Horsham Township Energy Assessment

Township Library

Prepared By:

Practical Energy Solutions of West Chester, PA

Prepared For:

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

APRIL 2016

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region — leading the way to a better future.

The symbol in our logo is adapted from the official DVRPC seal and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies.

DVRPC fully complies with Title VI of the Civil Rights Act of 1964 and related statutes and regulations in all programs and activities. DVRPC's website (www.dvrpc.org) may be translated into multiple languages. Publications and other public documents can be made available in alternative languages and formats, if requested. For more information, please call (215) 592-1800.

Acknowledgments

Assistance on development of best practices, provision of data, and the drafting of this report was provided by a team at Practical Energy Solutions led by Dianne Herrin.

The municipalities that participated in *Direct Technical Assistance* contributed time and knowledge to the creation of this report through their participation in the *Direct Technical Assistance* program. Those municipalities include Bristol Township of Bucks County; Easttown Township and Phoenixville Borough of Chester County; Lansdowne Borough, Nether Providence, and Upper Darby Township of Delaware County.

Table of Contents

Executive Summary 1

Building Description 3

Benchmarking and Historic Energy Use 3

- **Annual Energy Costs** 3
- **Annual Energy Use** 3
- **CO_2 Emissions** 4
- **Energy End Uses** 4

Scope of Analysis 5

HVAC 5

- **HVAC: Findings** 5
- **HVAC: Recommendations** 6
  - **Confirm Setback Schedule** 6
  - **Evaluate/Implement Hot-Water Reset Control** 6

Lighting 7

- **Computers and Receptacle Loads** 8

Appendix A. Stack Lighting Analysis A-1

- **Scope of Analysis** A-1
- **Findings** A-1
- **Recommendations** A-2

Tables

Table 1: Summary of Energy Conservation Measures 2

Table 2: Savings: HVAC Measures 6

Table 3: Savings: Lighting Controls 7

Table 4: Savings: Receptacle Power Management 8

Figures

Figure 1: EUI Scores for Libraries 3

Figure 2: Energy Use in kBtu (10^3 Btu) 4

Figure 3: Electricity End Uses 4

Figure 4: Grafik Eye® Lighting Controller, Community Meeting Room 7

Executive Summary

Horsham Township is a municipality of 26,147 residents[1] in Montgomery County, PA. The Horsham Township Library (28,000 ft^2) is a modern, one-story building constructed in 2004. It contains a main area with book stacks, reading space, and computers; a community meeting room; a children's "story hour" room; a teen room; three small conference rooms; librarians' offices; and a checkout area. Library hours total 56.5 hours per week, and the building is occupied approximately 65 hours per week.

From October 2011 through September 2012, Horsham spent $46,346 on energy for the library. Approximately 77 percent of this expense ($35,602) was for electricity, and the remaining $10,744 was for natural gas used for space heating. The annual cost of energy per square foot was $1.66.

The facility's estimated energy use intensity (EUI)—a commonly used measure for benchmarking whole-building energy performance—is 88.3 kBtu per square foot, which is on the high end of EUI scores for similar local facilities. High scores suggest opportunities for energy and cost savings.

On behalf of the *DVRPC Circuit Rider Program*[2], Practical Energy Solutions (PES) performed a general walkthrough of the Horsham Township library to identify opportunities to reduce energy use and costs. A separate analysis of the stack lighting was conducted after the assessment and is included as Appendix A of this report.

PES found that the best opportunity to save energy lies in improving management of the sophisticated heating, ventilation, and air conditioning (HVAC) and lighting control systems. While modern, automated control systems can save significant amounts of energy, they can also increase energy use if not properly managed. At this facility, the controls contractor has sole access to the system, and building occupants are not trained to use it. As a result, it is not clear if or how the HVAC system is being managed, and it appears that the lighting controls are not fully operational.

Therefore, PES recommends that Horsham Township contact its control system contractor to:

- Confirm or verify the HVAC setback schedule to ensure that the HVAC systems run to occupied temperatures only when the building is in use and are set back during off hours.
- Consider implementing an outside air reset control for the hot-water loop.
- Use boiler outside air reset controls, if not currently used. Outside air reset controls reduce hot water temperature in response to increasing outside air temperature. When it is warmer outside, the hot water used to heat the building can be a lower temperature because there is less need for heat. This helps prevent overheating while reducing natural gas use and costs.
- Evaluate the functionality of the Lutron lighting controllers, and configure the system to be fully operational. PES recommends using the vacancy controls, which can reduce overall lighting costs approximately 12 percent, and training building occupants to properly use these controls.
- Consider training a facilities employee to help manage the control software. This will save on contractor costs and should improve on-site energy management.

