Steven Winter Associates, Inc.
Architects and Engineers

293 Route 18 South, Suite 330
East Brunswick, NJ 08816
www.swinter.com

Telephone: (866) 676-1972
E-mail: swinter@swinter.com

February 7, 2010

Local Government Energy Program
Energy Audit Final Report

For

Livingston Heritage Middle School
Livingston, NJ 07039

Project Number: LGEA37

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INTRODUCTION

On October 13th, 15th, 16th, 20th, 21st, 22nd, 27th and 28th Steven Winter Associates, Inc. (SWA) performed an energy audit and assessment for the Livingston Public School buildings. The audit included a review of the:

- Administrative Offices
- Burnet Hill Elementary
- Collins Elementary
- Harrison Elementary
- Hillside Elementary
- Riker Hill Elementary
- Mount Pleasant Schools
- Heritage Middle School
- Livingston High School

The buildings are located in Livingston, NJ. A separate energy audit report is issued for each of the referenced buildings.

This report addresses the Livingston Heritage Middle School building located at 20 Foxcroft Drive, Livingston, NJ 07039. The current conditions and energy-related information were collected in order to analyze and facilitate the implementation of energy conservation measures for the building.

The three-story Heritage Middle School building was built in 1963 with renovations and additions in 2002. Besides various types of classrooms and administrative offices, the building has multipurpose, special education, science and music rehearsing rooms, a cafeteria, an auditorium, a gymnasium, a media center, boiler and utility rooms. The building consists of 150,861square feet of conditioned space. The building is occupied on weekdays by 111 teachers / staff employees and 920 students from 8:00 am to 3:30 pm and periodic evening meetings and recreational programs. There is Sunday Chinese teaching school during the school year and a YMCA summer program.

SWA was informed by the Livingston Board of Education that there is a plan for the Livingston Public Schools to upgrade the envelopes, interior spaces, mechanical and electrical systems, install photovoltaic systems and comply with ADA requirements, which will be presented in a two bond referendum for approval by the township voters on December 8, 2009.

The goal of this Local Government Energy Audit (LGEA) is to provide sufficient information to the Livingston Board of Education to make decisions regarding the implementation of the most appropriate and most cost effective energy conservation measures for the Heritage Middle School 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 (BPUs) Office of Clean Energy has assigned TRC Energy Services to administer the Program.

EXECUTIVE SUMMARY

The energy audit performed by Steven Winter Associates (SWA) encompasses the Heritage Middle School building located at 20 Foxcroft Drive, Livingston, NJ 07039. The Heritage Middle School building is a three-story building with a floor area of 150,861square feet. The original structure was built in 1963 with renovations and additions in 2002.

Based on the field visits performed by the SWA staff on October 13th, 15th, 16th, 20th, 21st, 22nd, 27th and 28th 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.

From March 2008 to February 2009 the Heritage Middle School building consumed 999,390 kWh or $168,409 worth of electricity at an approximate rate of $0.169/kWh and 43,491 therms or $68,073 worth of natural gas at an approximate rate of $1.565/therm . The joint energy consumption for the building, including both electricity and natural gas, was 7,759 MMBtu of energy that cost a total of $236,482.

SWA has entered energy information about the Heritage Middle School building in the U.S. Environmental Protection Agency's (EPA) *Energy Star Portfolio Manager* Energy benchmarking system. The building performance rating received is a score of 80 when compared to other buildings of its kind. Buildings achieving an Energy Star rating of 75 are eligible to apply for the Energy Star award and receive the Energy Star plaque to convey superior performance. These ratings also greatly help when applying for Leadership in Energy and Environmental Design (LEED) building certification through the United States Green Building Council (USGBC). SWA encourages the Livingston Board of Education 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 52 kBtu/ft^{2}yr compared to the national average of a school building consuming 70 kBtu/ft^{2}yr. Implementing this report's recommendations will reduce use by approximately 18.1 kBtu/ft^{2}yr, which when implemented would make the building energy consumption even lower. There may be energy procurement opportunities for the Heritage Middle School to reduce annual utility costs, which are $19,163 higher, when compared to the average estimated NJ commercial utility rates.

Based on the assessment of the Heritage Middle School building, SWA has separated the recommendations into three categories (See Section 4 for more details). These are summarized as follows:

Category I Recommendations: Capital Improvement Measures

- Replace H&V units serving the Auditorium
- Replace H&V units serving the 1964 Gym
- Replace common area heating emitters
- Replace window air conditioners
- Upgrade Building Management System (BMS)
- Replace exterior dust collection systems and Tech Education classroom associated interior ductwork
- Provide dedicated makeup air to the kitchen via rooftop makeup air unit
- Replace original windows
- Insulate exterior walls, replace roof and re-point exterior brick walls
- Upgrade building per ADA requirements
- Install premium motors when replacements are required - Select NEMA Premium motors

Category II Recommendations: Operations and Maintenance

- Maintain boiler room and building piping insulation
- Check water levels in the expansion tanks and the integrity of the tank bladders
- Inspect and replace gaskets around Kitchen walk-in refrigeration box doors
- Asbestos abatement
- Maintain roofs
- Maintain downspouts
- Provide weather stripping / air sealing
- Repair / seal wall cracks and penetrations
- Provide water efficient fixtures and controls
- Use Energy Star labeled appliances
- Use smart power electric strips
- Create an energy educational program

Category III Recommendations: Energy Conservation Measures - Upgrades with associated energy savings

At this time, SWA highly recommends a total of **7** Energy Conservation Measures (ECMs) for the Heritage Middle School building that are summarized in the following Table 1. The total investment cost for these ECMs with incentives is **$21,067**. SWA estimates a first year savings of **$9,630** with a simple payback of **2.2 years**. SWA estimates that implementing the highly recommended ECMs will reduce the carbon footprint of the Heritage Middle School building by **75,369 lbs of CO_2**, which is equivalent to removing approximately 6 cars from the roads each year or avoiding the need of 184 trees to absorb the annual CO_2 generated. SWA also recommends **2** ECMs with a total first year savings of **$116,269** that is summarized in Table 2 and **2** End of Life Cycle ECMs with a total first year savings of **$3,722** that are summarized in Table 3.

There are various incentives that the Livingston Board of Education could apply for that could also help lower the cost of installing the ECMs. SWA recommends that the Livingston Board of Education 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, to be rolled out soon, could also assist to cover 80% of the capital investment.

Institutional buildings with an average annual peak demand over 200 kW (Heritage Middle School is 320 kW) are eligible to participate in the NJ Clean Energy Pay for Performance program. Incentives for electricity and natural gas savings will be paid based on actual savings, provided that the minimum performance threshold of 15% savings has been achieved. To participate, select a Program Partner from an approved partner list and submit Application Package with your Partner's assistance. Reducing 15% of the energy use at Heritage Middle School will be challenging when considering the school's present operating efficiency.

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. When the Livingston Bond Proposal #2 referendum passes on December 2009, the state of NJ will aid the school by paying 40% of the debt service (interest and principal) for the PV system installation.

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 energy 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	install 5 Drinks, 2 Snacks vending machine and 5 reach-in Drink cooler energy misers - in cafeteria	www.usatech.com and established costs	3,148	none at this time	3,148	16,894	5.3	0	0.4	0	2,855	12	34,261	1.1	988	82	91	25,272	23,145
2.1	install (6) six occupancy sensors	RS Means, Lit Search, NJ Clean Energy Program	1,320	120	1,200	2,825	0.9	0	0.2	0	477	12	5,729	2.5	377	31	39	3,552	3,870
2.2	replace gym Metal Halide lamps with (20) twenty T5 fixtures	RS Means, Lit Search, NJ Clean Energy Program	7,100	320	6,780	15,608	4.9	0	1.1	53	2,690	15	39,566	2.5	495	33	39	25,336	21,383
3.1	replace (2) 10 HP hot water circulator pump motors with Premium Efficiency	similar projects, DOE Motor Master + International	1,352	180	1,172	2,739	0.8	0	0.1	0	463	20	9,258	2.5	690	34	39	5,715	3,752
2.3	replace (184) Auditorium stage incandescent lamps with CFLs	RS Means, Lit Search, NJ Clean Energy Program	5,520	none at this time	5,520	11,040	3.5	0	0.8	280	2,146	7	13,060	2.6	172	25	34	7,849	15,125
3.2	replace (2) 5 HP hot water circulator pump motors with Premium Efficiency	similar projects, DOE Motor Master + International	810	108	702	1,408	0.4	0	0.0	0	238	20	4,759	3.0	578	29	34	2,838	1,929
4	replace (5) 1 HP cond fan and (5) frac Hp motors with Premium Efficiency on walk-in refrigerated box	similar projects, DOE Motor Master + International	2,770	225	2,545	4,500	1.3	0	0.1	0	761	20	15,210	3.3	498	25	30	8,769	6,165
	TOTALS		**22,020**	**953**	**21,067**	**55,014**	**17.1**	**0**	**2.6**	**333**	**9,630**	**-**	**121,844**	**2.2**	**-**	**-**	**-**	**79,331**	**75,369**

Assumptions: Discount Rate: 3% 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 energy 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
without additional state aid																			
5a	install 116 kW PV rooftop system with incentives	similar projects	900,000	0	900,000	131,763	116	N/A	3.0	0	100,868	25	556,698	8.9	92.9	3.7	8.2	426,076	180,515
renewable PV system below, with additional 40% state aid for debt service																			
5b	install 116 kW PV rooftop system with incentives	similar projects	900,000	360,000	540,000	131,763	116	N/A	3.0	0	100,868	25	556,698	5.4	221.4	8.9	17.3	786,076	180,515
6	retro-commissioning	similar projects	113,146	none at this time	113,146	40,085	12.7	4,349	3.8	1,820	15,401	12	162,969	7.3	63	5	8	40,154	54,917
	TOTALS		**1,013,146**	**360,000**	**653,146**	**171,848**	**128.8**	**4,349**	**6.8**	**1,820**	**116,269**	**-**	**719,667**	**5.6**	**-**	**-**	**-**	**826,230**	**235,432**

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 energy 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
7	replace reach-in ice cream freezer with a 24 cu ft Energy Star freezer	Energy Star purchasing and procurement site, similar projects	2,700	0	2,700	311	0.1	0	0.0	150	203	12	631	13.3	-10	-1	-2	-684	426
8	replace 25 exhaust fans with premium efficiency units	similar projects, DOE Motor Master + International	71,250	1,350	69,900	12,750	4.0	0	0.3	1,365	3,520	10	21,548	19.9	-50	-5	-11	-39,876	17,468
	TOTALS		**73,950**	**1,350**	**72,600**	**13,061**	**4.1**	**0**	**0.3**	**1,515**	**3,722**	**-**	**22,178**	**19.5**	**-**	**-**	**-**	**-40,560**	**17,894**

1. HISTORIC ENERGY CONSUMPTION

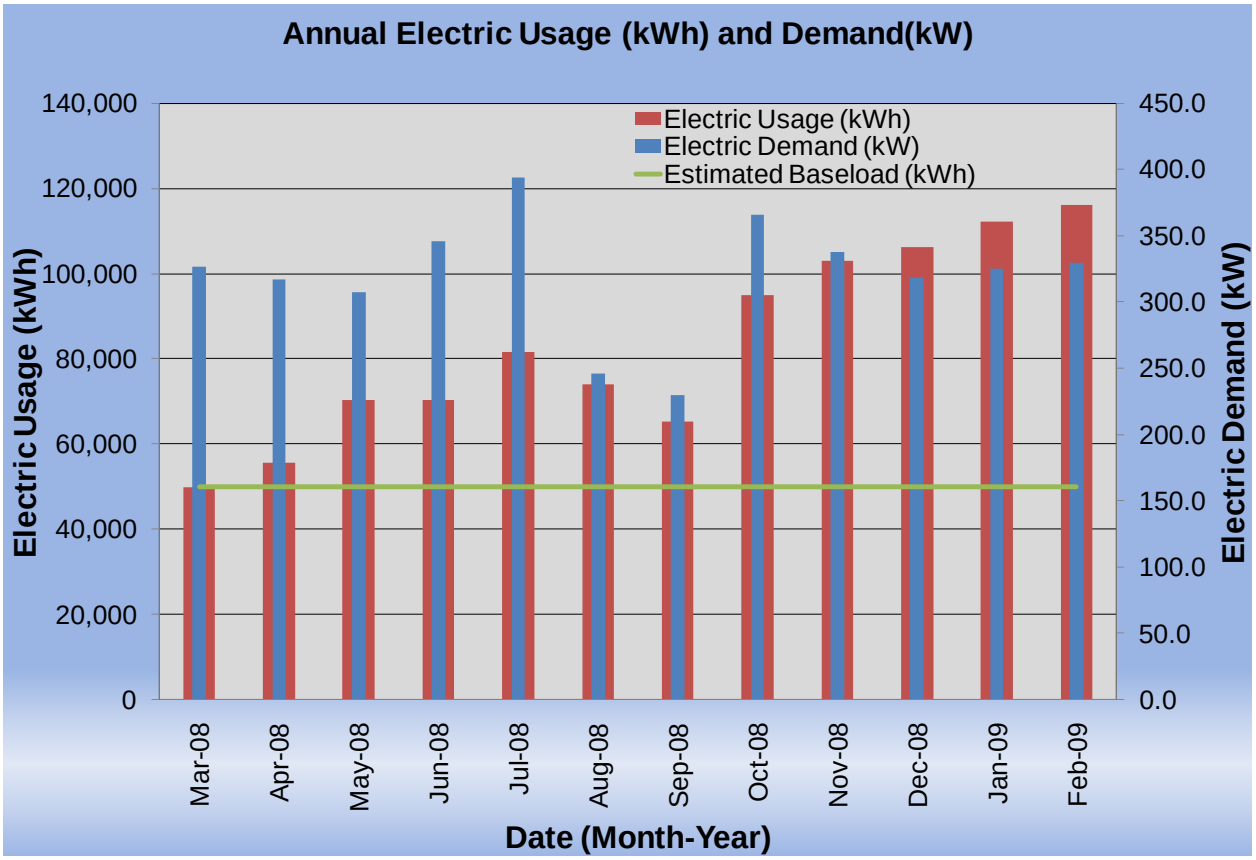
1.1. Energy usage and cost analysis

SWA analyzed utility bills from March 2007 through March 2009 that were received from the utility companies supplying the Heritage Middle School building with electric and natural gas.

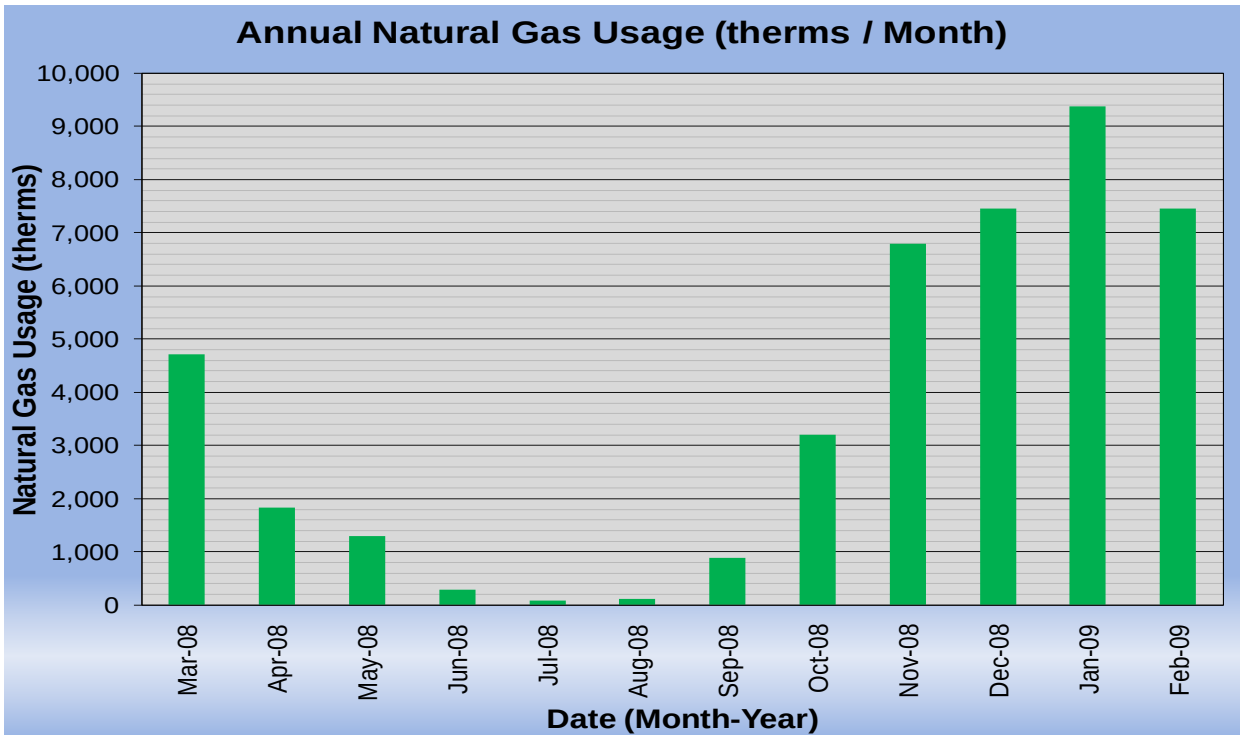
Electricity - The Heritage Middle School building is currently served by one electric meter. The Heritage Middle School building currently buys electricity from PSE&G at **an average rate of $0.169/kWh** based on 12 months of utility bills from March 2008 to February 2009. The Heritage Middle School building purchased **approximately 999,390 kWh or $168,409 worth of electricity** in the previous year. The average monthly demand was 320 kW.

