Cheltenham Township Energy Assessment

Rowland Community Center

400 Myrtle Ave, Cheltenham, PA 19012

Prepared By:

Practical Energy Solutions of West Chester, PA

Prepared For:

Cheltenham Township, as part of the Delaware Valley Regional Planning Commission's *Circuit Rider for Energy Efficiency* program

APRIL 2016

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Executive Summary

The Rowland Community Center (39,969 ft^2) is a multiuse facility housing community meeting rooms, classrooms, a gymnasium, a cafeteria, and the East Cheltenham Public Library. The original three-story building was constructed in 1915 as an elementary school. A one-story classroom wing and gymnasium were added in 1964.

This building is occupied by staff between 8:00 a.m. and 4:30 p.m., five days per week, it has evening programs five days per week, and it is rented out occasionally on weekends. The township is considering renovations to the 1915 section of the building for possible rental or lease. Currently, this portion of the building is used largely for storage.

On behalf of the DVRPC Circuit Rider Program, Practical Energy Solutions (PES) performed an energy assessment of the facility to identify opportunities for energy savings. In 2011, Cheltenham Township spent $27,060 on energy for the facility, with the majority of energy costs (63 percent; $17,040) and use (83 percent; 15,857 therms) due to natural gas used almost exclusively for the hot-water heating system.

The center's energy use intensity (EUI)—a commonly used measure for benchmarking whole-building energy performance—is relatively low at 47.6 kBtu per square foot per year. Low scores are desirable, as they signify lower energy use than comparable buildings. However, Rowland Community Center's favorable score is likely due to low occupancy and significant underuse of the building, as large portions remain unoccupied.

In this facility, a new high-efficiency condensing boiler is connected to a pre-existing hot-water fan-coil unit (FCU) heat delivery system. A primary finding is that the FCU system is not compatible with the high-efficiency condensing boiler (an expensive piece of equipment, and a significant investment). The high temperature demands, constant-volume piping, and thermostatic controls of the FCU system do not allow the new boiler to run at its design efficiency level. As a result, the township is not realizing the full value of its investment.

This illustrates an important lesson: To achieve optimal energy performance and return on investment, energy-efficient heating, ventilation, and air conditioning (HVAC) upgrades must be designed with consideration to the whole-building systems. While upgrades can be phased in over time, they should be part of a holistic plan that integrates all HVAC systems and components. PES therefore recommends assessing the feasibility of a full upgrade of the FCU system (including water piping and controls). In the case of building renovations, the township should also evaluate other HVAC systems, as a wholesale building renovation will open up opportunities for superior, higher-efficiency cooling and heating systems that maximize energy and cost savings.

PES also identified the following measures, presented in order of priority from no cost to higher cost:

- Consolidate activities into the 1964 portion of the building and place much of the 1915 building in "unoccupied mode" until its future use is determined. This will allow aggressive heating setbacks in this portion of the building, saving on natural gas use and costs.
- Use boiler outside air reset controls, if not currently used. Outside air reset controls (a common energy-saving strategy) ensure that boiler water is heated only as much as necessary to achieve the thermostatic setpoint. When it is warmer outside, the water temperature does not have to be as high. Reset controls will prevent overheating and reduce natural gas use and costs.

- Replace weather-stripping on exterior doors.
- Install a gym light timer or place a prominent “turn the lights off” reminder near the light switch.
- Install vestibule doors at the building’s east entrance. These doors are missing; as a result, the vestibule does not block cold air infiltration.
- Replace the library and administration package rooftop units (RTUs), which are nearing end of life, with the highest possible efficiency package units (12 to 14 EER) within the next one to two years. This upgrade should be made with consideration to whole-building systems and any future uses and renovations that will take place in the building.
- Use high-performance roof insulation (R-20) during future renovations.
- Install high-performance windows (U-0.45) during future renovations.

In the aggregate, these energy conservation measures are expected to cut natural gas use 45 percent and electricity use 35 percent, saving Cheltenham more than $11,000 in annual energy costs at today’s prices. They will also shrink the facility’s carbon footprint by more than 123,000 pounds of CO_2 per year, which has the same CO_2 reduction impact as removing nearly 11 passenger cars from the road or planting 2,753 mature trees.

Table 1 provides a summary of savings and paybacks, based on the premium costs of high-efficiency systems.

