# Horsham Township Energy Assessment

## Police Building

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

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# Executive Summary

Horsham Township is a municipality of 26,147 residents[1] located in Montgomery County, PA. On behalf of the DVRPC Circuit Rider Program[2], Practical Energy Solutions (PES) performed an energy assessment of the Horsham police facility to identify opportunities for energy savings.

The building (13,800 ft$^2$), constructed in 2009, is one of the newer township buildings. Despite its recent construction, the facility is served by an energy-intensive “reheat” system that represents a conventional, inherently inefficient, and increasingly outmoded approach to summertime dehumidification. With this system, supply air is intentionally subcooled to remove moisture (dehumidify) on hot, humid summer days, then the air is reheated to setpoint temperature. This subcool-reheat method requires a significant amount of energy.

As a result, Horsham spent $49,746 on energy for this facility in 2011, and the energy cost per square foot was relatively high at $3.60 despite competitive energy pricing. In addition, the energy use intensity (EUI)-a commonly used measure for benchmarking whole-building energy performance-is 150 percent of the national average for stand-alone police departments.

Despite the inherent inefficiency of the subcool-reheat approach, the facility’s HVAC system is equipped with several state-of-the art energy management features. The building automation system (BAS), in particular, enables electronic control of many parameters. PES recommends maximizing these controls to reduce energy use by programming the BAS to do the following:

- Decrease the occupied heating setpoint. Reducing the occupied heating setpoint from 71°F to 70°F could reduce space heating energy use by approximately 3 percent.
- Tighten thumbwheel control. Wall-mounted sensors have a manual thumbwheel that allows occupants to increase or decrease temperature in their zones. We recommend reducing the allowable temperature range from its current setting of +/-5°F to +/-2°F. This should satisfy most employees, eliminate over- or under-conditioning, and reduce space air conditioning and heating energy use by 1 percent.
- Create unoccupied setbacks. This facility is programmed to operate 24/7 in full occupancy mode. However, many areas are vacant at night and on weekends, using significant amounts of energy. Fortunately, most spaces in the building are equipped with thermostat overrides for employees who use the building after hours, and most areas that are occupied continuously (such as the dispatch office) are already equipped with dedicated heat pumps. PES recommends taking advantage of this override function by establishing heating and cooling temperature setbacks during largely unoccupied times, programming an override duration (e.g., three hours) into the BAS, and instructing employees to push the “occupied” button on the wall sensor in his or her zone to initiate these temporary overrides when needed. This measure could reduce space conditioning energy use by more than 11 percent.
- Enable hot water reset control. The boilers in the Horsham police facility are capable of outside air reset control, which ensures that water is heated only as much as necessary to achieve the thermostatic setpoint. When it is warmer outside, the water temperature does

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

not have to be as high. Initiating a typical outside air reset control sequence via the BAS could reduce space heating energy use up to 6 percent.

PES also recommends the following three lighting energy conservation measures:

- Install higher-efficiency fluorescent lamps. Phase out all 32W T-8 lamps in favor of higher-efficiency 28W T-8 lamps to reduce interior lighting energy use approximately 20 percent.
- Improve occupancy sensors. In many offices, occupants have overridden occupancy sensors with manual wall switches because the lights do not stay on otherwise. Redirecting, repositioning, and/or replacing the occupancy sensors could reduce current lighting costs as much as 9 percent.
- Install LED exit signs. The exit signs appear to be lit with incandescent bulbs. Replacing them with LED exit signs could reduce interior lighting energy use nearly 4 percent.

Overall, these energy conservation measures can cut total energy expenses 13 percent annually, save more than $6,200 a year, pay back in well under one year, and reduce $CO_2$ emissions due to fossil fuel use by nearly 75,000 pounds annually, as shown in Table 1 below. This has the same reduction in $CO_2$ emissions as removing seven passenger cars from the road per year or planting more than 1,560 mature trees.

