Combined Heat & Power (CHP) Program Impact Evaluation

Final Report

June 10, 2009

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1. Executive Summary

1.1 Program Overview

New Jersey's Clean Energy Program (NJCEP) provides financial incentives for the purchase and installation of Combined Heat & Power (CHP) systems. The Combined Heat and Power Program (CHP Program) began in 2004 and it continues to serve the same purpose today. According to the New Jersey's Clean Energy Program filing submitted on December 7, 2007, the objectives of the program include:

- Reducing the overall system peak demand,
- Encouraging the use of emerging technologies,
- Using energy more efficiently and reduce emissions, and
- Using distributed generation to provide reliability solutions for New Jersey.

CHP systems pair on-site power generation with heat recovery. This combination improves the overall efficiency of the energy system when meeting a facility's electrical and thermal demands. In addition to the benefits listed above, this overall efficiency gain can provide societal benefits such as emission reductions as well as energy savings and cost savings for the end user. The State of New Jersey included CHP in the Clean Energy Program and offered financial incentives to encourage the adoption of CHP technologies. This report summarizes KEMA's energy impact evaluation of the CHP projects that were installed with assistance from the CHP Program and, using available data, evaluates the effectiveness of the NJCEP CHP Program.

1.2 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.
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.

KEMA used a well-defined methodology to examine each of the installed CHP systems and then the program itself. The evaluation process couples our proprietary CHP feasibility model, a survey of the end users regarding the CHP Program process, and then site visits of selected facilities. Though the census of installed projects was small, conclusions and recommendations were drawn from the results of all the data collected. However, as the census size was only four projects, results may not be indicative of future CHP Program installations.

Utility billing data was provided by the utilities for some of these participants. Actual recorded performance information was not provided by the end users. However, the CHP model allowed KEMA to make estimates about system operation, using available utility data and expert knowledge. KEMA also compared model estimates to program applications. The comparison helped KEMA form the survey questionnaire and target areas for the survey. Utilizing the tools possessed by KEMA and data provided by the CHP Program, the utilities, and the participants our evaluation process was conducted in the following manner:

a. Obtained information on each of the four installed projects from the NJCEP grant applications and utility provided usage data

b. Inputted the data into the KEMA feasibility model to estimate project impacts

c. Conducted a phone survey to confirm installation, discuss equipment operation, investigate the project process, and assess overall satisfaction with the program and CHP installations

d. Conducted selected site visits to confirm information in the grant applications

e. Finalized the estimated models to perform calculations on estimated generation and energy and emissions savings

f. Compiled the information from the collected data to provide feedback and recommendations on the NJCEP CHP Program

1.3 Summary of Findings

1.3.1 CHP Installations

According to New Jersey's Clean Energy Program Report, submitted March 28, 2006, applications for ten CHP projects were approved in 2005. During the evaluation period, four projects were completed and running. To protect participant confidentiality, these projects are referenced according to case studies as Cases 1 through 4. A general description of the cases is provided below:

- Case 1: Nursing home facility
- Case 2: Large industrial company
- Case 3: Commercial food processor
- Case 4: Recreational/athletic center

KEMA compiled CHP system characteristics for each project through a review of project application data, provided utility billing data, telephone interviews with all four program participants and two site visits to review the system in operation. KEMA found that two of the installations differed from those specified in the applications. In both cases, the actual installed system was of greater total capacity. In one case a cleaner (lower emissions) system was installed. According to the applications the plan for Case 1 was to install two 60 kW UTC/Capstone microturbines but two 70 kW Ingersoll-Rand microturbines were actually installed. The plan for Case 3 was to install a 260 kW BluePoint Energy gas engine but five 60 kW Capstone Microturbines were actually installed. The ratio of total installed kW capacity to total planned kW capacity is 106 percent. That is, in total, the CHP Program installed more capacity than planned (documented in the project applications). Details regarding the actual type of equipment that was utilized in each of the cases are listed in Table 1.

Table 1: CHP System Characteristics

	Case 1: Nursing Home Facility	Case 2: Large Industrial Company	Case 3: Commercial Food Processor	Case 4: Recreational/Athletic Center
Equipment Type	Microturbine	Backpressure Steam Turbine	Microturbine	Reciprocating Gas Engine
Equipment #	2	1	5	2
Per Unit Capacity	70kW	509kW	60kW	75kW
Equipment Cost	$357,000	$654,701	$750,000	$515,500
Incentive Amount	$107,000	$196,410	$225,000	$150,000
Displaced Thermal Loads	- Heating - Service HW	NA	- Chiller - Service HW - Process HW	- Service HW - Pool
Operation	Roughly full-time	Roughly full-time	Roughly full-time	Engine 1: 100% all yr; Engine 2: 100% for ½ yr

Notes: "NA" = Not applicable, "Roughly full-time" means operators were not baseloading operation in the past, and "HW" = hot water applications

1.3.2 Generation, Energy and Emissions Savings

Table 2 lists KEMA's estimate of energy and emissions savings from the four projects. It also lists estimates of CHP electricity production (kWh), installed capacity (kW) and peak output (kW), which are reported as distributed generation rather than savings. The savings and distributed generation estimates represent average yearly estimates. In each of the cases, KEMA assumed that the generation devices were running as a baseload device. The differences in generation over each time period represents different power output for the generators (particularly in the case of microturbines), and the fact that the peak period is defined as Monday-Friday from 8:00AM to 8:00PM. For the microturbine, the peak output is slightly less during the summer months because of the device's degradation that occurs with hotter temperatures.

KEMA estimates total annual CHP electricity generation is 86 percent of planned. Planned generation was not provided in the project application documentation for all cases. Therefore, where data were not available, KEMA calculated the percent of total CHP electricity generation as the ratio of *estimated* planned generation to total generation from the model. KEMA estimated planned generation using information provided in the project application files and two scenarios. The first scenario assumes similar load profiles to modeled profiles and the second scenario assumes systems were baseloaded with 85 percent availability. Estimated planned savings used to calculate the difference between actual and planned is the average of the two scenarios. KEMA also estimates that there are no electricity savings. In particular, no facilities displaced electric cooling with cooling that uses recaptured heat from the CHP systems.[1]

Table 2 Summary of Estimated Generation, Energy & Emission Savings

	Case 1: Nursing Home Facility	Case 2: Large Industrial Company	Case 3: Commercial Food Processor	Case 4: Recreational/ Athletic Center
Equipment Type	Microturbine	Backpressure Steam Turbine	Microturbine	Gas IC Engine
CHP Installed Capacity (kW)	140	509	300	150
Total CHP Production (kWh)	888,615	1,460,927	1,151,800	930,635
CHP Thermal Offset (MMBtu)	5,850	0	9,915	7,600
CHP Production by Period				
Peak Summer (kWh)	165,668	73,302	276,458	196,862
Peak Winter (kWh)	235,307	114,652	398,679	221,253
Off-Peak Summer (kWh)	223,141	496,459	198,621	277,987
Off-Peak Winter (kWh)	264,500	776,513	278,043	234,533
CHP Peak Output (kW)	125	509	278	150
Emissions Reductions (lbs)				
Carbon Dioxide	858,288	2,220,608	1,128,654	956,342
Sulfur Dioxide	5,776	9,496	7,487	6,049
Nitric Oxide	2,446	4,091	3,172	2,567

[1] According to the *Protocols to Measure Resource Savings*, electricity savings should only be reported where recaptured thermal energy from a CHP system is used to drive an absorption chiller that displaces electricity previously consumed for cooling.

1.3.3 Protocols

The *Protocols to Measure Resource Savings* (Protocols) were developed to accurately and consistently determine energy and resource savings for measures supported by the NJCEP. The document is periodically updated as new programs are added, existing programs are modified, and new information becomes available. The Protocols were most recently updated in December 2007.

According to the Protocols the measurement of energy and demand savings for CHP systems is based on the characteristics of the individual CHP systems. The majority of the inputs used in the savings estimates are based on information provided on the project applications. The variety in the types of CHP projects installed makes it appropriate to base calculations on individual installations. **However, KEMA recommends that calculations use information from the post-installation design and operation of the CHP systems rather than application data.**

The CHP Program did not conduct post-installation reviews for the projects KEMA reviewed. Beginning in 2008, the CHP Program will perform post-installation inspections on 100 percent of installed projects and has the authority to request additional project information and documentation to ensure the installed system meets the requirements as detailed in the project application. In addition, a new requirement of the program included in the 2008 Program & Budget Filing[2] is that applicants must provide twelve months of operational data. KEMA supports these program improvements.

The Protocols for CHP systems also provide formulas for estimating emissions reductions. The emission savings are generated from the overall gain in efficiency of the unit. For example, the efficiency of a CHP system (typically above 70%) is used as the main factor in determining the emission savings. The approach is satisfactory for calculating emissions.

Alternative approaches are seen in the EPA Emission calculator. This approach starts with the fuel input (in MMbtus) and calculates the emissions from the CHP system, the displaced emissions from the thermal that is being generated, and measures that total against the displaced grid emissions. By examining the emission savings based on the fuel input may provide the opportunity to take into account individual variances of facilities.

[2] New Jersey's Clean Energy Program 2008 Program Description and Budget, Commercial & Industrial Energy Efficiency Program managed by TRC as C&I Program Manager, December 7, 2007.

1.3.4 Persistence of Energy Savings

The installed systems are very likely to continue to accrue savings. Based on the participant interviews and site visits there is no indication that participants are having technical problems with the CHP systems or plan to remove or shut them down. More specifically, three of the four participants responded that they were happy with the performance of their CHP systems. Additional comments from the one participant dissatisfied with the CHP system indicate that the facility will likely keep the system operating. For this case, the participant noted that the dissatisfaction was not due to the use of CHP systems as much as initial equipment issues, and that the system is currently operating. Furthermore, the four CHP systems were installed in what are typically very favorable facility types. Generally, the electricity load profiles compliment the thermal usages.

CHP systems typically last approximately ten years in length. Hence, it is expected that the savings should persist throughout this time. For microturbines, high-level maintenance typically occurs after about 40,000 hours, or five years of operation. For reciprocating engineers, high-level maintenance typically occurs after about 20,000 hours, or two-and-a-half years of operation.

Economics can heavily influence the decision to maintain operation of a CHP system. In particular, where fuel input costs add to operation and maintenance costs, the spark spread (the difference between gas and electricity rates) can influence whether the economics are favorable for a CHP system. Because the backpressure steam turbine installation (Case 2) requires no additional fuel input costs, the economics are quite favorable. The savings generated by the steam turbine are likely to persist throughout the life of the project. Other installations may be impacted by the spark spread over time.

KEMA learned from the interviews that some of the facilities did not seem to be focusing on economics and were not tracking their overall savings via benchmarking. This indicates that there may have been other motivations for installing the system other than project economics. For example, the economics may have been exclusive of some additional benefits that could be gained from an installation of a CHP system, such as back-up power or energy security. KEMA still expects these projects to accrue savings for the full lifetimes of the systems.

1.3.5 Free Ridership

KEMA used the interviews with participants to explore what affect the program had on the participants' decision to install the CHP system at the time it was installed. Participants who would have installed the same equipment at the same point in time in the absence of the program are considered to be free riders. The CHP Program should consider whether it is in the best interest of the program and the State of New Jersey to offer assistance and financial incentives for projects that would have been installed without assistance or financial incentives.

KEMA cannot establish free ridership trends based on only four cases. These four cases may not be indicative of future installations or participants. However, the four cases can provide insight for future program efforts. KEMA classified each of the four cases, noting where participants were more or less likely to be free riders. Based on the preponderance of evidence, KEMA determined that two of the cases were likely not free riders. The program should be credited full net saving credit for these projects. One survey respondent was "very likely" to install the project without the program's assistance, indicating full free ridership and the program should receive zero net savings for this CHP installation. Another respondent was "somewhat likely", indicating a high probability of partial free ridership. The program should receive a fraction (25-50 percent) of the savings for this CHP installation. KEMA estimates that the free ridership rate for the four installed systems is 46 to 52 percent of the total energy savings. That is, 46 to 52 percent of the total energy savings would have occurred in the absence of the program.

KEMA is bound by evaluation research ethics to protect respondent confidentiality. The small number of participants in the CHP Program makes it difficult for KEMA to balance respondent confidentiality with the need to provide the program with actionable research. Overall, responses to the surveys indicate that free ridership is associated with this program. It is noted that in each case, the grant shortens the simple payback by approximately three years. This research supports that theory that CHP system free ridership is positively correlated with the size of the customer. Explanations for the higher free ridership rates in large customers relative to small customers include:

- In general, the economics of larger customers tend to be greater. The reason for this is that larger facilities tend to be 24 hours – 7 day operations, running three shifts with a solid baseload of electrical and thermal usage. Hence, every kWh or btu generated by the CHP is captured for savings, thermal usage is high, and the system provides both energy savings and a hedge against gas prices. In addition, larger facilities tend to have their own maintenance and engineering staff and are able to handle and maintain the CHP system on their own without the need of employing outside assistance.

- For smaller facilities, the same two factors can run against the operator. Typically, smaller facilities do not run 24 hours or 7 days a week. An office building is an excellent example of this case where at most, the building operates six days a week and its thermal load and electrical load drop dramatically between the hours of midnight to 5 AM. Similar load profiles are seen for small industrial facilities. In addition, smaller facilities sometimes do not maintain the staff that can operate the system and tend to rely on the project developer to maintain the system. This causes increased cost to the project and in some cases an increased “hassle factor” to consider when adopting and implementing CHP.

1.3.6 Program Operation and Procedures

In addition to considering program impacts, KEMA examined program operation. KEMA noted the following key points from the evaluation:

- Program projects are meeting the goals set by the CHP Program on encouraging the use of emerging energy technologies and achieving energy and emissions savings from the adoption of CHP systems.
- Satisfaction with the CHP Program and installations are generally high. However, some applicants noted potential for improved turn-around times on application approval and rebate issuance.
- Improvements can be made in follow-up of the projects as equipment changes or project changes appeared to have been made after the applications were approved.
- In general, participants could use additional help with education and outreach to help them better assess the paybacks of their projects, acquire information from independent sources, and optimize the operation of the units.

1.4 Recommendations

This section provides KEMA’s recommendation for improving the accuracy of project impact estimates and supplemental recommendations based on the participant interviews.

Recommendation 1: Assistance with Project Feasibility

The program should consider providing participants with project feasibility studies, including a brief assessment of project financials. KEMA's analysis showed project paybacks on the applications that were longer than indicated in the grant applications, and participants relying solely on contractors for economic insights. If projects do not perform as initially projected and reported on the application, it may lead to dissatisfaction with the CHP system and the program.

Recommendation 2: Follow-Up with Applicants

KEMA recommends that the program conduct post-installation inspections with all CHP installations. While none of the installations surveyed for this evaluation received on-site inspections, KEMA recognizes that inspections are now part of the program going forward. KEMA recommends that the inspections occur as soon after installation as possible, be a part of the participation agreement and actively integrate information and guidance for facility managers.

KEMA recommends the Protocols be updated to require that the measurement of generation and energy savings of CHP systems be based on data and information from the post-installation inspections rather than data from the project applications.

Recommendation 3: Access to Operation Information

KEMA encountered some difficulty in accessing information about CHP system characteristics and performance. KEMA believes that the program should require participants, as part of the participation agreement, to provide the program with key information about the system design and operation after installation. KEMA is aware that new program procedures require that participants:

1. submit pre-installation applications;
2. allow the facility manager to monitor the facility's energy use;
3. provide the program with twelve months of operational data; and
4. fully document any changes between proposed and installed systems.

KEMA believes that these provisions will benefit both the program and the participants. KEMA also encourages the program to ensure that the information it collects as part of the post-installation follow-up include not only changes in system characteristics but also notable changes to system operation and to operation and maintenance costs.

Recommendation 4: Better Outreach on CHP Information Center

The Program should consider an education and training component of the program. While all participants noted doing background research on CHP Systems, the majority reported not having received information from the Program. The majority noted that contractors had a large influence on their model selection. Furthermore, while information sources were not discussed in depth during the surveys, the sources cited by many of the participants appear to be limited in scope in that they do not provide detailed information on system selection, installation and operation. KEMA recommends the Program facilitate further, in-depth learning about CHP by providing references to links where participants can find detailed information and guidance on system selection, installation and operation. There are many tools for these purposes accessible through a number of organizations and websites. For example, the Environmental Protection Agency's (EPA) CHP Partnership website, www.epa.gov/chp, contains a number of CHP resources including tools related to qualification, feasibility analysis, procurement, and operations and maintenance.

Recommendation 5: Shorter Approval Turn-Around

The Program should investigate ways to minimize the wait-time for project approvals, whether by amending existing procedures or implementing a rolling admissions process, as recommended by one participant.

