New Jersey's Clean Energy Program
Energy Impact Evaluation

Customer On-site Renewable Energy Program (CORE)

FINAL

September 4, 2009

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1. Executive Summary

KEMA has been contracted by the New Jersey Board of Public Utilities' Office of Clean Energy (OCE) to perform an evaluation of energy impacts of New Jersey's Clean Energy Program's (NJCEP) energy efficiency and renewable programs. The results of this impact evaluation will assist OCE in determining the net and gross energy impacts of the programs. The results will also help the OCE update and modify the *Protocols to Measure Resource Savings* (Protocols)[1].

KEMA submitted the *New Jersey's Clean Energy Program Energy Impact Evaluation Final Work Plan* (Final Work Plan)[2] to OCE on October 8, 2007. The Final Work Plan as specified in the RFP mirrors the information provided in the bid proposal modified to reflect adjustments discussed at the kick-off meeting and subsequent discussions with OCE, the BPU Program Coordinator, the market managers and the utilities. The Final Work Plan presents individual research plans for the following six program areas.

1. Residential Electric and Gas HVAC Programs (Cool Advantage and Warm Advantage)
2. Residential New Construction Programs
3. ENERGY STAR Products Program
4. Commercial and Industrial Programs (SmartStart)[3]
5. Combined Heat and Power Program
6. Customer On-site Renewable Energy Program (CORE)[4]

[1] *New Jersey's Clean Energy Program, Protocols to Measure Resource Savings,* Revisions to September 2004 Protocols, December 2007.

[2] *New Jersey's Clean Energy Program Energy Impact Evaluation Final Work Plan.* Prepared by KEMA for New Jersey Board of Public Utilities, Office of Clean Energy. October 8, 2007.

[3] The SmartStart work plan was updated and approved by OCE in May 2008.

New Jersey's Clean Energy Program Energy Impact Evaluation Updated SmartStart Work Plan. Prepared by KEMA for New Jersey Board of Public Utilities, Office of Clean Energy. May 2, 2008.

[4] The comprehensive CORE work plan was updated and approved by OCE in November 2008.

This report presents the results of KEMA's comprehensive impact evaluation of the Customer On-site Renewable Energy Program.

1.1. Program Overview

New Jersey's Clean Energy Program (NJCEP) offers support to help implement renewable energy generation technologies and systems. Through the Customer On-Site Renewable Energy Program (CORE)[5], the NJCEP offered rebates to New Jersey residents, commercial, public and non-profit entities for the installation of qualified clean energy generation systems in New Jersey. The CORE Program supports a variety of technologies, such as solar, wind, and biopower. The impact evaluation was limited to the photovoltaic (PV) component of the CORE Program, covering residential and non-residential participants from program years 2001 to 2006.

The CORE Program closed to new applicants on December 31, 2008. A new program, Renewable Energy Incentive Program (REIP), offers incentives and support services needed for participants to build on-site renewable energy projects using solar, wind, and biopower technologies. The most dramatic change pertains to upfront incentive eligibility. Under the new program' eligibility rules, residential systems larger than 10 kW[6] and commercial systems larger than 50 kW are no longer eligible for upfront incentives. These larger systems are still eligible to participate in the Solar Renewable Energy Certificate Program (SREC). These changes had not occurred during the program period included in the CORE impact evaluation and therefore any effects of these changes were beyond the scope of this report. However, KEMA's report addresses these changes in several places.

1.2. Approach

The NJCEP energy impact evaluation has two broad objectives:

New Jersey's Clean Energy Program Energy Impact Evaluation CORE Work Plan. Prepared by KEMA for New Jersey Board of Public Utilities, Office of Clean Energy. November 14, 2008.

[5] Customer On-site Renewable Energy Program is also referred to in this report as the "Program" and "CORE Program."

[6] The first 10 kW of residential systems is eligible for a rebate. For example, a 12 kW residential system is eligible for a rebate for 10 kW.

1. To revise the savings calculation Protocols so that going forward the calculations using these Protocols provide (more) accurate statements of savings accomplishments.

2. To provide a retrospective assessment of Program accomplishment, as part of a due diligence review of past utility Program effectiveness on behalf of ratepayers.

In this report KEMA refers to the first of these broad objectives as the Prospective Analysis and the second objective as the Retrospective Impact Analysis. KEMA's comprehensive evaluation approach incorporated primary data collection (telephone surveys and on-site visits), engineering analysis, and ratio estimation techniques to accomplish the objectives of the Retrospective Impact Analysis.

The objective of the Prospective Analysis, recommended updates to the current energy savings calculation methods described in the Protocols, was accomplished based on an engineering review of Protocols and the incorporation of the Retrospective Impact Analysis results. Because the results from the Retrospective Impact analysis are used in the Prospective Analysis, we present the Retrospective Impact Analysis first.

1.3. Retrospective Impact Analysis

1.3.1. Overview of Approach

KEMA used the statistical procedure of ratio estimation to develop estimates of evaluation verified gross and net impacts. There are two basic steps to the process.

1. **Verify energy savings in a sample of participants.** For a sample of participants that installed PV systems during program years 2001 through 2006[7], KEMA estimated actual energy output under current conditions. KEMA collected information for this estimation from a combination of telephone interviews and on-site visits. The telephone interview confirmed system installation and collected information about program attribution, satisfaction, and other process issues. The on-site visits were conducted by trained engineers that confirmed system installation, assessed the quality of the installation,

[7] KEMA developed a stratified random sample of Program participants based on their sector (residential, commercial, school, or other), program year, and the size of their system. KEMA completed a total of 400 phone interviews and 73 on-site visits.

obtained inverter readings, and took other measurements required to calculate system output.

2. **Expand sample results to the population of participants.** The sample results obtained in Step 1 were expanded to the population by calculating the ratios of verified-to-tracked (gross generation adjustment factor) and attributable-to-verified (attribution factor) for the sample.

The adjustment factors estimated from the data collection and analysis tasks include:

- **Gross savings adjustment factor:** This factor adjusts tracking gross savings for installation and changes based on the engineering review. Applying the gross savings adjustment factor to tracking gross savings produces the estimate of verified gross savings.
- **Attribution factors:** This factor adjusts verified gross savings for program attribution. That is, the fraction of verified gross savings that occurred because of the Program.
- **Realization rate:** This factor combines the gross savings adjustment factor and the attribution factor. (It is the ratio of net savings to tracking gross savings.) That is, the fraction of tracking gross savings that occurred because of the Program.

1.3.2. Summary of Findings

This section presents the results of the Retrospective Impact analysis. Evaluation verified gross and net savings estimates are provided for kW and kWh for the overall program and broken out by REIP eligibility status. The REIP breakouts provide a method of using the results of the CORE Program Retrospective Impact Analysis to make meaningful inferences about the structure of the new program (REIP).

1.3.2.1. Gross Adjustment Factors

Table 1-1, provides the gross generation adjustment factors for kWh and kW for the CORE Program overall and broken out by REIP eligibility. Overall, the CORE Program has done a good job estimating gross generation.

The gross adjustment factors represent how accurately the Program estimated energy (kWh) and capacity (kW) of the installed systems. A gross adjustment factor of 100 percent would mean that the Program's estimate was perfect. Gross adjustment factors less than 100 percent mean that the Program over-estimated. In contrast, gross adjustment factors greater than 100 percent indicate that the program under-estimated.

At the portfolio level, KEMA found that the energy produced per year is 95.6 percent (between 90.3 percent and 100.9 percent) of the estimate from the tracking database (rated system kW times 1200 hours/year). The estimate of actually-installed capacity is 99.7 percent of the capacity recorded in the tracking database (90 percent confidence interval is ±1.5 percent). The lower Gross Adjustment for kWh is not completely attributable to errors in tracked installed capacity of the panels, but due to other factors such as downtime, shading, and system efficiency.

Table 1-1
Gross Adjustment Factors for kWh and kW[8]

Gross Energy (kWh) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	**N**	**Gross Adjustment Factor**	**SE**	**Lower Bound**	**Upper Bound**
All	**73**	**95.6%**	**3.2%**	**90.3%**	**100.9%**
Res REIP Eligible	24	**88.6%**	3.8%	82.0%	95.1%
Res REIP Ineligible	21	**88.7%**	1.8%	85.6%	91.8%
Nonres REIP Eligible	17	**83.6%**	8.7%	68.3%	98.8%
Nonres REIP Ineligible	11	**105.6%**	3.1%	100.0%	111.2%

Gross Capacity (kW) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	**N**	**Gross Adjustment Factor**	**SE**	**Lower Bound**	**Upper Bound**
All	**73**	**99.7%**	**0.9%**	**98.2%**	**101.2%**
Res REIP Eligible	24	**100.1%**	0.4%	99.4%	100.7%
Res REIP Ineligible	21	**100.1%**	0.1%	100.0%	100.2%
Nonres REIP Eligible	17	**93.2%**	8.0%	79.2%	107.2%
Nonres REIP Ineligible	11	**100.6%**	1.1%	98.7%	102.5%

1.3.2.2. Attribution Adjustment Factor

The attribution factor is the theoretical proportion of the total energy that would be generated in a system's lifetime, or of total capacity, that is attributable to the Program. "Attributable to the program" means that this generation would not have occurred without the program. If an

[8] SE = Standard error of the estimate.

installation would have occurred entirely without the program, attribution is zero. If an installation would not have occurred at all without the program, attribution is 100 percent. In other words, attribution is 100 percent minus the rate of free ridership.

Table 1-2 shows the attribution adjustment factor, the ratio of program-attributed generation to evaluation verified gross generation, for the Program overall and by customer eligibility for REIP. As mentioned above, the REIP breakouts provide a method of using the results of the CORE Program Retrospective Impact Analysis to make meaningful inferences about the structure of the new program (REIP). The results of the attribution analysis are particularly striking and supportive of the new program design.

The overall attribution rate is 71 percent for annualized energy generation, and 70 percent for generating capacity. These are good results for a comprehensive PV program that serves residential and non-residential customers with the installation of systems of all sizes.

A closer look at the data shows some significant differences between REIP Eligible and REIP Ineligible customers. REIP Eligible customers are reporting higher levels of program attribution than REIP Ineligible customers. Nonresidential REIP Ineligible customers, systems larger than 50 kW attribute savings to the Program at half the rate of their REIP eligible counterparts. This difference is significant at the 99.5 percent level (p-value < 0.005). For residential customers, kWh attribution is 93.7 percent and 89.9 percent, and kW attribution is 89.4 percent and 83.6 percent for REIP Eligible and REIP Ineligible, respectively.

Table 1-2
Attribution Adjustment Factors by REIP Eligibility for kWh and kW

Attribution (kWh) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	**N**	**Attribution Factor**	**SE**	**Lower Bound**	**Upper Bound**
All	**375**	**71.0%**	**9.3%**	**55.7%**	**86.3%**
Res REIP Eligible	247	**93.7%**	1.7%	90.8%	96.5%
Res REIP Ineligible	55	**89.9%**	4.0%	83.2%	96.6%
Nonres REIP Eligible	55	**96.2%**	3.7%	90.1%	102.4%
Nonres REIP Ineligible	18	**45.6%**	14.9%	19.7%	71.6%

Attribution (kW) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	**N**	**Attribution Factor**	**SE**	**Lower Bound**	**Upper Bound**
All	**375**	**70.0%**	**8.2%**	**56.4%**	**83.5%**
Res REIP Eligible	247	**89.4%**	1.6%	86.8%	92.1%
Res REIP Ineligible	55	**83.6%**	3.5%	77.7%	89.4%
Nonres REIP Eligible	55	**90.8%**	3.3%	85.2%	96.4%
Nonres REIP Ineligible	18	**47.0%**	14.4%	21.9%	72.1%

1.3.2.3. Realization Rates

The Realization Rates are shown in Table 1-3. The realization rate is simply the product of the gross savings and attribution factor

Table 1-3
Realization Rates for kWh and kW, by REIP Eligibility

Realization Rate (kWh)					
	90% Confidence Interval				
Customer Segment	**N**	**Realization Rate**	**SE**	**Lower Bound**	**Upper Bound**
All	**375**	**67.9%**	**0.1%**	**67.8%**	**67.9%**
Res REIP Eligible	247	**82.9%**	0.2%	82.7%	83.2%
Res REIP Ineligible	55	**79.7%**	0.1%	79.5%	79.9%
Nonres REIP Eligible	55	**80.4%**	0.5%	79.5%	81.3%
Nonres REIP Ineligible	18	**48.2%**	0.9%	46.6%	49.7%

Realization Rate (kW)					
	90% Confidence Interval				
Customer Segment	**N**	**Realization Rate**	**SE***	**Lower Bound**	**Upper Bound**
All	**375**	**69.8%**	**0.0%**	**69.7%**	**69.8%**
Res REIP Eligible	247	**89.5%**	0.0%	89.5%	89.5%
Res REIP Ineligible	55	**83.6%**	0.1%	83.5%	83.7%
Nonres REIP Eligible	55	**84.6%**	0.5%	83.9%	85.4%
Nonres REIP Ineligible	18	**47.3%**	0.8%	45.9%	48.7%

* A 0.0% SE means that the standard error was less than 0.1% (but greater than 0%).

1.3.2.4. Application of Adjustment Factors

Table 1-4 summarizes the gross tracked, evaluation verified gross, and evaluation verified net generation and capacity for the Program. The tracking database reports that all of the systems installed during the period 2001-2006 together generate about 30.8 GWh/year. KEMA estimates that about 29.8 GWh/year are actually generated and 20.2 GWh/year are directly attributable to the Program[9]. The tracking database predicts that all of the systems installed between 2001 and 2006 have about 25.7 MW of capacity. KEMA estimates that the actual capacity is 25.6 MW and 17.9 MW are directly attributable to the program.

[9] The sector level adjustment factors were used to produce these results.

Table 1-4
Evaluation Verified Gross and Net Energy Impact

Sector	Gross Tracked MWh	Evaluation Verified Gross MWh	Evaluation Verified Net MWh	Gross Tracked kW	Evaluation Verified Gross kW	Evaluation Verified Net kW
Res REIP Eligible	10,933	9,683	9,069	9,111	9,118	8,156
Res REIP Ineligible	2,304	2,044	1,837	1,920	1,921	1,605
Nonres REIP Eligible	2,411	2,015	1,939	2,009	1,873	1,700
Nonres REIP Ineligible	15,190	16,040	7,317	12,659	12,735	5,989
Total	**30,838**	**29,781**	**20,161**	**25,698**	**25,648**	**17,451**

1.3.3. Recommendations

This section contains KEMA's recommendations to the Program based on the results of the Retrospective Impact Analysis. Note, these recommendations are limited because the CORE Program is closed to new applicant and there are fundamental differences between CORE and REIP (e.g.: eligibility).

Recommendation #1

KEMA recommends the Program consider using the attribution factors found in this evaluation to determine net impacts rather than the existing assumption that attribution is 100 percent. Furthermore, the Program could use the attribution factors for each of the separate REIP eligibility categories. Going forward, the BPU, OCE or the Program Coordinator could calculate estimated net impacts at any time by multiplying the program gross tracked savings estimate from the database by the attribution factors reported in this document.

Recommendation #2

The tracking database should be used to track gross kW and kWh. The tracking database should contain all data required for the calculations outlined in the Protocols. For example, the Protocols require an estimate for peak kW impact for summer and winter, but the tracking database did not provide these estimates. The tracking database should also include an estimate of annual energy (kWh) generated by each system. In addition, the program should make sure that the tracking database is kept up to date.

Tracked kW and kWh in the database should use information from follow-up site inspections by the REIP program team. In a few instances, KEMA learned during the on-site visits that the installed equipment was not always the same as the equipment recorded in the tracking database. This was not a systemic issue but something to consider as part of routine quality control measures.

1.4. Prospective Analysis

The results of the Retrospective Impact Analysis and a detailed engineering review of the kW and kWh calculations in the existing Protocols were used to recommend updates to the Protocols.

1.4.1. Overview of Approach

The Protocol review included an assessment of how the Program estimates annual solar energy (Energy Production (kWh)) and a review of the peak hour impact (Peak Demand (kW)) using equations established in the Protocols.

1.4.1.1. Energy Production (kWh)

The CORE Program has two methods for estimating annual solar energy delivered from a PV system to the electrical grid. The first method, Method 1,[10] relies on an engineered calculation using parameters relevant to each site (PVWatts). According to conversations with CORE staff[11] this method of estimation is used to assess projected individual system performance by the Clean Power Markets (CPM) (recently transferred to PJM GATS). The second method, Method 2, uses an empirically based deemed value. This deemed value is multiplied by the total kW_{STC} of PV systems installed to estimate annual solar energy. This value is used by the Market Managers to derive the Program's annual energy savings from all PV installations[12].

In order to assess the accuracy of Method 1 and Method 2, KEMA calculated several intermediate values. First, we calculated the amount of energy that would be expected if using the PVWats estimate (Method 1). Second, we calculated the amount of energy that would be expected if using the deemed value estimate (Method 2). Next, we annualized the kWh

[10] The terms Method 1 and Method 2 were created by KEMA for explanatory purposes.

[11] Telephone conversation with Mark Loeser, CORE Account Manager, NJCEP, 12/17/08.

[12] Email communication with Charlie Garrison, NJCEP Renewable Energy Market Manager, Honeywell, 01/20/09.

measurements we obtained from the on-site visits. Finally, we computed two System Performance ratios (one for Method 1 and one for Method 2) to verify the accuracy of the different methods.

1.4.1.2. Peak Demand (kW)

Although the Protocols require an estimate for peak kW impact for summer and winter, the tracking database did not include these estimates. We calculated a verified summer peak kW and a winter peak kW impact for the Program based on data gathered from the site visits and the Protocols. We then compared the verified peak kW impacts to the peak kW impacts calculated based on information from the database and the Program Protocols.

1.4.2. Summary of Findings

The results of the Protocol review first address energy production (kWh) followed by peak demand (kW).

1.4.2.1. Energy Production (kWh)

In order to assess the Protocols' methodology to estimate energy production for PV systems, we compared the Method 1 (PVWatts) and Method 2 (Deemed Value) estimates to the actual value measured during the on-site visit.

Table 1-5 shows the System Performance (SP) Ratio for Method 1 and Method 2 as compared to the measured value. The SP Ratio is shown for all systems and by the REIP eligibility category. SP Ratios greater than 1.0 indicate that the actual measured kWh is greater than the estimate provided by Method 1 or Method 2. In other words the Protocol estimate is lower than the measured value. SP Ratios less than 1.0 denotes that the actual measured kWh value is less than the calculated estimate. In other words the Protocols estimate is higher than actual.

Table 1-5
Method 1 and Method 2 Comparison

System Size	Sample Size	Method 1 (PVWatts) SP Ratio	Method 1 (PVWatts) 90% confidence interval	Method 2 (Deemed) SP Ratio	Method 2 (Deemed) 90% confidence interval
All Systems	73	1.06	1.01 – 1.11	0.96	0.90 – 1.01
Res REIP Eligible	24	1.01	0.95 – 1.06	0.89	0.82 – 0.95
Res REIP Ineligible	21	0.99	0.95 – 1.02	0.89	0.86 – 0.92
Nonres REIP Eligible	17	1.01	0.94 – 1.07	0.84	0.69 – 0.98
Nonres REIP Ineligible	11	1.12	1.05 – 1.19	1.06	1.01 – 1.11

It can be seen from Table 1-1 that both methods provided a fairly close estimate of the actual kWh measurements for systems overall. The Method 1 (PVWatts) SP Ratio for all systems of 1.06 indicates that Method 1 underestimated production by 6.0 percent. The Method 2 (Deemed Value) SP Ratio for all systems of 0.96 indicates that Method 2 (Deemed Value) overestimated production by 4.0 percent.[13]

When broken down by system size and type, for systems 50 kW or less (REIP Eligible), Method 1 (PVWatts) provided quite accurate estimates of energy production, whereas Method 2 (Deemed Value) did not. Conversely, for Nonresidential REIP Ineligible PV systems Method 2 provided a closer estimate to actual kWh measurements, although both methods predicted lower kWh values than actual. It is these larger (>50 kW) nonresidential systems which tend to skew energy production estimates lower (resulting higher SP ratios) for All Systems.

1.4.2.2. Peak Demand (kW)

In addition to installed capacity and annual electrical production, the Protocol requires an estimate of peak demand impact based on research conducted by Richard Perez of SUNY Albany for the New Jersey Board of Public Utilities. The peak demand impact is a measure of the likely reduction in the utility peak due to the installation of photovoltaic systems. As the

[13] This is equivalent to the kWh Gross Savings Adjustment Factor reported in the Retrospective Impact Analysis because the Retrospective Impact Analysis uses the Method 2 (Deemed Value) estimates recorded in the Program tracking database.

demand for electricity delivery through aging infrastructure grows, reduction in peak demand will be increasingly important to prevent rolling blackouts or other power system problems related to utility peaks.

The effective load carrying capacity indicates the potential portion of the system rated output that will be available during a utility peak. Perez et al developed the effective load carrying capacity factors through research and sophisticated analytical methods.[14,15] In simple terms, Perez et al determined when the utility peak occurred, estimated the solar irradiance during the utility peak, and estimated the probable portion of rated capacity that would be available during peak.

KEMA identified the following three issues the Program should consider with regards to its use of the Effective Load Carrying Capacity (ELCC) to estimate peak impact for summer.

1. The ELCC was estimated based on time of the existing utility peak. Rate structures and Programs that discourage electrical use during the peak period may cause the utility peak to shift over time thereby changing the ELCC.

2. The ELCC factor that is used is too high.

3. Estimating the peak impact based on the ELCC is inconsistent with the approach used in the rest of the Protocols.

KEMA also identified the following two issues the Program should consider with regards to its use of the Winter Effective Load Carrying Capacity (WELCC) to estimate winter peak impact.

1. The Protocols state that the summer and winter peak impacts are based on research by Richard Perez. We were unable to find research supporting the WELCC. In addition, the Protocols state that WELCC is estimated based on "monitored system data from White Plains NY". We were unable to find additional information on this source. As a result, we are unable to assess the validity of the WELCC value used in the Protocols.

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[14] Perez, Richard, *Determination of Photovoltaic Effective Capacity for New Jersey*, Project Manager: Cassandra Kling, BPU found at http://www.clean-power.com/research/capacityvaluation/ELCC_New_Jersey.pdf (accessed 24 June 2009)

[15] Perez, R., R. Margolis, M. Kmiecik, M. Schwab, and M. Perez, *Update Effective Load-Carrying Capability of Photovoltaics in the United States*, Conference paper NREL CP-620-40068, June 2006

2. The Protocols indicate that coincident peak demand savings in winter are not applicable and no time periods are provided defining the winter peak. Therefore, we were unable to use a time period defined by the Protocol to estimate the winter peak impact.