[1] 2010 US Census
[2] http://www.dvrpc.org/EnergyClimate/CircuitRider/

PES also recommends implementing a receptacle load power management strategy, which could reduce plug load energy use by up to 29 percent depending on how plug loads are currently managed. This strategy is as simple as designating one employee to shut down all equipment at night, but it can also involve a central software-based power management solution. PES strongly suggests engaging the employee responsible for IT operations in this effort, so software upgrades can be scheduled.

Overall, these energy conservation measures may cut natural gas use 24 percent and reduce electricity use 10 percent, lowering the library's EUI by 17 percent, to 73.4 kBtu per square foot. This will also save the township more than $6,200 annually in energy costs at today's prices (a 13 percent cost reduction. It will also reduce CO_2 emissions due to fossil fuel use by approximately 72,425 pounds of CO_2 per year, which has the same reduction in CO_2 emissions as removing more than six passenger cars from the road per year or planting more than 1,500 mature trees.

Table 1 provides a summary of calculated savings and paybacks.

Table 1: Summary of Energy Conservation Measures

#	Measure Description	Annual Energy Savings	CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Estimated Project Cost	Simple Payback [yrs]
1	Define Unoccupied Temperature Setpoints	14,580 kWh 2,037 ccf	18,371 23,955	$3,657	*	*
2	Implement Hot Water Reset Controls	448 ccf	5,273	$464	*	*
3	Vacancy Sensor Lighting Control in Meeting Rooms	6,048 kWh	7,621	$642	*	*
4	Receptacle Load Power Management	13,654 kWh	17,204	$1,449	$0	Immediate
	TOTAL	**34,282 kWh** **2,485 ccf**	**72,425**	**$6,212**	*	*

Notes: *Depends on township's existing contract with controls contractor.
All cost savings based on current electricity rate. Savings will vary as electricity prices change**. Source:** Practical Energy Solutions for DVRPC 2014

Building Description

The Horsham Township Library (28,000 ft^2) is a one-story building constructed in 2004. It is a high-quality steel frame/wood beam construction with a stone face, significant glazing, high ceilings, and impressive architectural features. The library contains a main area with book stacks, reading space, and computers, a community meeting room that holds up to 200 people and can be divided into three distinct spaces, a children's "story hour" room, a teen room, three small conference rooms, librarians' offices, and a checkout area.

Library hours total 56.5 hours per week, and the building is occupied approximately 65 hours per week.

Benchmarking and Historic Energy Use

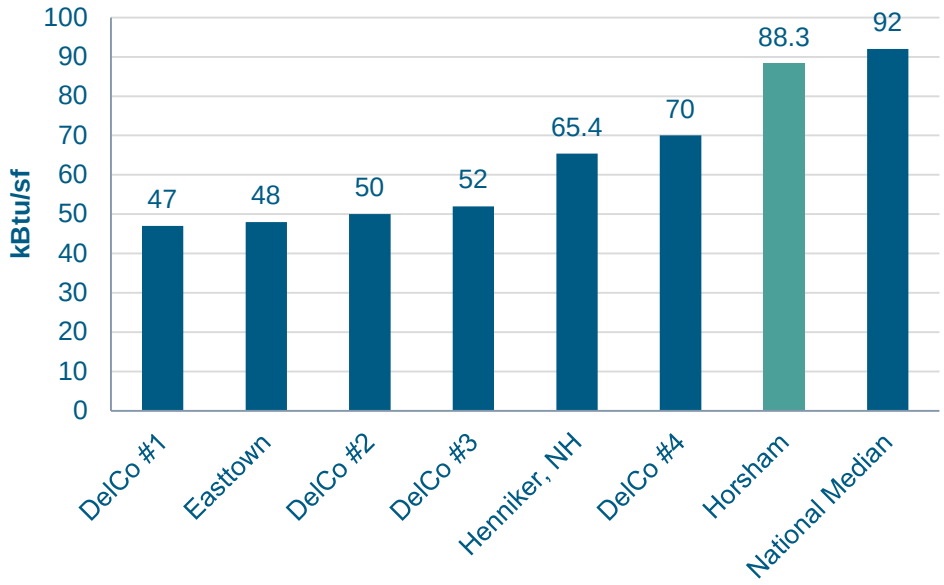
Annual Energy Costs

From October 2011 through September 2012, Horsham Township spent $46,346 on energy for the library. Approximately 77 percent of this expense ($35,602) was for electricity, and the remaining $10,744 was for natural gas used for space heating. The annual cost of energy per square foot was $1.66.