Natural gas - The Livingston Heritage Middle School building is currently served by one meter for natural gas. The Livingston Heritage Middle School building currently buys natural gas from PSE&G (supplied by the Hess Corporation) at **an average aggregated rate of $1.565/therm** based on 12 months of utility bills for March 2008 to February 2009. The Livingston Heritage Middle School building purchased **approximately 43,491 therms or $68,073 worth of natural gas** in the previous year.

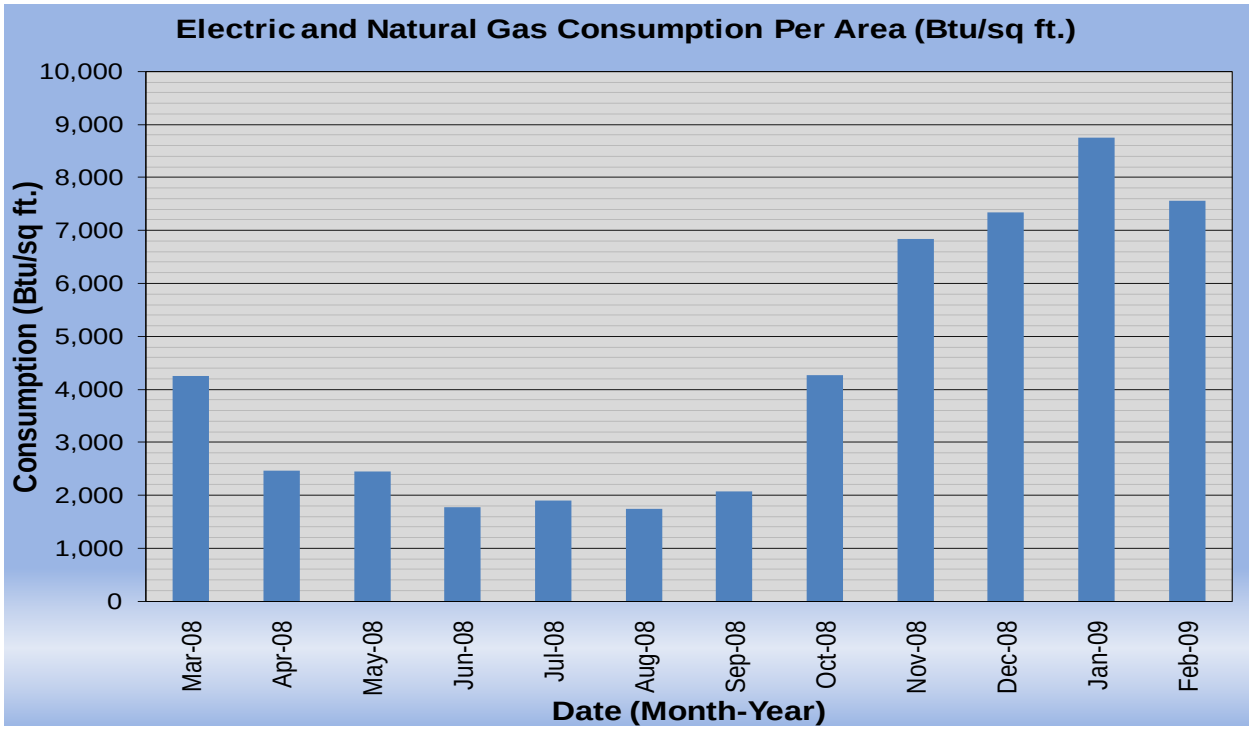
The following chart shows electricity use for the Heritage Middle School building based on utility bills for the 12 month period of March 2008 to February 2009.



The following chart shows the natural gas consumption for the Heritage Middle School building based on natural gas bills for the 12 month period of March 2008 to February 2009.

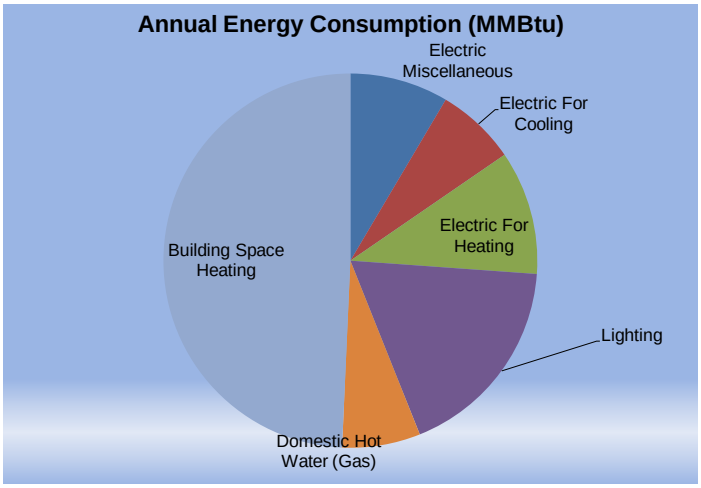


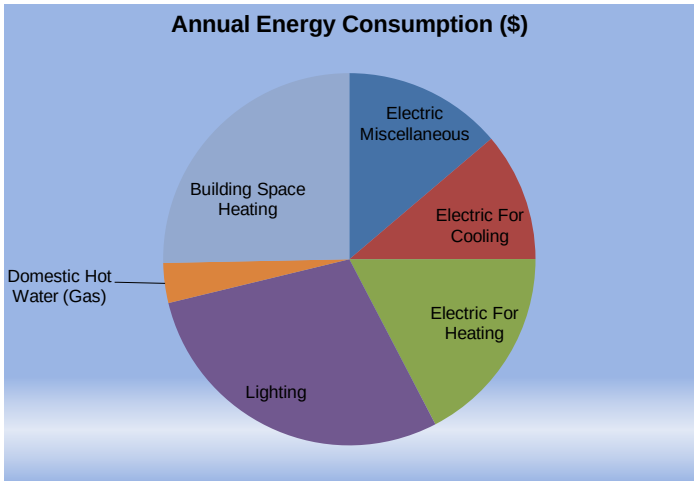
The following chart shows combined natural gas and electric consumption in Btu/sq ft for the Heritage Middle School building based on utility bills for the 12 month period of March 2008 to February 2009.



The following table and chart pies show energy use for the Heritage Middle School building based on utility bills for the 12 month period of March 2008 to February 2009. Note electrical cost at $49/MMBtu of energy is more than 3 times as expensive to use as natural gas at $16/MMBtu.

2008 Annual Energy Consumption / Costs					
	MMBtu	**% MMBtu**	**$**	**% $**	**$/MMBtu**
Electric Miscellaneous	660	9%	$32,605	14%	49
Electric For Cooling	536	7%	$26,475	11%	49
Electric For Heating	832	11%	$41,074	17%	49
Lighting	1,382	18%	$68,256	29%	49
Domestic Hot Water (Gas)	524	7%	$8,208	3%	16
Building Space Heating	3,825	49%	$59,864	25%	16
Totals	7,759	100%	$236,482	100%	30
Total Electric Usage	3,410	44%	$168,409	71%	49
Total Gas Usage	4,349	56%	$68,073	29%	16
Totals	7,759	100%	$236,482	100%	30





1.2. Utility rate

The Heritage Middle School building currently purchases electricity from PSE&G at a general service market rate for electricity use (kWh) with a separate (kW) demand charge. The Heritage Middle School building currently pays an average rate of approximately $0.169/kWh based on the 12 months of utility bills of March 2008 to February 2009.

The Heritage Middle School building currently purchases natural gas supply from the Hess Corporation at a general service market rate for natural gas (therms). PSE&G acts as the transport company. There is one gas meter that provides natural gas service to the Heritage Middle School building currently. The average aggregated rate (supply and transport) for the meter is approximately $1.565/therm based on 12 months of utility bills for March 2008 to February 2009.

Some of the minor unusual utility fluctuations that showed up for a couple of months on the utility bills may be due to adjustments between estimated and actual meter readings.

1.3. Energy benchmarking

SWA has entered energy information about the Heritage Middle School building in the U.S. Environmental Protection Agency's (EPA) *Energy Star Portfolio Manager* Energy benchmarking system. The building performance rating received is a score of 80 when compared to other school buildings of its kind. Buildings achieving an Energy Star rating of 75 or higher and professionally verified to meet current indoor environmental standards are eligible to apply for the Energy Star award and receive the Energy Star plaque to convey superior performance to students, parents, taxpayers, and employees. These ratings also greatly help when applying for Leadership in Energy and Environmental Design (LEED) building certification to the United States Green Building Council (USGBC).

The Site Energy Use Intensity is 52 kBtu/sq ft yr compared to the national average of a School building consuming 70 kBtu/sq ft yr. Implementing this report's highly recommended Energy Conservations Measures (ECMs) will reduce use by approximately 2.6 kBtu/sqft yr, with an additional 6.8 kBtu/sq ft yr from the recommended ECMs, 0.3 kBtu/sq ft yr from the recommended End of Life Cycle ECMs, and 8.4 kBtu/sq ft yr from improved window and roof insulation upgrades. These recommendations could account for at least 18.1 kBtu/sq ft yr reduction, which when implemented would make the building energy consumption even lower.

Per the LGEA program requirements, SWA has assisted the Livingston Board of Education to create an *Energy Star Portfolio Manager* account and share the Heritage Middle School facilities information to allow future data to be added and tracked using the benchmarking tool. SWA has shared this Portfolio Manager site information with the Livingston Board of Education (user name: "livingstonboe", with same password administered by Steven K. Robinson, Business Administrator / Board Secretary - Livingston Public Schools) and TRC Energy Services (user name: TRC-LGEA).

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Livingston BOE - Heritage Middle School

Building ID: 1877656
For 12-month Period Ending: January 31, 2009[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: November 09, 2009

Facility
Livingston BOE - Heritage Middle School
20 Foxcroft Drive
Livingston, NJ 07039

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1963
Gross Floor Area (ft²): 150,861

Energy Performance Rating[2] (1-100) 80

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	3,212,691
Natural Gas (kBtu)[4]	4,570,171
Total Energy (kBtu)	7,782,862

Energy Intensity[5]

Site (kBtu/ft²/yr)	52
Source (kBtu/ft²/yr)	103

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	732

Electric Distribution Utility
Jersey Central Power & Lt Co

National Average Comparison

National Average Site EUI	70
National Average Source EUI	141
% Difference from National Average Source EUI	-27%
Building Type	K-12 School

Stamp of Certifying Professional

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.

Meets Industry Standards[6] **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.

EPA Form 5900-16

2. FACILITY AND SYSTEMS DESCRIPTION

2.1. Building Characteristics

The three-story Heritage Middle School building was originally built in 1963 with several additions built in 2002. Currently the school consists of a total 150,861square feet of conditioned space. Besides various types of classrooms and administrative offices for both schools, the building has multipurpose, special education, science and music rehearsing rooms, a cafeteria, an auditorium, a gymnasium, a media center, boiler and utility rooms. The building consists of 150,861square feet of conditioned space.

2.2. Building occupancy profiles

Occupancy for the Heritage Middle School building is approximately 920 students and 111 teachers and staff personnel. The school is in session from 8:00 am to 3:30 pm. There are some weekly evening programs and gym activities 7:00 pm-10:00 pm. A Chinese teaching school with approximately 400 attendees meets Sundays 1:00 pm-5:00 pm from September through April. The YMCA operates a summer program from June 29 through August 15, 8:30 am-1:00 pm with a staff of approximately 20 counselors and attended by approximately 250 students. During summer recess, approximately 30 part-time workers clean and perform annual maintenance on the building.

2.3. Building envelope

2.3.1.Exterior Walls

The exterior wall envelope consists of a mixture of 4" brick veneer (original building sections) and split face masonry units (2002 additions). Interior wall finishes are a mix of painted CMU and gypsum wall board. The original building wall assemblies do not contain wall insulation. During the next major construction, SWA recommends insulating the exterior walls of the original structure by adhering 2" polyiso boards (Polyisocyanurate) together with furring strips and gypsum wall boards to the inside of the painted CMU walls.

The 2002 additions of the building wall assemblies contain 2" of rigid insulation between the interior and exterior CMU walls.

Two types of exterior wall finishes

Uncontrolled roof water run-off

The above image shows damage to the exterior brick veneer due to improper flashing. Noted in section 2.3.2, special attention should be given to roof drainage to avoid water damage to exterior wall assemblies. At the time of the audit, the exterior walls appeared to be in age appropriate condition. Attention and maintenance should be given to these areas as uncontrolled roof water runoff can potentially penetrate exterior walls and cause energy losses and structural damage.

2.3.2. Roof

There are four types of roofing systems employed at this school: A flat Hypalon system, single-ply ballasted EPDM roofing, built-up roofing and a pitched system with light grey asphalt shingles.

The older gym is covered with a white colored Hypalon roof system. This area is insulated with 1 to 2 inches of tapered insulation. At the time of the audit, maintenance personnel indicated this section is consistently leaking and has required numerous repairs over the years. The built-up roofing systems (installed in 2001 & 2004) over the newest additions has continuous insulation above the deck. Architectural plans exist for these areas, but do not specify a thickness of the insulation. A notes just indicates, "Cold Process Built-Up Roofing System over 'Uniform' Insulation (TYP.)". These roofs are in good condition and no major issues were reported by the maintenance staff. The single-ply EPDM roofing is in poor condition. There weren't any plans for these sections, and during the site visit, conditions were too warm to gage the condition of insulation via Infrared Technology. Experience with the other schools in the Livingston Public Schools district with similar roofs show these EPDM roofs to have very little and uneven insulation. The pitched light grey asphalt shingle roof sections were replaced in 2004 and appear to be in good condition. Maintenance staff reported problems with leaks around the structure that holds the mechanical equipment that penetrates the shingled portion. 1" faced batt insulation is installed under the pitched portions of the roof. Regular maintenance should be performed on all roof areas to prevent leaks and ensure damaged roof areas, such as the one in the following image, are avoided.

SWA recommends replacement of the older built-up roof sections with an Energy Star certified roof membrane and rigid insulation (3") assembly in addition to replacing asphalt shingle roofs with and architectural type asphalt shingle for better durability and life-span.

Image shows 4 different roofing materials

Roof water run-off causing water to penetrate exterior wall finish

2.3.3. Base

The building's base is a 4" concrete slab-on grade with a perimeter footing and concrete block or poured concrete stem walls. No water seepage through the slab or other issues related to thermal performance was detected.

2.3.4. Windows

A section of the building's windows are original, full height aluminum, single glazed and in need of replacement. Due to the fact that the windows are non-thermal break single glazed with un-insulated panels above them, they are very energy inefficient. Spacers between the older windows are cracked and brittle. SWA recommends replacing approximately 386 windows with double-glazed thermal break low-E aluminum framed windows. Regular maintenance should be performed, re-caulking around the perimeter of windows (exterior and interior) to ensure a tight seal. The newer building sections contain double glazed windows found to be in very good condition.


Older wall section with aluminum single pane windows; New addition with low-e double pane windows


Older windows showing cracked and damaged caulk


Duct tape used in classroom to try to prevent air infiltration

Additionally, window AC units should be removed for winter conditions. If removal of these units is not feasible, SWA recommends airtight covers (such as Chill Stop-R) or a gasketed cover for optimal performance.

2.3.5.Exterior doors

The aluminum and vinyl exterior doors were inspected and observed to be in good condition except for some weather-stripping that started to show wear and tear at the time of the inspection. SWA recommends that the exterior doors of the building be weather-stripped in order to decrease the amount of conditioned air that is lost around each door. SWA also recommends checking the weather-stripping of each door on a regular basis and replacing any broken seals. Tight seals around doors will help ensure the building to be is kept continuously insulated.

2.3.6.Building air tightness

In addition to the above mentioned recommendations SWA suggests air sealing, caulking and / or insulating around all plumbing, electrical, HVAC and structural envelope penetrations. This should include bottom and top plates, recessed light fixtures, electrical boxes, chimney walls and window, or sleeve air conditioner units. Special care and attention should be made to avoid the disturbance of asbestos throughout the building. SWA recommends removal of all asbestos-like material before air sealing the building.

2.4. HVAC Systems

Heritage Middle School is primarily heated by a hot water heating system. Much of the heating is provided by four (4) non-condensing boilers located in the Boiler Room, but there are also some newer portions of the building that utilize gas-fired heating or heating / cooling equipment. The boiler room also serves as storage space for the maintenance and vehicle repair staff, making access to the heating plant difficult.

2.4.1.Heating

The 2002 classroom wing addition has a variety of HVAC systems. The Second (top-most) Floor is served by two Carrier rooftop gas-fired Variable Air Volume (VAV) HVAC units for heating, ventilating and air conditioning, with each Second Floor classroom having its own VAV box and distribution ductwork to ceiling diffusers. The second floor corridors of the classroom addition, the adjacent Special Education Resource Rooms and the lower, first and second floor Special Education Resource Rooms just inside the original building from the addition are also served by this VAV system.

One of the two VAV Packaged Rooftop Units on the 2002 Addition

There are also three (3) roof-mounted gas-fired make-up air units which appear to supply air to the labs and one of the Food & Culinary Science rooms on the First Floor, when the respective room exhaust fan is energized. The First Floor and Ground Floor classrooms and SGI's each have a hot water unit ventilator. The Multi-Purpose Room on the back of the Gym was added in 2002, and it and its two vestibules are heated by an Aaon gas-fired H&V unit on the roof.