1.4.3. Recommendations

This section contains KEMA's Energy Production (kWh) and Peak Demand (kW) recommendations to the Program based on the Prospective Analysis.

1.4.3.1. Energy Production (kWh)

Recommendation #1

KEMA recommends the Program continue its use of PVWatts to calculate energy production and discontinue its deemed value method for purposes of reporting energy production to the BPU. The required input to the PVWatts model is already collected for each installed PV system by the CORE Program though its customer application technical worksheet and on-site inspection documentation. More specifically, KEMA is recommending the Program calculate energy production system-by-system with the data already collected during the Program's site inspections. The increase in accuracy from the system-by-system calculation approach should require minimal additional cost.

The NJCEP has issued a guidebook which contains the present processes and procedures by which the Renewable Energy Incentive Program (REIP) is administered by the Renewable Energy Market Managers.[16] It should be noted that the REIP is currently in transition from Clean Power Markets platform to the Generation Attributes Tracking System (GATS) operated by PJM. In the guidebook, PVWatts continues to be the calculation method by which kWh production for systems less than 10 kW is estimated for the purposes of issuing Solar Renewable Energy Certificates (SRECs). Systems larger than 10 kW are awarded SRECs on the basis of self reported or electronically reported PV energy production.

[16] Renewable Energy Incentive Program Guidebook, January 2009 version 1.0. New Jersey's Clean Energy Program, New Jersey Board of Public Utilities.

Recommendation #2

KEMA recommends the Program consider two changes to the PVWatts calculation methodology.

1.) In instances where arrays of panels at a site are at different tilt angles, orientations, or have different shading, the PVWatts calculations should be performed separately for each array and then added for the total system.

2.) Incorporation of a shade factor. Shading was found to be significant at many of the sites visited. On average shading decreased the solar radiation reaching the PV systems by 6.3 percent. To arrive at an overall system derate factor, the base derate factor should be multiplied by a factor for shading. This factor is not currently included in the base derate factor, but it is collected by the CORE Program. The calculation is performed as follows:

System derate factor = Base derate factor x Shade factor

Where:

System derate factor	=	Value entered into the PVWatts calculator to derate PV panel DC rating to an AC rating.
Base derate factor	=	Derate factor = 0.77 (default value).
Shade factor	=	100 percent minus percent shading (decimal value).

1.4.3.2. Peak Demand (kW)

Recommendation #1

The Program should consider periodically reviewing the load curves for the New Jersey utilities. If the peak load shifts substantially, the ELCC should be recalculated based on the new peak.

Recommendation #2

KEMA recommends the ELCC be reduced from 65 percent to 50 percent to more accurately reflect the types of systems installed.

Recommendation #3

KEMA recommends the Program revise the Protocols to include the average kW over the peak. This metric offers program planners a definition that is consistent with the rest of the Program kW metrics. However, since the ELCC method is useful for utilities, we also recommend that the Program continue to track peak kW impact based on this method with the revised ELCC factor.

Recommendation #4

KEMA recommends the Program document the basis for the WELCC. The documentation should be available for independent review and analysis. In the absence of documentation, revise the Protocols to include the average kW over the winter peak. This metric offers program planners a definition that is consistent with the rest of the Program kW metrics.

2. Introduction

KEMA has been contracted by the New Jersey Board of Public Utilities' Office of Clean Energy (OCE) to perform an evaluation of energy impacts of New Jersey's Clean Energy Program's (NJCEP) energy efficiency and renewable programs. The results of this impact evaluation will assist OCE in determining the net and gross energy impacts of the programs. The results will also help the OCE update and modify the *Protocols to Measure Resource Savings* (Protocols)[17].

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2.1. Program Overview

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KEMA's evaluation focused on the solar electric (photovoltaic; PV) portion of the CORE Program. For the program years covered in the evaluation (2001 through 2006) the CORE Program provided rebates for PV installations up to 1 MW DC. CORE provided a per-Watt rebate that ranged from $1 to $5 depending on the size of the system, and with additions if the participant was government or not-for-profit, received an energy audit, or used New Jersey materials/labor.

Table 2-1 provides a summary of the CORE Programs' overall budget, expenditures and tracked savings[22] over the analysis period (2001-2006).

New Jersey's Clean Energy Program Energy Impact Evaluation CORE Work Plan. Prepared by KEMA for New Jersey Board of Public Utilities, Office of Clean Energy. November 14, 2008.

[21] Customer On-site Renewable Energy Program is also referred to in this report as the "Program" and "CORE Program."

[22] Throughout this report we refer to energy "savings" as "generation" or "output" produced by the PV system.

Table 2-1[23]

Customer On-site Renewable Energy Program Summary from 2001-2006

CORE Programs						
	2001	2002	2003	2004	2005	2006
Program Budget (in 000's of $)	$17,250	$0	$0	$45,200	$85,700	$148,796
Actual Expenditures (in 000's of $)	$951	$0	$7,821	$13,361	$29,850	$82,723
Participants	6	0	58	284	496	1,005
Tracked kW Savings	8	0	1,743	2,644	7,386	18,725
Tracked MWh Savings	11	0	7,239	6,515	16,620	22,470
Tracked Dtherms Savings	0	0	1,664	0	0	0

2.1.1. Renewable Energy Incentive Program

The CORE Program ended on December 31, 2008. The CORE Program was replaced by the Renewable Energy Incentive Program (REIP). Similar to CORE, the new program offers incentives and support services needed for participants to build on-site renewable energy projects using solar, wind, and biopower technologies. The most dramatic change pertains to upfront incentive eligibility. Under the new program' eligibility rules, residential systems larger than 10 kW[24] and commercial systems larger than 50 kW are no longer eligible for upfront incentives. These larger systems are still eligible to participate in the Solar Renewable Energy Certificate Program (SREC). These changes had not occurred during the program period included in the CORE impact evaluation and therefore any effects of these changes were beyond the scope of this report. However, KEMA's report addresses these changes in several places.

2.2. Overview of Approach

The NJCEP energy impact evaluation has two broad objectives:

1. To revise the savings calculation Protocols so that going forward the calculations using these Protocols provide (more) accurate statements of savings accomplishments.

[23] New Jersey Clean Energy Program. *New Jersey's Clean Energy Program Report submitted to the New Jersey Board of Public Utilities*. Reports from 2001-2006.

[24] The first 10 kW of residential systems is eligible for a rebate. For example, a 12 kW residential system is eligible for a rebate for 10 kW.

2. To provide a retrospective assessment of Program accomplishment, as part of a due diligence review of past utility Program effectiveness on behalf of ratepayers.

In this report KEMA refers to the first of these broad objectives as the Prospective Analysis and the second objective as the Retrospective Impact Analysis. KEMA's comprehensive evaluation approach incorporated primary data collection (telephone surveys and on-site visits), engineering analysis, and ratio estimation techniques to accomplish the objectives of the Retrospective Impact Analysis. The objective of the Prospective Analysis, recommended updates to the current energy savings calculation methods described in the Protocols, was accomplished based on an engineering review of Protocols and the incorporation of the Retrospective Impact Analysis results. This report presents the results from the Retrospective Impact analysis first because they are incorporated into the Prospective Analysis. The impact evaluation was limited to the photovoltaic (PV) component of the CORE Program, covering residential and non-residential participants from program years 2001 to 2006.

2.2.1. Retrospective Impact Analysis

KEMA used the statistical procedure of ratio estimation to develop estimates of evaluation verified gross and net impacts. There are two basic steps to the process.

1. **Verify energy savings in a sample of participants.** For a sample of participants that installed PV systems during program years 2001 through 2006, KEMA estimated actual energy output under current conditions. KEMA collected information for this estimation from a combination of telephone interviews and on-site visits. The telephone interview confirmed system installation and collected information about program attribution, satisfaction, and other process issues. The on-site visits were conducted by trained engineers that confirmed system installation, assessed the quality of the installation, obtained inverter readings, and took other measurements required to calculate system output.

2. **Expand sample results to the population of participants.** The sample results obtained in Step 1 were expanded to the population by calculating the ratios of verified-to-tracked (gross generation adjustment factor) and attributable-to-verified (attribution factor) for the sample.

The adjustment factors estimated from the data collection and analysis include:

- **Gross generation adjustment factor**: This factor adjusts tracking gross generation[25] for installation and changes based on the engineering review. Applying the gross generation adjustment factor to tracking gross generation produces the estimate of verified gross generation.

- **Attribution factor**: This factor adjusts verified gross generation for program attribution. That is, the fraction of verified gross generation that occurred because of the Program.

- **Realization rate**: This factor combines the gross generation adjustment factor and the attribution factor. (It is the ratio of net generation to tracking gross generation.) That is, the fraction of tracking gross generation that occurred because of the Program.

2.2.2. Prospective Analysis

The results of the Retrospective Impact Analysis and a detailed engineering review of the kW and kWh calculations in the existing Protocols were used to recommend updates to the Protocols.

2.3. Report Organization

The remainder of the report is organized as follows. Section 3 and Section 4 provide the methods, results, and recommendations for the Retrospective Impact Analysis and the Prospective Analysis, respectively.

Four appendices accompany this report.

- *Appendix A: Ratio Expansion – Sample to Population Results.* Provides the ratio estimation computation KEMA employed to develop estimates of evaluation verified gross and net impacts.

- *Appendix B: Detailed Sample Information.* Provides additional detail on the CORE Program population and the sample design.

[25] Tracking gross generation is the installed generation recorded in the CORE Program tracking data base and provided to KEMA for this impact evaluation. Throughout this report the term “tracking” refers to information recorded in the CORE Program tracking data bases.

- *Appendix C: Additional Telephone Survey Results.* Provides a summary of the process related survey question results.
- *Appendix D: Telephone Survey Instrument.* Participant Survey Instrument.

3. Retrospective Impact Analysis

This section provides the methodology, results and recommendations of the Retrospective Impact Analysis. The primary objective of the Retrospective Impact Analysis was to develop estimates of evaluation verified gross and net impact.

3.1. Methodology

This section provides KEMA's Retrospective Impact Analysis methodology. First, we describe our data collection activities, including the tracking data, telephone surveys, and on-site visits. Next, we describe the sampling plan for the telephone and on-site visits. This section concludes with detailed descriptions of the analysis methods used to conduct the Protocol review and retrospective impact analysis.

3.1.1. Overview

KEMA took a comprehensive approach to evaluating the energy impacts of the CORE Program. This approach combined telephone interviews of Program participants with on-site inspections of a sub-sample of telephone interview participants. The telephone interviews allowed us to ask participants about program-related topics like satisfaction, participation drivers, and awareness. We also asked respondents to confirm the installation of their system and screened respondents for on-site visit sampling and recruitment.

KEMA selected a subset of participants from among the telephone interviewees to receive on-site visits from KEMA engineers. The on-site visits allowed our engineers to take direct measurements of actual system output (kW and kWh) under operating conditions, verifying or supplementing what was provided by telephone. The engineers were able to directly assess installation quality more generally, measure irradiance and array positioning. Data from the telephone interviews and on-site inspections were used to meet the following research objectives:

1. Assess the gross impacts of the Program. That is, verify for accuracy of the PV electrical energy output and resource savings reported by the Program (Retrospective Impact Analysis).
2. Assess the net impacts of the Program. That is, estimate the PV electrical energy output and resource savings attributable to the Program (Retrospective Impact Analysis).
3. Assess and recommend updates to the PV Protocols (Prospective Analysis).

3.1.2. Data Collection

KEMA collected data from three sources: the Program's tracking databases, telephone surveys, and on-site visits. The Program's tracking databases contained participant contact information, inverter and panel specifications, installed capacity, and estimated output. The telephone surveys collected information about the present status of participants' systems, program attribution, satisfaction with the Program, and other process-related data. The on-site visits confirmed system installation, assessed the quality of the installation, obtained inverter readings, and took other measurements required to estimate expected system output.

3.1.2.1. Tracking Data

KEMA was given two customer tracking databases. The first covered program years 2001 to mid-2003 and contained customer and site information collected and organized separately by each utility. This data was provided by the Board of Public Utilities' Office of Clean Energy (OCE). The second database, covering mid-2003 through September 2008, was collected and organized by the current Renewable Program Market Manager and provided to KEMA in a single format.

The customer tracking databases contain: the customer name and contact information; customer type; the installed capacity and cost of the system; various dates including application, approval, inspection and interconnection; data about the installers, and size of the rebate. We also received information about the equipment installed:

- Manufacturer and model numbers for both panels and inverters,
- Module rated capacity and quantity installed,
- Orientation and tilt of the solar panel array(s),
- Inverter efficiency.

The tracking database does not include an estimate of annual energy production (kWh) or peak demand impact (kW). Though the tracking database contained a kW rating for each system, it did not contain an estimation of annual kWh. There are multiple ways in which expected kWh can be derived from system rated kW capacity. The method to estimate kWh used most consistently in the years 2001-2006 appears to have been an assumption that in New Jersey, each system will produce 1200 kWh of energy per year for each kW of installed capacity; therefore the KEMA assumed tracking-estimate of generation is 1200 kWh/kW/year × tracked kW installed.

3.1.2.2. Telephone Survey

The telephone survey contacted a sample[26] of customers who received incentives from the Program in order to gather data on the PV system and the customer's experience with the Program. A computer assisted telephone interviewing (CATI) technique was employed by KEMA's research partner, Braun Research, to field the telephone survey. Telephone interviews were completed with 400 CORE Program participants between January 19 and February 18, 2009. The telephone survey collected information about the following topics (the telephone survey instrument is provided as Appendix D):

1. the present status of the PV system, including any new PV installations,
2. satisfaction with Program, installer, incentives, SRECs, and financing,
3. history of the equipment including resets and problems,
4. assessment of program attribution,
5. the customers' current and potential participation in other NJCEP programs, and
6. the eligibility of the customer to participate in the on-site survey.

KEMA used the telephone survey to determine whether a site was a good candidate for an on-site visit. During the telephone survey, participants were asked whether they were willing to have an engineer visit their site. The on-site inspectors needed to collect output data from inverters and take measurements from PV modules; therefore the phone interviews confirmed the accessibility and operating status of the customer's system. The system start date and length of power interruptions needed to be collected to accurately analyze cumulative output data and system performance. The phone surveys screened out customers who could not provide these data from an on-site visit.

3.1.2.3. On-Site Data Collection

The Technical Work Sheet for Solar Electrical Equipment shown on the Clean Energy website requires a user-accessible monitor for instantaneous and cumulative system output. Following a

[26] The sample design is provided in Section 3.1.3.

review of the database and discussions with CORE Program staff, it became clear that difficulties would be encountered trying to obtain PV output and other data from the customer via a telephone call.

There were 18 manufacturers of installed inverters, and over 50 different models of inverters. Each manufacturer had a different user interface for reading kWh output and kW output; sometimes the interface varied between a manufacturer's models. In addition, many households and businesses had more than one inverter. Finally, the inverters were installed in basements, garages, electrical closets, or outdoors. We were not confident that a random sample of customers could be coached over the telephone to accurately read their particular inverter. Therefore, trained professionals were deployed to measure operational data of the system as part of the on-site inspection in order to ensure accuracy and thoroughness. The site inspection obtained the electrical data necessary to assess the efficiency of the system and the observations to explain the efficiency numbers.

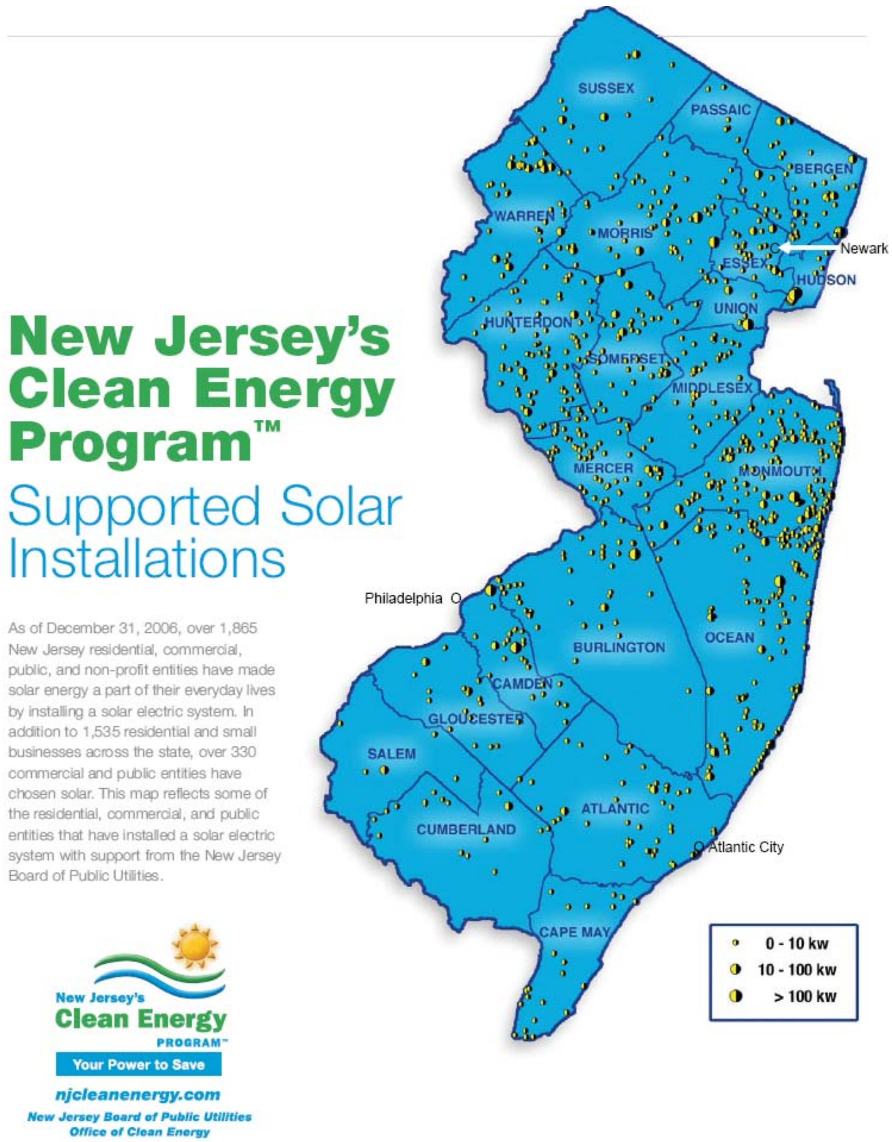
Participants were pre-screened for an on-site visit during the telephone survey. Potential on-site candidates were then sampled[27] and recruited for on-site visit participation. We then assigned one of four KEMA engineers to visit that site at the appointed time. KEMA divided New Jersey into four segments, and attempted to have each engineer visit sites in only one segment (to save travel time, fuel and expense). However, we did not sample participants by location. The same stratification plan used for the telephone survey sample was used for the on-site visit sample. Site visits occurred between April 6 and April 18, 2009.

3.1.2.3.1. Site Assignments

As can be seen in Figure 3-1, PV sites are fairly evenly distributed throughout New Jersey.

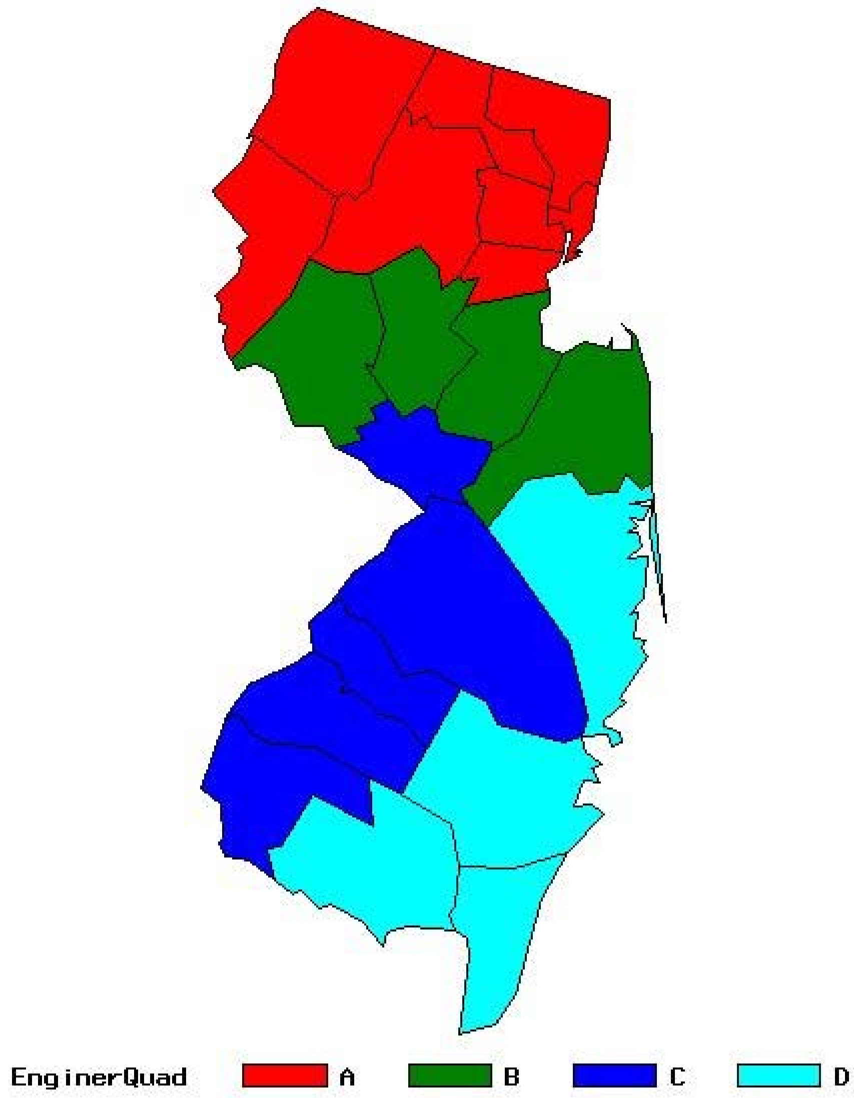
[27] The sample design is provided in Section 3.1.3.

Figure 3-1
CORE Supported PV Installations Through 2006



KEMA divided New Jersey into four quadrants with approximately the same number of sites in each (18-20 sites; Figure 3-2). One KEMA engineer was assigned to each quadrant.

Figure 3-2
New Jersey On-Site Visit Quadrants



3.1.2.3.2. Site Visits

Before the on-site visits, we obtained the user manuals for each inverter model in the sample. Only sites that had inverter models capable of suitable readout of electrical information were sampled. Inverters were not opened to gather additional information because of safety and liability concerns. Once on-site, KEMA collected the following information to characterize the reliability of metered data for calculation of system energy production:

1. Verified that the meter is operating at the time of the inspection.
2. The system operational start date.
3. The total kWh generation.
4. Solar irradiance.
5. Instantaneous watt reading at the inverter output.
6. Number and location of modules installed.
7. Module manufacturer, model type and nameplate data, when accessible.
8. Panel Orientation and Tilt Angle.
9. Shading.
10. System downtime.