Recommendation 6: Shorter Rebate Turn-Around

The Program should be sure to monitor this process to ensure that such delays do not grow to a perceived barrier to program participation by applicants. Two of the applicants cited this as an issue in their project implementation and installation.

2. Introduction

2.1 Program Overview

New Jersey's Clean Energy Program (NJCEP) provides financial incentives for the purchase and installation of Combined Heat & Power (CHP) systems. The Combined Heat and Power Program (CHP Program) began in 2004 and it continues to serve the same purpose today. According to the New Jersey's Clean Energy Program filing submitted on December 7, 2007, the objectives of the program include:

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e. Finalized the estimated models to perform calculations on estimated generation and energy and emissions savings

f. Compiled the information from the collected data to provide feedback and recommendations on the NJCEP CHP Program

2.3 Report Organization

The remainder of this report is organized as follows. Section 3 *CHP Model Inputs and Outputs* provides an explanation of KEMA's CHP Model and a description of the key inputs and outputs. Section 4 *CHP Surveys & Site Visits* provides the results of the participant interviews and on-site visits. The final two sections present the model results and KEMA's findings and recommendations (Section 5 *CHP Model Results* and Section 6 *Findings and Recommendations*).

Appendix A provides the survey instrument and responses to selected close-ended questions.

3. CHP Model Inputs and Outputs

To estimate the energy savings, emissions reductions and power generation of the CHP installations, KEMA modeled the installations using our proprietary CHP feasibility model. The model is an Excel-Based model that has been used to assess over a hundred CHP and distributed generation applications for technologies such as reciprocating engines, microturbines, and fuel cells. For the NJCEP evaluation, KEMA customized the model in order to obtain the information required by the NJCEP protocols. This section provides a summary of the model.

3.1 Key Inputs & Outputs

The key outputs of the model are the estimated annual electricity generation, energy savings, and emissions reductions due to the CHP installations. In order to estimate the energy savings from installing a CHP system, the model subtracts the facility's estimated energy consumption from external sources prior to installation from that after installation. Some of the key inputs used in the model are highlighted below:

- **CHP System Size & Technology**: Project Size and Technologies are inputted.
- **CHP System Efficiency**: KEMA estimated system efficiency based on the typical efficiencies of CHP types and models utilized. Adjustments for heat rates on each of the technologies are made based on temperature for each month and period of the day.
- **CHP Operation**: The model makes adjustments for facilities that do not run at 100 percent capacity for the entire year or have variable heat loads during a year. For the model, each facility type is examined by KEMA in order to determine the typical load profile and proper weighting of CHP capacity factors and thermal utilization.
- **Financial Parameters:** The model has the ability to measure cash flows and paybacks whether the system is under "Design Build" or "Own & Operate" business model and accounts for leasing factors as well.
- **Utility Tariffs:** The model has the ability to adjust for the different types of tariff rates that a facility is utilizing, whether a TOU (Time of Use), Block, or flat rate. For TOU rates, an internal tool allows adjustments to be made for the number of periods in the TOU rate.

- **Thermal Utilization:** Thermal output is calculated based on the actual projected operation of the unit.

In Figure 1 below, an example of the typical inputs that are used when modeling CHP systems is shown.

Figure 1: Example Input page for CHP Model

Plant Configuration/Specifications

# of Units		
Rated Output (kW @ ISO cnditions)		
Installed Capacity (KW)		
LP or HP System	Configuration chooses 1 for LP or 2 for HP	
Net Efficiency (HHV)		
Heat Rate (Btu/KWh)		
Min. Part Load Ratio (portion of unit)		
Variable O&M Cost ($/KWh)		
Site Elevation? (feet above sea level)		
Forced Outage Percentage		
Hours per Unplanned Outage		
Fuel Gas Compressor Auxillary Load (kW)		
BOP Auxillary Load (kW)		
Total Auxillary Load		
Choose Configuration		
HP/LP	High/Low Pressure	HP/SA/CHP
SA	Stand Alone	
CHP	Combined Heat & Power	

Heat Recovery?	YES

Economic Specifications

Equipment Price	
Installation Price	
Total Installed Price	
Amount of Expected Grant	
Final Installed Costs	$0
Insurance Rate (Annual % of Capital)	
Property Tax (Annual % of Capital)	
Tariff Used - Block Rate (use B) or Time of Use (use TOU)	
Gross thermal output from Generator (btu/hr)	
Losses in Steam Useful Steam Production (%)	
Gas Input (btu/hr)	
Thermal Heat Recovery From Generator	
Number of Generator Units Base Loaded	
Appliance Efficiency of Displaced Thermal Load	
Boiler	
Electricity	
Chillers	
CTC Exempt?	

When running the model, all the characteristics of the technology are inputted in order to determine the output and fuel use for summer, winter, and shoulder periods. A load profile is created for the facility that examines 7 days, 24 hours for each seasonal period. This load profile was estimated through a load profile tool within the model. Monthly kW, kWh data is used for the seasonal periods in the model. For each hour, loads are inputted based on the facility data and typical profiles KEMA has compiled from previous analysis. The data is summed to create a monthly kWh and peak kW that matches the facility data. From this extrapolation, a load profile of the facility is created. This process has been successfully used in previous KEMA CHP modeling efforts.

The model then "hypothetically" runs a generator against that load profile in order to determine the estimated generator output, fuel consumption, and maintenance cost. The thermal output of the unit is also calculated based on the hypothetical operation.

This operation is the heart of the model that was used by KEMA. For each selected technology, adjustments to the heat rate and output of the unit are made per season (month by month) and time of day (morning, mid-day, and evening). For each period of the day, the output and heat rate of the specific generator is calculated.

The model "load follows" the estimated profile of the facility. Hence, for each hour in the seasonal period (24 hours, 7 days from a summer period, spring period, and winter period), the model examines the available load and applies the maximum output that CHP system can supply. Based on this output and corresponding heat rate at the time of day, the amount of fuel consumed for that hour is calculated. This amount is summed for the 7 days, 24 hour period, extrapolated over four months of that period, and adjusted for the number of days in each of those months. From this output, thermal output of the CHP system is also calculated.

Based on running a generator over this simulated profile, accurate kWh of generation can be determined as well as fuel consumption. This data is summed over the year to determine yearly costs. An example of how the model simulates the generation of a unit is shown in the figure below:

Figure 2: Example of How Model Simulates Operation of a Generator

Production Module - Calculates Generation and Residual Usage Data
UNITS MUST BE ENABLED MANUALLY DEPENDING ON LOAD PROFILE

Actual Usage Data	**Summer**		**Winter**		**Spring**	
	On Peak	Off Peak	On Peak	Off Peak	On Peak	Off Peak
Max kW	29,600	25,000	24,000	27,120	26,000	28,510
Usage	5,397,778	11,565,430	4,409,672	9,255,029	4,584,604	9,670,232
Load Factor	25%	63%	25%	47%	24%	46%

	Weekday			Saturday			Sunday		
	Summer	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring
Hour Units Turned On	1	1	1	4	4	4	24	24	24
Hour Units Turned Off	24	24	24	24	24	24	24	24	24
--> To Baseload set off hour to 25									

Available Output	Summer			Winter			Spring		
Period	Day	Morning	Night	Day	Morning	Night	Day	Morning	Night
Output (KW)	**5050**	**5297**	**5588**	**5903**	**6150**	**6441**	**5476**	**5790**	**6127**
(Check BOP per unit)									

Unplanned Outage	Summer			Winter			Spring		
Period	Hour 6-8	Hour 10-12	Hour 15-17	Hour 6-8	Hour 10-12	Hour 15-17	Hour 6-8	Hour 10-12	Hour 15-17
0 = No 1 = One unit fails 2 = Full Outage, all units	0	1	0	1	0	0	0	0	1

Heat Rates	Day	Morn/Eve	Night		Thermal To Displace	Thermal Load	
Summer Heat Rate	12,012	11,818	11,595	(Btu/kWh)			
Winter Heat Rate	11,484	11,293	11,078	(Btu/kWh)	Winter	45,738	mmBtu/Month

Summer Month kW- Actual

	HOUR 1	HOUR 2	HOUR 3
SD	22,000	22,000	22,000
SD	22,000	22,000	22,000
SD	22,000	22,000	22,000
SD	22,000	22,000	22,000
SD	22,000	22,000	22,000
SW	22,000	22,000	22,000
SW	22,000	22,000	22,000

Summer Month kW- Generated

	1	2	3
SD	11,177	11,177	11,177
SD	11,177	11,177	11,177
SD	11,177	11,177	11,177
SD	11,177	11,177	11,177
SD	11,177	11,177	11,177
SW	-	-	-
SW	-	-	-

Summer Month kW- Residual

	1	2	3
SD	10,823	10,823	10,823
SD	10,823	10,823	10,823
SD	10,823	10,823	10,823
SD	10,823	10,823	10,823
SD	10,823	10,823	10,823
SW	22,000	22,000	22,000
SW	22,000	22,000	22,000

From this operation, costs are calculated and then rolled into the cash flows sheets for the lifetime of the project. The cash flows are run year on year for a period of 10 years. The savings are then run through a Net Present Value (NPV) calculation as well as a Simple Payback calculation.

For the purposes of this evaluation, which was intended to provide a high-level assessment of the project viability, the simple payback was compared to the grant applications. The reason for the selection of the simple payback was to focus on the participant's kWh savings and to match the methodology typically used in the grant application.

This methodology provides a high degree of accuracy for CHP systems and reduces the potential of overstating CHP savings. CHP systems are most economical when run 24 hours, 7 days a week. They typically are designed to match the baseload electricity usage and then capture all the available thermal output of the system. Our model tracks the operation of the CHP system with the actual electrical load so as to not overstate production and savings during off peak hours (midnight to 5 AM). The load following capability simulates the actual operation of the unit and thus more accurately measures the thermal savings and electrical production provided by the system.

For the participant savings calculation the model examines the electricity costs prior to installation of the CHP system, subtracts the cost of generation, adds in the cost of supplemental energy (remaining energy that typically is not provided by the CHP system and still must be purchased from the grid), credits the thermal benefit, and creates a cash flow of savings.

The model allowed KEMA to make estimates of the operation of the unit. However, we note that actual performance data was not obtained because the facilities did not record this data. In the absence of performance data, KEMA used simplified assumptions in the analysis. Table 3 lists a set of assumptions used for each of the three CHP models.

Table 3: Model Assumptions

Inputs	Values
Availability	92-95% Available was used
Electricity Tariffs	Used application costing data in lieu of tariff pricing data
Load Profile	Extrapolated from limited energy bill data
Financing	Conducted analysis assuming a capital purchase in lieu of a leasing program
Project Life	10 years
Maintenance	0.02 cents/kWh for reciprocating engines and 0.01 cents/kWh for Microturbines
Unplanned Outages	None
Standby Fees & Supplemental Energy Charges	Assumed to be the same as standard electricity price
Emissions Rates	Used grid emissions rates as specified by the New Jersey Protocols
Gas Tariff Discount	Assumed no discount in gas tariff

These assumptions were made to provide a baseline and an easy comparison to the grant applications that were submitted by the grant recipients. As the kWh savings and emission savings are based on the operation of the unit, focus was put on the load profiles and kWh production calculations rather than a facilities chosen method of lease, capital purchase, or own and operate business model. The reason is that the capital purchase is the most straight-forward method to assess the payback of the system, and is often employed by small firms using emerging technologies because the availability of lease terms are difficult to obtain (often five years in length, no aftermarket reduces salvage value, and lenders attached high risk premiums to the lease arrangements for new technologies).

Gas costs were adopted from applications and average around $7.00 per MMBtu. It is recognized that costs, year on year and monthly have a high degree of variability. The inputs that are listed above are variable inputs in the model, and can be adjusted for future analysis. However, as the purpose was to validate the grant submittals to ensure projects put the proper effort into estimating the potential savings that the project could offer the facility, a simple payback was chosen to evaluate the systems and input variables were kept consistent with the grant applications.

Additional factors such as whether a standby fees, unplanned outages, supplemental charges are factors that increase the simple payback and worsen the NPV of a project are also minimized. A standby fee is a charge that is incorporated into projects by the utility providing the interconnection. If applied, it is used to make up for the lost demand (kW) that is caused by the CHP. As stated, as the energy impact evaluation requirements were not designed to incorporate an in-depth economic feasibility analysis of a specific site and the financials of the companies, assumptions were kept simple in order to focus on the kWh and demand output, and emission savings offered by the projects. With regard to financials, there are a number of factors that can lead to reduction of paybacks or increased NPV. The factors are: offset purchases of equipment, reduced losses from outages, avoided need to purchase back-up power, or the desire of a facility to want to help the environment. Hence, the model focused on operational performance of the CHP systems and validation of the proposed financials of the project. The figure below shows that the model is capable of evaluating all financial aspects, but selected the simple payback financial metric in this assessment.

Figure 3: Example of Project Savings Assessment Format in Model

Project Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Inflation rates											
Fuel		0.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Utility Rate		5.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
O&M		0.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.0%	0.0%	0.0%
Revenues											
Generation Equipment	27,188,869										
Electric Capacity											
Electric Energy											
O&M Service											
Fuel Service		5,519,258	5,574,451	5,630,195	5,686,497	5,743,362	5,800,796	5,858,804	5,917,392	5,976,566	6,036,331
Thermal Energy											
Total Revenues		5,519,258	5,574,451	5,630,195	5,686,497	5,743,362	5,800,796	5,858,804	5,917,392	5,976,566	6,036,331
Expenses											
Generation Equipment Cost	24,968,983										
Fuel Commodity		5,353,680	5,407,217	5,461,289	5,515,902	5,571,061	5,626,772	5,683,040	5,739,870	5,797,269	5,855,241
Tax on Fuel Commodity		0	0	0	0	0	0	0	0	0	0
Tax on Thermal Credit Collected											
Fixed O&M											
Variable O&M											
Propoerty Tax & Insurance											
Lease Payment											
Total Expenses		5,353,680	5,407,217	5,461,289	5,515,902	5,571,061	5,626,772	5,683,040	5,739,870	5,797,269	5,855,241
EARNINGS BEFORE INT, TAX, DEP	2,219,886	165,578	167,234	168,906	170,595	172,301	174,024	175,764	177,522	179,297	181,090
Interest Expense											
Book Depreciation and Amortization											
EARNINGS BEFORE TAXES	2,219,886	165,578	167,234	168,906	170,595	172,301	174,024	175,764	177,522	179,297	181,090
Current Tax	887,954	66,231	66,893	67,562	68,238	68,920	69,610	70,306	71,009	71,719	72,436
NET INCOME	1,331,932	99,347	100,340	101,344	102,357	103,381	104,414	105,458	106,513	107,578	108,654
NPV DISCOUNT FACTOR	10%										
NET PRESENT VALUE	2,234,456.80										
EBIT NPV	3,724,094.67										

3.2 Emissions

Estimates of emissions reductions rely on assumptions about grid electricity emissions rates, CHP system emission rates, and amounts of electricity generated from the CHP system or bought from the grid. KEMA used grid electricity emission rates specified in "New Jersey Clean Energy Program Protocols to Measure Resource Savings: Revisions to September 2004 Protocols," (Protocols) published in December of 2007. KEMA estimated CHP generation amounts as discussed above. To estimate CHP emission rates, KEMA used the following formulas from the Protocols:

Base Emission Factors

DEP Emissions Reduction Factors for electric programs are as follows:

- CO_2 (Carbon Dioxide) emissions are reduced by 1,520 lbs. per MWh saved
- NO_x (Nitric Oxide) emission reductions are 2.8 lbs. per MWh saved
- SO_2 (Sulfur Dioxide) emission reductions are 6.5 lbs. per MWh saved
- Hg (Mercury) emission reductions are 0.0000356 lbs. per MWh saved

CHP Emission Reduction Algorithms

CO2 ER (lbs) = (1,520 * MWh) – (CHP CO2EF *MWh)

NOx ER (lbs) = (2.8 * MWh) – (CHP NOxEF *MWh)

SO2 ER (lbs) = (6.5 * MWh) – (CHP SO2EF *MWh)

HG ER (lbs) = (0.0000356 * MWh) – (CHP HGEF *MWh)

Definitions

ER = Emission reductions in pounds

CHP EF = the emission factors of the CHP system in pounds per MWh for each type of emission

MWh = the estimated annual and lifetime generation from the CHP system

Using the Protocol method emission savings are generated from the overall gain in efficiency of the unit. For example, the efficiency of a CHP system (typically above 70%) is used as the main factor in determining the emission savings. The approach is satisfactory for calculating emissions.

Alternative approaches are seen in the EPA Emission calculator. This approach starts with the fuel input (in MMbtus) and calculates the emissions from the CHP system, the displaced emissions from the thermal that is being generated, and measures that total against the displaced grid emissions. By examining the emission savings based on the fuel input may provide the opportunity to take into account individual variances of facilities.