Table 1: Summary of Energy Conservation Measures

#	Measure Description	Annual Energy Savings		Energy Cost Savings [$/yr.]	Est. Premium Cost	Simple Payback [yrs.]	% Energy Savings	Lifetime Energy Savings		CO2 Savings [lbs.]
1	Consolidate Operations/Thermostat Setbacks	739	ccf	$817	$-	-	5%	$16,333	*	8,870
2	Use Boiler Outside Air Reset Controls	604	ccf	$668	$-	-	4%	$10,020	^	7,255
3	Replace Library & Admin RTUs	12,979	kWh	$1,398	$6,360	4.5	14%	$14,677	^	16,354
4	High Performance Roof Insulation (R-20)	10,098	kWh	$4,283	$19,000	4.4	11%	$66,810	*	12,724
		2,889	ccf				19%			34,702
5	High Performance Windows (U-0.45)	8,828	kWh	$3,943	$15,075	3.8	9%	$63,879	*	11,123
		2,706	ccf				18%			32,501
TOTAL		6,938	ccf	$11,108	$40,435	3.6	45%	34%	**	123,529
		31,905	kWh				34%			
Other Measures										
-	Replace Weather-stripping on Exterior Doors									
-	Replace East Entrance Vestibule Doors									
-	Gym Light Timer or Reminder									
-	Occupancy Sensors in Classrooms, Bathrooms, Storage Closets									

= Immediate no- to low-cost measures. *20 years

= Measures recommended within 1—2 years. ^15 years

= Priority measures during future renovations. **Total of lifetime savings (15—20 years).

Notes: Savings are based on the cost difference between high-efficiency and standard-efficiency units/building envelope materials (i.e., premium cost), as these items will need to be replaced anyway. Savings shows the long-term benefit of investing in efficiency measures up-front. These cost savings will change as energy prices change. **Source:** Practical Energy Solutions for DVRPC 2014

Building Description

The Rowland Community Center (39,969 ft^2) is a multiuse facility housing community meeting rooms, classrooms, a gymnasium, a cafeteria, and the East Cheltenham Public Library. The original three-story building was constructed in 1915 as an elementary school, and the one-story classroom wing and gymnasium were added in 1964.

With the exception of the library, occupancy is generally low in much of the facility. The building is significantly underused; large portions remain unoccupied. There has been some interest in renting out the unused spaces, which would require substantial renovation.

The library and administrative office are used during regular working hours (about 43 hours per week), and the gymnasium is typically occupied for about 20 hours per week. The classrooms and multipurpose rooms are primarily used for evening programs (15 hours per week). The building is not used on weekends.

Historic Energy Use

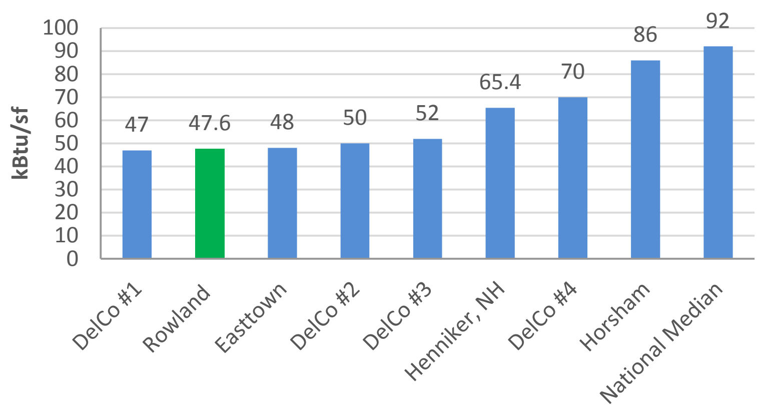
Annual Energy Cost

In 2011, Cheltenham Township spent $27,060 on energy for the Rowland Community Center, or 2 percent of total municipal energy costs. Sixty-three percent of this cost was for natural gas ($17,040; 15,410 ccf); the remainder was for electricity ($10,020; 93,040 kWh). The average cost for electricity was $0.117 per kWh; average cost for natural gas was $0.99 per ccf. The resulting average energy cost per square foot was $0.68.

Annual Energy Use

The center's energy use intensity (EUI)—a common measure of total energy use per square foot—is 47.6 kBtu per sf. As shown in Figure 1 below, this energy benchmark compares favorably with other local libraries, which is the most suitable category of buildings for the Rowland Community Center. However, Rowland Community Center's favorable score is likely due to low occupancy and significant underuse of the building, as large portions remain unoccupied.