The original 1964 portion of the building has a variety of hot water heating units. Scattered throughout the school are enclosed wall mounted and ceiling mounted finned tube radiation or convectors or cabinet unit heaters in the corridors, vestibules, stairways, lobbies and toilet rooms. The majority of the classrooms in the 3-story classroom wing contain unit ventilators. These appear to have been replaced, possibly when the 2002 addition was built, and are in very good condition. The unit ventilators on the Second (top-most) Floor have direct expansion (DX) cooling in the form of a cooling coil with split condensing units on the roof. See "Cooling" below for more discussion on this. First Floor and Second Floor Special Education rooms are heated by a gas-fired heating / DX cooling rooftop HVAC unit which was installed when the 2002 classroom wing was built. The SGI next to the Gym has a small unit ventilator.

The Gym has four (4) H&V units, one suspended from the roof structure in each corner, along with four (4) exhaust fan assemblies. Each of the locker rooms has a newer McQuay horizontal unit ventilator as well as two (2) electric unit heaters. The Auditorium is heated by (2) heating & ventilating units located in the attic space.

One of Four Heating & Ventilating Units Serving the Original Gym

Each of the Art Rooms has a hot water unit ventilator. The Computer Room was not accessible at the time of the survey, but evidence points to a unit ventilator providing the heating for this room.

Each of the First Floor exterior Music Rooms has a unit ventilator, while the interior ancillary rooms are heated by a gas-fired, DX cooling rooftop HVAC unit, which is ducted above the roof to the various rooms. The Music Rehearsal Rooms behind the stage appear to be heated by this same RTU.

Each of the two Tech Ed Rooms has a hot water unit ventilator, and there are un-ducted suspended air filtration units, as well as an exterior-mounted dust collection system. The Special Ed and Nurse, each has a unit ventilator. The other offices in that wing are served by an original vertical split system

air handler with electric heat that is ducted along the outside wall. It is suspected that the electric heat is no longer operational. In addition, these rooms contain enclosed finned-tube radiation.

The Media Center is heated by two (2) hot water unit ventilators on the outside wall. The Cafeteria is heated by two (2) hot water heating air handlers. All of this equipment was installed during the latest renovations to the building and is in relatively good condition.

It appears that all of the original unit ventilators were replaced as part of a 2002 renovation in the building. In total, the school contains approximately sixty (60) AAF unit ventilators. This equipment is in good condition.

Each unit ventilator contains a heating coil, fan assembly, damper, filter and controls within a metal cabinet. As mentioned above, some unit ventilators also have DX cooling coils. It is the intent of the equipment that it should introduce outdoor air via a grille and damper located on the outside wall. The units are designed to mix room air with outside air, condition the air as required, and delivered to the occupied space. The wall mounted AAF unit ventilators deliver the air directly through a grille on the top of the unit.

The heating hot water is produced by four (4) Patterson Kelly boilers of equal capacity located in the boiler room. The boilers were installed in the year 2001 approximately. According to their age, the boilers have more than 20 years remaining on their expected service life of 30 years, as published in the 2007 ASHRAE HVAC Applications Handbook. The burners are integral to these boilers.

The heating system piping is set up in a primary-secondary loop system. Each boiler has a small pump that injects hot water into the building hot water heating system loop. There are two pairs (main and backup) of base-mounted hot water circulating pumps, one pair for the old wing and one pair for the new wing. It is assumed that the circulating pumps were installed as part of the 2000 installation of the boilers. The pump motors are about half way through their expected service life of 20 years. SWA recommends that the pump motors are replaced with premium efficiency motors.

Boilers

The building contains a Johnson Controls Metasys EMS system to monitor the older equipment and control the newer equipment, and that can communicate with the district-wide EMS system.

There weren't any complaints about the ability of the heating system to provide adequate heating to the building occupants. At some point in time, the controls in this building were converted from pneumatic to direct digital control. All the control valves and sensors throughout the building were

reportedly converted to a Direct Digital Control (DDC) system, except for those serving the equipment in the office wing (probably because a retrofit may have been difficult or very expensive). Therefore, the air compressor remains for this one area. SWA recommends replacement of this air handler that is beyond its life expectancy, and tying the replacement unit into the DDC system, and removing or decommissioning the air compressor for the pneumatic controls.

2.4.2. Cooling

As mentioned above, the top floor of both classroom wings has cooling supplied by either unit ventilators or a rooftop VAV unit. All of this equipment is circa 2002 and not in need of replacement. Since the equipment is relatively recent, replacement solely for achieving higher energy efficiency would not be financially sensible.

First Floor and Second Floor Special Education rooms are cooled by a gas-fired heating / DX cooling rooftop HVAC unit which was installed when the 2002 classroom wing was built.

The Computer Room was not accessible at the time of the survey, but there is a condensing unit on the roof of the Wood Shop that appears to be associated with this room.

Each First Floor exterior Music Rooms has a unit ventilator with split system DX condensing unit, while the interior ancillary rooms are served by a gas-fired, DX cooling rooftop HVAC unit of about four tons, which is ducted above the roof to the various rooms. The Music Rehearsal Rooms behind the stage appear to be served by this same RTU.

The Media Center has two (2) unit ventilators on the outside wall, each with a split system condensing unit on grade outside. The Cafeteria is served by two (2) hot water heating air handlers with DX coils connected to two (2) remote condensing units on the roof.

Most of the cooling present in the remaining portions of the building is in the form of window air conditioning units in several of the classrooms and offices, approximately 25 in all. According to the head custodian, most of the window air conditioning units were 1-10 years old, and they appeared to be in operating condition but some were clearly nearing the end of their expected life.

2.4.3. Ventilation

The second floor of the 2002 addition, the First Floor and Second Floor Special Education rooms, and the newer Music rooms mentioned above are all ventilated by their respective rooftop HVAC units. The Cafeteria, original Gym and Auditorium are ventilated by their respective air handling units. The remainder of the spaces is ventilated by their unit ventilators.

As mentioned above, the grilles on the AAF unit ventilators provide fresh air to the occupied space. Air handlers have outside air intakes. Measurement or verification of the code compliance for ventilation was not part of this energy study. However, should any retro-commissioning or system upgrades be made part of some capital improvement project, the scope should include readjustment of outside air dampers to provide code compliant level of outside air to the spaces.

The building has many exhaust fans in various locations, some which do not operate. SWA recommends that this equipment is replaced as part of the End of Life ECM#8, and that it is designed to provide code minimum ventilation rates.

2.4.4.Domestic Hot Water

There are two domestic hot water heaters in the Boiler Room. One is a gas-fired Raypack water heater and the other is a Ruud electric tank type water heater. The former appears to be in good working condition as well as its circulating pumps. It is reported that the latter tank is not used (at one time it may have been used for a kitchen dishwasher booster heater). Further evidence of this conclusion is that this dishwasher appears to be used for storage of cleaning supplies.

Domestic Water Heater

2.5. Electrical systems

2.5.1.Lighting

Interior Lighting - The Heritage Middle School building currently consists of mostly T8 fluorescent fixtures with electronic ballasts. Based on measurements of lighting levels for each space, there are not any vastly over-illuminated areas. SWA recommends installing occupancy sensors in bathrooms, closets, offices and areas that are occupied only part of the day and payback on savings are justified. Typically, occupancy sensors have an adjustable time delay that shuts down the lights automatically if no motion or sound is detected within a set time period. SWA recommends replacing the gymnasium Metal Halide fixtures with T5 fixtures. SWA highly recommends replacing the Auditorium incandescent lamps with CFLs. See attached lighting schedule in Appendix A for a complete inventory of lighting throughout the building and estimated power consumption.

Exit Lights - Exit signs were found to be LED type.

Exterior Lighting - The exterior lighting surveyed during the building audit was found to be a mix of CFLs and High Pressure Sodium fixtures. Exterior lighting is controlled by astronomical timers. SWA does not recommend replacing these lights designed for building occupant safety and security. Also, SWA is not recommending at this time any upgrades to the exterior timers.

2.5.2.Appliances and process

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. Also, energy vending miser devices are now available for conserving energy usage by Drinks and Snacks vending machines. When equipped with the vending miser devices, vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR qualified machines.

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. fridges, coffee makers, televisions, etc) be plugged in to power strips and turned off each evening just as the lights are turned off. The Livingston Heritage Middle School building computers are generally programmed for the power save mode, to shut down after a period of time that they have not been used.

Commercial Kitchen Equipment

There are several pieces of refrigeration equipment located in the kitchen and adjacent Faculty Dining, including an ice machine, (2) residential refrigerators, (5) reach-in soft drink refrigerated merchandisers and a chest type ice cream freezer. This equipment all seems to be in fair to good condition. There is also a walk-in box that is approximately 20'wide x 15' deep. This unit appears to be at least 10-15 years old

There are also several pieces of commercial-style cooking equipment, including a gas-fired 6-burner oven range, a fryer, (2) electric convection ovens, an electric conveyor pizza oven and a tall heated storage cabinet. There is a large kitchen hood provided for this equipment. There is also a commercial kitchen style dishwasher with hood, but it did not appear that this dishwasher was used since it appeared to be used for storage of cleaning supplies. It does not appear that any dedicated makeup air is provided for the kitchen hoods. The makeup air is likely provided via transfer from the adjacent Cafeteria air handling units or via infiltration from nearby exterior doors and windows.

Commercial Dishwasher in Kitchen

2.5.3.Elevators

The Heritage Middle School has a hydraulic elevator for ADA purposes with a submersible hydraulic pump motor; HP 30; PF 87.1; SF 1.0; EFF 74, working PSI 500.

2.5.4. Others electrical systems

There are not currently any other significant energy impacting electrical systems installed at the Heritage Middle School building.

3. EQUIPMENT LIST

Inventory

Building System	Description	Location	Model #	Fuel	Space Served	Year Installed	Estimated Remaining Useful Life %
Heating	(4) boilers, Hot water	boiler rm	Patterson-Kelley M# N-2000-2 1,200-2,000 MBH input 1,700 MBH output	Natural Gas	Building	2001 2001 2001 2002	65% 65% 65% 70%
Heating	(4) circulator pumps to boilers	boiler rm	Grundfos Type UPS: 100-40/4 P/N: 96402935 PC: 0128	Electric	Building	circa 2002	Est. 50%
Heating	(28) hot water unit ventilators	3 story class-room wing	AAF	Electric	classrooms in 3 story wing	circa 2002	70%
Heating	(20) hot water unit ventilators	3 story class-room wing	AAF	Electric	1st & 2nd floor classrooms in 2002 addition wing	2002	70%
Heating / Cooling	(8+) VAV boxes	2002 addition 3rd flr class-rooms	Unknown	Electric	3rd floor classrooms in 2002 addition	2002	65%
Heating	(5) Cabinet unit heaters, hot water	stairwells in both 3 story wings	McQuay	Electric	stairwells in both 3 story wings	2002	65%
Heating	Finned-tube radiators (surface-mounted and recessed units)	both 3 story wings	Varies	Electric	various rooms, corridors, and toilet rooms in 3 story wings	2002	70%
Heating	(2) Hot water supply pumps	boiler rm	Taco Pump M# FE1510E2E1FL0A Baldor Motor CAT# M3218T Spec: 36B101Y697H1 208V, 13.2A, 5HP	Electric	1 & 2: New Wing	Pumps 2001	60%
Heating	(2) Hot water supply pumps	boiler rm	Taco Pump M# FE3008E2E1F2L0A Baldor Motor CAT# 33131 Spec: 37B101Y6514H1 208V, 28A, 10HP	Electric	3 & 4: Old Wing	Pumps 2000	55%

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Building System	Description	Location	Model #	Fuel	Space Served	Year Installed	Estimated Remaining Useful Life %
Domestic Hot Water	Domestic Hot Water circulator pump	boiler rm	Dayton M# 6XJ27BA 208V, 5.8A, 3/4HP	Electric	Building	circa 2001	Est. 75%
Domestic Hot Water	Pump to (Raypack) water heater	boiler rm	Taco M# 0012-F4-2 115V, 1.57A, 1/8HP	Electric	Building	circa 2001	Est. 75%
Domestic Hot Water	Gas water heater	boiler rm	Raypack M# WH1-0260 S# 0108185135 264 MBH in	Natural Gas	Building	2001	65%
Domestic Hot Water	Super Heat water heater	boiler rm	Ruudglas Commercial M# EGLS120-54-G S# RU 0486500277 480V, 65A, 54kW	Electric	Appears to be Abandoned	2004 (not con-firmed)	65%, some damage to exterior
Heating	(4) Hot Water H&V Units	Original Gym	Nameplate Not Accessible	Electric	Middle School Gym	Circa 1964	0%, operating past expected useful life
Heating	(2) Ceiling unit ventilators	locker-rooms	McQuay	Electric	Locker rooms	circa 2000	70%
Heating	(4) Electric unit heaters	locker-rooms	Unknown 5 KW ea.	Electric	Locker rooms	Circa 1964	20%
Heating	(2) Hot Water H&V Units	Auditorium	Nameplate Not Accessible	Electric	Auditorium	Circa 1964	0%, operating past expected useful life
Heating	(1) RTU	Gym roof	Aaon M# RK-13-3-00-33M: E0CD0B00H00G0X S# 200110-AKGK28949 390 MBH input 316 MBH output Evaporator 3 HP, 4.8 FLA	Natural Gas	Auxiliary Gym	2001	45%

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Building System	Description	Location	Model #	Fuel	Space Served	Year Installed	Estimated Remaining Useful Life %
Heating / Cooling	(1) RTU	2nd Floor Roof	Carrier M# 48HJD005- - - 541BW S# 3201G24617 50 - 72 MBH input 41 - 59.04 MBH output 82% Efficiency Compressor 208V, 3ph, 13.5 RLA	Natural Gas/Electric	Music Rehearsal Rooms and practice rooms	2001	45%
Cooling	(2) Air-cooled condensing units (Direct Expansion Evaporators)	2nd Floor Roof	McQuay M# ALP037CS27-ER10 S# STNV010800067 S# STNV010800066 Compressor 460V, 3ph, 60 RLA, 35HP	Electric	Cafeteria	2001	60%
Heating	(2) Hot Water H&V Units	Cafeteria	Nameplate Not Accessible	Electric	Cafeteria	Assumed 2001	60%
Heating / Cooling	(1) RTU	New Wing 3rd Floor	Carrier M# 48EKD028- - - S# 3201F03333 Series 610CD 262.5 - 350.1 MBH input 283.5 MBH output 81% efficient	Natural Gas/Electric	2002 addition	2001	45%
Heating / Cooling	(1) RTU	New Wing 3rd Floor	Carrier M# 48EKD024- - - S# 3201F03320262.5 350.1 MBH input 283.5 MBH output 81% efficient	Natural Gas/Electric	2002 addition	2001	45%
Heating / Cooling	(1) RTU	roof	Carrier, Similar to Music Rooms RTU above	Electric	Spec. Ed rooms floors 1-3	2001	45%
Cooling	(25) window AC units throughout the building	Offices	Varies	Electric	25 offices and classrooms	Varies	varies, estimating 50%
Heating / Cooling	Air handling unit	Front desk / office	General Electric M# RGWE960C1C02	Electric	Front desk/office	Circa 1964	0%, beyond expected useful life
Cooling	Condensing unit	Roof	General Electric M# BGTA860R1D S# 226652412	Electric	Front desk/office	Circa 1964	0%, beyond expected useful life
Cooling	(2) Condensing units	grade	York M# H1RA048S46A S# WKJM018724 S# WKJM020725	Electric	Media Center	2000	55%

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Building System	Description	Location	Model #	Fuel	Space Served	Year Installed	Estimated Remaining Useful Life %
Cooling	Condensing unit	roof	York (nameplate worn off)	Electric	Music room	circa 2002	65%
Cooling	Condensing unit	roof	Coleman M# ERCS0421BBB S# WOE7760472	Electric	Music Comp. Room	2007	90%
Cooling	Condensing unit	roof	York M# H1RA042S06D S# WALM005629	Electric	Music Comp. Room	2002	65%
Cooling	(2) Condensing units	roof	Coleman M# ERCS0361BBB S# WOD7672428 S# WOD7672429	Electric	Music practice room and Music Comp Room	2007	90%
Cooling	(9) Condensing units	original 3rd floor roof	York M# H1RA048S46A	Electric	3rd floor classrooms	2000	55%
Cooling	Condensing unit	original 3rd floor roof	Samsung M# UM18B1CS S# P1LW500001	Electric	VP Office/Sec/Rec	circa 2001	55%
Cooling	(3) Condensing units	2002 Addition roof	York M# H1RA048S06D	Electric	various roms in addition wing	2002	65%
Ventilation / heating	Tempered Make-up Air Unit	2002 Addition roof	Sterling / Kees M# MUA-12 3150 CFM, 1.5 HP	Natural Gas	Science room with hood	2002	55%
Ventilation / heating	(2) Tempered Make-up Air units	2002 Addition roof	Sterling / Kees M# MUA-9 800 CFM, 1/2 HP	Natural Gas	Science rooms with hood	2002	55%
Ventilation / heating	Tempered Make-up Air Unit	2002 Addition roof	Hastings M# RMUA-160G	Natural Gas	Science room with hood	2002	55%
Ventilation	(39) Roof exhaust fans; for general, toilet, and kitchen exhaust	roof	Varies	Electric	building	Varies	0-50%
Heating	(4) Cabinet unit heaters, hot water	stairwells & exits of original building	Nesbitt	Electric	stairwells & exits in original building	circa 2000	50%
Heating	Hot water Radiators	original building	Varies	Electric	various rooms and corridors on original building	circa 1964	0%, beyond expected useful life