4. CHP Surveys & Site Visits

4.1 Purpose

KEMA completed telephone surveys with all four of the recipients of CHP grants. The main objectives of the survey were:

- understand the decision to implement the CHP projects (including NJCEP's role),
- assess participant satisfaction with the program and the CHP system installed, and
- verify whether the CHP systems were installed and operating as specified on the application.

KEMA also conducted two on-site visits. The main objectives of the on-site visits were:

- obtain system operating logs,
- confirm verification of the CHP installations,
- obtain general information about system operation, and
- obtain a better understanding of prior and existing loads.

KEMA was not able to obtain operating logs for any of the CHP installations. This was one of the motivations behind the recommendation to conduct follow-up visits to the facilities so as to encourage operators to maintain logs. Beginning in 2008 the CHP Program will conduct post-installation inspection on 100 percent of installations. The program is also now requiring 12 months of post-installation data for all grant applicants.

4.2 Survey Structure

4.2.1 Phone Survey

Several introductory questions from the survey verify details about the installation, including its location, cost, rebate amount, operation and target payback period. Responses to these questions helped verify the inputs used in the CHP model. Additional questions gauge participant satisfaction with the CHP system and with the program's application process and assistance. As a result, some participants provided recommendations about possible improvements to the program. Finally, the survey contains questions about participant decision-making and how the NJCEP program may have influenced it. These questions helped understand whether the program influenced a participant's decision to install a CHP system, and whether the program influenced their selection of the type and model of CHP system. The survey instrument is provided in Appendix A.

4.2.2 Site Visit

In addition to the phone survey and interview, KEMA also conducted selected site surveys in order to confirm information that was interpreted from the incentive applications as well as the phone surveys. For this phase, in the case of the Industrial Facility that utilized a back-pressure steam turbine (no thermal savings), a site visit was not conducted because the system does not have the complexity of operation as the typical CHP systems – per requirements of the effort, the fact that adequate information was provided through the phone surveys, and no operational changes are expected because the system is not dependent on the costs of a fuel input but rather simply provides "free energy" when the plant is operating, a site visit was not made to the facility. KEMA was able to recruit two of the remaining three facilities for a site visit.

4.3 CHP Survey Results

4.3.1 Phone Survey/Interview Results

This section presents the results of selected survey questions. The survey focused on two areas,

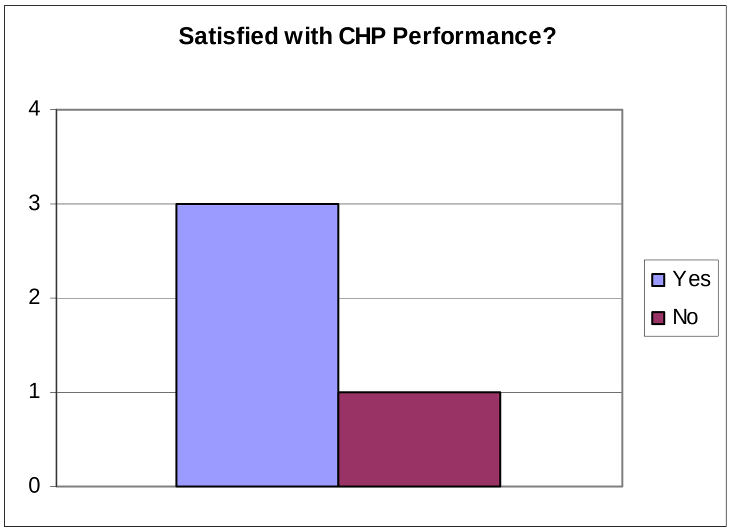
1. process questions that focused on participant satisfaction with the program and the assistance provided, and
2. system performance and feedback on installations.

Results of these key survey questions are briefly summarized below. Because of the census size for the interviews (only four participants), statistical measures of accuracy are not very useful. Instead we simply report the individual results. The four cases reviewed and surveyed are all completed installation as of the end of program year 2006 (December 31, 2006). In addition, as the census size is small, information may not be indicative of future projects.

Question 5: Are you satisfied with the performance of the CHP system that was installed at your facility?

Three of the users were satisfied with the system performance. For the user that was not satisfied, general difficulties with the selected equipment was cited.

Figure 4: Result Chart for Question 5 – Satisfaction with CHP Performance



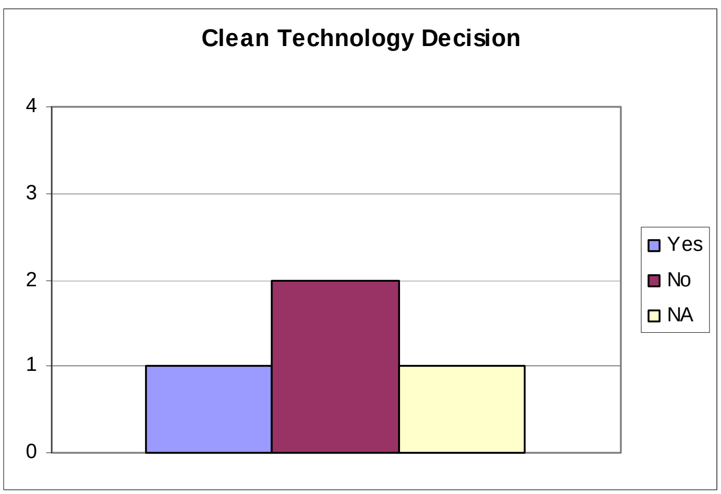
Question 11: Did the incentive impact your decision on whether to utilize a clean emitting, emerging technology, such as a fuel cell or microturbine?

This question was asked because utilizing clean generation was a main goal of the CHP Program. Some CHP technologies are cleaner than others. Cleaner options tend to also be more expensive. For example, emission rates of microturbines and fuel cells are lower than those of traditional reciprocating engines. However, those technologies are also more expensive and have longer paybacks. The question was designed to determine whether the incentive was enough to steer participants to emerging technologies.

Though two of the facilities utilized microturbines, two respondents indicated that the incentive did not motivate them to cleaner technologies; one respondent confirmed that it did, and the user of the backpressure steam turbine thought the question did not apply. KEMA believes this to be a correct assumption by the user of the steam turbine. Steam Turbines have been in existence for over 100 years. Utilizing back-pressure steam turbines to create energy from what is essentially "waste steam" is also a concept that is well known, but should be encouraged more by states as a strong energy saving opportunity.

The reason for this statement is two-fold. In another state, waste-heat applications were not allowed as renewable generation because it was believed that facilities would have the opportunity to alter their operations in order to increase the amount of electricity generated by the unit. In addition, there can be a general question raised as to whether a back-pressure steam turbine should qualify as a CHP system and receive grants. This point will be elaborated upon in the free-ridership section. However the application should be incentivized, or whether the application should fall under CHP or a different category is a question that is left open to the State of New Jersey. KEMA only offers that point that the application is a terrific means of generating electricity from "waste" energy and should be encouraged in some form or means by the State of New Jersey.

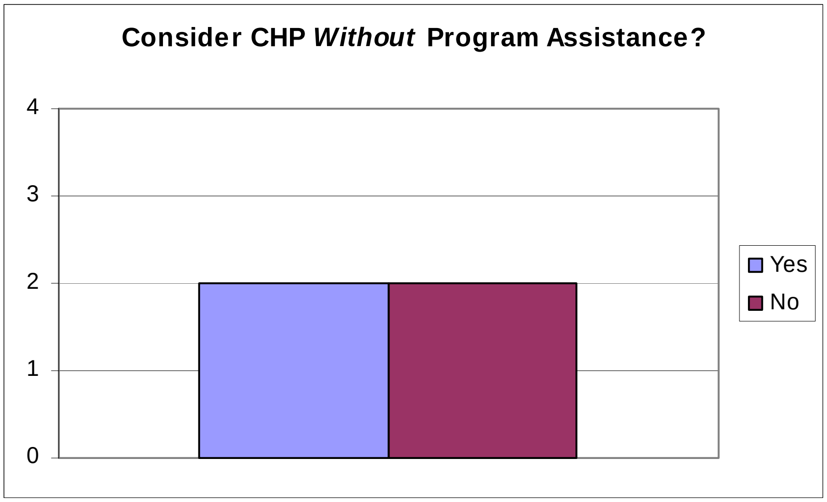
Figure 5: Results for "Whether Incentive Encouraged Use of Clean Technologies"



Question 15: Will you consider installing similar CHP Projects in the future *without assistance* from the New Jersey Clean Energy Program?

Two of the four participants indicated they would consider installing similar CHP projects in the future without assistance from the program. As will be discussed in the model results, KEMA notes that it did not appear that all the facility operators were maximizing the operations nor were they fully examining the system paybacks. The reason for this assessment is that facility operators did not maintain operational records or did not want to provide operational records. In addition, one operator indicated initial equipment difficulties while another operator indicated that though in the past, they did not baseload the system, the system would be baseload moving forward based upon the recommendations of their project developer. Hence, KEMA used these statements as the basis of the stated point that it did not appear that all facility operators were maximizing the operations of the unit. However, they still appeared to be generally satisfied with the system's performance and their projects.

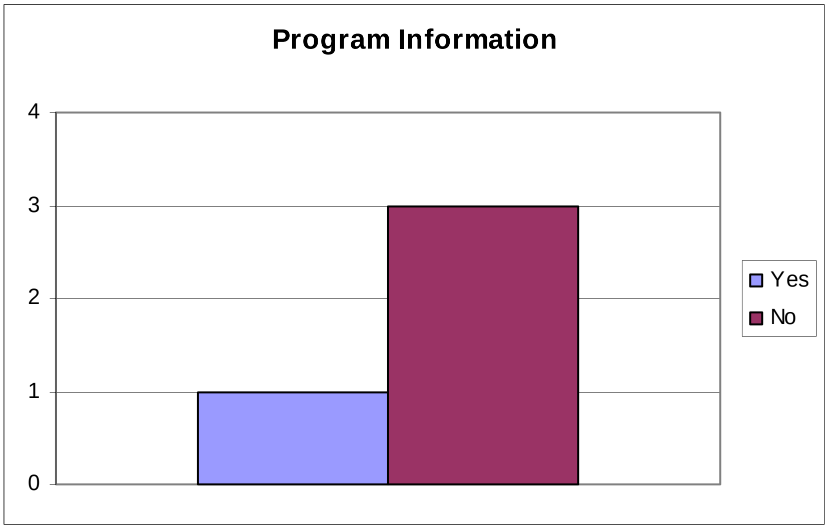
Figure 6: Results for "Whether CHP Systems Would Have Been Installed Without Program Assistance"



Question 17: Did the New Jersey Clean Energy Program provide your organization with any new information for CHP Systems?

Three of the four participants did not rely on the NJCEP for additional information. The three respondents relied on the contractors for information. KEMA recommends the program increase its outreach efforts, specifically in the areas of improving end users' understanding of the financial paybacks and operations of the systems. More specifics on this comment are provided in the conclusion recommendation on outreach efforts.

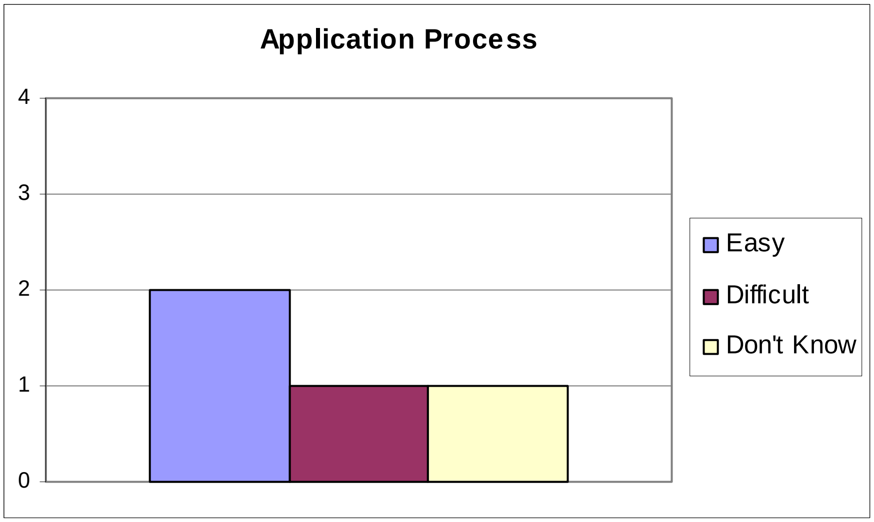
Figure 7: Results for NJCHP Provided New Information on CHP Systems



Question 18: Do you think the New Jersey Clean Energy Program application process was easy or difficult to use?

Two of the respondents noted that they thought the process was easy to use, one respondent indicated the process was difficult and one respondent had no opinion. The respondent that thought the process was difficult expressed frustration with the long time the program takes to review applications and get back to applicants. Though this opinion was offered by the interviewee, no specifics were offered to the reasons for the delays, other than the length of time that was taken to receive approval and funding. The respondent cited typical application response times of four to six months. It was noted that program changes may have been the reason but a specific area or group was not identified as the reason for the opinion.

Figure 8: Results of "Whether Application Process was Difficult or Easy"



Question 21: If you had not received help, including financial assistance, from the NJCEP, how likely would you have been to install the CHP System?

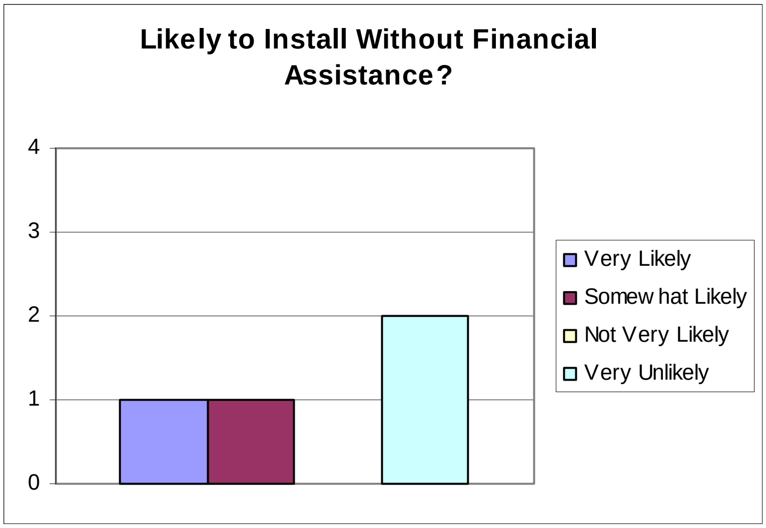
Question 22: Without the NJCEP's assistance, how different would the CHP system have been?

Question 23: Please describe in your own words what influence the NJCEP had on your decision to install the specific CHP system you did at the time you did.

Questions 21 through 23 were designed to measure free ridership. The purpose of this assessment is to determine what effect the program had on the participants' decision to install the CHP system at the time it was installed. Participants that would have installed the same equipment at the same point in time in the absence of the program are considered to be free riders. The program should consider whether it is in the best interest of the program and the State of New Jersey to offer assistance and financial incentives for projects that would be installed without assistance or financial incentives.

Question 21 assesses the likelihood the participant would have installed the CHP system in the absence of the program. Two of the four participants indicated the grant was an important component for moving forward with the project; the other two participants indicated the project may have been installed without the grant. More specifically, the one "very likely" response and the one "somewhat likely" response are evidence that free ridership is associated with this program.

Figure 9: Results of "Would You Have Been Likely to Install CHP without Financial Assistance"



KEMA followed up the initial free ridership question (Question 21) with *Question 22: Without the NJCEP's assistance, how different would the CHP system have been?* and *Question 23: Please describe in your own words what influence the NJCEP had on your decision to install the specific CHP system you did at the time you did?* These two questions assess the effect the program had on the size and/or number of the equipment installed, and timing of the installation. It is possible the participant would have installed a CHP system without the program but the program influenced the participant into installing a larger system, additional systems, or accelerated the time of installation. If either of these cases were true then the estimated level of free ridership for the "very likely" and "somewhat likely" respondents would be reduced. A participant's level of free ridership can range from full ridership to zero free ridership. Participants along the range of free ridership, between full ridership and zero free ridership, are referred to as partial free riders. Exactly where each respondent is on this range is dependent on their likelihood to install with the program and the program's influence on size, number, and timing.

The "very likely" and "somewhat likely" participants informed KEMA that they would have installed the same size and number of systems without the program incentive. When asked to describe in their own words the influence the program had on there decision to install the specific CHP system at the time they did, these respondents replied, "I don't think it had too much of an impact" and "It really didn't have any. We had explored it ahead of time. We just saw the rebate as an added bonus."

Further evidence of the free ridership status of these two participants is provided by their answers to the free ridership set up and confirmation questions earlier in the survey. Both participants indicated:

1. The incentive did not impact their decision to utilize a clean emitting, emerging technology, such as a fuel cell or microturbine.
2. They will consider installing similar CHP systems in the future without program assistance.
3. They had already considered installing CHP systems prior to being offered an incentive.
4. They did not receive any new information on CHP systems from the program.
5. They began discussing the installation of the CHP system with the program "just *after* planning had begun."
6. They had already research the costs of CHP systems *before* being contacted by the program or the project developer.