**Table 1:** Summary of Energy Conservation Measures

| # | Description | Annual Energy Savings | | $CO_2$ Savings [lbs] | Energy Cost Savings [$/yr] | Estimated Project Cost | Simple Payback [yrs] |
|---|---|---|---|---|---|---|---|
| 1 | Reduce Heating Occupancy Setpoint to 70°F | 510 | ccf | 6,173 | $537 | $- | - |
| 2 | Tighten Thumbwheel Control | 484 | kWh | 2,153 | $182 | $- | - |
| | | 128 | ccf | | | | |
| 3 | Institute Unoccupied Setback | 3,872 | kWh | 28,540 | $2,444 | $- | - |
| | | 1,955 | ccf | | | | |
| 4 | Hot Water Reset Control | 1,062 | ccf | 12,855 | $1,119 | $- | - |
| 5 | Install 28W T-8s | 11,932 | kWh | 15,035 | $1,188 | $- | - |
| 6 | Improve Occupancy Sensors | 5,364 | kWh | 6,759 | $534 | $2,580 | 4.8 |
| 7 | Install LED Exit Signs | 2,365 | kWh | 2,980 | $235 | $1,506 | 6.4 |
| **TOTAL** | | **24,017** | **kWh** | **74,495** | **$6,239** | **$ 4,086** | **0.7** |
| | | **3,655** | **ccf** | | | | |

**Note:** All savings based on current electricity rate. Savings will change as electricity prices change.
**Source:** Practical Energy Solutions for DVRPC 2014

# Building Description

The Horsham Township police facility (13,800 $ft^2$) was constructed in 2009 and is one of the newer township buildings. The building systems are generally in good condition, and there are few, if any, capital energy improvements to be made at this time. The energy conservation opportunities are largely operational and involve refining system controls.

Daytime occupancy in the police department is approximately 15 officers. This is a 24-hour use facility, but officers tend to come and go, and the building is rarely fully occupied. After 6:00 p.m., only the dispatch office is occupied, and just one to two officers are on duty (according to our employee interviews). During these times, when the majority of the building is vacant, there are significant opportunities to conserve energy.

# Historic Energy Use

## Annual Energy Costs

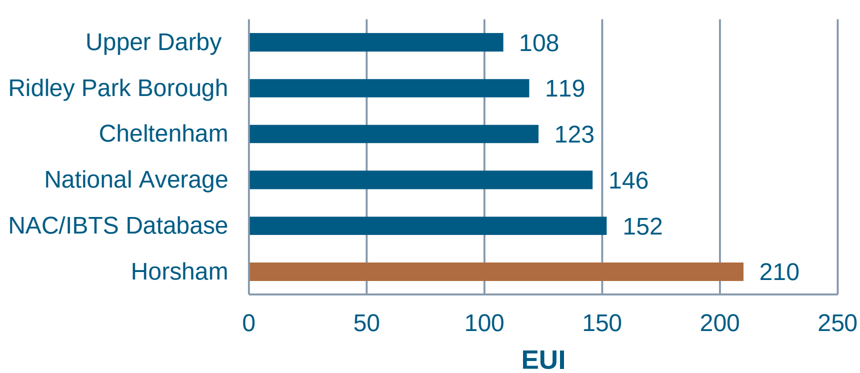
In 2011, Horsham spent $49,746 on energy for the police facility. Sixty-two percent of this expense is due to electricity ($31,019; 311,680 kWh); the remainder is for natural gas ($18,727; 17,784 ccf).

The township has obtained competitive energy prices for this facility. The average cost per kWh was $0.10; average cost of natural gas was $1.05 per ccf. The resulting average 2011 energy cost per square foot is $3.60.

## Annual Energy Use

The police facility's energy use intensity (EUI)—a measure of total energy use per square foot—is 210 kBtu per square foot. This is 150 percent of the national average for stand-alone police departments, as shown in Figure 1 below, further confirming the opportunities to cut energy use and operational energy costs.

