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June 28, 2010

**Local Government Energy Program
Energy Audit Report**

***Township of Livingston
Main Fire Department
62 South Livingston Avenue
Livingston, NJ 07039***

Project Number: LGEA50



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INTRODUCTION

As an approved energy consulting firm under the Local Government Energy Audit Program (LGEA), Steven Winter Associates, Inc. (SWA) was selected to perform an energy audit and assessment for the Township of Livingston. The audit included a review of the following buildings located in the Township of Livingston for which separate energy audit reports are issued for each of the following referenced buildings:

- Municipal Court
- Main Fire Department
- Northfield Fire Department
- Circle Fire Station
- Township Garage
- Livingston Free Public Library
- Senior & Community Center
- Water Department
- Monmouth Court Community Center
- Well House No. 3, Building 1
- Well House No. 3, Building 2
- Well House No. 4
- Well House No. 9
- Well House No. 11
- Okner Field Concession Building
- Storage Shed
- Northland Pool and Recreation Center
- Sewage Treatment Plant
- Animal Shelter
- Pump House
- Booster Station
- Sewer Station

This report addresses the Main Fire Department located at 62 South Livingston Avenue, Livingston NJ. The current conditions and energy-related information were collected in order to analyze and suggest the implementation of building improvements and energy conservation measures.

The Main Fire Department located at 62 South Livingston Avenue was opened in 1929. It is a three story free standing building with approximately 7,560 square feet of conditioned space. The building includes fire station bays, a bay used as a vehicle repair shop as well as offices, a conference room and storage. There are approximately 5 full time firefighters and administrative employees working at the station daily on weekdays from 8:30 AM to 4:30 PM. The remaining staff is composed of volunteers however there is always a dispatcher on duty at all times

The goal of this Local Government Energy Audit (LGEA) is to provide sufficient information to the Township of Livingston to make decisions regarding the implementation of the most appropriate and most cost effective energy conservation measures for the building.

Launched in 2008, the LGEA Program provides subsidized energy audits for municipal and local government-owned facilities, including offices, courtrooms, town halls, police and fire stations, sanitation buildings, transportation structures, schools and community centers. The Program will subsidize 75% of the cost of the audit. If the net cost of the installed measures recommended by the audit, after applying eligible NJ SmartStart Buildings incentives, exceeds the remaining cost of the audit, then that additional 25% will also be paid by the program. The Board of Public Utilities (BPU's) Office of Clean Energy has assigned TRC Energy Services to administer the Program.

- Section 1 and section 2 of the report cover a description and analysis of the building existing conditions.
- Section 3 provides a detail inventory of major electrical and mechanical systems in the building.
- Sections 4 through 5 provide a description of our recommendations.
- Appendices include further details and information supporting our recommendations.

EXECUTIVE SUMMARY

The Main Fire Department located at 62 South Livingston Avenue was opened in 1929. It is a three story free standing building with approximately 7,560 square feet of conditioned space. The building includes fire station bays, a bay used as a vehicle repair shop as well as offices, a conference room and storage. There are approximately 5 full time firefighters and administrative employees working at the station daily on weekdays from 8:30 AM to 4:30 PM the remaining staff is composed of volunteers however there is always a dispatcher on duty at all times.

Based on the field visit performed by the SWA staff on January 26, 2010 and the results of a comprehensive energy analysis, this report describes the site's current conditions and recommendations for improvements. Suggestions for measures related to energy conservation and improved comfort are provided in the scope of work. Energy and resource savings are estimated for each measure that results in a reduction of heating, cooling, and electric usage.

Existing conditions

From March 2008 through February 2009, the period of analysis for this audit, the building consumed 53,235 kWh or \$8,801 worth of electricity at an approximate rate of \$0.165/kWh and 5,458 therms or \$7,406 worth of natural gas at an approximate rate of \$1.357/ therm. The joint energy consumption for the building, including both electricity and fossil fuel was 727 MMBTUs of energy that cost a total of \$16,207.

SWA has entered energy information about the fire station in the U.S. Environmental Protection Agency's (EPA) *Energy Star Portfolio Manager* Energy benchmarking system. Currently, the building is not eligible to receive a performance rating because it is classified as a fire station which means that it is still ineligible for Energy Star. SWA encourages the Township of Livingston to continue entering utility data in *Energy Star Portfolio Manager* in order to track weather normalized source energy use over time.

The Site Energy Use Intensity is 103.0 kBtu/sq ft yr compared to the national average of a Fire Station consuming 78.0 kBtu/sq ft yr. Implementing this report's recommended Energy Conservations Measures (ECMs) will reduce use by approximately 8.3 kBtu/ sq ft yr, which would decrease the building's energy use intensity to 94.7 kBtu/sq ft yr.

Recommendations

The Main Fire Department is eighty-one years old and most HVAC equipment has exceeded their recommended useful life cycle and additionally much of the lighting is inefficient. In Appendix C, SWA has included a mechanical inventory list of equipment for the Main Fire Department. Based on the assessment of the building, SWA has separated the recommendations into three categories (See Section 4 for more details). These are summarized as follows:

Category I Recommendations: - Capital Improvements

- Replace heating terminal units
- Replace two (2) hot water circulating pumps
- Replace toilet exhaust fan and sidewall attic fans

Category II Recommendations: - Operations and Maintenance

- Boiler room and building piping insulation
- Water levels in the expansion tank and the integrity of the tank bladder should be checked to confirm proper operation.
- Tighten belts on exhaust fans
- Bi-annual maintenance inspections of exterior walls
- Bi-annual maintenance inspections of roof surfaces
- Bi-annual maintenance inspections of windows and exterior doors
- Provide water efficient fixtures and controls
- Use Energy Star labeled appliances - such as Energy Star refrigerators that should replace older energy inefficient equipment.

Category III Recommendations: Energy Conservation Measures

At this time, SWA highly recommends a total of **5** Energy Conservation Measures (ECMs) for The Main Fire Department as summarized in the following Table 1. The total investment cost for these ECMs with incentives is **\$3,250**. SWA estimates a first year savings of **\$1,113** with a simple payback of **2.9 years**. SWA also recommends **4** ECMs with a 5-10 year payback that have a total first year savings of **\$3,023** as summarized in Table 2 and **2** End of Life Cycle ECMs that have a total first year savings of **\$289** as summarized in Table 3.

The implementation of all the recommended ECMs would reduce the building electric usage by 17,423 kWh annually, or 33% of the building's current electric consumption and 72 therms or 1% of the buildings current gas consumption. SWA estimates that implementing these ECMs will reduce the carbon footprint of The Main Fire Department by **24,712 lbs of CO₂**, which is equivalent to removing approximately 2 cars from the roads each year or avoiding the need of 77 trees to absorb the annual CO₂ produced. SWA also recommends that Township of Livingston contacts third party energy suppliers in order to negotiate a lower electricity rate. Comparing the current electric rate to average utility rates of similar type buildings in New Jersey, it may be possible to save up to \$0.015/kWh, which would have equated to \$799 for the past 12 months.

There are various incentives that Township of Livingston could apply for that could also help lower the cost of installing the ECMs. SWA recommends that the Township of Livingston apply for the NJ SmartStart program through the New Jersey Office of Clean Energy. This incentive can help provide technical assistance for the building in the implementation phase of any energy conservation project. A new NJ Clean Power program, Direct Install could also assist to cover up to 80% of the capital investment.

Renewable ECMs require application approval and negotiations with the utility and proof of performance. There is also a utility-sponsored loan program through PSE&G that would allow the building to pay for the installation of the PV system through a loan issued by PSE&G

The following three tables summarize the proposed Energy Conservation Measures (ECM) and their economic relevance.

Table 1 - Highly Recommended 0-5 Year Payback ECMs

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr	
1.1	Install (3) occupancy sensors in offices	RS Means, Lit Search	660	60	600	699	0.1	0	0.2	0	119	15	1,783	5.0	197	13	18	799	958	
1.2	Install (15) CFLs	RS Means, Lit Search	953	0	953	3,011	0.6	0	1.0	-50	462	5	2,310	2.1	142	28	39	1,151	4,125	
1.3	Install (2) LED Exit Signs	RS Means, Lit Search	407	40	367	788	0.2	0	0.3	109	243	15	3,640	1.5	893	60	66	2,489	1,080	
3.2	Incremental cost to replace domestic water heater with 95% efficient unit	similar projects	500	50	450	0	0.0	72	1.0	0	98	15	1,466	4.6	226	15	20	716	842	
4.2	incremental cost to replace 2 vehicle exhaust fans with premium efficiency units	similar projects, DOE Motor International	1,000	120	880	250	0.5	0	0.0	150	191	10	413	4.6	117	12	14	631	343	
TOTALS			-	3,520	270	3,250	4,748	1.4	72	2.5	209	1,113	-	9,612	2.9	-	-	-	5,786	7,348

Assumptions: Discount Rate: 3.2% per DOE FEMP; Energy Price Escalation Rate: 0% per DOE FEMP Guidelines

Note: A 0.0 electrical demand reduction / month indicates that it is very low / negligible

Table 2 - Recommended 5-10 Year Payback ECMs

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
1.4	Replace (47) T12 fixtures with T8 fixtures	RS Means, Lit Search	10,880	705	10,175	6,934	1.4	0	2.3	178	1,356	15	20,344	7.5	100	7	10	5,784	9,499
1.5	Install (1) PSMH	RS Means, Lit Search	709	25	684	346	0.1	0	0.1	18	77	15	1,152	8.9	68	5	7	220	474
2.1	replace 3-ton HW heating / DX cooling split system with high efficiency system	similar projects	7,500	276	7,224	2,310	0.5	0	1.0	350	731	15	5,717	9.9	52	3	6	1,504	3,165
2.2	replace 4-ton HW heating / DX cooling split system with high efficiency system	similar projects	9,000	368	8,632	3,085	0.6	0	1.4	350	859	15	7,635	10.0	49	3	5	1,623	4,226
	TOTALS	-	28,089	1,374	26,715	12,675	2.6	0	4.8	896	3,023	-	34,848	8.8	-	-	-	9,131	17,364

Table 3 - Recommended End of Life Cycle ECMs																			
ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
3.1	Replace domestic water heater with 95% efficient unit	similar projects	2,000	50	1,950	0	0.0	72	1.0	0	98	15	1,466	20.0	-25	-2	-3	-784	842
4.1	replace 2 Vehicle exhaust fans with premium efficiency units	similar projects, DOE Motor Master International	7,000	120	6,880	250	0.1	0	0.0	150	191	10	413	36.0	-72	-7	-9	-5,369	343
TOTALS			9,000	170	8,830	250	0.1	72	1.0	150	289	-	1,879	30.6	-	-	-	-6,153	1,185

Note: For more details on End of Life Cycle ECMs and associated incremental cost for high efficiency equipment and performance see Section 4.