3.1.3. Sampling

In setting the sample sizes for the telephone interviews and on-site visits, we considered the variability of underlying conditions we wanted to measure, gained from our previous experience, consultation with Program staff, and review of the tracking data. The primary objective of the sample design was to provide the best possible estimates of gross and net generation for the CORE Program as a whole. The sample stratification employed allowed KEMA to also produce meaningful estimates for sub-populations of interest (e.g.: residential versus non-residential).

As stated in the work plan, this evaluation looks both backwards and forwards. Looking forward, the most recent technology is the best guide to what new customers will purchase in the next few years, and how those systems will behave. Looking backward, assessing the contribution of the PV systems installed at the start of the CORE Program, and examining the extent to which these systems have deteriorated, is key to understanding what happened during the period from 2001-2006, and the total costs and benefits of the CORE Program.

Sample selection for this impact evaluation was designed to address both factors. When a widely-different population can be clustered into relatively homogeneous groups, stratifying the sample means that when we extrapolate from the survey sample back to the wider population, our estimates will be more precise, with less uncertainty, than estimates from a simple random sample[28]. We stratified the CORE population by three different criteria: customer type, installation year, and system size (rated power).

- **Customer type (or Sector)**. The CORE Program tracking data classify participants into eight customer type categories: Residential, Commercial, Government Facility, Non Profit, Public School (K-12), Other School, Private University, and Public University. The top three categories – Residential, Commercial and Public School (K-12) together account for 97 percent of the installations and 93 percent of the installed capacity. For this reason, we combined the other five categories when stratifying by customer type.

- **Installation year** is defined as the calendar year in which the rebate check was sent (i.e. the year of the variable *Checkdate* in the data provided by the Renewable Program Market Manager). Projects were assigned to one of four time-based groupings: the years 2001-2003 were combined (because they comprise only 6 percent of the total), and 2004, 2005, and 2006 were treated separately.

- **System size** groupings are aggregates of the CORE Program's rebate classes.[29] The smallest system size grouping, 10 kW or less, accounts for over 80 percent of the installations and over 35 percent of the installed kW. Conversely, over 21 percent of the capacity installed by the Program is due to just 12 projects of between 500kW and 700kW (no larger systems were installed prior to 2007). Therefore, we created three capacity-based classes for stratification: 0-10kW, 10kW to 500kW, and 500kW to 700kW.

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[28] Additional information on the ratio estimation technique used to expand the sample results to the population is provided in Appendix A.

[29] Historical data on rebate levels were downloaded on January 21, 2008 from http://www.njcleanenergy.com/files/file/CORE%20Solar%20Incentive%20Levels.xls. Although the rebate levels have varied over the years, the system size classes have remained the same, and are shown in the appendix to this report.

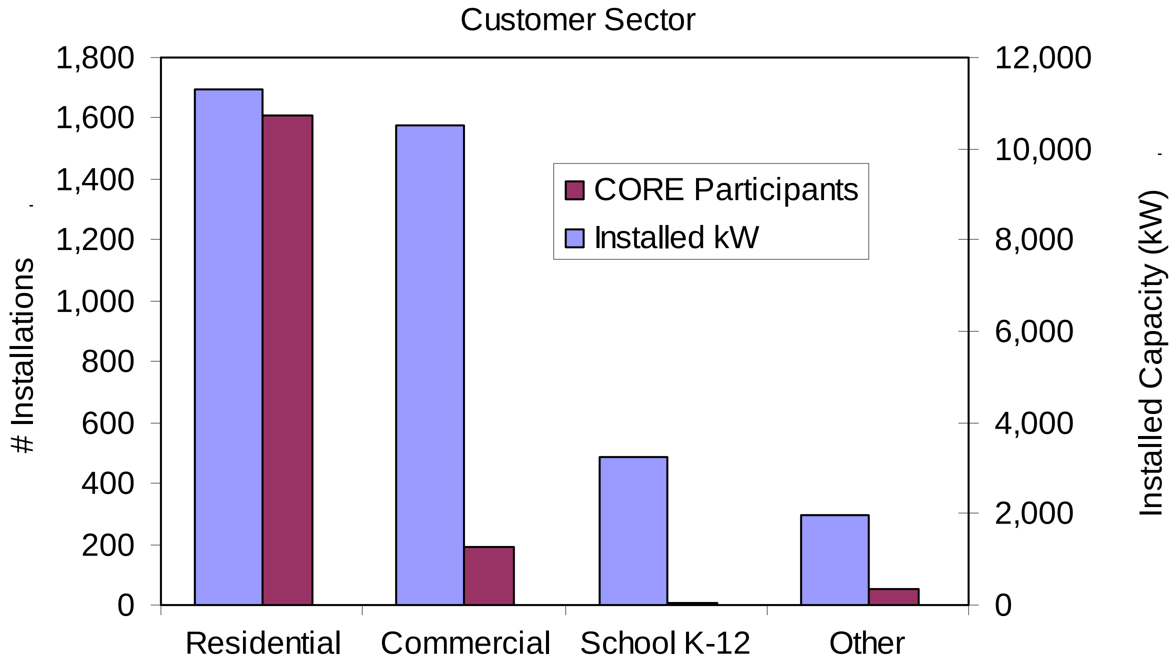
Of the 48 possible strata defined by combinations of these three classes, there are 28 non-empty ones, shown in Table 3-1(additional sample design breakouts are provided in Appendix B). We completed telephone interviews with participants in 23 of the 28 strata, for a total of 400 interviews. The 73 on-site visits were distributed across 19 of the 23 available strata. There were five strata for which KEMA was not able to achieve a complete. Three of these strata had only one participant in the population, one had three, and the last one had six. Each of these strata was exhausted, that is, these participants either refused to participate in the study or KEMA attempted to contact each of these participants at least six times, during different times of day, and on different weeks.

Table 3-1
Number of Participants in the Population,
CATI Sample and On-Site Sample by Sampling Cell

Sector	Program Year	Rebate Class	CORE Participants	CATI Completes	On-Site Completes
Residential	2001-2003	0 to 10 kW	80	7	1
Residential	2001-2003	10 to 500 kW	1	0	0
Residential	2004	0 to 10 kW	228	48	4
Residential	2004	10 to 500 kW	9	5	2
Residential	2005	0 to 10 kW	388	68	7
Residential	2005	10 to 500 kW	47	16	7
Residential	2006	0 to 10 kW	764	144	12
Residential	2006	10 to 500 kW	95	34	12
Commercial	2001-2003	0 to 10 kW	11	2	0
Commercial	2001-2003	10 to 500 kW	6	0	0
Commercial	2001-2003	> 500 kW	1	0	0
Commercial	2004	0 to 10 kW	30	5	1
Commercial	2004	10 to 500 kW	8	5	2
Commercial	2005	0 to 10 kW	23	4	1
Commercial	2005	10 to 500 kW	19	6	3
Commercial	2006	0 to 10 kW	47	9	3
Commercial	2006	10 to 500 kW	47	25	6
Commercial	2006	> 500 kW	7	1	1
School K-12	2004	10 to 500 kW	2	0	0
School K-12	2005	10 to 500 kW	5	1	3
School K-12	2006	10 to 500 kW	11	0	0
Other	2001-2003	0 to 10 kW	4	1	0
Other	2004	0 to 10 kW	3	1	0
Other	2004	10 to 500 kW	2	1	1
Other	2005	0 to 10 kW	5	1	0
Other	2005	10 to 500 kW	6	4	1
Other	2006	0 to 10 kW	14	2	1
Other	2006	10 to 500 kW	16	10	5

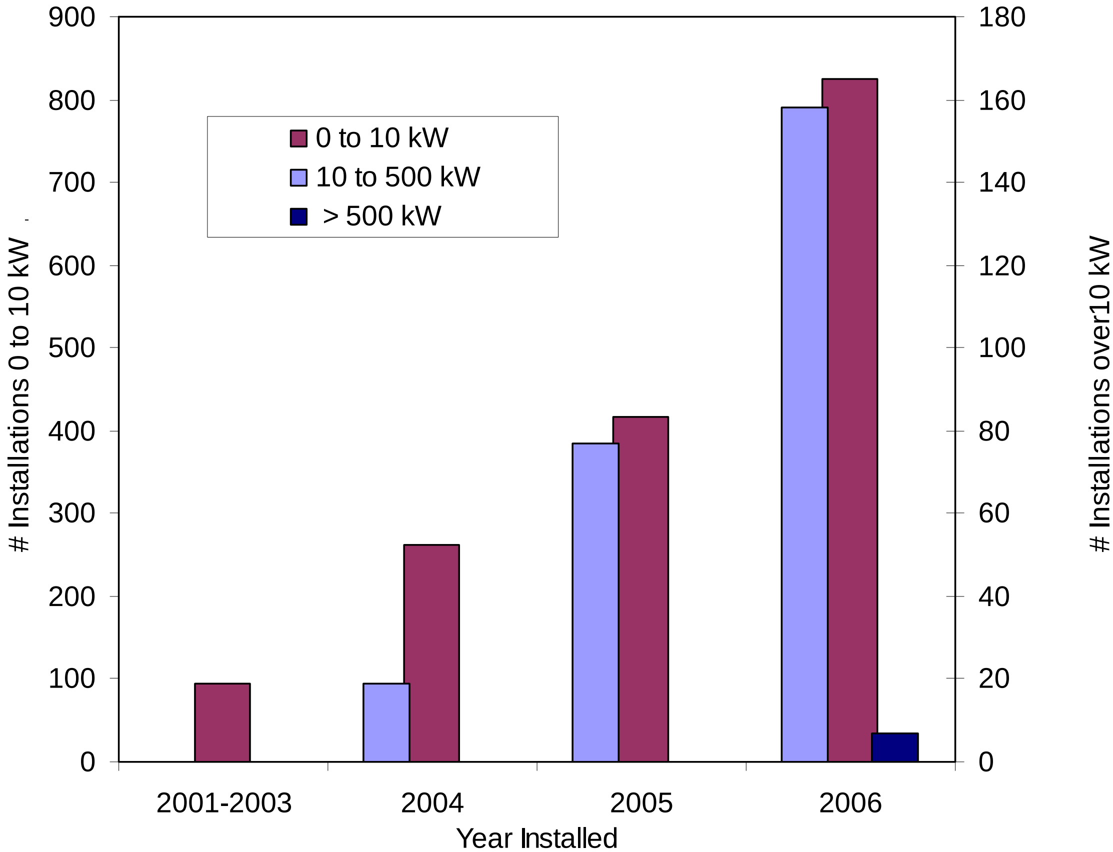
The majority of installations were small residential systems (10kW and under). Figure 3-3 shows that installed commercial capacity is nearly as much as residential, though concentrated in fewer systems. Public schools and other sites comprise a large fraction of total CORE capacity, though noticeably less than the other two sectors. Installed capacity is summarized in more detail in Appendix B, Table B-4.

Figure 3-3
Number of Installations and Installed Capacity



Participation in the CORE Program has increased dramatically over time as can be seen in Figure 3-4. Also shown is the increase in system sizes over time (including all sectors). Prior to 2006, there was only one installed system larger than 500 kW.

Figure 3-4
Solar Power Growth



3.1.4. Analysis Methods

This section describes the analyses KEMA performed during the Retrospective Impact Analyses. KEMA computed the actual capacity (verified gross kW) and energy (verified gross kWh) generated by the systems in the Program and the amount of that capacity and energy that is attributable directly to the Program (net).

KEMA used the statistical procedure of ratio estimation to develop estimates of evaluation verified gross and net impacts. There are two basic steps to the process.

- **Verify energy savings in a sample of participants.** For a sample of participants that installed PV systems during program years 2001 through 2006, KEMA estimated actual energy output under current conditions. KEMA collected information for this estimation from a combination of 400 telephone interviews and 73 on-site visits. The telephone interview verified that the system was (and remains) installed and collected information about Program attribution and other process issues (Section 3.1.2.2 above). The on-site visits were conducted by trained engineers and confirmed system installation and capacity, assessed the quality of the installation, obtained inverter readings, and took other measurements required to calculate system output (Section 3.1.2.3 above).

- **Expand sample results to the population of participants.** The sample results obtained in Step 1 were expanded to the population by calculating the ratios of verified-to-tracked (gross generation adjustment factor) and attributable-to-verified (attribution factor) for the sample. These were then applied to the whole population of CORE participants to give an estimate of adjusted generation savings and the attributable realized generation rate for the CORE Program 2001-2006.

These factors are briefly described in the next subsection of the report. Detailed descriptions of these calculations are found in Appendix A.

3.1.4.1. Adjustment factors defined

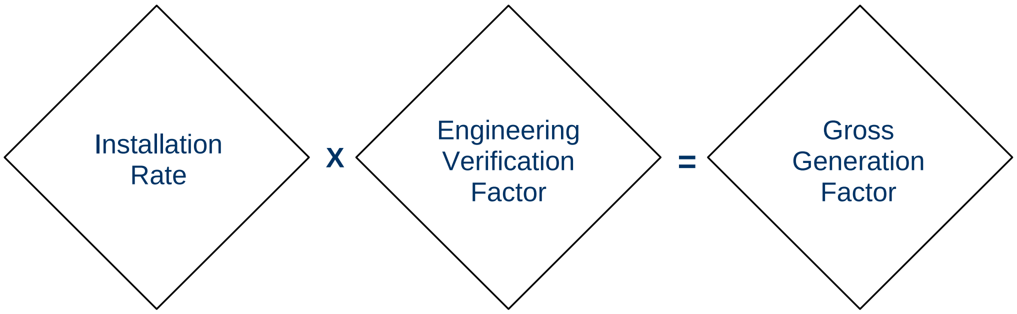
The adjustment factors estimated from the data collection and analysis are as follows:

- **Installation rate:** This factor corresponds to the fraction of measures in the tracking database that were installed. Each measure is assigned a binary factor that identifies whether it was installed or not installed. It is calculated from responses to the telephone survey, based on the sample of 400. Adjustments to the number of units installed for a particular measure are included in the engineering verification factor, not in the installation rate.

- **Engineering verification factor:** This is the ratio of the verified gross generation to the tracking estimate of gross generation for installed measures. The engineering verification factor includes the results of KEMA's engineering assessment based on data collected from the 73 on-site visits. Calculations for verified gross kWh and kW are described in section Figure 3-5 below.

- **Gross generation adjustment factor:** This factor combines the installation rate and the engineering verification factor. It corresponds to the ratio of the verified gross generation to the tracking estimate of generation. Figure 3-5 shows how the installation rate and engineering verification factor are combined to produce the gross generation factor.

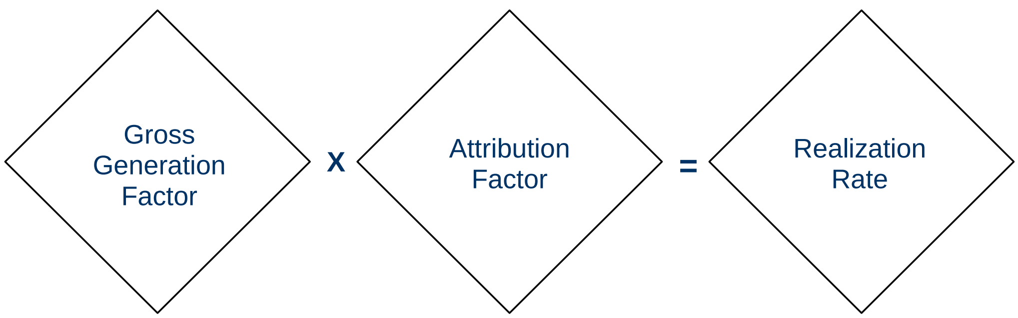
Figure 3-5
Gross Generation Adjustment Factor Calculation



- **Attribution factors:** This factor adjusts verified gross generation for program attribution, which is the estimated proportion of verified gross generation attributable to the CORE Program. It corresponds to the ratio of net generation to verified gross generation. Attribution factors used to estimate net generation are calculated using the telephone survey results. KEMA determined attribution to the Program on a system-by-system basis using participant self-reported information about their plans and intentions. The calculation includes adjustments for the size and timing of system that the participant may have installed in the absence of the Program.

- **Realization rate:** This factor combines the gross generation adjustment factor and the attribution factor as shown in Figure 3-6. It corresponds to the ratio of the net generation to the tracking estimate of generation.

Figure 3-6
Realization Rate Calculation



Note that the gross generation adjustment factor calculation is based on results from two different samples, one a subset of the other. For this reason, it cannot be calculated site-by-site. Each of the factors must be estimated independently, extrapolated to the population as a whole, and only then multiplied to give adjusted gross generation and an overall realization rate. The technique appropriate to these calculations is called ratio estimation, and is described in Appendix A.

3.1.4.1.1. Evaluation Verified Gross Generation

The gross generation adjustment factor is an aggregate measurement of the ratio of kWh production as measured in the field to kWh production as estimated in the tracking database[30]. We also calculated the ratio of measured kW to tracked kW. This section describes how measured kWh and kW were derived.

The data analysis consisted of four parts:

1. on-site collection with on-site calculation of kWh and kW to confirm metered data,
2. shading calculation,
3. online calculation of kWh using PVWatts, and
4. measured kW calculation.

Kilowatt (kW) and kilowatt hours (kWh) estimates were made using measurements obtained during the on-site surveys. Measured system kW was computed as the product of the number of panels and the kW_{STC} rating on the panel nameplates.

$$\textit{Measured kW} = \textit{Nameplate } kW_{STC} \times \textit{Number of Panels}$$

When the nameplate was inaccessible or unreadable, KEMA used the kW_{STC} rating from the Program tracking database.

During its on-site visits, KEMA obtained the actual measured energy output of 73 PV systems throughout New Jersey. The annual measured energy production was calculated as follows:

$$\textit{Measured Annual kWh} = (\textit{Total measured kWh / Days of operation}) \times \textit{365 days/yr}$$

[30] As mentioned in Section 3.1.2.1, tracked was imputed as kWh = 1200 x installed capacity

Where:

Total measured kWh	=	Data from inverter(s) readout.
Days of operation	=	The total number of days the system was in place, also from inverter readout.

As mentioned above, KEMA engineers performed calculations during the on-site visit to confirm that the collected site data were reasonable. KEMA obtained the instantaneous kW readout of the inverters during the on-site visit and compared those readings to the estimated kW derived from sunlight and ambient temperature measurements. The ratio of these two values is known as the instantaneous performance (IP) ratio and gives an indication of how well the system is functioning.

Manufacturers rate the output of PV modules in Watts under Standard Test Conditions (STC). STC ratings refer to the peak DC output, measured in Watts or Kilowatts, produced by the PV modules under laboratory test conditions (irradiance of 1000 W/m^2 and a module temperature of 25 degree C). We used the ratio of the instantaneous output of the system (kW) as measured at the inverter output versus expected system kW (irradiance adjusted array power) computed using the PV module STC ratings to estimate the Instantaneous Performance (IP) Ratio. We used the following formula:

$$IP\ Ratio = MP/EP,$$

Where:

Measured Performance (MP)	=	Watt reading from inverter or installed ac meter.
Expected Performance (EP)	=	[(module W_{STC} x # of modules x (0.80) x (measured irradiance /1000W/m^2)] ÷ [(1- ((20°C- T_{amb}) x(-0.005/°C)) x (1-(1000W/m^2 - measured irradiance) x (0.015/100W/m^2))].

The temperature adjustment factor above is based on the power temperature factor for a particular system technology. For many crystalline silicon PV systems, this factor is -0.5%/^oC. The temperature adjustment factor accounts for the variation of performance relative to ambient temperature. The STC test conditions rarely occur in the field in temperate climates because they combine relatively low cell operating temperatures with very high levels of solar irradiance. The use of a panel's STC rating however, is a generally acknowledged baseline for PV performance. The second adjustment of 0.015/100W/m2 is for the irradiance impact on the module temperature. Lower irradiance means lower module temperature and more efficient conversion from solar energy to electrical energy. The formula also takes into account losses from module production tolerances and other system losses in the wiring and inverter. We must take those losses into account when comparing expected system capacity to measurements taken at the inverter output.

An IP ratio of one would indicate that the systems were performing exactly as expected. The IP ratio was between 0.8 and 1.2 for all systems when measured irradiance was over 500 watts/m^2. This indicates that the systems were operating within an acceptable range.

3.1.4.1.2. Attribution Factor

KEMA computed an attribution factor for each respondent. The attribution factor is the theoretical proportion of the total energy that would be generated in a system's lifetime, or of total capacity, that is attributable to the Program. "Attributable to the program" means that this generation would not have occurred without the program. If an installation would have occurred entirely without the program, attribution is zero. If an installation would not have occurred at all without the program, attribution is 100 percent. In other words, attribution is 100 percent minus the rate of free ridership.

In principle, attribution could be increased by "spillover" installations, meaning installations that occurred because of the program but did not receive program funds and were not tracked by the program. In practice, the attribution factor for the CORE program does not include participant or non-participant spillover effects. There is little evidence that solar PV programs are producing spillover effects that merit the allocation of resources needed for measurement. However, we did collect some information to qualitatively assess the magnitude of possible participant spillover. First, we asked participants if they installed additional inverters or panels since installing the rebated system. For respondents that answered yes, we then asked if they received additional funding from the program. Very few respondents indicated that they made any unfunded changes or additions. Based on these results, we do not recommend participant spillover research at this time.[31]

KEMA computed the attribution score for each respondent in three steps based on their response about the Program's effect on the timing of their installation, then on the Program's effect on the size (capacity) of their installation, then on an open-ended confirmation question. In cases where a respondent failed to provide information necessary for the attribution computation (e.g.: said "don't know" to the timing question), KEMA used the respondent's open-ended confirmation question to assess that respondent's program attribution.

KEMA followed guidelines laid out by The California Public Utilities Commission[32] and the Public Service Commission of Wisconsin[33] that recommend including a sequence of set-up questions to help establish a context for attribution questions. These questions help the respondent to recall past events, the sequence of events, and how the events may have affected the respondent's decisions. The intent of these context-setting is to reduce inaccuracies that can occur in self-report measures.

Prior to the sequence of attribution questions, KEMA asked the respondents several questions to set the context for the attribution sequence. These questions included reminding the participant how much money they received from CORE, asking them whether they received funding from any other sources, reminding them about the SREC program, asking them to think about why they decided to install solar panels, and asking them at what point during the decision and installation process they heard about the CORE Program (see Appendix D for the complete instrument). After this series of questions, we asked the attribution questions used in the attribution algorithm.

[31] Investigation of non-participant spillover effects was outside the scope of this evaluation. PV technology is both cutting-edge and expensive, and these attributes makes implementation by non-participants as a results of the program unlikely. KEMA does not recommend investing in a study to measure non-participant spillover.