Figure 1: Regional Energy Use Intensity Scores: Libraries



Notes: Data set courtesy the County of Delaware, DVRPC Circuit Rider Program and other sources.
Source: Practical Energy Solutions for DVRPC 2014

CO_2 Emissions

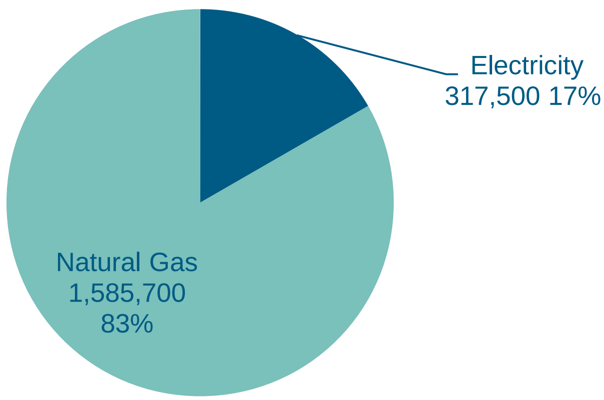
Total energy use at Rowland is responsible for more than 303,000 pounds of CO_2 emissions annually—the emissions equivalent of more than 26 passenger cars per year. Nearly two-thirds of emissions were due to natural gas use.

Energy End Uses

To determine the most appropriate energy conservation measures (ECMs), it is important to understand how building systems use energy. PES developed the following breakdown of energy end uses (i.e., lighting, HVAC, pumps, etc.) based on historical utility energy use and PES's site walkthrough:

- Natural gas comprises 83 percent of all energy used, as shown in Figure 2 below.

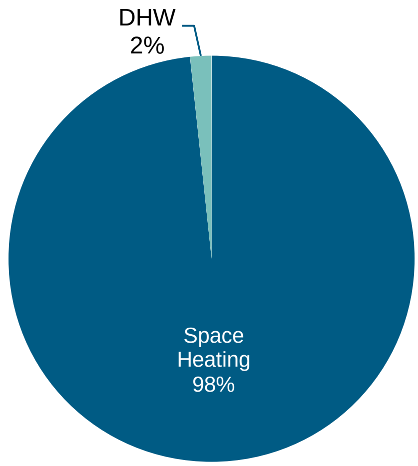
Figure 2: Energy Use in kBtus (10^3 Btu)



Source: Practical Energy Solutions for DVRPC 2014

- Nearly all natural gas is used for heating, as shown in Figure 3 below.

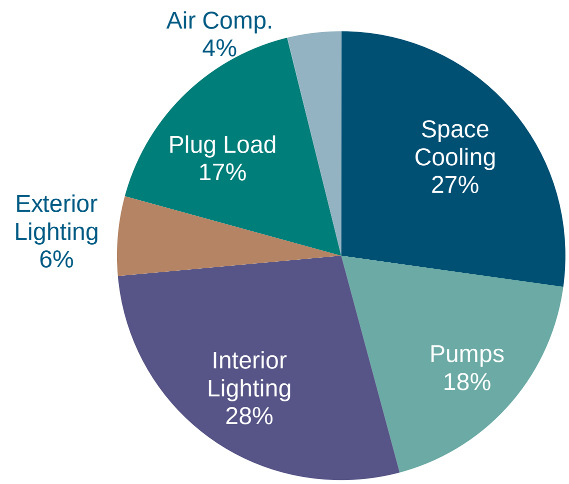
Figure 3: Natural Gas End Uses



Source: Practical Energy Solutions for DVRPC 2014

- Figure 4 below shows all end uses for electricity. Interior lighting and space cooling together use more than half of the electricity.

Figure 4: Electricity End Uses



Notes: Plug Loads = computers, desk lamps, printers, faxes, copiers vending machines, other plug loads. Air comp. = air compressors. **Source:** Practical Energy Solutions for DVRPC

Scope of Analysis

Practical Energy Solutions (PES) performed a walkthrough energy assessment of the Rowland Community Center to identify the best opportunities for cost and energy savings. Since natural gas comprises the majority of total energy use, PES focused its analysis on gas-consuming equipment and the integrity of the building envelope, because excess air infiltration increases heating demand. Since electricity is more expensive per unit of energy than natural gas, PES also assessed opportunities for reducing electricity use.