Table 4 - Description of Renewable ECMs																			
ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
5	Install 16.0 kW PV rooftop system with incentives	similar projects	124,000	16,000	108,000	16,179	16	0	7.3	0	12,270	25	66,738	8.8	1,989	80	122	72,698	22,165

1. HISTORIC ENERGY CONSUMPTION

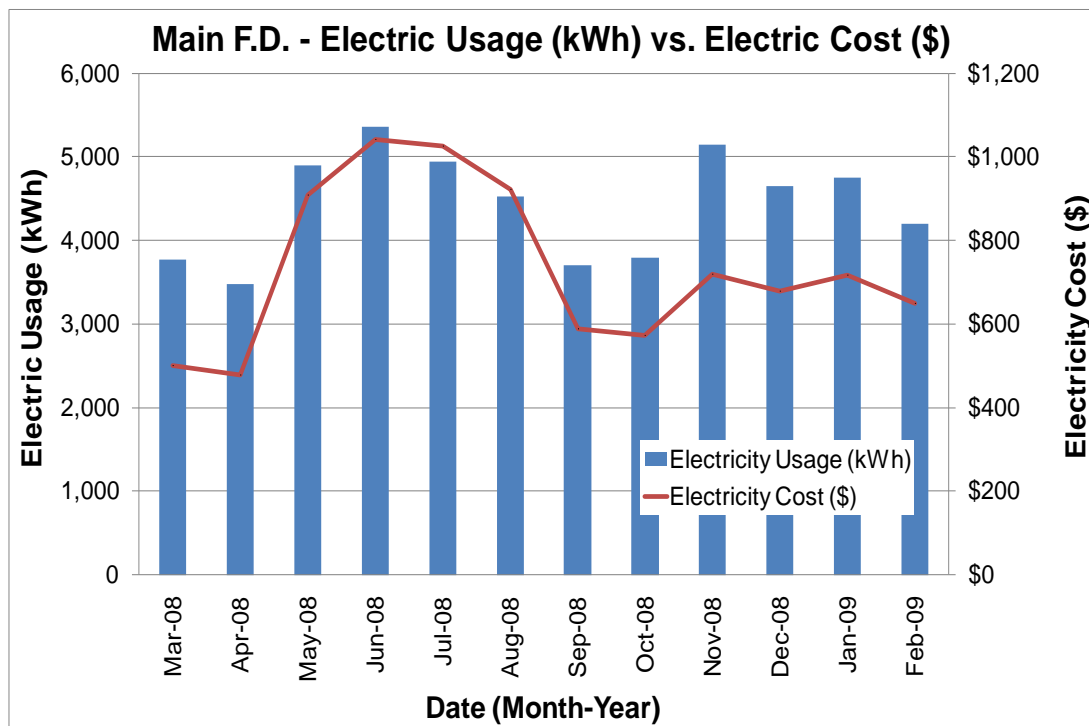
1.1. Energy usage, load profiles and cost analysis

SWA analyzed utility bills for the library for the 24 months between March 2007 to February 2009 with an analysis period between **March 2008 through February 2009**.

Electricity - The Main Fire Department buys electricity from PSE&G at an **average rate of \$0.165/kWh** based on 12 months of utility bills from **March 2008 through February 2009**. The building purchased **approximately 53,235 kWh or \$8,801 worth of electricity** during the analysis period and is currently charged for demand (kW) which has been factored into each monthly bill. The building had an average monthly demand of **15.4 kW** and an annual peak demand of **18.3 kW**.

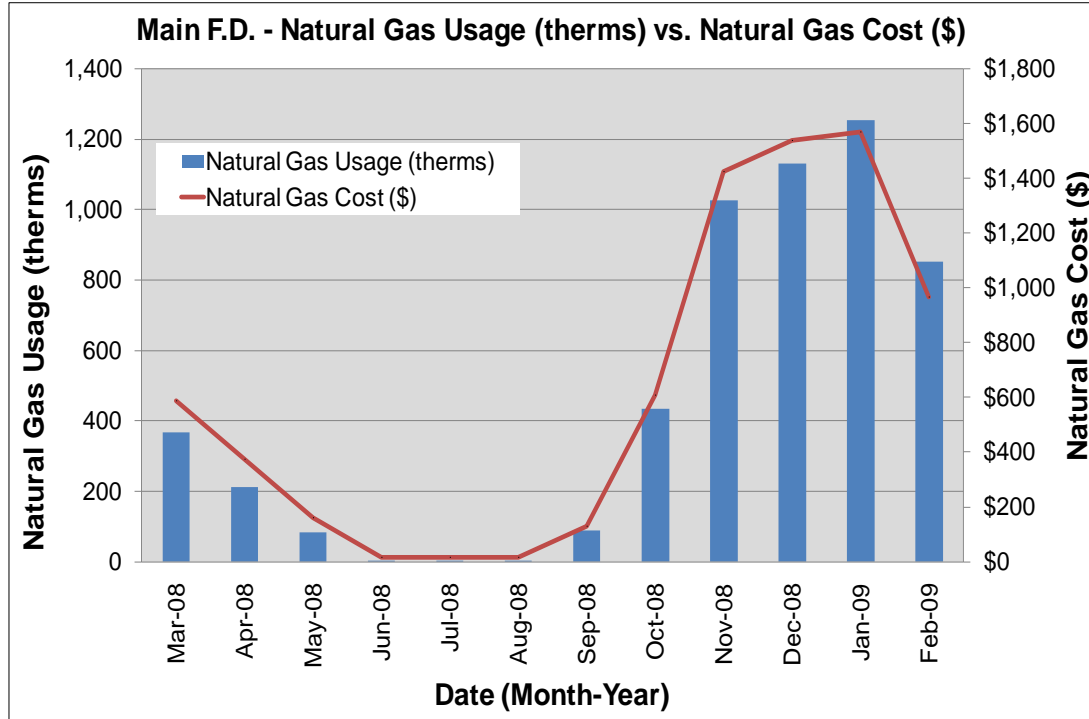
Natural gas – The Main Fire Department is currently served by one meter for natural gas. They currently buy natural gas from PSE&G which acts as the transportation company and energy supplier at an **average aggregated rate of \$1.357/therm** and purchased **approximately 5,458 therms or \$7,406 worth of natural gas** in the 12 months from March 2008 to February 2009.

The following chart shows electricity use versus cost for the Main Fire Department based on utility bills for the 12 month period of March 2008 to February 2009.

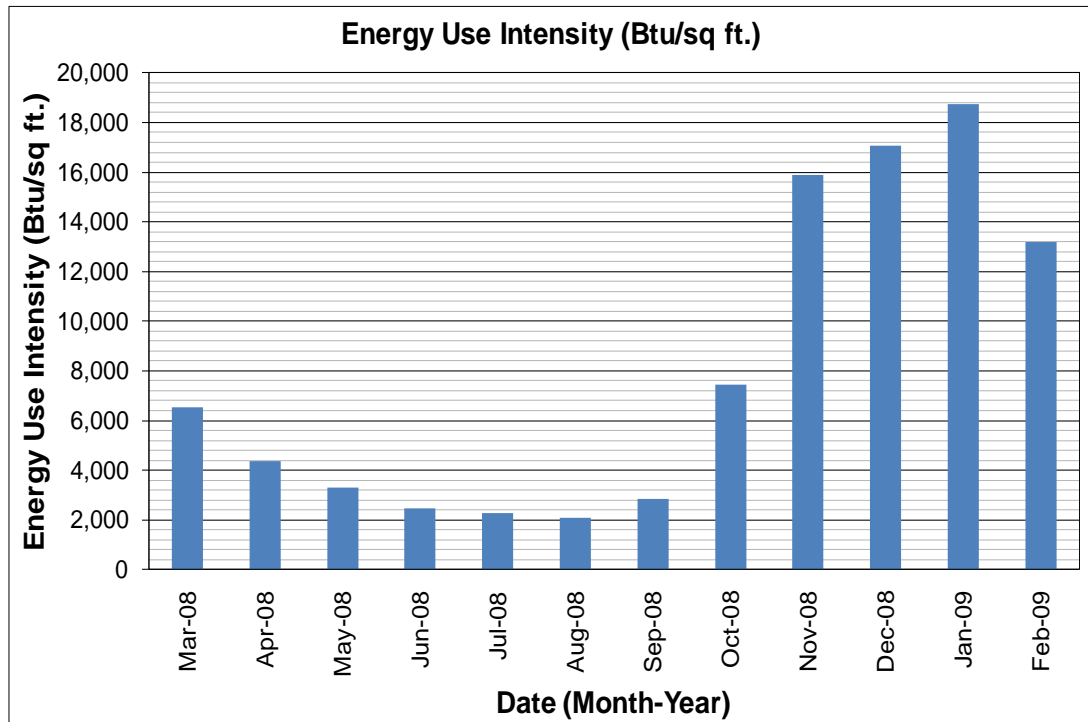


Electricity use follows a trend that is expected for this building with usage peaking during the summer due to DX cooling and also peaks in the winter due to the electric heating equipment. The cost of electricity fluctuates as expected with usage peaking in the summer during the time of highest usage.

The following is a chart of the natural gas annual load profile for the building versus natural gas costs, peaking in the coldest months of the year and a chart showing natural gas consumption following the “heating degree days” curve.

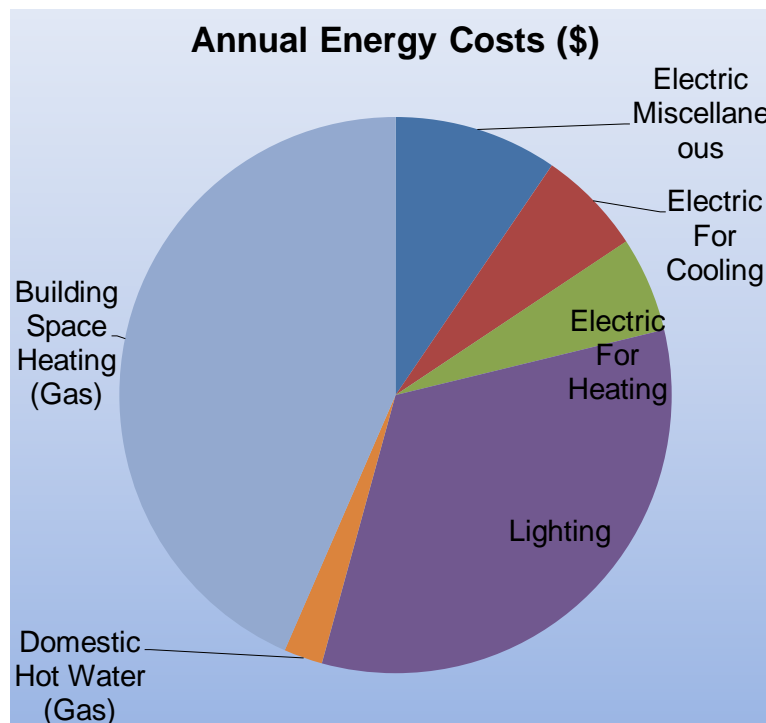
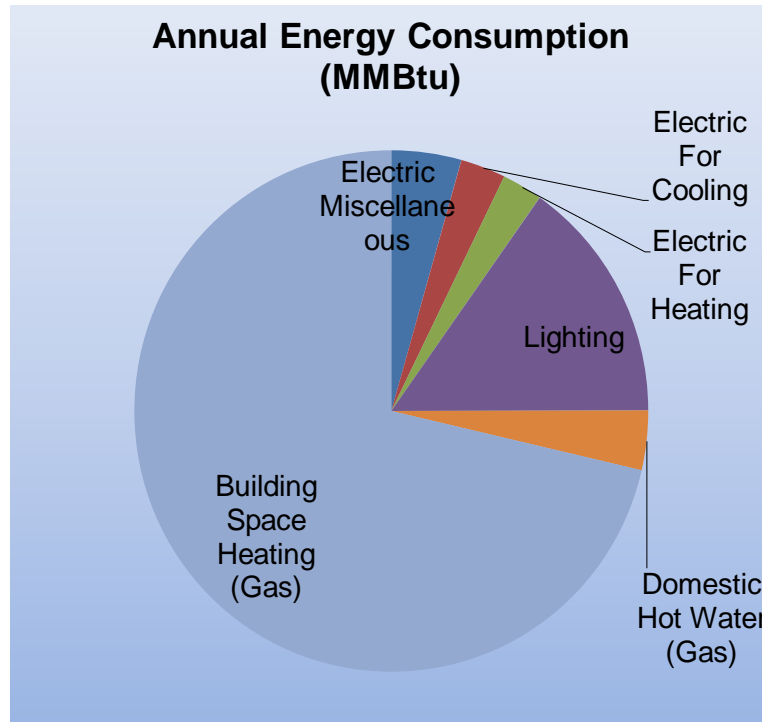


The following chart shows electric consumption in Btu/sq ft for the Main Fire Department based on utility bills for the 12 month period of March 2008 to February 2009.