[32] Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches, California Public Utilities Commission Energy Division and the Master Evaluation Contractor Team, October 15, 2007.

[33] Framework for Self-Report Net-To-Gross (Attribution) Questions, Rick Winch & Tom Telerico, Glacier Consulting Group, Bobbi Tannenbaum, KEMA Inc., Pam Rathbun, PA Consulting Group, Prepared for Public Service Commission of Wisconsin, January 29, 2008.

Step 1: Program's Effect on Timing

The first step of the attribution computation examined the Program's effect on the timing of the respondent's installation. The survey asked respondents when they would have installed the system if the Program did not exist. They were given four choices: earlier, at the same time, later, or never. If the respondent said that they would have installed earlier or at the same time, the Program did not accelerate the installation. When the Program did not accelerate the installation, Program attribution is based completely on the Program's effect on the size of the system (Step 2a).

If the respondent said that they would have installed the system later, then the Program accelerated the installation. To assess how much acceleration occurred, KEMA asked the respondents to specify how many months later. KEMA assumes that respondents can accurately report up to 48 months of acceleration. When respondents indicate an acceleration period greater than 48 months, KEMA assumes that it is unlikely the respondent would ever do the project. Thus, if the acceleration was 48 months or greater, or if the respondent said they never would have installed without the Program, then KEMA gave the Program full (100 percent) attribution for the installation. Responses of less than 48 months were considered a viable acceleration period. In these cases, the Program attribution was based on a combination of the acceleration and the Program's effect on the size of the system (Step 2b). Table 3-2 summarizes the timing component of the attribution computation.

Table 3-2
Step 1: Timing Component of Attribution

Without Program, respondent would have installed...	Attribution
Earlier	Skip to Step 2a
At same time	Skip to Step 2a
Less than 48 months later	Skip to Step 2b
48 or more months later	100%
Never	100%

Step 2a: Program's Effect on Size (And No Effect on Timing)

In Step 2a, the Program did not accelerate the timing of the installation, so attribution was based entirely on the Program's effect on the size (capacity) of the system. This step is only used for respondents that indicated the program did not accelerate the timing of the installation. The survey asked respondents if they would have installed a different sized system in the absence of the Program. There were four choices: smaller, same size, larger, or would not have installed a system at all (none). If the respondent answered that they would have installed a system of the same size or larger, then the Program did not affect the size of the installation, and attribution was zero.[34] If the respondent said that they would not have installed at all without the Program, then the Program received credit for the entire installation and an attribution score of 100 percent.

If the respondent said that they would have installed a smaller system in the absence of the Program, then KEMA asked the respondent what size system they would have installed. Attribution was based on the difference in capacity. To compute this attribution number, KEMA first computed how much energy the existing system would generate during its service life (240 months):

$$E_{tot} = 240 \times kW_i$$

Where:

kW_i = the capacity that was actually installed according to the tracking database.

Next, KEMA computed how much energy the smaller system would produce during its service life:

$$E_{small} = 240 \times kW_s$$

Where:

kW_s = The capacity the respondent would have installed in the absence of the Program.

[34] Step 2a is only entered when the Program had no effect on the timing of the installation. Therefore, if the Program also has no effect on the size of the installation, then the Program had no effect on the installation at all, and attribution equals zero.

Finally, KEMA divided the difference of the existing and smaller system by the lifetime energy output of the existing system:

$$Attribution = (E_{tot} - E_{small}) / E_{tot}.$$

This ratio represents the percentage of the total energy generated over the system's lifetime that the Program was responsible for. Table 3-3 summarizes the attribution computation for step 2a.

Table 3-3
Step 2a: Attribution Based on Size

Without Program, respondent would have installed...	Attribution
Smaller	$(E_{tot} - E_{small}) / E_{tot}$
Same size	0%
Larger	0%
None	100%

Step 2b: Program's Effect on Size (With Effect on Timing)

If the respondent indicated that the Program accelerated their installation, then attribution was based on a combination of the acceleration and the Program's effect on the capacity that was installed.

For the acceleration period, the Program got credit for the entire amount of energy generated by the system. KEMA computed this figure by multiplying the existing capacity by the number of months of the acceleration period:

$$E_{acc} = M \times kW_i$$

Where:

M = The number of months of acceleration.
kW_i = The system capacity that was actually installed.

For the post acceleration period, the Program got credit for the difference between what they respondent installed versus what they would have installed in the absence of the Program. To generate this quantity, KEMA took the difference between the existing capacity and the capacity the respondent would have installed and multiplied the difference by the number of months in the post acceleration period:

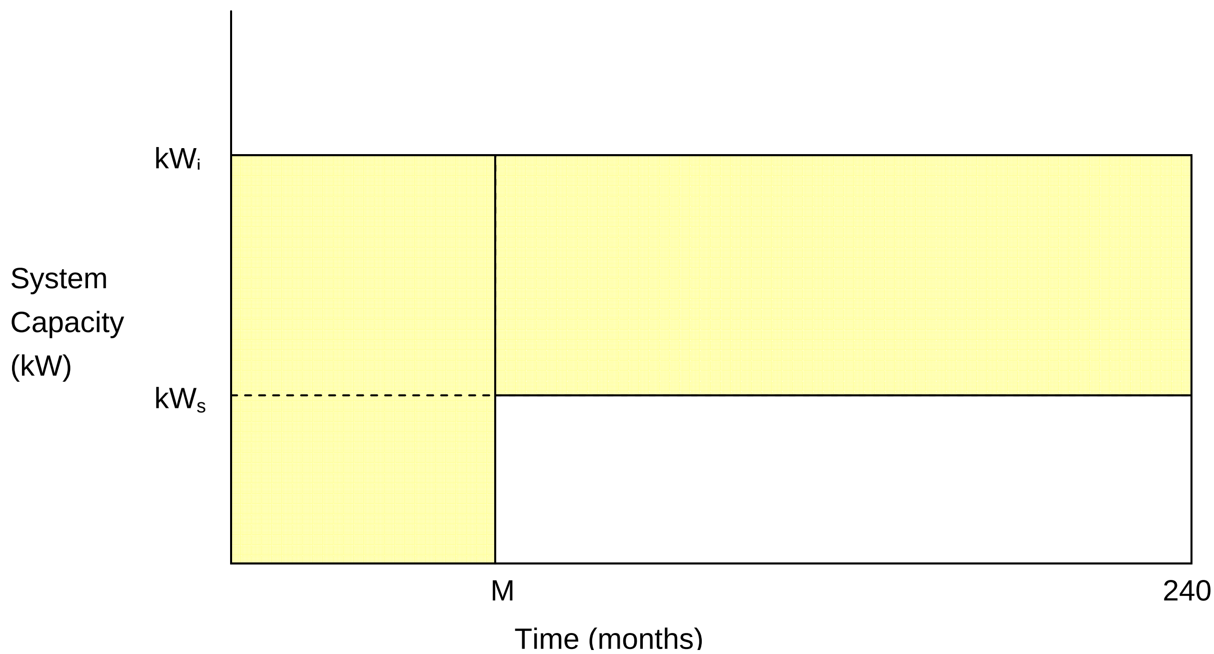
$$E_{rst} = (240 - M) \times (kW_i - kW_s)$$

Finally, to compute an attribution score, KEMA added the amount of energy credited to the Program during the acceleration period to the amount of energy credited to the Program during the post acceleration period and divided the sum by the total amount of energy the existing system would produce during its service life:

$$Attribution = (E_{acc} + E_{rst}) / E_{tot}$$

Figure 3-7 graphically demonstrates the portion of energy that the Program was credited with in Step 2b. The Program received credit for the yellow areas of the graph. The Program's attribution score is the ratio between the yellow area and the entire area of the graph.

Figure 3-7
Attribution Based on Acceleration and Size



Program gets credit (attribution) for the shaded portion of the graph.

Step 3: Confirmation

Finally, KEMA asked the respondents to describe in their own words the effect that the CORE Program had on their decisions to install solar panels. KEMA used the confirmation question to verify the attribution score computed in steps 1, 2a, and 2b. KEMA assigned an attribution value of 100 percent (giving the Program credit for the entire installation) when the confirmation question indicated that the respondent would not have installed any solar panels without the Program. KEMA assigned an attribution value of zero (giving the Program no credit for the installation) when a respondent indicated that the Program had no effect on their decision to install solar panels. In some cases, respondents' answers to the confirmation question indicated that they would have installed solar panels anyway, but that the Program caused them to install a larger system, caused them to install earlier, or both. In these cases, we used the computed attribution score from steps 1 through 2b.

The site level attribution factor was multiplied by the tracking kW and kWh to determine a site level estimate of attributed generation. The site level estimates of attributed generation were then used as inputs into the ratio estimation procedure (details on ratio estimation are provided in Appendix A).

3.2. Retrospective Impact Analysis Results

This section presents the results of the Retrospective Impact analysis. Evaluation verified gross and net savings estimates are provided for kW and kWh for the overall program and broken out by REIP eligibility status. The REIP breakouts provide a method of using the results of the CORE Program Retrospective Impact Analysis to make meaningful inferences about the structure of the new program (REIP). The results are presented in the following order.

1. **Gross generation adjustment factor.** This factor combines the installation rate and the engineering verification factor. It is the product of the Installation Rate and the Engineering Verification Factor.
2. **Attribution factor.** This factor adjusts verified gross generation for program attribution. It is determined from the self-reported survey responses.
3. **Realization rate.** This factor simply combines the effect of all adjustment factors. It is the product of the gross generation adjustment factor and the attribution factor.

The adjustment factors[35] are provided in the tables below with indicators of statistical precision, the 90 percent confidence interval, and sample sizes.[36] In this report, the sampling frame includes all systems installed within the analysis period (January 1, 2001–December 31, 2006) with energy impacts associated with the program tracking database. The number of customers in this frame is fixed and finite, so we use the finite population correction (FPC) to our estimates when applying the calculated adjustment factors to that period. We would not use the FPC when applying these adjustment factors to energy impacts outside the analysis period; for example energy impacts associated with measures installed after 2006.

3.2.1. Gross Generation Adjustment Factors by REIP Eligibility

The installation rate adjusts the tracking gross generation for non-installation and the engineering verification factor adjusts tracking gross generation for changes based on the engineering review. The installation rate was determined to be uniformly 100 percent; that is all of the solar projects were confirmed to have been installed. Therefore by definition the gross generation adjustment factor is equal to the engineering verification factor.

Table 3-4, provides the gross generation adjustment factors for kWh and kW for the CORE Program overall and broken out by REIP eligibility. Overall, the CORE Program has done a good job estimating gross generation.

[35] The adjustment factors are calculated using a SAS® macro provided by SAS for ratio estimation by domains. The procedure also returns the standard error of the estimate. See also Appendix A.

[36] The critical value for calculating the confidence interval ± for each adjustment factor is determined using Student's t-distribution and n-1 for the degrees of freedom, where n is the sample size. The critical value for the Gross Generation Adjustment Factor and the Realization Rate is determined using the degrees of freedom based on the minimum sample size for the components of the adjustment factor. These two adjustment factors are products of other adjustment factors.

Table 3-4
Gross Adjustment Factors for kWh and kW[37]

Gross Energy (kWh) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	N	Gross Adjustment Factor	SE	Lower Bound	Upper Bound
All	**73**	**95.6%**	**3.2%**	**90.3%**	**100.9%**
Res REIP Eligible	24	**88.6%**	3.8%	82.0%	95.1%
Res REIP Ineligible	21	**88.7%**	1.8%	85.6%	91.8%
Nonres REIP Eligible	17	**83.6%**	8.7%	68.3%	98.8%
Nonres REIP Ineligible	11	**105.6%**	3.1%	100.0%	111.2%

Gross Capacity (kW) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	N	Gross Adjustment Factor	SE	Lower Bound	Upper Bound
All	**73**	**99.7%**	**0.9%**	**98.2%**	**101.2%**
Res REIP Eligible	24	**100.1%**	0.4%	99.4%	100.7%
Res REIP Ineligible	21	**100.1%**	0.1%	100.0%	100.2%
Nonres REIP Eligible	17	**93.2%**	8.0%	79.2%	107.2%
Nonres REIP Ineligible	11	**100.6%**	1.1%	98.7%	102.5%

The gross adjustment factors represent how accurately the Program estimated energy (kWh) and capacity (kW) of the installed systems. A gross adjustment factor of 100 percent would mean that the Program's estimate was perfect. Gross adjustment factors less than 100 percent mean that the Program over-estimated. In contrast, gross adjustment factors greater than 100 percent indicate that the program under-estimated.

At the portfolio level, KEMA found that the energy produced per year is 95.6 percent (between 90.3 percent and 100.9 percent) of the estimate from the tracking database (rated system kW times 1200 hours/year). The estimate of actually-installed capacity is 99.7 percent of the capacity recorded in the tracking database (90 percent confidence interval is ±1.5 percent). The lower Gross Adjustment for kWh is not completely attributable to errors in tracked installed capacity of the panels, but due to other factors such as downtime, shading, and system efficiency.

[37] Standard error of the estimate.

The results shown in Table 3-4 show that, overall, the Program's estimates were fairly accurate (the overall gross adjustment factors were close to 100 percent for both energy and capacity). Table 3-4 also shows that the Program did a better job of estimating the energy produced by larger systems (Nonres REIP Ineligible) than the other categories. The Program slightly under-estimated the energy production of systems in the Nonresidential REIP Ineligible group. These systems generated about 5.6 percent more energy per year than the tracking database predicted. This means that applying KEMA's adjustment factor will increase tracked savings for these systems. However, the Program over-estimated the energy that was produced by the other three groups. The systems in these sectors produced between 11.3 percent and 16.4 percent less energy than tracked. Therefore, when KEMA's adjustment factor is applied, tracked savings for these systems will decrease.

There is a substantive difference between results for smaller (REIP eligible) and larger (ineligible) nonresidential systems. This kWh difference is statistically significant at the 95 percent level; the corresponding difference in the kW Gross Adjustment Factor is smaller and not significant. The residential groups are not statistically different from each other.

3.2.2. Attribution Factors by REIP Eligibility

Table 3-5 shows the attribution adjustment factor, the ratio of program-attributed generation to evaluation verified gross generation, for the Program overall and by customer eligibility for REIP. As mentioned above, the REIP breakouts provide a method of using the results of the CORE Program Retrospective Impact Analysis to make meaningful inferences about the structure of the new program (REIP). The results of the attribution analysis are particularly striking and supportive of the new program design.

The overall attribution rate is 71 percent for annualized energy generation, and 70 percent for generating capacity. These are good results for a comprehensive PV program that serves residential and non-residential customers with the installation of systems of all sizes.

A closer look at the data shows some significant differences between REIP Eligible and REIP Ineligible customers. REIP Eligible customers are reporting higher levels of program attribution than REIP Ineligible customers. Nonresidential REIP Ineligible customers, systems larger than 50 kW attribute savings to the Program at half the rate of their REIP eligible counterparts. This difference is significant at the 99.5 percent level (p-value < 0.005). For residential customers, kWh attribution is 93.7 percent and 89.9 percent, and kW attribution is 89.4 percent and 83.6 percent for REIP Eligible and REIP Ineligible, respectively.

Table 3-5
Attribution Adjustment Factors by REIP Eligibility for kWh and kW

Attribution (kWh) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	N	Attribution Factor	SE	Lower Bound	Upper Bound
All	**375**	**71.0%**	**9.3%**	**55.7%**	**86.3%**
Res REIP Eligible	247	**93.7%**	1.7%	90.8%	96.5%
Res REIP Ineligible	55	**89.9%**	4.0%	83.2%	96.6%
Nonres REIP Eligible	55	**96.2%**	3.7%	90.1%	102.4%
Nonres REIP Ineligible	18	**45.6%**	14.9%	19.7%	71.6%

Attribution (kW) Adjustment Factor					
	90% Confidence Interval				
Customer Segment	N	Attribution Factor	SE	Lower Bound	Upper Bound
All	**375**	**70.0%**	**8.2%**	**56.4%**	**83.5%**
Res REIP Eligible	247	**89.4%**	1.6%	86.8%	92.1%
Res REIP Ineligible	55	**83.6%**	3.5%	77.7%	89.4%
Nonres REIP Eligible	55	**90.8%**	3.3%	85.2%	96.4%
Nonres REIP Ineligible	18	**47.0%**	14.4%	21.9%	72.1%

The attribution factor results compare favorably with recent studies KEMA has conducted of other PV rebate programs. KEMA used similar attribution data collection methods and attribution factor computation in a recent study of another East Coast states' rebate program. That program achieved a kWh attribution factor of 80 percent for residential systems. As shown above, the REIP eligible residential systems are roughly 14 percentage points higher. Recently, KEMA estimated Wisconsin's Focus on Energy Program attribution level at 63 percent for solar electric.[38] The reader should note that the Focus estimate includes both residential and non-residential installations and uses a slightly different computation methodology.

[38] M. L. Goldberg, B. Tannenbaum, B. Dunn, and B. Jones (KEMA). *Renewables: Impact Evaluation Report, The 18-month Contract Period.* Public Service Commission of Wisconsin, Focus on Energy Evaluation, April 21, 2009.

3.2.2.1. Supplemental Attribution Results

As described in section 3.1.4.1.2, the attribution results in the previous section were based on self-reported net-to-gross methods. This section provides additional discussion and results of individual survey questions used in the attribution algorithm as well as set up and confirmation questions. Set up questions[39] prepare the respondent to answer the questions used in the algorithm and the confirmation questions are used for quality control.

The first question in the series asked respondents at what point during their decision process they heard about the CORE Program. About half of the respondents (53 percent) indicated that they had heard of the rebate Program before they decided to install. Another 27 percent heard about the Program while they were considering whether to install. Fifteen percent heard about the Program after they decided to install.

Table 3-6
When Respondents Heard About CORE Program

Timing	Percent
Before Deciding to Install	53%
While Considering to Install	27%
After Deciding to Install	15%
Didn't know about rebates	2%
Don't know / Can't remember	2%

The next question asked respondents how likely they were to install solar panels if the CORE Program did not exist. Respondents were given the choices of "very likely", "somewhat likely", "not very likely", or "very unlikely." Most respondents answered "very unlikely" (61 percent), followed by "not very likely" (16 percent), and "somewhat likely" (11 percent). Eleven percent of the respondents answered "very likely".

[39] Common set-up questions remind the respondent of: financial and other support received by the program; non-program financial assistance they received; and at what point in the process of system installation they learned about the program.

Table 3-7

How Likely Respondents Would Have Installed Solar Panels without CORE

Likelihood	Percent
Very Unlikely	61%
Not Very Likely	16%
Somewhat Likely	11%
Very Likely	11%
Don't know / Can't remember	4%

The next several questions were used in the attribution calculation. We asked respondents how different their timing would have been without the CORE Program. Respondents were given the choices of "the same time," "earlier," "later," or "never." The frequencies of responses are summarized in Table 3-8. If respondents answered "later" to this question, we followed up by asking them how many months later. On average, respondents who answered later indicated 34 months later. However, these answers had a wide range: from 2 to 120 months. In addition, a number of respondents (33 percent of those who answered later) could not estimate when they would have installed without the Program.

Table 3-8

When Respondents Would Have Installed Without CORE Rebates

Timing Relative to Actual Install	Percent
The Same Time	14%
Earlier	2%
Later	23%
Never	57%
Didn't Know / Can't Remember	2%

The next attribution question asked respondents the effect the CORE Program had on the size of their installation. Respondents were asked to estimate the size of the system they would have installed without the CORE Program. They selected from the following choices: a system of "the same size," "smaller," "larger," or "not installed at all." Frequencies for these answers are summarized in Table 3-9. If respondents answered "smaller" to this question, we followed up by asking them what size system (in kilowatts) they would have installed without the Program.

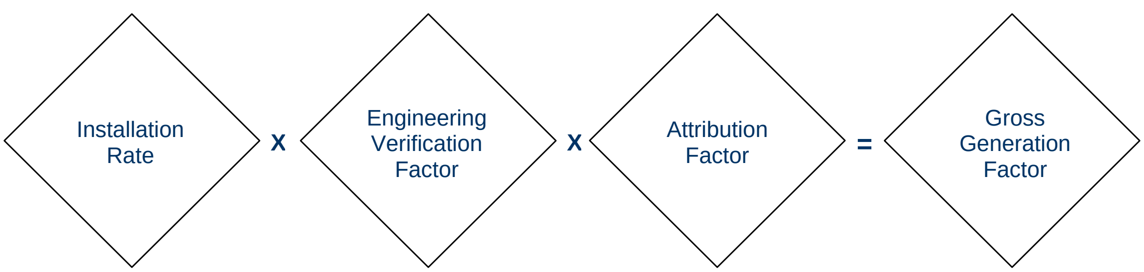
Table 3-9
Size of System Installed Without the CORE Program

Size Relative to Actual Installation	Percent
The Same Size	19%
Smaller	14%
Larger	3%
Not Installed at All	61%
Didn't Know / Can't Remember	3%

3.2.3. Realization Rates

The realization rate is simply the product of the adjustment factors, as shown in Figure 3-8. It is the chained ratio estimate of (Installed / Tracked) × (Verified / Installed) × (Attributed / Verified), that gives an estimate of (Attributed / Tracked) generation and capacity. This gives the fractions of interest to the Program, which is Attributed kW and kWh as a percent of Tracked kW and kWh.[40]

Figure 3-8
Realization Rate Components



The Realization Rates are shown in Table 3-10 for the Program as a whole and for the sectors describing eligibility for REIP incentives under current rules. Realization rates for the Program

[40] The standard error calculations are slightly more complex, and explained in more detail in Appendix A.

as a whole are 67.9 percent for energy generation, and 69.8 percent for generation capacity. These are strong results.

Nonresidential REIP Ineligible customers, systems larger than 50 kW, have realization rates of 48.2 percent for kWh and 47.3 percent for kW. The corresponding nonresidential eligible customers have significantly larger realization rates, 80.4 percent for kWh and 84.6 percent for kW. The residential customer segments have a similar but less dramatic pattern.

Table 3-10
Realization Rates for kWh and kW, by REIP Eligibility

Realization Rate (kWh)					
	90% Confidence Interval				
Customer Segment	**N**	**Realization Rate**	**SE**	**Lower Bound**	**Upper Bound**
All	**375**	**67.9%**	**0.1%**	**67.8%**	**67.9%**
Res REIP Eligible	247	**82.9%**	0.2%	82.7%	83.2%
Res REIP Ineligible	55	**79.7%**	0.1%	79.5%	79.9%
Nonres REIP Eligible	55	**80.4%**	0.5%	79.5%	81.3%
Nonres REIP Ineligible	18	**48.2%**	0.9%	46.6%	49.7%

Realization Rate (kW)					
	90% Confidence Interval				
Customer Segment	**N**	**Realization Rate**	**SE***	**Lower Bound**	**Upper Bound**
All	**375**	**69.8%**	**0.0%**	**69.7%**	**69.8%**
Res REIP Eligible	247	**89.5%**	0.0%	89.5%	89.5%
Res REIP Ineligible	55	**83.6%**	0.1%	83.5%	83.7%
Nonres REIP Eligible	55	**84.6%**	0.5%	83.9%	85.4%
Nonres REIP Ineligible	18	**47.3%**	0.8%	45.9%	48.7%

* A 0.0% SE means that the standard error was less than 0.1% (but greater than 0%).