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Building System	Description	Location	Model #	Fuel	Space Served	Year Installed	Estimated Remaining Useful Life %
Heating	(14) Hot water unit ventilators	original building	AAF	Electric	various rooms and offices in original building	circa 2000	65%
Ventilation	(4) Un-ducted air cleaners	Tech. Ed Rooms	Airflow Systems M# F70	Electric	Tech. Ed. Rooms	circa 2000	50%
Ventilation	(2) Ducted dust collection systems	Tech. Ed Rooms	Unknown	Electric	Tech. Ed. Rooms	unknown, est 1980s	20%
Heating	Ceiling cabinet unit ventilator	Mezz. of Tech Ed. Room	Unknown	Electric	Tech. Ed. Rooms	circa 1964	20%
Heating	Wall mounted unit ventilator	Tech. Ed Room	MagicAire M# MUHA-5-1 S# W010585023	Electric	Tech. Ed. Rooms	2001	65%
Misc.	(2) Kilns	Art rooms	Everheat M# RM11-2329D 9984 Watts Paragon M# 290359 10800 Watts	Electric	Art rooms	Circa 2002	Est 80%
Electrical	(2) Transformers	2nd floor near elevator	General Electric M# 9T23Q9872 30 KVA	Electric	2002 addition	2002	75%
Refriger.	(2) Refrigerators	Faculty Dining	Whirlpool M# ET1WTKXKQ00 6.5 FLA Gen. Elec. M# GTS21KBXAWW	Electric	Faculty Dining	2001	Est. 50%

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Building System	**Description**	**Location**	**Model #**	**Fuel**	**Space Served**	**Year Installed**	**Estimated Remaining Useful Life %**
Refriger.	(5) Reach-in coolers	Kitchen	True cooler M# QDM-37HLPE57221 Refrig M# AK4460Y 1/2 HP, 8.9 FLA True M# GDM-37 1/2 HP, 8.9 A Refrig. M# AK4460Y (2) Beverage Air M# MT38 Beverage Air M# UR30G 4 A Carrier M# CT96 3.9 A	Electric	Kitchen	Varies	Est. 50%
Refriger.	Walk-in Box Cooler	Kitchen	Unknown	Electric	Kitchen	Est 1990s	Est 50%
Refriger.	Ice cream freezer	Kitchen	AHT M# R10S100 270 Watts	Electric	Kitchen	unknown	Good Condition, est. 75%
Refriger.	Ice cube machine	Kitchen	Hoshizaki M# KM-450MWB	Electric	Kitchen	unknown	Good Condition, est. 70%
Elevator	Hydraulic ADA Elevator	Middle School	ThyssenKrupp elevator with submersible hydraulic pump motor; HP 30; PF 87.1; SF 1.0; EFF 74, working PSI 500.	Electric	Middle School	Circa 2002	Est. 75%
Lighting	See details - Appendix A	building	-	Electric	Building	varies	varies, average 60%

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 Livingston Heritage Middle School, 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 (2) H&V units serving the Auditorium - The hot water heating only ventilation system for the Auditorium is beyond its expected service life. SWA recommends that this equipment is replaced as part of a capital improvement project, and that it is designed to provide code minimum ventilation rates. The Livingston Public Schools may wish to consider providing DX cooling as part of this system to make the room more functional in warm weather, but should recognize that this will increase energy usage versus providing a heating and ventilation system only. If cooling is desired, it is strongly recommended that a system is provided that utilizes a heat recovery wheel for pretreatment of the outside air. This is a replacement in kind recommendation which offers negligible energy savings.

- Replace (4) H&V units serving the 1964 Gym - The hot water heating only ventilation system for the 1964 Gym is operating beyond its expected service life. SWA recommends that this equipment is replaced as part of a capital improvement project, and that it is designed to provide code minimum ventilation rates. The Livingston Public Schools may wish to consider providing DX cooling as part of this system to make the room more functional in warm weather, but should recognize that this will increase energy usage versus providing a heating and ventilation system only. If cooling is desired, it is strongly recommended that a system is provided that utilizes a heat recovery wheel for pretreatment of the outside air. This is a replacement in kind recommendation which offers negligible energy savings.

- Replace common area heating emitters - such as finned tube radiation and cabinet unit heaters in the toilet rooms, vestibules and corridors. This equipment is in fair condition, but 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 along with upgrades to other portions of the heating system. This is a replacement in kind recommendation which offers negligible energy savings.

- Replace window air conditioners - Several of the existing window air conditioners still have some useful life remaining (on the average 0-5 years left) but replacement should be considered with more modern, energy efficient systems. The window air conditioners should be replaced with split systems to allow for closing up of the existing window penetrations. These upgrades cannot be justified by energy savings alone but will result in a decrease in energy usage versus the existing equipment. In addition, the existing systems utilize R-22 refrigerant, which is not an ozone-friendly refrigerant. Newer systems should be specified with R-410A refrigerant.

- Upgrade Building Management System (BMS) - Currently, the office wing is controlled by an antiquated, pneumatic temperature control system while the remainder of the building is controlled by a more modern Direct Digital system. The BMS should be expanded and upgraded to control the new equipment proposed to be replaced as part of the capital improvement recommendations. This upgrade will result in energy savings via improved temperature control and by the elimination of the air compressor. This recommendation will ensure that the retro-commissioning estimated savings (per ECM#6) are maintained and reproducible.

- Replace (2) exterior dust collection systems and associated interior ductwork, exhaust arms, etcetera… in (2) Tech Education classrooms. This is a replacement in kind recommendation which offers negligible energy savings (since systems are operated only a few hours/year) even when upgrading the low Hp blower motors to NEMA premium motors.

- Provide dedicated makeup air to the kitchen via rooftop makeup air unit to reduce the possibility of infiltration of outside air via doors and windows when the kitchen hood is running. Infiltration of outside air may cause the heating or cooling systems to work harder than necessary in response to thermostat adjustments by the occupants.

- Replace windows - SWA evaluated, as part of a capital improvement plan, replacing approximately 386 single-pane windows with newer models with thermal breaks, dual glazing and a low-e rating. Proper flashing and caulking should be performed upon installation of the new windows.

  Most of the building contains double glazed windows found to be in good condition. Sections of the building contain approximately 386 single-pane fixed and casement aluminum-framed windows with single-glazing. These windows appear to be original to the building. In context of other energy measures proposed in this report and in an effort to maximize the cost-benefit factor for improvements, SWA recommends that these 386 windows be replaced with the next major capital improvement / renovation project. Windows considered for replacement should have the following outline specifications besides conforming to local code and regulations: the windows shall be aluminum frame thermally manufactured as double hung commercial type modules. The clear, low-e, argon filled dual glazing should be 2 independent panes. The walls should be extruded aluminum with integral poured-in-place thermal barrier. All horizontal rails should be of tubular shape and joinery should be butted and coped with stainless steel screws. Air infiltration shall not exceed 0.10 cfm/sf of unit. The conductive thermal transmittance (U-Value) shall not be more than 0.51 Btu/hr sq ft °F.

  An E-Quest model was performed to estimate energy savings with the new proposed windows.
  The assumptions made in the E-Quest model were that existing window U-Value is 1.09 Btu/hr sq ft °F vs. the improved thermally insulated window U-Value of 0.51 Btu/hr sq ft °F. The installed cost of approximately 386 replacement school building window units of the type outlined above is estimated to cost $772,000, based on RS Means 2009 (Building Construction Cost Data) and similar projects, which would provide $12,671 annual energy savings and a 61 year simple payback, which could reduce the building's energy requirements by at least 3.5 kBtu/sq ft yr. The Livingston Public Schools are eligible for a 40% state grant, which will decrease the new windows simple payback to 37 years when the December bond referendum passes. Window replacement rebates and tax incentives are available only for residential buildings at this time. This investment cannot be justified by energy savings alone and should be considered as part of a major renovation plan.

  In the meanwhile, operable commercial grade blinds for more glair and thermal control can be an economical solution throughout the building where necessary, while selected window films are only effective on thermally manufactured window frames or tight vinyl frames.

- Insulate exterior walls and replace roof - During the next major construction, SWA recommends insulating the exterior walls of at least the original structure by adhering 2" polyiso boards (Polyisocyanurate) together with furring strips and gypsum wall boards to the inside of the painted CMU walls.

SWA recommends adding 10" of fiberglass insulation at the interior or 3"exterior XPS during future reroofing. SWA also recommends the EPDM areas of the roof to be replaced due to age and condition. Cracked seams were detected and overall it looks that the roof has reached its expectant life span. SWA recommends replacement of the 1992 Hypalon and ballasted EPDM single-ply roof sections with an Energy Star certified membrane and insulation (3" rigid) assembly. Maintenance should be performed at regular intervals with a roofing contractor to prevent future roof leaks. It is also advisable to upgrade any questionable roof integrity areas before photovoltaics are installed, as any repairs after the system is installed will be costly.

An E-Quest model was performed to estimate energy savings with the new proposed roof. The assumptions made in the E-Quest model were that the existing roof U-Value is 0.475 Btu/hr sq ft °F vs. the new EPDM - 3" XPS insulated roof U-Value of 0.069 Btu/hr sq ft °F. The estimated 26,500 sq ft insulated roof replacement cost is approximately $265,000, based on RS Means 2009 (Building Construction Cost Data) and similar projects, which would provide $11,529 annual energy savings and a 23 year simple payback, which could reduce the building's energy requirements by at least 4.9 kBtu/sq ft yr. The Livingston Public Schools are eligible for a 40% state grant, which will decrease the new roof simple payback to 14 years when the December bond referendum passes.

- Upgrade building per ADA requirements - SWA recommends that the Livingston Board of Education do as much as possible to comply with the latest ADA regulations.

- Install premium motors when replacements are required - Select NEMA Premium motors when replacing motors that have reached the end of their useful operating lives.

Category II Recommendations: Operations and Maintenance

- Boiler room and building piping insulation - Insulate un-insulated hot water piping to efficiently deliver heat where required and provide personnel protection.

- Check water levels in the expansion tanks and the integrity of the tank bladders in order to confirm proper operation.

- Inspect and replace gaskets around doors into walk-in refrigeration box in the Kitchen. Ineffective gaskets allow infiltration of warm air into the walk-in box, which increases the run-time of the compressors.

- Asbestos abatement - Abate asbestos insulating old piping and other building systems per local codes and regulations.

- Maintain roofs - SWA recommends regular maintenance to verify water is draining correctly.

- Maintain downspouts - Repair / install missing downspouts as needed to prevent water / moisture infiltration and insulation damage.

- Provide weather stripping / air sealing - SWA observed that exterior door weather-stripping in places was beginning to deteriorate. Doors and vestibules should be observed annually for deficient weather-stripping and replaced as needed. The perimeter of all window frames should also be regularly inspected and any missing or deteriorated caulking should be re-caulked to provide an unbroken seal around the window frames. Any other accessible gaps or penetrations in the thermal envelope penetrations should also be sealed with caulk or spray foam.

- Repair / seal wall cracks and penetrations - SWA recommends as part of the maintenance program to install weep holes, install proper flashing, correct masonry efflorescence and seal wall cracks and penetrations wherever necessary in order to keep insulation dry and effective.

- 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.

- Use smart power electric strips - in conjunction with occupancy sensors to power down computer equipment when left unattended for extended periods of time.

- Create an energy educational program - that teaches how to minimize their energy use. The US Department of Energy offers free information for hosting energy efficiency educational programs and plans, for more information please visit: http://www1.eere.energy.gov/education/

Category III Recommendations: Energy Conservation Measures

Summary table

ECM#	Description of Highly Recommended 0-5 Year Payback ECMs
1	install Drinks and Snacks vending machine energy misers
2.1, 2.2 & 2.3	install occupancy sensors, replace gymnasium Metal Halide lamps with T5 fixtures and Auditorium stage incandescent lamps with CFLs
3.1& 3.2	replace motors with premium efficiency type on heating hot water circulating pumps
4	replace motors with premium efficiency type on refrigerated walk-in box
	Description of Recommended 5-10 Year Payback ECMs
5	install 116 kW PV rooftop system
6	retro-commission mechanical equipment
	Description of Recommended End of Life Cycle ECMs
7	replace reach-in ice cream freezer with an Energy Star model
8	replace exhaust fans with premium efficiency units

ECM#1: *Install Vending Misers*

Description:

The Heritage Middle School building has one Drinks and two Snacks vending machines in the Cafeteria, two Drinks vending machines outside and one in the Teacher's Lounge, besides the five Drinks reach-in refrigerated coolers in the Cafeteria. Energy vending miser devices are now available for conserving energy with these vending machines and coolers. There isn't a need to purchase new machines to reduce operating costs and greenhouse gas emissions. When equipped with the vending miser devices, refrigerated beverage vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR qualified machines. Vending miser devices incorporate innovative energy-saving technology into small plug-and-play devices that installs in minutes, either on the wall or on the vending machine. Vending miser devices use a Passive Infrared Sensor (PIR) to: Power down the machine when the surrounding area is vacant; Monitor the room's temperature; Automatically repower the cooling system at one- to three-hour intervals, independent of sales; Ensure the product stays cold.

Snacks vending miser devices can be used on Snacks vending machines to achieve maximum energy savings that result in reduced operating costs and decreased greenhouse gas emissions with existing machines. Snacks vending miser devices also use a Passive Infrared Sensor (PIR) to determine if there is anyone within 25 feet of the machine. It waits for 15 minutes of vacancy, then powers down the machine. If a customer approaches the machine while powered down, the snacks vending miser will sense the presence and immediately power up.

Installation cost:

Estimated installed cost: $3,148
Source of cost estimate: www.usatech.com *and established costs*

Economics (without 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 energy 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	install 5 Drinks, 2 Snacks vending machine and 5 reach-in Drink cooler energy misers - in cafeteria	www.usatech.com and established costs	3,148	none at this time	3,148	16,894	5.3	0	0.4	0	2,855	12	34,261	1.1	988	82	91	25,272	23,145

Assumptions: SWA assumes energy savings based modeling calculator found at www.usatech.com or http://www.usatech.com/energy_management/energy_calculator.php

Rebates/financial incentives:

This measure does not qualify for a rebate or other financial incentive at this time.

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

ECM#2: *Building Lighting Upgrades*

Description:

On the days of the site visits, SWA completed a lighting inventory of the Heritage Middle School building (see Appendix A). The existing lighting consists of mostly T8 fluorescent fixtures with electronic ballasts. Many of the lights in the Heritage Middle School building appear to have been upgraded to T8 fixtures. SWA has performed an evaluation of installing occupancy sensors in large spaces, offices and bathrooms that may be left unoccupied a considerable amount of time throughout the day, installing T5 fixtures in place of Metal Halide gymnasium lighting and replacing Auditorium stage incandescent lamps with CFLs. The labor in all these installations was evaluated using prevailing electrical contractor wages. The Livingston Board of Education may decide to perform this work with in-house resources from its Maintenance Department on a scheduled, longer timeline than otherwise performed by a contractor, to obtain savings.

Installation cost:

Estimated installed cost: $13,500
Source of cost estimate: RS *Means; Published and established costs, NJ Clean Energy Program*

Economics (Some of the options considered 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 energy 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	install (6) six occupancy sensors	RS Means, Lit Search, NJ Clean Energy Program	1,320	120	1,200	2,825	0.9	0	0.2	0	477	12	5,729	2.5	377	31	39	3,552	3,870
2.2	replace gym Metal Halide lamps with (20) twenty T5 fixtures	RS Means, Lit Search, NJ Clean Energy Program	7,100	320	6,780	15,608	4.9	0	1.1	53	2,690	15	39,566	2.5	495	33	39	25,336	21,383
2.3	replace (184) Auditorium stage incandescent lamps with CFLs	RS Means, Lit Search, NJ Clean Energy Program	5,520	none at this time	5,520	11,040	3.5	0	0.8	280	2,146	7	13,060	2.6	172	25	34	7,849	15,125

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 9.5 hrs/yr to replace aging burnt out lamps vs. newly installed.

Rebates/financial incentives:

NJ Clean Energy - Wall Mounted occupancy sensors ($20 per control)
Maximum incentive amount is $120.

NJ Clean Energy - T5 and T8 lamps with electronic ballast in existing facilities ($10-30 per fixture, depending on quantity and lamps)
Maximum incentive amount is $320.

Options for funding the Lighting 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: *Install Premium Efficiency Motors on Heating / Hot Water Circulators*

Description:

The boiler room houses two sets of two (2) floor-mounted circulator pumps as part of the hot water heating system to serve the hot water unit ventilators and other hot water terminal units listed in this report. The pumps are in relatively good condition. One pair of pumps serves the old wing of the building. Each pump is rated at 10 Hp. The other two pumps serve the new wing, and each pump is rated at 5 Hp. Each set operates in a lead-lag fashion. The pump motors are standard efficiency. The Heritage Middle School will realize energy savings by utilizing premium efficiency motors for the pumps.

Installation cost:

Estimated installed cost: $1,874
Source of cost estimate: Similar projects and DOE Motor Master International selection & savings analysis

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 energy 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 (2) 10 Hp hot water circulator pump motors with Premium Efficiency	similar projects, DOE Motor Master + International	1,352	180	1,172	2,739	0.8	0	0.1	0	463	20	9,258	2.5	690	34	39	5,715	3,752
3.2	replace (2) 5 Hp hot water circulator pump motors with Premium Efficiency	similar projects, DOE Motor Master + International	810	108	702	1,408	0.4	0	0.0	0	238	20	4,759	3.0	578	29	34	2,838	1,929

Assumptions: SWA calculated the savings for this measure using nameplate data taken and using the billing analysis. The DOE Motor Master International selection and calculator was used with the assumption that one of each set of heating water pumps operates for the heating season. According to weather bin data for Newark, each set of pumps considered should operate for approximately 5,000 hours per year.