The following table and chart pies show energy use for the Main Fire Department based on utility bills for the 12 month period of March 2008 to February 2009. Note: Electrical cost at \$48/MMBTU of energy is almost more than 3 times as expensive to use as typical natural gas at \$14/MMBTU.

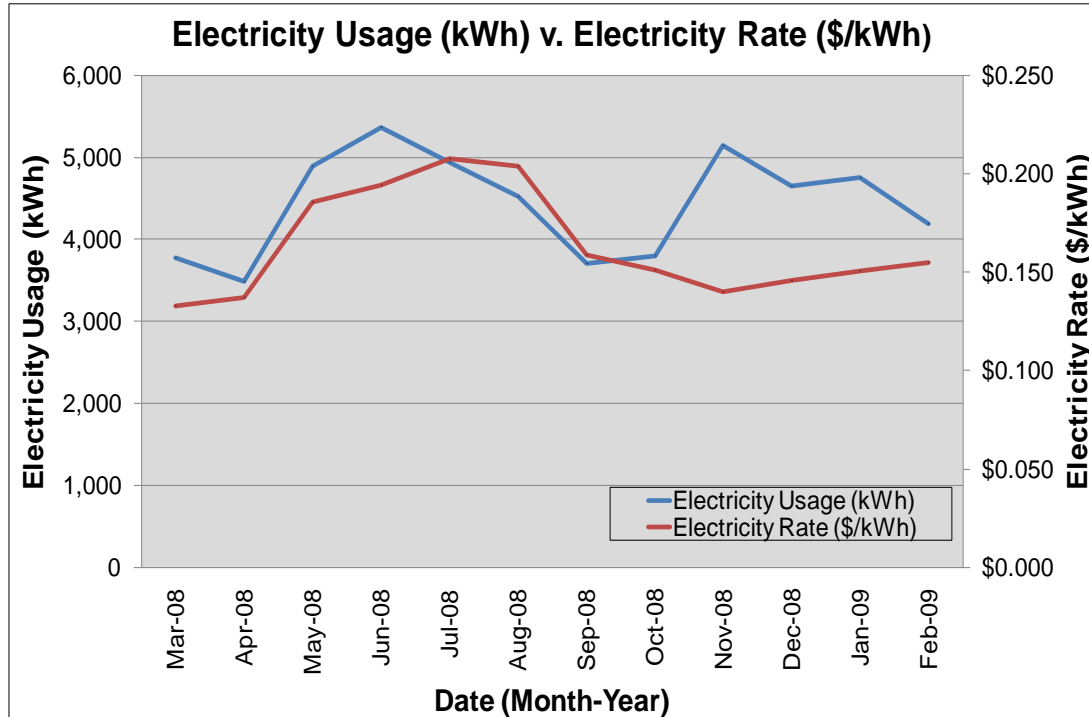
March 2008 - February 2009 Annual Energy Consumption / Costs					
	MMBtu	% MMBtu	\$	% \$	\$/MMBtu
Electric Miscellaneous	32	4%	\$1,549	10%	48
Electric For Cooling	21	3%	\$995	6%	48
Electric For Heating	18	3%	\$896	6%	48
Lighting	111	15%	\$5,360	33%	48
Domestic Hot Water (Gas)	27	4%	\$365	2%	14
Building Space Heating (Gas)	519	71%	\$7,042	43%	14
Totals	727	100%	\$16,207	100%	
Total Electric Usage	182	25%	\$8,801	54%	48
Total Gas Usage	546	75%	\$7,406	46%	14
Totals	727	100%	\$16,207	100%	



1.2. Utility Rate Analysis

The Main Fire Department currently purchases electricity from PSE&G at a general service market rate for electricity use (kWh) including a separate (kW) demand charge that is factored into each monthly bill. The Main Fire Department currently pays an average rate of

approximately \$0.165/kWh based on the 12 months of utility bills of March 2008 to February 2009. Demand prices are reflected in the utility bills and can be verified by observing the price fluctuations throughout the year. The electric rate does not show large fluctuations throughout the year except for an anticipated rise in the summer time. Based on these observations this appears to be the appropriate rate for the building.



The Main Fire Department currently purchases natural gas from PSE&G which acts as the transportation company and energy supplier at a general service market rate for natural gas (therms). There is one gas meter that provides natural gas service to the Main Fire Department currently. The average aggregated rate (supply and transport) for the meter is approximately \$1.357/therm based on 12 months of utility bills March 2008 to February 2009. The suppliers' general service rate for natural gas charges a market-rate price based on use and the buildings billing does not breakdown demand costs for all periods. Demand prices are reflected in the utility bills and can be verified by observing the price fluctuations throughout the year. Typically, the natural gas prices increase during the summer months when natural gas is only used by the hot water boilers. The high gas price per therm fluctuations in the summer may be due to low use caps for the non-heating months. Thus the building pays for fixed costs such as meter reading charges during the summer months.

1.3. Energy benchmarking

SWA has entered energy information about the fire station in the U.S. Environmental Protection Agency's (EPA) *Energy Star Portfolio Manager* Energy benchmarking system. Currently, the building is not eligible to receive a performance rating because it is classified as a fire station which means that it is still ineligible for Energy Star. SWA encourages the Township of Livingston to continue entering utility data in *Energy Star Portfolio Manager* in order to track weather normalized source energy use over time.

The Site Energy Use Intensity is 103.0 kBtu/sq ft yr compared to the national average of a Fire Station consuming 78.0 kBtu/sq ft yr. Implementing this report's recommended Energy Conservations Measures (ECMs) will reduce use by approximately 8.3 kBtu/sqft yr, which would decrease the building's energy use intensity to 94.7 kBtu/ft²yr.

Per the LGEA program requirements, SWA has assisted the Township of Livingston to create an *Energy Star Portfolio Manager* account and has shared the building facility information to allow future data to be added and tracked using the benchmarking tool. SWA is sharing this Portfolio Manager Site information with TRC Energy Services. As per requirements, the account information is provided below:

Username: LivingstonTownship

Password: Livingston

Project Name: Township of Livingston - Main Fire Department

Also, below is a statement of energy performance generated based on historical energy consumption from the Portfolio Manager Benchmarking tool.

STATEMENT OF ENERGY PERFORMANCE Township of Livingston - Main Fire Department

Building ID: 2049823
For 12-month Period Ending: February 28, 2009¹
Date SEP becomes ineligible: N/A

Date SEP Generated: March 08, 2010

Facility
Township of Livingston - Main Fire
Department
62 South Livingston Avenue
Livingston, NJ 07039

Facility Owner
Township of Livingston
357 South Livingston Avenue
Livingston, NJ 07039

Primary Contact for this Facility
Richard Calbi
357 South Livingston Avenue
Livingston, NJ 07039

Year Built: 1929
Gross Floor Area (ft²): 7,560

Energy Performance Rating² (1-100) N/A**Site Energy Use Summary³**

Electricity - Grid Purchase(kBtu)	188,191
Natural Gas (kBtu) ⁴	592,125
Total Energy (kBtu)	780,316

Energy Intensity⁴

Site (kBtu/ft ² /yr)	103
Source (kBtu/ft ² /yr)	165

Emissions (based on site energy use)

Greenhouse Gas Emissions (MtCO ₂ e/year)	60
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Electric Distribution Utility
Public Service Elec & Gas Co

National Average Comparison

National Average Site EUI	78
National Average Source EUI	157
% Difference from National Average Source EUI	5%
Building Type	Fire Station/Police Station

<p>Stamp of Certifying Professional</p> <p>Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.</p>

Meets Industry Standards⁵ for Indoor Environmental Conditions:

Ventilation for Acceptable Indoor Air Quality	N/A
Acceptable Thermal Environmental Conditions	N/A
Adequate Illumination	N/A

Certifying Professional
N/A

Notes:

1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, PE facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S., EPA (2622T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

EPA Form 5900-16

2. FACILITY AND SYSTEMS DESCRIPTION

2.1. Building Characteristics

The free-standing, three-story (slab on grade), 7,560 square feet fire station was originally constructed in 1929. The building includes fire station bays, a bay used as a vehicle repair shop as well as offices, a conference room and storage.



Partial East Façade



Partial West Façade



Partial South Façade



Partial West Façade

2.2. Building Occupancy Profiles

There are 5 full time firefighters and administrative employees that work at the station on weekdays from 8:30 AM to 4:30 PM. The remaining staff is composed of volunteers however there is always a dispatcher on duty at all times.

2.3. Building Envelope

Due to unfavorable weather conditions (min. 18 deg. F delta-T in/ outside & no/ low wind) no exterior envelope infrared (IR) images were taken during the field audit. Thermal imaging/ infrared (IR) technology helps to identify energy compromising problem areas in a non-invasive way.

General Note: All findings and recommendations on the exterior envelope (base, walls, roofs, doors and windows) are based on the energy auditors' experience and expertise, on construction document reviews (if available) and on detailed visual analysis, as far as accessibility and weather conditions allowed at the time of the field audit.

2.3.1. Exterior Walls

The exterior wall envelope is mostly constructed of exposed CMU (Concrete Masonry Unit) with 0 inches of detectable/ assumed insulation.

Note: Wall insulation levels could be visually verified in the field by non-destructive methods.

During the field audit exterior and interior wall surfaces were inspected. They were found to be in overall good condition with only a few signs of uncontrolled moisture, air-leakage or other energy-compromising issues located mostly at the sides of the building.

The following specific exterior wall problem spots and areas were identified:



Examples of cracked and missing caulk and un-sealed exterior wall penetrations

In light of the exterior wall conditions mentioned above SWA has the following recommendation;

1. Inspect and replace cracked/ ineffective caulk.
2. Efflorescence coated brick and masonry materials need to dry out and possible cause of water infiltration into wall cavities should be investigated.
3. Maintain and inspect all exterior wall surfaces with a focus on the condition of caulking, displaced masonry, and signs of water damage and locations that correspond to areas of known infiltration.