Annual Energy Use

The facility's estimated energy use intensity (EUI)—a measure of total energy use per square foot—is 88.3 kBtu per square foot, which is on the high end of EUI scores for similar local facilities, as shown in Figure 1 below. This suggests opportunities for energy and cost savings.

Figure 1: EUI Scores for Libraries



Note: National median is relatively high because it includes large city-based libraries.
Source: Practical Energy Solutions for DVRPC 2014.

CO_2 Emissions

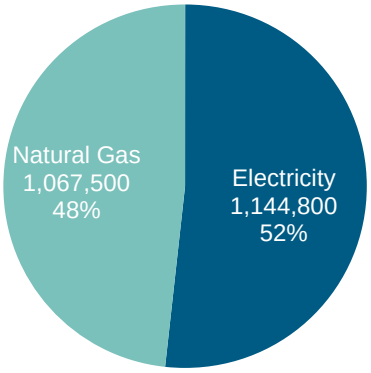
Total energy use at this facility is responsible for approximately 548,291 pounds of CO_2 emissions annually—the CO_2 emissions equivalent of nearly 48 passenger cars per year. Seventy-seven percent of emissions were from the use of electricity; the remainder were from the use of natural gas.

Energy End Uses

To determine the most appropriate energy conservation measures, it is important to understand how the various building systems use energy. PES developed a breakdown of energy "end-uses" (i.e., lighting, cooling, ventilation fans, etc.) based on historic utility energy use and PES's walkthrough:

- On a Btu basis, approximately 52 percent of all energy use is due to electricity, and the remaining 48 percent is due to natural gas, as shown in Figure 2 below.

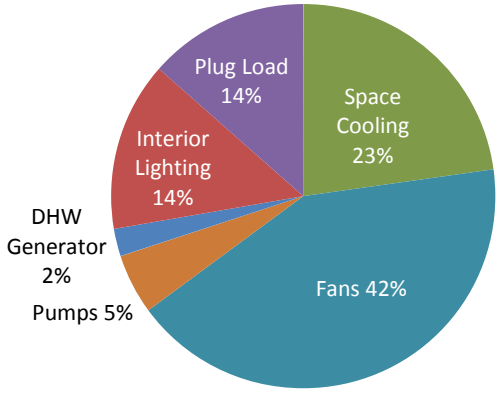
Figure 2: Energy Use in kBtu (10^3 Btu)



Source: Practical Energy Solutions for DVRPC 2014

- One hundred percent of natural gas is used for space heating.
- Ventilation fans use a full 42 percent of the electric load, and space cooling uses 23 percent of all electricity. Figure 3 shows all electricity end uses.

Figure 3: Electricity End Uses



Notes: Plug Load = computers, desk lamps, printers, faxes, copiers vending machines, other plug loads. Fans = air handlers/ventilation.DHW = domestic hot water. **Source:** Practical Energy Solutions for DVRPC 2014

Scope of Analysis

On behalf of the DVRPC Circuit Rider Program, PES performed a general walkthrough of the Horsham library to identify opportunities to reduce energy use and costs. PES evaluated all building systems.

HVAC

HVAC: Findings

The Horsham Township library HVAC system provides heat in three ways:

1. Air handlers (AHU). Three air handlers (AHU-1, Rooftop Unit-1 (RTU-1), and RTU-2) deliver forced-air heat into the rooms via air ducts containing variable air volume (VAV) boxes. Dampers in the VAV boxes regulate air volume delivered to individual spaces in response to a thermostat, and this helps maintain a temperature balance throughout the building. AHU-1, located in the mechanical room, contains hot-water coils; the hot water is heated using two UBW natural gas-fired, standard efficiency boilers (520 MBH[3] output, 81 percent thermal efficiency), also located in the mechanical room. The rooftop units (RTUs) contain natural gas-fired furnaces.
2. Hot water radiators, also served by the two boilers, provide perimeter heating.
3. Fan-powered VAV boxes. In some sections of the building, the VAV boxes contain fans and hot-water coils, which also receive hot water from the boilers. The VAV fans push conditioned air over the coils to further increase the temperature of the forced air as needed.