KEMA cannot establish free ridership trends based on only four cases. These four cases may not be indicative of future installations or participants. However, the four cases can provide insight for future program efforts. KEMA classified each of the four cases, noting where participants were more or less likely to be free riders. Based on the preponderance of evidence, KEMA determined that two of the cases were likely not free riders. The program should be credited full net saving credit for these projects. One survey respondent was "very likely" to install the project without the program's assistance, indicating full free ridership and the program should receive zero net savings for this CHP installation. Another respondent was "somewhat likely", indicating a high probability of partial free ridership. The program should receive a fraction (25 to 50 percent) of the savings for this CHP installation. KEMA estimates that the free ridership rate for the four installed systems is 46 to 52 percent of the total energy savings. That is, 46 to 52 percent of the total energy savings would have occurred in the absence of the program.

KEMA is bound by evaluation research ethics to protect respondent confidentiality. The small number of participants in the CHP Program makes it difficult for KEMA to balance respondent confidentiality with the need to provide the program with actionable research. Overall, responses to the surveys indicate that free ridership is associated with this program. Free ridership in the CHP market appears to be positively correlated with the size of the customer. It is noted that in each case, the grant shortens the simple payback by approximately three years. But for facilities that display the proper characteristics for CHP, economics are often favorable as long as gas prices allow for a spark spread (difference between gas and electricity rates) are positive for CHP systems.

In general, the economics of larger customers tend to be greater. The reason for this is that larger facilities tend to be 24 hours – 7 day operations, running three shifts with a solid baseload of electrical and thermal usage. Hence, every kWh or btu generated by the CHP is captured for savings, thermal usage is high, and the system provides both energy savings and a hedge against gas prices. In addition, larger facilities tend to have their own maintenance and engineering staff and are able to handle and maintain the CHP system on their own without the need of employing outside assistance.

For smaller facilities, the same two factors can run against the operator. Typically, smaller facilities do not run 24 hours or 7 days a week. An office building is an excellent example of this case where at most, the building operates six days a week and its thermal load and electrical load drop dramatically between the hours of midnight to 5 AM. Similar load profiles are seen for small industrial facilities. In addition, smaller facilities sometimes do not maintain the staff that can operate the system and tend to rely on the project developer to maintain the system. This causes increased cost to the project and in some cases an increased “hassle factor” to consider when adopting and implementing CHP.

When distributing grants for CHP, it is understood that some facilities will be better candidates based on their overall hours of operation and thermal load at the facility. Outside of the back-pressure steam turbine, some facilities are going to have characteristics that are more conducive to positive CHP economics than others. It will be difficult to differentiate this moving forward in New Jersey’s program. However, a couple of factors can be noted:

- Smaller facilities will continue to need support: The reasons are discussed above; small facilities typically do not have the hours of operation of large facilities. Hence, there is going to be a higher probability that the capacity utilization of the CHP system will keep economics on a positive but marginally favorable basis. In such cases, grants are essential to the final go / no go decision for a facility. For most states, large facilities have either already evaluated or installed CHP systems, so the majority of projects moving forward will most likely be with the smaller facilities where assistance should be highly beneficial for the project.

- Cleaner technologies: Clean Technologies, such as microturbines and fuel cells are still slightly more expensive that traditional reciprocating technologies. KEMA acknowledges that the program provides three incentive levels based on technologies with the highest incentives for fuel cells. The incentive levels by technology are:

  Level 1: Fuel Cells, \$4/W, max 60% of project cost;
  Level 2: Microturbines, Internal Combustion Engines, Gas Turbines, \$1/W, max 30% of project cost (40% if cooling application is included); and
  Level 3: Heat Recovery or Other Mechanical Recovery from existing equipment utilizing new electric generation equipment, \$0.50/W, max 30% of project cost.[3]

  KEMA thinks this is the appropriate approach but recommends the program consider further dividing Level 2 to offer a higher incentive for microturbines compared to the more traditional internal combustion engines and combustion turbines. This may help reduce the number of partial free riders and help encourage a clean technology to be installed over a traditional reciprocating technology.

  This statement needs to have a crucial caveat. Traditional reciprocating technologies are expending great effort to reduce emissions of their generators. KEMA is not recommending that grants be used to drive choices to one technology over another, but rather to state that traditional technologies tend to have lower install costs, and hence, shorter paybacks than some of the emerging technologies. Providing different grants for different technologies should allow a facility operator to choose between the technologies rather than design grants to the detriment of one technology versus another.

[3] Incentive levels are for the 2009 program year. At the time the four projects evaluated were installed the Fuel Cell incentive was \$2.50/W, 40% of project costs.

Another solution that is often employed with small facilities is an "own & operate" model where the developer owns the machine and sells the electrical and thermal output of the CHP system to the facility owner. In each case, whether contracting outside help to maintain the CHP system or using and "own & operate" approach, the paybacks can be less for smaller systems therefore the incentives typically mean much more. Whether CHP Program wants to consider an incentive for maintaining small systems on type of the installation grant is an open question to be considered by the State of New Jersey.

4.3.2 CHP Site Visits and Performance Comments

The site visits and phone surveys also played a role in helping KEMA understand how the systems were generally being used and served as a feedback mechanism for the operators of the systems. When addressing operational and performance issues the surveys and site visits noted some issues that are discussed in the recommendations. These issues focused in the following areas:

- General Satisfaction: Overall, the majority of program participants are satisfied with the program and with the decision to install a CHP system. Three out of four participants are satisfied with the CHP systems they selected. The unsatisfied participant cited issues with the manufacturer of the equipment and expressed satisfaction with the program.

  Two participants experienced reimbursement delays; one attributed the delay to program process changes. One participant cited a delay of over six months before receiving a response to an inquiry about a missing reimbursement. In addition, some participants sited potential improvements in the application process. In particular, they suggested shortening the wait-time for application approval. One participant suggested that this would help make the program more developer-friendly and minimize the risk of designing for installation of a CHP system without the assurance of a rebate. The same participant suggested the use of rolling applications rather than a single application period to shorten the turn-around on application approval.

- Payback: Our estimated paybacks indicated that the time to payback was slightly longer than contractors were telling end users. KEMA recommends that more education and outreach be conducted to assist end users in evaluating their potential projects. However, these differences in paybacks did not seem to correlate to a reduced satisfaction level on the projects. It did not appear that customers where doing post-installation and operation analysis of their CHP systems to confirm the original savings estimates, but rather were satisfied with the general benefits of having the CHP system on the site – such as back-up power systems and energy security.

To expand on additional savings opportunities, the savings that are associated with back-up power can be compared to that of a diesel back-up generator. Such a generator typically has a cost of $250/kW. Hence, the savings would be a one-time cost savings associated with the cost of a back-up generator.

For energy security, this term can be associated with the avoided costs of outages that can be obtained by the use of the CHP system. It was not assessed as to whether the systems were set up to operate during grid outages; however, the costs of outages have a large range depending on the type of facilities. A food processor was assessed in this analysis. Typically, food processors have very large outage costs as losses result from inability to produce product, and if the outage is extensive, requirements of cleaning all machinery before restarting may apply. Under some circumstances, the ability to avoid one extensive outage in CHP may provide all the required payback. As our assessment of the facilities did not examine outage costs, it is simply noted that there may be other reasons for a facility to install a CHP other than straight savings from the electricity prices and gas cost offsets. The term energy security is used to define potential outage costs as well as the reduced risks that are typically associated with outages.

- Operational knowledge: KEMA discovered that some of the projects were not being optimized in their hours of operation. The customers were simply not running the system all the time and could generate more savings if they did. CHP systems generally perform best with a baseloaded operation (running near 24 hours / 7 days). However, interviews indicated that not all the projects were being operated in such a manner. Typically, this has a negative impact on system paybacks, but reviews of project performance do not appear to be occurring at these facilities.

  There are many reasons why a facility owner may not have operated a unit to its maximum available hours. In the cases mentioned above, responses indicated that the operator simply was not aware of how to operate the system. This is a known limitation of smaller facilities and is addressed in the general conclusions of the report. Small facilities may simply not have the engineering support and manpower to operate CHP systems effectively. In each of the cases, the facilities owners mentioned that their developers had assisted by informing the operators how to maximize the savings by running systems to their maximum potential. Facility owners did not indicate that the reasons were because of price of natural gas fuel or operational problems with the system. This is an area where general education of the facility owners can provide benefits.

- Equipment itemization: It was discovered that in two of the four cases, different equipment was installed than listed in the program application. Table 4 highlights this issue in more detail. For the cases examined, manufacturer or technology changes were made in two of the instances. In each case, the technologies either involved swapping of a similar microturbine technology or switching from a reciprocating engine technology to a cleaner emitting, microturbine technology.

  In both cases the actual installed system was of greater total capacity. In one case a cleaner (lower emissions) system was installed. According to the applications the plan for Case 1 was to install two 60 kW UTC/Capstone microturbines but two 70 kW Ingersoll-Rand microturbines were actually installed. The plan for Case 3 was to install a 260 kW BluePoint Energy gas engine but five 60 kW Capstone Microturbines were actually installed. The ratio of total installed kW capacity to total planned kW capacity is 106 percent. That is, in total the CHP Program installed more capacity than planned (documented in the project applications).

Table 4: System Information

	Case 1: Nursing Home Facility		Case 3: Commercial Food Processor	
	Application	Actual	Application	Actual
Equipment Type	UTC/Capstone Microturbines	Ingersoll-Rand Microturbines	BluePoint Energy Gas Engine	Capstone Microturbines
Equipment #	2	2	1	5
Equipment Capacity	60kW	70kW	260kW	60kW
Equipment Cost	$210,000	$357,000	$533,000	750,000
Incentive Amount	$60,000	$107,000	$213,000	225,000
Displaced Thermal Loads	- Heating - Service HW	Confirmed	- Chiller - Service HW - Process HW	Confirmed
Operation	Roughly full time	Much Lower Exact Unknown	Roughly full time	Roughly full time

Note: Though facilities responded to surveys, complete analysis of CHP operations was not provided. Use of the term "confirmed" is used because facilities confirmed that they were using the thermal output of the system but did not elaborate on exactly where in their operations, and "roughly full time" was in response to indicate that responses indicated the machine was not operated in a baseload operation due to facility upgrades or changes to the facility. Exact details were not provided.

- Operational Logs: Actual information was difficult to maintain because facilities were not keeping operational logs of systems performance or were not willing to share their records. Only general answers were provided on how many hours the CHP system was operating, over what shifts, and over what part of the year. Three of the four units were operating roughly full-time. The fourth was operating much less than had been planned. Reduced operation of CHP systems will have significant impacts on overall payback. However, for the one project with reduced hours, this reduction was not associated with low customer satisfaction.

The four CHP systems were installed in what are typically very favorable facility types. For CHP to work, a facility needs to have a certain load profile for electricity usage and thermal usage. Nursing homes, recreational/athletic facilities, and food processors have historically been very good CHP candidates because their operations tend to be for multiple shifts and the facilities have a steady thermal load.

In addition to the operational profile of these facilities, the facilities also have a need for hot water rather than steam. Engines in the size range for the projects in the NJCEP program are typically only capable of producing hot water. Though such engines can still be used to pre-heat water for steam production, the best applications are for facilities that have a high need for hot water. Such is the case with the facilities and projects selected in the NJCEP program.

However, more follow-up and education appeared to be necessary in order to maximize the operation of the systems. Such issues reflect improvements that can be made in the NJCEP program, but some are systemic as well. In KEMA's opinion, there are two types of facilities that utilize CHP systems: large industrial and small commercial operations. For large industrial facilities, the plants are usually large enough for there to be on-site engineering support to ensure that projects are being operated properly and maintained as well. For small commercial operations, the facilities tend not to operate on a 24 – 7 basis, have less of a "consistent baseload" energy profile, and often do not have the staff to operate and maintain the system on a consistent basis.

5. CHP Model Results

This section describes the CHP model results for each of the four installed systems. KEMA modified its proprietary CHP feasibility model to obtain the information required by the NJCEP protocols. The main objectives of KEMA's CHP evaluation were to determine the following generation and savings estimates for the installed systems:

- Electrical Generation: Estimate the reduction in energy that is purchased from the grid.
- Thermal savings: Estimate the reduction in thermal usage of the facility because of the CHP system.
- Financial Savings: Calculation includes a check to make sure that the grants are being utilized to promote projects that make financial sense.
- Emission Reductions: The higher efficiency of the CHP systems and the energy savings translate into emission savings as a societal benefit (emission often increases to run the CHP generator but when the energy savings are taken into account, an overall emission reduction occurs).

Table 5 again provides a summary of the four installed CHP systems. Following the summary KEMA presents model results for each project. Three of the case studies involved "traditional" CHP applications where a fuel input is used to power a generator to create electricity and heat is captured to offset facility heating requirements. For the fourth case, a back-pressure steam turbine is used to generate electricity only. This application is relatively rare. Facilities that have a high steam load usually have pressure reduction values throughout their steam loop. Instead of steam being vented to the atmosphere, it is captured and used to drive a steam generator. Electricity is generated from facility excess steam to create electricity that offset grid usage. Such projects are often considered in renewable / thermal generation but differ from the CHP analysis in that there is no fuel input that is required. Hence, participant savings are simply the offset gained by the electricity generated.

Table 5: CHP System Characteristics

	Case 1: Nursing Home Facility	Case 2: Large Industrial Company	Case 3: Commercial Food Processor	Case 4: Recreational/Athletic Center
Equipment Type	Microturbine	Backpressure Steam Turbine	Microturbine	Reciprocating Gas Engine
Equipment #	2	1	5	2
Per Unit Capacity	70kW	509kW	60kW	75kW
Equipment Cost	$357,000	$654,701	$750,000	$515,500
Incentive Amount	$107,000	$196,410	$225,000	$150,000
Displaced Thermal Loads	- Heating - Service HW	NA	- Chiller - Service HW - Process HW	- Service HW - Pool
Operation	Roughly full-time	Roughly full-time	Roughly full-time	Engine 1: 100% all yr; Engine 2: 100% for ½ yr

Notes: “NA” = Not applicable, “Roughly full-time” means operators were not baseloading operation in the past, and “HW” = hot water applications

For the facilities that were evaluated, there is the common theme that the facilities are under 1 MW of total load. In KEMA’s experience, this fits expected trends seen in other states. CHP is not a new concept, and technologies such as reciprocating engines have been in the marketplace for over 70 years. Large industrial facilities, because of their typical operational patterns of 7 days, 24 hour (3-Shift) operation have either examined CHP potential at their facilities or already have installed CHP at their facilities, if practical.

Based on KEMA’s experience, we offer opinions on recent trends in the CHP industry. What has changed in the industry over the last 15 years is the development of cleaner technologies and “smaller” engines that allow CHP applications to be extended to smaller facilities – facilities under 1 MW. The reason is the advancement of technologies such as microturbines and fuel cells started in the 30 kW to 250 kW range. These technologies offered cleaner emissions but their small size made them appropriate for facilities under 1 M. Traditional CHP technologies responded by providing cleaner emitting engines in this size range.

With products now available for under 1 MW facilities, markets have been examined in numerous state cases that can be found on the EPA CHP Partnership web site, (www.epa.gov/chp), the DOE OE web site (www.oe.energy.gov/de.htm) or the U.S. Combined Heat & Power Association web site (www.uschpa.org). KEMA experience has shown the following characteristics with facilities that are under 1 MW in size.

- Largest potential market in most states: Market opportunities have not been pursued because of traditionally did not have generators sized for such facilities.
- Market economics tend to be more difficult for facilities under 1 MW as they tend not to operate under 24-7 periods, hence, capacity utilization of CHP systems is reduced.
- Installation costs for emerging, clean technologies tend to be high, putting stress on overall project economics and level of customization that is often required at smaller facilities.
- Construction costs: It is also noted that in states such as New Jersey, construction costs can vary depending on the location of the installation. Urban locations tend to have higher construction costs due to labor and available space at the facility. This factor should be included in overall market penetration analysis.

With these factors being kept in mind, proper type facilities that can be targeted in this range are facilities that have a high "Thermal" usage throughout the year. Facilities that fit these types of characteristics and are often under 1 MW are plating facilities, nursing homes, hospitality, small hospitals, food processors, colleges & universities, and recreational/athletic centers that have hot water loads and pool heating loads. It is noted that the facilities that utilized the NJ CHP program fit in these categories.

5.1 Case 1: Nursing Home

The nursing home facility is typically a great facility to site small-scale CHP applications because their operations are 7 days and their need for hot water is steady for the majority of each of the days. The closer a CHP system can operate at a "baseload" mode of operation, the better the financial economics will be. KEMA believes that the site is a good CHP candidate.