2.3.2. Roof

The building's roof is predominantly a flat surface, no parapet type over steel decking with an dark-colored EPDM single membrane finish It was recently installed. 2 inches of roof insulation were recorded. There is also a medium-pitch gable type over a wood structure with an asphalt shingle finish. It was recently installed.

Note: Roof insulation levels could not be verified in the field and are based on reports from building management/ maintenance personnel.

During the field audit roofs, related flashing, gutters and downspouts were inspected. They were found/reported to be in overall good/ age appropriate condition with some signs of water pooling, uncontrolled moisture, air-leakage and other energy-compromising issues mostly detected on flat roof areas.

The following typical roof was identified:



In light of the exterior wall conditions mentioned above SWA has the following recommendation;

1. Unclog and maintain all roof drains/scuppers.
2. Maintain/ inspect all roof surfaces on a regular basis.

2.3.3. Base

The building's base is composed of a slab-on-grade floor with a perimeter footing with poured concrete foundation walls and no detectable slab edge/perimeter insulation.

Slab/ perimeter insulation levels could not be verified in the field or on construction plans and are based upon similar wall types and time of construction.

The building's base and its perimeter were inspected. Judging from signs of uncontrolled moisture or water presence and other energy compromising issues, overall the base was found/reported to be in good condition with no signs of uncontrolled moisture, air-leakage and/ or other energy-compromising issues neither visible on the interior nor exterior.

2.3.4. Windows

The building contains basically four different types of windows

1. Double-hung type windows with an insulated aluminum frame, clear double glazing and interior roller blinds. The windows are located throughout the building.
2. Double-hung type windows with a non-insulated aluminum frame, clear single glazing and interior roller blinds. The windows are located throughout the building.
3. Slider type windows with a non-insulated aluminum frame, clear double glazing and interior roller blinds. The windows are located throughout the building.

4. There are also transom and sidelight units installed in the door systems and glass window panels in the garage.

The following specific window problem spots and typical installations were identified:



Exposed and damaged frames that are major sources of thermal bridging

In light of the exterior wall conditions mentioned above SWA has the following recommendation;

1. Replace/ dd/maintain caulk around window frames and sills.
2. Replace all original/ single glazed windows with a low-E, double glazed type.
3. Maintain and inspect all exterior windows with a focus on the condition of the frames,

2.3.5. Exterior doors

The building contains several different types of exterior doors.

1. Overhead aluminum type exterior door with glass panels. They are located on either side of the building and were recently installed.

2. Aluminum type exterior door with glass panels. They are located on either side of the building and were recently installed.
3. Solid metal type exterior door with glass panels. They are located on either side of the building and were recently installed.

All exterior doors, thresholds, related flashing, caulking and weather-stripping were inspected. Based on signs of moisture, air-leakage and other energy compromising issues, overall the doors were found/ reported to be in acceptable/ age appropriate condition with only a few signs of uncontrolled moisture, air-leakage and/ or other energy-compromising issues.

The following typical installations were identified:



In light of the exterior wall conditions mentioned above SWA has the following recommendation;

1. Maintain and inspect all doors with a focus on the condition of the weather-stripping, door frame, air tight seal and signs of water damage and infiltration.

2.3.6. Building air-tightness

Overall the field auditors found the building to be reasonably air-tight, considering the building's use and occupancy, as described in more detail earlier in this chapter.

In addition to all the above mentioned findings SWA recommends air sealing, caulking and/or insulating around all structural members, recessed lighting fixtures, electrical boxes and chimney walls that are part of or penetrate the exterior envelope and where air-leakage can occur.

The air tightness of buildings helps maximize all other implemented energy measures and investments and minimizes potentially costly long term maintenance/ repair/ replacement expenses.

2.4. HVAC Systems

2.4.1. General

The Main Fire Department consists of a main level with garage and office space, and a partial upper level with office space. There is also a walk-up attic. Access to the roof is via a second floor window. The main level and upper level are heated by a boiler supplying hot water to radiators in the offices, and to unit heaters in the garage. The office areas are also cooled via a split system (1 per floor).

2.4.2. Heating

The entire building is heated via an H.B. Smith gas fired boiler. This boiler is circa 1997 and provides 652,000 btuh of output. It has an estimated remaining life of 55%. The heating system is separated into (4) zones, with a supply pump for each zone above the boiler. Hot water is supplied to radiators in each office room/area (both levels), to a radiator in the lower Attic level, and to (7) forced air unit heaters hanging in the garage. Heating is controlled by wall mounted manual thermostats in each zone which are also timers that prevent unnecessary heating. This combined with the standard operating procedure of turning off all heating equipment when the building is unoccupied makes programmable thermostats an ineffective source of savings.



Gas fired boiler in Mechanical Room



Unit heaters in garage

2.4.3. Cooling

The office areas on both levels are provided with cooling. The main level office area is cooled via a split system with an air handler above the ceiling of the kitchen, and a condensing unit on grade outside. This system is over 20 years old (circa 1987) and is past its expected life span. The upper level office is cooled via a split system with an air handler in the attic, and a condensing unit on the roof. This system is circa 1995 and is at the end of its expected life span. The cold air is distributed throughout both levels by ductwork and diffusers. Cooling is controlled by a wall mounted thermostat on each level.



Split system air handler in attic



Split system condensing unit on roof



Split system condensing unit on grade

2.4.4. Ventilation

The office areas are ventilated by a combination of natural ventilation from windows and the previously described air handlers assigned to each area. The garage area is ventilated via vehicle exhaust fans, a sidewall exhaust fan, and a roof mounted fan. The attic also has a sidewall exhaust fan, and open louvers in the roof gable/ridge. Both sidewall fans are very old, actual age unknown. The roof exhaust fan is also very old, age unknown. The vehicle exhaust fans are both circa 1992, with an estimated 10% of their useful life remaining.



Exhaust fan (left) and vehicle exhaust (right, typical for (2)) on roof

2.4.5. Domestic Hot Water

The domestic hot water for the building is provided by a gas-fired, 40 gallon, 40 MBH tank-type water heater located in the mechanical room. This water heater is from 1987 and has far exceeded its expected life span.

2.5. Electrical systems

2.5.1. Lighting

Interior Lighting – The Main Fire Department contains mostly inefficient lighting. There is primarily inefficient lighting such as the existing 2', 4' and 8' T12 fixtures with magnetic ballasts and screw in incandescent fixtures however; there are also some T8 fixtures that should remain. SWA recommends replacing the T12 lights with T8 electronic ballast fixtures

and incandescent fixtures with CFL's as well as installing 3 new occupancy sensors to reduce electricity usage. See attached lighting schedule in Appendix A for a complete lighting inventory throughout the building and estimated power consumption.

Exit Lights - Exit signs were found to be LED and fluorescent type. SWA recommends that the fluorescent type exit signs should be replaced with LED units.

Exterior Lighting - The exterior lighting surveyed during the building audit was found to be a combination of metal halide and mercury vapor fixtures. SWA recommends replacing the metal halides with pulse start metal halides and installing CFLs in place of the mercury vapor fixtures.

2.5.2. Appliances

SWA performed a basic survey of appliances installed at the Main Fire Department and has determined that it would be cost-effective to replace all existing refrigeration appliances except for the vending machines. Appliances, such as refrigerators, that are over 10 years of age should be replaced with newer efficient models with the Energy Star label. For example, Energy Star refrigerators use as little as 315 kWh / yr. When compared to the average electrical consumption of older equipment, Energy Star equipment results in a large savings. Building management should select Energy Star label appliances and equipment when replacing: refrigerators, printers, computers, copy machines, etc. More information can be found in the "Products" section of the Energy Star website at: <http://www.energystar.gov>.

Computers left on in the building consume a lot of energy. A typical desk top computer uses 65 to 250 watts and uses the same amount of energy when the screen saver is left on. Televisions in meeting areas use approximately 3-5 watts of electricity when turned off. SWA recommends all computers and all appliances (i.e. coffee makers, televisions, etc) except refrigerators, freezers and ice makers be plugged into power strips and turned off each evening just as the lights are turned off. The Main Fire Department computers are generally programmed for the power save mode, to shut down after a period of time that they have not been used.

2.5.3. Elevators

The Main Fire Department does not have any elevators installed on the premises.

2.5.4. Process and others electrical systems

There is currently no significant process and other electrical systems installed at the fire station.

3. EQUIPMENT LIST - Inventory

Building System	Description	Location	Model #	Fuel	Space Served	Year Installed	Estimated Remaining Useful Life %
Cooling	Air-cooled condensing unit (paired with AHU in attic)	Low Roof	Carrier M# 38TRA036310 S# 4895E01404 208V 1ph 23.3MCA 40MOCP 6.63 lbs R-22 refrigerant	Electric	2nd Floor Offices	1995	0%
Ventilation	Exhaust Fan	Low Roof	Jenn-Air M# 241 RVGJ	Electric	Toilet Rooms	Est. 1992	10%
Ventilation	Vehicle Exhaust Fan	Middle Roof	American Fan M# AF-12 1075921793K-7 Baldor Motor: M# M3610T 230V 3HP 85.5% efficiency	Electric	Garages	1992	10%
Ventilation	Vehicle Exhaust Fan	Middle Roof	American Fan M# AF-12 1075921793K-6 Toshiba Motor: M# B0032FLF2AM S# 92305391 230V 3HP 80.0% efficiency	Electric	Garages	1992	10%
Cooling	Air Handling Unit	Attic	Carrier M# FB4ANF036 S# 4295A06464 208V 1ph 3.1A R-22 refrigerant	Electric	2nd Floor Offices	1995	0% unit is at the end of its expected useful life
Ventilation	Sidewall Exhaust Fan	Attic	Chelsea CAT# HVB30 0G2397 115V 1ph 6A 1/3HP	Electric	Attic	Est. 1950s	0% unit is beyond its expected useful life
Cooling	Air Handling Unit	1st Floor Ceiling	Trane M# TWH048A140AD S# B30462820 230V 1ph 4.2A 1/2HP	Electric	1st floor offices & break room	1987	0% unit is beyond its expected useful life
Cooling	Air-cooled condensing unit (paired with AHU in break room)	On grade	Trane XL 1200 M# TTX742A100A2 S# D21216406 208V 3ph 27MCA 45MOCP R-22 refrigerant	Electric	1st floor offices & break room	1989	0% unit is beyond its expected useful life
Lighting	Appendix A	-	-	-	-	-	-

Note: The remaining useful life of a system (in %) is an estimate based on the system date of built and existing conditions derived from visual inspection.

4. ENERGY CONSERVATION MEASURES

Based on the assessment of the Administration Building, SWA has separated the investment opportunities into three recommended categories:

1. Capital Improvements – Upgrades not directly associated with energy savings
2. Operations and Maintenance – Low Cost/No Cost Measures
3. Energy Conservation Measures – Higher cost upgrades with associated energy savings

Category I Recommendations: - Capital Improvements

- Replace heating terminal units- such as baseboard radiators in the finished areas and hydronic unit heaters in the garage. This equipment is in fair condition and beyond its expected service life. Age and wear have reduced the heat transfer capacity. This equipment should be replaced with more modern equipment suited for the intended use. These changes cannot be justified based on energy savings alone. However, replacement is strongly recommended to improve the overall efficiency of the heating system. This is a replacement in kind recommendation which offers negligible energy savings.
- Replace two (2) hot water circulating pumps- two (2) hot water circulating pumps are operating beyond their expected service lives. These pumps should be replaced with pumps containing premium efficiency motors. Since the pumps are fractional horsepower, this measure would yield minimal energy savings and does not qualify for NJ Clean Energy incentives, and so it was not included as an ECM.
- Replace toilet exhaust fan and sidewall attic fans – this equipment is run by fractional horsepower motors, so the replacements cannot be justified by energy savings alone and there are no NJ Clean Energy rebates available. However, due to the age and condition of the equipment, replacement is recommended.

