150	20	Sunny Boy	SMA 2500	0.941	230	23	Complete
Avon by the Sea	07717	3	BP Solar	BP3150	150	20	SMA	Sunny Boy 2500U	0.94	110	35	Complete
Roseland	07068	3	BP Solar	BP3150	150	20	SMA	SB 2500U	0.941	140	41	Complete
Surf City	08008	3	BP Solar	BP5x150S	150	20	Sunny Boy	SMA 2500	0.94	223	43	Complete
Lambertville	08530	3.09	Sharp/BP	NEQ5E2U/BP3150	165	6	Trace	SW 4048	0.95	250	23	Complete
North Beach Haven	08008	3.15		150	150	21	Fronius	IG3000	0.94	216	22	Complete
Oceanport	07757	3.162	Astropower	AP120	120	28	SMA	SB1800	0.941	190	25	Complete
Morristown	07960	3.2	BP Solar	3160	160	20	SMA America	2500U	0.93	130	20	Check Request
Red Bank	07701	3.2	BP Solar	BP3160	160	20	SMA	SB2500U	0.93	175	23	Complete
Edison	08837	3.2	BP Solar	BP3160	160	20	SMA America	SB 2500U	0.941	210	22	Complete
Bradley Beach	07720	3.3	Evergreen Solar	EC-110	110	30	SMA	SB1800U	0.944	200	31	Complete
Manahawkin	08050	3.33	Sharp	NE-Q5E2U	185	18	Sharp Sunvista	JH3500-U	0.93	150	22.5	Complete
Marmora	08223	3.36	BP Solar	BP3160	160	21	Fronius	IG3000	0.94	230	11	Complete
Hardwick	07825	3.45	Evergreen Solar	EC-115	115	30	SMA	SB1800U	0.94	200	32	Complete

Appendix 2
NJCEP CORE Program
PV Systems Installed 2003-2004

City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
West Orange	07052	3.45	Evergreen Solar	EC-115	115	30	SMA	SB1800U	0.944	200	45	Complete
Lakewood	08701	3.6	BP Solar	BP 3150	150	24	SMA	SWR 1800 U SBD	0.94	235	20	Complete
Egg Harbor Township	08234	3.675	Sharp	NT-175U1	175	21	Sharp	Sunvista JH-3500U	0.94	175	43	Complete
Hardwick	07825	3.68	Evergreen Solar	EC-115	115	32	SMA	SB1800U	0.944	150	35	Complete
Newton	07860	3.68	Evergreen Solar	EC-115	115	32	SMA	SB1800U	0.944	160	30	Complete
Asbury	08802	3.68	Evergreen Solar	EC-115	115	32	SMA-America	SB1800U	0.944	172	38	Complete
North Beach Long Island	07901	3.7	Sharp	NT- 185U1	185	20	Sharp	JH-3500U	0.94	135	25	Complete
Hamilton	08610	3.7	Sharp	NT-185U1	185	20	Sharp	JH3500U	0.94	210	20	Complete
Hope	07844	3.795	Evergreen Solar	EC-115	115	33	SMA	SB1800U	0.944	160	32	Complete
Marlboro	07751	3.84	BP Solar	BP-3160	160	24	SMA	SB1800U	0.93	102	15	Complete
Egg Harbor City	08215	3.84	Astropower	AP-120	120	32	SMA	1800U	0.94	145	25	Complete
Brick	08723	3.84	BP Solar	BP3160	160	24	SMA	Sunny Boy 1800	0.941	130	22	Complete
Pennington	08534	3.885	Sharp	NT-S5EIU	185	21	Sharp	JH-3500U	0.93	90	16	Complete
Atlantic City	08401	3.885	Sharp	NT-185U1	185	21	Sharp	SunVista 3500	0.93	150	18	Complete
Atlantic City	08401	3.885	Sharp	NT-185U1	185	21	Sharp	SunVista 3500	0.93	150	18	Inspected
Hasbrouck Heights	07604	3.885	Sharp	NT-5E1U	185	21	Sharp	JH3500U	0.924	180	15	Complete
Allentown	08501	3.885	Sharp	NT-S5E1U	185	21	Sharp	JH-3500	0.93	170	35	Complete
Palermo	08223	3.885	Sharp	NT-185-U1	185	21	Sharp	JH 3500 U	0.924	240	30	Complete
Villas	08251	3.885	Sharp	NT-185U	185	21	Sharp	Sunvista JH3500U	0.92	225	45	Check Request
Clifton	07004	3.9	Sharp	ND-NOECU	140	28	Sharp	Sunvista JH3500u	0.92	180	30	Check Request
Titusville	08560	3.91	Evergreen Solar	EC-115	115	34	SMA	SB1800U	0.994	162	30	Complete
Cherry Hill	08003	3.936	Sharp	NT-123U1	123	32	SMA	SWR1800U	0.94	270	30	Complete
Bridgeton	08302	3.95	Sharp	10-185w	185	22	SMA	SWR1800U	0.93	160	17	Complete
Mt. Ephraim	08059	3.96	Sharp	165	165	24	SMA	2500U	0.935	170	30	Complete
Mickleton	08056	3.96	Astropower	AP 120	120	33	SMA	Sunnyboy 1800U	0.935	180	30	Complete
Morristown	07960	3.96	Evergreen Solar	EC-110	110	36	SMA America	1800U	0.941	180	30	Complete
Morristown	07960	3.96	Evergreen Solar	EC-110	110	36	SMA America	1800U	0.941	180	30	Complete
Morristown	07960	3.96	Evergreen Solar	EC-110	110	36	SMA America	1800U	0.941	180	30	Complete
Ringoes	08551	4	Sharp	ND167U1	167	24	Sharp	JH 3500U	0.924	170	28	Complete
Short Hills	07078	4	BP Solar	3160	160	25	SMA	SB2500	0.94	220	30	Complete
Lambertville	08530	4.008	Sharp	ND 16701	167	24	Sharp	JH 3500U	0.93	155	17	Complete
Titusville	08560	4.008	Sharp	ND-167U1	167	24	Sharp	JH-3500U	0.93	140	22	Complete
SeaBright	07760	4.008	BP Solar	3160B	167	24	SMA	1800U	0.94	270	38	Complete
Howell	07731	4.05	BP Solar	BP3150	150	27	SMA	SB 2500	0.94	130	22	Complete
Stone Harbor	08247	4.08	Astropower	AP-120	120	36	Sunny Boy	1800U	0.942	135	30	Complete
Crosswicks	08515	4.2	Powerlight	Powerguard	175	24	SMA America	SWR 1800	0.94	220	0	Complete

Appendix 2
NJCEP CORE Program
PV Systems Installed 2003-2004

City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Atco	08004	4.2	RWESchott	ASE-300	300	14	SMA	SunnyBoy2500U	0.96	180	25	Check Request
Hewitt	07421	4.2	RWESchott	ASM-300/D6F150	300	14	SMA	2500U	0.91	220	26	Complete
Basking Ridge	07920	4.2	BP Solar	3150	150	28	SMA America	SWR 1800	0.94	165	30	Complete
Tuckerton	08087	4.2	BP Solar	BP2150	150	28	SMA America	Sunny boy 1800	0.943	220	45	Inspected
Williamstown	08094	4.32	Astropower	AP120	120	36	SMA	SMA 2500 &SMA 1300	0.941	190	25	Complete
Egg Harbor	08234	4.32	Astropower	AP120	120	36	Sharp	JH3500U	0.941	238	35	Complete
Sewell	08080	4.32	Astropower	AP120	120	36	SMA America	SMA 1800 &SMA 2500	0.941	270	30	Complete
Port Murray	07865	4.4	Evergreen Solar	EC-110	110	40	SMA America	Sunny Boy 2500U	0.944	170	35	Complete
Cherry Hill	08003	4.4	Sharp	185	185	24	Trace Xantrex	SW5548 w/Gti	0.96	170	37	Complete
Hillsborough	08844	4.44	Sharp	NT S5E1U	185	24	Sharp	1800U	0.93	200	30	Complete
Titusville	08560	4.44	Sharp	NT-185U1	185	24	Trace Engineering	SW 5548 w/ GTI	0.96	191	45	Complete
Andover	07821	4.45	Sharp	Isofoton 165w	165	27	Fronius	IG2000	0.93	195	45	Complete
Villas	08251	4.46	Astropower	GEPV165	165	27	SMA	SMA2500U	0.94	225	30	Complete
West Orange	07052	4.48	BP Solar	BP 3160B	160	28	SMA	Sunny Boy 2500U	0.944	135	20	Complete
East Brunswick	08816	4.48	BP Solar	BP 3160	160	28	SMA	SWR-1800D	0.94	180	25	Complete
Holmdel	07733	4.48	BP Solar	3160	160	28	SMA	2500U	0.93	210	30	Check Request
Port Murray	07865	4.485	Evergreen Solar	EC-115	115	39	SMA	SB1800U	0.944	200	30	Complete
East Brunswick	08816	4.495	Matrix Solar/Photowatt	PW1650-175	155	29	SMA	SWR-2500-SBD	0.941	237	20	Complete
Howell	07731	4.5	BP Solar	BP3150	150	30	SMA	SunnyBoy2500	0.94	210	22	Complete
Marlboro	07746	4.62	Evergreen Solar	EC-110	110	42	SMA America	Sunny Boy 2500U	0.941	215	25	Complete
Maplewood	07040	4.625	Sharp	NT-185U1	185	25	SMA	SWR1800U	0.941	120	35	Complete
Hillsborough	08844	4.671		GE 173	173	27	SMA	SB2500U	0.94	174	20	Complete
Blairstown	07825	4.7	Evergreen Solar	EC-115	115	41	SMA	SB2500U	0.94	135	35	Complete
Roseland	07068	4.8	BP Solar	BP3160	160	30	SMA	Sunny Boy 1800/2500	0.941	160	22	Check Request
Pennington	08534	4.8	Astropower	AP 120	120	40	Trace Xantrex	SW 5548	0.96	130	25	Complete
Marlboro	07746	4.8	BP Solar	BP3160	160	30	SMA	SunnyBoy2500	0.94	180	22	Complete
North Haledon	07508	4.8	BP Solar	SX120	120	39	SMA America	SWR1800, SWR 2500	0.94	180	25	Complete
S.Toms River	08753	4.8	BP Solar	BP SX 160	160	30	SMA	Sunny Boy 1800(1) 2500(1)	0.94	240	25	Complete
Lumberton	08048	4.8	Astropower	AP120	120	40	SMA	2500U	0.94	80	38	Complete
Farmingdale	07727	4.8	BP Solar	BP3150	150	32	SMA	SB2500	0.94	250	28	Complete