KEMA's site surveys and phone interviews indicated that the system has not been operated at its full capacity. The reasons for this can range from (1) a need for increased education on system operation, or (2) inversion of the spark spread for CHP projects. Spark spreads are defined as the difference between the cost of gas to produce electricity and the cost of electricity itself. When the price of gas rises significantly and the price of electricity falls, it can become uneconomical to operate a CHP system. In addition, gas prices can be more volatile than electricity prices; hence, facilities may determine that it is best not to run the system. However, our indications from interviews are that the system will be operated at is full potential plus a favorable spark spread should further encourage the facility to utilize the CHP system for more hours.

The ramifications of not running the system in a steady mode impacts the financial savings of the system as well as the societal benefits (reducing NJ's overall peak demand) not meeting program expectations. It is for this reason that one of the recommendations for the assessment of the project will be more timely feedback of projects. For our analysis, we measured the savings based on the projected operation of the units, a summary of the system performance are listed in Tables 6 and 7.

What was noted in the system was the financial savings factor. Preliminary estimates of the operation where showing length of paybacks for the system that were slightly longer than the application. Reasons for this can vary and be due to (1) not accounting for supplemental energy costs if the CHP system is not providing all of the electricity for the system, or (2) assuming all the heat is being utilized to displace boiler gas when the system may be producing heat in off hours. In addition, the fact that the CHP system was not being optimized in its operation further contributed to a longer simple payback for the system.   It is still noted that the participant was very satisfied with the system. KEMA recommends the program increase its education effort and provide more information on system operation and impacts on savings.

Table 6: Yearly savings amounts for Case 1 Facility

System Characteristic	Value	Unit
Electric Capacity	140	kW
Average Net Heat Rate (HHV)	13,478	btu/kWh
Electric Energy	**888,615**	**kWh**
Fuel Volume Consumed	12,345	MMBtu
Average Gen Thermal Output	350,000	btu/hr
Boiler Efficiency	80%	%
Total CHP Thermal Benefit	**5850**	**MMBtu**
Total Potential Run Hours	8,760	Hr
Total Run Hours with Outage	8,059	Hr
Planned Outage Percentage	8.0%	%
Numbers of Outage Hours	700.80	Hr
Unplanned Hours Per Outage	0	Hr

Table 7: Summary of Yearly Emission Savings Calculations for Case 1 Facility

Variable	Value	Unit	Variable	Value	Unit
Estimated Emission Rate from Grid			**Heat Rate of CHP System**		
CO_2	1.520	lbs/kWh	Total Efficiency	60	%
SO_2	0.00650	lbs/kWh	Estimated Heat Rate	4,736	btu/kWh
NOX	0.00280	lbs/kWh	**Emissions Pre-CHP**		
			Electricity Produced from Grid	1,239,130	kWh
Emissions Rate from CHP System			CO_2	1,883,477	lbs
CO_2	0.6425	lbs/kWh	SO_2	8,054.34	lbs
SO_2	0	lbs/kWh	NOX	3,469.56	lbs
NOX	0.00005	lbs/kWh	**Emissions with CHP Plant**		
			Electricity Produced from CHP	888,615	kWh
Emission Savings			CO_2	492,407	lbs
CO_2	**858,288**	**Lbs**	SO_2	0	lbs
SO_2	**5,776**	**Lbs**	NOX	42.09	lbs
NOX	**2,446**	**Lbs**	*Remaining Electricity from Grid*	350,514	kWh
			CO_2	532,782	lbs
			SO_2	2,278.34	lbs
			NOX	981.44	lbs

5.2 Case 2: Industrial Facility

This case involved a facility that utilized a back-pressure steam turbine rather than a traditional CHP system. Hence, the savings estimates are not calculated in the same manner as the other cases. This system is unique in that it operates off the steam that is typically vented to the atmosphere by pressure reduction values (PRV). The steam turbine actually is installed in place of the PRV valves and the steam is used to drive the generator. It essentially creates “free” energy for the facility. There is no natural gas consumption, relatively low maintenance, and all the electricity produced is considered electricity savings and reduction from the grid and peak power. Such systems lead to greater emission reductions but do not possess a thermal offset component as with traditional CHP systems.

A summary of the generation, savings and emission reductions from the system are listed in Table 8 and Table 9.

Table 8: Yearly Savings Amount of Case 2 Facility

System Characteristic	Value	Unit
Electric Capacity	509	kW
Average Net Heat Rate (HHV)	0	btu/kWh
Electric Energy	**1,460,927**	**kWh**
Fuel Volume Consumed	0	MMBtu
Average Gen Thermal Output	0	btu/hr
Boiler Efficiency	80%	%
Total CHP Thermal Benefit	**0**	**MMBtu**
Total Potential Run Hours	8,760	Hr
Total Run Hours with Outage	7,884	Hr
Planned Outage Percentage	10.0%	%
Numbers of Outage Hours	876	Hr
Unplanned Hours Per Outage	0	Hr

The emission savings in this case was greatly simplified because of the type of project that is being utilized. The back-pressure steam turbine uses waste steam as a fuel input to produce electricity that is used to reduce the total facility consumption. Though the system does not contribute to a thermal offset, the project is a straight reduction of electricity consumption and thus, a straight reduction in the accompanying emissions. A simple payback method is used to evaluate the project. The reason for this assessment is that the unit does not use a purchased, fuel input to power the device, but rather uses steam that is typically vented to atmosphere. The steam to power the generator is from steam that is often "wasted" energy. The electricity offset is the output of the steam generator running off this vented steam. The savings are simply the (cost of the generator) / (cost of the kWh generated – cost of maintenance). Because there is no fuel costs, paybacks of such systems are often fall into a 2-4 year range. This range is often cited as a standard industry hurdle to meet for go / no go decisions of projects.

Table 9: Summary of Yearly Emission Savings Calculations for Case 2 Facility

Variable	Value	Unit	Variable	Value	Unit
Estimated Emission Rate from Grid			**Heat Rate of CHP System**		
CO2	1.520	lbs/kWh	Total Efficiency		%
SO2	0.00650	lbs/kWh	Estimated Heat Rate		btu/kWh
NOX	0.00280	lbs/kWh	**Emissions Pre-CHP**		
			Electricity Produced from Grid	0	kWh
Emissions Rate from CHP System			CO2	0	lbs
CO2	0	lbs/kWh	SO2	0	lbs
SO2	0	lbs/kWh	NOX	0	lbs
NOX	0	lbs/kWh	**Emissions with CHP Plant**		
			Electricity Produced from ST	**1,460,927**	kWh
Emission Savings			CO2	0	lbs
CO2	**2,220, 608**	**Lbs**	SO2	0	lbs
SO2	**9,496**	**Lbs**	NOX	0	lbs
NOX	**4,091**	**Lbs**	*Remaining Electricity from Grid*	0	kWh
			CO2	0	lbs
			SO2	0	lbs
			NOX	0	lbs

5.3 Case 3: Commercial Food Processor

The third case is a commercial food processor. Again, such facilities are prime CHP candidates. However, during the site visit KEMA discovered that a different technology was incorporated rather than the reciprocating engine that was on the original application. Though this has led to some recommendations by KEMA on the feedback mechanisms of the program, it was viewed as a positive step because the microturbine that was utilized was is a much cleaner emitting product and fits within the program goals of encouraging advanced generator technology.

Typically, the impacts of switching from a reciprocating engine to the microturbine are on the costs of installation and the system paybacks. Microturbines generally have higher install costs and their lower efficiencies lead to high operating costs as well. However, microturbines do have a lower maintenance costs than reciprocating engines and the reduction in the need to maintain the systems is often a motivating factors for facility owners. In addition, the participant added additional benefits by using the five microturbines in place of the single reciprocating engine. The paralleling of the microturbines provides higher reliability and allows for better efficiency in off hours. Where the single unit may have been required to shut down during off-peak usage, the microturbine units would simply be able to shut off machines and still run one at is optimum efficiency.

Examining the costs of the unit, the operating characteristics of the machine versus the project facility load profile, even with the NJCEP incentive grant, the project's simple payback was long. Despite the long payback this participant was satisfied with the unit. Even greater satisfaction and increased energy savings could be achieved though improved optimization of the unit. The program should consider education and training and other outreach efforts to facilitate more efficient use of installed systems.

Below, Table 10 and Table 11 show the generation, energy savings and societal benefits gained from the use of these low-emission units.

Table 10: Summary of Yearly Energy Outputs for Facility Case 3

System Characteristic	Value	Unit
Electric Capacity	300	kW
Average Net Heat Rate (HHV)	13,433	btu/kWh
Electric Energy	**1,151,800**	**kWh**
Fuel Volume Consumed	15,598	MMBtu
Average Gen Thermal Output per	408,000	btu/hr
Boiler Efficiency	80%	%
Total CHP Thermal Benefit	**9,915**	**MMBtu**
Total Potential Run Hours	8,760	Hr
Total Run Hours with Outage	7,884	Hr
Planned Outage Percentage	10.0%	%
Numbers of Outage Hours	876	Hr
Unplanned Hours Per Outage	0	Hr

Table 11: Summary of Yearly Emission Savings Calculations for Facility Case 3

Variable	Value	Unit	Variable	Value	Unit
Estimated Emission Rate from Grid			**Heat Rate of CHP System**		
CO2	1.520	lbs/kWh	Total Efficiency	73.9	%
SO2	0.00650	lbs/kWh	Estimated Heat Rate	4,616	btu/kWh
NOX	0.00280	lbs/kWh	**Emissions Pre-CHP**		
			Electricity Produced from Grid	1,418,547	kWh
Emissions Rate from CHP System			CO2	2,156,192	lbs
CO2	0.5635	lbs/kWh	SO2	9,220.56	lbs
SO2	0	lbs/kWh	NOX	3,971.93	lbs
NOX	0.00005	lbs/kWh	**Emissions with CHP Plant**		
			Electricity Produced from CHP	1,151,800	kWh
Emission Savings			CO2	622,081	lbs
CO2	**1,128,654**	**lbs**	SO2	0	lbs
SO2	**7,487**	**lbs**	NOX	53.17	lbs
NOX	**3,172**	**lbs**	*Remaining Electricity from Grid*	266,477	kWh
			CO2	405,456	lbs
			SO2	1,734	lbs
			NOX	747	lbs

5.4 Case 4: Recreational/Athletic Center

This system, when run with the KEMA feasibility model to validate the financial estimates of the projects, also showed a longer payback than the application had originally targeted. This facility utilized a standard reciprocating engine. The costs and paybacks of the system are generally lower/shorter compared with microturbine CHP systems. However, the emission savings are less. Summaries of the model outputs and emission savings are listed in Tables 12 and 13.

Table 12: Summary of Yearly Energy Outputs for Facility Case 4

System Characteristic	Value	Unit
Electric Capacity	150	kW
Average Net Heat Rate (HHV)	12,318	btu/kWh
Electric Energy	**930,635**	**kWh**
Fuel Volume Consumed	11,937	MMBtu
Average Gen Thermal Output per	490,000	btu/hr
Boiler Efficiency	80%	%
Total CHP Thermal Benefit	**7,600**	**MMBtu**
Total Potential Run Hours	8,760	Hr
Total Run Hours with Outage	8,322	Hr
Planned Outage Percentage	5%	%
Numbers of Outage Hours	438	Hr
Unplanned Hours Per Outage	0	Hr

Table 13: Summary of Emission Savings Calculations for Facility Case 4

Variable	Value	Units	Variable	Value	Units
Estimated Emission Rate from Grid			**Heat Rate of CHP System**		
CO2	1.520	lbs/kWh	Total Efficiency	81.1%	%
SO2	0.00650	lbs/kWh	Estimated Heat Rate	4,208	btu/kWh
NOX	0.00280	lbs/kWh	**Emissions Pre-CHP**		
			Electricity Produced from Grid	1,174,666	kWh
Emissions Rate from CHP System			CO2	1,785,492	lbs
CO2	0.4924	7,635.33	SO2	9,620.51	lbs
SO2	0	3,289.06	NOX	2,584.26	lbs
NOX	0.00004	lbs/kWh	**Emissions with CHP Plant**		
			Electricity Produced from CHP	930,635	kWh
Emission Savings			CO2	458,223	lbs
CO2	**956,342**	**lbs**	SO2**	0	lbs
SO2	**6,049**	**lbs**	NOX	39.16	lbs
NOX	**2,567**	**lbs**	*Remaining Electricity from Grid*	244,031	kWh
			CO2	370,927	lbs
			SO2	1,586.20	lbs
			NOX	683.29	lbs

6. Findings and Recommendations

This section presents the findings of this energy impact evaluation and KEMA's recommendations for program improvement.

6.1 Protocol Review

The *Protocols to Measure Resource Savings* (Protocols) were developed to accurately and consistently determine energy and resource savings for measures supported by the NJCEP. The document is periodically updated as new programs are added, existing programs are modified, and new information becomes available. The Protocols were most recently updated in December 2007.

According to the Protocols the measurement of energy and demand savings for CHP systems is based on the characteristics of the individual CHP systems. The majority of the inputs used in the savings estimates are based on information provided on the project applications. The variety in the types of CHP projects installed makes it appropriate to base calculations on individual installations. However KEMA recommends rather than using application data, information from the post-installation design and operation of the CHP systems should be used.

The CHP Program did not conduct post-installation reviews for the projects reviewed by KEMA. Beginning in 2008, the CHP Program will perform post-installation inspections on 100 percent of installed projects and has the authority to request additional project information and documentation to ensure the installed system meets the requirements as detailed in the project application. In addition, a new requirement of the program included in the 2008 Program & Budget Filing[4] is that applicants must provide twelve months of operational data. KEMA supports these program improvements.

The Protocols for CHP systems also provide formulas for estimating emissions reductions. The emission savings are generated from the overall gain in efficiency of the unit. For example, the efficiency of a CHP system (typically above 70%) is used as the main factor in determining the emission savings. The approach is satisfactory for calculating emissions.

Alternative approaches are seen in the EPA Emission calculator. This approach starts with the fuel input (in MMbtus) and calculates the emissions from the CHP system, the displaced

[4] New Jersey's Clean Energy Program 2008 Program Description and Budget, Commercial & Industrial Energy Efficiency Program managed by TRC as C&I Program Manager, December 7, 2007.

emissions from the thermal that is being generated, and measures that total against the displaced grid emissions. By examining the emission savings based on the fuel input may provide the opportunity to take into account individual variances of facilities.

6.2 Persistence of Energy Savings

The installed systems are very likely to continue to accrue savings. Based on the participant interviews and site visits there is no indication that participants are having technical problems with the CHP systems or plan to remove or shut them down. More specifically, three of the four participants responded that they were happy with the performance of their CHP systems. Additional comments from the one participant dissatisfied with the CHP system indicate that the facility will likely keep the system operating. For this case, the participant noted that the dissatisfaction was not due to the use of CHP systems as much as initial equipment issues, and that the system is currently operating. Furthermore, the four CHP systems were installed in what are typically very favorable facility types. Generally, the electricity load profiles compliment the thermal usages.

CHP systems typically last approximately ten years in length. Hence, it is expected that the savings should persist throughout this time. For microturbines, high-level maintenance typically occurs after about 40,000 hours, or five years of operation. For reciprocating engineers, high-level maintenance typically occurs after about 20,000 hours, or two-and-a-half years of operation.

Economics can heavily influence the decision to maintain operation of a CHP system. In particular, where fuel input costs add to operation and maintenance costs, the spark spread (the difference between gas and electricity rates) can influence whether the economics are favorable for a CHP system. Because the backpressure steam turbine installation (Case 2) requires no additional fuel input costs, the economics are quite favorable. The savings generated by the steam turbine are likely to persist throughout the life of the project. Other installations may be impacted by the spark spread over time.

KEMA learned from the interviews that some of the facilities did not seem to be focusing on economics and were not tracking their overall savings via benchmarking. This indicates that there may have been other motivations for installing the system other than project economics. For example, the economics may have been exclusive of some additional benefits that could be gained from an installation of a CHP system, such as back-up power or energy security. KEMA still expects these projects to accrue savings for the full lifetime of the system.

6.3 Estimated CHP Production, Emissions Reduction & Gross Savings

The main goals of the CHP Program are to encourage the following:

- Reduce New Jersey's overall system peak demand.
- Encourage the use of emerging technologies.
- Use energy more efficiency and reduce emissions of greenhouse gases.
- Use distributed generation to provide reliable solutions for New Jersey.

This section assesses the program's accomplishments and progress towards meeting these stated goals.

6.3.1 Feasibility

The number of CHP projects installed is directly related to the feasibility as well as the societal and facility savings. The impacts of paybacks are highlighted in this assessment to judge if there are trends resulting from the incentive being either too small or the program not encouraging the proper technologies to meet the stated goals.

