Homestead Nursing Home Facility

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Field Survey of Existing Building

CEG personnel performed a field survey of the four (4) story Homestead Nursing Home Facility and interviewed the appropriate facility staff focusing on lighting, HVAC systems, and water efficiency. The Homestead was opened as a nursing home in 1955 expanding its services over the years and has transformed into a comprehensive long and short term healthcare institution with various renovations to the interior of the building based on the counties changing needs. The building is a 102 bed, 52 patient room, nursing facility with the first floor comprised of patient care facilities, rehabilitation room, office space, conference room, kitchen, staff dining, exam rooms, mechanical, electrical, etc., while the second and third floors are mostly comprised of patient rooms with restrooms, nurses station, office space, multi-purpose dining/activity areas, plus the entire fourth floor used for storage.

The building is environmentally conditioned with multiple 4-pipe fan coil units throughout the facility, providing individual space cooling and/or heating simultaneously as required. Fresh air requirements are met and introduced through the outside intake louvers connected to the fan coil units.

The central cooling and heating plants consists of a chiller and modular boilers located in separate mechanical rooms. A York Millennium centrifugal chiller with a turbo-modulator variable speed drive provides chilled water throughout the building to all the individual fan coil units. The water cooled condenser is connected to the Baltimore Air Coil cooling tower located outside at ground level, adjacent to the chiller mechanical room, and provides the heat rejection for the York chiller. The central heating plant consisting of three dedicated hot water modular boilers that circulate hot water to the individual fan coil units located throughout the facility. The temperature is controlled by a 3-way valve on each cooling and heating coil and wall mounted thermostat.

The following table provides the chiller, and boiler manufacturer information and each unit assignment.

Unit	Manufacturer	Model Number	Serial Number	Area Served
CH-1	York	YTG0A1B2-CGH	GLFM105186	All Floors
B-1	RBI	MB1500	050642464	All Floors
B-2	RBI	MB1500	050642395	All Floors
B-3	RBI	MB1500	050642507	All Floors
CT-1	BAC	VT1 N220-KMCSR	R971010	York Chiller

The domestic hot water is provided by a Bradford White hot water heater throughout the entire building and was recently installed in 2008. In addition, hot water for the kitchen is supplied by a Bock water heater.

Unit	Manufacturer	Model Number	Serial Number	Description
DWH-1	Bradford & White	CF-80-630-3A	ED10396647	630 MBH Input, 80 Gal
KWH-1	Bock Water Heaters	73E	06073003T	242 MBH Input, 67 Gal

Building exhaust for each floor and kitchen is provided by individual roof mounted Loren Cook exhaust fans.

The lighting primarily consists of two and four lamp, T-12 fluorescent fixtures. The majority of the building was illuminated by four foot 40 watt T12 magnetic ballast linear fluorescents, as well as by U-lamp 40 watt T12 magnetic ballast fluorescent fixtures. The following table provides the detailed room by room fixture count.

Location	Description	Qty of Fixtures
1st Floor		
102 Waiting	2L T12 F40 2x4	6
103 Women's Restroom	2L T12 F40 2x4	2
104 Men's Restroom	2L T12 F40 2x4	2
105 Reception	2L T12 F40 2x4	2
First Floor Corridor	2L T12 F40 2x4	24
Vestibule	100 W incandescent Cans	7
106 General office	2L T12 F40 2x4	8
	4L T12 F40 2x4	1
	2L 40W T12 U-tube	1
110 TB Exam	2L T12 F40 2x4	2
115 Waiting Room	2L T12 F40 2x4	2
112 Office	2L T12 F40 2x4	2
111 Closet	100 W incandescent Cans	1
117 Storage	2L T12 F40 2x4	2
118 Dental Operating	2L T12 F40 2x4	1
119 Dental Operating	2L T12 F40 2x4	2
122 Crippled Children Clinic	2L T12 F40 2x4	4
120 Inserving Office	2L T12 F40 2x4	4
	100 W incandescent Cans	1
124 Waiting Room	2L T12 F40 2x4	4