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Long Branch	07740	4.8	BP Solar	BP3160B	160	30	SMA	SMA2500	0.94	270	20	Complete
Martinsville	08836	4.8	BP Solar	3160	160	30	SMA	SunnyBoy2500U	0.94	160	35	Complete
Livingston	07039	4.8	Astropower	AP120	120	40	Trace Xantrex	SW5548 w/Gti	0.96	140	30	Complete
Highstown	08520	4.8	BP Solar	3160	160	30	SMA	1800U	0.93	180	35	Complete
Avon By The Sea	07717	4.8	BP Solar	BP3160	160	30	SMA	SB2500U	0.94	180	30	Complete
Hampton	08827	4.8	Astropower	AP-120	120	40	Trace Xantrex	SW5548 w/Gti	0.96	180	35	Complete
High Bridge	08829	4.83	Evergreen Solar	EC-115	115	42	SMA	2500U	0.944	230	30	Complete
East Brunswick	08816	4.95	Matrix Solar/Photowatt	PW1650-165	165	30	SMA America	SWR2500U	0.941	165	20	Complete
Lincoln Park	07035	4.95		GEPV165	165	30	SMA	SWR2500U	0.94	130	40	Complete
Edison	08820	4.96	BP Solar	BP3160B	160	31	Fronius	3000	0.94	220	23	Complete
Turnersville	08012	4.99	Sharp	NT185U1	185	27	Sharp	JH 3500U	0.93	180	30	Complete
Bayville	08721	5.01	Kyocera	KC167G	167	30	SMA	Sunny Boy 1800U;2500U	0.94	176	30	Complete
Rahway	07065	5.01		I165	165	24	Sharp	JH3500HPVP1800	0.924	225	35	Complete
Freehold	07728	5.1	BP Solar	BP3150	150	34	SMA	SB1800	0.94	140	35	Complete
Northfield	08225	5.12	BP Solar	3160	160	32	SMA	SB2500U	0.941	220	30	Complete
Seaside Park	08752	5.177	Kyocera	KC 167G	167	36	SMA	Sunny Boy 2500U	0.94	120	30	Complete
Hillsborough	08844	5.28	BP Solar	BP3160	160	33	SMA America	SWR 2500 & SWR 1800	0.96		0	Complete
North Beach Haven	08008	5.28		165	165	32	Fronius	IG3000	0.94	215	14	Complete
Newton	07860	5.28	Evergreen Solar	EC-110	110	48	SMA America	SB2500U	0.944	215	22	Complete
Cinnaminson	08077-4513	5.344	Kyocera	Kyocera	167	32	SMA	SunnyBoy2500U	0.94	170	35	Complete
Wyckoff	07481	5.365	Sharp	NT-S5E1U	185	29	Sharp/SMA	Sun Vista JH3500U/Sunny Boy 2500U	0.93	140	25	Complete
Bradley Beach	07720	5.4	BP Solar	SX150	150	36	SMA	2500 U	0.941	110	20	Complete
Shrewsbury	07702	5.4	BP Solar	BP SX 150	150	36	SMA America	2500U	0.94	180	20	Complete
Jackson	08527	5.4	BP Solar	BP3150	150	36	SMA	SB2500	0.94	160	30	Complete
West Long Branch	07764	5.4	BP Solar	SX150S	150	36	Sunny Boy	SMA 2500	0.94	157	30	Complete
Cherry Hill	08003	5.4	BP Solar	167W	150	36	Fronius	IG3000	0.93	180	30	Complete
Hoboken	07030	5.4	RWESchott	ASE 300-DGF	300	18	SMA	2500U	0.94	180	37	Complete
Delran	08075-2035	5.4	BP Solar	SX 150B	150	36	SMA America	Sunny Boy SWR 2500	0.941	170	30	Complete

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City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
West Orange	07052	5.4	BP Solar	BP3150	150	36	SMA	SB1800U	0.941	180	30	Complete
Hope	07844	5.52	Evergreen Solar	EC-115	115	48	SMA	SB2500U	0.94	145	16	Complete
Washington	07882	5.52	Evergreen Solar	EC-115	115	48	SMA-America	SB2500U	0.944	126	22	Complete
Blairstown	07825	5.52	Evergreen Solar	EC-115	115	48	SMA	SB2500U	0.944	167	31	Complete
Rosemount	08559	5.52	Evergreen Solar	EC-115	115	48	SMA	SB2500U	0.944	180	31	Complete
Hardwick	07825	5.52	Evergreen Solar	EC-115	115	48	SMA	2500U	0.944	180	35	Complete
Blairstown	07825	5.528	Evergreen Solar	EC-115	115	48	SMA-America	SB2500U	0.94	180	40	Complete
Glen Rock	07452	5.55	Sharp	NT185U1	185	30	Sharp	JH3500U	0.93	140	25	Complete
Monroeville	08343	5.55	Sharp	185W	185	30	SMA America	1800U	0.941	180	30	Complete
Franklinville	08322	5.61		I165	165	34	Fronius	IG3000	0.93	280	30	Complete
Brick	08724	5.678	Kyocera	KC167G	167	34	SMA	SB2500U	0.94	220	20	Complete
Edison	08817	5.678	Kyocera	KC167G	167	34	SMA	SB2500U	0.94	185	35	Complete
East Windsor	08520	5.678	Kyocera	KC167G	167	34	SMA	SB2500U	0.94	210	35	Complete
Union Beach	07735	5.68	Kyocera	KC167G	167	34	SMA	SunnyBoy2500U	0.94	220	35	Complete
Kendall Park	08824-1145	5.76	BP Solar	BP 3160	160	36	SMA	Sunnyboy 2500	0.94	120	22	Check Request
Toms River	08753	5.76	BP Solar	BP3160	160	36	SMA	Sunny Boy 2500U	0.941	145	25	Complete
Manalapan	07726	5.76	BP Solar	BP3160	160	36	SMA	Sunnyboy2500U	0.94	170	20	Complete
Forked River	08731	5.76	BP Solar	BP3160	160	36	SMA	Sunny Boy 2500U	0.94	195	22	Complete
Springfeild	07051	5.76	Sharp	NT-185U1	160	36	SMA	SWR 2500U	0.941	180	23	Complete
Perrineville	08535	5.76	BP Solar	BP 3150B	160	36	SMA America	Sunny boy 1800 & Sunny boy 2500	0.94	210	25	Complete
Wayne	07470	5.76	BP Solar	3160	160	36	SMA	2500U	0.94	110	30	Complete
West Orange	07052	5.76	BP Solar	BP3160B	160	36	SMA	Sunny Boy 2500	0.944	135	35	Complete
Farmingdale	07727	5.76	BP Solar	BP3160	160	36	SMA	SB2500U	0.94	180	35	Complete
New Egypt	08533	5.76	BP Solar	BP3160	160	36	SMA	Sunny Boy 2500	0.941	190	30	Complete
Old Bridge	08857	5.76	BP Solar	BP3160	160	36	SMA	Sunny Boy 2500U	0.94	240	32	Complete
Somerset	08873	5.9	Sharp	NT185U1	185	32	SMA	SMA2500U	0.94	230	27	Complete
Lawrence	08759	5.92	Sharp	NT-S5EIU	185	32	Sunny Boy	2500 U	0.941	150	15	Complete
Rutherford	07070	5.92	Sharp	NT-S5E1U	185	32	SMA	SWR2500U SBD	0.94	210	30	Complete
Princeton	08540	5.94	Sharp	NE-165U1	165	36	SMA	SWR2500U	0.944	125	10	Complete
Flemington	08822	5.94		GEsunline36	165	36	SMA	SB2500U	0.94	190	26	Complete
Oldwick	08858	5.94	Sharp	NE-Q5E2U	165	36	SMA	SWR2500U	0.94	150	37	Complete
Redbank	07701	6	BP Solar	BP-3150B	150	40	SMA	SB2500	0.94	90	10	Complete
Sewell	08080	6	BP Solar	3150 PU	150	40	SMA	2500U	0.92	180	24	Complete
Brick	08723	6	BP Solar	BP3150	150	40	SMA	Sunny Boy 2500U	0.94	240	25	Complete
Howell	07731	6	BP Solar	BP150	150	40	Sunny Boy	SMA 2500	0.941	249	20	Complete
Surf City	08008	6	BP Solar	BP5X	150	40	Sunny Boy	SMA 2500	0.94	133	30	Complete
Wrightstown	08562	6	BP Solar	BP3150	150	40	SMA	SunnyBoy2500	0.94	170	35	Complete

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City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Wall	07719	6	BP Solar	BP3150	150	40	SMA	SB2500	0.94	200	30	Complete
Bargenfield	07621	6.012	Sharp	NT-167U1	167	36	SMA	SMA2500U	0.94	120	22	Check Request
Bayville	08721	6.012	Kyocera	KC-167G	167	36	SMA America	Sunny Boy SWR 2500U	0.94	170	30	Complete
Montville	07045	6.012	Kyocera	KC-167G	167	36	SMA America	SMA 2500 UL-SBD	0.944	225	30	Complete
Brigantine	08203	6.105	Sharp	NT-185-U1	185	33	Sharp	JH 3500 U	0.924	240	25	Complete
Springfield	07081	6.29	Sharp	NT-185U1	185	34	SMA America	Sunny Boy 2500U	0.941	220	18	Complete
Edison	08820	6.3	Matrix Solar/Photowatt	PW1650-165	175	36	SMA America	SWR2500U	0.94	130	40	Complete
Kendall Park	08824	6.358	Kyocera	KC187	187	34	SMA	SB1800	0.94	170	35	Check Request
Wall	07719	6.4	Uni-solar	PVL-128	128	50	SMA	PV10208	0.94	157	0	Complete
Pennington	08534	6.66	Sharp	NT-185U1	185	36	Sharp	JH 3500U	0.93	180	0	Complete
Glassboro	08028	6.66		ND 16701	165	24	Fronius	IG3000	0.93	165	24	Complete
Hillsborough	08844	6.66	Sharp	NT-S5EIU	185	36	SMA	SWR 1800U	0.94	200	25	Complete
Holmdel	07731	6.66	Sharp	NT188U1	185	36	SMA America	SWR2500U	0.941	220	20	Complete
Cedar Grove	07009	6.68	Kyocera	KC167G	167	40	SMA	Sunnyboy 2500U	0.94	190	28	Complete
Tuckerton	08087	6.72	BP Solar	BP3160	160	42	SMA	2500U	0.94	220	16	Check Request
Allenhurst	07711	6.72	BP Solar	BP3160	160	42	SMA	Sunny Boy 1800/2500	0.941	270	45	Complete
Freehold	07728	6.8	BP Solar	BP 5170	170	40	SMA	2500U	0.941	190	25	Complete
Hamilton	08610	6.825	Sharp	NT-S5E1U	175	39	Sharp	JH3500	0.93	100	40	Complete
Franklinville	08322	6.89	Sharp	185W	185	21	Sharp	JH-3500U	0.93	180	22	Complete
Hackettstown	07840	6.9	Evergreen Solar	EC-115	115	60	SMA	SB2500U	0.944	160	31	Complete
Hamilton Square	08690	7	Sanyo	HIP-J54BA2	180	40	Sharp	JH-3500U	0.94	190	19	Complete
Lebanon		7	Astropower	AP 100	100	70	SMA America	SWR2500U	0.96	190	35	Complete
Belle Mead/ Griggstown	08502	7.014	Sharp	ND-167U1	167	42	Sharp	JH-3500U	0.924	235	18	Complete
Corbin City	08270	7.175	Sharp	NT-175U1	175	41	Sunvista	JH3500	0.94	145	27	Complete
Palmyra	08065	7.2	RWESchott	ASE300	300	24	SMA	Sunny Boy 2500	0.93	155	5	Complete
White house Station	08889	7.2	BP Solar	SX150S	150	48	SMA America	Sunny Boy 1800 and 2500	0.94	170	25	Complete
Frenchtown	08825	7.2	Astropower	AP-120	120	60	SMA America	2,500U SBD	0.94	180	30	Complete
Lebanon		7.2	Astropower	AP 100	100	72	SMA America	SWR 1800, SWR 2500	0.96	190	30	Complete
Jackson	08527	7.2	Astropower	AP120	120	60	SMA	2500U	0.94	160	40	Complete
Iselin	08830	7.2	RWESchott	300ASE	300	24	SMA	SunnyBoy2500	0.96	135	40	Complete