3.2.4. Application of Adjustment Factors

Table 3-11 summarizes the gross tracked, evaluation verified gross, and evaluation verified net generation and capacity for the Program. The tracking database reports that all of the systems installed during the period 2001-2006 together generate about 30.8 GWh/year. KEMA estimates that about 29.8 GWh/year are actually generated and 20.2 GWh/year are directly attributable to the Program[41]. The tracking database predicts that all of the systems installed between 2001 and 2006 have about 25.7 MW of capacity. KEMA estimates that the actual capacity is 25.6 MW and 17.9 MW are directly attributable to the program.

Table 3-11
Evaluation Verified Gross and Net Energy Impact

Sector	Gross Tracked MWh	Evaluation Verified Gross MWh	Evaluation Verified Net MWh	Gross Tracked kW	Evaluation Verified Gross kW	Evaluation Verified Net kW
Res REIP Eligible	10,933	9,683	9,069	9,111	9,118	8,156
Res REIP Ineligible	2,304	2,044	1,837	1,920	1,921	1,605
Nonres REIP Eligible	2,411	2,015	1,939	2,009	1,873	1,700
Nonres REIP Ineligible	15,190	16,040	7,317	12,659	12,735	5,989
Total	**30,838**	**29,781**	**20,161**	**25,698**	**25,648**	**17,451**

3.3. Recommendations

This section contains KEMA's recommendations to the Program based on the results of the Retrospective Impact Analysis. Note, these recommendations are limited because the CORE Program is closed to new applicant and there are fundamental differences between CORE and REIP (e.g.: eligibility).

Recommendation #1

KEMA recommends the Program consider using the attribution factors found in this evaluation to determine net impacts rather than the existing assumption that attribution is 100 percent. Furthermore, the Program could use the attribution factors for each of the separate REIP eligibility categories. Going forward, the BPU, OCE or the Program Coordinator could calculate estimated net impacts at any time by multiplying the program gross tracked savings estimate from the database by the attribution factors reported in this document.

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[41] The sector level adjustment factors were used to produce these results.

Recommendation #2

The tracking database should be used to track gross kW and kWh. The tracking database should contain all data required for the calculations outlined in the Protocols. For example, the Protocols require an estimate for peak kW impact for summer and winter, but the tracking database did not provide these estimates. The tracking database should also include an estimate of annual energy (kWh) generated by each system. In addition, the program should make sure that the tracking database is kept up to date.

Tracked kW and kWh in the database should use information from follow-up site inspections by the REIP program team. In a few instances, KEMA learned during the on-site visits that the installed equipment was not always the same as the equipment recorded in the tracking database. This was not a systemic issue but something to consider as part of routine quality control measures.

4. Prospective Analysis

The primary objective of the Prospective Analysis was to recommend updates to the energy savings Protocols for PV systems. This section provides the methodology, results and recommendations of the Prospective Analysis for Energy Production (kWh) and Peak Demand (kW).

4.1. Methodology

The Protocol review included an assessment of how the Program estimates annual solar energy (Energy Production (kWh)) and a review of the peak hour impact (Peak Demand (kW)) using equations established in the Protocols.

4.1.1. Energy Production (kWh)

The CORE Program has two methods for estimating annual solar energy delivered from a PV system to the electrical grid. The first method, Method 1,[42] relies on an engineered calculation using parameters relevant to each site (PVWatts). According to conversations with CORE staff[43] this method of estimation is used to assess projected individual system performance by the Clean Power Markets (CPM) (recently transferred to PJM GATS). The second method, Method 2, uses an empirically based deemed value. This deemed value is multiplied by the total kW_{STC} of PV systems installed to estimate annual solar energy. This value is used by the Market Managers to derive the Program's annual energy savings from all PV installations[44].

4.1.1.1. Overview of Current Methods

4.1.1.1.1. Method 1 (PVWatts)

The Protocols for CORE designate PVWatts (Version 1) as the calculation model to be used to estimate annual solar electric generation. PVWatts is recognized as an industry standard for the

[42] The terms Method 1 and Method 2 were created by KEMA for explanatory purposes.

[43] Telephone conversation with Mark Loeser, CORE Account Manager, NJCEP, 12/17/08.

[44] Email communication with Charlie Garrison, NJCEP Renewable Energy Market Manager, Honeywell, 01/20/09.

calculation of solar energy from crystalline silicon photovoltaic (PV) systems.[45] PVWatts was developed by the National Research Energy Laboratory (NREL) which is part of the US Department of Energy's Office of Energy Efficiency and Renewable Energy. PVWatts is made available as an online tool by the Renewable Resource Data Center. The NJCEP directs participants to the PVWatts website to estimate their solar system production.

The PVWatts model estimates the annual energy output using its database of TY2[46] solar irradiance and temperature for cities throughout the United States. In addition, the model requires site specific information about the PV system's DC rated output (based on standard test conditions of 1000 W/m^2 and 25 degrees C module temperature), panel tilt and directional orientation. The model can also take into account system inefficiencies and irregularities such as DC to AC inverter power transitions and shading. PVWatts assumes a default derate factor of 0.77 (i.e. a 23% loss due to inefficiencies in the system from the panel to electrical power grid). Finally the model can make calculations for fixed tilt, one axis and two axis tracking PV systems. The required input to the model is collected for each installed PV system by the CORE Program though its customer application technical worksheet and on-site inspection documentation.

4.1.1.1.2. Method 2 (Deemed Value)

A value of 1200 kWh/kW/year has been deemed to approximate the amount of electricity generated per year per kW of installed capacity and is calculated by the algorithm:

$$\textit{Deemed Annual Energy} = 1200\ kWh/kW/yr \times \textit{installed } kW$$

KEMA understands that this deemed value is the results of entering the "typical" New Jersey site information into PVWatts.

[45] PVWatts does have some limitations which should be taken into account during its use. PVWatts is designed for grid tied systems and therefore is not meant for estimating production of off-grid battery or water pumping systems. PVWatts is modeled for crystalline silicon PV systems. It is not meant for other materials and designs such as amorphous silicon and thin film panels. PVWatts uses data from a typical year and therefore estimates for a specific system will differ from actual production in a given year.

[46] Typical Year2 (TY2) is a method of assigning daily solar irradiance values for what is established as "typical months" over a full year from historical climate data.

4.1.1.2. Engineering Assessment

In order to assess the accuracy of Method 1 and Method 2, KEMA calculated several intermediate values. First, we calculated the amount of energy that would be expected if using the PVWats estimate (Method 1). Second, we calculated the amount of energy that would be expected if using the deemed value estimate (Method 2). Next, we annualized the kWh measurements we obtained from the on-site visits. Finally, we computed two System Performance ratios (one for Method 1 and one for Method 2) to verify the accuracy of the different methods.

4.1.1.2.1. Method 1 (PVWatts)

During the on-site visits, we collected the system operational parameters of DC rating, tilt, orientation, tracking capability (i.e. fixed, single axis, or dual axis) and shading for entry into the PVWatts model. In addition, we used the closest reference city and the CORE Program default derate factor of 0.77 as inputs to the model. Finally, we calculated an estimated annual average kWh energy value with the model for each site visited.

4.1.1.2.2. Method 2 (Deemed Value)

Annual energy was calculated for each site visited using the *Annual Deemed Energy* formula provided above.

4.1.1.2.3. Measured Annual kWh

KEMA obtained the actual measured energy output of 73 PV systems throughout New Jersey during our on-site visits. We annualized the measured energy production as follows:

$$\textit{Measured Annual kWh} = (\textit{Total measured kWh} / \textit{Days of operation}) \times 365 \textit{ days/yr}$$

Where:

Total measured kWh	=	data from inverter(s) readout.
Days of operation	=	The total number of days the system was in place.

4.1.1.2.4. System Performance (SP) Ratio Calculations

To compare the annual measured energy production to the Method 1 and Method 2 estimates we calculated the System Performance (SP) $\text{Ratio}_{\text{kWh}}$ using the following algorithm:

$$SP\ Ratio_{kWh} = \frac{Measured\ Annual\ kWh}{Estimated\ Annual\ kWh}$$

Where:

Measured Annual kWh = (Total measured kWh / days of operation) × 365 days / year.

Estimated Annual kWh = Value obtained from Method 1 **or** Method 2.

4.1.2. Peak Demand (kW)

Although the Protocols require an estimate for peak kW impact for summer and winter, the tracking database did not include these estimates. We calculated a verified summer peak kW impact for the Program based on data gathered from the site visits and the Protocols. We then compared the verified peak kW impact to the peak kW impact calculated based on information from the database and the Program Protocols.

We calculated the verified peak kW impact using the equation established in the Protocols:

$$\text{Summer Peak Impact} = System\ Rated\ Output \times ELCC$$

and

$$\text{Winter Peak Impact} = System\ Rated\ Output \times WELCC$$

Where:

Summer Peak Impact	=	Summer demand (kW_{AC}) offset by the system.
Winter Peak Impact	=	Winter demand (kW_{AC}) offset by the system.
System Rated Output	=	System rated output (kW_{AC}).
ELCC	=	Summer Effective Load Carrying Capacity = 0.65.
WELCC	=	Winter Effective Load Carrying Capacity = 0.08.

The system rated output was not provided in the database and we estimated it based on:

$$\text{System Rated Output} = PV\ Module\ Rating\ (kW_{DC}) \times Number\ of\ Modules \times DF_{DCtoAC}$$

Where:

PV Module Rating (kW_{DC})	=	DC wattage rating of the module at standard test conditions (STC)[47].
$DF_{DC\ to\ AC}$	=	Derating factor to convert from DC to AC = 0.77.

For the verified peak kW impact, we used module quantities and ratings that we verified during the on-site visits. For tracking peak kW impact, we used module quantities and ratings that were provided in the database.

4.2. Results

The results of the Protocol review first address energy production (kWh) followed by peak demand (kW).

[47] We used the module kW_{STC} rating since it was the only rating available in the database.

4.2.1. Energy Production (kWh)

In order to assess the Protocols' methodology to estimate energy production for PV systems, we compared the Method 1 (PVWatts) and Method 2 (Deemed Value) estimates to the actual value measured during the on-site visit.

Table 4-1 shows the System Performance (SP) Ratio for Method 1 and Method 2 as compared to the measured value. The SP Ratio is shown for all systems and by the REIP eligibility category. SP Ratios greater than 1.0 indicate that the actual measured kWh is greater than the estimate provided by Method 1 or Method 2. In other words the Protocol estimate is lower than the measured value. SP Ratios less than 1.0 denotes that the actual measured kWh value is less than the calculated estimate. In other words the Protocols estimate is higher than actual.

Table 4-1
Method 1 and Method 2 Comparison

System Size	Sample Size	Method 1 (PVWatts)		Method 2 (Deemed)	
		SP Ratio	90% confidence interval	SP Ratio	90% confidence interval
All Systems	73	1.06	1.01 – 1.11	0.96	0.90 – 1.01
Res REIP Eligible	24	1.01	0.95 – 1.06	0.89	0.82 – 0.95
Res REIP Ineligible	21	0.99	0.95 – 1.02	0.89	0.86 – 0.92
Nonres REIP Eligible	17	1.01	0.94 – 1.07	0.84	0.69 – 0.98
Nonres REIP Ineligible	11	1.12	1.05 – 1.19	1.06	1.01 – 1.11

It can be seen from Table 4-1 that both methods provided a fairly close estimate of the actual kWh measurements for systems overall. The Method 1 (PVWatts) SP Ratio for all systems of 1.06 indicates that Method 1 underestimated production by 6.0 percent. The Method 2 (Deemed Value) SP Ratio for all systems of 0.96 indicates that Method 2 (Deemed Value) overestimated production by 4.0 percent.[48]

[48] This is equivalent to the kWh Gross Savings Adjustment Factor reported in the Retrospective Impact Analysis because the Retrospective Impact Analysis uses the Method 2 (Deemed Value) estimates recorded in the Program tracking database.

When broken down by system size and type, for systems 50 kW or less (REIP Eligible), Method 1 (PVWatts) provided quite accurate estimates of energy production, whereas Method 2 (Deemed Value) did not. Conversely, for Nonresidential REIP Ineligible PV systems Method 2 provided a closer estimate to actual kWh measurements, although both methods predicted lower kWh values than actual. It is these larger (>50 kW) nonresidential systems which tend to skew energy production estimates lower (resulting higher SP ratios) for All Systems.

4.2.2. Peak Demand (kW)

In addition to installed capacity and annual electrical production, the Protocol requires an estimate of peak demand impact based on research conducted by Richard Perez of SUNY Albany for the New Jersey Board of Public Utilities. The peak demand impact is a measure of the likely reduction in the utility peak due to the installation of photovoltaic systems. As the demand for electricity delivery through aging infrastructure grows, reduction in peak demand will be increasingly important to prevent rolling blackouts or other power system problems related to utility peaks.

4.2.2.1. Overview of Existing Protocol

The Protocols require estimates for the peak demand in summer and winter are based on the following relationships:

$$\text{Summer Peak Impact} = System\,Rated\,Output \times ELCC$$

and

$$\text{Winter Peak Impact} = System\,Rated\,Output \times WELCC$$

Where:

Summer Peak Impact	=	Summer demand (kW_{AC}) offset by the system.
Winter Peak Impact	=	Winter demand (kW_{AC}) offset by the system.
System Rated Output	=	Rated PV output (kW_{AC}).
ELCC	=	Summer Effective Load Carrying Capacity = 0.65.
WELCC	=	Winter Effective Load Carrying Capacity = 0.08.

4.2.2.2. Review of Existing Protocol Summer Peak Impact

The effective load carrying capacity indicates the potential portion of the system rated output that will be available during a utility peak. Perez et al developed the effective load carrying capacity factors through research and sophisticated analytical methods.[49,50] In simple terms, Perez et al determined when the utility peak occurred, estimated the solar irradiance during the utility peak, and estimated the probable portion of rated capacity that would be available during peak.

KEMA identified the following three issues the Program should consider with regards to its use of the ELCC to estimate peak impact for summer.

1. The ELCC was estimated based on time of the existing utility peak. Rate structures and Programs that discourage electrical use during the peak period may cause the utility peak to shift over time thereby changing the ELCC.

2. The ELCC factor that is used is too high.

[49] Perez, Richard, *Determination of Photovoltaic Effective Capacity for New Jersey*, Project Manager: Cassandra Kling, BPU found at http://www.clean-power.com/research/capacityvaluation/ELCC_New_Jersey.pdf (accessed 24 June 2009)

[50] Perez, R., R. Margolis, M. Kmiecik, M. Schwab, and M. Perez, *Update Effective Load-Carrying Capability of Photovoltaics in the United States*, Conference paper NREL CP-620-40068, June 2006

3. Estimating the peak impact based on the ELCC is inconsistent with the approach used in the rest of the Protocols.

4.2.2.2.1. ELCC Based on Out-dated Peak

The first issue can be addressed by simply recalculating the ELCC based on the new utility peak if the peak shifts. This will probably not be necessary, but should be a consideration as loads shapes may change over time.

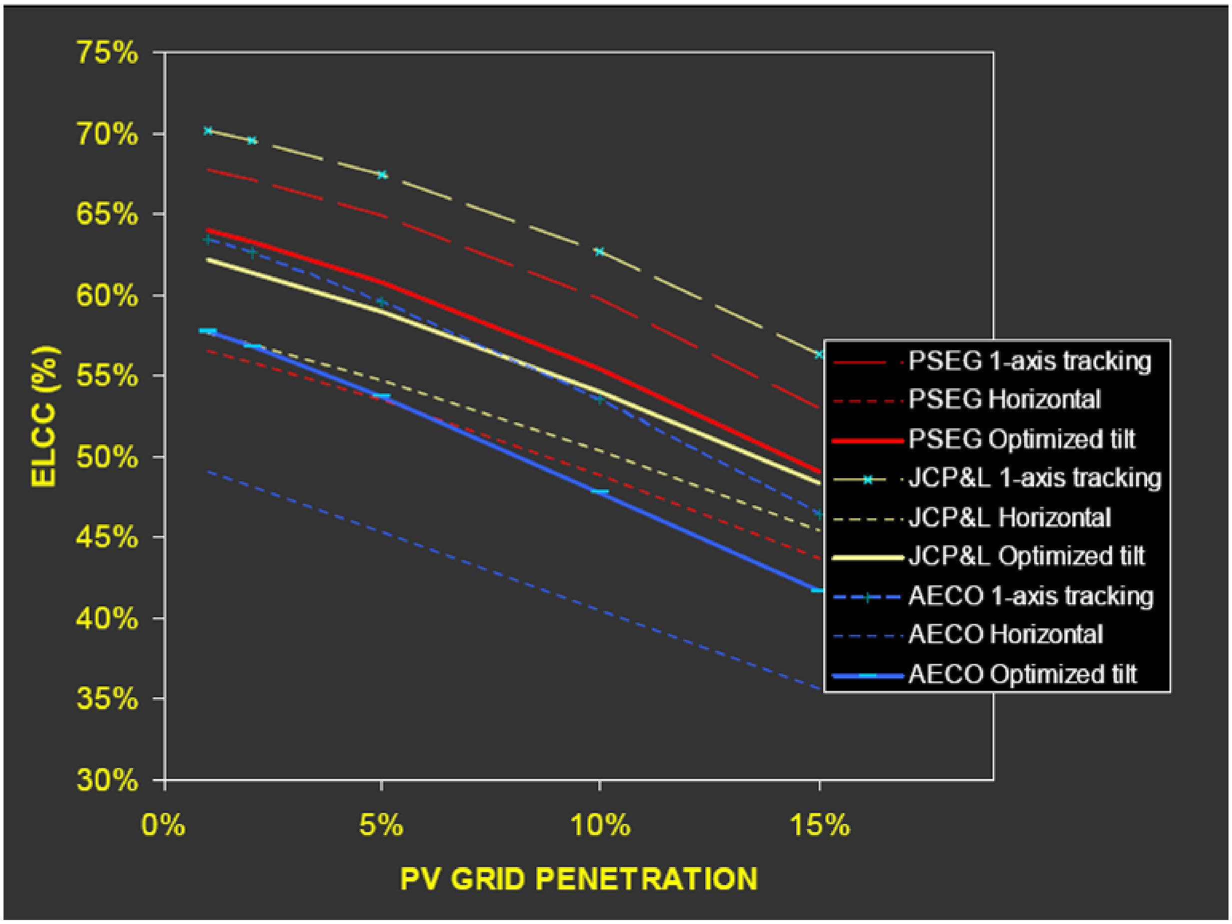
4.2.2.2.2. ELCC Too High

As shown above, the existing Protocols stipulate an ELCC of 0.65; this value is potentially too high. The Protocols state, "the estimated summer effective load carrying capacity (ELCC) for New Jersey is 60 percent to 70 percent"[51] and assign an ELCC of 65 percent. However, in the "Determination of Photovoltaic Effective Capacity for New Jersey"[52], Perez states the ELCC for New Jersey ranges from 40 to 70 percent. In addition, the graphics in the report by Perez show the ELCC for non-tracking systems with optimized tilts range from roughly 40 to 65 percent (see Figure 4-1). Modules on non-tracking systems are mounted with a fixed tilt and orientation whereas modules on tracking systems move to follow the sun as it moves through the sky.

[51] *New Jersey's Clean Energy Program Protocols to Measure Resource Savings,* Draft revisions to September 2004 Protocols, January 2007

[52] Perez, Richard, *Determination of Photovoltaic Effective Capacity for New Jersey*, Project Manager: Cassandra Kling, BPU

Figure 4-1
ELCC as a Function of PV Penetration and Array Geometry[53]



Of the sites included in this impact evaluation's data collection activities, only one site had a tracking system. The remainder of the sites had fixed mounting systems. This finding suggests that any curves associated with 1-axis tracking will have a minimal impact on the statewide ELCC. Additional work by Perez has estimated ELCCs as 49 percent for horizontal systems, 51 percent for south facing systems with a 30 degree tilt and 56 percent for southwest facing

[53] ibid.

systems with a 30 degree tilt.[54] Assuming low PV grid penetration (i.e. less than two percent) and almost no tracking systems, we recommend the Protocols be revised to use an ELCC of no more than 50 percent.

4.2.2.2.3. Inconsistent with Other Measures

The ELCC method is not consistent with peak impact as defined for the rest of the Protocols. All other measures in the Protocols use a different definition for peak kW impact. These measures define the peak electrical impact as the average kW saved during the Peak Demand Period. Based on the protocols, the peak demand period occurs between 12:00 and 8:00 p.m. (11:00 a.m. and 7:00 p.m. solar time) weekdays from June through August[55]. KEMA has estimated the peak impact using this definition by estimating a peak kW savings ratio using the following procedure.

We used PVWatts version 1 to find the hourly production for each hour of the year. Using the hourly data, we directly calculated the average kW displaced by the PV system during peak by summing the kWh production during the peak period and dividing the sum by 736 hours or [8 hours * (30 + 31 + 31) days]. PVWatts hourly output is based on solar time. Therefore, the closest PVWatts time period coinciding with peak output is 11:00 a.m. to 7:00 p.m. (solar time). Finally, we defined the peak kW savings ratio as:

$$\text{Peak kW Savings Ratio} = \frac{kW_{AVG}\ \text{(During Utility Peak)}}{kW_{Rated}}$$

Where:

Peak kW Savings Ratio = the percent of the PV system rated kW that offsets utility peak demand.

kW_{AVG} (During Utility Peak) = average kW available during utility peak.

[54] Perez, R., R. Margolis, M. Kmiecik, M. Schwab, and M. Perez, *Update Effective Load-Carrying Capability of Photovoltaics in the United States*, Conference paper NREL CP-620-40068, June 2006

[55] "New Jersey Clean Energy Program Protocols to Measure Resource Savings", December 2007, pg 6

kW_{Rated} = PV system rated total module kW rating (DC) at standard test conditions (STC).

and the summer peak impact is

$$\text{Summer Peak Impact}_{\text{KEMA}} = kW_{Rated} \times Peak\,kW\,Savings\,Ratio$$

The Peak kW Savings Ratio conceptually represents a similar adjustment factor as the ELCC. However, this method is a substantially different approach than that used by Perez et al. The average peak kW savings ratio for the sites we visited is 0.298.Table 4-2 shows the ratios that we calculated for different site types, installation years, and system sizes.