Category II Recommendations: - Operations and Maintenance

- Boiler room and building piping insulation - Insulate un-insulated heating and domestic hot water piping in the basement and throughout the building to efficiently deliver heat where required and provide personnel protection.
- Water levels in the expansion tank and the integrity of the tank bladder should be checked to confirm proper operation.
- Tighten belts on exhaust fans – tightening belts on belt-driven exhaust fans can maximize overall efficiency of the equipment.
- Bi-annual maintenance inspections of exterior walls – SWA recommends that bi-annual inspections are conducted of the exterior walls as part of a preventative maintenance plan. The focus should be inspecting exterior walls for cracks, pointing of masonry, degraded caulking and locating other possible sources of water and air leakage.

- Bi-annual maintenance inspections of roof surfaces – SWA recommends that bi-annual inspections are conducted of the roof surfaces as part of a preventative maintenance plan. The focus of the inspections should be deterioration in surface condition, proper drainage and locating any sources for possible water or air penetration.
- Bi-annual maintenance inspections of windows and exterior doors – SWA recommends that bi-annual inspections are conducted of the roof surfaces as part of a preventative maintenance plan. The focus of the inspections should be on window and door frames, proper sealing between the frame and the exterior wall, proper sealing between the window/door and the frame, locating any sources of possible air or water leakage.
- Provide water efficient fixtures and controls - Adding controlled on / off timers on all lavatory faucets is a cost-effective way to reduce domestic hot water demand and save water. Building staff can also easily install faucet aerators and / or low-flow fixtures to reduce water consumption. There are many retrofit options, which can be installed now or incorporated as equipment is replaced. Routine maintenance practices that identify and quickly address water leaks are a low-cost way to save water and energy. Retrofitting with more efficient water-consumption fixtures / appliances will save both energy and money through reduced energy consumption for water heating, while also decreasing water / sewer bills.
- Use Energy Star labeled appliances - such as Energy Star refrigerators that should replace older energy inefficient equipment.

Category III Recommendations: Energy Conservation Measures

ECM#	Description of Highly Recommended 0-5 Year Payback ECMs
1.1	Install (3) occupancy sensors in offices
1.2	Install (15) CFLs
1.3	Install (2) LED Exit Signs
3.2	Incremental cost to replace domestic water heater with 95% efficient unit
4.2	Incremental cost to replace 2 vehicle exhaust fans with premium efficiency units
Description of Recommended 5-10 Year Payback ECMs	
1.4	Replace (47) T12 fixtures with T8 fixtures
1.5	Install (1) PSMH
2.1	Replace 3-ton HW heating / DX cooling split system with high efficiency system
2.2	Replace 4-ton HW heating / DX cooling split system with high efficiency system
Description of Recommended End of Life Cycle ECMs	
3.1	Replace domestic water heater with 95% efficient unit
4.1	Replace 2 Vehicle exhaust fans with premium efficiency units
Description of Renewable ECMs	
5	Install a 16 kW solar PV rooftop system

ECM#1: Building Lighting Upgrades

Description:

On the days of the site visits, SWA completed a lighting inventory of the Main Fire Department (see Appendix A). The Main Fire Department currently consists of mostly inefficient lighting with T12 fluorescent fixtures with magnetic ballasts, and incandescent fixtures. Based on measurements of lighting levels for each space, there are not any vastly over-illuminated areas. SWA recommends replacing the following inefficient fixtures with more energy efficient types: T12 lamps should be replaced with T8 electronically ballasted lamps and incandescent should be replaced with compact fluorescent. SWA recommends installing 3 occupancy sensors in areas that are occupied only part of the day and payback on savings are justified, such as the first and second floor offices. Typically, occupancy sensors have an adjustable time delay that shuts down the lights automatically if no motion is detected within a set time period. Advance micro-phonic lighting sensors include sound detection as a mean to control lighting operation. See attached lighting schedule in Appendix A for a complete inventory of lighting throughout the building and estimated power consumption. The exterior lighting surveyed during the building audit was found to be a mix of metal halide and mercury vapor lamp fixtures. Exterior lighting is controlled by photocells. SWA recommends replacing the Metal Halide lamps with pulse start Metal Halide lamps, and mercury vapor fixtures with CFL's. Pulse-start metal halide (MH) lamps offer the advantages of standard (probe-start) MH lamps, but minimize the disadvantages. They produce higher light output both initially and over time, operate more efficiently, produce whiter light, and turn on and re-strike faster. SWA is not recommending at this time any upgrades to the exterior timers. The labor in all these installations was evaluated using prevailing electrical contractor wages. The Township of Livingston may decide to perform this work with in-house resources on a scheduled, longer timeline than otherwise performed by a contractor.

Installation cost:

Estimated installed cost: \$8,246 (this includes \$2,612 in labor cost)

Source of cost estimate: *RS Means; Published and established costs*

Economics:

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
1.1	Install (3) occupancy sensors in offices	RS Means, Lit Search	660	60	600	699	0.1	N/A	0.2	0	119	15	1,783	5.0	197	13	18	799	958
1.2	Install (15) CFLs	RS Means, Lit Search	953	0	953	3,011	0.6	N/A	1.0	-50	462	5	2,310	2.1	142	28	39	1,151	4,125
1.3	Install (2) LED Exit Signs	RS Means, Lit Search	407	40	367	788	0.2	N/A	0.3	109	243	15	3,640	1.5	893	60	66	2,489	1,080
1.4	Replace (47) T12 fixtures with T8 fixtures	RS Means, Lit Search	10,880	705	10,175	6,934	1.4	N/A	2.3	178	1,356	15	20,344	7.5	100	7	10	5,784	9,499
1.5	Install (1) PSMH	RS Means, Lit Search	709	25	684	346	0.1	N/A	0.1	18	77	15	1,152	8.9	68	5	7	220	474
Totals			13,609	830	12,779	11,778	2.4	0	3.9	254	2,257	-	29,229	5.7	-	-	141	10,443	16,136

Assumptions: SWA calculated the savings for this measure using measurements taken the days of the field visits and using the billing analysis. SWA also assumed an aggregated 10% failure rate in addition to the standard life cycle.

Rebates / Financial Incentives:

NJ Clean Energy - There aren't any incentives at this time offered by the state of NJ for this energy conservation measure.

Options for Funding ECM:

This project may benefit from applying for a grant from the State of New Jersey - American Recovery and Reinvestment Act Energy Efficiency and Conservation Block Grant (EECBG) Program to offset a portion of the cost of implementation.

http://www.state.nj.us/recovery/infrastructure/eecbg_program_criteria.html

ECM#2: Replace Hot Water Heating/DX Cooling Split System Serving Offices

Description:

The first floor office area is heated and cooled by a 4-ton air handling unit with hot water coil and with split system DX cooling, with air handler located in the ceiling space above the office area and condensing unit located on grade. This equipment was installed in 1989 and is beyond its expected service life of 15 years. The second floor office area is heated and cooled by a 3-ton air handling unit with hot water coil and with split system DX cooling, with air handler located in the attic space above the office area and condensing unit located on the low roof. This equipment was installed in 1995 and is at the end of its expected service life of 15 years. SWA recommends replacement of this equipment to gain an increase in operating efficiency. This project has a simple payback period of approximately 10 years.

The current equipment has a listed cooling Seasonal Energy Efficiency Ratio (SEER) of approximately 10.0. However, due to age the equipment is likely operating with an SEER of approximately 7.0. The new equipment should have a minimum 14.0 EER rating, preferably closer to 17.0. The higher EER will involve increased cost for the equipment over units with lower EER. The equipment shall be Energy Star certified and ASHRAE 90.1 compliant. The equipment shall utilize R-410A refrigerant.

Installation Cost:

Estimated installed cost: \$16,500 (Includes \$3,630 of labor)

Source of cost estimate: *Similar projects*

Economics (with no incentives):

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
2.1	replace 3-ton HW heating / DX cooling split system with high efficiency system	similar projects	7,500	276	7,224	2,310	0.5	0	1.0	350	731	15	5,717	9.9	52	3	6	1,504	3,165
2.2	replace 4-ton HW heating / DX cooling split system with high efficiency system	similar projects	9,000	368	8,632	3,085	0.6	0	1.4	350	859	15	7,635	10.0	49	3	5	1,623	4,226

Assumptions: SWA calculated the savings for this measure using measurements taken the days of the field visits and using the billing analysis. SWA assumed an annual operating time of 1,200 hours for the cooling portion of the system.

Rebates/financial incentives:

*NJ Clean Energy - Unitary AC and split systems (\$73- \$92 per ton)
Maximum incentive amount is \$644.*

Options for funding the ECM: *This project may benefit from enrolling in NJ SmartStart program with Technical Assistance to offset a portion of the cost of implementation.*

<http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings>

ECM#3: Replace Domestic Water Heater

Description:

There is one (1) gas-fired domestic water heater that serves the toilet rooms that are utilized for the entire year. This unit typically achieves approximately 70% efficiency in natural gas usage considering its current age. This equipment is approaching the end of its expected service life and should be replaced. Main Fire Department can realize energy savings by installing a direct vent high efficiency water heater. This type of heater can achieve up to 95% efficiency. This measure cannot be justified by energy savings alone, but should be considered as an end-of-life energy savings opportunity as the incremental cost will yield an acceptable payback as seen below.

Installation cost:

Estimated installed cost: \$2,000 (Includes \$980 of labor)

Source of cost estimate: Similar projects

Economics (with incentives):

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetimecost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
3.1	Replace domestic water heater with 95% efficient unit	similar projects	2,000	50	1,950	0	0.0	72	1.0	0	98	15	1,466	20.0	-25	-2	-3	-784	842
3.2	Incremental cost to replace domestic water heater with 95% efficient unit	similar projects	500	50	450	0	0.0	72	1.0	0	98	15	1,466	4.6	226	15	20	716	842

Assumptions: SWA calculated the savings for this measure using nameplate data taken the days of the field visits, equipment efficiencies listed above and using the billing analysis.

Rebates/financial incentives:

*NJ Clean Energy – Gas-fired water heaters <50 gallons (\$50 per heater)
Maximum incentive amount is \$50.*

Options for funding the ECM: *This project may benefit from enrolling in NJ SmartStart program with Technical Assistance to offset a portion of the cost of implementation.*

<http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings>

ECM#4: Replace Exhaust Fans with High Efficiency Units

Description:

The two (2) rooftop vehicle exhaust fans are in fair condition and should be considered for replacement. SWA recommends replacement since the fans are operating near the end of their useful lives. It was assumed that the vehicle exhaust fans are utilized during maintenance and cleaning of the vehicles, therefore SWA estimated 500 annual hours runtime for the fans. The motors rated for 3 horsepower, and replacement of the entire fan assembly cannot be justified by energy savings alone. However, the incremental cost to utilize premium efficiency motors in the replacement equipment will yield an acceptable simple payback as seen below.