Location	Description	Qty of Fixtures
125 Exam Room	2L T12 F40 2x4	2
127 Exam Room	2L T12 F40 2x4	2
126 Exam Room	4L T12 F40 2x4	4
129 Break room	2L T12 F40 2x4	6
	100 W incandescent Cans	1
131 Office	2L T12 F40 2x4	2
130 Office	2L T12 F40 2x4	2
132 Nursing Office	2L T12 F40 2x4	4
133 Office	2L T12 F40 2x4	2
134 Clerical Office	2L T12 F40 2x4	6
153 Staff Dining & Recreation	2L T12 F40 2x4	4
153A Closet	2L T12 F40 2x4	1
154 Kitchen	2L T12 F40 2x4	23
163 Food Storage	2L T12 F40 2x4	1
	4L T12 F40 2x4	1
164 Boiler Room	2L T12 Industrial 8'	4
162 Mechanical room	2L T12 Industrial 8'	6
161 Men's Toilet	100 W incandescent Cans	1
160 Women's Toilet	100 W incandescent Cans	1
159 Telephone Equipment	2L T12 F40 2x4	4
Stair "B"	100 W incandescent Cans	2
156 Storage	2L T12 F40 2x4	1
	100 W incandescent Cans	2
156A Soiled Linen	2L T12 F40 2x4	1
	100 W incandescent Cans	2
152 Linen Room	2L T12 F40 2x4	3
151 Conference Room	2L T12 F40 2x4	17
148 Dietician & Social Services	2L T12 F40 2x4	4
147 Patient activities	2L T12 F40 2x4	6
144 Laboratory	2L T12 F40 2x4	6
146 Pharmacist Office	2L T12 F40 2x4	4
145 Environmental Services Office	2L T12 F40 2x4	2
	4L T12 F40 2x4	2
142 Rehab Therapy	2L T12 F40 2x4	9
141 Hair Salon	2L T12 F40 2x4	6
139 Medical Records	2L T12 F40 2x4	4
140 Office	2L T12 F40 2x4	2
137 Elevator Room	100 W Porch Socket	5
138 Copy Room	2L T12 F40 2x4	1
Stair "A"	100 W incandescent Cans	2
2nd Floor		
234B Dining Room/Activity	2L T12 F40 2x4	12
234A Safe Room	2L T12 F40 2x4	5

Location	Description	Qty of Fixtures
Stair "B"	100 W incandescent Cans	2
233 Utility Room	2L T12 F40 2x4	1
2nd Floor Patient Room (26)	2L T12 F40 2x4	26
2nd Floor Corridor	2L T12 F40 2x4	18
216 Linen Room	4L T12 F40 2x4	2
214 Nurses Station	4L T12 F40 2x4	6
205 Nurses Supervisor	2L T12 F40 2x4	2
213 Janitors Closet	2L 40W T12 U-tube	1
211 Tub room	2L 40W T12 U-tube	1
215 Tub room	2L 40W T12 U-tube	1
3rd Floor		
334 Dining Room/Activity	2L T12 F40 2x4	17
3rd Floor Patient Room (22)	2L T12 F40 2x4	22
3rd Floor Patient Room (4)	x6 150 W Incandescent Cans	24
333 Utility Room	2L T12 F40 2x4	1
3rd Floor Corridor	2L T12 F40 2x4	18
316 Linen Room	2L T12 F40 2x4	1
314 Nurses Station	2L T12 F40 2x4	3
314C Medication Room	2L T12 F40 2x4	1
305 Assistant Admin Office	2L T12 F40 2x4	2
313 Janitors Closet	2L 40W T12 U-tube	1
311 Tub room	2L 40W T12 U-tube	1
315 Tub room	2L 40W T12 U-tube	1