First, CHP feasibility is correlated more towards the price of natural gas and the price of electricity than on cost of installations. Traditionally, reciprocating engine technologies have had a long history of operation and are generally 20-50 percent lower in installation costs than advanced technologies such as fuel cells and microturbines. However, the gap on technology costs is lowering, particularly for microturbines. For the projects that have been installed, the fact that microturbines were used in two of the four installations may provide an indication that the incentive is appropriate to encourage the program goals of encouraging the use of emerging technologies.

For some of the operators, the above statement has the caveats that the facilities did not seem to be focusing on actual payback and were not tracking their overall savings via benchmarking. This indicates that there were other motivations for installing the system other than project economics. Furthermore, firms that only focus on the savings potential and track system operations are likely to determine that projects are not feasible to implement. KEMA believes that this is one reason that the overall number of participants in the program was low. In general, our model was indicating that project paybacks were in the 7-10 year range for simple paybacks with the incentive used.

These paybacks were exclusive of some additional benefits that could be gained from an installation of a CHP system, such as back-up power or energy security.

6.3.2 Generation, Energy and Emission Savings

Table 14 summarizes the estimated gross program impacts for each case. All four cases have contributed to reductions in demand from the Grid and in emission savings. These projects are meeting the CHP Program goals of creating energy and emission savings.

KEMA estimates that total annual electricity generation is 86 percent of planned. Planned generation was not provided in the project application documentation for all cases. Therefore, where data were not available, KEMA calculated the percent of estimated total CHP electricity generation as the ratio of *estimated* planned generation to total generation from the model. KEMA estimated planned generation using information provided in the project application files and two scenarios. The first scenario assumes similar load profiles to modeled profiles and the second scenario assumes systems were baseloaded with 85 percent availability. Estimated planned savings used to calculate the difference between actual and planned is the average of the two scenarios. KEMA also estimates that there are no electricity savings. In particular, no facilities displaced electric cooling with cooling that uses recaptured heat from the CHP systems.[5]

[5] According to the *Protocols to Measure Resource Savings*, electricity savings should only be reported where recaptured thermal energy from a CHP system is used to drive an absorption chiller that displaces electricity previously consumed for cooling.

Table 14: Summary of Estimated Yearly Generation, Energy & Emission Savings

	Case 1: Nursing Home Facility	Case 2: Large Industrial Company	Case 3: Commercial Food Processor	Case 4: Recreational/ Athletic Center
Equipment Type	Microturbine	Backpressure Steam Turbine	Microturbine	Gas IC Engine
CHP Installed Capacity (kW)	140	509	300	150
Total CHP Production (kWh)	888,615	1,460,927	1,151,800	930,635
CHP Thermal Offset (MMBtu)	5,850	0	9,915	7,600
CHP Production by Period				
Peak Summer (kWh)	165,668	73,302	276,458	196,862
Peak Winter (kWh)	235,307	114,652	398,679	221,253
Off-Peak Summer (kWh)	223,141	496,459	198,621	277,987
Off-Peak Winter (kWh)	264,500	776,513	278,043	234,533
CHP Peak Output (kW)	125	509	278	150
Emissions Reductions (lbs)				
Carbon Dioxide	858,288	2,220,608	1,128,654	956,342
Sulfur Dioxide	5,776	9,496	7,487	6,049
Nitric Oxide	2,446	4,091	3,172	2,567

6.3.3 Reducing Overall Peak Demand

By definition, the projects are accomplishing the goal of reducing overall peak demand. However, as has been noted in Section 5: CHP Model Results, not all projects have been utilized in the manner typical of CHP projects. For overall demand to be reduced, projects need to be utilized during peak periods and consistently during peak periods. Though projects reduce demand every time they run, the projects need to be run consistently for New Jersey to see a demand reduction. Running CHP systems to their optimum mode of operation may result in greater savings for the facility owner and reduced peak demand for New Jersey. CHP systems, because they run as a baseload system, reduce the overall demand load for New Jersey, and thus, reduce the peak load. This reduction in load is equivalent to the total kW of all the systems. However, they generally should not be considered as a "load reduction" tool because of their continuous operation.

6.3.4 Encouraging the Use of Emerging Technologies

For CHP applications, technologies break down into emerging and traditional. Traditional technologies are reciprocating or Internal Combustion (IC) engines. They are essentially car engines and have an equally long history and track record of operation. Emerging technologies are typically labeled as microturbines and fuel cells.

Two of the four projects utilized microturbines, and one of those switched from an IC engine to a microturbine, KEMA concludes the program is meeting its targeted goal in this area for these projects.

6.3.5 Using Distributed Generation to Provide Reliable Solutions for New Jersey

The program is getting projects installed, and thus, decentralizing energy production. However, reliability improvements through distributed generation are a debated benefit. Allowing specific facilities to have their own generation source will help specific facilities as a backup power source. Adding power to the grid at specific locations can also help alleviate potential congestions issues as well. However, there are also potential drawbacks to the grid in having large amounts of distributed generation connected to the grid. The degree of this drawback is often debated, but centers on potential instabilities that may be encountered if units dropped off line or the fact that grid operators tend not to be able to track the operation of these systems. Such analysis is beyond the scope of this evaluation. At some level the NJCEP program is meeting its goal of getting facilities to use distributed generation. However, no real penetration or MWh goal has been set for the program.

6.4 Market Penetration of CHP

Business models tend to differ between CHP applications with large facilities and those with small facilities. A large facility typically has an internal engineering staff that can monitor and maintain the operation of a CHP system. A small facility typically does not have this staff and essentially does not actively maintain operation of a CHP system.

Because of these trends, two types of business models have developed with CHP. One business model is the design and build, where a contractor essentially constructs the project and leaves the operation to the facility. This tends to be preferred for large facilities because they have the staff to maintain the project and are able to generate more savings by maintaining the project internally. The second business model is the “own & operate” model, where a contractor owns the equipment and charges the facility owner for the output of the CHP system, typically at a five to 10 percent discount to the electricity and gas tariff.

Two of the four cases reviewed in this evaluation were large facilities and two were small facilities. However all four cases used the business model most aptly suited for large facilities. This mismatch of business model and facility size may have led to some of the system operation problems KEMA encountered during the phone interviews and site visits.

A program needs to be designed to serve its market. If the CHP market in New Jersey is weighted towards smaller facilities (in general, under two MW opportunities predominate the CHP future potential market), NJCEP may want to consider a program design that focuses on smaller facilities with better education, outreach, and customer monitoring as the program evolves. Another option is to offer separate services and levels of assistance for large and small facilities.

6.5 Program Recommendations

The recommendations that are provided are based on customer feedback as well as KEMA observations and evaluation of the program. As the program currently stands, though the number of installations to date is low, the program has been hitting the right target of facilities and has participants that are generally satisfied with the program and results. Hence, we offer recommendations in the following areas the program may be able to make as it evolves:

1. Assistance with Project Feasibility
2. Follow-up with Applicants
3. Access to Operation Information
4. CHP Information Center
5. Shorter Approval Turn-Around
6. Shorter Rebate Turn-around

Below, we provide more detail on the aforementioned recommendations.

Recommendation 1: Assistance with Project Feasibility

The program should consider providing participants with project feasibility studies including a brief assessment of project financials. Our analysis consistently revealed optimistic project paybacks on the applications, and participants relying solely on contractors for economic insights. If projects do not perform as initially projected and reported on the application, it may lead to dissatisfaction with the CHP system and the program. In addition, overall program impact estimates will be overstated. The program should have greater control and oversight of the project feasibility process.

KEMA had initial concerns that the projects' original estimates for savings were not in line with actual savings. In some cases, our review confirmed this to be the case. This disparity often occurs when high-level feasibility studies skip factors such as whether all the energy that can be outputted by the system is used by the facility, or excluding additional cost factors in the analysis. There are many tools available for individuals and NJCEP evaluators to utilize to assess projects more closely. We recommend that the program provide simple tools for the individual applicants to allow them the ability to check the numbers being provided and proposed by their contractors.

Recommendation 2: Follow-Up with Applicants

The program should conduct post-installation inspections with all CHP installations. KEMA recognizes that such inspections will be part of the program going forward, but notes the issue because inspections were not conducted at the facilities surveyed and evaluated. In addition, KEMA recommends that inspections should occur as soon after installation as possible and be a part of the participation agreement. The following is a list of potential benefits:

- Early verification of whether the installation type and operation match the proposal. Project impact claim and final rebate amount could be based on this inspection.
- Opportunity to provide guidance or training on how to integrate the CHP system into an applicant's energy system.
- Better internal quality control input from participants when they can more easily recollect their experience with program and equipment installation process.

Overall, the site visits highlighted the potential benefits that can be obtained with short-term follow-up with program participants. In particular, such follow-ups would verify whether the installed CHP systems are the same as those specified in the applications. This ensures that installed equipment meets eligibility requirements, and that the program has on record accurate information to develop estimates of program impacts. However, in addition to serving verification purposes, site visits provide an opportunity to give guidance to facility managers on post-installation operation and maintenance. While some facility managers may already be well informed users of CHP systems, others may benefit from learning more about its maintenance and how to optimize its operation to meet loads while reducing costs. It appears that at least one of the four participants interviewed could have benefited from such information.

Finally, once participants have received the full incentive amount from the program, prompt follow-up with applicants would serve another beneficial purpose, gathering internal quality control information from participants. This step will provide the program with timely feedback from program participants on their experiences with the program and CHP systems installed.

New program procedures provide that Market Managers will inspect the installations prior to the program issuing the incentive. KEMA endorses this measure, and believes that the program should do its best to ensure follow-up is prompt. In addition, the program should actively integrate information and guidance for facility managers as part of the follow-up.

Recommendation 3: Access to Operation Information

KEMA encountered some difficulty in accessing information about CHP system characteristics and performance. The program should consider requiring participants, as part of the participation agreement, to provide the program with key information about the system design and operation after installation.

Information about system operation was not readily available from program participants upon visiting the sites. It is important to pre-arrange the delivery of key information for verifying system operation and estimating program impacts. Pre-approval clarifies which information the facility should provide and ensure that such information is available to the program.

KEMA acknowledges that program changes in 2008 require that participants:

- Submit pre-installation applications with information on CHP system energy, economic and emissions performance.

- Allow the facility manger to monitor the facility's energy usage to verify savings (i.e., install metering).
- Provide the program with 12 months of operational data demonstrating that the equipment achieves the efficiency levels that were originally proposed.
- Fully document any changes between the initially proposed system and the installed system.

These provisions will benefit both the program and the participants. In particular, they help the program verify eligibility and estimate program impacts. They will help encourage participants to monitor the performance of their own systems. Interviews with participants indicate that at least one, if not two of the participants would have benefited from closer review of system performance.

KEMA also encourages the program to ensure that the information it collects as part of the post-installation follow-up include not only changes in system characteristics but also notable changes to system operation, and to operation and maintenance costs.

With regard to protocols to measure resource savings, KEMA believes that the variety in the types of CHP projects installed makes it appropriate to base calculations on individual installations. In addition, rather than using application data, KEMA believes it is appropriate to use information about post-installation design and operation of the CHP systems.

Recommendation 4: Better Outreach on CHP Information Center

The program should consider an education and training component of the program. The program could facilitate additional, in-depth learning about CHP by providing reference to links where participants can find useful information. This approach:

- Avoids duplicating existing information sources.
- Provides a low-cost way to provide access to valuable, pre-screened resources on CHP selection, installation and operation.
- Complements other approaches to increasing participant awareness of optimal ways to operate and maintain systems.

Several participants gathered information about CHP online or by discussing the experience of other CHP users. The majority reported not having received information from the program on CHP systems. In addition, the majority noted that the contractors had a large influence on their model selection. Furthermore, while information sources were not discussed in depth during the surveys, the sources cited by many of the participants appear to be limited in scope in that they do not provide detailed information on system selection, installation and operation. The program could facilitate in-depth learning about CHP by providing reference to links where participants can find useful information. These links could be recommended by the program or by past participants. This approach avoids duplicating existing information sources. It also is a low-cost way to provides access to valuable, pre-screened resources on CHP selection, installation and operation. Such learning could benefit customers by serving as an independent source of information and by providing guidance on optimizing system performance.

Most of these tools are easily accessible through a number of organizations and web sites. For example, the Environmental Protection Agency's (EPA) CHP Partnership website, www.epa.gov/chp, contains a number of CHP resources including the CHP Project Development Handbook. This Handbook contains links to tools and information regarding qualification, feasibility analysis, procurement and operations and maintenance. Another useful website is the Department of Energy's (DOE) Office of Electricity Delivery and Energy Reliability website on distributed energy, which has a number of studies on CHP applications. This website can be found at www.oe.energy.gov/de.htm. A third website is the U.S. Combined Heat & Power Association's website at www.uschpa.org. Organizations in the New Jersey area that promote CHP include the Mid-Atlantic CHP Application Center and Rutgers University's Center for Advanced Energy Systems (CAES) provide valuable resources. The websites for each are www.chpcenterma.org and www.caes.rutgers.edu, respectively.

Recommendation 5: Shorter Approval Turn-Around

The program should investigate ways to minimize the wait-time for project approvals, whether by amending existing procedures or implementing a rolling admissions process, as recommended by one participant.

Minimizing the wait-time for project approvals limits perceived risks for developers and applicants in investing in CHP systems. If wait-times are perceived as too long, the associated uncertainty could inhibit CHP investments. This is especially the case where a facility seeks to incorporate a CHP installation with other building renovation plans. In response to the survey, one participant noted: “If designing a project, it is hard to design and not know where it’s going. You have to design for it, with or without it in the end.” This participant delayed installation until they were guaranteed a financial incentive.

Recommendation 6: Shorter Rebate Turn-Around

Two of the four participants indicated problems with receiving rebates in a timely manner. One participant cited a delay of over six months before receiving a response to an inquiry about a missing reimbursement. One held the program responsible, but noted that it may simply have been due to issues with management hand-over. The other cited issues with their gas company. Both issues may be due to management transitions rather than any inherent issues with the program. However, the program should be sure to monitor this process to ensure that such delays do not grow to a perceived barrier to program participants by applicants.

Appendix A: *Survey Questions for Combined Heat and Power Program Participants*

PRE-SURVEY PREP:
List the following items regarding the project and facility

Name of the Facility___________________________________
Facility Address___________________________________
Name of Contact(s): ___________________________________[Multiple contacts may be needed to complete this survey because the person familiar with the technical aspects of the CHP Project may not have been involved in the decision to install the CHP Project.]
Contact Number(s):____________________________________
CHP Generator Manufacturer:__________________________
Total Installed System Cost (all financial assistance plus the costs not covered by financial assistance):____
Financial Incentive Amount: ___________________________________

---

q1. Hello, may I please speak with [Name of Contact]?

Yes: [ ]

Not available: [ ] [Arrange call-back]

No longer with company: [ ] [Ask to speak with contact familiar with the project and/or involved in the decision to install the CHP system.]

"Hello, my name is ___________ and I'm calling from KEMA on behalf of the New Jersey Clean Energy Program's Combined Heat & Power Program. [If necessary, say "the New Jersey Clean Energy Program is a statewide program that promotes energy efficiency and supports the installation of clean and renewable sources of energy."]

I would like to ask you a few questions regarding the CHP generator your organization installed with the help of the program. This is not a sales or marketing call. This interview will be used to help the program improve the services it provides to organizations like yours. The interview should only take about 20 minutes and your responses will be kept entirely confidential."

[Arrange call back if necessary]

q2. According to program records your organization installed a [CHP Generator Manufacturer] CHP System at [Name of the Facility] located at [Facility Address]. Is this correct?

Yes: [ ]

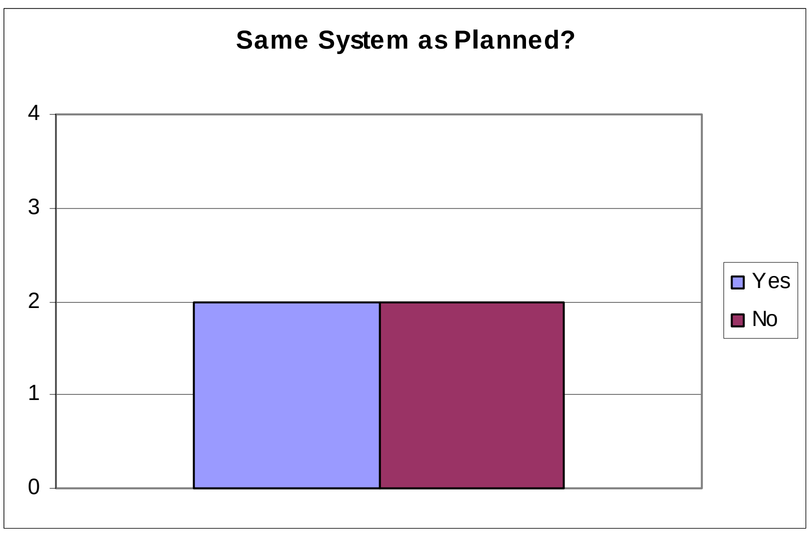
No: [ ] - [DESCRIBE WHY NOT]

____

____

Don't know: [ ] [Ask to speak with contact familiar with the project and/or involved in the decision to install the CHP system. Return to q1 with new contact.]