Installation cost:

Estimated installed cost: \$7,000 (Includes \$3,280 in labor)

Source of cost estimate: Similar projects

Economics (with incentives):

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
4.1	replace 2 Vehicle exhaust fans with premium efficiency units	similar projects, DOE Motor Master International	7,000	120	6,880	250	0.1	0	0.0	150	191	10	413	36.0	-72	-7	-9	-5,369	343
4.2	incremental cost to replace 2 vehicle exhaust fans with premium efficiency units	similar projects, DOE Motor Master International	1,000	120	880	250	0.5	0	0.0	150	191	10	413	4.6	117	12	14	631	343

Assumptions: SWA calculated the savings for this measure using measurements taken the days of the field visits and using the billing analysis. It was assumed that the vehicle exhaust fans are utilized during maintenance and cleaning of the vehicles, SWA estimated 500 annual hours runtime for the fans.

Rebates/financial incentives:

*NJ Clean Energy - Premium three-phase motors (\$45-\$700 per motor)
Maximum incentive amount is \$120.*

Options for funding the ECM: *This project may benefit from enrolling in NJ SmartStart program with Technical Assistance to offset a portion of the cost of implementation.*

<http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings>

ECM#5: *Install 16.0 kW PV system*

Description:

Currently the Main Fire Department does not use any renewable energy systems. Renewable energy systems such as photovoltaic panels, can be mounted on the building roofs, and can offset a portion of the purchased electricity for the building. Power stations generally have two separate electrical charges: usage and demand. Usage is the amount of electricity in kilowatt-hours that a building uses from month to month. Demand is the amount of electrical power that a building uses at any given instance in a month period. During the summer periods, when electric demand at a power station is high due to the amount of air conditioners, lights, equipment, etc... being used within the region, demand charges go up to offset the utility's cost to provide enough electricity at that given time. Photovoltaic systems not only offset the amount of electricity use by a building, but also reduce the building's electrical demand, resulting in a higher cost savings as well. It is recommended at this time that the Main Fire Department further review installing a 16.0 kW PV system to offset electrical demand and reduce the annual net electric consumption for the building, and review guaranteed incentives from NJ rebates to justify the investment. The Main Fire Department may consider applying for a grant and/or engage a PV generator/leaser who would install the PV system and then sell the power at a reduced rate. PSE&G provides the ability to buy SREC's at \$600/MWh or best market offer.

The building has flat roof with several locations for portions of a 16.0 kW PV installation on the building roof. A commercial crystalline 230 watt panel has 17.5 square feet of surface area (13.1 watts per square foot). A 16.0 kW system needs approximately 76.0 panels which would take up 1,320 square feet. The installation of a renewable Solar Photovoltaic power generating system could serve as a good educational tool and exhibit for the community.

Installation cost:

Estimated installed cost: \$124,000 (Includes \$49,600 in labor)

Source of cost estimate: Similar Projects

ECM #	ECM description	source	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime cost savings, \$	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, \$	CO ₂ reduced, lbs/yr
5	Install 16.0 kW PV rooftop system with incentives	similar projects	124,000	16,000	108,000	16,179	16	N/A	7.3	0	12,270	25	66,738	8.8	1,989	80	122	72,698	22,165

Assumptions: SWA estimated the cost and savings of the system based on past PV projects. SWA projected physical dimensions based on a typical Polycrystalline Solar Panel (230 Watts, model #ND-U230C1). PV systems are sized based on Watts and physical dimensions for an array will differ with the efficiency of a given solar panel (W/sq ft).

Rebates/financial incentives:

NJ Clean Energy - Renewable Energy Incentive Program, Incentive based on \$1.00 / watt Solar PV application for systems 50kW or less. Incentive amount for this application is \$16,000 for the proposed option.

<http://www.njcleanenergy.com/renewable-energy/programs/renewable-energy-incentive-program>

NJ Clean Energy - Solar Renewable Energy Certificate Program. Each time a solar electric system generates 1,000kWh (1MWh) of electricity, a SREC is issued which can then be sold or traded separately from the power. The buildings must also become net-metered in order to earn SRECs as well as sell power back to the electric grid. A total annual SREC credit of \$9,600 has been incorporated in the above costs; however it requires proof of performance, application approval and negotiations with the utility.

Options for funding ECM:

This project may benefit from enrolling in NJ SmartStart program with Technical Assistance to offset a portion of the cost of implementation.

<http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings>

5. Renewable and Distributed Energy Systems

5.1. Existing Systems

There aren't currently any existing renewable energy systems.

5.2. Wind

A Wind system is not applicable for this building because the area does not have winds of sufficient velocity to justify installing a wind turbine system.

5.3. Solar Photovoltaic

Please see the above recommended ECM # 5

5.4. Solar Thermal Collectors

Solar thermal collectors are not cost effective for this building and would not be recommended due to the insufficient and not constant use of domestic hot water throughout the building to justify the expenditure.

5.5. Combined Heat and Power

CHP is not applicable for this building because of insufficient domestic water use.

5.6. Geothermal

Geothermal is not applicable for this building because it would not be cost effective considering the size of the existing HVAC systems

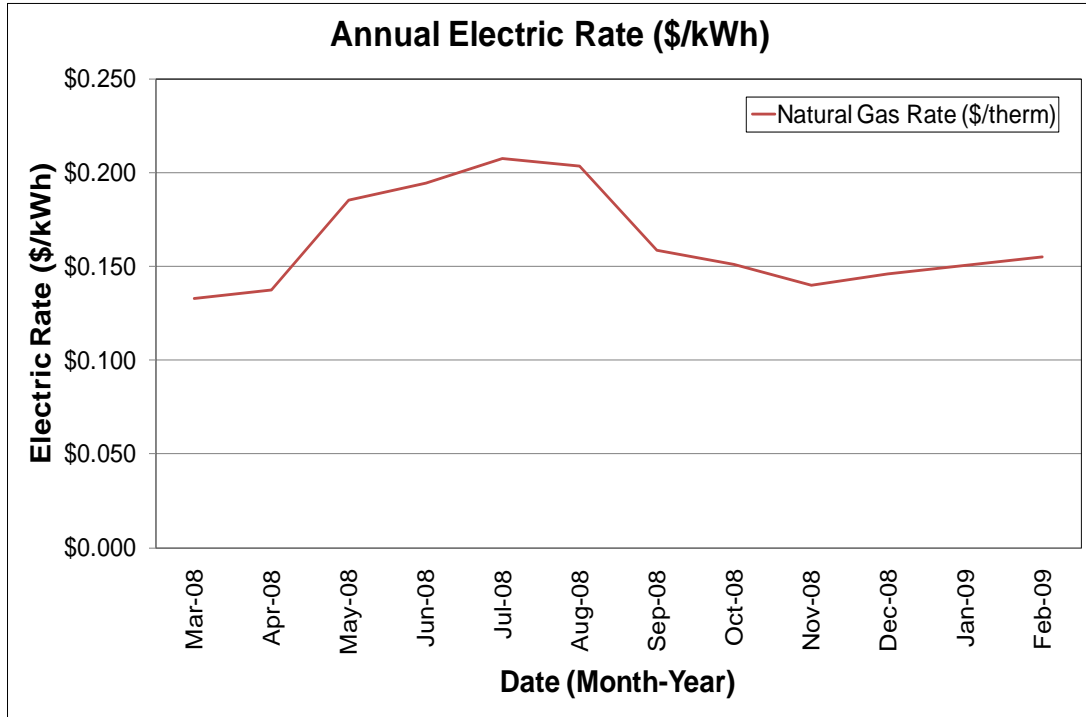
6. ENERGY PURCHASING AND PROCUREMENT STRATEGIES

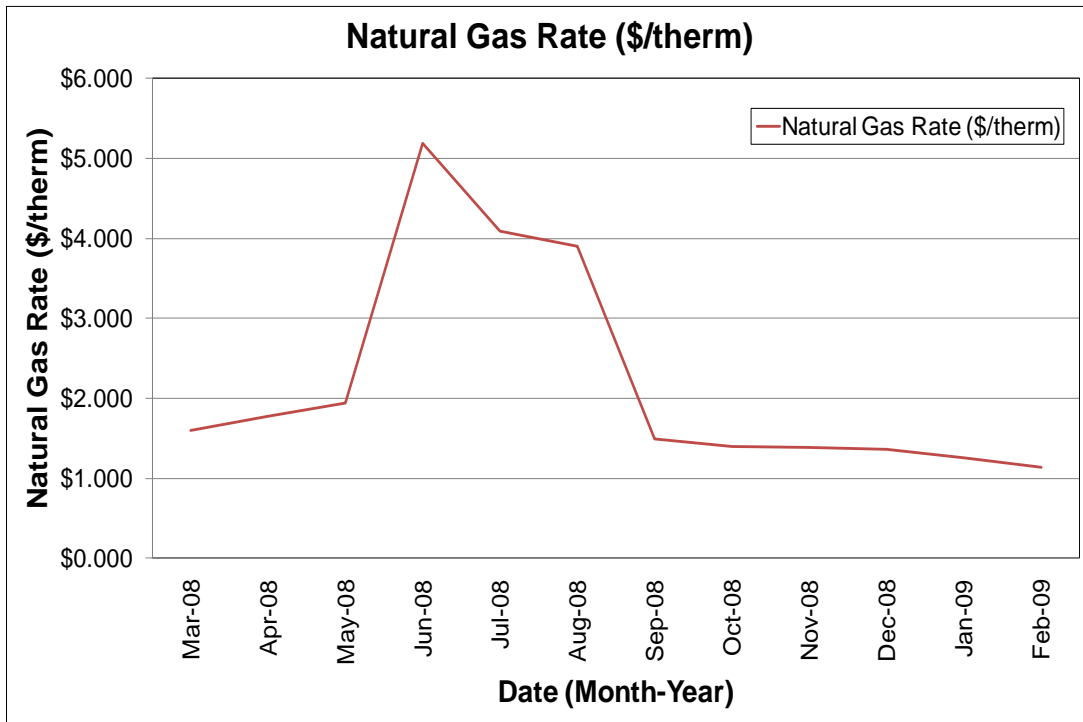
6.1. Energy Purchasing

The Main Fire Department receives electricity purchased via one incoming meter directly for the Main Fire Department from PSE&G without an ESCO. An Energy Services Company (ESCO) is a consultancy group that engages in a performance based contract with a client firm to implement measures which reduce energy consumption and costs in a technically and financially viable manner. SWA analyzed the utility rate for electricity supply over an extended period. Electric bill analysis shows fluctuations of 36% over the 12 month period between March 2008 and February 2009. Natural gas is also purchased via one incoming meter directly from PSE&G as well. Natural gas bill analysis shows fluctuations of up to 78% over the 12 month period between March 2008 and February 2009. The high gas price per therm fluctuations in the summer may be due to low use caps for the non-heating months. Thus the building pays for fixed costs such as meter reading charges during the summer months.