Energy Cost Information

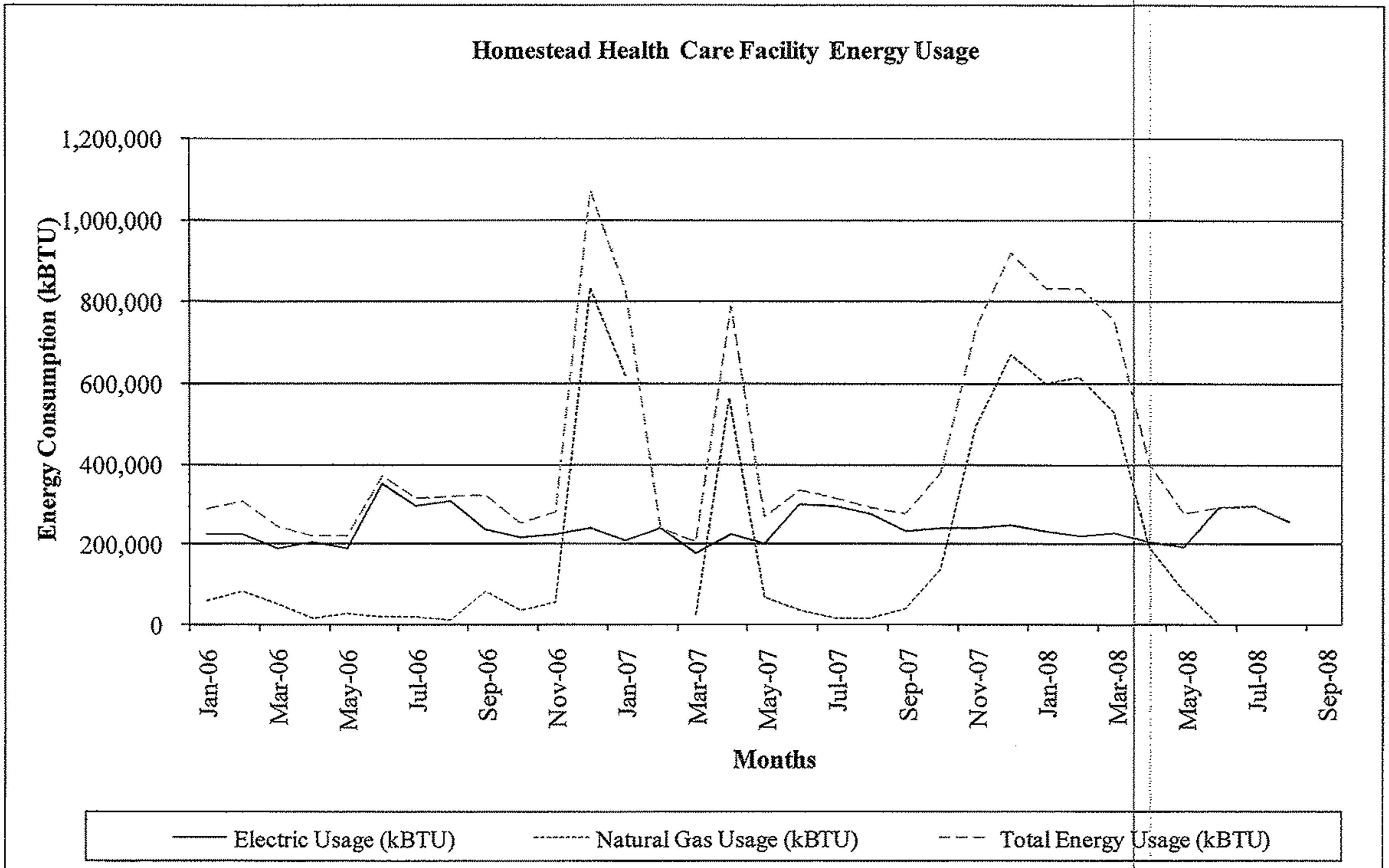
The existing facility is currently delivered electricity through Jersey Central Power and Light under the General Service Secondary (GSS) Electric Tariff. **(Refer to Appendix – JCP&L Electric Tariff).** CEG has compiled a total of thirty-three months of billing history and summarized twelve months of usage from March 2007 to February 2008. The overall electric consumption for the twelve months was 844,868 kilowatt hours with a peak demand of 229 kilowatts, resulting in a total electric cost of $130,985 or $0.1550 per kWh. **(Refer to Appendix – Electric Cost Summary).**

The facility is currently served natural gas under the Elizabethtown Gas General Delivery Service (GDS) Gas Tariff. **(Refer to the Appendix – Elizabethtown Gas Tariff).** CEG has compiled thirty-three months and summarized 12 months of natural gas billing history from January 2006 through December 2006. The overall natural gas usage for this period was 13,029 therms, resulting in a total cost of $17,912 or $1.37 per therm. **(Refer to the Appendix – Natural Gas Cost Summary).**

The billing history for water and sewerage usage was not available at this time to CEG and could not be included in this report.