All three air handlers contain direct expansion (DX) air-cooled condensers, which provide air conditioning throughout the building during summer months.

A centralized Teletrol Building Automation System (BAS) controls all HVAC operations, schedules, and temperature setpoints. The BAS is managed by a contractor, and employees do not have direct access to the system. Therefore, PES was unable to examine the system in detail, and PES gathered all information about the BAS anecdotally, through conversations with administrative staff.

BAS systems can be instrumental in saving energy, but they can also cause unnecessary energy use if not well managed. When a BAS is properly programmed to enter unoccupied mode after-hours, the space temperature is “set back” during cooling season or “set up” during heating season by 10°F or more, outside air dampers close fully to eliminate ventilation loads, and the system fan cycles only as necessary to meet the unoccupied setpoints.

Township administrators and library personnel indicated that the contractor did not ask them for operating hours and scheduling information when the BAS was first installed. This suggests that there may be no, or inadequate, unoccupied temperature setbacks. This would cause the HVAC system to fully condition the air during unoccupied hours, which in this case would be up to well over half (62 percent) of the time. This would cause considerable unnecessary energy use and may be a reason for the high EUI.

[3] Thousand BTUs per hour

HVAC: Recommendations

Confirm Setback Schedule

Horsham Township should contact its controls contractor to confirm and verify the setback schedule. If there are no setbacks, programming the BAS to set back 10°F, as recommended, will reduce HVAC energy use by 13 percent.

PES also recommends training an in-house employee to access and control the BAS, as this will save on contractor costs, which can be considerable.

Evaluate/Implement Hot-Water Reset Control

If not already in place, Horsham Township should consider implementing outside air reset control for the library's hot-water loop. Outside air reset reduces the hot water supply temperature in response to increasing outdoor air temperature, allowing the boiler to more accurately match output temperature to the demand for heat. A typical control strategy would produce 180°F water at outside temperatures of 20°F or less, produce 150°F hot water at outside temperatures of 50°F or more, and ramp hot water temperature linearly between 180°F and 150°F at outside air temperatures between 20°F and 50°F.

It is estimated that every 4°F decrease in water temperature will result in heating energy savings of approximately 1 percent.[4] Based on this assumption and the control strategy outlined above, outside air reset control could reduce heating energy use at the Horsham Township library by approximately 4 percent.

The existing boilers do not appear to have any advanced "on-board" controls, so a hot-water reset strategy will likely need to be implemented through the BAS. The controls contractor should perform this work, and care must be taken not to override any of the boilers' built-in safety settings.

Table 2: Savings: HVAC Measures

#	Measure Description	Annual Energy Savings		CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Est. Project Cost	Simple Payback [yrs]
1	Define Unoccupied Temperature Setpoints	14,580	kWh	18,371	$3,657	*	*
		2,037	ccf	23,955			
2	Implement Hot Water Reset Controls	448	ccf	5,273	$464	*	*
TOTAL		14,580	kWh	47,599	$4,121	*	*
		2,485	ccf				

Notes: *Depends on township's existing contract with controls contractor. All savings based on current electricity rate. Savings will change as electricity prices change.
Source: Practical Energy Solutions for DVRPC 2014

[4] http://www.heat-timer.com/En/EducationDetail.aspx?Id=3

Lighting

Interior lighting is primarily 48″, 32W T-8 linear fluorescent lamps in two-lamp fixtures. A mix of LED and halogen incandescent multifaceted reflector (MR)-style bulbs provide decorative and accent lighting in the reading area.

Throughout the facility, PES observed Lutron wall-mounted lighting controllers and vacancy sensors. The community meeting room has advanced Lutron Grafik Eye® controllers with vacancy sensors, as shown in Figure 4 below. These sensors offer the ability to incorporate several energy conservation strategies in addition to occupancy-based operation—such as daylight harvesting, time clock control, and automated shades.