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City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Long Valley	07853	7.35	Matrix Solar/Photowatt	PW 1650-175	175	42	Xantrex	SW 4080	0.94	140	30	Complete
West Milford	07840	7.36	Evergreen Solar	EC-115	115	64	SMA	SB2500U	0.94	220	30	Complete
Whitehouse Statiion	08889	7.4		GEPV 165	165	45	SMA America	Sunnyboy 2500-SBD(3)	0.94	200	35	Complete
Kendall Park	08824	7.425		GE165	165	45	SMA	SB 2500	0.94	180	16	Complete
West Atlantic City	08234	7.425		I165	165	45	Fronius	IG2000	0.94	125	20	Check Request
Bridgewater	08807	7.49	Sharp	SH140	140	42	Xantrex	SW5548	0.94	210	20	Complete
Elm	08037	7.56	Sharp	NE-Q5E2U	180	42	SMA America	SWR2500U	0.94	180	49	Check Request
Flemington	08822	7.59	Evergreen Solar	EC-115	115	66	SMA	SB2500U	0.94	190	25	Complete
Clarksburg	08510	7.63		Sunslates	14	545	Trace&Sharp	Sw5548&JH3500	0.95	220	40	Complete
Little Silver	07739	7.65	BP Solar	SX150	150	51	Xantrex	SW4048	0.96	220	45	Complete
Old Bridge	08857	7.68	BP Solar	BP3160	160	48	SMA	Sunny Boy 2500U	0.94	110	25	Complete
Hamilton Square	08690	7.68	BP Solar	3160	160	48	SMA	2500	0.94	180	20	Check Request
Chatsworth	08019	7.77	Sharp	185W	185	42	Sharp	Sun Vista JH3500U/ Sunny Boy 2500U	0.93	190	20	Complete
Hampton	08827	7.77	Sharp	NT-S5EIU	185	42	Sharp	JH-3500U	0.92	205	23	Complete
Galloway	08205	7.77	Sharp	NT-185U1	185	42	Sharp	JH-3500U	0.924	190	35	Complete
Warren	07059	7.77	Sharp	NT-185U1	185	42	SMA America	Sunnyboy 2500 and 1800	0.944	190	47	Complete
Northfield	08225	7.8	BP Solar	3150B	150	52	SMA America	Sunny Boy 2500	0.941	235	35	Complete
Little Egg Harbor	08087	7.84	BP Solar	BP3160	160	49	SMA	Sunny Boy 1800/2500	0.941	180	22	Check Request
Union	07083	7.84	Sharp	NDNU ECU&NDO70 ERU	140	46	Sharp	Sharp JH-3500U	0.924	140	30	Complete
Hopewell	08525	7.92		AP110	110	72	SMA	SWR2500U	0.94	160	24	Complete
Glen Gardner	08828	7.92	Evergreen Solar	EC-115	115	72	SMA-America	SB2500U	0.944	240	22	Complete
Blairstown	07825	7.94	Evergreen Solar	EC-115	115	61	SMA	SB2500U	0.944	228	40	Complete
Lawrence Township	08648-1431	8.016	Kyocera	KC167G	167	48	SMA	2500U	0.94	220	35	Complete
Wall twp	07753	8.1	BP Solar	SX150B	150	54	SMA America	Sunny Boy 2500U	0.941	150	23	Complete
Long Valley	07853	8.28	Evergreen Solar	EC-115	115	72	SMA	SB2500U	0.944	193	31	Complete
Mendham	07945	8.36	Evergreen Solar	EC-110	110	76	SMA America	SB2500U	0.944	153	30	Complete
Newton	07860	8.4	Sharp	NT175U1	175	48	SMA	Sunny Boy SWR 2500U	0.93	157	25	Complete

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City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Monmouth Beach	07750	8.4	BP Solar	BP3160	150	56	SMA	SB2500U	0.94	135	22	Complete
Lawrence Twp.	08648	8.4	Sharp	NT175U1	175	48	SMA	SWR2500U	0.94	180	22	Complete
Freehold	07728	8.64	BP Solar	BP3160	160	54	SMA	SB2500U	0.94	200	22	Complete
Holmdel	07733	8.64	BP Solar	3160	160	54	Outback	GUFX7248	0.94	180	30	Check Request
Flemington	08822	8.64	Astropower	AP120	120	72	Trace	SW4048	0.96	191	40	Complete
Mays Landing	08330	8.684	Sharp	ND-167U1	167	52	Sharp	Sunvista JH 3500U	0.92	265	40	Check Request
Pitman	08071	8.695	Sharp	NT-S5EIU	185	47	SMA America	Sunny Boy 2500U	0.941	180	38	Complete
Blairstown	07825	8.8	Evergreen Solar	EC-115	115	80	SMA America	Sunny Boy 2500U	0.944	170	35	Complete
Ringoes	08551	8.85	Sharp	ND-167U1	167	53	Sharp	JH-3500U	0.93	176	26	Complete
Chester	07930	8.88	Sharp	NE-S5E1U	185	48	SMA America	SMA2500 UL-SBD	0.944	180	18	Complete
Califon	07830	8.888	Sharp	NT-SSEIV	185	48	SMA America	SWR 1800 V w/display	0.94	180	15	Complete
Voorhees	08043	8.91	Sharp	NE-Q5E2U	165	54	SMA America	SMA 2500	0.94	150	25	Complete
Hackettstown	07840	9.018	Kyocera	KC167G	167	54	SMA	SunnyBoy2500U	0.94	180	22	Complete
Marlboro	07746	9.018	Kyocera	KC167G	167	54	SMA	Sunny Boy 2500U	0.941	180	30	Complete
Randolph	07869	9.018	Kyocera	KC167G	167	54	SMA	SB2500U	0.94	260	30	Complete
Allentown	08514	9.24		GEPV-110	110	84	SMA	Sunny Boy 2500U	0.94	170	45	Complete
Mansfield	08022	9.28	BP Solar	3160	160	58	SMA	2500U	0.94	210	25	Complete
Edison	08820	9.45	Sharp	NT175U1	175	54	Sharp	JH-3500U	0.941	180	15	Complete
Edison	08820	9.45	Sharp	NT185U1	175	54	Sharp	JH3500U	0.941	180	15	Complete
Pennington	08534	9.45	Sharp	NT-S5E1N	175	54	Sharp	JH3500	0.93	180	23	Complete
Bridgeton	08302	9.45	Sharp	NT-175U1	175	54	Fronius	IG3000	0.94	180	30	Complete
Neshanic Station	08853	9.45		I150S	150	63	SMA	SB2500U	0.93	220	35	Check Request
Andover Township	07860	9.6	BP Solar	3160	160	60	Fronius	IG2000	0.94	180	30	Complete
Red Bank	07701	9.6	BP Solar	3160	160	60	SMA	1800	0.94	180	35	Complete
Belle Meade	08502	9.72	Terra Solar	TS 40	243	40	SMA America	2500U	0.94	180	15	Complete
Brick	08723	9.76	BP Solar	BP3160	160	61	SMA	Sunny Boy 2500	0.941	280	24	Check Request
Manalapan	07726	9.76	BP Solar	BP3160	160	61	SMA	SB2500U	0.94	193	30	Complete
Lebanon	08833	9.795	RWESchott	ASE-300DGF150		32	SMA	SWR2500U	0.96	180	34	Complete
Hopewell	08525	9.8	Sharp	NT175U1	175	56	SMA	JH3500U	0.93	180	30	Complete
Holmdel	07733	9.8	BP Solar	SX140S	140	70	SMA America	SMA-2500	0.94	180	30	Complete
Holmdel	07733	9.8	BP Solar	SX140S	140	70	SMA America	SMA-2500	0.94	180	30	Complete
Mahwah	07430	9.8	Sanyo	HIP-G751BA2	167	59	SMA America	Sunny Boy 2500U	0.941	180	37	Complete

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Ringoes	08551	9.8	Sharp	NT-175U1	175	56	Sharp Electronics	J3500U	0.93	240	30	Complete
Morristown	07960	9.8	Sharp	NT-175U1	175	56	Sharp	JH3500	0.93	150	45	Complete
Long Branch	07740	9.805	Sharp	NT-185U1	185	53	Sunny Boy	2500u	0.941	175	25	Complete
Morganville	07751	9.81	BP Solar	BP3160	150	66	SMA	SB2500	0.94	90	20	Complete
Titusville	08560	9.84	Astropower	AP120	120	82	SMA America	SWR2500U	0.94	235	23	Complete
Princeton	08540	9.853	Kyocera	KC167G	167	59	SMA	SB1100U	0.94	180	26	Complete
Glenwood	07418-2015	9.853	Kyrocera	KC161G	167	59	SMA	Sunny Boy 2500U(3)Sunny Boy 1800U (1)	0.94	165	35	Complete
Clifton	07013	9.9	Sharp	NT-185U1	185	54	Sharp	Sunvista 3500	0.924	130	22	Check Request
Cedarbrook	08009	9.9	Sharp	NT-185W	185	54	SMA	2500U	0.93	135	23	Complete
Ringoes	08551	9.9	Sharp	NT-185U1	185	54	Sharp	JH-3500U	0.93	180	20	Complete
Milford	08848	9.9		GE-165	165	60	SMA	SB2500U	0.94	180	20	Complete
Elwood	08217	9.9	Sharp	NE-165U1	165	60	SMA	Sunny Boy 2500U	0.941	190	20	Complete
Manalapan	07726	9.9		GEPV165	165	60	SMA	SB2500	0.94	180	30	Complete
Pittstown	08867	9.9		GEPV165	165	60	SMA-America	Sunny Boy 2500	0.94	270	30	Complete
Manalapan	07726	9.9		GEPV165	165	60	SMA	SB2500	0.94	270	30	Complete
Southampton/Tabernacle	08088	9.9	Sharp	NT-S5E1U	185	54	Sharp	JH 3500U	0.924	260	30	Complete
Pennington	08534	9.9	Sharp	NE-Q5E2U	165	60	SMA America	SWR2500U	0.94	180	45	Complete
Trenton	08619	9.92	BP Solar	3160	160	62	SMA	2500	0.94	190	10	Check Request
East Brunswick	08816	9.92	Sharp	NT-185U1	160	62	SMA	Sunny Boy 2500U	0.941	100	20	Check Request
Belmar	07719	9.96	Astropower	AP120	120	83	SMA America	2500 U	0.94	0	0	Complete
Brick	08723	9.96	Astropower	AP120	120	83	SMA America	SW4048	1	210	19	Complete
Lambertville	08530	9.96	Astropower	AP120	120	83	SMA	SWR2500U	0.94	180	25	Complete
Whitehouse Station	08889	9.967		GEPV 165	165	69	SMA America	SunnyBoy 2500	0.94	180	30	Complete
Atco	08004	9.975	Sharp	NE-175	175	57	Sharp	JH3500u	0.93	180	23	Complete
Waterford	08089	9.98	Sharp	NT-175U1	175	57	Sharp	JH3500U	0.93	220	34	Complete
Southampton	08088	9.99	Sharp	NT-185U1	185	54	SMA	2500U	0.93	90	16	Complete
Brown's Mill	08015	9.99	Sharp	NT-185U1	185	54	Sharp	JH-3500U	0.92	270	18	Complete
Lebanon	07753	9.99	Sharp	NT 185U1	185	54	SMA	Sunny Boy SWR 2500U	0.941	100	20	Complete
Burlington	08016	9.99	Sharp	NT S5E1U	185	54	Sharp	Sunvista JH 3500U	0.93	150	25	Complete
Little Egg Harbor	08087	9.99	Sharp	NT-185U1	185	54	Sharp	JH-3500U	0.94	160	25	Complete
Long Valley	07853	9.99	Sharp	NT-55EIU	185	54	Sharp	Sunvista	0.92	180	20	Complete
Westampton	08060	9.99	Sharp	NT185U1	185	54	Sharp	JH3500U	0.93	180	37.5	Complete