The total building energy consumption and costs were compiled for twelve consecutive months with the utility bills received encompassing a 33 month period. Typically the energy consumption units for electric are measured in kilowatt hours and natural gas in therms. The energy usage was converted to a universal form of energy unit, the British Thermal Unit (BTU) in order to provide a common basis for comparison. The building energy usage and costs considered were electric usage (kBTU), electric cost, natural gas usage (kBTU), natural gas cost, total energy usage (kBTU), and total energy cost, that resulted with a total building cost in $/kBTU. A profile graph summary of utility usage was then developed for the 33 month time line dating from January 2006 to September 2008. The following table summarizes the 12 month energy consumption and costs; and the graph displayed below represents the collected thirty-three months worth of utility data summarized.

Annual Total	
Summary of Utility Usage	May-07
Month	Apr-08
Electric Usage (kBTU)	2,914,496
Electric Cost ($)	$134,369
Natural Gas Usage (kBTU)	3,976,395
Natural Gas Cost ($)	$44,543
Total Energy Usage (kBTU)	6,326,379
Total Energy Cost	$178,911
$/kBTU	$0.0283


Homestead Health Care Facility Energy Usage
Energy Consumption (kBTU)
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Months
Electric Usage (kBTU)
Natural Gas Usage (kBTU)
Total Energy Usage (kBTU)

Energy Purchasing & Procurement

Since the deregulation of utility companies in New Jersey many public, private, and government entities have turned to purchasing energy commodity through providers other then the local major utility companies. Commodity purchasing generally provides the owner with a way to receive energy commodity at a lower price than the local utility can provide. The way commodity purchasing works is you still are charged a delivery fee for electricity and natural gas from your local utility for using there transmission systems, however your commodity supply comes from another source/provider (Third Party Supplier/ TPS).

CEG has reviewed the existing facility natural gas tariff and bills for the 12 month period dated January 2008 to December 2007. During this time your natural gas commodity charges totaled $38,135, at an average cost of $11.10 per dekatherm. We have seen a very steep drop in energy commodity prices recently. Comparing Sussex County's 2008 annual costs with energy prices in today's marketplace, we calculate an average annual variance of $2.01 per dekatherm with an annual savings of $6,725 as compared with the utility bill. . **(See Appendix – Natural Gas Procurement)**

CEG has reviewed the existing facility electric tariff and bills for the 12 month period dated January 2008 to December 2007. The average annual electric supply commodity charges totaled $110,207 at an average cost of $0.131 per kilowatt-hour. The electric market is difficult to trend given the variations in on grid demand during different seasons throughout the year. In general customers who contract for Third Party purchasing and procurement of electric can receive up to a 1 cent to 2 cent reduction in cost per kilowatt hour compared to the local utility provider. Considering a 2 cent reduction from the current electric supply charge received from the local utility provider an annual savings of nearly $16,880 could be realized. **(See Appendix – Electric Supply Procurement)**

CEG recommends that the County should go out to bid for 3rd party electric and natural gas supply purchasing. The County should however aggregate into one contract bid all of there electric supply and natural gas commodity usage for all County owned buildings. This will allow the County to receive a greater reduction in supply charges over the local utility provider; given the consumption profile should be much improved thus lowering the overall cost of the energy on an annualized basis.

Energy Conservation Measure Opportunities

CEG has surveyed the existing building, interviewed the facility staffs, and considered many energy savings opportunities. The following lists of energy conservation measures represent what we believed to warrant further investigation and analyses.