Currently, New Jersey commercial buildings of similar type pay \$0.150/kWh for electricity and \$1.55/therm for natural gas. The electricity rate for the fire department is \$0.165/kWh, which means there is a potential cost savings of \$799 per year. The natural gas rate is \$1.357 which means that they are already paying below market rate. A large cost savings

potential for electricity exists, however this involves contacting third party suppliers and negotiating utility rates. SWA recommends that the Township of Livingston further explore opportunities of purchasing electricity from third party energy suppliers in order to reduce rate fluctuation and ultimately reduce the annual cost of energy for The Main Fire Department. Appendix B contains a complete list of third party energy suppliers for the Township of Livingston service area. The Township of Livingston may want to consider partnering with other school districts, municipalities, townships and communities to aggregate a substantial electric and natural gas use for better leveraging in negotiations with ESCOs and of improving the pricing structures. This sort of activity is happening in many parts of the country and in New Jersey.





6.2. Energy Procurement strategies

Also, the Main Fire Department would not be eligible for enrollment in a Demand Response Program, because there isn't the capability at this time to shed a minimum of 150 kW electric demand when requested by the utility during peak demand periods, which is the typical threshold for considering this option.

7. METHOD OF ANALYSIS

7.1. Assumptions and tools

Energy modeling tool: Established / standard industry assumptions, DOE e-Quest
Cost estimates: RS Means 2009 (Facilities Maintenance & Repair Cost Data)
RS Means 2009 (Building Construction Cost Data)
RS Means 2009 (Mechanical Cost Data)
Published and established specialized equipment material and labor costs
Cost estimates also based on utility bill analysis and prior experience with similar projects

7.2. Disclaimer

This engineering audit was prepared using the most current and accurate fuel consumption data available for the site. The estimates that it projects are intended to help guide the owner toward best energy choices. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

THE RECOMMENDATIONS PRESENTED IN THIS REPORT ARE BASED ON THE RESULTS OF ANALYSIS, INSPECTION, AND PERFORMANCE TESTING OF A SAMPLE OF COMPONENTS OF THE BUILDING SITE. ALTHOUGH CODE-RELATED ISSUES MAY BE NOTED, SWA STAFF HAVE NOT COMPLETED A COMPREHENSIVE EVALUATION FOR CODE-COMPLIANCE OR HEALTH AND SAFETY ISSUES. THE OWNER(S) AND MANAGER(S) OF THE BUILDING(S) CONTAINED IN THIS REPORT ARE REMINDED THAT ANY IMPROVEMENTS SUGGESTED IN THIS SCOPE OF WORK MUST BE PERFORMED IN ACCORDANCE WITH ALL LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS THAT APPLY TO SAID WORK. PARTICULAR ATTENTION MUST BE PAID TO ANY WORK WHICH INVOLVES HEATING AND AIR MOVEMENT SYSTEMS, AND ANY WORK WHICH WILL INVOLVE THE DISTURBANCE OF PRODUCTS CONTAINING MOLD, ASBESTOS, OR LEAD.

Appendix A: Lighting Study of the Main Fire Department

Location			Existing Fixture Information											Retrofit Information											Annual Savings					
Marker	Floor	Room Identification	Fixture Type	Ballast	Lamp Type	# of Fixtures	# of Lamps per Fixture	Watts per Lamp	Controls	Operational Hours per Day	Operational Days per Year	Ballast Voltage	Total Watts	Energy Use kWh/year	Category	Fixture Type	Lamp Type	Ballast	Controls	# of Fixtures	# of Lamps per Fixture	Watts per Lamp	Operational Hours per Day	Operational Days per Year	Ballast Watts	Total Watts	Energy Use kWh/year	Fixture Savings (kWh)	Controls Savings (kWh)	Total Savings (kWh)
1	1	Garage bay	Parabolic	M	8'T12	5	2	110	S	6	365	24	1,220	2,672	T8	Parabolic	8'T8	E	OS	5	2	59	6	365	15	655	1434	1237	0	1237
2	1	Storage Rm	Parabolic	M	8'T12	1	2	110	S	2	365	24	244	178	T8	Parabolic	8'T8	E	OS	1	2	59	2	365	13	131	96	82	0	82
3	1	Garage	Parabolic	M	8'T12	17	2	110	S	6	365	24	4,148	9,084	T8	Parabolic	8'T8	E	OS	17	2	59	6	365	13	2,227	4,877	4,207	0	4,207
4	1	Janitor's Closet	Screw-in	N	Inc	1	1	100	N	2	365	0	100	73	CFL	Screw-in	CFL	N	N	1	1	35	2	365	0	35	26	47	0	47
5	1	Hallway	Parabolic	M	4'T12	1	2	34	S	6	365	15	83	182	T8	Parabolic	4'T8	E	OS	1	2	32	6	365	6	70	153	28	0	28
6	1	Boiler Rm	Screw-in	N	Inc	2	1	60	S	2	365	0	120	88	CFL	Screw-in	CFL	N	S	2	1	20	2	365	0	40	28	58	0	58
7	1	Dispatch Room	Recessed	M	4'T12	4	4	34	S	24	365	24	640	5,606	T8	Recessed	4'T8	E	OS	4	4	32	24	365	13	584	4941	686	0	686
8	1	Office	2U-shape	M	4'T12	6	2	34	S	6	365	15	498	1,091	T8	2U-Shape	4'T8	E	OS	6	2	32	5	365	6	420	690	171	230	401
9	1	Office	Recessed	M	4'T12	1	4	34	S	6	365	24	160	350	T8	Recessed	4'T8	E	OS	1	4	32	5	365	13	141	232	42	77	119
10	1	Office	Recessed	M	2'T12	4	4	17	S	6	365	32	400	876	T8	Recessed	2'T8	E	OS	4	4	17	5	365	5	292	480	237	160	396
11	1	Lunch Rm	Recessed	M	4'T12	2	4	34	S	6	365	24	320	701	T8	Recessed	4'T8	E	OS	2	4	32	6	365	13	262	618	83	0	83
12	1	Bathroom	Recessed	M	4'T12	1	4	34	S	4	365	24	160	234	T8	Recessed	4'T8	E	OS	1	4	32	4	365	13	141	206	28	0	28
13	1	Storage Rm	Screw-in	N	Inc	2	1	100	S	2	365	0	200	146	CFL	Screw-in	CFL	N	S	2	1	35	2	365	0	70	51	95	0	95
14	1	Staircase	2U-shape	M	4'T12	1	2	34	S	6	365	15	83	182	T8	2U-Shape	4'T8	E	OS	1	2	32	6	365	6	70	153	28	0	28
15	1	Staircase	Recessed	M	4'T12	2	3	34	S	6	365	20	244	534	T8	Recessed	4'T8	E	OS	2	3	32	6	365	10	212	464	70	0	70
16	2	Bathroom	Screw-in	N	Inc	3	1	40	S	4	365	0	120	175	CFL	Screw-in	CFL	N	S	3	1	15	4	365	0	45	66	110	0	110
17	2	Hallway	Recessed	M	4'T12	1	3	34	S	6	365	20	122	267	T8	Recessed	4'T8	E	OS	1	3	32	6	365	10	106	232	35	0	35
18	2	Bathroom	Parabolic	M	4'T12	1	2	34	S	4	365	15	83	121	T8	Parabolic	4'T8	E	OS	1	2	32	4	365	6	70	102	19	0	19
19	2	Hallway	Exit Sign	N	LED	1	1	5	N	24	365	1	6	53	N/A	Exit Sign	LED	N	N	1	1	5	24	365	1	6	53	0	0	0
20	2	Meeting Rm	Recessed	E	4'T8	3	3	32	S	6	365	10	318	696	N/A	Recessed	4'T8	E	OS	3	3	32	6	365	10	318	696	0	0	0
21	2	Office Area	Recessed	E	4'T8	4	3	32	S	6	365	10	424	929	C	Recessed	4'T8	E	OS	4	3	32	5	365	10	424	696	0	232	232
22	2	Office	Recessed	E	4'T8	2	3	32	S	6	365	10	212	464	N/A	Recessed	4'T8	E	S	2	3	32	6	365	10	212	464	0	0	0
23	2	Office	Recessed	E	4'T8	2	3	32	S	6	365	10	212	464	N/A	Recessed	4'T8	E	S	2	3	32	6	365	10	212	464	0	0	0
24	2	Office	Recessed	E	4'T8	2	3	32	S	6	365	10	212	464	N/A	Recessed	4'T8	E	S	2	3	32	6	365	10	212	464	0	0	0
25	2	Office Area	Exit Sign	N	FL	2	3	15	N	24	365	6	102	884	LEDex	Exit Sign	LED	N	N	2	1	5	24	365	1	12	105	788	0	788
26	3	Storage Rm	Screw-in	N	Inc	2	1	100	S	2	365	0	200	146	CFL	Screw-in	CFL	N	S	2	1	35	2	365	0	70	51	95	0	95
27	Ext	Exterior	Exterior	N	MV	5	1	175	PC	12	365	44	1,095	4,796	CFL	Exterior	CFL	N	PC	5	1	100	12	365	0	500	2190	2606	0	2606
28	Ext	Exterior	Exterior	N	MH	1	1	175	PC	12	365	44	219	959	PSMH	Exterior	PSMH	N	PC	1	1	115	12	365	25	140	613	346	0	346
Totals:						79	66	1,617				445	11,945	32,425						79	64	1,039			217	7,677	20,647	11,079	699	11,778

Rows Highlighted Yellow Indicate an Energy Conservation Measure is recommended for that space

Legend				
Fixture Type	Lamp Type	Control Type	Ballast Type	Retrofit Category
Exit Sign	LED	N (None)	N/A (None)	N/A (None)
Screw-in	Inc (Incandescent)	S (Switch)	E (Electronic)	T8 (Install new T8)
Pin	T5	OS (Occupancy Sensor)	M (Magnetic)	T5 (Install new T5)
Parabolic	2T5	T (Timer)		CFL (Install new CFL)
Recessed	3T5	PC (Photocell)		LEDex (Install new LED Exit)
2U-shape	4T5	D (Dimming)		LED (Install new LED)
Circline	2T8	DL (Daylight Sensor)		D (Delamping)
Exterior	3T8	M (Microphonic Sensor)		C (Controls Only)
	4T8			PSMH (Install new Pulse-Start Metal Halide)
	6T8			
	8T8			
	2T12			
	3T12			
	4T12			
	6T12			
	8T12			
	CFL (Compact Fluorescent Lightbulb)			
	Hal (Halogen)			
	MV (Mercury Vapor)			
	MH (Metal Halide)			
	HPS (High Pressure Sodium)			
	FL (Fluorescent)			

Appendix B: Third Party Energy Suppliers (ESCOs)
<http://www.state.nj.us/bpu/commercial/shopping.html>