HVAC

The Rowland Community Center is fully heated; only the library and administrative offices are centrally air-conditioned. Occupants also use several portable air-conditioning units as necessary.

Heating System: Findings

Hot water is provided to perimeter fan-coil units (FCUs) by a gas-fired Aerco Benchmark condensing hot water boiler (2,000 MBH, 91 percent thermal efficiency) installed in 2010. An image of the condensing hot water boiler is shown as Figure 5 below. This unit is in excellent condition and includes many energy-saving features such as a condensing heat exchanger, a 20:1 turndown ratio, and hot water reset control. At its lowest output, it is capable of achieving an operating efficiency of over 99 percent.

Figure 5: Condensing Hot Water Boiler

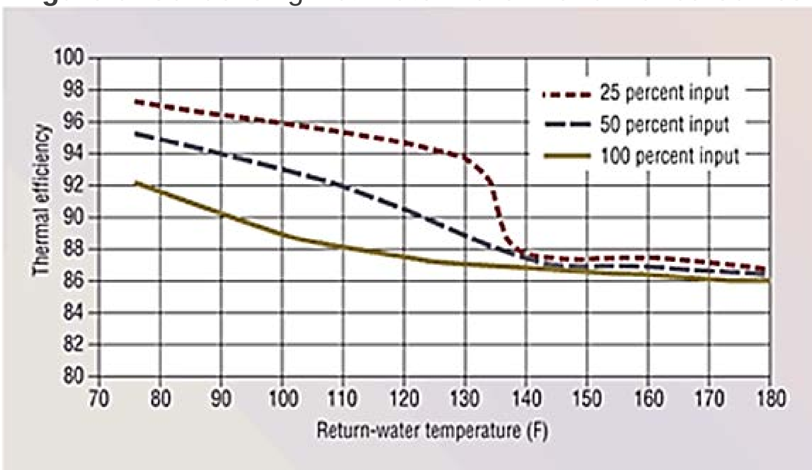
Source: Practical Energy Solutions for DVRPC 2014

However, the other components of the heating system (i.e., FCUs, piping, thermostatic controls) are significantly older and were not designed to take advantage of the boiler's energy-saving features. There are two reasons for this:

- *High water temperatures*. Unlike conventional boilers, which corrode if return water temperatures are too low (i.e., below 140°F to 150°F) due to acidic flue gas condensation, condensing boilers operate most efficiently at low return temperatures (generally below 120°F). In fact, they lose their efficiency advantage at high return temperatures. Figure 6 below illustrates the performance curve of condensing hot water boilers. The FCUs in Rowland require higher (160°F) water temperatures and are thus not designed to operate with this boiler.
- *High heating load.* Condensing boilers are also most efficient at low loads, because they can modulate, or "power down," with reduced hot water demand (i.e., on a mild winter day, or after setpoint is reached) (Figure 6). The water piping system in Rowland, however, requires constant water volume regardless of heating demand.

The high temperature, high water volume, and continuous, uncontrolled operation of the fan coil unit system continually place significant and high energy demands on the boiler, preventing it from operating in energy-efficient modes. As a result, the township is not realizing its investment in this expensive piece of equipment.

Figure 6: Condensing Hot Water Boiler Performance Curves



Source: HPAC Engineering. Maximizing Small-Boiler Efficiency: Stretching spending dollars by cutting energy costs.
http://hpac.com/heating/maximizing-small-boiler-efficiency

Heating System: Recommendations

To enable the boiler to achieve its efficiency potential, and to significantly improve heating performance, Cheltenham Township can install more sophisticated controls (i.e., programmable controls in each room); convert the piping to a variable-flow, low-temperature loop; and replace the FCUs with units designed to operate at lower water temperatures (i.e., units with greater heat exchange surfaces). This will require significant capital investment, depending on the design and condition of the existing components, and should be a priority in any future renovation.

Interim Measures

In the interim, PES believes a practical and achievable first step is to consolidate activities into the 1964 portion of the building and place much of the 1915 building in "unoccupied mode" until its future use is determined. This means ensuring that all lights are turned off, all receptacle equipment is unplugged, and all thermostats are manually turned down to 60°F or lower.

The Department of Energy estimates annual energy savings as high as 1 percent for each degree of setback over an eight-hour period. Using this estimate, PES calculates that the Rowland Community Center could reduce total annual gas use by as much as 5 percent by simply turning thermostats from 65°F down to 60°F in each room on the first and second floors of the 1915 portion of the facility (Table 2). This no-cost measure should be implemented as soon as possible.