**Figure 1:** Police Facility Energy Use Intensity Scores




**Notes:** National Average = ENERGY STAR Portfolio Manager CBECS Database.[3] NAC/IBTS = National Association ofounties/Institute for Building Safety and Technology Database, from 101 police stations across the country[4].
**Source:** Practical Energy Solutions for DVRPC 2014

[3] ww.energystar.gov/ia/business/tools_resources/new_bldg_design/2003_CBECSPerformanceTargetsTable.pdf
[4] www.naco.org/research/pubs/Documents/Infastructure%20and%20Sustainability/Energy-Efficient-County-Buildings.pdf

## $CO_2$ Emissions

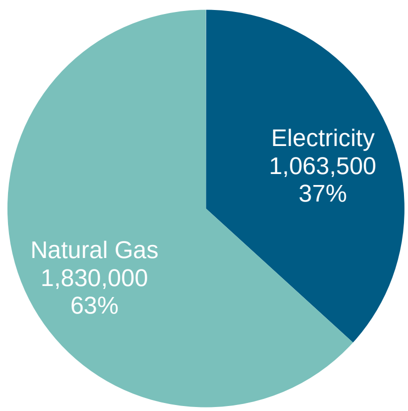
Total energy use at this facility is responsible for nearly 608,000 pounds of $CO_2$ emissions annually—the $CO_2$ emissions equivalent of more than 53 passenger cars per year. This is significant for a facility of this size. Sixty-five percent of emissions were due to electricity use; the remaining 35 percent 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, fans, etc.) based on historical utility energy use and the site walkthrough:

- On a Btu basis, 63 percent of all energy used is due to natural gas, as shown in Figure 2 below.

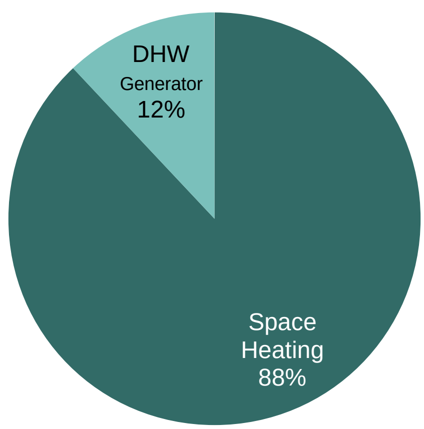
**Figure 2:** Energy Use in kBtu ($10^3$ Btu)




**Source:** Practical Energy Solutions for DVRPC 2014

- Eighty-eight percent of natural gas is used for heating; the remainder heats domestic hot water (DHW), as shown in Figure 3 below.

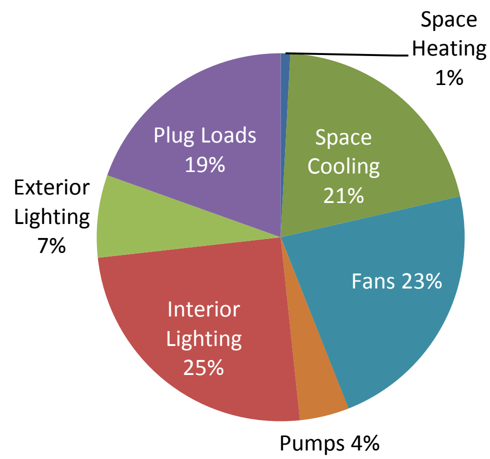
**Figure 3:** Energy Use in kBtu ($10^3$ Btu)




**Source:** Practical Energy Solutions for DVRPC 2014

- Figure 4 shows all electricity end uses. Air conditioning and ventilation fans use 44 percent of all electricity. Interior lighting uses an additional 25 percent of electricity.

**Figure 4:** Electricity End Uses




**Notes:** Plug Load = computers, desk lamps, printers, faxes, copiers vending machines, other plug loads. **Source:** Practical Energy Solutions for DVRPC 2014

# Scope of Analysis

PES performed a general walkthrough to identify opportunities to reduce energy use and costs. PES focused largely on operational changes, since the systems and building are new.

# HVAC

## HVAC: Findings

This building is conditioned by a forced-air variable air volume (VAV) system, with both standard and fan-powered VAV boxes located in ductwork throughout the facility. 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.