Figure 4: Grafik Eye® Lighting Controller, Community Meeting Room

Source: Practical Energy Solutions for DVRPC 2014

These lighting controls appear to be underused, as the library staff members reportedly turn all lights on and off manually and use the Grafik Eye® controllers only for dimming the lights during events. During the PES site visit, the community meeting rooms (which were divided at the time) were empty, but all lights were on, indicating that the Grafik Eye® controllers are not responding to the ceiling-mounted vacancy sensors.

PES recommends evaluating the functionality of all Lutron lighting controllers and configuring the system to be fully operational where needed. Proper use of the vacancy controls could reduce lighting energy use in those rooms up to 40 percent and reduce overall lighting use by approximately 12 percent. The controls contractor may be required to make any needed changes to the lighting control system.

Table 3: Savings: Lighting Controls

#	Measure Description	Annual Energy Savings		CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Est. Project Cost	Simple Payback [yrs]
3	Vacancy Sensor Lighting Control in Meeting Rooms	6,048	kWh	7,621	$642	*	*

Notes: *Depends on township's existing contract with controls contractor. All savings based on current electricity rate. Savings will change as electricity prices change.
Source: Practical Energy Solutions for DVRPC 2014

Computers and Receptacle Loads

Receptacle, or “plug,” loads—such as computers, copiers, and printers—represent approximately 11 percent of annual electricity use at the Horsham Township library. A significant portion of this load is due to a mixture of computers—including approximately six thin client computers, 32 small form factor computers, and nine large desktop computers—as well as approximately five printers and three large copiers.

These appliances (and many others, including televisions, refrigerators, microwaves, and vending machines) can create “phantom” loads because they use energy even when not in use. A key strategy for trimming plug load energy use is to reduce any idle time,or the amount of time the equipment is on but not in use. For example, putting a desktop computer to “sleep” when not in use and shutting it down during evenings and Sundays (rather than leaving it on 24/7) can yield greater than $20 per year in energy savings.

Further investigation is needed to determine if this equipment is turned off at night. If not already in place, PES recommends implementing a receptacle load power management strategy, which could reduce plug load energy use by up to 29 percent. This strategy is as simple as designating one employee to shut down all the equipment at night, but it can also involve a central software-based power management solution. PES also recommends engaging the employee responsible for IT operations so computers can be left on once per week or monthly for scheduled software upgrades.

Table 4: Savings: Receptacle Power Management

#	Measure Description	Annual Energy Savings [kWh]	CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Est. Project Cost	Simple Payback [yrs]
4	Receptacle Load Power Management	13,654	17,204	$1,449	$ -	Immediate

Note: All savings based on current electricity rate. Savings will change as electricity prices change.
Source: Practical Energy Solutions for DVRPC 201

Appendix A

Appendix A. Stack Lighting Analysis

Scope of Analysis

On behalf of the DVRPC Circuit Rider Program, Practical Energy Solutions (PES) evaluated retrofit opportunities for the stack lighting at the Horsham Township Library to identify an LED lamp to replace the existing halogens.

Findings

There are 93 ea. 50 W Ushio Reflekto MR-16 halogen lamps currently installed at the Horsham Township Library. PES evaluated three MR-16 LED lamp options to replace the existing inefficient 50W M-16 halogen lamps. As shown in Table 1 below, PES analyzed lamps with comparable specifications to the existing MR-16 halogen lamps. Images of the existing halogen lamps and the three replacement options are provided as Figures 2,3, 4, and 5 below.

Table 1: Possible Replacement Lamps

Item	Brand	Item #	Watts	Beam Angle	Max Overall Length (mm)	Kelvin	Life (hrs)	Candle Power	Dia (mm)	Dimmable?	ENERGY STAR Rated?	Warranty	Cost/Bulb*
Existing product	Ushio Reflekto Halogen (existing)	1000408	50	36° flood	45.2	3,000	3,500	1,580	50.7	Y			$ 9.98
Replacement 1	Ushio Uphoria LED	1002484	6.5	35° flood	45.5	3,000	35,000	885	49.78	N	N	3 yr ltd	$ 30.38
Replacement 2	GE Energy Smart/2nd generation	69950	7	35° flood	47.75	3,000	25,000	1,500	50.8	Y	Y	3 yr ltd	$ 31.05
Replacement 3	Phillips Master LED Spot	195702	10	36° flood	54.2	3,000	30,000	N/A	50.5	Y	N	5 yr	$ 41.73