Table 4-2
KEMA Peak kW Savings Ratios

		Ratio
Site Type	All	0.298
	Residential	0.284
	Commercial	0.312
	School K-12	0.298
	Other	0.316
Installation Year	All	0.298
	2003	0.234
	2004	0.309
	2005	0.301
	2006	0.296
System Size	All	0.298
	0-10kW	0.286
	10-100kW	0.282
	100kW+	0.317

On initial review, these values appear to be less than half of the ELCC of 0.65. However, the kW_{Rated} value used to calculate the KEMA summer peak impact is a DC value. Conversely the System Rated Output used to calculate the summer peak impact as defined in the Protocol is an AC value. As defined earlier:

$$\text{Summer Peak Impact} = System\,Rated\,Output \times ELCC$$

Where:

$$System\ Rated\ Output = kW_{AC}$$

There are losses involved in converting DC power to AC power. For PV systems:

$$kW_{AC} \approx kW_{Rated} \times 0.77$$

Where kW_{Rated} is the STC module rating of the system. Therefore, the Summer Peak Impact equation could be written as:

$$\text{Summer Peak Impact} = kW_{Rated} \times 0.77 \times ELCC$$

We could then define the ELCC on a DC basis as:

$$ELCC_{DC} = 0.77 \times ELCC$$

Finally, we can compare the $ELCC_{DC}$ to the KEMA Peak kW Savings Ratio. The ELCC of 0.65 is equal to an $ELCC_{DC}$ of 0.50. Further, the KEMA recommended Protocol ELCC of 0.50 is equal to an $ELCC_{DC}$ of 0.39. This shows that the KEMA Peak kW Savings Ratio is much closer to the ELCC than the raw values suggest.

While the ELCC method is more useful for electric utilities, the average kW generated during the peak hours method is consistent with the definition in the Protocols used for all other technologies. It will provide consistency to Program results since all Program measures would use the same definition. KEMA recommends the Protocols stipulate that both calculations be performed.

4.2.2.3. Review of Existing Protocol Winter Peak Impact

The winter effective load carrying capacity (WELCC) indicates the potential portion of the system rated output that will be available during a winter utility peak. KEMA identified the following two issues the Program should consider with regards to its use of the WELCC to estimate winter peak impact.

1. The Protocols state that the summer and winter peak impacts are based on research by Richard Perez. We were unable to find research supporting the WELCC. In addition, the Protocols state that WELCC is estimated based on "monitored system data from White

Plains NY". We were unable to find additional information on this source. As a result, we are unable to assess the validity of the WELCC value used in the Protocols.

2. The Protocols indicate that coincident peak demand savings in winter are not applicable and no time periods are provided defining the winter peak. Therefore, we were unable to use a time period defined by the protocol to estimate the winter peak impact.

4.2.2.3.1. Winter Peak Estimate

Although we were not able to assess the WELCC factor, we estimated a winter peak electrical impact. The peak electrical impact is defined as the average kW saved during the winter peak demand period. According to a FERC Electric Tariff filing affecting New Jersey, the winter peak demand period occurs between 7:00 and 9:00 a.m. and between 6:00 and 8:00 p.m. weekdays from January through February[56]. KEMA estimated the peak impact based on this definition by estimating a peak kW savings ratio using the following procedure.

We used PVWatts version 1 to find the hourly production for each hour of the year. Using the hourly data, we directly calculated the average kW displaced by the PV system during winter peak by summing the kWh production during the peak periods and dividing the sum by 236 hours or [4 hours * (31 + 28) days]. Finally, we defined the peak kW savings ratio as:

$$\text{Peak Winter kW Savings Ratio} = \frac{kW_{WinterAVG}\ (\text{During Utility Winter Peak})}{kW_{Rated}}$$

Where:

Peak Winter kW Savings Ratio	=	the percent of the PV system rated kW that offsets utility winter peak demand.
$kW_{WinterAVG}$ (During Utility Winter Peak)	=	average kW available during utility winter peak.

[56] "Revised Sheets to the PJM Tariff and Reliability Assurance Agreement", Sixth Revised Volume No. 1, December 2008.

kW_{Rated}	=	PV system rated total module kW rating (DC) at standard test conditions (STC).

and the winter peak impact is

$$\text{Winter Peak Impact}_{\text{KEMA}} = kW_{Rated} \times Winter\ Peak\ kW\ Savings\ Ratio$$

The Winter Peak kW Savings Ratio conceptually represents a similar adjustment factor as a WELCC. However, this method is a substantially different approach. The average winter peak kW savings ratio for the sites we visited is 0.031.Table 4-2 shows the ratios that we calculated for different site types, installation years, and system sizes.

Table 4-3
KEMA Winter Peak kW Savings Ratios

		Ratio
Site Type	All	0.031
	Residential	0.033
	Commercial	0.024
	School K-12	0.018
	Other	0.051
Installation Year	All	0.031
	2003	0.030
	2004	0.054
	2005	0.027
	2006	0.029
System Size	All	0.031
	0-10kW	0.032
	10-100kW	0.054
	100kW+	0.022

These ratios provide insights into the types of systems installed at different sites. The low ratio for School K-12 sites (0.018) suggests that these types of systems tend to be installed at a lower tilt angle than average. It is possible that many of these systems are installed on a flat roof in a horizontal position. Since the winter sun is relatively low, the sun light reaches the panels at a very oblique angle. Therefore less solar energy is converted to electrical energy for these systems during the winter.

In addition, these values appear to be substantially less than the WELCC of 0.08. However, the kW_{Rated} value used to calculate the KEMA winter peak impact is a DC value. Conversely the System Rated Output used to calculate the winter peak impact as defined in the Protocol is an AC value. As defined earlier:

$$\text{Winter Peak Impact} = System\,Rated\,Output \times WELCC$$

Where:

$$System\ Rated\ Output\ = kW_{AC}$$

There are losses involved in converting DC power to AC power. For PV systems:

$$kW_{AC} \approx kW_{Rated} \times 0.77$$

Where kW_{Rated} is the STC module rating of the system. Therefore, the Winter Peak Impact equation could be written as:

$$\text{Winter Peak Impact} = kW_{Rated} \times 0.77 \times WELCC$$

We could then define the WELCC on a DC basis as:

$$WELCC_{DC} = 0.77 \times WELCC$$

Finally, we can compare the $WELCC_{DC}$ to the KEMA winter Peak kW Savings Ratio. The WELCC of 0.08 is equal to a $WELCC_{DC}$ of 0.062. This shows that the impact based on the KEMA winter Peak kW Savings Ratio is half that of the Protocol estimate using the WELCC.

The WELCC method could be more useful for electric utilities if it were supported by documentation. In the absence of WELCC documentation, the average kW generated during the peak hours method can be applied. It is consistent with the definition in the Protocols used for all other technologies and can be easily estimated. It will provide consistency to Program results since all Program measures would use the same definition. KEMA recommends the Protocols stipulate that both calculations be performed.

4.3. Recommendations

This section contains KEMA's Energy Production (kWh) and Peak Demand (kW) recommendations to the Program based on the Prospective Analysis.

4.3.1. Energy Production (kWh)

Recommendation #1

KEMA recommends the Program continue its use of PVWatts to calculate energy production and discontinue its deemed value method for purposes of reporting energy production to the BPU. The required input to the PVWatts model is already collected for each installed PV system by the CORE Program though its customer application technical worksheet and on-site inspection documentation. More specifically, KEMA is recommending the Program calculate energy production system-by-system with the data already collected during the Program's site inspections. The increase in accuracy from the system-by-system calculation approach should require minimal additional cost.

The NJCEP has issued a guidebook which contains the present processes and procedures by which the Renewable Energy Incentive Program (REIP) is administered by the Renewable Energy Market Managers.[57] It should be noted that the REIP is currently in transition from Clean Power Markets platform to the Generation Attributes Tracking System (GATS) operated by PJM. In the guidebook, PVWatts continues to be the calculation method by which kWh production for systems less than 10 kW is estimated for the purposes of issuing Solar Renewable Energy Certificates (SRECs). Systems larger than 10 kW are awarded SRECs on the basis of self reported or electronically reported PV energy production.

Recommendation #2

KEMA recommends the Program consider two changes to the PVWatts calculation methodology.

[57] Renewable Energy Incentive Program Guidebook, January 2009 version 1.0. New Jersey's Clean Energy Program, New Jersey Board of Public Utilities.

1.) In instances where arrays of panels at a site are at different tilt angles, orientations, or have different shading, the PVWatts calculations should be performed separately for each array and then added for the total system.

2.) Incorporation of a shade factor. Shading was found to be significant at many of the sites visited. On average shading decreased the solar radiation reaching the PV systems by 6.3 percent. To arrive at an overall system derate factor, the base derate factor should be multiplied by a factor for shading. This factor is not currently included in the base derate factor, but it is collected by the CORE Program. The calculation is performed as follows:

System derate factor = Base derate factor x Shade factor

Where:

System derate factor	=	Value entered into the PVWatts calculator to derate PV panel DC rating to an AC rating.
Base derate factor	=	derate factor = 0.77 (default value).
Shade factor	=	100 percent minus percent shading (decimal value).

4.3.2. Peak Demand (kW)

Recommendation #1

The Program should consider periodically reviewing the load curves for the New Jersey utilities. If the peak load shifts substantially, the ELCC should be recalculated based on the new peak.

Recommendation #2

KEMA recommends the ELCC be reduced from 65 percent to 50 percent to more accurately reflect the types of systems installed.

Recommendation #3

KEMA recommends the Program revise the Protocols to include the average kW over the peak. This metric offers program planners a definition that is consistent with the rest of the Program kW metrics. However, since the ELCC method is useful for utilities, we also recommend that the Program continue to track peak kW impact based on this method with the revised ELCC factor.

Recommendation #4

KEMA recommends the Program document the basis for the WELCC. The documentation should be available for independent review and analysis. In the absence of documentation, revise the Protocols to include the average kW over the winter peak. This metric offers program planners a definition that is consistent with the rest of the Program kW metrics.

APPENDIX A: Ratio Expansion – Sample to Population Results

This section provides the ratio estimation computation KEMA employed to develop estimates of evaluation verified gross and net impacts.

Ratio Estimation

KEMA used the statistical procedure of ratio estimation to develop estimates of evaluation verified gross and net impacts. There are two basic steps in the process. The first step is to verify energy production in a sample of participating customers. KEMA accomplished this first step via engineering reviews, customer interviews, and on-site visits. The second step is to expand the sample results to the population of customers. This is accomplished by calculating the ratios of verified-to-reported and attributable-to-verified for the sample. The ratios are also referred to in this analysis as adjustment factors. The adjustment factors estimated from the data collection and analysis include:

- **Gross generation adjustment factor:** This factor combines the installation rate and the engineering verification factor. It corresponds to the ratio of the verified gross kW and kWh generation to the tracking estimate of system capacity and capacity* 1200 hours.
- **Attribution factors:** This factor adjusts verified gross generation for program attribution. It is the estimated proportion of verified gross generation attributable to the Focus Business Programs. It corresponds to the ratio of net generation to verified gross generation.
- **Realization rate:** This factor combines the gross production adjustment factor and the attribution factor. It corresponds to the ratio of the net generation to the tracking estimate of generation.

Expansion of sample results to the population via ratio analysis

The calculation of the adjustment factors for tracking system gross and net generation uses appropriate weights corresponding to the sampling rate. The three primary adjustment factors are the installation rate, the engineering verification factor, and the attribution factor. Each of these is calculated as a ratio estimator over the sample of interest (Cochran, 1977, p.165). The formulas for these factors are given below.

Notation: The following terms are used in calculating the adjustment factors:

G_{Tj} = tracking estimate of gross generation for project *j*

G_{Ij} = tracking estimate of gross generation for project *j*, adjusted for non-installation

G_{Vj} = verified gross generation for project *j* based on engineering review

N_{Cj} = net generation determined from the CATI survey.

N_{Vj} = net generation determined from the engineering site review.

w_{Ej} = weighting factor for project *j* used to expand the engineering sample to the full population

w_{Aj} = weighting factor for project j used to expand the combined engineering and CATI sample to the full population

E denotes the engineering sample

C denotes the CATI sample

A denotes the combined engineering and CATI samples.

Installation rate

The installation rate R_I is calculated using the combined engineering and CATI samples as:

$$R_I = \frac{\sum_{j\varepsilon A} G_{Ij} w_{Aj}}{\sum_{j\varepsilon A} G_{Tj} w_{Aj}}.$$

Engineering verification factor

The engineering verification factor R_V is calculated from the engineering sample only as:

$$R_v = \frac{\sum_{j\varepsilon E} G_{Vj} w_{Ej}}{\sum_{j\varepsilon E} G_{Ij} w_{Ej}}.$$

Attribution factor

The attribution factor R_{FR} uses data from both the engineering and CATI samples:

$$R_{FR} = \frac{\sum_{j\varepsilon E} N_{Vj} w_{Aj} + \sum_{j\varepsilon C} N_{Cj} w_{Aj}}{\sum_{j\varepsilon E} G_{Vj} w_{Aj} + \sum_{j\varepsilon C} G_{Cj} w_{Aj}}.$$

Standard errors

The ratio estimator is calculated using a SAS® macro provided by SAS for ratio estimation by domains. The procedure also returns the standard error of the estimate. The standard error is calculated using two methods.

The first method recognizes the sample as drawn from a finite population: the projects completed within the analysis period with associated energy impacts in the program-tracking database. This calculation uses the Finite Population Correction (FPC) factor. This factor is a reduction to the calculated variance that accounts for the fact that a relatively large fraction of the population of interest has been observed directly and is not subject to uncertainty. It is appropriate to apply precision statistics, such as confidence intervals, based on the standard error calculated in this manner when quantifying the results of the program during the study period only.

The second calculation treats the population of interest as essentially infinite. Thus, the projects completed to date and the sample selected from them is regarded as random instances of a virtually infinite number of projects that could have been completed under the program. In this case, the FPC is not included. It is appropriate to apply standard errors calculated in this manner when applying the verification factors developed from this study to tracked generation from other years to estimate verified generation in those years.

Gross verification factor and overall realization rate

The gross verification factor is the ratio of verified gross to tracking estimate of gross generation. This factor is calculated by chaining together the installation rate, based on the combined Engineering and CATI samples, and the engineering verification factor, which uses only the Engineering sample:

$$R_G = R_I\, R_V \qquad = \left[\frac{\sum_{j\varepsilon A} G_{Ij} w_{Aj}}{\sum_{j\varepsilon A} G_{Tj} w_A}\right]\left[\frac{\sum_{j\varepsilon E} G_{Vj} w_{Ej}}{\sum_{j\varepsilon E} G_{Ij} w_{Ej}}\right].$$

This is an example of a chained ratio estimator using a nested sample. The standard error for the chained ratio is approximated by the formula

$$\mathrm{SE}(\mathrm{AB}) \simeq \mathrm{AB}\sqrt{\left[\left(\frac{\mathrm{SE(A)}}{\mathrm{A}}\right)^2 + \left(\frac{\mathrm{SE(B)}}{\mathrm{B}}\right)^2\right]}.$$

(This formula overstates the standard error, because it ignores the correlation between the numerator of R_I and the denominator of R_V, which reduces the variance of the product. This makes for a more conservative significance test in our results)

Likewise, the overall realization rate is calculated by chaining together the gross verification factor with the attribution factor. The same approximation formula allows (an over-estimate of) the standard error of the realization rate to be calculated from the two separate standard errors.

APPENDIX B: Detailed Sample Information

This appendix provides additional detail on the CORE Program population and the sample design.

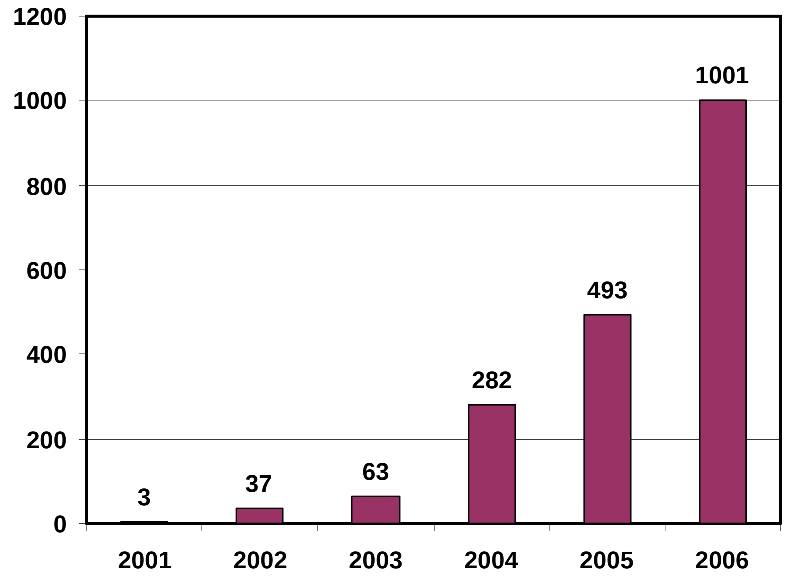
Sample stratification

In order to accurately and efficiently assess the contributions of the disparate PV systems installed under the CORE Program, we performed a stratified random sample from the set of all projects rebated by the CORE Program in the years 2001-2006. When a widely-different population can be clustered into relatively homogeneous groups, stratifying the sample means that when we extrapolate from the survey sample back to the wider population, our estimates will be more precise, with less uncertainty, than estimates from a simple random sample.

This survey sample is stratified by three different criteria: installation year, system size (rated power) and customer type.

Installation year is defined as the calendar year in which the rebate check was cut (i.e. the year of the variable *Checkyear* in the data provided by the Renewable Program Market Manager). As shown in Figure B-, less than 6 percent of the projects were approved in the first three years of the Program. A simple random sample might not survey enough members of this group to learn how these older systems compare to newer ones, so KEMA took year into account in stratifying the sample. We assigned projects to one of four time-based groupings: the years 2001-2003 were combined, and 2004, 2005 and 2006 were treated one at a time.

Figure B-1
Number of Projects Rebated Over Time



System size groupings were chosen by the CORE Program's rebate classes.[58] Although the rebate levels have varied over the years, the system size classes have remained the same, and are shown in Table B-1. The smallest system size grouping, 10 kW or less, account for over 80 percent of the installations and over 35 percent of the installed kW. A simple random sample would include too few interviews with owners of larger systems for the results to have acceptably small uncertainty. For these reasons, we chose to stratify the sample on system size.

[58] Historical data on rebate levels were downloaded on January 21, 2008 from http://www.njcleanenergy.com/files/file/CORE%20Solar%20Incentive%20Levels.xls

Table B-1
Number of Systems and Total kW by System Size

System Size	Rebate Class	Number of Installations	Sum of kW Installed
0 to 10,000 watts	0 to 10 kW	1,592	10,145
10,001 to 40,000 watts	10 to 40 kW	221	3,038
40,001 to 100,000 watts	40 to 100kW	21	1,252
100,001 to 500,000 watts	100 to 500 kW	33	6,832
500,001 to 700,000 watts	500 to 700 kW	12	5,739
Total		**1,879**	**27,006***

The total kW sums to 27,005.9 in all cases, however, rounding the semi-total kW causes the sum to vary between 27,005 to 27,009.

The work plan calls for the telephone survey to be followed by site visits for measurement and verification of total generation. Because the largest system size category of installations (500 to 700 kW) generates 21 percent of the CORE Program's power (see Table B-2), site visits to these are among the most urgent. Consequently, that one system size category (500-700kW) is not collapsed for sample stratification. The three midsized system size categories can be collapsed into one class (10 to 500 kW) for stratification purposes. As shown in Table B-2, this group has 15 percent of the installations, but 41 percent of the kW generated. This leaves the smallest system size category (0 to 10 kW), with the most installations, as its own stratification category.

Table B-2
System Size Categories for Stratification

System Size	Number of Installations	Sum kW	% of Total Generated kW
0 to 10 kW	1,592	10,145	37.6%
10 to 500 kW	275	11,122	41.2%
500 to 700 kW	12	5,739	21.2%
Total	**1,879**	**27,006***	

*The total kW sums to 27,005.9 in all cases, however, rounding the semi-total kW causes the sum to vary between 27,005 to 27,009.

Customer type is the third stratification variable. Table B-3 shows the CORE Program eight categories of customer type along with the number of installations and the total kW generated by those installations.

Table B-3
Number of Installations and Total Generation by Customer Type

Customer Type	Number of Installations	Total kW
Commercial	199	10,503
Government Facility	9	1,222
Non Profit	29	379
Residential	1,612	11,293
School Other	6	101
School Public K-12	18	3,259
University Private	4	247
University Public	2	4
Total	**1,879**	**27,006***

*The total kW sums to 27,005.9 in all cases, however, rounding the semi-total kW causes the sum to vary between 27,005 to 27,009.

Based on the distribution of projects and of kW generated, we retained the three largest categories, and combined the remainder as shown in Table B-4. This allows adequate coverage of the less-common customer types.

Table B-4
Four Customer Types: Installations and kW Distribution

Customer Type	Number of Installations	Total kW	%Installations	% Total kW
Residential	1,612	11,293	86%	42%
Commercial	199	10,503	11%	39%
School K-12 (Pub)	18	3,259	1%	12%
Other	50	1952	3%	7%
Total	**1,879**	**27,006***		

*The total kW sums to 27,005.9 in all cases, however, rounding the semi-total kW causes the sum to vary between 27,005 to 27,009.

In Table B-5, the possible combinations of the three stratification variables are displayed in one table. To the left, the table shows the number of installations in each stratum. Of the 48 possible strata, there are 28 non-empty ones. To the right, the table shows the total kW generated in each non-empty stratum. It is also possible to see program growth – in numbers of installations, sizes of installations, and variety of customer types.

Table B-5
Number of Installations and Total kW Stratified

		# Installations by Group					kW by Group				
		2001-2003	2004	2005	2006	Total	2001-2003	2004	2005	2006	Total
Residential	0 to 10 kW	80	228	388	764	**1,460**	357	1,340	2,500	5,159	**9,358**
Residential	10 to 500 kW	1	9	47	95	**152**	15	118	554	1,247	**1,935**
Residential	> 500 kW										
Commercial	0 to 10 kW	11	30	23	47	**111**	56	142	161	293	**652**
Commercial	10 to 500 kW	6	8	19	47	**80**	498	350	606	3,808	**5,263**
Commercial	> 500 kW	1			7	**8**	530			4,057	**4,588**
School K-12	0 to 10 kW										
School K-12	10 to 500 kW		2	5	11	**18**		101	1,408	1,750	**3,259**
School K-12	> 500 kW										
Other	0 to 10 kW	4	3	5	14	**26**	15	21	30	83	**149**
Other	10 to 500 kW		2	6	16	**24**		63	261	1,479	**1,803**
Other	> 500 kW										
Total		**103**	**282**	**493**	**1001**	**1,879**	**1,472**	**2,136**	**5,520**	**17,878**	**27,006**

Table B-6 shows the definitions of the strata, their identifying numbers, and both the targeted and the achieved number of completes for the telephone (CATI) and on-site samples.