- **Alternative 1:** Base Case Existing Conditions
- **Alternative 2:** Lighting Retrofit – Remove existing linear fluorescent T12 lighting and magnetic ballast and perform a one for one replacement with new T8 electronic ballast lighting. Retrofit existing incandescent lamp fixtures with compact fluorescent lamps. The following table compares the Ballast Efficacy factor (or percentage light output to wattage input) for existing T12 fluorescent fixtures to proposed T8 fluorescent fixtures. **(See Appendix – Lighting Audit).**

Existing Fixture				Proposed Fixture			
Type	No. of Lamps	Input Watts	Ballast Efficacy Factor (BEF)	Type	No. of Lamps	Input Watts	Ballast Efficacy Factor (BEF)
4' Linear T12 Magnetic Ballast	2	77	1.16	4' Linear T8 Electronic Ballast	2	48	1.63
4' Linear T12 Magnetic Ballast	4	154	0.58	4' Linear T8 Electronic Ballast	4	95	0.82
2' U Tube T12 Magnetic Ballast	2	77	1.16	2' U Tube T8 Electronic Ballast	2	55	1.60

- **Alternative 3:** Variable Primary Pumping – Install variable speed drive controls on existing two (2) chilled water pumps. Replace existing 3-way valves with 2-way valves. Install differential pressure sensor at furthest point on chilled water loop to regulate pump flow.
- **Alternate 4:** Variable Speed Drives – Install Variable Speed Drive Controls on existing BAC Cooling Tower. Replace existing fan motors with new premium efficient motors.
- **Alternative 5:** Kitchen Hood Controls – Install Melink Intelli-Hood Kitchen Ventilation Controls. This variable air volume control system will automatically adjust the exhaust and supply air volume based on sensing the temperature and effluent output from the cooking appliances. This system includes the master controller, temperature sensor, optic sensor, and variable speed drives, see appendix **(Appendix – Melink Intelli-Hood Controls)**

The following is the energy savings summary:

Alt	Description	Electric, KW	KW Savings	Electric, KWH	KWH Savings	Electric Cost	Electric Cost Savings, $	Natural Gas, therms	Natural Gas Savings, therms	Natural Gas Cost	Natural Gas Cost Savings, $	Total Utility Cost	Utility Cost Savings *
Utility conservation upgrades													
1	BASE CASE - EXISTING EQUIPMENT	183		845,793		$141,406		16,123		$20,315		$161,721	$0
2	LIGHTING RETROFIT	163	20	748,688	97,105	$125,265	$16,141	17,069	(946)	$21,506	($1,191)	$146,771	$14,950
3	VARIABLE PRIMARY PUMPING ON CHILLED WATER PUMPS	182	1	827,515	18,278	$138,393	$3,013	16,123	0	$20,315	$0	$158,708	$3,013
4	VARIABLE SPEED DRIVE CONTROLS ON COOLING TOWER FAN	184	(1)	831,226	14,567	$139,027	$2,379	16,123	0	$20,315	$0	$159,342	$2,379
5	VARIABLE AIR VOLUME KITCHEN HOOD CONTROLS	183	0	843,482	2,311	$141,020	$386	14,967	1,702	$18,170	$2,145	$159,190	$2,531

Construction Cost Estimates

CEG obtained pricing from various equipment vendors and contractors on each of the alternatives. Pricing depicted below also includes the utility incentive rebates available through the NJ Smartstart$_{tm}$ buildings and NJ Clean Energy programs. The following describes each alternative scope of work and budgetary cost:

CONSTRUCTION COST AND REBATES

HOMESTEAD BUILDING

ALT 1 BASE CASE - EXISTING EQUIPMENT

	Qty	Unit Cost $	Material $	Labor $	Total $
Total Cost			$0	$0	$0
Annual Energy Cost					$161,721

ALT 2 LIGHTING RETROFIT

	Qty	Unit Cost $	Material $	Labor $	Total $
Lighting Retrofit	1	$12,432	$12,432	$20,960	$33,392
Total Cost			$12,432	$20,960	$33,392
Utility Incentive					$5,550
Total Cost Less Rebate					$27,842

ALT 3 VARIABLE PRIMARY PUMPING ON CHILLED WATER PUMPS

	Qty	Unit Cost $	Material $	Labor $	Total $
Variable Speed Drive Controls	2	$3,500	$7,000	$28,500	$35,500
2-Way Valves	100	$125	$12,500	$37,500	$50,000
CHW Premium Efficiency Motors	2	$1,700	$3,400	$6,800	$10,200
Total Cost			$22,900	$72,800	$95,700
Utility Incentive					$0
Total Cost Less Rebate					$95,700