Notes: All lamps = GU 5.3 pin base for compatibility with existing fixture. *Taken from Internet sources. Replacement 1 is not dimmable; it is included for comparative purposes only and should not be used in dimmable fixtures. **Source:** Practical Energy Solutions for DVRPC 2014

Figure 2. Existing Product

Figure 3. Replacement 1

Figure 4. Replacement 2

Figure 5. Replacement 3

Recommendations

As shown in Table 2 below, PES recommends lamp Replacement 2. Replacement 2 will result in an estimated 86 percent reduction in energy use, and at today's energy prices could pay back in just over two years. Further, LED lamps offer a longer lifespan, lasting more than seven times as long as the existing halogen lamps. Replacement 2 offers excellent energy and maintenance savings, compatible project cost, an identifiable brand name, and it is a second-generation LED bulb. PES recommend purchasing an identifiable brand name product, even though the list price may be higher. Early MR-16 technology has been substandard, with overheating of bulbs and quality issues. This will also help ensure that the manufacturer will remain in business to fulfill the warranty.

PES recommends purchasing one or two of the recommended bulbs and trialing them to ensure light quality and fixture compatability. The bulb must be compatible with the fixture's transformer and dimmer, and this should be confirmed in advance of purchase by calling the manufacturer. For more information on MR-16 LED technology, see www.ledsmagazine.com/articles/print/volume-9/issue-6/features/are-mr16-led-lamps-ready-for-the-50w-halogen-switch-magazine.html .

Table 2: Operational and Project Costs

Description	Watts	kWh/ Year	Electricity Cost/Year ^,*	Utility Savings/Year (%)		LED Replacement Project Cost**	Payback (years)	No. Replacements Over 8 Years	Replacement Costs Over 8 Years^^	Total Cost Over 8 Years	% Total Cost Savings Over 8 Years
Existing MR-16 Halogen	50	13,662	$1,461.80	$-				6	$5,568.84	$17,263.26	
Replacement 1	6.5	1,776	$190.03	$1,271.77	87%	$2,825.34	2.2	0	$-	$1,520.27	91%
Replacement 2	7	1,913	$204.65	$1,257.15	86%	$2,887.65	2.3	0	$-	$1,637.22	91%
Replacement 3	10	2,732	$292.36	$1,169.44	80%	$3,880.89	3.3	0	$-	$2,338.88	86%

Notes: Based on 93 fixtures. *Based on current rate of $0.107/kWh. Rates are likely to change over time. **Bulb prices taken from Internet sources. ^assumed 56.5 run hours per week. ^^At current bulb prices. __= recommended for trial. **Source:** Practical Energy Solutions for DVRPC 2014

Appendix B

Horsham Township Energy Assessment

Township Library

Publication Number: 15024E

Date Published: Aprili 2016

Geographic Area Covered: Horsham Township

Key Words:

Energy, natural gas, electricity, energy management, HVAC, steam, windows, lighting, controls, load power management, plug load, CO_2 emissions

Abstract:

On behalf of the DVRPC Circuit Rider Program Practical Energy Solutions (PES) performed an energy assessment of the Horsham Township Library. The Horsham Township Library (28,000 ft^2) is a modern, one-story building constructed in 2004, and is occupied 65 hours per week. PES performed a general walkthrough of the Horsham Township library and an analysis of the library's stack lighting to identify opportunities to reduce energy use and cost. PES identified opportunities to save energy through improved management of the sophisticated heating, ventilation, and air conditioning (HVAC) and lighting control systems. PES identified several steps that the Horsham Township controls system contractor could perform to improve management of the HVAC and lighting controls systems. Additionally, PES recommended implementing a load power management strategy to reduce plug load by 29 percent. Overall, these improvements are estimated to reduce natural gas use 24 percent and reduce electricity use 10 percent, saving the township more than $6,200 annually in energy costs at today's prices

Staff Contact:

Liz Compitello
Senior Research Analyst
☏ (215) 238-2897
ecompitello@dvrpc.org

Delaware Valley Regional Planning Commission
190 N. Independence Mall West, 8th Floor
Philadelphia, PA 19106-1520
Phone: (215) 592-1800
Fax: (215) 592-9125
Internet: www.dvrpc.org

DVRPC, 8TH FLOOR
190 N. INDEPENDENCE MALL WEST
PHILADELPHIA, PA 19106-1520
215.592.1800
WWW.DVRPC.ORG