Rebates/financial incentives:

NJ Clean Energy - Premium three-phase motors ($45-$700 per motor)
Maximum incentive amount is $288.

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

ECM#4: *Install Premium Efficiency Motors on Refrigerated Walk-In Box*

Description:

There is one walk-in cooler box in the Kitchen of the Heritage Middle School. Typically, the evaporator and condenser fans of walk-in coolers will run 24 hours per day, 7 days per week. The motors on these fans are standard efficiency, shaded pole motors. There are (5) evaporator cooler fans motors and (5) condenser fan motors. Nameplates were not very legible and it is assumed that five (5) of the motors are 1 Hp and five (5) of the motors are fractional horsepower. The Heritage Middle School will realize energy savings by utilizing premium efficiency motors for these fans.

Installation cost:

Estimated installed cost: $2,545
Source of cost estimate: Similar projects and DOE Motor Master International selection & savings analysis

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 energy 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	replace (5) 1 Hp cond fan and (5) frac Hp motors with Premium Efficiency on walk-in refrigerated box	similar projects, DOE Motor Master + International	2,770	225	2,545	4,500	1.3	0	0.1	0	761	20	15,210	3.3	498	25	30	8,769	6,165

Assumptions: SWA calculated the savings for this measure using nameplate data taken and using the billing analysis. The DOE Motor Master International selection and calculator was used with the assumption that all of the fans operate for 8,760 hours per year.

Rebates/financial incentives:

NJ Clean Energy - Premium three-phase motors ($45-$700 per motor)
Maximum incentive amount is $225.

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

ECM#5: *Install 116 kW PV system*

Description:

Currently, the Heritage Middle School building 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. SWA presents below the economics, and recommends at this time that Livingston Board of Education further review installing a 116 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 Heritage Middle School building is not eligible for a 30% federal tax credit. Instead, the Livingston Board of Education 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 SRECs at $600 / MWh or best market offer.

There are many possible locations for a 116 kW PV installation on the building roofs and away from shade. A commercial multi-crystalline 230 Watts panel (37.0 volts, 8.24 amps) has 17.5 square feet of surface area (13. 1 Watts per square foot). A 116 kW system needs approximately 505 panels, which would take up 8,858 square feet. The installation of a renewable Solar Photovoltaic power generating system could also serve as a good educational tool and exhibit for the community.

Installation cost:

Estimated installed cost: $900,000
Source of cost estimate: Similar projects

Economics (<u>without</u> NJ 40% debt service aid - pending December referendum approval):

school	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 energy 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
Burnet Hill Elementary	install 120 kW PV rooftop system with incentives	similar projects	932,250	0	932,250	136,459	120	N/A	9.0	0	106,1112	25	624,302	8.7	98.3	3.9	8.5	476,728	186,949
Collins Elementary	install 128 kW PV rooftop system with incentives	similar projects	995,000	0	995,000	145,591	128	N/A	10.2	0	110,003	25	575,086	9.0	89.0	3.6	7.9	444,163	199,460
Harrison Elementary	install 45 kW PV rooftop system with incentives	similar projects	349,350	51,000	298,350	51,140	45	N/A	2.7	0	38,885	25	207,116	7.7	123.3	4.9	10.5	211,212	70,061
Hillside Elementary	install 98 kW PV rooftop system with incentives	similar projects	7111,560	0	7111,560	110,890	98	N/A	8.4	0	83,742	25	443,558	9.0	89.2	3.6	7.9	339,294	151,919
Mount Pleasant Schools	install 248 kW PV rooftop system with incentives	similar projects	1,925,000	0	1,925,000	281,1110	248	N/A	7.1	0	211,714	25	1,077,846	9.1	87.4	3.5	7.8	838,484	386,052
Riker Hill Elementary	install 170 kW PV rooftop system with incentives	similar projects	1,319,000	0	1,319,000	193,078	170	N/A	13.6	0	147,465	25	791,621	8.9	91.7	3.7	8.1	614,1117	264,517
Heritage Middle School	install 116 kW PV rooftop system with incentives	similar projects	900,000	0	900,000	131,763	116	N/A	3.0	0	100,868	25	556,698	8.9	92.9	3.7	8.2	426,076	180,515
Livingston High School	install 195 kW PV rooftop system with incentives	similar projects	1,509,745	0	1,509,745	220,996	195	N/A	2.4	0	165,370	25	834,261	9.1	86.4	3.5	7.8	647,147	302,765
Totals			8,687,905	51,000	8,636,905	1,271,708	1,121		56.5	0	964,1110		5,110,489					3,997,901	1,742,239

Economics (<u>with</u> NJ 40% debt service aid - pending December referendum approval):

school	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 energy 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
Burnet Hill Elementary	install 120 kW PV rooftop system with incentives	similar projects	932,250	372,900	559,350	136,459	120	N/A	9.0	0	106,1112	25	624,302	5.2	230.4	9.2	17.7	849,1118	186,949
Collins Elementary	install 128 kW PV rooftop system with incentives	similar projects	995,000	398,000	597,000	145,591	128	N/A	10.2	0	110,003	25	575,086	5.4	214.9	8.6	17.0	842,163	199,460
Harrison Elementary	install 45 kW PV rooftop system with incentives	similar projects	349,350	190,740	158,610	51,140	45	N/A	2.7	0	38,885	25	207,116	4.1	320.0	12.8	23.7	350,952	70,061
Hillside Elementary	install 98 kW PV rooftop system with incentives	similar projects	7111,560	303,024	454,1116	110,890	98	N/A	8.4	0	83,742	25	443,558	5.4	215.4	8.6	17.0	642,318	151,919
Mount Pleasant Schools	install 248 kW PV rooftop system with incentives	similar projects	1,925,000	770,000	1,155,000	281,1110	248	N/A	7.1	0	211,714	25	1,077,846	5.5	212.3	8.5	16.8	1,608,484	386,052
Riker Hill Elementary	install 170 kW PV rooftop system with incentives	similar projects	1,319,000	527,600	1111,400	193,078	170	N/A	13.6	0	147,465	25	791,621	5.4	219.5	8.8	17.2	1,142,397	264,517
Heritage Middle School	install 116 kW PV rooftop system with incentives	similar projects	900,000	360,000	540,000	131,763	116	N/A	3.0	0	100,868	25	556,698	5.4	221.4	8.9	17.3	786,076	180,515
Livingston High School	install 195 kW PV rooftop system with incentives	similar projects	1,509,745	603,898	905,847	220,996	195	N/A	2.4	0	165,370	25	834,261	5.5	210.7	8.4	16.8	1,251,045	302,765
Totals			8,687,905	3,526,1111	5,161,743	1,271,708	1,121		56.5	0	964,1110		5,110,489					7,473,063	1,742,239

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 $45,000 only for the Heritage Middle Schools.

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 1000kWh (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 Livingston Public Schools $760,200 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

ECM#6: *Retro-Commissioning*

Description:

Retro-commissioning is a process that seeks to improve how building equipment and systems function together. Depending on the age of the building, retro-commissioning can often resolve problems that occurred during design or construction and / or address problems that have developed throughout the building's life. Owners often undertake retro-commissioning to optimize building systems, reduce operating costs, and address comfort complaints from building occupants.

Since the systems at the Heritage Middle School building have undergone some renovations in recent years, and the building continues to have concerns with thermal comfort control, SWA recommends undertaking retro-commissioning to optimize system operation as a follow-up to completion of the upgrades. The retro-commissioning process should include a review of existing operational parameters for both newer and older installed equipment. During retro-commissioning, the individual loop temperatures should also be reviewed to identify opportunities for optimizing system performance.

Installation cost:

Estimated installed cost: $113,146
Source of cost estimate: Similar projects

Economics (without 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 energy 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
6	retro commission-ing	similar projects	113,146	none at this time	113,146	40,085	12.7	4,349	3.8	1,820	15,401	12	162,969	7.3	63	5	8	40,154	54,917

Assumptions: Since the utility bills have some accounting fluctuations, it is difficult to determine the amount of energy used for heating and cooling the Heritage Middle School building. Based on experience with similar buildings, SWA estimated the heating and cooling energy consumption. Typical savings for retro-commissioning range from 5-20%, as a percentage of the total space conditioning consumption. SWA assumed 10% savings. Estimated costs for retro-commissioning range from $0.50-$2.00 per square foot. SWA assumed $0.75 per square foot of a

total square footage of 150,861. SWA also assumed on the average 1 hr/wk operational savings when systems are operating per design vs. the need to make more frequent adjustments.

Rebates / financial incentives:

There are currently no incentives for this measure at this time.

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

ECM#7: *Replace Old Freezer with Energy Star Model*

Description:

On the days of the site visits, SWA observed that there is an existing ice cream chest freezer in the kitchen area which is not Energy Star rated (using approximately 4,300 kWh/yr). Appliances, such as refrigerators, that are over 10-12 years of age should be replaced with newer efficient models with the Energy Star label. SWA recommends the replacement of the existing refrigerators, freezers and ice cream chest freezers, which are operating at the end of their useful lives with more modern, ENERGY STAR®, energy efficient systems. Besides saving energy, the replacement will also keep the kitchen and other areas cooler. In addition, the existing systems utilize R-12 refrigerant, which is not an ozone-friendly refrigerant. Newer systems should be specified with R-134A or R-404A refrigerant. When compared to the average electrical consumption of older equipment, Energy Star equipment results in large savings. Look for the Energy Star label when replacing appliances and equipment, including: window air conditioners, 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.

Installation cost:

Estimated installed cost: $2,700
Source of cost estimate: *Energy Star purchasing and procurement site, similar projects, Manufacturer and Store 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 energy 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
7a	replace reach-in ice cream freezer with a 24 cu ft Energy Star freezer	Energy Star purchasing and procurement site, similar projects	2,700	0	2,700	311	0.1	0	0.0	150	203	12	631	13.3	-10	-1	-2	-684	426
7b	incremental cost to replace reach-in ice cream freezer with a 24 cu ft Energy Star freezer	Energy Star purchasing and procurement site, similar projects	300	0	300	311	0.1	0	0.0	150	203	12	631	1.5	710	59	67	1,716	426

Assumptions: SWA calculated the savings for this measure using measurements taken the day of the field visit and using the billing analysis. SWA assumed one annual call to a refrigeration contractor to perform minor repairs on old freezer.

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 the Lighting 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#8: Replace Exhaust Fans with High Efficiency Units

Description:

Several of the building rooftop exhaust fans are in fair condition and should be considered for replacement. Some of the fans are not operating at all. SWA recommends replacement of approximately twenty-five (25) of the building exhaust fans that are operating beyond their useful lives. The motors are small, in the 2 horsepower range, and replacement units will have small energy savings over the existing.

Installation cost:

Estimated installed cost: $69,900
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 energy 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
8a	replace 25 exhaust fans with premium efficiency units	similar projects, DOE Motor Master + International	71,250	1,350	69,900	12,750	4.0	0	0.3	1,365	3,520	10	21,548	19.9	-50	-5	-11	-39,876	17,468
8b	incremental cost to replace 25 exhaust fans with premium efficiency units	similar projects, DOE Motor Master + International	10,675	1,350	9,325	12,750	4.0	0	0.8	1,365	3,520	10	21,548	2.6	277	28	36	20,699	17,468

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 3/4 hr/wk to troubleshoot exhaust fan malfunctions vs. newly installed.

Rebates/financial incentives:

NJ Clean Energy - Premium three-phase motors ($45-$700 per motor)
Maximum incentive amount is $2,700.

State of NJ School Grant - The Livingston Public Schools are eligible for a 40% state grant, which will decrease investment and simple payback when the December bond referendum passes. Since approval is pending, this has not been included in the above calculations.

Options for funding the Lighting 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 MEASURES

5.1. Existing systems

There aren't currently any existing renewable energy systems.

5.2. Wind

Description:

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

Pleases see the above recommended ECM#5.

5.4. Solar Thermal Collectors

Description:

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

Description:

CHP is not applicable for this building because of several existing split system cooling, insufficient domestic hot water use and plans to install a large PV system that would generate a large portion of the building electricity needs.

5.6. Geothermal

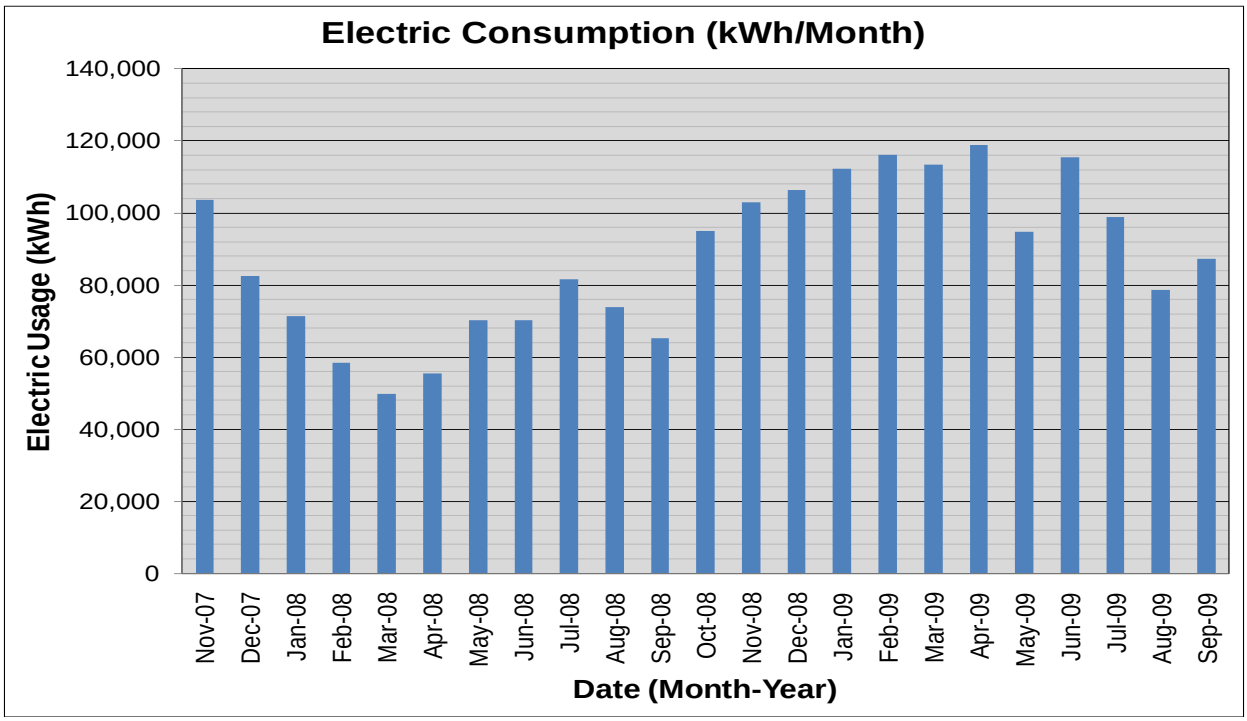
Description:

Geothermal is not applicable for this building because it would not be cost effective, since it would require replacement of the existing HVAC system, of which major components still have as a whole a number of useful operating years.