The system includes a 2009 Trane MCCB030 central air handler; a 2009 Trane RAUCC40 four-stage direct expansion (DX) condensing unit for cooling and dehumidification (11.3 EER, 43 tons); and two 2009 Slant/Fin Caravan GG-375 natural gas-fired modular hot water boilers (608 MBH total capacity, 80.9 percent efficiency) for winter heating and reheating overcooled air. Appendix A includes an inventory of HVAC equipment.

This system uses a traditional “reheat” approach to summertime dehumidification. The DX unit intentionally subcools supply air to remove moisture, then the boiler reheats the air to setpoint temperature. This approach is energy intensive and requires the boiler to run year-round. For this reason, and because less energy-intensive technologies exist, reheat systems are falling out of favor.

Despite its inherent inefficiency, the HVAC system in this facility has several high-end energy management features that enable facilities personnel to control energy use. Variable frequency drives (VFDs)-which produce energy savings by adjusting motor speed and torque with changes in demand-are installed on the air handler supply fan and the two hot water pumps. In addition, a building automation system (BAS) allows electronic control of all heating and cooling setpoints, fan schedules, overrides, economizer parameters, and more. This allows a high degree of control over individual system components and, importantly, offers the ability to track energy performance and verify the success of energy-saving control strategies.

## HVAC: Recommendations

Horsham Township should consider the following adjustments to the BAS system:

- Decrease occupied heating setpoint. The current occupied heating setpoint is 71°F. Reducing this to 70°F could reduce space heating energy use by approximately 3 percent.[5]
- Tighten thumbwheel control. Many of the wall-mounted temperature sensors have a manual thumbwheel that allows occupants to increase or decrease temperature in their areas by a few degrees. Figure 5 below is an image of a temperature sensor with a manual thumbwheel on top. The range of allowable temperatures, or “throttling range,” is adjustable in the BAS and is currently set to +/-5°F. This is a relatively large range and may cause balance problems and poor energy performance. We recommend reducing the throttling range to +/-2°F. This should be sufficient to satisfy most employees and will eliminate over- or under-conditioning. This measure could reduce space conditioning energy use by 1 percent.

**Figure 5:** Wall-Mounted Temperature Sensor

**Source:** Practical Energy Solutions for DVRPC 2014

[5] Based on DOE estimate of 1 percent energy savings per 1°F setback over an 8-hour period: http://energy.gov/energysaver/articles/thermostats-and-control-systems

- Create unoccupied setbacks with temporary overrides during heating season. This facility is programmed to operate continuously (24/7) in full occupancy mode. However, many areas are vacant at night and on the weekends, using significant amounts of energy.

  PES recommends implementing a weekly occupancy schedule for the air handler (e.g., 6:00 a.m. to 6:00 p.m. Monday through Friday). During unoccupied mode, the supply fan should shut down, the outdoor air damper should close completely, and all VAVs should begin maintaining a 60°F unoccupied temperature setpoint. When an employee arrives during the unoccupied mode, pushing the "occupied" button on the wall-sensor in his or her zone (the bottom button shown in Figure 5 above) will initiate a temporary override. During this time, the fan-powered VAV will maintain the occupied (standby) setpoint. The BAS allows a maximum override duration of 4 hours; the durations for each zone should be individually programmed into the BAS based on needs (e.g., two to three hours).

  This approach will allow small portions of the building to be conditioned as needed during the largely unoccupied hours, rather than conditioning the entire building. Most of the areas that are occupied continuously or that require 24/7 conditioning—such as the dispatch office and server room—are already equipped with dedicated split-system heat pumps and do not rely on the VAV system.

  Importantly, overrides are not possible in all areas, as some areas (e.g., Rooms 115, 111, and the cellblock) do not have fan-powered VAV boxes. If needed, this can be addressed by installing fan-powered VAVs with appropriate wall-mounted temperature sensors in these areas. If the cellblocks are in use for extended periods of time during otherwise unoccupied hours, consider installing a split system in this area.

  This measure will enable the township to reduce space conditioning energy use by more than 11 percent. PES recommends this measure even if an outside contractor is needed, due to the significant energy savings.