Refused: [ ] [Thank and terminate the call]



q3. …And the total cost of your installed system was [Total Installed System Cost]. Is this correct?

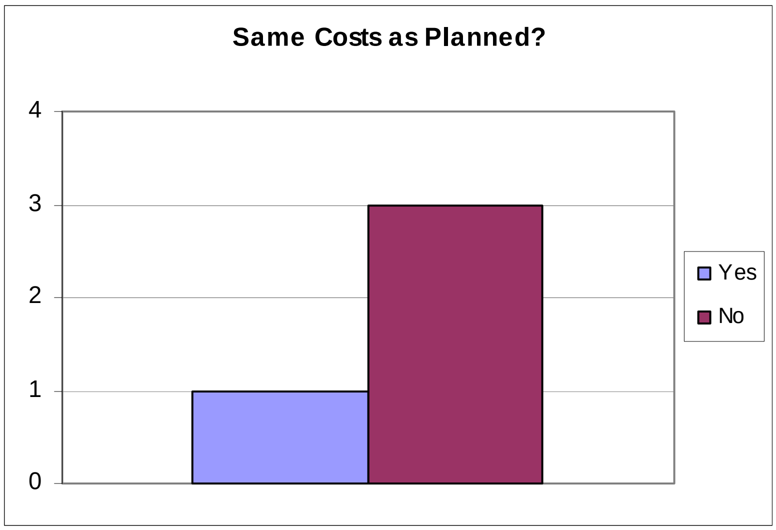
Yes: [ ]

No: [ ] - [DESCRIBE WHY NOT, WHAT WAS THE TOTAL COST?]

____

____

Don't know: [ ] [Ask to speak with contact familiar with the project and/or involved in the decision to install the CHP system. Return to q1 with new contact.]
Refused: [ ]



q4. …And the New Jersey Clean Energy Program awarded your organization a financial incentive in the amount of [Financial Incentive Amount]. Or ________ [Financial Incentive Amount /Total Installed System Cost] percent of the total cost of installing the system.

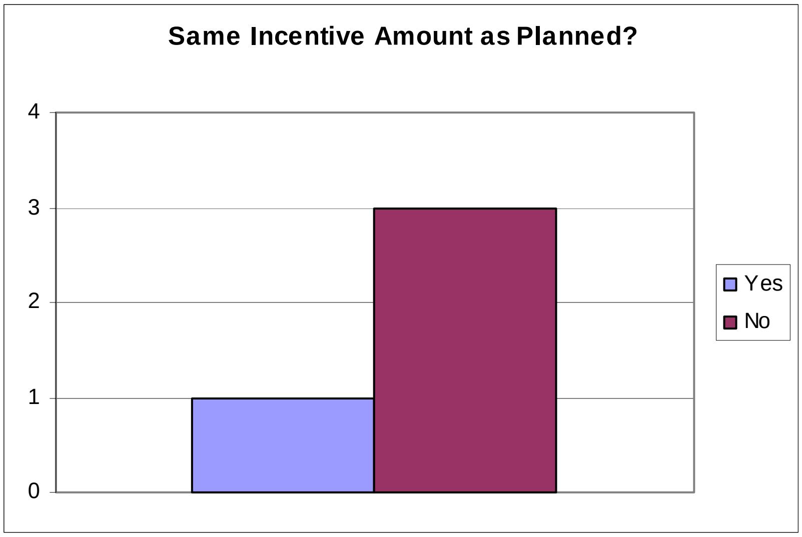
Is this correct?

Yes: [ ]
No: [ ] - [DESCRIBE WHY NOT, WHAT WAS THE INCENTIVE AMOUNT?]

____

____

Don't know: [ ] [Ask to speak with contact familiar with the project and/or involved in the decision to install the CHP system. Return to q1 with new contact.]
Refused: [ ]



"Now, I'd like to start with a few questions about your satisfaction with the CHP Project and about your decisions to go forward with it."

q5. Are you satisfied with the performance of the CHP system that you installed at your facility?

If no, why not?

Yes: [ ]

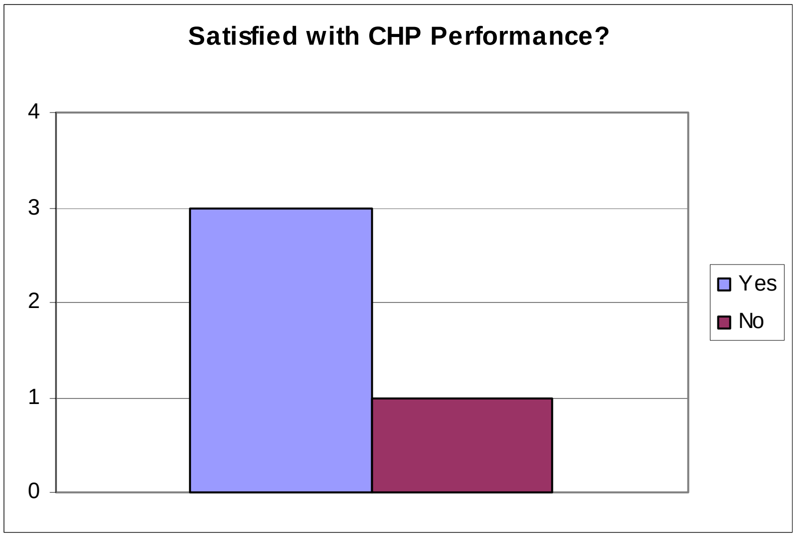
No: [ ] - [DESCRIBE WHY NOT]

____

____

Don't know: [ ]

Refused: [ ]



q6. [IF q5 = No, ELSE skip to q7]
Is there anything else you think the New Jersey Clean Energy Program might have done that would have increased your satisfaction with the performance of the CHP Project?

Yes: [ ] - [DESCRIBE]

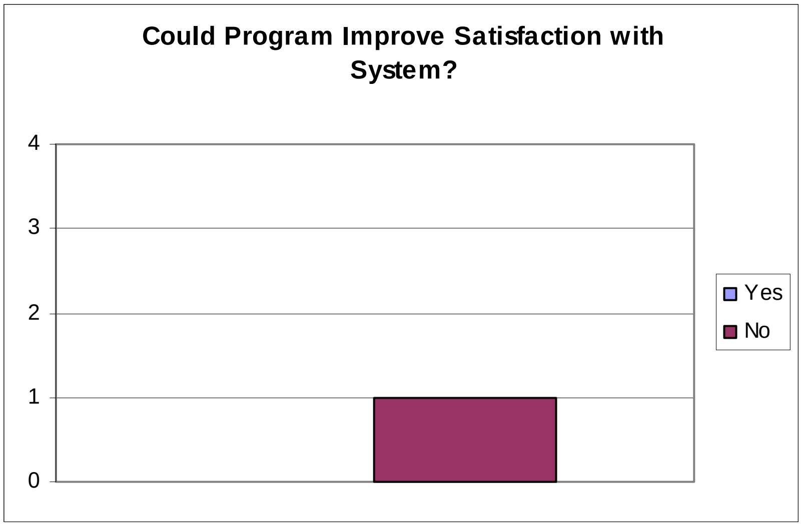
____

____

No: [ ]

Don't know: [ ]

Refused: [ ]



q7. Is the CHP system still operating at the capacity and number of hours that were originally expected?

If no, why not?

Yes: [ ]

No: [ ] - [DESCRIBE WHY NOT]

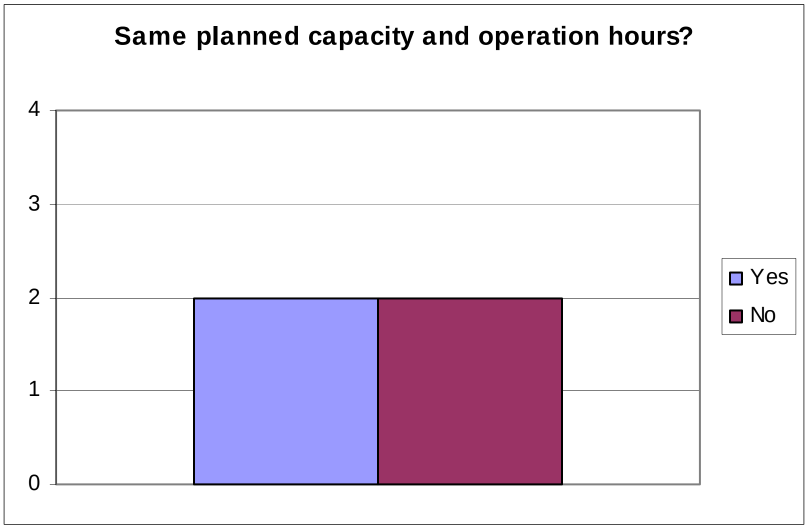
___

___

Don't know: [ ] [Ask if you can follow up with the person responsible for operating the system]

Refused: [ ]

[Note: Price of Gas often forces companies to alter operating modes (use it less), do not need to end call if it is not operating as originally planned. They may have decided to operate only when economical or may be having many mechanical problems.]



q8. What first made your organization start thinking about installing a CHP System at your facility?

[DESCRIBE ANSWER]

____

____

Don't know: [ ]
Refused: [ ]

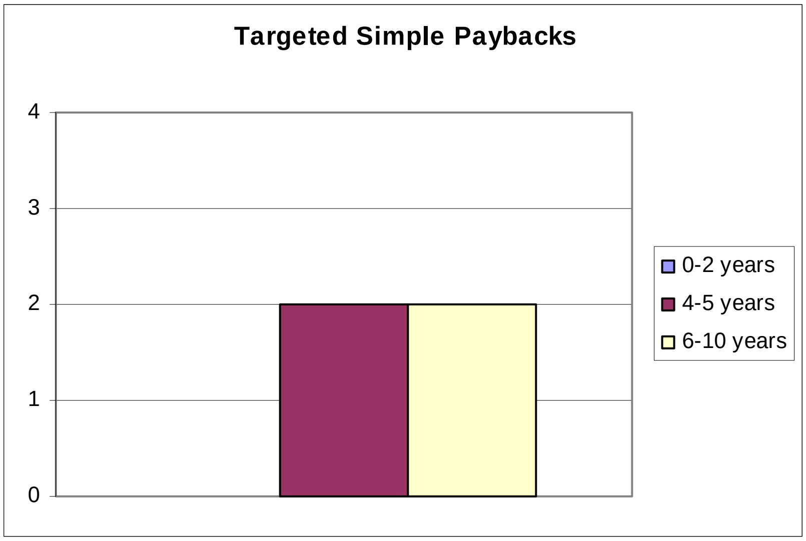
q9. In terms of numbers of years, what type of simple paybacks were you targeting before moving forward with the CHP system?

0-2 Years: [ ]
4-5 Years: [ ]
6-10 Years: [ ]
Not considered, motivated by other reasons: [ ] - [DESCRIBE]

____

____

Don't know: [ ]
Refused: [ ]



q10. What factors impacted your decision to use the type of system you chose (e.g., heat recovery, emissions, price, etc.)?

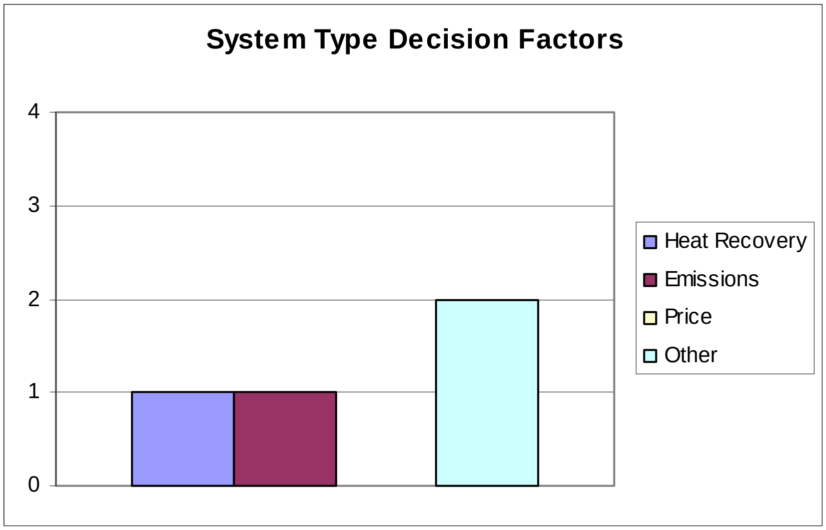
[DESCRIBE ANSWER]

____

____

Don't know: [ ]

Refused: [ ]

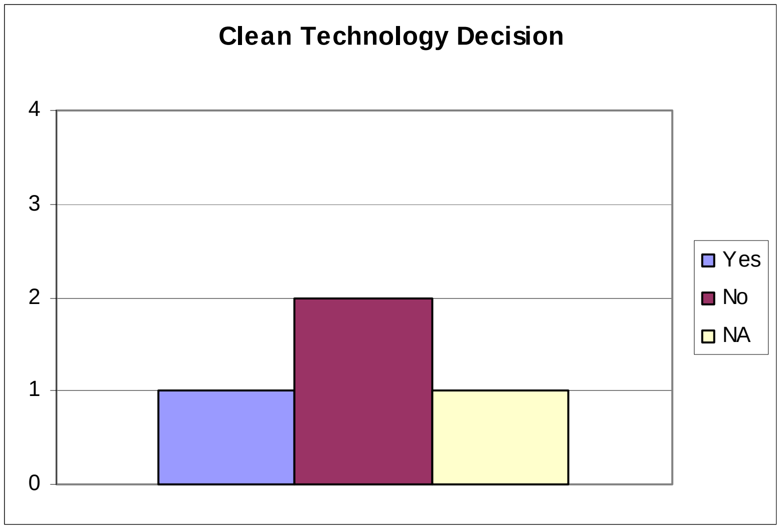


q11. [IF UTILIZED FUEL CELL OR MICROTURBINE, ELSE SKIP TO q12]
Did the incentive impact your decision on whether to utilize a clean emitting, emerging technology, such as a fuel cell or microturbine?
If yes, how?
Yes: [ ] - [DESCRIBE]

____

____

No: [ ]
Don't know: [ ]
Refused: [ ]



q12. Why did you select this particular model? [DO NOT READ RESPONSES. CHECK ALL THAT APPLY]

Price/value/on sale: [ ]

Rebate: [ ]

Costs less to operate/energy savings: [ ]

Good for the environment: [ ]

All that was available/only choice: [ ]

Contractor/retailer recommended it: [ ]

Features I wanted: [ ]

Right size: [ ]

Like the brand: [ ]

NJCEP Recommendation: [ ]

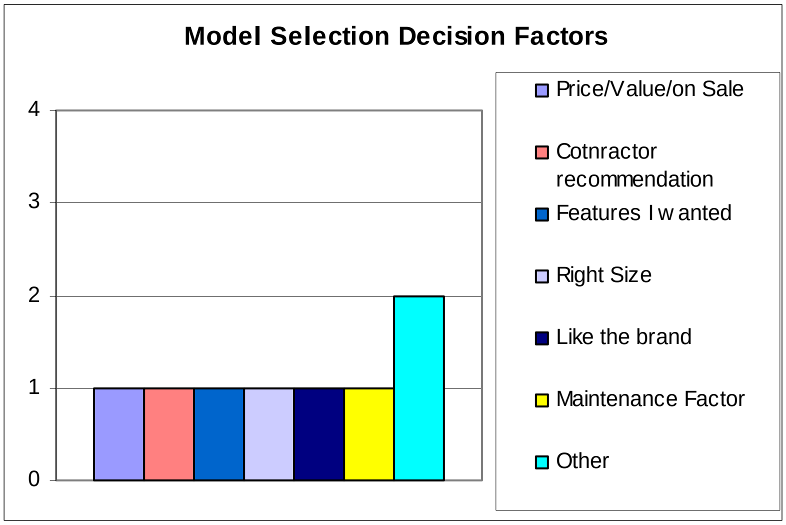
Other (RECORD): [ ]

___

___

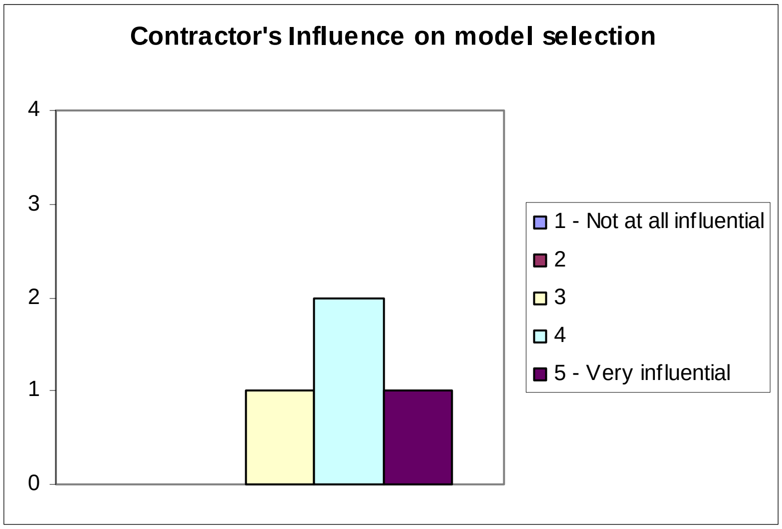
Don't know: [ ]

Refused: [ ]



q13. On a scale of 1 to 5, where 1 means “not at all influential” and 5 means “very influential”, how would you rate the influence of the contractor/retailer’s recommendation on your decision to install this model?