Appendix 2
NJCEP CORE Program
PV Systems Installed 2003-2004

City	Zip Code	System Size (DC kW)	Module Manufacturer	Model #.	Power Rating / Output	# of Modules	Inverter Manufacturer	Inverter Model #	Inverters Peak Efficiency	Solar Electric Module Orientation	Solar Electric Module Tilt	Status
Freehold	07728	10	BP Solar	BP3150	160	63	SMA	SB2500U	0.94	200	32	Complete
Colts Neck	07722	10.02	Kyocera	KC167G	167	60	SMA	SB1100U	0.94	170	30	Complete
Neptune	07753	10.8	BP Solar	BP-110	150	72	SMA America	Sunny Boy 2500U	0.941	180	30	Complete
Magnolia	08049	11.04	Evergreen Solar	EC-115	115	96	SMA-America	Sunny Boy 2500U	0.944	200	5	Complete
Cream Ridge	08514	11.04	Evergreen Solar	EC-115	115	96	SMA America	SB2500U	0.944	190	30	Complete
Farmingdale	07727	11.04	Evergreen Solar	EC-115	115	96	SMA-America	SB2500U	0.944	170	35	Complete
Colts Neck	07722	11.1	Sharp	NT-185U1	185	60	Sharp	JH-3500U	0.924	180	24	Complete
Alloway	08001	11.84	Sharp	NT-185U1	185	64	SMA America	Sunny Boy 2500U	0.941	170	40	Complete
Somerset	08873-2861	12.3	BP Solar	SX150B	150	82	SMA	Sunny Boy 2500(2) 1800(3)	0.94	180	27	Complete
Gladstone	07934	12.6	Astropower	AP75	75	168	SMA	SB1800U	0.944	165	14	Complete
Springfiled	07081	14.4	RWESchott	ASE300 DGF50	300	48	SMA	SU2500	0.94	150	5	Check Request
Lafayette	07848	16.56	Evergreen Solar	EC-115	115	144	SMA	SB2500U	0.94	180	35	Complete
Newton	07860	16.56	Evergreen Solar	EC-115	115	144	SMA	SB2500U	0.944	180	30	Check Request
Rockleigh	07647	19.2	RWESchott	ASE 300DG	300	64	SMA America	SWR2500U	0.94	180	52	Complete
Wall	07719	21.84	Astropower	AP 130	130	168	Trace Xantrex	PV 20	0.96	180	0	Complete
Mandham	07945	22.08	Evergreen Solar	EC-115	115	192	SMA-America	Sunny Boy 2500U	0.944	180	35	Check Request
Long Valley	07853	22.08	Evergreen Solar	EC-115	115	192	SMA	SB2500U	0.944	193	30	Complete
Cream Ridge	08514	38.64	Evergreen Solar	EC-115	115	336	SMA America	SB2500U	0.944	190	30	Complete
East Windsor	08520	41.4	Evergreen Solar	EC-115	115	360	SMA	SB2500U	0.94	170	31	Complete
Howell	07731	50.4	BP Solar	MSX 120	120	420	Trace Xantrex	PV 45	0.96	180	0	Complete
Howell	07731	50.4	BP Solar	MSX 120	120	420	Trace Xantrex	PV 45	0.96	180	0	Complete
Newark	07102	50.4	RWESchott	ASE3005OV 315W	315	160	PVPowered	PVP2800 PVP1800	0.944	195	5	Complete
Sewell	08080	88.8	Sharp	NT-S5EIU	185	480	SMA America	Sunny Boy 2500U	0.941	170	30	Complete
EdgeWater	07020	120.96	BP Solar	3140	140	864	Xantrex	PV100208	0.96	180	0	Complete
Total		2521.178										

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Appendix 3

New Jersey Clean Energy Program

Protocols to Measure Resource Savings

New Jersey Clean Energy Protocols
September 2004

Table of Contents

New Jersey Clean Energy Program
Protocols to Measure Resource Savings

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 JCP&L 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 Clean Energy technologies and measures supported by 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[1]. Data that were metered over that time period are from measures that were installed over an eight-year period. Many input values are based on program evaluations of prior New Jersey programs or similar programs in other regions.

For the standard input assumptions for which metered or measured data were not available, the input values (e.g., delta watts, delta efficiency, equipment capacity, operating hours, coincidence factors) were based on the best available industry data or standards. These input values were based on a review of literature from various industry organizations, equipment manufacturers, and suppliers.

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

Baseline Estimates

For most programs the Δ kW and Δ kWh values are based on the energy use of standard new products vs. the high efficiency products promoted through the programs. This baseline may be different than the baseline estimates used in previous programs such as the Standard Offer in which the baseline assumptions were based on either the existing equipment for retrofits or current code or practice for new construction. The approach used for the new programs encourages residential and business consumers to purchase and install high efficiency equipment vs. new standard efficiency equipment. The baseline estimates used in the protocols are documented in the baseline studies or other market information. Baselines will be updated to reflect changing codes, practices and market transformation effects.

Resource Savings in Current and Future Program Years

The Protocols support tracking and reporting 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.

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

Prospective Application of the Protocols

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

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

Resource Savings

Electric

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

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

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

The time periods for energy savings and coincident peak demand savings were chosen to best fit the seasonal avoided cost patterns for electric energy and capacity that were used for the energy efficiency program cost effectiveness purposes. For energy, the summer period May through September was selected based on the pattern of avoided costs for energy at the PJM level. In order to keep the complexity of the process for calculating energy savings benefits to a reasonable level by using two time periods, the knee periods for spring and fall were split approximately evenly between the summer and winter periods. For capacity, the summer period June through August was selected to match the highest avoided costs time period for capacity. The experience in PJM and New Jersey has been that nearly all system peak events occur during these three months.

The electric energy savings are tracked by rate schedules.

Natural Gas

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

Summer - April through September
Winter - October through March

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

Other Resources

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

Post-Implementation Review

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

Adjustments to Energy and Resource Savings

Coincidence with Electric System Peak

Coincidence factors are used to reflect the portion of the connected load savings 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 following loss factors multiplied by the savings calculated from the protocols will result in savings at the supply level.

Electric Loss Factor

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

Gas Loss Factor

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

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

Calculation of Clean Air Impacts

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

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

Electric Emissions Factors

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

NO_X	6.42 lbs per metric ton of CO_2 saved	2.8 lbs per MWh saved
SO_2	10.26 lbs per metric ton of CO_2 saved	6.5 lbs per MWh saved
Hg	0.00005 lbs per metric ton of CO_2 saved	0.0000356 lbs per MWh saved

Gas Emissions Factors

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

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

Measure Lives

Measure lives are provided in Appendix A for informational purposes and for use in other applications such as reporting lifetime savings or in benefit cost studies that span more than one year. For regulatory reporting, the following are the average lives that relate lifetime savings to annual savings for each program reporting savings.

	Measure Life (Years)	
Program	Electric	Gas
Residential HVAC	15	20
Residential Low Income	16	20
Energy Star Homes	20	20
C&I Construction	15	15
Customer Sited Generation		
PV	20	
Wind	15	
Fuel Cell		10

Protocols for Program Measures

The following pages present measure-specific protocols.

Residential Electric HVAC

Protocols

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

Heating Energy Savings – ASHP

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

Ground Source Heat Pumps (GSHP)

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

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

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

GSHP Desuperheater

Energy (kWh) Savings = EDSH

Peak Demand Impact (kW) = PDSH

<u>Definition of Terms</u>

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

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

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

EER_b = The Energy Efficiency Ratio of the Baseline Unit.

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

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

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

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

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

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

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

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

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

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

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

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

EDSH = Assumed savings per desuperheater.

PDSH = Assumed peak demand savings per desuperheater.

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

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

Residential Electric HVAC

Component	**Type**	**Value**	**Sources**
CAPY	Variable		Rebate Application
$SEER_b$	Fixed	Baseline = 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. This value is identified as a priority for future evaluation.
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

Protocols

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

Space Heaters

Algorithms

Gas Savings = $Capy_q/Capy_t$ 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: 80% Boilers: 83%	2
Baseline Heating Usage	Fixed	965 therms	3

Component	Type	Value	Source
Time Period Allocation Factors	Fixed	Summer = 12% Winter = 88%	4

Sources:
1. NJ utility analysis of heating customers, typical output capacity.
2. Based on the quantity of models available by efficiency ratings as listed in the April 2003 Gamma Consumers Directory of Certified Efficiency Ratings.
3. NJ utility analysis of heating customers, annual gas heating usage.
4. Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.

Water Heaters

Algorithms

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

Definition of Variables

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

EF_b = 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	0.544	1
Baseline Water Heater Usage	Fixed	277	2
Time Period Allocation Factors	Fixed	Summer = 50% Winter = 50%	3

Sources:
1. Federal EPACT Standard for a 40 gallon gas water heater. Calculated as 0.62 – (0.0019 X gallons of capacity).
2. DOE/FEMP website. http://www.eren.doe.gov/femp/pro
3. Prorated based on 6 months in the summer period and 6 months in the winter period.