ALT 4 VARIABLE SPEED DRIVE CONTROLS ON COOLING TOWER FAN

	Qty	Unit Cost $	Material $	Labor $	Total $
Cooling Tower Variable Speed Drive Controls	1	$3,395	$3,395	$5,941	$9,336
Total Cost			$3,395	$5,941	$9,336
Utility Incentive					$0
Total Cost Less Rebate					$9,336

ALT 5 VARIABLE AIR VOLUME
KITCHEN HOOD CONTROLS

	Qty	Unit Cost $	Material $	Labor $	Total $
MELINK Kitchen Hood Controls	1	$6,020	$6,020	$9,030	$15,050
Total Cost			$6,020	$9,030	$15,050

Equipment Replacement Cost

CEG developed equipment replacement cost for the study, which was used in the life cycle analysis. Replacement cost was based on vendor estimates and experience. Life expectancy of equipment was based upon Table 3 in the 1999 ASRAE Applications Handbook ASHRAE titled Estimates of Service Lives of Various System Components. The below table displays a description of equipment existing and new, present value cost to replace, equipment life in years, and remaining equipment life in years. Equipment associated with a zero dollar cost for replacement was not considered for that alternative when compared to the Base Case equipment replacement costs in the life cycle analysis.

EQUIPMENT REPLACEMENT COST FOR EACH ALTERNATE

HOMESTEAD BUILDING

ALT 1 BASE CASE - EXISTING EQUIPMENT

	$	Life	Yr Remaining
Existing Chilled Water Pumps & Motors	$18,000	18	10
Existing Bock Hot Water Boiler	$5,000	15	12
Existing BAC Cooling Tower	$70,000	20	8
Variable Speed Drive CHW Pump Controls	$0	17	17
New Premium Efficiency Pump Motors	$0	18	18
New Kitchen DHW Boiler	$0	15	15

ALT 2 LIGHTING RETROFIT

	$	Life	Yr Remaining
Existing Chilled Water Pumps & Motors	$18,000	18	10
Existing Bock Hot Water Boiler	$5,000	15	12
Existing BAC Cooling Tower	$70,000	20	8
Variable Speed Drive CHW Pump Controls	$0	17	17
New Premium Efficiency Pump Motors	$0	18	18
New Kitchen DHW Boiler	$0	15	15

ALT 3 VARIABLE PRIMARY PUMPING ON CHILLED WATER PUMPS

	$	Life	Yr Remaining
Existing Chilled Water Pumps & Motors	$0	18	10
Existing Bock Hot Water Boiler	$5,000	15	12
Existing BAC Cooling Tower	$70,000	20	8
Variable Speed Drive CHW Pump Controls	$8,000	17	17
New Premium Efficiency Pump Motors	$8,000	18	18
New Kitchen DHW Boiler	$0	15	15

ALT 4 VARIABLE SPEED DRIVE CONTROLS ON COOLING TOWER FAN

	$	Life	Yr Remaining
Existing Chilled Water Pumps & Motors	$18,000	18	10
Existing Bock Hot Water Boiler	$5,000	15	12
~~Existing BAC Cooling Tower~~	~~$70,000~~	~~20~~	~~10~~
Variable Speed Drive CHW Pump Controls	$0	17	17
New Premium Efficiency Pump Motors	$0	18	18
New Kitchen DHW Boiler	$0	15	15

ALT 5 VARIABLE AIR VOLUME KITCHEN HOOD CONTROLS

	$	Life	Yr Remaining
Existing Chilled Water Pumps & Motors	$18,000	18	10
Existing Bock Hot Water Boiler	$5,000	15	12
Existing BAC Cooling Tower	$70,000	20	8
Variable Speed Drive CHW Pump Controls	$0	17	17
New Premium Efficiency Pump Motors	$0	18	18
New Kitchen DHW Boiler	$0	15	15

Annual Maintenance Cost

CEG developed maintenance cost estimates for the study, which were used in the life cycle analysis. Maintenance cost was based on the 1999 ASHRAE Applications Handbook - Owning and Operating Costs and experience.