Table 2: Thermostat Setback in 1915 Portion of Building

Annual Energy Savings	CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Est. Project Cost	Simple Payback [yrs]	Savings Over 20 Years [$]
739 ccf	8,870	$817	-	-	$16,333

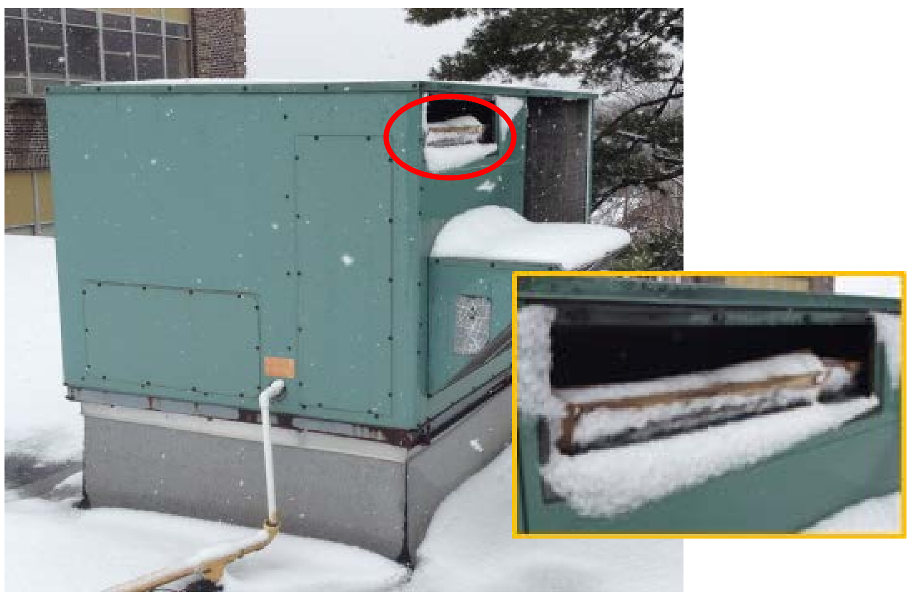
Notes: Cost savings calculated at current natural gas rates. Savings will change as energy prices change. **Source:** Practical Energy Solutions for DVRPC 2014

In addition, the Aerco Benchmark boiler is capable of outside air reset control, which conserves energy by reducing hot water supply temperature as outside air temperature increases. This is a common energy conservation strategy and should be implemented on this boiler if it is not already. It should not require any changes to the existing FCUs or hot water loop components. A typical control sequence would deliver 160°F water at ambient temperatures below 20°F, 130°F water at temperatures above 50°F, and ramp linearly between 160°F and 130°F at outside temperatures between 20°F and 50°F. This control strategy could reduce space heating energy use by 4 to 6 percent and save from 600–900 ccf of natural gas per year, further reducing gas costs by $660–$1,000 annually at current prices.

Cooling System: Findings

Three package rooftop units (RTUs) provide cooling to the library and administrative offices. They have no legible nameplates but appear to be nearly 20 years old and are in poor condition. These units (120 MBH estimated capacity each) have exceeded the typical 15-year service life, and their estimated efficiency is low (approximately 7.0 EER). Energy performance is worsened by improper filter installation, as shown in Figure 7 below.

Figure 7: Library RTU



Source: Practical Energy Solutions for DVRPC 2014

Cooling System: Recommendations

The package RTUs should be replaced soon. While the efficiency of package units is inherently limited, higher-efficiency package units are available (12-14 EER) from several manufacturers. With proper thermostat programming, these higher-efficiency units could reduce annual electricity use by approximately 14 percent. Table 3 shows the potential energy savings and estimated premium cost for these higher-efficiency package RTUs.

Table 3: Higher Efficiency RTU Savings

Annual Energy Savings (kWh)	Annual Energy Cost Savings	Estimated Premium Cost	Simple Payback [yrs]	Net Savings Over 15-Year Unit Life [$]	CO_2 Reduction [lbs]
12,979	$1,398	$6,360	4.5	$14,678	16,354

Notes: Payback based on premium cost, or cost difference between a standard-efficiency and a high-efficiency package RTU. All savings based on current electricity rate. Savings will change as electricity prices change.
Source: Practical Energy Solutions for DVRPC 2014

Again, however, if renovations are planned, PES recommends first evaluating all HVAC replacement options as part of a building-wide project prior to investing in this upgrade. If the building will be undergoing wholesale renovations, this will open up opportunities for superior, higher-efficiency cooling and heating systems.