- Create unoccupied setbacks during cooling season. During cooling season, we recommend implementing a weekly occupancy schedule for the air handler similar to the heating season schedule (e.g., 6:00 a.m. to 6:00 p.m. Monday through Friday). The unoccupied setpoint should not be too aggressive (i.e., 78°F); this will allow employees working off-hours to remain comfortable. This measure will reduce space cooling electricity use by 6 percent.

- Enable hot water reset control. The Slant/Fin Caravan boilers, shown in Figure 6 below, are capable of outside air reset control, which reduces hot water supply temperature in response to increasing outside air temperature. This enables the boiler to more accurately match output temperature to the demand for heat. A typical control sequence delivers 180°F water at ambient temperatures of 20°F or less, 150°F water at temperatures of 50°F or more, and ramps linearly between 180°F and 150°F at temperatures between 20°F and 50°F. This control strategy could reduce space heating energy use by up to 6 percent.[6]

[6] Based on a 1 percent heating energy savings for every 4°F decrease in hot water supply temperature: http://www.heat-timer.com/En/EducationDetail.aspx?Id=3

**Figure 6:** Slant/Fin Caravan Boilers


**Source:** Practical Energy Solutions for DVRPC 2014

Together, these measures can reduce natural gas use by 21 percent, reduce total electricity use by 1.4 percent, and cut total energy costs by more than $4,200 (9 percent), as shown in Table 2 below. These measures are cost-free, will pay back immediately, and can be managed through the existing BAS.

**Table 2:** HVAC System Energy Conservation Measures

| Description | Annual Energy Savings | | $CO_2$ Savings [lbs] | Energy Cost Savings [$/yr] |
|---|---|---|---|---|
| Reduce Heating Occupancy Setpoint to 70°F | 510 | ccf | 6,173 | $537 |
| Tighten Thumbwheel Control | 484 | kWh | 2,153 | $182 |
| | 128 | ccf | | |
| Unoccupied Setback* | 3,872 | kWh | 28,540 | $2,444 |
| | 1,955 | ccf | | |
| Hot Water Reset Control | 1,062 | ccf | 12,855 | $1,119 |
| **TOTAL** | **3,655** | **ccf** | **49,721** | **$4,282** |
| | **4,356** | **kWh** | | |

**Notes:** *Estimated cost of new fan-powered VAV box with wall-mounted temperature sensor at $1,400 each, including materials and installation. Installation of four VAVs/sensors will result in an approximate two-year payback. Contractor quotation recommended. All savings based on current electricity rate. Savings will change as electricity prices change.
**Source:** Practical Energy Solutions for DVRPC 2014.

## Lighting

Interior lighting is primarily 32W T-8 fluorescent tubes in two-lamp fixtures controlled by occupancy sensors in all private offices and conference rooms. Many sensors have been manually overridden, however, due to unsatisfactory performance.

## Lighting: Recommendations

PES recommends three lighting energy conservation measures: switching to higher-efficiency fluorescent lamps, installing LED exit signs, and improving occupancy sensor controls.

- Install higher-efficiency fluorescent lamps. Consider phasing out all 32W T8 lamps in favor of higher-efficiency 28W T8 lamps. These lamps produce the same light output as standard 32W lamps, are the same price, and last just as long, but they could reduce interior lighting energy use in this facility by approximately 20 percent.

- Improve occupancy sensors. Interviews during our site visit suggest that many occupancy sensors may be positioned improperly. They appear to have an obstructed view of the room or are focused toward the ceiling or wall. The result is poor performance, and in many offices, occupants have overridden the sensors with the manual wall switch because the lights do not stay on otherwise. There are, however, significant energy-saving opportunities associated with occupancy sensor control in 24-hour facilities, and PES' analysis indicates that repositioning and repairing the occupancy sensor controls could reduce current lighting operational expenses by as much as 9 percent.

  PES recommends using a qualified lighting expert to evaluate and correct current sensor placement. If the sensors are unable to accurately sense occupancy even when properly positioned, the lighting contractor should consider replacing them with dual-technology passive infrared (PIR)/ultrasonic sensors. These units are more sensitive because they detect both body heat and motion, greatly reducing the risk that lights will switch off while someone is in the office. Placement of these sensors is also important; for example, ultrasonic sensors cannot be placed near areas with high levels of vibration or air flow.