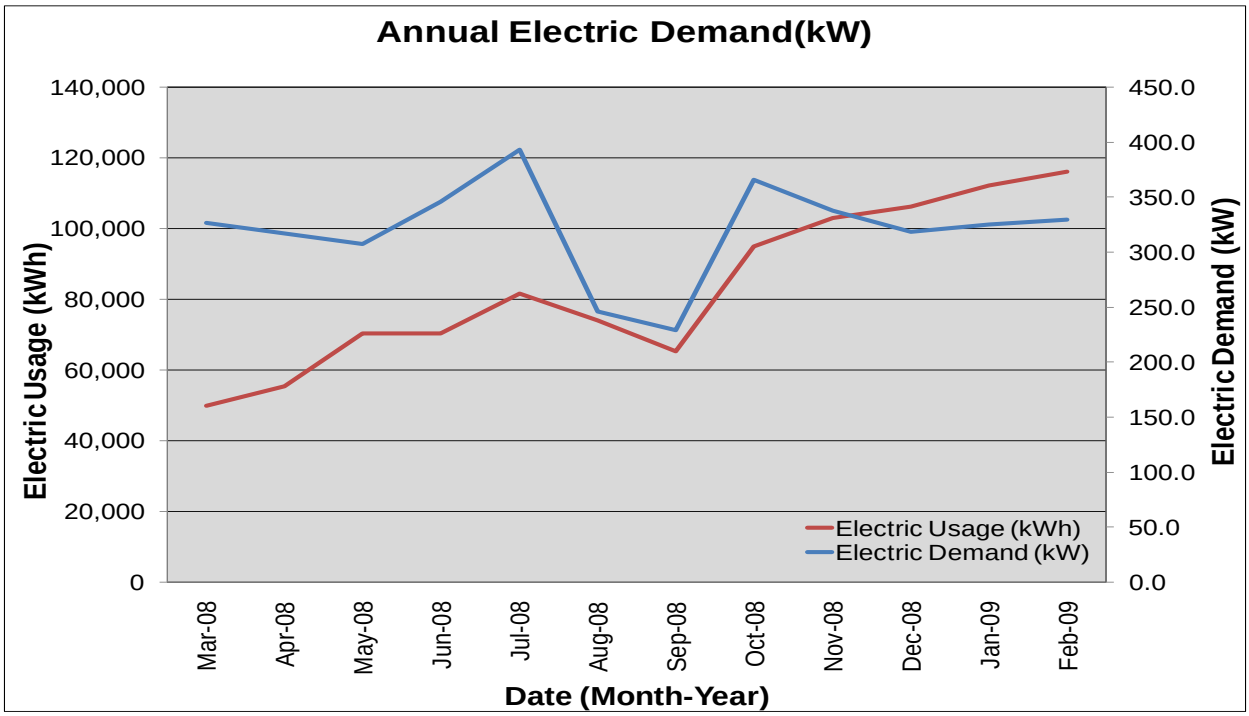
6. ENERGY PURCHASING AND PROCUREMENT STRATEGIES

6.1. Load profiles

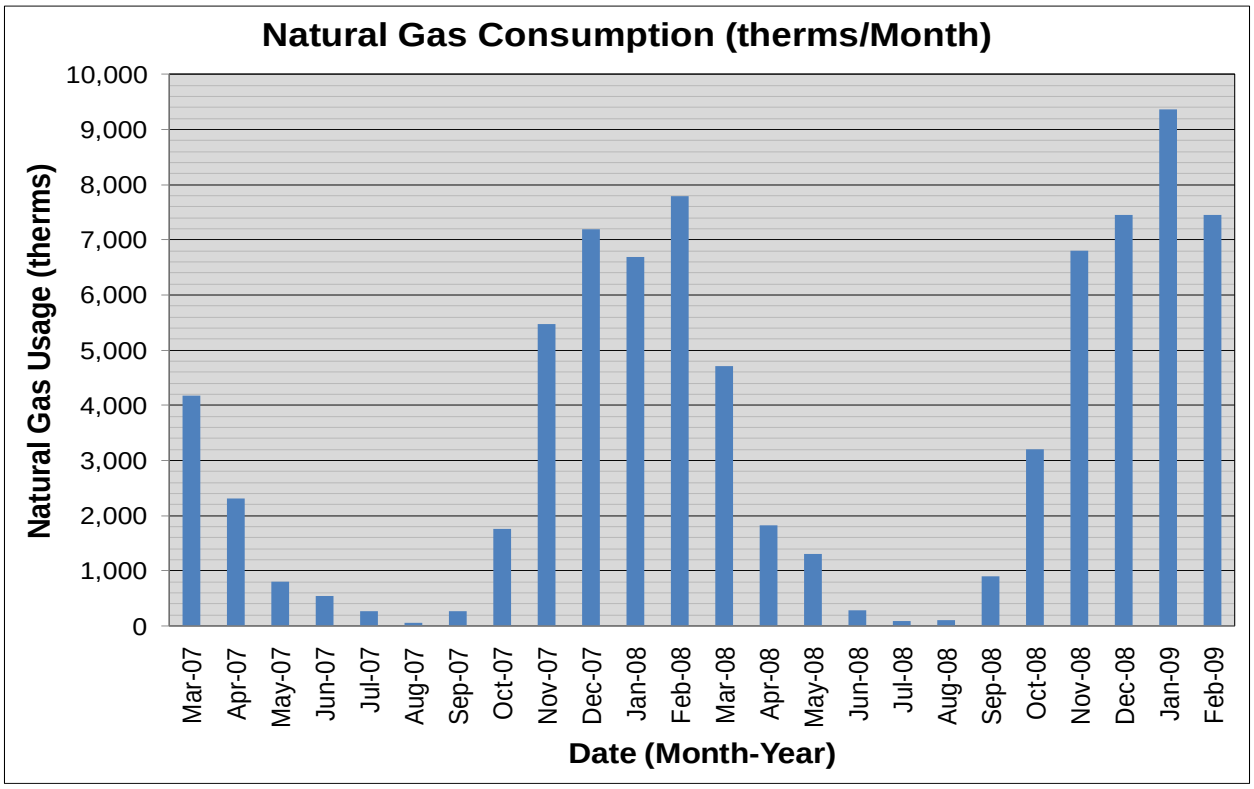
The following are charts that show the annual electric and natural gas load profiles for the Livingston Heritage Middle School building.

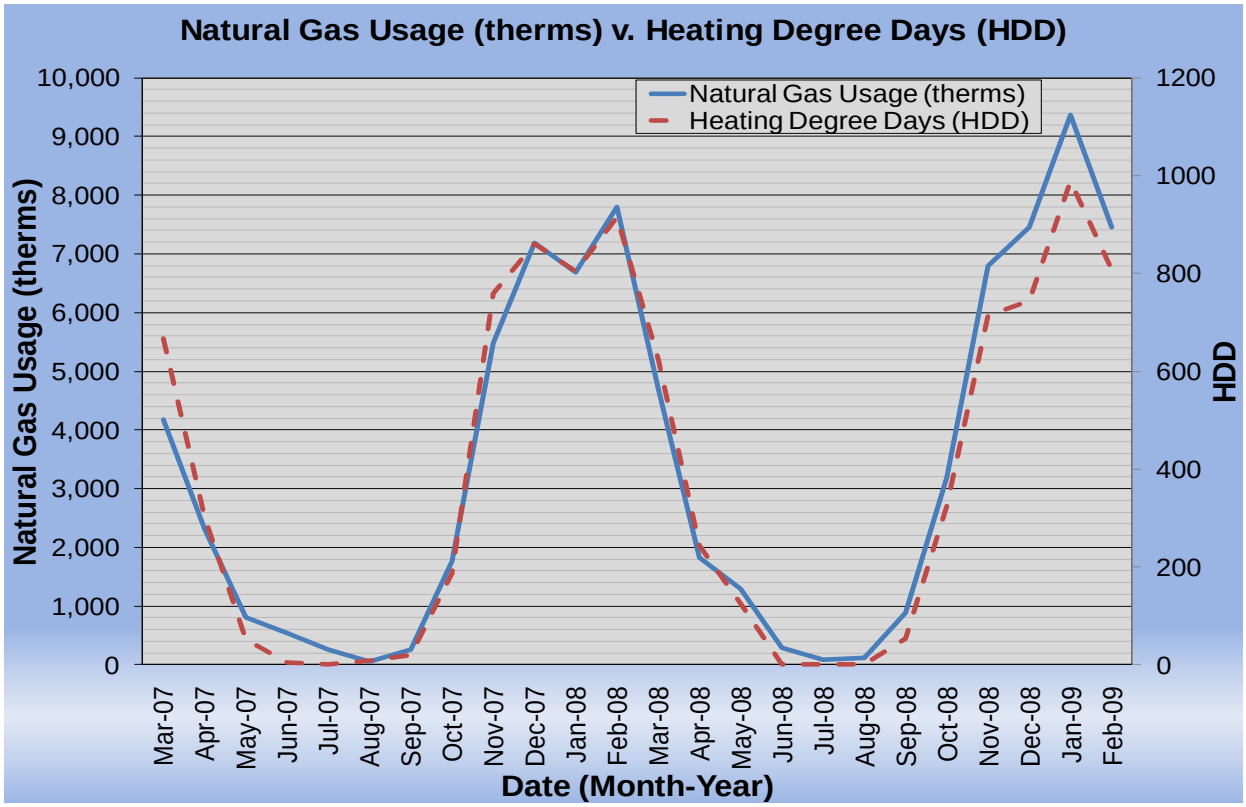


Some minor unusual electric fluctuations shown may be due to adjustments between estimated and actual meter readings. Also, note on the following chart how the electrical Demand peaks (except for a few unusual fluctuation anomalies) follow the electrical consumption peaks.



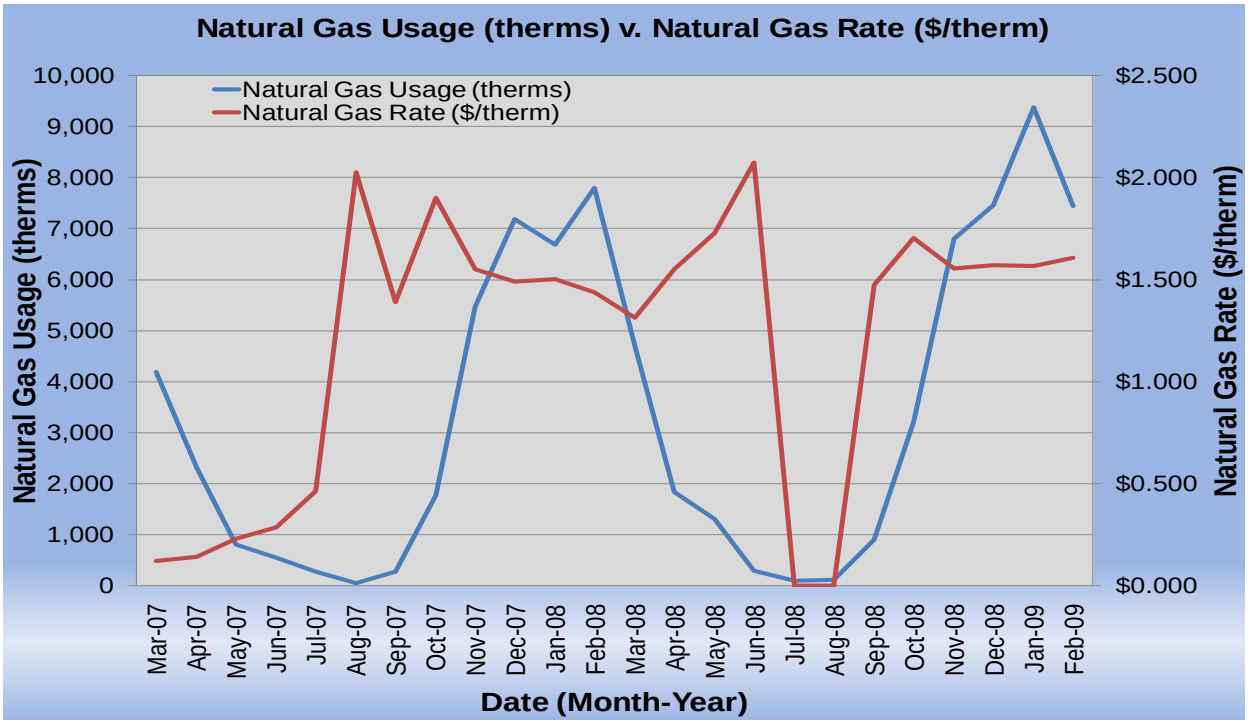
The following is a chart of the natural gas annual load profile for the building, peaking in the coldest months of the year and a chart showing natural gas consumption following the "heating degree days" curve.


Natural Gas Consumption (therms/Month)
Natural Gas Usage (therms)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Date (Month-Year)


Natural Gas Usage (therms) v. Heating Degree Days (HDD)
Natural Gas Usage (therms)
Heating Degree Days (HDD)
Natural Gas Usage (therms)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
HDD
1200
1000
800
600
400
200
0
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Date (Month-Year)

6.2. Tariff analysis

Currently, natural gas is provided to the Heritage Middle School building via one gas meter with the Hess Corporation acting as the supply and PSE&G acting as the transport company. Gas is provided by the Hess Corporation at a general service rate. The suppliers' general service rate for natural gas charges a market-rate price based on use and the Heritage Middle School 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 heating months when natural gas is used by the hot water boiler units. The high gas price per therm fluctuations in the summer may be due to high energy costs that occurred in 2008 and low use caps for the non-heating months. Thus the building pays for fixed costs such as meter reading charges during the summer months. So July and August cap payment are excluded from the following chart.

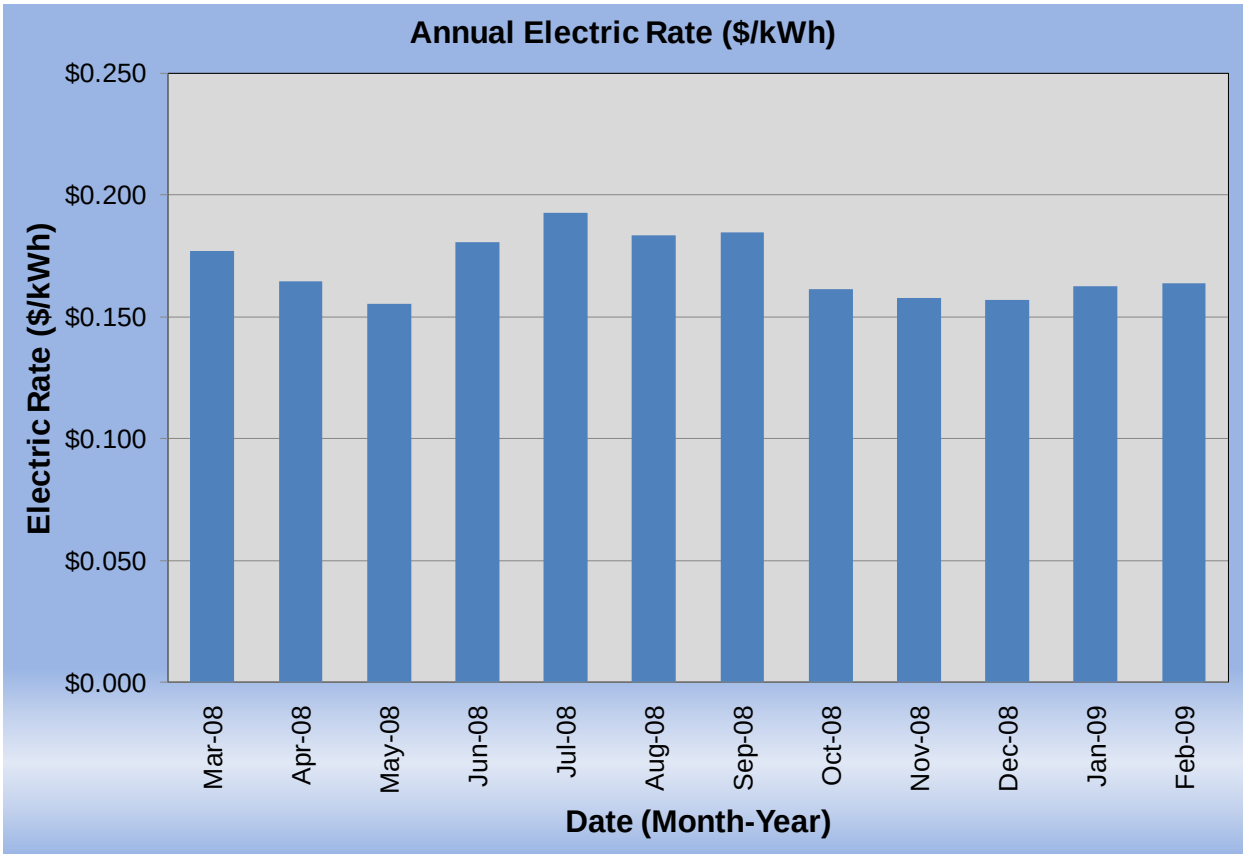


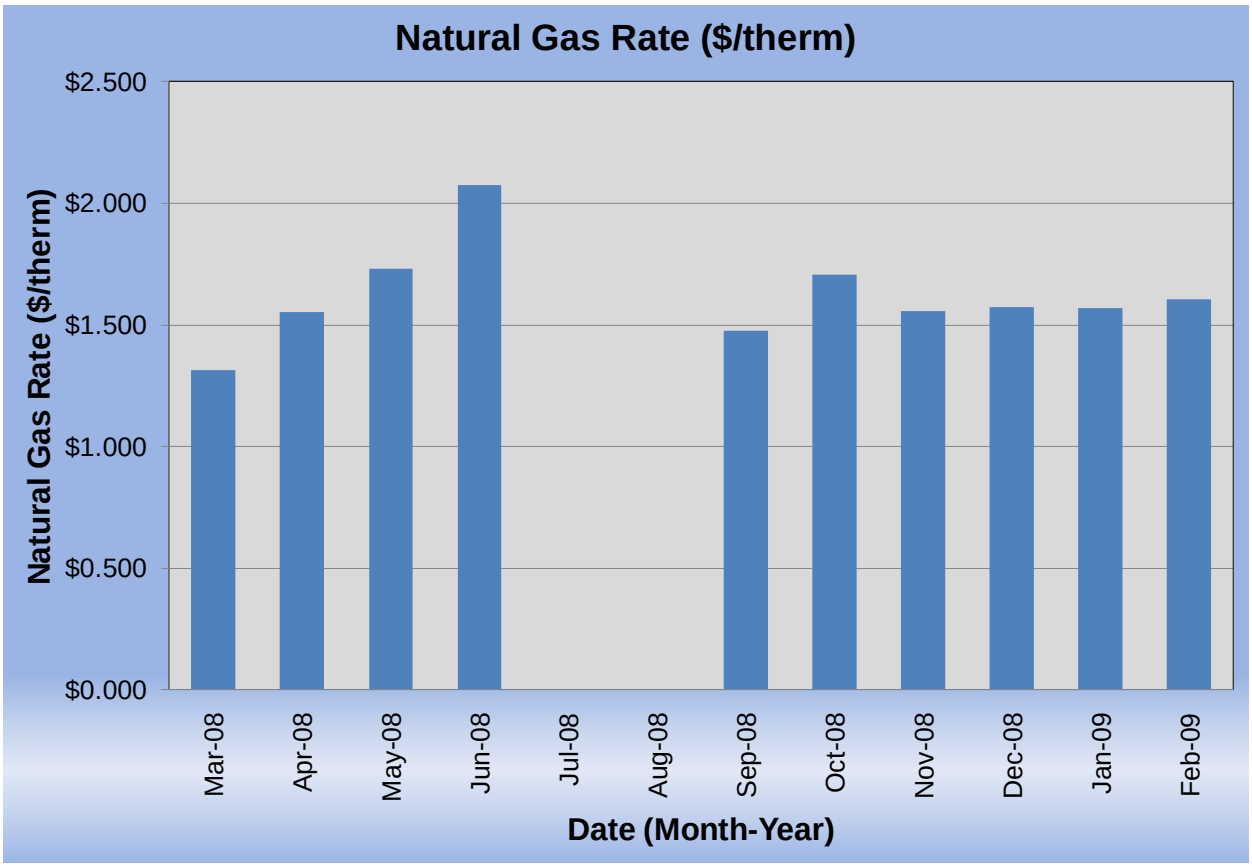
The Heritage Middle School building is direct-metered (via one main meter) and currently purchases electricity from PSE&G at a general service rate. The general service rate for electric charges are market-rate based on use and the Heritage Middle School building billing does show a breakdown of demand costs. Demand prices are reflected in the utility bills and can be verified by observing the price fluctuations throughout the year. Typically, the electricity prices increase during the cooling months when electricity is used by the HVAC condensing units and air handlers.