Annual Maintenance Cost (Homestead Building)				
Alt.	Description	Base	Additional	Total
1	BASE CASE EXISTING CONDITIONS	$12,705	$0	$12,705
2	LIGHTING RETROFIT	$12,705	$0	$12,705
3	VARIABLE PRIMARY PUMPING ON CHILLED WATER PUMPS	$12,705	$250	$12,955
4	VARIABLE SPEED DRIVE CONTROLS ON COOLING TOWER FAN	$12,705	($150)	$12,555
5	VARIABLE AIR VOLUME KITCHEN HOOD CONTROLS	$12,705	$75	$12,780

Financial Summary

Financial analysis was based on the energy usage and cost comparing alternative one ("base case") to other alternatives using the Trane Trace 700 Version 6.2 Software. Note Lighting Alternatives were evaluated using spreadsheet analysis. CEG developed budget construction pricing on each of the alternatives. Budgetary pricing was obtained from various equipment supply vendors. Net project cost depicted below in the Financial Analysis includes the utility incentive rebates available through the NJ Smartstart$_{tm}$ Buildings and NJ Clean Energy programs.

Financial assumptions were as follows:

- JCP&L General Service Secondary (GSS) Electric Tariff with a blended average electric rate of $0.1550 per kilowatt-hour.
- Elizabethtown Gas General Delivery Service (GDS) Tariff with an average rate of $1.37 per therm.
- Newark, NJ Weather.
- Construction estimates include engineering, equipment cost and installation.
- Weighted Average Cost of Capital of 7.0%.
- Energy Cost escalates at 3% per annum.
- Maintenance Cost escalates at 3% per annum.
- 20-Year Life Cycle Analysis.

The following table is a summary of our financial analysis:

Alt	Description	Total Utility Cost	Utility Cost Savings	Annual Maintenance Savings	Total Annual Savings	Total Project Cost, $	Utility Rebate, $	Net Project Cost, $	Simple Payback, Years	NPV 20 Year, $	Lifecycle Payback	Internal Rate of Return
Utility conservation upgrades												
1	BASE CASE - EXISTING EQUIPMENT	$161,721										
2	LIGHTING RETROFIT		$14,950	$0	$14,950	$33,392	$5,550	$27,842	1.86	$171,471	2.00	56.7%
3	VARIABLE PRIMARY PUMPING ON CHILLED WATER PUMPS		$3,013	($250)	$2,763	$95,700	$0	$95,700	34.64	($54,898)	N/A	N/A
4	VARIABLE SPEED DRIVE CONTROLS ON COOLING TOWER FAN		$2,379	$150	$2,529	$9,336	$0	$9,336	3.69	$28,052	4.20	40.60%
5	VARIABLE AIR VOLUME KITCHEN HOOD CONTROLS		$2,531	($75)	$2,456	$15,050	$0	$15,050	6.13	$16,537	N/A	18.3%

. Measurement and Verification Protocol

The primary purpose of Measurement and Verification (M&V) is to validate performance of energy efficiency upgrades and payments made towards these upgrades. M&V should not be used to derive a precise energy savings for every project, but to assess whether or not the properly installed projects are reasonable close to the projected savings. Careful consideration should be taken in selecting an M&V plan based on risk and cost benefit to the County for the proposed projects.

The U.S. Department of Energy has produced and published Measurement and Verification Guidelines for Federal Energy Projects. These guidelines have been used as a base reference for this report and a full copy of the U.S. DOE guidelines are available at www.eere.energy.gov/femp.

The following table outlines the four most common approaches for M&V.