Table B-6
Stratification and Sampling Plan

Stratum Number	Program Year	Rebate Class	Sector	Target CATI	Achieved CATI	Target Site Visits	Achieved Site Visits
1	2001-2003	0 to 10 kW	Residential	10	7	2	1
2	2001-2003	0 to 10 kW	Commercial	2	2	0	0
3	2001-2003	0 to 10 kW	Other	1	1	0	0
4	2001-2003	10 to 500 kW	Residential	1	0	0	0
5	2001-2003	10 to 500 kW	Commercial	3	0	0	0
6	2001-2003	> 500 kW	Commercial	1	0	0	0
7	2004	0 to 10 kW	Residential	37	48	4	4
8	2004	0 to 10 kW	Commercial	4	5	1	1
9	2004	0 to 10 kW	Other	1	1	0	0
10	2004	10 to 500 kW	Residential	3	5	2	2
11	2004	10 to 500 kW	Commercial	4	5	2	2
12	2004	10 to 500 kW	School K-12	1	0	0	0
13	2004	10 to 500 kW	Other	1	1	1	1
14	2005	0 to 10 kW	Residential	68	68	7	7
15	2005	0 to 10 kW	Commercial	4	4	1	1
16	2005	0 to 10 kW	Other	1	1	0	0
17	2005	10 to 500 kW	Residential	15	16	6	7
18	2005	10 to 500 kW	Commercial	10	6	2	3
19	2005	10 to 500 kW	School K-12	3	1	1	3
20	2005	10 to 500 kW	Other	3	4	1	1
21	2006	0 to 10 kW	Residential	141	144	11	12
22	2006	0 to 10 kW	Commercial	8	9	3	3
23	2006	0 to 10 kW	Other	2	2	1	1
24	2006	10 to 500 kW	Residential	34	34	13	12
25	2006	10 to 500 kW	Commercial	24	25	9	6
26	2006	10 to 500 kW	School K-12	6	0	0	0
27	2006	10 to 500 kW	Other	8	10	3	5
28	2006	> 500 kW	Commercial	4	1	0	1

Table B-7 compares the distribution of number of installations and capacity in the population (tracking database), the CATI sample, and the onsite sample by sector and size category.

Table B-7
Population and Sample Distributions

Sector	Size Category	% Number of Installations			% Tracked kW		
		Population	CATI	Onsite	Population	CATI	Onsite
Residential	0 to 10 kW	78%	67%	33%	35%	24%	5%
Residential	10 to 500 kW	8%	14%	29%	7%	10%	8%
Residential	> 500 kW						
Commercial	0 to 10 kW	6%	5%	7%	2%	2%	1%
Commercial	10 to 500 kW	4%	9%	15%	19%	33%	15%
Commercial	> 500 kW	<1%	<1%	1%	17%	7%	15%
School K-12	0 to 10 kW						
School K-12	10 to 500 kW	1%	<1%	4%	12%	5%	29%
School K-12	> 500 kW						
Other	0 to 10 kW	1%	1%	1%	1%	<1%	<1%
Other	10 to 500 kW	1%	4%	10%	7%	19%	27%
Other	> 500 kW						
	Total	100%	100%	100%	100%	100%	100%

APPENDIX C: Additional Telephone Survey Results

The goals of this evaluation were to assess the energy impacts of the CORE Program. However, because we needed to speak to program participants to collect data necessary for the impact evaluation, we also took the opportunity to ask them a series of process-related questions. Although these process-related questions were outside the scope of the evaluation, we report those results in this appendix.

KEMA asked the Program participants where they heard about the CORE Program. One-third of the participants said that they heard about the Program from the contractor who installed their solar system. The next most common answer was word of mouth (17%), followed by an Internet site other than the NJCEP/CORE site (12%). Eleven percent of the participants reported hearing about the Program from a print advertisement, and seven percent said they heard about the Program from the NCJEP/CORE website. Participants cited a variety of other information sources, including retail stores (5%), home or trade shows (4%), bill stuffers (2%), TV advertisements (2%), radio advertisements (2%), that they are part of the PV industry (2%), personal research (1%), a utility website (1%), and from the government or other organization (1%). Table C-1 shows the distribution of responses provided by participants.

Table C-1
Sources of Information about CORE

Source of Information About CORE	Percent (n=400)*
Installer	33%
Word of mouth	17%
Internet, not NJCEP/CORE	12%
Print ad	11%
NCJEP/CORE Website	7%
Retail Store	5%
Home/Trade show	4%
Utiltity Bill/Stuffer	2%
TV ad	2%
Radio ad	2%
Part of the Industry	2%
Personal Research	1%
Utility website	1%
Government/Organization	1%
Previous CORE Experience	0%
Email	0%
Chance Encounter	0%
Other	13%

* Total may exceed 100% because multiple answers were allowed.

KEMA asked the participants where they obtained information about their installer. About one-third (31%) of the participants reported hearing about their installer via word of mouth. Another 19 percent said they heard about their installer from an Internet site other than the NJCEP/CORE website. Thirteen percent reported finding out about their installer through the NJCEP/CORE website. Other sources of information about installers included home/trade shows (8%), print advertisements (8%), signs in retail stores (8%), direct marketing from the installers themselves (4%), utility bill stuffers (3%), road signs or billboards (2%), utility websites (1%), TV advertisements (1%), radio advertisements (1%), and government or other organizations (1%). About two percent of the participants said that they installed the systems themselves. A wide range of other sources were mentioned, including window signs, a public bid, bids from several different installers, and unspecified locations on the Internet. Table C-2 shows the distribution of where the participants said they heard about their installers.

Table C-2
Sources of Information About Installer

Sources of information about Installer	Percent (n=400)*
Word of Mouth	31%
Internet, not NJCEP/CORE Site	19%
NJCEP / CORE Website	13%
Home / Trade Show	8%
Print Advertisement	8%
Retail Store	8%
Installer / Contractor	4%
Bill Stuffer	3%
Road Sign / Billboard	2%
Self-installed	2%
Utility Website	1%
TV Advertisement	1%
Radio Advertisement	1%
Government / Organization	1%
Other	29%

* Total may exceed 100% because multiple answers were allowed.

KEMA asked the participants how satisfied they were with the CORE Program using a 5-point scale anchored at one for “not at all satisfied” and five for “very satisfied.” Over three-fourths (83%) of the participants said that they were satisfied (4 or 5 on the 5-point scale) with the CORE Program, overall (Table C-3). Overall satisfaction with the Program was somewhat dependent on the size of the system a participant installed. Eighty-five percent of the participants with 10 kW or smaller system said they were satisfied. Likewise, 91 percent of the participants with system larger than 100 kW said they were satisfied. Participants with systems between 10 and 100 kW were slightly less satisfied. Only 70 percent of these participants reported satisfaction with the Program overall.

Table C-3
Overall Satisfaction with CORE Program

Satisfaction with Core Program	Percent (n=400)
1, Not at all satisfied	0%
2	3%
3	5%
4	20%
5, Very Satisfied	63%
Don't Know	9%
Total	**100%**

KEMA asked the participants who indicated that they were less than satisfied with the Program (3 or less on the 5-point scale) why they were dissatisfied. The most common response (22%) was that they encountered problems with Program administration. The next most common response was dissatisfaction that Program funds ran out before they could complete their project (14%), followed by having problems in the SREC market (12%). Some participants said that they did not receive enough information or received incorrect information from the Program 11%). Seven percent were dissatisfied with rebate reductions. Six percent said that their rebate payment took too long to arrive. Five percent said that they had problems with the contractor who installed their system. Five percent said that their system is producing less power than they expected (Table C-4). Participants expressed a wide range of other reasons, including that they are not familiar with the Program, that electricity is getting more expensive generally, and that they just did not have a strong opinion.

Table C-4
Reasons for Dissatisfaction with CORE Program

Reason for Dissatisfaction w/ Program	Percent (n=39)
Administration Problems	22%
Program Discontinued	14%
SREC Market Problems	12%
Not Enough / Wrong Info	11%
Rebate Reductions	7%
Payment Delay	6%
Problems with Contractor	5%
Low / Unexpected Output	5%
Other	21%

KEMA asked the participants how satisfied they were with the contractor who installed their solar system. We used the same 5-point scale, anchored at 1 for “not at all satisfied” and 5 for “very satisfied”. Almost all (91%) of the participants said they were satisfied (4 or 5 on the 5-point scale) with their installer (Table C-5).

Table C-5
Satisfaction with Installer

Satisfaction w/ Installer	Percent (n=400)
1, Not at all satisfied	2%
2	2%
3	5%
4	16%
5, Very Satisfied	75%
Don't Know	0%
Total	**100%**

KEMA also asked the participants how satisfied they were with their system. This question used the same 5-point satisfaction scale. Almost all (97%) of the participants said that they were satisfied with their solar system (Table C-6). KEMA asked the respondents who were less than satisfied (3 or less on the 5-point scale) why they were dissatisfied with their system. The most common answer was that the system was not producing as much energy as the participant expected (48%). Eighteen percent of the participants said their equipment had malfunctioned or broken down in some way, and 11 percent reported having difficulties with the installation (Table C-7).

Table C-6
Satisfaction with System

Satisfaction w/ Solar System	Percent (n=400)
1, Not at all satisfied	0%
2	1%
3	3%
4	15%
5, Very Satisfied	82%
Don't Know	0%
Total	**100%**

Table C-7
Reasons for Dissatisfaction with System

Reason for Dissatisfaction w/ Solar System	Percent (n=20)
Not Saving	48%
Breakdowns	18%
Installation Problem	11%
Other	23%

In a separate question, KEMA asked the participants if their solar system had ever malfunctioned. Less than one-third (31%) of the participants reported any malfunctions (Table C-8). KEMA asked the participants who did report a malfunction what had happened. Almost two-thirds (63%) of these participants reported having a problem with their inverter. Five percent of the participants reported that their system was damaged due to a lightning strike. Five percent said that they had problems with the panels. Four percent of the participants reported damage from animals, such as squirrels chewing through wires (Table C-9).

Table C-8
Malfunctions with Solar System

Have Solar Panels or Inverter Malfunctioned	Percent (n=400)
Yes	31%
No	69%
Don't Know	1%
Total	**100%**

Table C-9
Type of Solar System Malfunction

Type of Malfunction	Percent (n=126)
Inverter	63%
Lightning Strike	5%
Panels	5%
Animal Damage	4%
Meter	0%
Other	13%
Don't Know	10%

KEMA asked the participants if they had made any changes or repairs to their system since it was installed. Almost three-fourths (73%) of the participants reported that they had not made any changes. The most common type of changes was to replace (7%), repair (7%), or add (6%) an inverter. Six percent of the participants reported making some other repairs such as replacing wiring or panel mounts. Three percent reported making repairs to their panels. Two percent said that they added panels and another two percent said they replaced panels (Table C-10).

Table C-10
Changes or Repairs Made to System

Repairs / Changes to System	Percent (n=400)*
No changes	73%
Repaired/serviced inverter	7%
Replaced inverter	7%
Added inverter	6%
Other repairs	6%
Repaired/Serviced panels	3%
Added panels	2%
Replaced panels	2%
Other	3%

* Total may exceed 100% because multiple answers were allowed.

KEMA asked the participants who reported making changes to their systems whether they received any additional funding from CORE for those changes. Almost all (91%) of the participants said that they did not receive additional funding (Table C-11).

Table C-11
Received Additional Funding from CORE for System Changes

Customer Received Additional Funding From CORE	Percent (n=105)
Yes	5%
No	91%
Don't Know / Can't Remember	4%
Total	**100%**

KEMA asked the participants if they received any sources of funding for their solar system other than the CORE Program. Almost all (97%) of the participants said that they did not receive funding from any other sources (Table C-12). However, when asked specifically if they received any federal tax credits for their systems, 34 percent reported that they had (Table C-13). There was an upward trend in the percentage of participants who said they received federal tax rebates the more recently a participant installed their system. Nine percent of the participants who installed their systems in 2004 reported receiving federal tax benefits. This increased to 13 percent of the participants who installed in 2005 and 54 percent of those who installed in 2006.

This upward trend is probably due to the greater availability of federal tax credits in recent years.

Table C-12
Received Funding from Sources Other than CORE

Customer Received Funding From Additional Source(s)	Percent (n=400)
Yes	2%
No	97%
Don't Know / Refused	1%
Total	**100%**

Table C-13
Received Federal Tax Credits

Received Federal Tax Credits	Percent (n=400)
Yes	34%
No	54%
Don't Know	12%
Total	**100%**

KEMA asked the participants if they participated in New Jersey's SREC market. Almost all (86%) of the participants said that they did already participate in the SREC market (Table C-14). However, participation in the SREC market was somewhat dependent on economic sector. Residential participants were more likely to report participation in the SREC market (89%) than commercial participants (74%) or government/non-profits (47%; Table C-15).

Table C-14
Participation in SREC Program

Participates in SREC Program	Percent (n=400)
Yes	86%
No	13%
Don't Know / Refused	1%
Total	**100%**

Table C-15
Participation in SREC Program by Sector

Customer Participates in SREC Program	Residential (n=322)	Commercial (n=57)	Other (n=20)
Yes	89%	74%	47%
No	10%	22%	53%
Don't Know / Refuse	1%	5%	0%
Total	**100%**	**100%**	**100%**

KEMA asked any participants who reported that they did not already participate in the SREC market if they planned to participate in it. Only about one-fourth (27%) of these participants said that they intended to participate in the SREC market. Forty-three percent said that they did not intend to participate, and thirty percent said that they could not or would not answer the question (Table C-16).

Table C-16
Plans to Participate in SREC Program

Plans to Participate in SREC Program	Percent (n=67)
Yes	27%
No	43%
Don't Know / Refused	30%
Total	**100%**

KEMA asked the residential participants if they had received an energy audit from NJCEP. Only nine percent of the residential participants said that they had. Eighty-three percent said that they had not, and eight percent did not know (Table C-17).

Table C-17
Received an Energy Audit

Received Energy Audit	Percent (n=322)
Yes	9%
No	83%
Don't Know	8%
Total	**100%**

KEMA asked all participants whether they had done any energy savings measures since 2001. Most (92%) of the participants had taken at least one energy saving measure. The most commonly reported energy saving measure was to install CFLs or more efficient lighting (57%). Upgrading or installing new insulation was the second most common response (39%), followed by conservation practices such as turning off lights when leaving rooms (31%). Nineteen percent of the participants reported purchasing a new furnace, 14 percent purchased new appliances, and 12 percent purchased new air conditioning. Eight percent of the participants reported changing their fuel source (switching from gas to electric or vice versa). One percent said that they installed motion sensors on lights, and one percent reported receiving an energy audit (Table C-18).

Table C-18
Other Energy Savings Measures Taken Since Installing Solar System

Energy Saving Measures	Percent (n=400)*
CFLs / Efficient Lighting	57%
Upgraded / New Insulation	39%
Conservation Policies	31%
Upgraded / New Furnace	19%
Upgraded Appliances	14%
Upgraded / New AC	12%
None	8%
Change Fuel Source	8%
Motion Sensors	1%
Energy Audit	1%
Other	3%

* Total may exceed 100% because multiple answers were allowed.

Finally, KEMA asked the participants if they also participated in any other energy efficiency programs. Over three-fourths (79%) of the participants said that they did not participate in any other programs. Eleven percent of the participants said they purchased Energy Star™ products, and four percent said that they received rebates for Energy Star™ products. One percent reported participating in the Smart Start Buildings Program, and one percent said they participated in the Clean Power Choice Program (Table C-19).

Table C-19
Participated in Other Energy Efficiency Programs

Other NJ CEP Customer Participated In	Percent (n=400)
None	79%
Energy Star Products	11%
Energy Star Rebates	4%
Smart Start Buildings	1%
Clean Power Choice Program	1%
Home Performance w/ E. Star	0%
Alternative Vehicle Fuel	0%
Energy Star Homes	0%
Local Govt. Energy Audit	0%
Alternative Infrastructure Fuel	0%
Combined Heat and Power	0%
Other	3%
Total	**99%**

APPENDIX D: Telephone Survey Instrument

New Jersey's Clean Energy Program
Customer On-site Renewable Energy Program (CORE)
Participant Survey

KEMA ID
Unique id # for participant

CONTACT
Contact Name

ADDRESS
Service Address for confirmation (e g. Edison, New Jersey)

PROPERTY TYPE
"Home" if contact is residential,
"Building" if contact is non-residential.

REBATE
Amount of rebate in dollars

INSTALL COST
Total cost of installation (including rebate) in dollars

INVERTER MAKE
Manufacturer of inverter (for use with inverter display document)

INSTALLER
Name of installer

STRATA
Sample Stratum

DUPLICATED
Whether this person appears more than once in the database

CHECKYEAR
Year the person received their check (proxy for the year they installed their system)

Notes to interviewers:

Except where indicated, record only one answer per question.
Anything in square brackets [ ] should NOT be read.
Anything in carrots < > is a variable that the CATI programming should fill in a value for.

Introduction

[What we want from the introduction is to get the person who knows the most about the solar panels on the phone. If that person isn't available, we'd like a time to call back. Once we have that person on the phone, start the survey at C0.]

Hi. May I please speak with <CONTACT>?

I1.

My name is ____ and I'm calling from Braun Research on behalf of New Jersey's Clean Energy Program. We are contacting people who have installed solar panels on their <PROPERTY TYPE>. This is not a sales or marketing call. New Jersey's Clean Energy Program is conducting these interviews to better understand and improve the program. Your responses will be kept entirely confidential. Are you the person who is most familiar with the purchase of your solar panels?

[IF NEEDED]: It will take about 15 minutes.
[IF NEEDED]: I'm calling from Braun Research, an independent research firm, who has been contracted to conduct the study.

[Yes] .... 1 [SKIP TO C0]
[No] 2
[Refused] .... 3 [TERMINATE SURVEY]
[Wrong number / Didn't install solar panels] .... 4 [TERMINATE SURVEY]

I2.

May I please speak to the person who is the most familiar with your solar panels?

[IF NEEDED]: It will take about 15 minutes.
[IF NEEDED]: I'm calling from Braun Research, an independent research firm, who has been contracted to conduct the study.

[Yes, new person picks up phone] .... 1 [SKIP TO I4]
[Person not available] 2
[No such person] .... 3 [TERMINATE SURVEY]
[No/Refused] .... 4 [TERMINATE SURVEY]
[Wrong number] .... 5 [TERMINATE SURVEY]

I3a.

What is his or her name?

[IF NEEDED]: I'm calling from Braun Research, an independent research firm, who has been contracted to conduct the study.

[RECORD RESPONSE]________________________________
[No/Refused] 97

I3b.

What would be a good time for me to call back?

[IF NEEDED]: It will take about 15 minutes.

[IF NEEDED]: I'm calling from Braun Research, an independent research firm, who has been contracted to conduct the study.

[RECORD RESPONSE]________________________________ [TERMINATE SURVEY]
....
[No/Refused] ....2 [TERMINATE SURVEY]

I4.

[READ IF NEW PERSON FROM I2]: My name is ____ and I'm calling from Braun Research on behalf of New Jersey's Clean Energy Program. We are contacting people who have installed solar panels on their <PROPERTY TYPE>. This is not a sales or marketing call. New Jersey's Clean Energy Program is conducting these interviews to better understand and improve the program. Your responses will be kept entirely confidential. Are you the person who is most familiar with the purchase of your solar panels?

[IF NEEDED]: It will take about 15 minutes.

[IF NEEDED]: I'm calling from Braun Research, an independent research firm, who has been contracted to conduct the study.

[Yes] 1
[No]..2 [REPEAT I2]
[No such person]..3 [TERMINATE SURVEY]
[Refused]..4 [TERMINATE SURVEY]
[Wrong number / Do not have solar panels] ....5 [TERMINATE SURVEY]

I5.

What is your first name?

[RECORD RESPONSE]________________________________
[Refused]..97
[Wrong number / Do not have solar panels] ....98 [TERMINATE SURVEY]

Confirmation of address

C0. [RECORD KEMA ID, DATE (MM/DD/YYYY), AND TIME OF SURVEY]

[IF DUPLICATED = FALSE]

I have a few questions that will take about 15 minutes.

[IF ADDRESS is missing, SKIP to C2]

C1.

First, I'd like to confirm that your solar panels are installed at your <PROPERTY TYPE> at <ADDRESS>. Is this correct?

[Yes]... ....1 [SKIP TO C3]
[No]..2
[Don't know / Not sure / Can't remember]......................97 [TERMINATE SURVEY]
[Refused]..98 [TERMINATE SURVEY]

C2.

What is the address where the solar panels are installed?

[RECORD RESPONSE, INCLUDING STREET ADDRESS and CITY]_______________________
[Don't know / Not sure / Can't remember]......................97 [TERMINATE SURVEY]
[Refused]..98 [TERMINATE SURVEY]

[IF DUPLICATED = TRUE]

[IF ADDRESS has value]

I have a few questions that will take about 15 minutes. Our records indicate that you have more than one solar system, so for this interview, I would like you to answer regarding only the solar system that was installed in <CHECKYEAR> at your <PROPERTY TYPE> at <ADDRESS>.

[IF ADDRESS is missing, READ, then SKIP to C2]

I have a few questions that will take about 15 minutes. Our records indicate that you have more than one solar system, so for this interview, I would like you to answer regarding only the solar system that was installed in <CHECKYEAR> at your <PROPERTY TYPE>.

C1.

First, I'd like to confirm that your solar panels are installed at your <PROPERTY TYPE> at <ADDRESS>. Is this correct?

[Yes]... ....1 [SKIP TO C3]
[No]..2
[Don't know / Not sure / Can't remember]......................97 [TERMINATE SURVEY]
[Refused]..98 [TERMINATE SURVEY]

C2.

What is the address where the solar panels are installed?

[RECORD RESPONSE, INCLUDING STREET ADDRESS and CITY]________________________
[Don't know / Not sure / Can't remember]......................97 [TERMINATE SURVEY]
[Refused]..98 [TERMINATE SURVEY]

C3.

Is your <PROPERTY TYPE> on or off the electric grid?

[On]..1
[Off]..2
[Don't know / Not sure / Can't remember]...................................97
[Refused]...98

Satisfaction with the NJCEP

S1a.

First, I'd like to ask you about your overall satisfaction with New Jersey's Clean Energy Program Customer On-site Renewable Energy Program? This program is also referred to as CORE. On a scale of 1 to 5, where 1 means not at all satisfied and 5 means very satisfied, overall, how satisfied are you with the CORE Program?
[Note to callers, this is pronounced, like apple "core", rather than C-O-R-E]**.**

[1 / Not at all satisfied]	1	
[2]	2	
[3]	3	
[4]	4	[SKIP TO S2]
[5 / Very satisfied]	5	[SKIP TO S2]
[Don't know / Not sure / Can't remember]	97	[SKIP TO S2]
[Refused]	98	[SKIP TO S2]

S1b.