- Install LED exit signs. The exit signs in this facility appear to be lit with incandescent bulbs, which are typically 20W per face (40W total). While this may seem insignificant, exit signs account for at least 5 percent of interior lighting energy use in this facility and can easily be replaced with LED exit signs, which are up to 75 percent more efficient. This could reduce interior lighting energy use by nearly 4 percent. Note: PES did not remove any exit signs to verify bulb type; please confirm that the existing signs are not already LED before replacing them.

Together, these lighting measures can reduce overall electricity use by 6 percent and cut total annual energy costs by almost $2,000 (4 percent), as shown in Table 3 below.

**Table 3:** Lighting Energy Conservation Measures

| Description | Annual Energy Savings [kWh] | $CO_2$ Savings [lbs] | Energy Cost Savings [$/yr] | Estimated Project Cost | Simple Payback [yrs] |
|---|---|---|---|---|---|
| Upgrade to 28W T8s | 11,932 | 15,035 | $1,188 | $- | - |
| Improve Occupancy Sensors | 5,364 | 6,759 | $534 | $2,580 | 4.8 |
| LED Exit Signs | 2,365 | 2,980 | $235 | $1,506 | 6.4 |
| **TOTAL** | **19,662** | **24,774** | **$1,957** | **$4,086** | **2.0** |

**Note:** All savings based on current electricity rate. Savings will change as electricity prices change.
**Source:** Practical Energy Solutions for DVRPC 2014

# Appendix A

# Appendix A. Inventory of HVAC Equipment

| Description | Serves | Make/Model | Year | Cooling | | Heating | |
|---|---|---|---|---|---|---|---|
| | | | | Capacity [Btuh] | Efficiency [EER] | Capacity [Btuh] | Efficiency [EER] |
| Hot Water Cast Iron Boilers (2) | AHU-1, Reheats | Slant/Fin Caravan GG-375 HEC | 2009 | - | - | 608,000 | 80.9% |
| Electric Radiant Panels | | Berko CP371 | 2009 | - | - | 0.750 | |
| Indoor AHU | Bldg | Trane MCCB030 | 2009 | 10 | | - | - |
| Air-Cooled CU | AHU-1 | Trane RAUCC40EE200AB | 2009 | 517,000 | 11.3 | - | - |
| Split Sys CU | Dispatch | EMI KWCA18D0 | 2009 | 13,500 | 11.5 | | |
| Split Sys CU | Server | EMI KWCA18D0 | 2009 | 13,500 | 11.5 | | |
| VAV Fan-Powered Boxes | MECH SCH | | | 4 | | | |

**Notes:** AHU = air handling unit. CU = condensing unit
**Source:** Practical Energy Solutions for DVRPC 2014

# Horsham Township Energy Assessment

## Police Building

**Publication Number:** 15024D

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**Key Words:**
Energy, natural gas, electricity, energy management, heating ventilation air conditioning (HVAC), reheat, boiler, building automated system (BAS), lighting, controls, $CO_2$ emissions

**Abstract:**
On behalf of the DVRPC Circuit Rider Program Practical Energy Solutions (PES) performed an energy assessment of the Horsham Township Police Building. The Horsham Township Police Building (13,800 $ft^2$) is a modern, one-story building constructed in 2009. The building uses an energy intensive “reheat” system for summertime dehumidification, which is a conventional technology that requires a significant amount of energy to sub cool air on hot days to remove moisture (dehumidify) and then the boiler reheats the air to set point temperature. PES evaluated several ways that Horsham Township could maximize the controls of the state-of the art building automated system (BAS) to improve the efficiency of the “reheat” HVAC system. Additionally, PES identified lighting improvements, including controls and lamp upgrades, to improve lighting functionality and efficiency in the building. Overall, these improvements are estimated to reduce total energy expenditures by 13 percent annually, save more than $6,200 a year, pay back in well under one year, and reduce $CO_2$ emissions due to fossil fuel use by nearly 75,000 pounds annually.

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