M&V Option	Performance[1] and Usage[2] Factors	Savings Calculation
Option A—Retrofit Isolation with Key Parameter Measurement	This option is based on a combination of measured and estimated factors when variations in factors are not expected. Measurements are spot or short-term and are taken at the component or system level, both in the baseline and post-installation cases. Measurements should include the key performance parameter(s) which define the energy use of the ECM. Estimated factors are supported by historical or manufacturer's data. Savings are determined by means of engineering calculations of baseline and post-installation energy use based on measured and estimated values.	Direct measurements and estimated values, engineering calculations and/or component or system models often developed through regression analysis Adjustments to models are not typically required.
Option B—Retrofit Isolation with All Parameter Measurement	This option is based on periodic or continuous measurements of energy use taken at the component or system level when variations in factors are expected. Energy or proxies of energy use are measured continuously. Periodic spot or short-term measurements may suffice when variations in factors are not expected. Savings are determined from analysis of baseline and reporting period energy use or proxies of energy use.	Direct measurements, engineering calculations, and/or component or system models often developed through regression analysis Adjustments to models may be required.

Option C – Utility Data Analysis	This option is based on long-term, continuous, whole-building utility meter, facility level, or sub-meter energy (or water) data. Savings are determined from analysis of baseline and reporting period energy data. Typically, regression analysis is conducted to correlate with and adjust energy use to independent variables such as weather, but simple comparisons may also be used.	Based on regression analysis of utility meter data to account for factors that drive energy use Adjustments to models are typically required.
Option D— Calibrated Computer Simulation	Computer simulation software is used to model energy performance of a whole-facility (or sub-facility). Models must be calibrated with actual hourly or monthly billing data from the facility. Implementation of simulation modeling requires engineering expertise. Inputs to the model include facility characteristics; performance specifications of new and existing equipment or systems; engineering estimates, spot-, short-term, or long-term measurements of system components; and long-term whole-building utility meter data. After the model has been calibrated, savings are determined by comparing a simulation of the baseline with either a simulation of the performance period or actual utility data.	Based on computer simulation model (such as eQUEST) calibrated with whole-building or end-use metered data or both. Adjustments to models are required.

Each of the above approaches can be used for a wide array of energy efficiency upgrades, and each has different costs and complexities associated with it. When selecting an M&V approach the following general rules of thumb can be applied.

- Option A
  - When magnitude of savings is low for the entire project or a portion of the project.
  - The risk for not achieving savings is low.

- Option B
  - For simple equipment replacement projects.
  - When energy savings values per individual measure are desired.
  - When interactive effects are to be ignored or are estimated using estimating methods that do not involve long term measurements.
  - When independent variables that affect energy use are not complex and excessively difficult or expensive to monitor.
  - When sub meters already existing that record the energy use of subsystems under consideration.

- Option C
  - For complex equipment replacement and controls projects.
  - When predicted energy savings are in excess of 10 to 20 percent as compared with the record energy use.
  - When energy savings per individual measure are not desired.
  - When interactive effects are to be included.
  - When the independent variables that affect energy use are complex and excessively difficult or expensive to monitor.

- Option D
  - When new construction projects are involved.
  - When energy savings values per measure are desired.
  - When Option C tools cannot cost effectively evaluate particular measures or their interactions with the building when complex baseline adjustments are anticipated.

Recommended Measurement & Verification Options

Homestead Nursing Home		Measurement & Verification Protocol			
Alt	Description	Option A	Option B	Option C	Option D
Utility conservation upgrades					
1	BASE CASE - EXISTING EQUIPMENT				
2	LIGHTING RETROFIT	X			
3	VARIABLE PRIMARY PUMPING ON CHILLED WATER PUMPS			X	
4	VARIABLE SPEED DRIVE CONTROLS ON COOLING TOWER FAN			X	
5	VARIABLE AIR VOLUME KITCHEN HOOD CONTROLS	X			

Conclusions and Recommendations

Based on our analysis, CEG recommends that the Owner proceed with the following alternatives:

- Alternative 2: Lighting Retrofit
- Alternative 4: Cooling Tower Variable Speed Drive Controls
- Alternative 5: Variable Air Volume Kitchen Hood Controls

Each of the above recommended alternatives yields a positive Net Present Value. CEG also recommends the replacement of the hot water and chilled water pump motors to newer premium efficiency motors at the time of their replacement.

Appendix

- JCP&L Electric Tariff
- Electric Cost Summary
- Elizabethtown Gas Tariff
- Natural Gas Cost Summary
- Natural Gas Procurement
- Electric Supply Procurement
- Lighting Audit
- Melink Intelli-Hood Controls