6.3. Energy Procurement strategies

The Heritage Middle School building receives natural gas via one incoming meter. The Hess Corporation supplies the gas and PSE&G transports it. There is not an ESCO engaged in the process. 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. Electricity is also purchased via one incoming meter directly for the Heritage Middle School building from PSE&G without an ESCO. SWA analyzed the utility rate for natural gas and electricity supply over an extended period. Electric bill analysis shows fluctuations up to 19% over

the most recent 12 month period. Natural gas bill analysis shows fluctuations up to 33% over the most recent 12 month period. Some of these fluctuations may have been caused by adjustments between estimated and actual meter readings, others may be due to unusual high and escalating energy costs in 2008. The average estimated NJ commercial utility rates for electric and gas are $0.150/kWh and $1.550/therm respectively. The Heritage Middle School building annual utility costs are $18,501 higher for electric and $662 higher for natural gas for a total of $19,163 higher, when compared to the average estimated NJ commercial utility rates. SWA recommends that the Livingston Board of Education further explore opportunities of purchasing both natural gas and electricity from ESCOs in order to reduce rate fluctuation and ultimately reduce the annual cost of energy for the Heritage Middle School building. Appendix B contains a complete list of third party energy suppliers for the Livingston Township service area. The Livingston Board of Education 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. Also, the Heritage Middle School building would not be eligible for enrollment in a Demand Response Program, because there isn't the capability at this time (without a large capital investment) 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. Demand Response could be an option in the future when the Livingston Board of Education may install a large enough back-up emergency generator. The following charts show the Heritage Middle School building monthly spending per unit of energy in 2008.




Natural Gas Rate ($/therm)
$2.500
$2.000
$1.500
$1.000
$0.500
$0.000
Natural Gas Rate ($/therm)
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Date (Month-Year)

7. METHOD OF ANALYSIS

7.1. Assumptions and tools

Energy modeling tool:	established / standard industry assumptions, 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

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 Wattage	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	2	Main Office	Recessed	E	4'T8	24	3	32	S	9	230	4	2,308	4,968	N/A	Recessed	4'T8	E	S	24	3	32	9	230	4	2,308	4,968	0	0	0
2	2	Main Office	Recessed	E	4'T8	2	3	32	S	9	230	4	196	414	N/A	Recessed	4'T8	E	S	2	3	32	9	230	4	196	414	0	0	0
3	2	Main Office workroom	Recessed	E	4'T8	2	3	32	S	9	230	4	196	414	N/A	Recessed	4'T8	E	S	2	3	32	9	230	4	196	414	0	0	0
4	2	Main Office principal	Recessed	E	4'T8	2	3	32	S	9	230	4	196	414	N/A	Recessed	4'T8	E	S	2	3	32	9	230	4	196	414	0	0	0
5	2	Main Office conference	Recessed	E	4'T8	2	3	32	S	9	230	4	196	414	N/A	Recessed	4'T8	E	S	2	3	32	9	230	4	196	414	0	0	0
6	2	Main Office vice principal	Recessed	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Recessed	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
7	2	Main Office guidance	Recessed	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Recessed	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
8	2	Main Office guidance2	Recessed	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Recessed	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
9	2	Main Office small conference	Recessed	E	4'T8	2	3	32	S	9	230	4	196	414	N/A	Recessed	4'T8	E	S	2	3	32	9	230	4	196	414	0	0	0
10	2	Main Office guidance3	Recessed	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Recessed	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
11	2	Main Office guidance4	Recessed	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Recessed	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
12	2	Main Office bath	Recessed	E	4'T8	1	4	32	S	9	230	6	134	277	N/A	Recessed	4'T8	E	S	1	4	32	9	230	6	134	277	0	0	0
13	**2**	**Nurses office**	**Recessed**	**E**	**4'T8**	**5**	**3**	**32**	**S**	**9**	**230**	**4**	**484**	**1,035**	**C**	**Recessed**	**4'T8**	**E**	**OS**	**5**	**3**	**32**	**6.75**	**230**	**4**	**484**	**776**	**0**	**259**	**259**
14	**2**	**Staff development rm 229**	**Recessed**	**E**	**4'T8**	**12**	**4**	**32**	**S**	**9**	**230**	**6**	**1,542**	**3,329**	**C**	**Recessed**	**4'T8**	**E**	**OS**	**12**	**4**	**32**	**6.75**	**230**	**6**	**1,542**	**2,496**	**0**	**832**	**832**
15	2	Hallway	Recessed	E	4'T8	33	1	32	S	16	230	1	1,057	4,008	N/A	Recessed	4'T8	E	S	33	1	32	16	230	1	1,057	4,008	0	0	0
16	2	Hallway	Exit sign	None	LED Exit	3	2	5	N	24	365	1	31	289	N/A	Exit sign	LED Exit	None	N	3	2	5	24	365	1	31	289	0	0	0
17	2	Media center	Parabolic	E	4'T8	81	1	32	S	9	230	2	2,594	5,701	N/A	Parabolic	4'T8	E	S	81	1	32	9	230	2	2,594	5,701	0	0	0
18	2	Media center	Exit sign	None	LED Exit	2	2	5	N	24	365	1	21	193	N/A	Exit sign	LED Exit	None	N	2	2	5	24	365	1	21	193	0	0	0
19	2	Main entrance	2'U-shape	E	T8 U	2	2	32	S	16	230	3	131	493	N/A	2'U-shape	T8 U	E	S	2	2	32	16	230	3	131	493	0	0	0
20	2	Main entrance	Parabolic	E	4'T8	6	4	32	S	16	230	6	774	2,959	N/A	Parabolic	4'T8	E	S	6	4	32	16	230	6	774	2,959	0	0	0
21	2	Main entrance	2'U-shape	E	T8 U	20	2	32	S	16	230	3	1,283	4,931	N/A	2'U-shape	T8 U	E	S	20	2	32	16	230	3	1,283	4,931	0	0	0
22	2	Audio-visual aid	2'U-shape	E	T8 U	4	1	32	S	9	230	2	130	282	N/A	2'U-shape	T8 U	E	S	4	1	32	9	230	2	130	282	0	0	0
23	2	Cafeteria	Parabolic	E	4'T8	50	2	32	S	9	230	3	3,203	6,935	N/A	Parabolic	4'T8	E	S	50	2	32	9	230	3	3,203	6,935	0	0	0
24	2	Cafeteria	Recessed	None	LED Exit	3	2	5	N	24	365	1	31	289	N/A	Recessed	LED Exit	None	N	3	2	5	24	365	1	31	289	0	0	0
25	**2**	**Kitchen**	**Parabolic**	**E**	**4'T8**	**37**	**2**	**32**	**S**	**9**	**230**	**3**	**2,371**	**5,132**	**C**	**Parabolic**	**4'T8**	**E**	**OS**	**37**	**2**	**32**	**6.75**	**230**	**3**	**2,371**	**3,849**	**0**	**1,283**	**1,283**
26	**2**	**Staff lounge**	**Recessed**	**E**	**4'T8**	**8**	**2**	**32**	**S**	**9**	**230**	**3**	**515**	**1,110**	**C**	**Recessed**	**4'T8**	**E**	**OS**	**8**	**2**	**32**	**6.75**	**230**	**3**	**515**	**832**	**0**	**277**	**277**
27	**2**	**Kitchen**	**Recessed**	**E**	**4'T8**	**5**	**2**	**32**	**S**	**9**	**230**	**3**	**323**	**693**	**C**	**Recessed**	**4'T8**	**E**	**OS**	**5**	**2**	**32**	**6.75**	**230**	**3**	**323**	**520**	**0**	**173**	**173**
28	2	Music storage	Recessed	E	4'T8	2	3	32	S	2	230	3	195	91	N/A	Recessed	4'T8	E	S	2	3	32	2	230	3	195	91	0	0	0
29	**2**	**Office 221**	**Parabolic**	**E**	**4'T8**	**3**	**3**	**32**	**S**	**9**	**230**	**3**	**291**	**615**	**C**	**Parabolic**	**4'T8**	**E**	**OS**	**3**	**3**	**32**	**6.75**	**230**	**3**	**291**	**461**	**0**	**154**	**154**
30	2	Office	2'U-shape	E	T8 U	3	2	32	S	9	230	3	195	416	N/A	2'U-shape	T8 U	E	S	3	2	32	9	230	3	195	416	0	0	0
31	2	Music Office	2'U-shape	E	T8 U	3	3	32	S	9	230	3	291	615	N/A	2'U-shape	T8 U	E	S	3	3	32	9	230	3	291	615	0	0	0
32	2	Music Office	2'U-shape	E	T8 U	2	2	32	S	9	230	3	131	277	N/A	2'U-shape	T8 U	E	S	2	2	32	9	230	3	131	277	0	0	0
33	2	Classroom 222	Parabolic	E	4'T8	6	3	32	S	9	230	4	580	1,242	N/A	Parabolic	4'T8	E	S	6	3	32	9	230	4	580	1,242	0	0	0
34	2	Classroom hallway	Recessed	E	4'T8	2	3	32	S	16	230	4	196	736	N/A	Recessed	4'T8	E	S	2	3	32	16	230	4	196	736	0	0	0
35	2	Classroom hallway 223	Recessed	E	4'T8	4	3	32	S	16	230	4	388	1,472	N/A	Recessed	4'T8	E	S	4	3	32	16	230	4	388	1,472	0	0	0
36	2	Classroom	Parabolic	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Parabolic	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
37	2	Classroom 224	Parabolic	E	4'T8	18	2	32	S	9	230	3	1,155	2,496	N/A	Parabolic	4'T8	E	S	18	2	32	9	230	3	1,155	2,496	0	0	0
38	2	Classroom 225	Parabolic	E	4'T8	18	2	32	S	9	230	3	1,155	2,496	N/A	Parabolic	4'T8	E	S	18	2	32	9	230	3	1,155	2,496	0	0	0
39	2	Band Classroom 226	Parabolic	E	4'T8	20	3	32	S	9	230	4	1,924	4,140	N/A	Parabolic	4'T8	E	S	20	3	32	9	230	4	1,924	4,140	0	0	0
40	2	Classroom 227	Parabolic	E	4'T8	48	2	32	S	9	230	3	3,075	6,657	N/A	Parabolic	4'T8	E	S	48	2	32	9	230	3	3,075	6,657	0	0	0
41	2	Classroom office 227	Parabolic	E	4'T8	3	2	32	S	9	230	3	195	416	N/A	Parabolic	4'T8	E	S	3	2	32	9	230	3	195	416	0	0	0
42	2	Classroom office 227	Exit sign	None	LED Exit	1	2	5	N	24	365	3	13	114	N/A	Exit sign	LED Exit	None	N	1	2	5	24	365	3	13	114	0	0	0
43	2	Classroom 228	Parabolic	E	4'T8	40	2	32	N	9	230	3	2,563	5,548	N/A	Parabolic	4'T8	E	N	40	2	32	9	230	3	2,563	5,548	0	0	0
44	2	Hallway	Recessed	E	4'T8	7	3	32	S	16	230	4	676	2,576	N/A	Recessed	4'T8	E	S	7	3	32	16	230	4	676	2,576	0	0	0
45	2	Classroom 230	Parabolic	E	4'T8	18	3	32	S	16	230	4	1,732	6,624	N/A	Parabolic	4'T8	E	S	18	3	32	16	230	4	1,732	6,624	0	0	0
46	2	Staircase	Parabolic	E	4'T8	8	2	32	S	16	230	3	515	1,972	N/A	Parabolic	4'T8	E	S	8	2	32	16	230	3	515	1,972	0	0	0
47	GF	Classroom 126	Parabolic	E	4'T8	25	4	32	S	16	230	6	3,206	12,328	N/A	Parabolic	4'T8	E	S	25	4	32	16	230	6	3,206	12,328	0	0	0
48	GF	Classroom 125	Parabolic	E	4'T8	21	2	32	S	16	230	3	1,347	5,178	N/A	Parabolic	4'T8	E	S	21	2	32	16	230	3	1,347	5,178	0	0	0
49	GF	Electrical rm	Parabolic	E	4'T8	1	2	32	S	2	230	3	67	31	N/A	Parabolic	4'T8	E	S	1	2	32	2	230	3	67	31	0	0	0
50	GF	Classroom 124	Parabolic	E	4'T8	21	2	32	S	9	230	3	1,347	2,912	N/A	Parabolic	4'T8	E	S	21	2	32	9	230	3	1,347	2,912	0	0	0

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 Wattage	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)
51	GF	Classroom Closet 124	Parabolic	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Parabolic	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
52	GF	Classroom Closet 124	Parabolic	E	4'T8	1	4	32	S	9	230	6	134	277	N/A	Parabolic	4'T8	E	S	1	4	32	9	230	6	134	277	0	0	0
53	GF	Boys locker rm	Parabolic	E	4'T8	1	1	39	S	9	230	2	41	85	N/A	Parabolic	4'T8	E	S	1	1	39	9	230	2	41	85	0	0	0
54	**GF**	**Gymnasium**	**HID**	**E**	**MH**	**20**	**1**	**400**	**S**	**9**	**230**	**90**	**8,090**	**20,286**	**T5**	**Parabolic**	**4'T5**	**E**	**S**	**20**	**4**	**28**	**9**	**230**	**1**	**2,241**	**4,678**	**15,608**	**0**	**15,608**
55	GF	Hallway	Recessed	E	4'T8	101	1	32	S	16	230	2	3,234	12,637	N/A	Recessed	4'T8	E	S	101	1	32	16	230	2	3,234	12,637	0	0	0
56	GF	Gymnasium	Exit sign	None	LED Exit	6	2	5	N	24	365	1	61	578	N/A	Exit sign	LED Exit	None	N	6	2	5	24	365	1	61	578	0	0	0
57	GF	Girls locker rm	Parabolic	E	4'T8	1	1	39	S	9	230	2	41	85	N/A	Parabolic	4'T8	E	S	1	1	39	9	230	2	41	85	0	0	0
58	GF	Mechanical Rm	Parabolic	E	4'T8	12	2	32	S	2	230	3	771	370	N/A	Parabolic	4'T8	E	S	12	2	32	2	230	3	771	370	0	0	0
59	GF	Mechanical Rm	Parabolic	E	2'T8	6	2	16	S	2	230	3	195	97	N/A	Parabolic	2'T8	E	S	6	2	16	2	230	3	195	97	0	0	0
60	GF	Mechanical Rm	Parabolic	E	4'T8	9	2	32	S	2	230	3	579	277	N/A	Parabolic	4'T8	E	S	9	2	32	2	230	3	579	277	0	0	0
61	GF	Classroom 101	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
62	GF	Classroom 102	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
63	GF	Classroom 103	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
64	GF	Classroom 104	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
65	GF	Classroom 105	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
66	GF	Classroom 123	Parabolic	E	4'T8	5	2	32	S	9	230	3	323	693	N/A	Parabolic	4'T8	E	S	5	2	32	9	230	3	323	693	0	0	0
67	2	Classroom 201	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
68	2	Classroom 202	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
69	2	Classroom 203	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
70	2	Classroom 204	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
71	2	Classroom 205	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
72	2	Classroom 220	Recessed	E	4'T8	7	4	32	S	9	230	6	902	1,942	N/A	Recessed	4'T8	E	S	7	4	32	9	230	6	902	1,942	0	0	0
73	3	Classroom 301	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
74	3	Classroom 302	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
75	3	Classroom 303	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
76	3	Classroom 304	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
77	3	Classroom 305	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
78	GF	Classroom 106	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
79	GF	Classroom 107	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
80	GF	Classroom 108	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
81	GF	Classroom 109	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
82	GF	Classroom 110	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
83	GF	Classroom 111	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
84	2	Classroom 206	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
85	2	Classroom 207	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
86	2	Classroom 208	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
87	2	Classroom 209	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
88	2	Classroom 210	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
89	2	Classroom 211	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
90	3	Classroom 306	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
91	3	Classroom 307	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
92	3	Classroom 308	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
93	3	Classroom 309	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
94	3	Classroom 310	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
95	3	Classroom 311	Parabolic	E	4'T8	10	2	32	S	9	230	3	643	1,387	N/A	Parabolic	4'T8	E	S	10	2	32	9	230	3	643	1,387	0	0	0
96	GF	Janitor's Closet	Parabolic	E	4'T8	2	3	32	S	2	230	3	195	91	N/A	Parabolic	4'T8	E	S	2	3	32	2	230	3	195	91	0	0	0
97	GF	Janitor's Closet	Parabolic	E	4'T8	2	3	32	S	2	230	4	196	92	N/A	Parabolic	4'T8	E	S	2	3	32	2	230	4	196	92	0	0	0
98	2	Janitor's Closet	Parabolic	E	4'T8	2	3	32	S	2	230	4	196	92	N/A	Parabolic	4'T8	E	S	2	3	32	2	230	4	196	92	0	0	0
99	2	Janitor's Closet	Parabolic	E	4'T8	2	3	32	S	2	230	4	196	92	N/A	Parabolic	4'T8	E	S	2	3	32	2	230	4	196	92	0	0	0