Third Party Electric Suppliers for PSEG Service Territory	Telephone & Web Site
Hess Corporation 1 Hess Plaza Woodbridge, NJ 07095	(800) 437-7872 www.hess.com
American Powernet Management, LP 437 North Grove St. Berlin, NJ 08009	(877) 977-2636 www.americanpowernet.com
BOC Energy Services, Inc. 575 Mountain Avenue Murray Hill, NJ 07974	(800) 247-2644 www.boc.com
Commerce Energy, Inc. 4400 Route 9 South, Suite 100 Freehold, NJ 07728	(800) 556-8457 www.commerceenergy.com
ConEdison Solutions 535 State Highway 38 Cherry Hill, NJ 08002	(888) 665-0955 www.conedsolutions.com
Constellation NewEnergy, Inc. 900A Lake Street, Suite 2 Ramsey, NJ 07446	(888) 635-0827 www.newenergy.com
Credit Suisse, (USA) Inc. 700 College Road East Princeton, NJ 08450	(212) 538-3124 www.creditsuisse.com
Direct Energy Services, LLC 120 Wood Avenue, Suite 611 Iselin, NJ 08830	(866) 547-2722 www.directenergy.com
FirstEnergy Solutions 300 Madison Avenue Morristown, NJ 07926	(800) 977-0500 www.fes.com
Glacial Energy of New Jersey, Inc. 207 LaRoche Avenue Harrington Park, NJ 07640	(877) 569-2841 www.glacialenergy.com
Metro Energy Group, LLC 14 Washington Place Hackensack, NJ 07601	(888) 536-3876 www.metroenergy.com
IntegrYS Energy Services, Inc. 99 Wood Ave, South, Suite 802 Iselin, NJ 08830	(877) 763-9977 www.integrYSenergy.com
Liberty Power Delaware, LLC Park 80 West Plaza II, Suite 200 Saddle Brook, NJ 07663	(866) 769-3799 www.libertypowercorp.com
Liberty Power Holdings, LLC Park 80 West Plaza II, Suite 200 Saddle Brook, NJ 07663	(800) 363-7499 www.libertypowercorp.com
Pepco Energy Services, Inc. 112 Main St. Lebanon, NJ 08833	(800) 363-7499 www.pepco-services.com

Third Party Electric Suppliers for PSEG Service Territory	Telephone & Web Site
PPL EnergyPlus, LLC 811 Church Road Cherry Hill, NJ 08002	(800) 281-2000 www.pplenergyplus.com
Sempra Energy Solutions 581 Main Street, 8th Floor Woodbridge, NJ 07095	(877) 273-6772 www.semprasolutions.com
South Jersey Energy Company One South Jersey Plaza, Route 54 Folsom, NJ 08037	(800) 756-3749 www.southjerseyenergy.com
Sprague Energy Corp. 12 Ridge Road Chatham Township, NJ 07928	(800) 225-1560 www.spragueenergy.com
Strategic Energy, LLC 55 Madison Avenue, Suite 400 Morristown, NJ 07960	(888) 925-9115 www.sel.com
Suez Energy Resources NA, Inc. 333 Thornall Street, 6th Floor Edison, NJ 08837	(888) 644-1014 www.suezenergyresources.com
UGI Energy Services, Inc. 704 East Main Street, Suite 1 Moorestown, NJ 08057	(856) 273-9995 www.ugienergyservices.com

Third Party Gas Suppliers for PSEG Service Territory	Telephone & Web Site
Cooperative Industries 412-420 Washington Avenue Belleville, NJ 07109	(800) 628-9427 www.cooperativenet.com
Direct Energy Services, LLC 120 Wood Avenue, Suite 611 Iselin, NJ 08830	(866) 547-2722 www.directenergy.com
Dominion Retail, Inc. 395 Highway 170, Suite 125 Lakewood, NJ 08701	(866) 275-4240 www.retail.dom.com
Gateway Energy Services Corp. 44 Whispering Pines Lane Lakewood, NJ 08701	(800) 805-8586 www.gesc.com
UGI Energy Services, Inc. 704 East Main Street, Suite 1 Moorestown, NJ 08057	(856) 273-9995 www.ugienergyservices.com
Great Eastern Energy 116 Village Riva, Suite 200 Princeton, NJ 08540	(888) 651-4121 www.greateastern.com
Hess Corporation 1 Hess Plaza Woodbridge, NJ 07095	(800) 437-7872 www.hess.com

Third Party Gas Suppliers for PSEG Service Territory	Telephone & Web Site
Hudson Energy Services, LLC 545 Route 17 South Ridgewood, NJ 07450	(877) 483-7669 www.hudsonenergyservices.com
Intelligent Energy 2050 Center Avenue, Suite 500 Fort Lee, NJ 07024	(800) 724-1880 www.intelligentenergy.org
Keil & Sons 1 Bergen Blvd. Fairview, NJ 07002	(877) 797-8786 www.systrumenergy.com
Metro Energy Group, LLC 14 Washington Place Hackensack, NJ 07601	(888) 536-3876 www.metroenergy.com
MxEnergy, Inc. 510 Thornall Street, Suite 270 Edison, NJ 08837	(800) 375-1277 www.mxenergy.com
NATGASCO (Mitchell Supreme) 532 Freeman Street Orange, NJ 07050	(800) 840-4427 www.natgasco.com
Pepco Energy Services, Inc. 112 Main Street Lebanon, NJ 08833	(800) 363-7499 www.pepco-services.com
PPL EnergyPlus, LLC 811 Church Road Cherry Hill, NJ 08002	(800) 281-2000 www.pplenergyplus.com
Sempra Energy Solutions 581 Main Street, 8th Floor Woodbridge, NJ 07095	(877) 273-6772 www.semprasolutions.com
South Jersey Energy Company One South Jersey Plaza, Route 54 Folsom, NJ 08037	(800) 756-3749 www.southjerseyenergy.com
Sprague Energy Corp. 12 Ridge Road Chatham Township, NJ 07928	(800) 225-1560 www.spragueenergy.com
Stuyvesant Energy LLC 10 West Ivy Lane, Suite 4 Englewood, NJ 07631	(800) 646-6457 www.stuyfuel.com
Woodruff Energy 73 Water Street Bridgeton, NJ 08302	(800) 557-1121 www.woodruffenergy.com

Appendix C: Glossary and Method of Calculations

Glossary of ECM Terms

Net ECM Cost: The net ECM cost is the cost experienced by the customer, which is typically the total cost (materials + labor) of installing the measure minus any available incentives. Both the total cost and the incentive amounts are expressed in the summary for each ECM.

Annual Energy Cost Savings (AECS): This value is determined by the audit firm based on the calculated energy savings (kWh or Therm) of each ECM and the calculated energy costs of the building.

Lifetime Energy Cost Savings (LECS): This measure estimates the energy cost savings over the lifetime of the ECM. It can be a simple estimation based on fixed energy costs. If desired, this value can factor in an annual increase in energy costs as long as the source is provided.

Simple Payback: This is a simple measure that displays how long the ECM will take to break-even based on the annual energy and maintenance savings of the measure.

ECM Lifetime: This is included with each ECM so that the owner can see how long the ECM will be in place and whether or not it will exceed the simple payback period. Additional guidance for calculating ECM lifetimes can be found below. This value can come from manufacturer's rated lifetime or warranty, the ASHRAE rated lifetime, or any other valid source.

Operating Cost Savings (OCS): This calculation is an annual operating savings for the ECM. It is the difference in the operating, maintenance, and / or equipment replacement costs of the existing case versus the ECM. In the case where an ECM lifetime will be longer than the existing measure (such as LED lighting versus fluorescent) the operating savings will factor in the cost of replacing the units to match the lifetime of the ECM. In this case or in one where one-time repairs are made, the total replacement / repair sum is averaged over the lifetime of the ECM.

Return on Investment (ROI): The ROI is expressed as the percentage return of the investment based on the lifetime cost savings of the ECM. This value can be included as an annual or lifetime value, or both.

Net Present Value (NPV): The NPV calculates the present value of an investment's future cash flows based on the time value of money, which is accounted for by a discount rate (assumes bond rate of 3.2%).

Internal Rate of Return (IRR): The IRR expresses an annual rate that results in a break-even point for the investment. If the owner is currently experiencing a lower return on their capital than the IRR, the project is financially advantageous. This measure also allows the owner to compare ECMs against each other to determine the most appealing choices.

Calculation References

ECM = Energy Conservation Measure
AOCS = Annual Operating Cost Savings
AECS = Annual Energy Cost Savings
LOCS = Lifetime Operating Cost Savings
LECS = Lifetime Energy Cost Savings
LCS = Lifetime Cost Savings

NPV = Net Present Value
IRR = Internal Rate of Return
DR = Discount Rate

Net ECM Cost = Total ECM Cost – Incentive
LECS = AECS X ECM Lifetime
AOCS = LOCS / ECM Lifetime
LCS = LOCS+LECS

Note: The lifetime operating cost savings are all avoided operating, maintenance, and / or component replacement costs over the lifetime of the ECM. This can be the sum of any annual operating savings, recurring or bulk (i.e. one-time repairs) maintenance savings, or the savings that comes from avoiding equipment replacement needed for the existing measure to meet the lifetime of the ECM (e.g. lighting change outs).

Simple Payback = Net ECM Cost / (AECS + AOCS)
Lifetime ROI = (LECS + LOCS – Net ECM Cost) / Net ECM Cost
Annual ROI = (Lifetime ROI / Lifetime) = (AECS + OCS) / Net ECM Cost – 1 / Lifetime
It is easiest to calculate the NPV and IRR using a spreadsheet program like Excel.

Excel NPV and IRR Calculation

In Excel, function =IRR(values) and =NPV(rate, values) are used to quickly calculate the IRR and NPV of a series of annual cash flows. The investment cost will typically be a negative cash flow at year 0 (total cost - incentive) with years 1 through the lifetime receiving a positive cash flow from the annual energy cost savings and annual maintenance savings. The calculations in the example below are for an ECM that saves \$850 annually in energy and maintenance costs (over a 10 year lifetime) and takes \$5,000 to purchase and install after incentives:

	A	B	C	D	E	F	G	H	I
1									
2									
3					Year	Cash Flow			
4					0	\$ (5,000.00)		Investment Cost	
5					1	\$ 850.00		Cash Flow: Annual Energy Cost Savings + Annual Maintenance Savings	
6					2	\$ 850.00			
7					3	\$ 850.00			
8					4	\$ 850.00			
9	ECM Lifetime				5	\$ 850.00			
10					6	\$ 850.00			
11					7	\$ 850.00			
12					8	\$ 850.00			
13					9	\$ 850.00			
14					10	\$ 850.00			
15								Formula:	
16					IRR	11.03%		=IRR(F4:F14)	
17					NPV	\$2,250.67		=NPV(0.03,F5:F14)+F4	
18									
19									

ECM and Equipment Lifetimes

Determining a lifetime for equipment and ECM's can sometimes be difficult. The following table contains a list of lifetimes that the NJCEP uses in its commercial and industrial programs. Other valid sources are also used to determine lifetimes, such as the DOE, ASHRAE, or the manufacturer's warranty.

Lighting is typically the most difficult lifetime to calculate because the fixture, ballast, and bulb can all have different lifetimes. Essentially the ECM analysis will have different operating cost savings (avoided equipment replacement) depending on which lifetime is used.

When the bulb lifetime is used (rated burn hours / annual burn hours), the operating cost savings is just reflecting the theoretical cost of replacing the existing case bulb and ballast over the life of the recommended bulb. Dividing by the bulb lifetime will give an annual operating cost savings.

When a fixture lifetime is used (e.g. 15 years) the operating cost savings reflects the avoided bulb and ballast replacement cost of the existing case over 15 years minus the projected bulb and ballast replacement cost of the proposed case over 15 years. This will give the difference of the equipment replacement costs between the proposed and existing cases and when divided by 15 years will give the annual operating cost savings.

NJCEP C & I Lifetimes

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