Residential Energy Star Windows

Protocols

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

Square Feet of Window Area X Savings per Square Foot

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

ENERGY STAR Windows

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

<u>Heat Pump</u>

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

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

<u>Gas Heat/CAC</u>

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

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

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

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

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

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

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

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	Summer/On-Peak 10% Summer/Off-Peak 7% Winter/On-Peak 40% Winter/Off-Peak 44%	2
$ESav_{GAS/CAC}$	Fixed	0.2462 kWh	1
Gas/CAC Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 65% Summer/Off-Peak 35% Winter/On-Peak 0% Winter/Off-Peak 0%	2
$ESav_{GAS/NOCAC}$	Fixed	0.00 kWh	1
Gas/No CAC Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2
Gas Heating Gas Time Period Allocation Factors	Fixed	Summer = 12% Winter = 88%	4
$ESav_{OIL/CAC}$	Fixed	0.2462 kWh	1
Oil/CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 65% Summer/Off-Peak 35% Winter/On-Peak 0% Winter/Off-Peak 0%	2
$ESav_{OIL/NOCAC}$	Fixed	0.00 kWh	1
Oil/No CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2

Component	Type	Value	Sources
$ESav_{RES/CAC}$	Fixed	4.0 kWh	1
Res/CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 10% Summer/Off-Peak 7% Winter/On-Peak 40% Winter/Off-Peak 44%	2
$ESav_{RES/NOCAC}$	Fixed	3.97 kWh	1
Res/No CAC Time Period Allocation Factors	Fixed	Summer/On-Peak 3% Summer/Off-Peak 3% Winter/On-Peak 45% Winter/Off-Peak 49%	2
$DSav_{HP}$	Fixed	0.000602 kW	1
$DSav_{CAC}$	Fixed	0.000602 kW	1
$DSav_{NOCAC}$	Fixed	0.00 kW	1
$GSav_{GAS}$	Fixed	0.169 therms	1
$OSav_{OIL}$	Fixed	0.0169 MMBtu	1
CF	Fixed	0.75	3

Sources:

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

Residential Low Income Program

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

Base Load Measures

Efficient Lighting

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

<u>Algorithm</u>

Compact Fluorescent Screw In Lamp

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

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

Efficient Fixtures

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

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

Efficient Torchieres

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

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

Hot Water Conservation Measures

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

Algorithm

Electricity Impact (kWh) = HW_{eavg}

Gas Savings (MMBtu) = HW_{gavg}

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

Water Savings (gallons) = WS

Efficient Refrigerators

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

Algorithm

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

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

Space Conditioning Measures

Savings from individual space conditioning measures are affected by any other measures that also are being installed; i.e., such savings are not cumulative. Further, technical reasons dictate prioritizing certain measures over others. The savings algorithms for all space conditioning measures accommodate these considerations by presuming a fixed sequence of measure installation for the purpose of projecting savings and by limiting total estimated electric space conditioning savings to 10% of electric space conditioning pre-treatment usage. Fossil fuel heated houses typically have more substantial opportunities for space conditioning savings than electrically heated houses. Further, there are greater opportunities for interaction between measure types. For protocol reporting, these savings estimates will be capped at 15% of pre-treatment space heating consumption. When available, gas heat measure savings will be based on heating use. If only total gas use is known, heating use will be estimated as total use less 300 therms.

Air Sealing

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

Algorithm

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

MMBtu savings = (GHpre X 0.05)

Duct Sealing and Repair

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

Algorithm

With CAC

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

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

MMBtu savings = (GHpre X 0.02)

No CAC

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

MMBtu savings = (GHpre X 0.02)

Insulation Up-Grades

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

Algorithm

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

MMBtu savings = GH_{pre} X 0.13

Thermostat Replacement

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

Algorithm

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

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

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

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

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

Total Space Conditioning Savings

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

Algorithm

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

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

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. Refrigerator demand savings factor.

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

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

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

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

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

Capy = Capacity of Heat Pump in Btuh

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

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

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

GC_{pre} = Pre treatment gas consumption.

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

WS = Water Savings associated with water conservation measures. Currently fixed at 3,640 gallons per year per home receiving low flow showerheads, plus 1,460 gallons saved per year per home receiving aerators.

Residential Low Income

Component	Type	Value	Sources
CFL_{Watts}	Fixed	42 Watts	1
CFL_{Hours}	Fixed	2.5 hours	1
$Fixt_{Watts}$	Fixed	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
WS Water Savings	Fixed	3,640 gal/year per home receiving low flow shower heads, plus 1,460 gal/year per home receiving aerators.	12
HW_{watts}	Fixed	0.022 kW	4
HW CF	Fixed	75%	4
Ref_{old}	Variable		Contractor Tracking
Ref_{new}	Variable		Contractor Tracking and Manufacturer data
Ref DF	Fixed	0.000139 kW/kWh savings	5
RefCF	Fixed	100%	6
ESC_{pre}	Variable		7
$Ecool_{pre}$	Variable		7
ELFH	Fixed	650 hours	8
AC CF	Fixed	85%	4
Capy	Fixed	33,000 Btu/hr	1
EER	Fixed	9.2	8
HP CF	Fixed	70%	9

Component	Type	Value	Sources
DSF	Fixed	7%	10
GC_{pre}	Variable		7
GH_{pre}	Variable		7
Time Period Allocation Factors - Electric	Fixed	Summer/On-Peak 21% Summer/Off-Peak 22% Winter/On-Peak 28% Winter/Off-Peak 29%	11
Time Period Allocation Factors - Gas	Fixed	Heating: Summer 12% Winter 88% Non-Heating: Summer 50% Winter 50%	13

Sources/Notes:

1. Working group expected averages for product specific measures.
2. Efficiency Vermont Reference Manual – average for lighting products.
3. Experience with average hot water measure savings from low income and direct install programs.
4. VEIC estimate.
5. UI Refrigerator Load Data profile, .16 kW (5pm July) and 1,147 kWh annual consumption.
6. Diversity accounted for by Ref DF.
7. Billing histories and (for electricity) contractor calculations based on program procedures for estimating space conditioning and cooling consumption.
8. 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.
12. VEIC estimate, assuming 1 GPM reduction for 14 five minute showers per week for shower heads, and 4 gallons saved per day for aerators.
13. Heating: Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.
    Non-Heating: Prorated based on 6 months in the summer period and 6 months in the winter period.

Residential New Construction Program

Protocols

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

The energy savings due to the Residential New Construction Program will be a direct output of the home energy rating software. This software has a module that compares the energy characteristics of the energy efficient home to the baseline/reference home and calculates savings.

The system peak electric demand savings will be calculated from the software output with the following algorithms then applied:

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

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

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

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.

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

2001 through March 2003 and for installations completed in April 2003 through the present. The application of the code changes to completions starting in April allows for the time lag between when the permits are issued and a when a home would reasonably be expected to be completed.

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

Applicable to building completions from January 2001 through March 2003

Component	Type	Value	Sources
PL_b	Variable		1
OF_b	Fixed	1.6	2
$SEER_b$	Fixed	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.

Applicable to building completions from April 2003 to present

Component	Type	Value	Sources
PL_b	Variable		1
OF_b	Fixed	1.6	2
$SEER_b$	Fixed	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 -- Applicable to building completions from January 2001 through March 2003

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

Data Point	Single Family	Multiple Single Family	Multifamily
PTAC / PTHP	*3.0 COP*	*3.0 COP*	*3.0 COP*
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.
An asterisk (*) indicates the value is more stringent than code.

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

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

Data Point	Single and Multiple Family Except as Noted.		
Geothermal Heat Pump	Open not modeled, 3.0 COP closed		
PTAC / PTHP	Not differentiated from air source HP		
Cooling Efficiency			
Central Air Conditioning	10.0 SEER		
Air Source Heat Pump	10.0 SEER		
Geothermal Heat Pump	3.4 COP (11.6 EER)		
PTAC / PTHP	Not differentiated from central AC		
Window Air Conditioners	Not differentiated from central AC		
Domestic WH Efficiency			
Electric	0.86 EF (4)		
Natural Gas	0.53 EF (4)		
Water Heater Tank Insulation	None		
Duct Insulation	N/A		

Notes:

(1) Varies with heating degree-days ("HHD"). Above value reflects 5000 HDD average for New Jersey.
U values represent total wall system U value, including all components (i.e., clear wall, windows, doors).
Type A-1 - Detached one and two family dwellings.
Type A-2 - All other residential buildings, three stories in height or less.
(2) Closest approximation to MEC 95 requirements given the limitations of REM/Rate UDRH scripting language.
(3) MEC 95 minimum requirement is 78 AFUE. However, 80 AFUE is adopted for New Jersey based on typical minimum availability and practice.
(4) Size dependent. 50 gallon assumed.

Residential Retrofit Program

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

Protocols

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

<u>ENERGY STAR CFL Bulbs</u>

Same as Compact Flourescent Screw In Lamp.

<u>ENERGY STAR Torchieres</u>

Same as Efficient Torchieres

<u>ENERGY STAR Recessed Cans</u>

Same as Efficient Fixtures.

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

Same as Efficient Fixtures.

Residential ENERGY STAR Appliances

Protocols

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

Number of Units X Savings per Unit

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

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

ENERGY STAR Refrigerators

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

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

ENERGY STAR Clothes Washers

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

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

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

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

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

ENERGY STAR Dishwashers

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

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

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

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

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

ENERGY STAR Room Air Conditioners

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

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

<u>Definition of Terms</u>

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

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

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

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

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

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

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

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

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

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

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

ENERGY STAR Appliances

Component	**Type**	**Value**	**Sources**
$ESav_{REF}$	Fixed	48 kWh	1
$DSav_{REF}$	Fixed	0.0066 kW	1
REF Time Period Allocation Factors	Fixed	Summer/On-Peak 20.9% Summer/Off-Peak 21.7% Winter/On-Peak 28.0% Winter/Off-Peak 29.4%	2
$ESav_{CW}$	Fixed	201 kWh	3
$Gsav_{CW}$	Fixed	10.6 therms	3

Component	Type	Value	Sources
$Osav_{CW}$	Fixed	1.06 MMBtu	3
$DSav_{CW}$	Fixed	0.0267 kW	3
$WSav_{CW}$	Fixed	4,915 gallons	4
CW Electricity Time Period Allocation Factors	Fixed	Summer/On-Peak 24.5% Summer/Off-Peak 12.8% Winter/On-Peak 41.7% Winter/Off-Peak 21.0%	2
CW Gas Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	
$ESav_{DW}$	Fixed	82 kWh	5
$Gsav_{DW}$	Fixed	0.0754 kW	5
$Osav_{DW}$	Fixed	1.0	5
$DSav_{DW}$	Fixed	0.0225	5
$Wsav_{DW}$	Fixed	159 gallons	5
DW Electricity Time Period Allocation Factors	Fixed	19.8%, 21.8%, 27.8%, 30.6%	2
DW Gas Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	9
$ESav_{RAC}$	Fixed	56.4 kWh	6
$DSav_{RAC}$	Fixed	0.1018 kW	7
$CF_{REF,}$ $CF_{CW,}$ CF_{DW}, CF_{RAC}	Fixed	1.0, 1.0, 1.0, 0.58	8
RAC Time Period Allocation Factors	Fixed	65.1%, 34.9%, 0.0%, 0.0%	2

Sources:

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

7. Average demand savings based on engineering estimate.
8. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.
9. Prorated based on 6 months in the summer period and 6 months in the winter period.

Commercial and Industrial Energy Efficient Construction

C&I Electric Protocols

Baselines and Code Changes

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

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

Lighting Equipment

With the exception of small commercial lighting, savings are calculated using market-driven assumptions for new construction, renovation, remodeling, or equipment replacement that presume a decision to upgrade the lighting system. For small commercial lighting, the most efficient T-12 lamp and magnetic ballast fixture serves as the baseline. This approach is different from earlier protocols that referenced pre-existing lighting connected load.

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

<u>Algorithms</u>

Demand Savings = ΔkW X CF X (1+IF)

Energy Savings = ΔkW X EFLH X (1+IF)

ΔkW is calculated from example worksheet below:

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

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

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

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

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. - Watts/Sq.Ft. (qualified equipment by same area))*Area Sq.Ft./1000 (see table above).