Building Envelope

PES investigated the major building envelope components—including roof, walls, windows, and doors—for opportunities to improve energy performance. PES found that the roof and the majority of the windows (with the exception of the cafeteria windows, replaced in 1995) are performing poorly and should be considered for replacement.

Roof

The existing roof is a membrane construction with insulation entirely above deck. Township staff report that it is in poor condition due to water leaks in several places and is in need of replacement. On the day of the site visit, the roof was covered with snow, so PES was unable to accurately assess roof condition. However, PES estimates the existing roof insulation is approximately R-5 based on the age, condition, and type of construction.

When this roof is replaced, the RFP should specify a layer of continuous high-performance roof insulation having a thermal resistance of at least R-20. This could reduce energy costs by more than $4,200 versus the existing roof. Table 4 presents energy savings versus the existing roof, along with the ROI for investing in the high-performance roof insulation.

Table 4: High-Performance Roof Insulation

Annual Energy Savings		CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Est. Premium Cost[1]	Simple Payback [yrs]	Net Savings Over 20-Year Roof Life [$]
10,098	kWh	12,724	$4,283	$19,000	4.4	$66,810
2,889	ccf	34,702				

Notes: Savings based on current energy prices. Savings will change as energy prices change. **Source:** Practical Energy Solutions for DVRPC 2014

[1] Estimated project costs derived from the *RSMeans 2011 Building Construction Cost* data guide for all measures unless noted otherwise.

Windows

Windows in most of the building were installed in 1964 when the one-story school addition was constructed and are generally in poor condition. The combination of poor thermal characteristics and air infiltration around the window frames may be causing significant energy waste. An image of a typical window at the Rowland Community Center is provided as Figure 8 below.

Figure 8: Typical Window

Source: Practical Energy Solutions for DVRPC 2014

Due to the low occupancy levels in much of the building, it is unlikely that replacing the windows is cost-effective at this time. However, if parts of this facility are to be rented or leased, upgrading the windows should be a priority in any future renovation.

When these windows are replaced, the bid documents should specify an assembly U-factor (i.e., glazing and frame) of at least 0.45 Btu per hr•ft^2•°F. This represents an estimated 51 percent improvement in thermal performance over the existing windows and may reduce annual energy costs by nearly $4,000 versus the existing windows.

The potential energy savings are presented in Table 5 below, along with the estimated premium cost of installing high-performance versus standard windows.

Table 5: High-Performance Insulated Windows

Annual Energy Savings		CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Est. Premium Cost	Simple Payback [yrs]	Net Savings Over 20 Years [$]
8,828	kWh	11,123	$3,943	$15,075	3.8	$63,879
2,706	ccf	32,501				

Source: Practical Energy Solutions for DVRPC 2014

Doors

PES noted that several of the metal exterior doors have insufficient weatherproofing and door sweeps, and they have sizeable air gaps around the frames and door bottoms, as shown in Figure 9 below. In many cases, this is a relatively simple fix requiring new weather-stripping around the door frame and a door sweep on the bottom. PES recommends installing a high-quality vinyl weather-stripping product with a metal backing that is mechanically attached (bolted) to the door. Adhesive-backed weather-stripping is insufficient and should be avoided.

PES also noted that the east interior vestibule doors are missing; as a result, the vestibule is ineffective at blocking cold air infiltration. This vestibule should be repaired before the next heating season.

Figure 9: Doors Lacking Weatherproofing/Sweeps

Source: Practical Energy Solutions for DVRPC 2014

Lighting

The gymnasium has high-intensity metal halide lamps that are used only when the gym is occupied (approximately 20 hours per week). It is common for this type of lighting to be left on when users leave the space, so consider installing a timer to control the lights, or simply place a prominent reminder near the light switches.

Lighting throughout the remainder of this facility was renovated in 2010 with two-lamp, 32W T8 linear fluorescent fixtures. These are energy-efficient fixtures, and the lights were typically turned off in unoccupied areas.

PES recommends that future lighting renovations include occupancy sensors in all classrooms, bathrooms, and storage closets so lights are not left on in unoccupied rooms.

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