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 Wattage	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)
100	3	Janitor's Closet	Parabolic	E	4'T8	2	3	32	S	2	230	4	196	92	N/A	Parabolic	4'T8	E	S	2	3	32	2	230	4	196	92	0	0	0
101	3	Janitor's Closet	Parabolic	E	4'T8	2	3	32	S	2	230	4	196	92	N/A	Parabolic	4'T8	E	S	2	3	32	2	230	4	196	92	0	0	0
102	2	Hallway	Recessed	E	4'T8	101	1	32	S	16	230	2	3,234	12,637	N/A	Recessed	4'T8	E	S	101	1	32	16	230	2	3,234	12,637	0	0	0
103	2	Classroom 112	Parabolic	E	4'T8	6	3	32	S	9	230	4	580	1,242	N/A	Parabolic	4'T8	E	S	6	3	32	9	230	4	580	1,242	0	0	0
104	2	Hallway	Recessed	E	4'T8	10	3	32	S	16	230	4	964	3,680	N/A	Recessed	4'T8	E	S	10	3	32	16	230	4	964	3,680	0	0	0
105	2	Hallway	2'U-shape	E	T8 U	2	2	32	S	16	230	4	132	500	N/A	2'U-shape	T8 U	E	S	2	2	32	16	230	4	132	500	0	0	0
106	2	Hallway	Exit sign	None	LED Exit	4	2	5	N	24	365	1	41	385	N/A	Exit sign	LED Exit	None	N	4	2	5	24	365	1	41	385	0	0	0
107	GF	Electrical rm	Parabolic	E	4'T8	3	2	32	S	9	230	3	195	416	N/A	Parabolic	4'T8	E	S	3	2	32	9	230	3	195	416	0	0	0
108	GF	Hallway	Recessed	E	4'T8	15	4	32	S	16	230	6	1,926	7,397	N/A	Recessed	4'T8	E	S	15	4	32	16	230	6	1,926	7,397	0	0	0
109	GF	Hallway	Recessed	E	2'T8	11	2	16	S	16	230	3	355	1,417	N/A	Recessed	2'T8	E	S	11	2	16	16	230	3	355	1,417	0	0	0
110	GF	Classroom 114	Parabolic	E	4'T8	8	3	32	S	9	230	4	772	1,656	N/A	Parabolic	4'T8	E	S	8	3	32	9	230	4	772	1,656	0	0	0
111	GF	Classroom 115	Parabolic	E	4'T8	8	3	32	S	9	230	4	772	1,656	N/A	Parabolic	4'T8	E	S	8	3	32	9	230	4	772	1,656	0	0	0
112	GF	Classroom 116	Parabolic	E	4'T8	8	3	32	S	9	230	4	772	1,656	N/A	Parabolic	4'T8	E	S	8	3	32	9	230	4	772	1,656	0	0	0
113	GF	Classroom 117	Parabolic	E	4'T8	12	3	32	S	9	230	4	1,156	2,484	N/A	Parabolic	4'T8	E	S	12	3	32	9	230	4	1,156	2,484	0	0	0
114	GF	Bathroom Women	Parabolic	E	4'T8	3	3	32	S	9	230	4	292	621	N/A	Parabolic	4'T8	E	S	3	3	32	9	230	4	292	621	0	0	0
115	GF	Bathroom Men	Parabolic	E	4'T8	3	3	32	S	9	230	4	292	621	N/A	Parabolic	4'T8	E	S	3	3	32	9	230	4	292	621	0	0	0
116	GF	Staircase to third fl	Parabolic	E	4'T8	12	2	32	S	16	230	3	771	2,959	N/A	Parabolic	4'T8	E	S	12	2	32	16	230	3	771	2,959	0	0	0
117	2	Bathroom Women	Parabolic	E	4'T8	3	3	32	S	9	230	4	292	621	N/A	Parabolic	4'T8	E	S	3	3	32	9	230	4	292	621	0	0	0
118	2	Bathroom Men	Parabolic	E	4'T8	3	3	32	S	9	230	4	292	621	N/A	Parabolic	4'T8	E	S	3	3	32	9	230	4	292	621	0	0	0
119	2	Classroom 216	Parabolic	E	4'T8	14	3	32	S	9	230	4	1,348	2,898	N/A	Parabolic	4'T8	E	S	14	3	32	9	230	4	1,348	2,898	0	0	0
120	2	Classroom office 216	Parabolic	E	4'T8	6	3	32	S	9	230	4	580	1,242	N/A	Parabolic	4'T8	E	S	6	3	32	9	230	4	580	1,242	0	0	0
121	2	Classroom 217	Parabolic	E	4'T8	15	3	32	S	9	230	4	1,444	3,105	N/A	Parabolic	4'T8	E	S	15	3	32	9	230	4	1,444	3,105	0	0	0
122	2	Classroom 214	Parabolic	E	4'T8	16	3	32	S	9	230	4	1,540	3,312	N/A	Parabolic	4'T8	E	S	16	3	32	9	230	4	1,540	3,312	0	0	0
123	2	Classroom 213	Parabolic	E	4'T8	13	3	32	S	9	230	4	1,252	2,691	N/A	Parabolic	4'T8	E	S	13	3	32	9	230	4	1,252	2,691	0	0	0
124	2	Classroom 213	Parabolic	E	4'T8	2	2	32	S	9	230	3	131	277	N/A	Parabolic	4'T8	E	S	2	2	32	9	230	3	131	277	0	0	0
125	2	Classroom 218	Parabolic	E	4'T8	14	2	32	S	9	230	4	900	1,971	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	4	900	1,971	0	0	0
126	2	Hallway	Exit sign	None	LED Exit	3	1	5	N	24	365	1	16	158	N/A	Exit sign	LED Exit	None	N	3	1	5	24	365	1	16	158	0	0	0
127	2	Classroom 219	Parabolic	E	4'T8	12	3	32	S	9	230	4	1,156	2,484	N/A	Parabolic	4'T8	E	S	12	3	32	9	230	4	1,156	2,484	0	0	0
128	3	Janitor's Closet	Parabolic	E	4'T8	1	3	32	S	2	230	4	100	46	N/A	Parabolic	4'T8	E	S	1	3	32	2	230	4	100	46	0	0	0
129	3	Janitor's Closet 313	Parabolic	E	4'T8	12	3	32	S	2	230	4	1,156	552	N/A	Parabolic	4'T8	E	S	12	3	32	2	230	4	1,156	552	0	0	0
130	3	Classroom 314	Parabolic	E	4'T8	12	3	32	S	9	230	4	1,156	2,484	N/A	Parabolic	4'T8	E	S	12	3	32	9	230	4	1,156	2,484	0	0	0
131	3	Classroom 315	Parabolic	E	4'T8	14	2	32	S	9	230	3	899	1,942	N/A	Parabolic	4'T8	E	S	14	2	32	9	230	3	899	1,942	0	0	0
132	3	Hallway	Recessed	E	4'T8	14	4	32	S	16	230	6	1,798	6,904	N/A	Recessed	4'T8	E	S	14	4	32	16	230	6	1,798	6,904	0	0	0
133	3	Hallway	Recessed	E	4'T8	8	4	32	S	16	230	6	1,030	3,945	N/A	Recessed	4'T8	E	S	8	4	32	16	230	6	1,030	3,945	0	0	0
134	GF	Auditorium	Parabolic	E	4'T8	20	2	32	S	9	230	3	1,283	2,774	N/A	Parabolic	4'T8	E	S	20	2	32	9	230	3	1,283	2,774	0	0	0
135	GF	Auditorium	Exit sign	None	LED Exit	8	2	5	N	24	365	1	81	771	N/A	Exit sign	LED Exit	None	N	8	2	5	24	365	1	81	771	0	0	0
136	GF	Auditorium stage	Parabolic	E	4'T8	6	2	32	S	3	230	3	387	277	N/A	Parabolic	4'T8	E	S	6	2	32	3	230	3	387	277	0	0	0
137	GF	Auditorium stage	Parabolic	E	4'T8	8	4	32	S	3	230	6	1,030	740	N/A	Parabolic	4'T8	E	S	8	4	32	3	230	6	1,030	740	0	0	0
138	**GF**	**Auditorium stage**	**Screw-in**	**None**	**Inc**	**8**	**16**	**60**	**S**	**3**	**230**	**0**	**7,680**	**5,299**	**CFL**	**Screw-in**	**CFL**	**None**	**S**	**8**	**16**	**20**	**3**	**230**	**0**	**2,560**	**1,766**	**3,533**	**0**	**3,533**
139	**GF**	**Auditorium stage**	**Screw-in**	**None**	**Inc**	**4**	**3**	**60**	**S**	**3**	**230**	**0**	**720**	**497**	**CFL**	**Screw-in**	**CFL**	**None**	**S**	**4**	**3**	**20**	**3**	**230**	**0**	**240**	**166**	**331**	**0**	**331**
140	**GF**	**Auditorium stage**	**Screw-in**	**None**	**Inc**	**52**	**1**	**300**	**D**	**3**	**230**	**0**	**15,600**	**10,764**	**CFL**	**Screw-in**	**CFL**	**None**	**D**	**52**	**1**	**100**	**3**	**230**	**0**	**5,200**	**3,588**	**7,176**	**0**	**7,176**
141	2	Bathroom Women	Parabolic	E	4'T8	3	2	32	S	9	230	3	195	416	N/A	Parabolic	4'T8	E	S	3	2	32	9	230	3	195	416	0	0	0
142	2	Bathroom Men	Parabolic	E	4'T8	3	2	32	S	9	230	3	195	416	N/A	Parabolic	4'T8	E	S	3	2	32	9	230	3	195	416	0	0	0
143	P	Exterior	Exterior	None	HPS	21	1	400	T	24	365	90	8,490	90,140	N/A	Exterior	HPS	None	T	21	1	400	24	365	90	8,490	90,140	0	0	0
144	Ext	Exterior	Exterior	None	HPS	33	1	150	T	24	365	34	4,984	53,191	N/A	Exterior	HPS	None	T	33	1	150	24	365	34	4,984	53,191	0	0	0
145	Ext	Exterior	Exterior	None	CFL	2	1	13	T	24	365	2	28	263	N/A	Exterior	CFL	None	T	2	1	13	24	365	2	28	263	0	0	0
Totals:						**1,701**	**353**	**5,565**				**677**	**148,688**	**437,681**						**1,701**	**356**	**4,913**			**588**	**126,839**	**408,055**	**26,648**	**2,978**	**29,626**

Note: Bolded items in yellow represent fixtures with proposed improvements

Total Building Floor Area (SF)	150,861
Total Interior Existing Annual Consumption (kWh)	294,087
Total Interior Proposed Annual Consumption (kWh)	264,461
Total Existing Interior Lighting Power(Watts)	135,186
Total Existing Interior Lighting Power Density (Watts/SF)	0.90
Total Proposed Interior Lighting Power(Watts)	113,337
Total Proposed Interior Power Density (Watts/SF)	0.75
Total Exterior Existing Annual Consumption (kWh)	143,594
Total Exterior Proposed Annual Consumption (kWh)	143,594
Total Existing Exterior Lighting Power(Watts)	13,502
Total Proposed Exterior Lighting Power(Watts)	13,502
Estimated Cost of Fixture Replacements ($)	$12,620
Estimated Cost of Controls Improvements ($)	$1,320
Proposed Annual Savings (kWh)	29,473
Proposed Annual Cost Savings ($)	$5,313

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 (Installl new T8)
Pin	1'T5	OS (Occupancy Sensor)	M (Magnetic)	T5 (Install new T5)
Parabolic	2'T5	T (Timer)		CFL (Install new CFL)
Recessed	3'T5	PC (Photocell)		LEDex (Install new LED Exit)
2'U-shape	4'T5	D (Dimming)		LED (Install new LED)
Circiline	2'T8	DL (Daylight Sensor)		D (Delamping)
Exterior	3'T8	M (Microphonic Sensor)		C (Controls Only)
HID (High Intensity Discharge)	4'T8			
	6'T8			
	8'T8			
	2'T12			
	3'T12			
	4'T12			
	6'T12			
	8'T12			
	CFL (Compact Fluorescent Lightbulb)			
	MR16			
	Halogen			
	MV (Mercury Vapor)			
	MH (Metal Halide)			
	HPS (High Pressure Sodium			
	LPS (Low Pressure Sodium)			

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

PSE&G ELECTRICAL SERVICE TERRITORY Last Updated: 06/15/09		
Hess Corporation 1 Hess Plaza Woodbridge, NJ 07095 (800) 437-7872 www.hess.com	**BOC Energy Services, Inc.** 1115 Mountain Avenue Murray Hill, NJ 011174 (800) 247-2644 www.boc.com	**Commerce Energy, Inc.** 4400 Route 9 South, Suite 100 Freehold, NJ 07728 (800) 556-84111 www.commerceenergy.com
Constellation NewEnergy, Inc. 900A Lake Street, Suite 2 Ramsey, NJ 07446 (888) 635-0827 www.newenergy.com	**Direct Energy Services, LLC** 120 Wood Avenue Suite 611 Iselin, NJ 08830 (866) 547-2722 www.directenergy.com	**FirstEnergy Solutions Corp.** 300 Madison Avenue Morristown, NJ 0111111 (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	**Integrys Energy Services, Inc.** 99 Wood Ave, South, Suite 802 Iselin, NJ 08830 (877) 763-9977 www.integrysenergy.com	**Strategic Energy, LLC** 55 Madison Avenue, Suite 400 Morristown, NJ 011160 (888) 925-9115, www.sel.com
Liberty Power Holdings, LLC Park 80 West, Plaza II, Suite 200 Saddle Brook, NJ 07663 (866) 769-31119 www.libertypowercorp.com	**Pepco Energy Services, Inc.** 112 Main St. Lebanon, NJ 08833 (800) ENERGY-9 (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 The Mac-Cali Building 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) 800-756-3749 www.south jerseyenergy.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 080111 (856) 273-9995 www.ugienergyservices.com	**American Powernet Management, LP** 437 North Grove St. Berlin, NJ 08009 (800) 437-7872 www.hess.com	**ConEdison Solutions** Cherry Tree, Corporate Center 1115 State Highway 38 Cherry Hill, NJ 08002 (888) 665-0955 www.conedsolutions.com
Credit Suisse, (USA) Inc. 700 College Road East Princeton, NJ 08450 212-1118-3124 www.creditsuisse.com	**Sprague Energy Corp.** 12 Ridge Road Chatham Township NJ 011128 (800) 225-1560 www.spragueenergy.com	

PSE&G NATURAL GAS SERVICE TERRITORY Last Updated: 06/15/09		
Cooperative Industries 412-420 Washington Avenue Belleville, NJ 07109 800-6BUYGAS (6-289427) www.cooperativenet.com	**Direct Energy Services, LLP** 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 http://retail.dom.com
Gateway Energy Services Corp. 44 Whispering Pines Lane Lakewood, NJ 08701 800-805-8586 www.gesc.com	**UGI Energy Services, Inc. d/b/a GASMARK** 704 East Main Street, Suite 1 Moorestown, NJ 080111 856-273-9995 www.ugienergyservices.com	**Great Eastern Energy** 116 Village Riva, Suite 200 Princeton, NJ 08540 888-651-4121 www.greateastern.com
Hess Energy, Inc. One Hess Plaza Woodbridge, NJ 07095 800-437-7872 www.hess.com	**Hudson Energy Services, LLC** 920 Route 17 South Ridgewood, NJ 07450 877- Hudson 9 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 1-877-Systrum www.systrumenergy@aol.com	**Metromedia Energy, Inc.** 6 Industrial Way Eatontown, NJ 07724 877-750-7046 www.metromediaenergy.com	**Metro Energy Group, LLC** 14 Washington Place Hackensack, NJ 07601 888-111-Metro www.metroenergy.com
MxEnergy, Inc. 510 Thornall Street, Suite 270 Edison, NJ 088327 800-375-1277 www.mxenergy.com	**NATGASCO (Mitchell Supreme)** 1112 Freeman Street Orange, NJ 07050 800-840-4GAS 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 - Office 105 Cherry Hill, NJ 08002 800-281-2000 www.pplenergyplus.com	**Sempra Energy Solutions** The Mac-Cali Building 581 Main Street, 8th fl. Woodbridge, NJ 07095 877-273-6772 800-2 SEMPRA www.semprasolutions.com	**South Jersey Energy Company** One South Jersey Plaza, Route 54 Folsom, NJ 08037 800-756-3749 www.sjindustries.com/sje.htm
Sprague Energy Corp. 12 Ridge Road Chatham Township, NJ 011128 800-225-1560 www.spragueenergy.com	**Stuyvesant Energy LLC** 10 West Ivy Lane, Suite 4 Englewood, NJ 07631 800-646-64111 www.stuyfuel.com	**Woodruff Energy** 73 Water Street Bridgeton, NJ 08302 800-5111-1121 www.woodruffenergy.com