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

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

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

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

Lighting Verification Summary

Component	Type	Value	Source
ΔkW	Fixed	Change in connected load from baseline.	• Installed load is based on standard wattage tables and verified watts/sq.ft. • For commitments prior to 7/16/2002, baseline is 30% better than ASHRAE 90.1 1989 by space. • For commitments after 7/16/2002, baseline is *5* percent better than ASHRAE 90.1-*1999* by space.
CF	Fixed	Large Office* 65% Large Retail 81% Large Schools 41% Large All Other 63% All Hospitals 67% All Other Office 71% All Other Retail 84% Other Schools 40% All Other 69% Industrial 71% Continuous 90%	JCP&L metered data[2] Cost effectiveness study Estimate

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

Component	Type	Value	Source
IF	Fixed	5%	Impact of lighting watt reduction on air-conditioning load used in previous lighting savings.
EFLH	Fixed	Large Office 3309 Large Retail 5291 Large Schools 2289 Large All Other 3677 All Hospitals 4439 All Other Office 2864 All Other Retail 4490 Other Schools 2628 All Other 2864 Industrial 4818 Continuous 7000	JCP&L metered data[3] Cost effectiveness study Estimate
Time Period Allocation Factors	Fixed	Summer/On-Peak 26% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 22%	

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

<u>Traffic Signals (data from NJDOT)</u>

Traffic Signals

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

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

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

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

Prescriptive Lighting for Small Commercial Customers

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

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

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

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

Algorithms

Demand Savings = ΔkW X CF

Energy Savings = ΔkW X EFLH

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

Prescriptive Lighting for Small Commercial Customers

Component	Type	Value	Source
ΔkW	Fixed	See Prescriptive Lighting Savings Table (below)	From NJ lighting tables
CF	Fixed	Average of the small retail and office from lighting verification summary table, 77.5%.	JCP&L metered data[4]
EFLH	Fixed	Average of small retail and office from lighting verification summary 3,677.	JCP&L metered data

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

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

Prescriptive Lighting Savings Table

Fixture Type	**New Watts (w/ fixture)**	**Baseline (w/ fixture)**	**Savings (w/ fixture)**
COMPACT FLUORESCENT (2) 18W CF/HW	36	144	108
COMPACT FLUORESCENT (2) 11W CF/HW	26	104	78
COMPACT FLUORESCENT (2) 13W CF/HW	30	120	90
COMPACT FLUORESCENT (2) 18W QD/ELEC	38	152	114
COMPACT FLUORESCENT (2) 26W CF/HW	53	212	159
COMPACT FLUORESCENT (2) 26W QD/ELEC	54	216	162
COMPACT FLUORESCENT (2) 5W CF/HW	14	56	42
COMPACT FLUORESCENT (2) 7W CF/HW	18	72	54
COMPACT FLUORESCENT (2) 9W CF/HW	22	88	66
COMPACT FLUORESCENT 11W CF/HW	13	52	39
COMPACT FLUORESCENT 13W CF/HW	15	60	45
COMPACT FLUORESCENT 18W CF/HW	19	76	57
COMPACT FLUORESCENT 18W QD/ELEC	22	88	66
COMPACT FLUORESCENT 20W CF/HW	22	88	66
COMPACT FLUORESCENT 22W QD/ELEC	26	104	78
COMPACT FLUORESCENT 26W CF/HW	28	112	84
COMPACT FLUORESCENT 26W QD/ELEC	27	108	81
COMPACT FLUORESCENT 28W CF/HW	30	120	90
COMPACT FLUORESCENT 32W CF/HW	34	136	102
COMPACT FLUORESCENT 36W CF/HW	41	164	123
COMPACT FLUORESCENT 40W CF/HW	45	180	135
COMPACT FLUORESCENT 5W CF/HW	7	28	21
COMPACT FLUORESCENT 7W CF/HW	10	40	30
COMPACT FLUORESCENT 9W CF/HW	11	44	33
High Efficiency Fluorescent 1L2 (1) FO17T8/Elec	18	32	14
High Efficiency Fluorescent 1L2 (2) FO17T8/Elec	34	56	22
High Efficiency Fluorescent 1L2 (3) FO17T8/Elec	50	78	28
High Efficiency Fluorescent 1L2 (4) FO17T8/Elec	62	112	50
High Efficiency Fluorescent 1L3 (1) FO25T8/Elec	30	46	16
High Efficiency Fluorescent 1L3 (2) FO25T8/Elec	48	80	32
High Efficiency Fluorescent 1L3 (3) FO25T8/Elec	68	126	58
High Efficiency Fluorescent 1L3 (4) FO25T8/Elec	90	160	70
High Efficiency Fluorescent T-8 1L4	28	42	14
High Efficiency Fluorescent T-8 1L8	67	78	11
High Efficiency Fluorescent T-8 2L2	62	94	32
High Efficiency Fluorescent T-8 2L4	55	73	18
High Efficiency Fluorescent T-8 2L8	118	158	40
High Efficiency Fluorescent T-8 3L4	79	105	26
High Efficiency Fluorescent T-8 4L4	110	146	36
High Efficiency Fluorescent T-8 4L8	233	316	83
LED Exit Sign	20	18	2
PULSE START METAL HALIDE 50 W	68	95	27
PULSE START METAL HALIDE 70 W	90	95	5
PULSE START METAL HALIDE 100 W	120	120	0
PULSE START METAL HALIDE 125 W	150	205	55
PULSE START METAL HALIDE 150 W	190	205	15
PULSE START METAL HALIDE 175 W	205	205	0
PULSE START METAL HALIDE 200 W	235	290	55
PULSE START METAL HALIDE 250 W	288	290	2
PULSE START METAL HALIDE 300 W	342	450	108
PULSE START METAL HALIDE 320 W	368	450	82

Fixture Type	New Watts (w/ fixture)	Baseline (w/ fixture)	Savings (w/ fixture)
PULSE START METAL HALIDE 350 W	400	450	50
PULSE START METAL HALIDE 400 W	450	450	0
PULSE START METAL HALIDE 750 W	815	1075	260
PULSE START METAL HALIDE 875 W	940	1075	135
PULSE START METAL HALIDE 1000 W	1075	1075	0

Lighting Controls

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

Algorithms

Demand Savings = kW_c X SVG X CF

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

Definition of Variables

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

kW_c = kW lighting load connected to control

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

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

EFLH = Equivalent full load hours.

Lighting Controls

Component	Type	Value	Source
kW_c	Variable	Load connected to control	Application
SVG	Fixed	Occupancy Sensor, Controlled Hi-Low Fluorescent Control and controlled HID = 30% Daylight Dimmer System=50%	See sources below
CF	Fixed	By building type and size see lighting verification summary table	Assumes same as JCP&L metered data
EFLH	Fixed	By building type and size see lighting verification summary table	JCP&L metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 26% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 22%	

Sources:

- Northeast Utilities, *Determination of Energy Savings Document*, 1992
- Levine, M., Geller, H., Koomey, J., Nadel S., Price, L., "Electricity Energy Use Efficiency: Experience with Technologies, Markets and Policies" ACEEE, 1992
- Lighting control savings fractions consistent with current programs offered by National Grid, Northeast Utilities, Long Island Power Authority, NYSERDA, and Energy Efficient Vermont.

Motors

Algorithms

From application form calculate ΔkW where:

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

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	JCP&L metered data[5] and PSEG audit data for industrial

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

Component	Type	Value	Source
Efficiency – EFF $_b$	Fixed	Comparable EPACT Motor	From EPACT directory.
Efficiency - EFF $_q$	Variable	Nameplate	Application
CF	Fixed	35%	JCP&L metered data
Time Period Allocation Factors	Fixed	Summer/On-Peak 25% Summer/Off-Peak 16% Winter/On-Peak 36% Winter/Off-Peak 23%	

HVAC Systems

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

<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	See Table below	Collaborative agreement and C/I baseline study
EER_q	Variable	ARI or AHAM Values	Application
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	HVAC 1,131 HP cooling 381 HP heating 800	JCP&L metered data[6]
Cooling Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	
Heating Time Period Allocation Factors	Fixed	Summer/On-Peak 0% Summer/Off-Peak 0% Winter/On-Peak 41% Winter/Off-Peak 58%	

HVAC Baseline Table

Equipment Type	Baseline	ASHRAE Std. 90.1 – 1989	ASHRAE Std. 90.1 – 1999
Unitary HVAC/Split Systems			
· <=5.4 tons:	10 SEER	10 SEER	10 SEER
· >5.4 to 11.25 tons	8.9 EER	8.9 EER	10.3 EER
· >11.25 to 30 tons	8.5 EER	8.5 EER up to 20 tons 8.2 EER above 30 tons	9.7 EER up to 20 tons 9.7 EER above 30 tons

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

Equipment Type	Baseline	ASHRAE Std. 90.1 – 1989	ASHRAE Std. 90.1 – 1999
Air-Air Heat Pump Systems · <=5.4 tons: · >5.4 to 11.25 tons · >11.25 to 30 tons	 6.8 HSPF & 10.0 SEER 8.9 EER 8.5 EER	 10 SEER 8.9 EER 8.5 EER up to 20 tons 8.2 EER above 30 tons	 10 SEER 10.1 EER 9.3 EER up to 20 tons 9.0 EER above 30 tons
Package Terminal Systems	9 EER	10 – [0.91 * cap/1000]	10.9 – [0.213 * cap/1000] EER
Water Source Heat Pumps <=30 tons >30 tons	 10.5 EER 10.5 EER	up to 5.4 tons– 9.3 EER >5.4 Tons 10.5 10.5 EER	up to 5.4 tons– 12.0 EER >5.4 Tons 12.0 EER 12.0 EER
Central DX AC Systems · >30 to 63 tons · > 63 tons	8.5 EER 8.5 EER	8.5 EER 8.2 EER	9.5 EER 9.5 EER
GWSHPs	11 EER		3.1 COP

Electric Chillers

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

<u>Algorithms</u>

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

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

<u>Definition of Variables</u>

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

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

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

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

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

Electric Chillers
(Applicable to project commitments before 7/16/2002)

Component	Type	Value	Source
Tons	Variable	From Rebate Application	
kW/ton$_b$	Fixed	**Water Cooled Chillers (<70 tons)** *Baseline:…………… 0.93 kW/Ton* *ASHRAE Std 90.1-1989…..0.93 kW/Ton* **Water Cooled Chillers (70 to <150 tons)** *Baseline:…………… 0.86 kW/Ton* *ASHRAE Std 90.1-1989…..0.93 kW/Ton* **Water Cooled Chillers (150 to <300 tons)** *Baseline:…………… 0.72 kW/Ton* *ASHRAE Std 90.1-1989…..0.84 kW/Ton* **Water Cooled Chillers (=>300 tons)** *Baseline:…………… 0.64 kW/Ton* *ASHRAE Std 90.1-1989…..0.68 kW/Ton* **Air Cooled Chillers (<150 tons)** *Baseline:…………… 1.30 kW/Ton* *ASHRAE Std 90.1-1989…..1.41 kW/Ton* **Air Cooled Chillers (+150 tons)** *Baseline:…………… 1.30 kW/Ton* *ASHRAE Std 90.1-1989…..1.41 kW/Ton*	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	JCP&L metered data[7]
Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	

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

Electric Chillers
(Applicable to project commitments on or after 7/16/2002)

Component	Type	Value	Source
Tons	Variable	From Rebate Application	
kW/ton$_b$	Fixed	**Water Cooled Chillers (<70 tons)** *Baseline:…………… 0.79 kW/Ton* *ASHRAE Std 90.1-1999.....0.84 kW/Ton* **Water Cooled Chillers (70 to <150 tons)** *Baseline:…………… 0.79 kW/Ton* *ASHRAE Std 90.1-1999.....0.84 kW/Ton* **Water Cooled Chillers (150 to <300 tons)** *Baseline:…………… 0.718 kW/Ton* *ASHRAE Std 90.1-1999.....0.718 kW/Ton* **Water Cooled Chillers (=>300 tons)** *Baseline:…………… 0.639 kW/Ton* *ASHRAE Std 90.1-1999.....0.639 kW/Ton* **Air Cooled Chillers (<150 tons)** *Baseline:…………… 1.256 kW/Ton* *ASHRAE Std 90.1-1999....1.256 kW/Ton* **Air Cooled Chillers (+150 tons)** *Baseline:…………… 1.256 kW/Ton* *ASHRAE Std 90.1-1999.....1.256 kW/Ton*	Collaborative agreement, C/I baseline study, E-Cube Inc. Study, May 2003
kW/ton$_q$	Variable	ARI Standards 550/590-Latest edition	Application
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L metered data[8]
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.