1 – Not at all influential: [ ]
2: [ ]
3: [ ]
4: [ ]
5 – Very influential: [ ]
Don’t know: [ ]
Refused: [ ]



q14. Will you consider installing similar CHP Projects in the future in this or other facilities? Why not?

Yes: [ ]

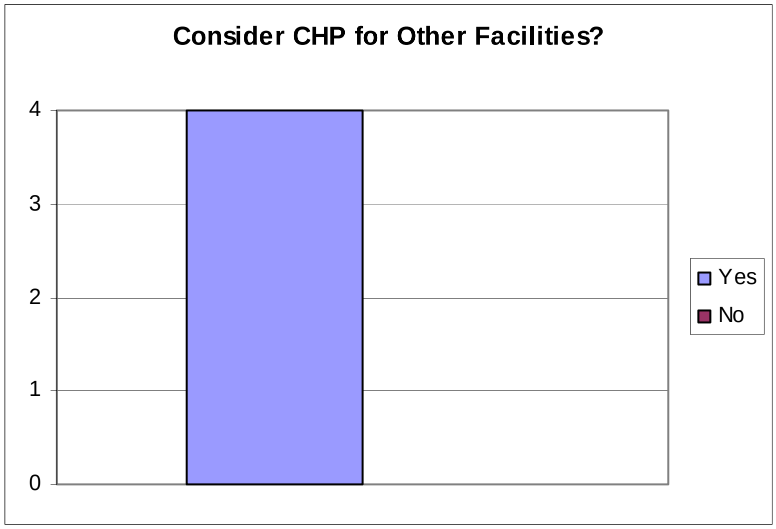
No: [ ] - [DESCRIBE WHY NOT]

____

____

Don't know: [ ]

Refused: [ ]



q15. [IF q14 = No THEN SKIP TO q16]

Will you consider installing similar CHP Projects in the future *without assistance* from the New Jersey Clean Energy Program?

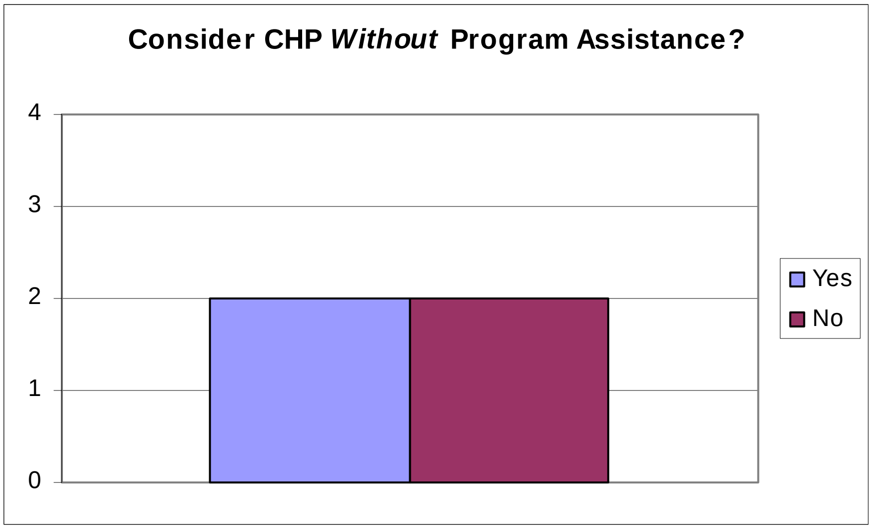
If no, can you describe why?

Yes: [ ]

No: [ ] - [DESCRIBE WHY NOT]

Don’t know: [ ]

Refused: [ ]



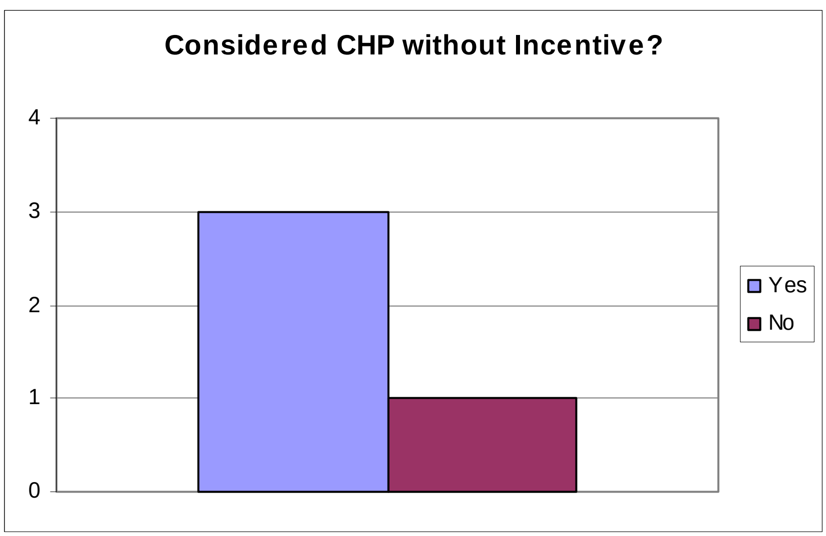
q16. Prior to the incentive program being offered, had your organization considered any CHP applications without receiving incentives?

Yes: [ ]

No: [ ]

Don't know: [ ]

Refused: [ ]



q17. Did the New Jersey Clean Energy Program provide your organization with any new information for CHP Systems?

Yes: [ ] - [DESCRIBE]

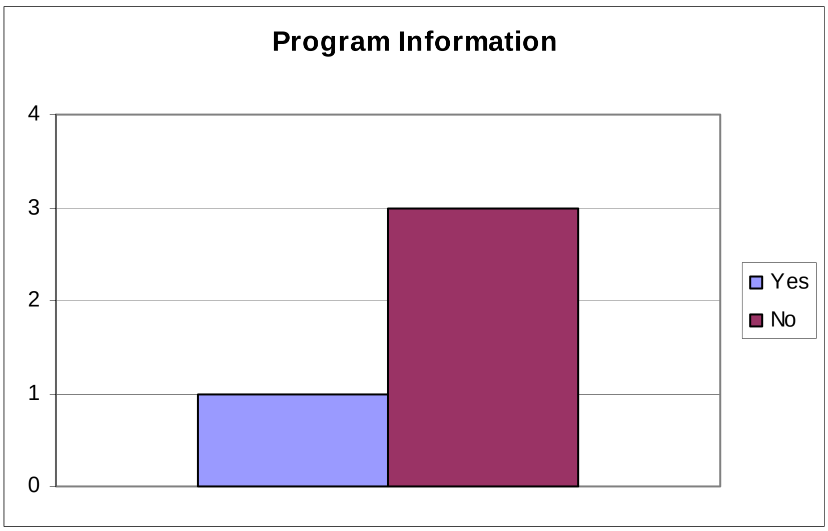
____

____

No: [ ]

Don’t know: [ ]

Refused: [ ]



q18. Do you think the New Jersey Clean Energy Program application process was easy or difficult to use?

If difficult please explain.

Easy: [ ]

Difficult: [ ] - [DESCRIBE]

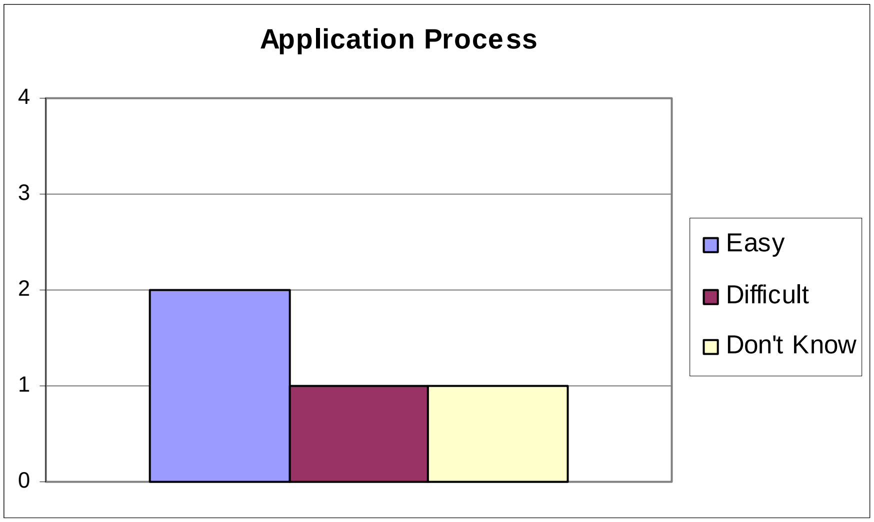
____

____

Developer filled out application: [ ]

Don’t know: [ ]

Refused: [ ]



q19. At what point in your plan to install this system did your organization begin discussing them with New Jersey Clean Energy Program representatives? Would you say it was… [READ RESPONSES]

Clearly before the start of planning: [ ]

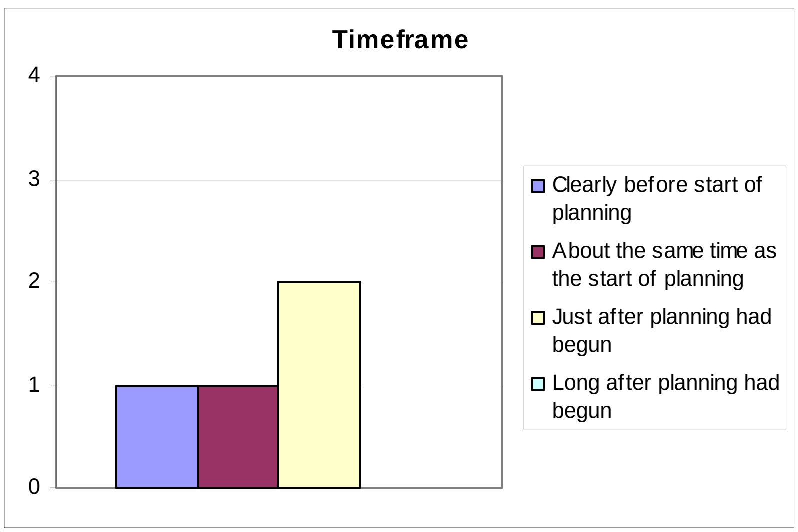
About the same time as the start of planning: [ ]

Just after planning had begun: [ ]

Long after planning had begun: [ ]

Don't know: [ ]

Refused: [ ]



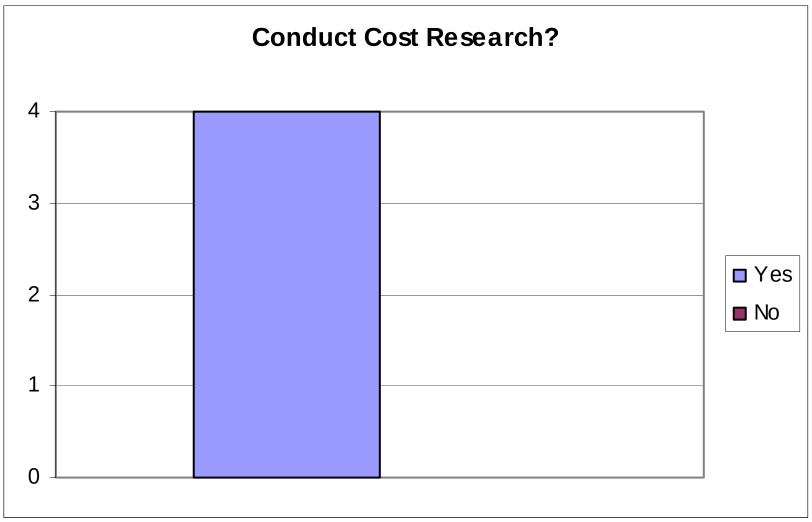
q20. Had you researched the costs of CHP systems before being contacted initially by the program or the project developer?

Yes: [ ]

No: [ ]

Don't know: [ ]

Refused: [ ]



q21. If you had not received help, including financial assistance, from the New Jersey Clean Energy Program, how likely would you have been to install the CHP System? Would you say you would have been… [READ RESPONSES]

Very likely: [ ]

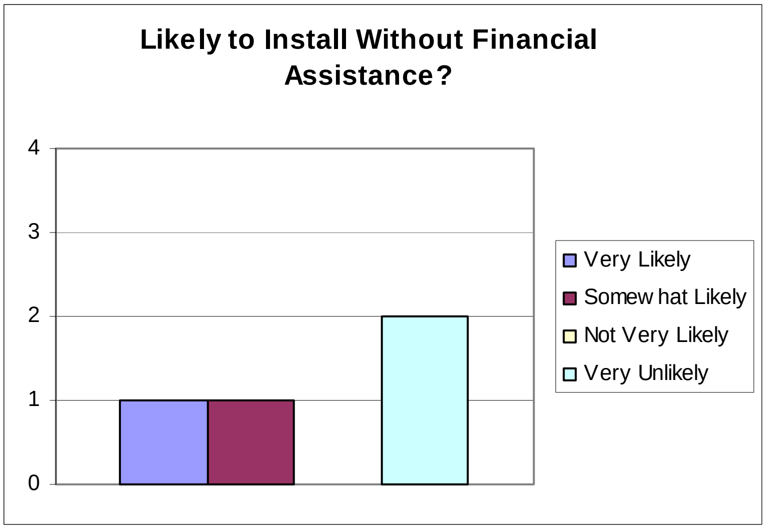
Somewhat likely: [ ]

Not very likely: [ ]

Very unlikely: [ ] - SKIP TO q23

Don't know: [ ]

Refused: [ ]



q22. [IF q21 = "Very unlikely" THEN SKIP TO q23] Without the NJCEP program's assistance, how different would the CHP system have been? Would you say you would have used the same, smaller, or larger size or number of CHP systems?

Same (size or number): [ ]

Smaller (size or number): [ ] - [DESCRIBE]

____

____

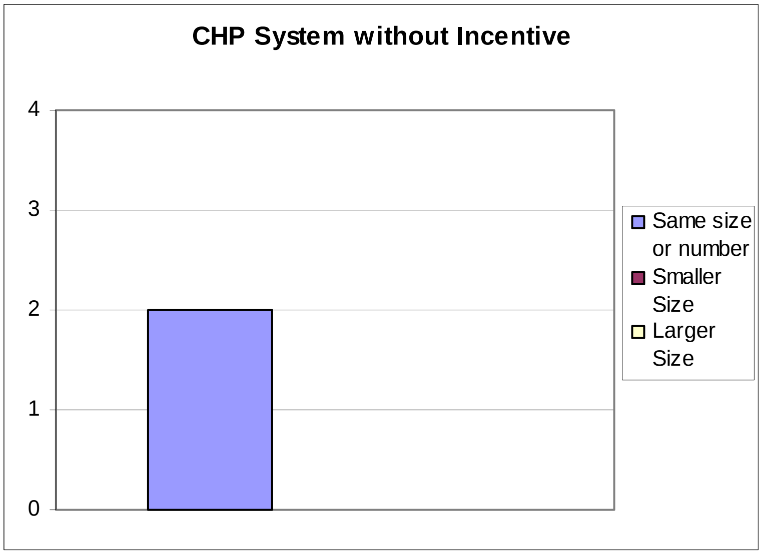
Larger (size or number): [ ] - [DESCRIBE]

____

____

Don't know: [ ]

Refused: [ ]



q23. [CONFIRMATION QUESTION] Please describe in your own words what influence the New Jersey Clean Energy Program had on your decision to install the specific CHP system you did at the time you did?
[DESCRIBE]

____

____

____

q24. [IF system is in operation (q7), ELSE END SURVEY] We would like to visit your facility to view the system in operation. Can we visit your facility for a short time to view the CHP system? Typically we would just like to view the installation, location, review operating logs, and speak to folks that work with the system on a day-to-day basis.

Yes: [ ] - [DESCRIBE]

____

No: [ ] - [DESCRIBE WHY NOT]

____

____

"Thank you very much for your time and cooperation."