Why do you say this? [Probe if necessary: Why aren't you satisfied?]

[RECORD RESPONSE VERBATIM]______________________
[Don't know / Not sure / Can't remember] 97
[Refused] 98

S2a.

How did you hear about CORE?
Anywhere else? [Keep asking anywhere else until you get a negative response.]
[ALLOW MULTIPLE RESPONSES, CIRCLE ALL THAT APPLY]

[My installer]	1
[NJCEP-CORE website]	2
[Utility bill insert/stuffer or direct mail]	3
[Utility website]	4
[Friend / Colleague / Neighbor]	5
[TV ad]	6
[Newspaper article or ad]	7
[Radio ad]	8
[Home/trade show]	9
[Internet – not NJCEP-CORE or Utility website]	10
[Email]	11
[Other]	12
[Don't know / Not sure / Can't remember]	97
[Refused]	98

S2b.

[IF S2a = 12, Other, Specify]_________________________

Information about the installer

Now I'd like to ask you some questions about your installer.

IT1a.

From what sources did you find information about installers?

Any others? [Keep asking any others until you get a negative response]

[ALLOW MULTIPLE RESPONSES, CIRCLE ALL THAT APPLY]

[NJCEP-CORE website]..1
[Utility bill insert/stuffer or direct mail] 2
[Utility website] 3
[Friend / Colleague / Neighbor] 4
[TV ad]..5
[Newspaper article or ad] 6
[Radio ad]...7
[Home/trade show]...8
[Internet – not NJCEP-CORE or Utility website] 9
[Other] 10
[Don't know / Not sure / Can't remember]..................................97
[Refused]..98

IT1b.

[IF IT1a = 10, Other, Specify]_________________________

IT2a.

Our records show your solar panels were installed by <INSTALLER>. Is this correct?

[Yes]... ....1 [SKIP TO IT3a]
[No]..2
[Don't know / Not sure / Can't remember]..................................97 [SKIP TO IT3a]
[Refused]..98 [SKIP TO IT3a]

IT2b.

Who installed your solar panels?

[RECORD RESPONSE]___________________________________

[Don't know / Not sure / Can't remember]..................................97
[Refused]..98

IT3a.

Next, I'd like to ask you about your overall satisfaction with the company that installed your solar system. On a scale of 1 to 5, where 1 means not at all satisfied and 5 means very satisfied, overall, how satisfied are you with your installer?

[1 / Not at all satisfied]....................1
[2] 2
[3] 3
[4] ....4 [SKIP TO IE1a]
[5 / Very satisfied]....................5 [SKIP TO IE1a]
[Don't know / Not sure / Can't remember]....................97 [SKIP TO IE1a]
[Refused]....................98 [SKIP TO IE1a]

IT3b.

Why do you say this? [Probe if necessary: Why aren't you satisfied?]

[RECORD RESPONSE VERBATIM]______________________
[Don't know / Not sure / Can't remember]....................97
[Refused]....................98

Information about installed equipment

IE1a.

Next, I'd like to ask you about your overall satisfaction with your solar system. On a scale of 1 to 5, where 1 means not at all satisfied and 5 means very satisfied, overall, how satisfied are you with your solar system?

[1 / Not at all satisfied]....................1
[2] 2
[3] 3
[4] ....4 [SKIP TO IE2a]
[5 / Very satisfied]....................5 [SKIP TO IE2a]
[Don't know / Not sure / Can't remember]....................97 [SKIP TO IE2a]
[Refused]....................98 [SKIP TO IE2a]

IE1b.

Why do you say this? [Probe if necessary: Why aren't you satisfied?]

[RECORD RESPONSE VERBATIM]______________________
[Don't know / Not sure / Can't remember]....................97
[Refused]....................98

IE2a.

Have your solar panels or inverter ever malfunctioned?

[Yes]... 1
[No]..2 [SKIP TO IE3a]
[Don't know / Not sure / Can't remember]..................................97 [SKIP TO IE3a]
[Refused] ....98 [SKIP TO IE3a]

IE2b.

What was the problem?

[RECORD RESPONSE VERBATIM]______________________
[Don't know / Not sure / Can't remember]..................................97
[Refused] 98

IE2c.

On about what date did the problem occur?

[RECORD RESPONSE MM/DD/YYYY]______________________
[Don't know / Not sure / Can't remember]..................................97
[Refused] 98

IE2d.

How many days, total, were your solar panels offline because of this problem?

[RECORD RESPONSE]____days
[Don't know / Not sure / Can't remember]................................997
[Refused] 998

IE3a.

What changes, if any, including repairs or service, have you made to your solar system since it was installed? [ALLOW MULTIPLE RESPONSES, CHECK ALL THAT APPLY]

[No changes] ....1 [SKIP TO INC1]
[Replaced the inverter] 2
[Repaired/serviced an inverter] 3
[Added an inverter] 4
[Replaced solar panels]..5
[Repaired/serviced solar panels]..6
[Added solar panels] 7
[Other repairs (to mounts, wires, etc)]...8
[Other] 9
[Don't know / Not sure / Can't remember]..................................97 [SKIP TO INC1]
[Refused] ....98 [SKIP TO INC1]

IE3b. [IF IE3a = 9, Other, Specify______________]

IE3c. [IF IE3a = 2 or 3, replaced or repaired inverter]

What was the problem with your inverter?

[RECORD RESPONSE VERBATIM]______________________
[Don't know / Not sure / Can't remember]..................................97
[Refused]...98

IE3d. [IF IE3a = 4, added an inverter]

Why did you add an inverter?

[RECORD RESPONSE VERBATIM]______________________
[Don't know / Not sure / Can't remember]..................................97
[Refused]...98

IE3e. [IF IE3a = 7, added solar panels]

How much capacity, in kilowatts, did you add?

[RECORD RESPONSE]____kW
[Don't know / Not sure / Can't remember]..............................9997
[Refused]...9998

IE3f.

Did you receive funding for these changes from CORE in addition to the rebate you received for your initial installation?

[Yes]..1
[No]...2 [SKIP TO INC1]
[Don't know / Not sure / Can't remember]..................................97 [SKIP TO INC1]
[Refused]...98 [SKIP TO INC1]

IE3g.

How much additional funding did you receive from CORE for these changes?

[RECORD RESPONSE] ______ dollars
[Don't know / Not sure / Can't remember]........................9999997
[Refused]...9999998

Information about Incentives

INC1.

Our records show that you received a <REBATE> dollar rebate from CORE for the installation of your solar panels. Is this correct?

[Yes]..1
[No]...2 [RECORD CORRECT AMT] ______ dollars
[Don't know / Not sure / Can't remember]9999997
[Refused]..9999998

INC2.

Our records also show that the total cost of your project was <INSTALL COST>. Is this correct?
[Yes] 1
[No]..2 [RECORD CORRECT AMT] ______ dollars
[Don't know / Not sure / Can't remember]9999997
[Refused]...9999998

INC3a.
Did you receive federal tax credits for the installation of your solar system?
[Yes] 1
[No]..2 [SKIP TO INC4]
[Don't know / Not sure / Can't remember]........97 [SKIP TO INC4]
[Refused]..98 [SKIP TO INC4]

INC3b.
How much money have you received from federal tax credits?
[RECORD AMOUNT] ______dollars
[Don't know / Not sure / Can't remember]...9999997
[Refused]...9999998

[Interview note: SREC is pronounced as S-REC; as opposed to S-R-E-C]

INC4.
New Jersey has a program that allows people to buy and sell Solar Renewable Energy Certificates, or SRECs for short. Do you participate in New Jersey's SREC Program?
[IF NECESSARY: A Solar Renewable Energy Certificate, or SREC for short, is a type of clean energy credit that can be bought or sold. An SREC is issued once a solar facility has generated 1000 kilowatt hours, and represents all the clean energy benefits of electricity generated from a solar electric system. SRECs can be sold or traded separately from the electricity (kilowatt hours), thus providing solar system owners a source of revenue to help offset the cost of installation.]

[Yes]…………………..1
[No]…………...2 [SKIP TO INC6a]
[Don't know / Not sure / Can't remember]........................97 [SKIP TO INC6a]
[Refused]..98 [SKIP TO INC6a]

INC5.
Since you installed your solar system, how much money have you received in exchange for your SRECs?
[RECORD RESPONSE] _______ dollars [SKIP TO INC7]
[Don't know / Not sure / Can't remember]...........9999997 [SKIP TO INC7]
[Refused]..9999998 [SKIP TO INC7]

INC6a.

Do you plan to participate in the SREC Program?

[Yes]………………... 1 [SKIP TO INC7]
[No]………… 2
[Don't know / Not sure / Can't remember]........................ 97 [SKIP TO INC7]
[Refused].. 98 [SKIP TO INC7]

INC6b.

Why aren't you interested in the SREC Program?

[ALLOW MULTIPLE RESPONSES, CHECK ALL THAT APPLY]
[Need upfront rebate].. 1
[Not aware of the SREC program] 2
[Don't understand the SREC program] 3
[Other reason: ________________] 4
[Don't know] 97
[Refused]... 98

INC7.

Have you received financial assistance from any other sources that we haven't already discussed? This would include things such as grants, reduced-interest loans, or other rebates or tax credits. If so, please describe the source and how much assistance you received from them.

[Keep asking **"Any others?"** UNTIL THEY SAY NO]
[RECORD RESPONSE VERBATIM]_______________
[Don't know] 97
[Refused]... 98

Attribution

A1a.

Now I'd like you to think about why you decided to install solar panels. For what reasons did you install solar panels?

Any other reasons? [Keep asking any other reasons until you get a negative response]

[ALLOW MULTIPLE RESPONSES, CIRCLE ALL THAT APPLY]

[Save energy / Save money]..1
[Concern for the environment/global warming]... 2
[Increase my home's value] 3
[Because the NJCEP-CORE rebate made it affordable] 4
[Tax credits]...5
[Other] 6
[Don't know / Not sure / Can't remember]..................................97
[Refused]..98

A1b.
[IF A1a = 6 (OTHER), PLEASE SPECIFY]____________________

A2.
I'd like to know at what point during your purchase of the solar panels you heard about the CORE Program. Would you say it was ... [READ OPTIONS]
Before you decided to install 1
While considering whether to install? 2
Or after you had decided to install a system? 3
[Don't know / Not sure / Can't remember] 97
[Refused] 98
[Didn't know I received a rebate / Didn't hear about program]............99 [SKIP TO A6]

A3.
The CORE program includes several services such as the rebates, SRECs, and technical assistance. I'd like you to think about the impact the entire CORE Program had on your installation of solar panels. First, I'd like to know about the effect if any, that the CORE Program had on your decision to install solar panels. If the program did not exist, would you say that it was "*very* likely," "*somewhat* likely,", "*not* very likely," or "very unlikely" that you would have installed solar panels?
[Very likely]..1
[Somewhat likely] 2
[Not very likely]..3
[Very unlikely]..4
[Don't know / Not sure / Can't remember]..................................97
[Refused]..98

A4a.
If the program did not exist, how different would the timing have been? Would you say you would have installed solar panels at ... [READ OPTIONS]
The same time... ....1 [SKIP TO A5a]
Earlier..2 [SKIP TO A5a]
Later 3
Or Never...4 [SKIP TO A5a]
[Don't know / Not sure / Can't remember]..................................97 [SKIP TO A5a]
[Refused]..98 [SKIP TO A5a]

A4b.
Approximately how many months later?
[RECORD RESPONSE]____months
[Don't know / Not sure / Can't remember]..................................97
[Refused]..98

A5a.

Finally, I'd like to know about the effect, if any, that the rebate program had on the size of the solar panel system you installed. If the program did not exist would you have installed a system of ... [READ OPTIONS]

The same size... ....1 [SKIP TO A6]
Smaller 2
Larger...3 [SKIP TO A6]
Or not installed at all ....4 [SKIP TO A6]
[Don't know / Not sure / Can't remember]...................................97 [SKIP TO A6]
[Refused]...98 [SKIP TO A6]

A5b.

If the program did not exist, approximately what size (in kilowatts) would you have installed?
[RECORD RESPONSE]_________kilowatts
[Don't know / Not sure / Can't remember]...............................9997
[Refused]...9998

A6.

Please describe what you would have done if the program did not exist.
[RECORD RESPONSE]_________
[Don't know / Not sure / Can't remember]...................................97
[Refused]...98

Energy Efficiency

Now I have a few questions about your energy consumption and saving habits.

[IF <PROPERTY TYPE> = Building, SKIP TO E3]
E1.
Has your home received an Energy Star inspection from New Jersey's Clean Energy Program?
[Yes]………………... 1
[No]……….. 2 [SKIP TO E3a]
[Don't know / Not sure / Can't remember]........................ 97 [SKIP TO E3a]
[Refused].. 98 [SKIP TO E3a]

E2.
Did this inspection occur before or after you installed the solar system?
[Before]………………... 1
[After]………... 2
[About the same time]... 3
[Don't know / Not sure / Can't remember]........................ 97
[Refused].. 98

E3a.
Since 2001, what, if anything, have you done to save energy at the <PROPERTY TYPE> where the solar panels are installed? Any others?
[ALLOW MULTIPLE RESPONSES, CHECK ALL THAT APPLY
KEEP ASKING **"Any others?"** UNTIL YOU GET A NO]
[None] 1
[Installed CFLs / Installed more efficient lighting]..................... 2
[Upgraded / new furnace]... 3
[Upgraded / new AC unit(s)]... 4
[Upgraded / new insulation] 5
[Conservation policies (turn off lights, turn down thermostat, etc)] 6
[Other] 7
[Don't know / Not Sure / Can't Remember]............................ 97
[Refused].. 98

E3b.
[IF E3a = 7 (Other), Specify_____________]

E4a.

What New Jersey Clean Energy programs have you participated in, other than the solar rebate program? Any others?
[ALLOW MULTIPLE RESPONSES, CHECK ALL THAT APPLY,
KEEP ASKING "ANY OTHERS?"]
[None] 1
[Buy/Install Energy Star Products] 2
[NJ Energy Star Homes] 3
[NJ Energy Star Rebates] 4
[CleanPower Choice Program] 5
[Home Performance with Energy Star] 6
[Cool Advantage] 7
[Warm Advantage] 8
[NJ SmartStart Buildings] 9
[Combined Heat and Power] 10
[Local Govt Energy Audit] 11
[Alternative Fuels for Vehicles (including biodeisel)] 12
[Alternative Fuels for Infrastructure] 13
[Clean Power Community Partners] 14
[Clean Energy Conference] 15
[Clean Energy Leadership Awards] 16
[Other] 17
[Don't know / Not Sure / Can't Remember] 97
[Refused] 98

E4b.
[IF E4a = 17 (Other), Specify_____________]

E5a.

What New Jersey Clean Energy programs do you *plan* to participate in, other than the solar rebate program? Any others?

[ALLOW MULTIPLE RESPONSES, CHECK ALL THAT APPLY, KEEP ASKING "ANY OTHERS?"]

[None] 1
[Buy/Install Energy Star Products] 2
[NJ Energy Star Homes] 3
[NJ Energy Star Rebates] 4
[CleanPower Choice Program] 5
[Home Performance with Energy Star] 6
[Cool Advantage] 7
[Warm Advantage] 8
[NJ SmartStart Buildings] 9
[Combined Heat and Power] 10
[Local Govt Energy Audit] 11
[Alternative Fuels for Vehicles (including biodeisel)] 12
[Alternative Fuels for Infrastructure] 13
[Clean Power Community Partners] 14
[Clean Energy Conference] 15
[Clean Energy Leadership Awards] 16
[Other] 17
[Don't know / Not Sure / Can't Remember] 97
[Refused] 98

E5b.

[IF E5a = 17 (Other), Specify_____________]

E6.

Are you planning any other energy saving activities at the <PROPERTY TYPE> where the solar panels are installed?

[PROBE FOR THEM TO ELABORATE **"What are you planning?"**]

[PROBE FOR MORE PLANS **"Anything else?"**]

[RECORD RESPONSE VERBATIM]________

[Don't know / Not Sure / Can't Remember] .... 97 [SKIP TO INVERTER READING]

[Refused] .... 98 [SKIP TO INVERTER READING]

[SKIP TO INVERTER READING if E6 = No other plans]

E7.
Do you intend to seek financial assistance from New Jersey's Clean Energy Program for these activities?
[Yes]…………………... 1
[No]………. 2
[Don't know / Not sure / Can't remember]....................... 97
[Refused]... 98

Inverter Reading

[We are ultimately looking for three pieces of information in this section:

1. **The date their system was installed, when it was connected to the grid, and whether they have a battery system.**
2. **The total amount of energy produced by the participant's system**, including the exact units on their readout. The units are probably kilowatt hours (kWh), but may be watt hours (Wh) or megawatt hours (MWh).
3. **The total amount of time the participant's system has been operating**, including the units on their readout. This information is available on about half of the inverters in the sample, and the units should be hours, but still record the exact units.

There is a some script here to get the date of when the inverter was installed, then the caller should guide the participant through the reading of the inverter.]

INV1a.
On approximately what date did your installer finish installing your system?
[RECORD RESPONSE MM/DD/YYYY]____________________
[Don't know / Not sure / Can't remember]..............................9997
[Refused]..9998

INV1b.
On approximately what date was your system connected to the power grid?
[RECORD RESPONSE MM/DD/YYYY]____________________
[Don't know / Not sure / Can't remember]..............................9997
[Refused]..9998

INV1c.

Is your system connected to a battery?

[Yes] 1
[No]...2
[Don't know / Not sure / Can't remember]...............................9997
[Refused] 9998

INV2a.

Next, I'd like to get some information from your inverter. Do you know where the inverter is located?

[IF NECESSARY] It will probably be in the basement, near your electric meter or your breaker box.

[IF NECESSARY] It is a metal box, smaller than a typical computer CPU, probably white or gray, and should have an LCD display on it with some numbers on it.

[Yes]... 1
[No]...2 [SKIP TO D1]
[Don't know / Not sure / Can't remember]...................................97 [SKIP TO D1]
[Refused] ....98 [SKIP TO D1]
[Inverter is inaccessible]..99 [SKIP TO D1]

INV2b.

Where is the inverter located?

[Basement]... 1
[Garage] 2
[Outdoors]...3
[Other] 4
[Don't know / Not sure / Can't remember]...................................97 [SKIP TO D1]
[Refused] ....98 [SKIP TO D1]
[Inverter is inaccessible]..99 [SKIP TO D1]

INV2c.
[IF INV2b = 4 (OTHER), PLEASE SPECIFY]____________________

Please go to the inverter and let me know when you get there.

[WAIT UNTIL PARTICIPANT IS AT THE INVERTER]

[Guide participant through getting the inverter reading.]

INV3a.

[RECORD ENERGY PRODUCED BY SYSTEM] ______

[Couldn't get reading]..9999997 [SKIP TO INV4a]
[Refused]...9999998 [SKIP TO INV4a]

INV3b.

[Record units for system energy]

[kWh / kilowatt hours]..1 [SKIP TO INV4a]
[Wh / watt hours]..2 [SKIP TO INV4a]
[MWh / megawatt hours]...3 [SKIP TO INV4a]
[Other]...4

INV3c. [If INV3b = OTHER, RECORD UNIT]________________

INV4a.

[RECORD TOTAL TIME SYSTEM HAS OPERATED]______

[Couldn't get reading]..999997 [SKIP TO D1]
[Refused]..999998 [SKIP TO D1]

INV4b.

[Record units for system operation time.]

[Hours]...1 [SKIP TO D1]
[Days]..2 [SKIP TO D1]
[Other]...3

INV4c. [If INV4b = OTHER, RECORD UNIT]________________

Demographics/Firmographics

D1.

Lastly, I have some questions to ask you about the <PROPERTY TYPE> where the solar panels are installed. What is the approximate square footage of heated and/or air conditioned internal space of the <PROPERTY TYPE> where the solar panels are installed?

[RECORD RESPONSE]__________square feet
[Don't know / Not sure / Can't remember] 97
[Refused] 98

D2.

Approximately how many years old is the <PROPERTY TYPE>?

[RECORD RESPONSE]___________years
[Don't know / Not sure / Can't remember] 997
[Refused] 998

D3.

Approximately how many weeks per year is the <PROPERTY TYPE> where the panels are installed occupied?

[RECORD RESPONSE]____________weeks

[Don't know / Not sure / Can't remember] 97
[Refused] 98

[IF <PROPERTY TYPE> = building, SKIP TO F1.]

D4.

Are the solar panels installed on your primary residence?

[Yes]... 1
[No] 2
[Don't know / Not sure / Can't remember] 97
[Refused] 98

D5.

How many people, including yourself, live in this home 9 or more months per year?

[RECORD RESPONSE]_____________people
[Don't know / Not sure / Can't remember] 97
[Refused] 98

D6.

What is the highest level of education you completed? Is it ... [READ OPTIONS]

High school diploma or GED..1
Some college but no degree..2
An Associate's degree..3
A Bachelor's degree..4
A Graduate or professional degree...5
[Don't know / Not sure / Can't remember]..................................97
[Refused]...98

D7.

What was your total household income in 2007, before taxes? Was it ... [READ OPTIONS]

Less than $35,000...1
$35,001 to less than 50,000..2
$50,001 to less than 75,000..3
$75,001 to less than 100,000..4
$100,001 to less than 150,000..5
$150,001 to less than 200,000..6
or more than $200,000..7
[Don't know]...97
[Refused]...98

F1.

In March and April, KEMA engineers will be conducting a small number of on-site visits to verify the output of some solar systems. Sites will be selected randomly. If your site is selected, would you be willing to allow KEMA to review your system? For the on-site, KEMA will need access to the inverter, which may be located in your basement.

[IF NEEDED]: The site visit would entail downloading information from the inverter and a visual inspection of the panels. An adult representing your household will need to be present. We will need access to the inverter but we will not use a ladder to climb onto your roof. The site visit will take approximately 1 hour.

[Yes]... 1
[No]..2 [END SURVEY]
[Don't know / Not sure / Can't remember]..................................97 [END SURVEY]
[Refused to answer]..98 [END SURVEY]

F2.

Would you be willing to provide the KEMA engineer with access to your solar panel paperwork and manuals?

[Yes]... 1
[No]...2
[Don't know / Not sure / Can't remember]....................................97
[Refused to answer] 98

F3.
Will the engineer be able to see your solar panels from the ground?
[IF NECESSARY: The engineer will *not* use a ladder to climb onto your roof.]
[Yes]... 1
[No]...2
[Don't know / Not sure / Can't remember]....................................97
[Refused to answer] 98

You will be contacted by the end of February if your solar panels have been selected for a site visit.

Thank you for your time and cooperation.

End