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

Variable Frequency Drives

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

<u>Algorithms</u>

Energy Savings = Motor HP X kWh/motor HP

There are no Demand Savings for VFD's

<u>Definitions of Variables</u>

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

Variable Frequency Drives

Component	**Type**	**Value**	**Source**
Motor HP	Variable	Nameplate	Application
kWh/motor HP	Fixed	1,653 for VAV air handler systems. 1,360 for chilled water pumps.	JCP&L metered data for VFD's[9] and chillers[10].
Time Period Allocation Factors	Fixed	Summer/On-Peak 22% Summer/Off-Peak 10% Winter/On-Peak 47% Winter/Off-Peak 21%	

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

C&I Construction Gas Protocols

Gas Chillers

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

Algorithms

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

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

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

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

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

Definition of Terms

VBE_q = Vacuum Boiler Efficiency

BE_b = Efficiency of the baseline gas boiler

IR = Input Rating = Therms/hour

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

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

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

COP = Efficiency of the gas chiller

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

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

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

Gas Chillers
(Applicable to project commitments before 7/16/2002)

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** 1.30 kW/Ton **100 to 150 tons** 0.86 kW/ton **150 to <300 tons:** 0.72 kW/Ton **300 tons or more:** 0.64 kW/ton	Collaborative agreement and C/I baseline study Assumes new electric chiller baseline using air cooled unit for chillers less than 100 tons;water cooled for chillers greater than 100 tons
kW/Ton_{gc}	Variable		Manufacturer Data
COP	Variable		Manufacturer Data
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L Measured data[11]
Electric Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	

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

Gas Chillers
(Applicable to project commitments on or after 7/16/2002)

Component	Type	Value	Source
VBE_q	Variable		Rebate Application or Manufacturer Data
BE_b	Fixed	75%	ASHRAE 90.1
IR	Variable		Rebate Application or Manufacturer Data
Tons	Variable		Rebate Application
MMBtu	Variable		Rebate Application
kW/Ton_b	Fixed	**<100 tons** 0.79kW/Ton **100 to 150 tons** 0.79 kW/ton **150 to <300 tons:** 0.718 kW/Ton **300 tons or more:** 0.639 kW/ton	Collaborative agreement and C/I baseline study. Assumes new electric chiller baseline using air cooled unit for chillers less than 100 tons; water cooled for chillers greater than 100 tons
kW/Ton_{gc}	Variable		Manufacturer Data
COP	Variable		Manufacturer Data
CF	Fixed	67%	Engineering estimate
EFLH	Fixed	1,360	JCP&L Measured data[12]
Electric Time Period Allocation Factors	Fixed	Summer/On-Peak 45% Summer/Off-Peak 39% Winter/On-Peak 7% Winter/Off-Peak 9%	

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

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

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

Gas Fired Desiccants

Protocols to be developed.

Gas Booster Water Heaters

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

<u>Algorithms</u>

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

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

Gas Usage Increase = IR X EFLH

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

<u>Definition of Variables</u>

IR = Input Rating in Btuh

EFF = Efficiency

CF = Coincidence Factor

EFLH = Equivalent Full Load Hours

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

Gas Booster Water Heaters

Component	Type	Value	Source
IR	Variable		Application Form or Manufacturer Data
CF	Fixed	50%	PSE&G
EFLH	Fixed	1,000	PSE&G
EF	Variable		Application Form or Manufacturer Data

Component	Type	Value	Source
Electric Time Period Allocation Factors	Fixed	*Requires additional research*	

Water Heaters

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

Algorithms

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

Definition of Variables

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

EF_b = Energy factor of the baseline water heater. Calculated as 0.62 – (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	0.544	Federal EPACT Standard
Baseline Usage	Fixed	277	DOE/FEMP website http://www.eren.doe.gov/femp/pro
Time Period Allocation Factors	Fixed	Summer 50% Winter 50%	1

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

Furnaces and Boilers

This prescriptive measure targets the use of smaller-scale boilers (less than or equal to 1500 MBH) and furnaces (no size limitation) in all commercial facilities. Larger sized boilers are treated under the custom measure path. The measurement of energy savings for C&I gas fired furnaces and boilers is based on algorithms with key variables (i.e. Annual Fuel Utilization Efficiency, capacity of the furnace, EFLH) provided by manufacturer data or utility data.

<u>Algorithms</u>

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

<u>Definition of Variables</u>

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

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

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

EFLH = Equivalent full load heating hours

Furnaces and Boilers

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

1. Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.

Commercial and Industrial Building Operation & Maintenance Program

Protocols

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

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

<u>Algorithms</u>

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

<u>Definition of Variables</u>

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

Protocols

Compressed Air Systems

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

Residential Air Conditioning Cycling Load Control Program

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

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 Generation

Protocols

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

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

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

All of the customer sited generation protocols report the gross energy production from the 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, sub-metering must be installed to measure the gross output of the generating systems capable of recording at 15 minute intervals for a minimum of 12 months.

Sub-Metering Samples Size by technology:

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

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

Algorithms

Photovoltaic Systems

PVWATTS will be used to estimate the energy generated by photovoltaic systems. PVWATTS was developed and is available through the Renewable Resource Data Center (RReDC). The RReDC is supported by the National Center for Photovoltaics (NCPV) and managed by the Department of Energy's Office of Energy Efficiency and Renewable

Energy. The RReDC is maintained by the Distributed Energy Resources Center of the National Renewable Energy Laboratory. The subroutines used to calculate the energy generation are based on information developed by Sandia National Laboratories. PVWATTS is available through the RReDC website, http://rredc.nrel.gov/solar/codes_algs/PVWATTS/.

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

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

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

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

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

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

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

Photovoltaic Systems

Component	Type	Value	Sources
System Rated Output (SRO)	Variable		Application Technical Worksheet
Fixed, Single, 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	Application Technical Worksheet

Component	Type	Value	Sources
		(Wilkes Barre PA, Newark NJ, Philadelphia PA, and Atlantic City, NJ	
ELCC	Fixed	65%	(http://www.nrel.gov/ncpv/documents/pv_util.html)
WELCC	Fixed	8%	Monitored system data from White Plains NY

Wind Systems

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

Annual Energy Output (kWh) is a function of:

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

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

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

Wind Systems

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

Component	Type	Value	Sources
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 recovery	Variable		Project specific based on estimated duty cycle
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.

Appendix A
Measure Lives

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

PROGRAM/Measure	Measure Life
Residential Programs	
Energy Star Appliances	
ES Refrigerator post 2001	17
ES Refrigerator 2001	17
ES Dishwasher	13
ES Clotheswasher	20
ES RAC	10
Energy Star Lighting	
CFL	6.4
Recessed Can Fluourescent Fixture	20
torchiere residential	10
Fixtures Other	20
Energy Star Windows	
WIN-heat pump	20
WIN-gas heat/CAC	20
WIN-gas No CAC	20
Win-elec No AC	20
Win-elec AC	20
Residential New Construction	
SF gas w/CAC	20
SF gas w/o CAC	20
SF oil w/CAC	20
SF all electric	20
TH gas w/CAC	20
TH gas w/o CAC	20
TH oil w/CAC	20
TH all electric	20
MF gas w/AC	20
MF gas w/o AC	20
MF oil w/CAC	20
MF all electric	20
ES Clotheswasher	20
Recessed Can Fluor Fixture	20
Fixtures Other	20
Efficient Ventilation Fans w/Timer	10
Residential Electric HVAC	
CAC 13	15
CAC 14	15

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

Non-Residential Programs

C&I Construction	
Commercial Lighting — New	15
Commercial Lighting — Remodel/Replacement	15
Commercial Custom — New	18
Commercial Chiller Optimization	18
Commercial Unitary HVAC — New - Tier 1	15
Commercial Unitary HVAC — Replacement - Tier 1	15
Commercial Unitary HVAC — New - Tier 2	15
Commercial Unitary HVAC — Replacement Tier 2	15

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

Appendix 4: Comparison of Alternative Methodologies to Calculate Avoided NO_x Emissions

*The team completed an analysis of avoided emissions to determine if reductions from energy efficiency and renewable energy sources would offset at least 1.5 lbs/MWh of NO_x emissions. The methodology used in our analysis focused on the **generation-weighted average of the emissions of fossil fuel fired plants.** This is the fourth methodology listed below. We present alternative methodologies for informational purposes.*

Several methods may be employed to model the avoided emissions resulting from energy efficiency or renewable energy measures. These include:

1) A complete grid-system dispatch analysis;
2) A system mix analysis;
3) A surrogate plant analysis; or
4) A generation-weighted average of the emissions of fossil fuel fired plants.

A ***complete grid-system dispatch analysis*** considers the dispatch order and scheduling of specific fossil fuel-fired units (coal, oil, or natural gas) at each facility on the regional grid, providing the most comprehensive estimate of the avoided emissions. An analysis of this type may be based on historical data and/or on a unit dispatch model. The principal unit dispatch models are proprietary.[1]

The dispatch analysis methodology allows the analyst to compare the EERE measures with the actual generation of variably dispatched fossil fuel units for specific time periods. This methodology is very time consuming and resource intensive and is hard to justify for validating an avoided emissions rate already stipulated in a State NO_x trading regulation. However, the additional expense of this detailed approach can be justified to provide more precise estimates of displaced NO_x emissions resulting from a large renewable energy project, such as a large wind farm.[2] In such as case, a large premium obtained for Renewable Energy Certificates may justify the additional expense.

The ***system mix analysis*** uses the generation weighted average of **all** the plants in the electric generating system. In other words, the universe of plants covered by this methodology is not limited to fossil fuel generating plants but also includes nuclear and hydroelectric plants.

A major weakness of the system mix methodology is that it significantly underestimates the emission reductions resulting from EERE projects because it includes nuclear and

[1] However, some utilities will enter into agreements to share such data for analysis purposes on a confidential basis. In addition, some of the new generation tracking systems may provide sufficient data to conduct this analysis.

[2] See National Renewable Energy Laboratory, "Model State Implementation Plan (SIP) Documentation for Wind Energy Purchase in a State with Renewable Energy Set-Aside," http://www.eere.energy.gov/windandhydro/windpoweringamerica/sips.asp

hydroelectric generating plants, which do not produce emissions, in calculating the average displaced emissions. In reality, EERE almost always displaces fossil fuel generation because EERE generally has zero or very low fuel and operating costs, whereas fossil fueled generation has relatively high operating costs. Fossil fueled units also have the ability to vary their output relatively quickly.

In comparison, nuclear power and hydroelectric generation is almost never displaced by EERE measures. Nuclear plants cannot vary their output quickly and have relatively low marginal operating costs. Hydroelectric plants also have low marginal operating costs, and therefore, generation from other renewable energy rarely displaces that from hydroelectric power. In addition, hydroelectric plants have externally imposed storage limits and flow constraints that restrict the ability to meet unpredicted load changes. For these reasons, the generation at renewable energy plants and reductions in demand from energy efficiency programs will displace generation almost entirely at fossil fueled plants in the period from now through 2012.

The ***surrogate plant analysis*** calculates the emissions of the next new plant or unit that is likely to be added to the electric grid as a basis for determining what emissions would be avoided if the demand were reduced by energy efficiency measures or displaced by renewable energy generation. In New Jersey, under prevailing fuel prices and air quality regulations, the most likely new plant would be a combined cycle natural gas plant with best available NO_x control technology. With this approach, the calculated NO_x reductions would be below the 1.5 lbs/MWh stipulated in the NJ NO_x trading regulations. This approach is unrealistic in the short term because actual generation and energy efficiency displacement is spread across a wide range of fossil fueled generating units, some of which have relatively high NO_x emission rates. The surrogate plant methodology may provide a reasonable estimate of the long-term avoided emissions if current trends continue. However, the actual mix of plants may be very different in the future depending on fuel prices and public policy.

A fourth methodology – and the one relied upon by the project team – is an analysis based on the ***generation-weighted average of the emissions of fossil fuel fired plants.*** This methodology is a reasonable approximation of the marginal emission rate, without the time and cost of a complete grid-system dispatch analysis.

Two independent analyses were conducted based on the generation-weighted average emissions of fossil fueled plants. Resource Systems Group, Inc. (RSG) performed the first analysis and relied on emissions and generation data from the EPA's eGRID 2002 database.[3] The emissions data in eGRID 2002 is based on emissions data collected in 2000. The list of facilities used for this assessment and their associated NO_x emission rates, generation, and primary fuel are included in Table 1.

The team included small facilities in the analysis even though such facilities do not influence the estimate significantly. In addition, it should be noted that although the

[3] Emissions & Generation Resource Integrated Database (eGRID) 2002.

primary fuel is listed for each facility, many facilities operate subordinate units that burn other fuels, often contributing to varying emission rates among a fuel group.

Based on the eGRID 2002 data, the team estimated the generation-weighted NO_x emissions for both annual operation and ozone-season operations. The annual avoided NO_x emission rates are 2.7 lbs/MWh, and the ozone season rates are 2.2 lbs/MWh. Both of these rates are well above the 1.5 lbs/MWh avoided emissions rate that is currently stipulated in the NJ NO_x trading regulations. Even removing several of the largest and most inefficient coal burning facilities from the analysis is not enough to drop the estimate below 1.5 lbs/MWh. Therefore, the project team believes that 1.5 lbs/MWh is a reasonable (and probably conservative) value for avoided emissions credit in 2005. However, it should be noted that this emission rate is expected to decline in the future as older, dirtier generating plants are replaced by more efficient plants with superior NO_x control technology.

New Jersey DEP provided the second analysis,[4] and the project team ultimately relied on this analysis for the calculations of emission reductions contained in the body of this report. The NJ DEP analysis was similar to the RSG analysis because both methodologies were based on the generation weighted average of emissions from fossil fueled plants in New Jersey. The two major differences were that the DEP analysis relied on: (1) plants operating in 2004 (compared to the 2000 data in the eGRID/RSG analysis); and (2) plants with a capacity of more than 15 MW (compared to all fossil fuel plants in the RSG analysis).

The NJ DEP data provided an estimate of 1.85 lbs/MWh for the average avoided emissions rate in 2004. DEP also projected future average avoided ozone season NO_x emission rates based on data about new plants completed, under construction, or expected to be retired. In addition, the NJ data included information projecting the installation of NO_x control systems. Based on this information, DEP estimated the generation-weighted NO_x emissions rates to be 1.65 lbs/MWh in 2005, 1.24lbs/MWh in 2007, and 0.97lbs/MWh in 2008.

Both the RSG and DEP analyses validate the use of 1.5 lbs/MWh for 2005. The analysis team recommends the use of the DEP estimates beyond 2005 as they are based on more recent data and incorporate projected changes in control technology and the fossil fueled generation mix. These DEP estimates beyond 2005 have been incorporated into the projections for each of the four alternative scenarios in the report.

[4] Tom McNevin, Bureau Air Quality Planning, NJ DEP, Personal Communication, September 2005.

Table 1: Fossil Fueled Generation Units Used In the Generation Weighted Analysis of Variably Dispatched Plants in New Jersey.

Name	Fuel	Capacity Factor	Capacity (MW)	Annual Net Generation (MWh)	Ozone Season Net Geneation (MWh)	Nox Rate Annual (lbs/MWh)	Nox Rate Ozone Season (lbs/MWh)
Chambers Cogeneration LP	Coal	57%	285	1,433,629	597,345	0.8	0.8
Hudson Generating Station	Coal	31%	1229	3,307,562	1,570,699	5.6	4.3
Logan Generating Plant	Coal	56%	230	1,126,726	469,469	0.9	0.9
Mercer Generating Station	Coal	44%	768	2,926,302	1,376,294	8.9	6.2
B L England	Coal	30%	484	1,256,331	550,443	8.3	6.5
Deepwater	Coal	17%	259	377,442	193,346	5.9	5.2
Howard Down	Coal	10%	71	62,270	35,368	10.4	10.0
Bayonne Generating Station	Distillate Oil	0%	43	596	516	16.8	8.1
Carlis Corner	Distillate Oil	1%	84	9,532	5,896	7.6	5.1
Cedar Station	Distillate Oil	3%	63	18,508	10,075	4.2	3.2
Middle Station	Distillate Oil	1%	80	7,408	3,686	7.3	6.1
Missouri Avenue	Distillate Oil	1%	56	6,503	3,686	8.0	5.9
National Park Generating Station	Distillate Oil	0%	19	146	142	9.1	3.9
Werner	Distillate Oil	0%	159	5,100	2,125	2.3	2.3
Forked River	Natural Gas	7%	77	46,764	22,135	5.6	4.9
Anheuser Busch Inc Newark Brewery	Natural Gas	66%	13	75,513	31,464	1.3	1.3
Asbury Park Press Inc	Natural Gas	53%	1	6,044	2,518	1.6	1.6
Aventis Pharmaceuticals	Natural Gas	81%	4	26,529	11,054	1.7	1.7
Bayonne Cogen Plant	Natural Gas	84%	192	1,409,971	587,488	0.4	0.4
Bayville Central Facility	Natural Gas	27%	1	3,008	1,253	1.7	1.7
Bergen Generating Station	Natural Gas	22%	765	1,485,866	840,246	1.2	0.9
Bristol Myers Squibb Co	Natural Gas	89%	10	74,373	30,989	1.4	1.4
Burlington Generating Station	Natural Gas	3%	807	228,102	157,538	0.9	0.7
Calpine Newark Inc	Natural Gas	48%	65	271,413	113,089	0.4	0.4
Calpine Parlin Inc	Natural Gas	32%	141	389,001	162,084	0.2	0.2
Camden Cogen LP	Natural Gas	70%	157	969,174	403,823	0.5	0.5
Cumberland	Natural Gas	5%	99	40,545	19,619	1.9	1.6
Eagle Point Cogeneration	Natural Gas	87%	225	1,712,749	713,645	1.0	1.0
Edison Generating Station	Natural Gas	3%	510	114,502	71,238	3.8	2.5
Essex Generating Station	Natural Gas	4%	596	186,746	103,326	2.9	2.2
Fiber Mark Technical Specialties Inc	Natural Gas	33%	2	5,801	2,417	1.8	1.8
Gilbert	Natural Gas	5%	606	243,950	101,646	1.4	1.8
Glenn Gardner	Natural Gas	1%	157	16,837	7,016	2.1	2.1
Green Tree Chemical Technologies Inc	Natural Gas	76%	5	30,141	12,559	2.2	2.2
Hoffmann Laroche Inc	Natural Gas	61%	12	63,694	26,539	1.4	1.4
Hunterdon Cogeneration Facility	Natural Gas	82%	4	29,322	12,218	1.2	1.2
Kenilworth Energy Facility	Natural Gas	85%	30	224,139	93,391	1.2	1.2
Kms Crossroads	Natural Gas	78%	7	47,629	19,846	1.5	1.5
Lakewood Cogeneration LP	Natural Gas	26%	239	550,345	229,311	0.1	0.1
Linden Cogen Plant	Natural Gas	64%	762	4,289,494	1,787,289	0.4	0.4
Linden Generating Station	Natural Gas	5%	778	346,952	201,210	1.2	1.6
Lowe Paper Co Division Of Simkins Industries	Natural Gas	44%	3	11,574	4,822	1.4	1.4
M&M Mars	Natural Gas	82%	9	63,277	26,365	1.7	1.7
Merck Rahway Power Plant	Natural Gas	47%	11	44,164	18,402	1.0	1.0
Mickleton Station	Natural Gas	3%	71	21,574	14,313	4.3	2.7
Milford Power LP	Natural Gas	0%	33	203	85	1.4	1.4
Montclair Cogeneration Facility	Natural Gas	91%	4	32,656	13,607	0.9	0.9
Newark Bay Cogeneration Project	Natural Gas	52%	135	619,417	258,090	1.1	1.1
Novartis Pharmaceuticals	Natural Gas	59%	3	14,550	6,063	1.5	1.5
Pedricktown Cogeneration Plant	Natural Gas	19%	135	228,139	95,058	0.4	0.4
Pharmacia Corp	Natural Gas	18%	5	7,434	3,097	1.8	1.8
Prime Energy LP	Natural Gas	72%	83	521,052	217,105	1.1	1.1
Roche Vitamins Inc	Natural Gas	81%	45	320,477	133,532	1.2	1.2
Rowan University	Natural Gas	53%	2	6,909	2,879	1.8	1.8
Sayreville	Natural Gas	1%	463	21,511	8,963	1.5	2.9
Sayreville Cogeneration Facility	Natural Gas	55%	430	2,063,072	859,613	1.2	1.2
Schering Corp Cogeneration Facility	Natural Gas	88%	8	63,086	26,286	2.0	2.0
Schweitzer Mauduit International Inc	Natural Gas	29%	4	9,056	3,773	1.6	1.6
Sherman Avenue	Natural Gas	6%	113	61,976	32,070	0.9	1.2
Trigen Trenton Energy Co	Natural Gas	83%	12	87,464	36,443	2.9	2.9
University Medicine Dentistry	Natural Gas	89%	11	81,669	34,029	1.4	1.4
Vineland Cogeneration Plant	Natural Gas	19%	53	88,095	36,706	0.4	0.4
West Station	Oil	4%	27	10,169	5,721	13.5	10.0
Kearny Generating Station	Residual Oil	0%	1165	39,974	29,376	4.1	3.5
Sewaren Generating Station	Residual Oil	4%	576	216,431	136,897	1.7	1.3

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The MARO pilot project represents the first effort in the country to seek to obtain credit under a Clean Air Act (CAA) State Implementation Plan (SIP) for nitrogen oxide (NOx) emission reductions. This project came about because of state-funded incentive programs and projects for RE and EE. Specifically, the pilot project focuses on the New Jersey (NJ) SIP and efforts to facilitate attainment of the new, 8-hour ozone standard under CAA by implementing selected categories of RE and EE programs and projects funded by the New Jersey Clean Energy Program (NJ CEP) of the New Jersey Board of Public Utilities (NJ BPU).

15. SUBJECT TERMS

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