Lansdowne Borough Energy Assessment Report

Borough Hall

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Prepared By:

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Prepared For:

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

APRIL 2016

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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; and Cheltenham Township, Horsham Township, and Towamencin Township of Montgomery County.

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Executive Summary

Lansdowne Borough is a municipality of 10,579 residents[1] located in Delaware County, PA. The Lansdowne Borough Hall/Police Building (10,301 ft^2) is a multiuse facility containing administrative offices, council meeting space, and the police department. The 1903 building comprises two above-grade floors and a basement.

The administrative offices are typically occupied between 40 and 45 hours per week, and the council and conference areas are occupied intermittently. The police department is used 24/7, with at least two officers on duty continuously and a receptionist on duty until 10:00 p.m. on weeknights.

In 2011, the Borough of Lansdowne spent $39,040 on energy for this facility. Sixty-four percent of this expense ($25,051) was for electricity, and the remaining $13,989 was for natural gas used primarily for space heating. The annual cost of energy per square foot was $3.66, which is high relative to other similar facilities in Delaware County.

The facility's 2011 estimated energy use intensity (EUI)—a commonly used measure for benchmarking whole-building energy performance—is 199 kBtu per square foot (kBtu/sf), which is also high compared to similar facilities in Delaware County. This suggests significant opportunities for energy and cost savings.

On behalf of the DVRPC Circuit Rider Program[2], Practical Energy Solutions (PES) performed a focused assessment of the Lansdowne Borough Hall/Police Building to identify energy conservation measures for the building envelope and HVAC (heating, ventilation, and air conditioning) systems. PES did not evaluate receptacle equipment or lighting systems, as the borough upgraded its lighting systems in 2012, which contributed to a 32 percent drop in the EUI between 2011 and 2013 (to 135).

The assessment showed that this building is served by an energy-intensive "reheat" system. With this system, supply air is intentionally subcooled to remove moisture (dehumidify) on hot, humid summer days, then the boiler reheats the air to setpoint temperature. This subcool-reheat method uses a significant amount of energy.

In addition, the entire building is fully conditioned 24/7, year-round, to accommodate two night-shift police officers, even though the officers use just a small portion of the building at night and on weekends. The whole building must be conditioned because a single air handler in the rooftop unit (RTU) serves the entire building, preventing the facility manager from putting the HVAC system into unoccupied mode for the unused portion of the building. The primary energy conservation opportunity involves installing a separate HVAC system in the police areas that operate 24/7 and revising the existing HVAC controls to allow temperature setbacks in unoccupied portions of the building. This will eliminate many hours of unnecessary whole-building conditioning. Specifically, PES recommends:

- Installing ductless split-system heat pumps in the 24/7 spaces to enable continual heating and cooling in these areas.
- Using the building automation system (BAS) to put the HVAC system into unoccupied mode at night and on weekends. This measure will dramatically reduce heating, cooling, and fan operating times—yielding annual energy cost savings of nearly $7,500 (19 percent of total annual energy spending).

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

- Enabling the BAS to control the RTU supply and return fans and hot water pumps, so they may be cycled to meet the unoccupied setpoints rather than scheduled to run continuously.

PES also recommends replacing the existing windows with ENERGY STAR-qualified windows as funds allow. The windows are in poor condition, are made of low-quality materials, and have poor energy performance. New windows will significantly improve thermal and solar heat gain performance, while nearly eliminating drafts and improving aesthetics of the building façade. Window replacements are necessary investments that typically do not pay back as energy efficiency measures.

PES also recommends weather-stripping exterior doors as needed.

Overall, these energy conservation measures will cut electricity use by an estimated 28 percent and reduce natural gas use 26 percent, saving the borough approximately $8,370 in annual energy costs (2011 prices). These measures will also reduce CO_2 emissions due to fossil fuel use by more than 90,000 pounds of CO_2 per year, which has the same reduction in CO_2 emissions as removing nearly nine passenger cars from the road/year or planting 2,110 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]	Savings Over 15 Years
1	Ductless Split-System Heat Pumps/BAS Refinement	42,077 kWh	53,017	$7,454	$52,000	7	$59,630
		2,293 ccf	26,963				
2	Replace Windows	2,087 kWh	2,630	$916	$23,879	26	N/A
		652 ccf	7,668				
TOTAL		**44,164 kWh**	**90,278**	**$8,370**	**$98,648**	**11.8**	
		2,945 ccf					

Notes: *Reflects cost for double-hung, argon-filled vinyl frame windows with U-factor ≤.40. Calculations reflect recommended U-factor of .32. Cost includes installation at prevailing wage rates. Also reflects cost based on high-end, flash-injection technology mini split systems, which are desired by the borough to ensure performance during extreme outdoor temperatures. Cost of standard units is significantly less at $29,000 (four-year simple payback). Cost of BAS revision not included. Costs may vary. Contractor quotation recommended. Cost savings based on current energy prices. Savings will change as energy prices change.
Source: Practical Energy Solutions for DVRPC 2014

Building Description

The Lansdowne Borough Hall/Police Building (10,301 ft^2) is a multiuse facility containing administrative offices, council meeting space, and the police department. The building comprises two above-grade floors and a basement, and it was constructed in 1903.

The administrative offices are typically occupied between 40 and 45 hours per week, and the council and conference areas are occupied intermittently for scheduled meetings. The police department is a 24/7 use area, with at least two officers on duty continuously and a receptionist on duty until 10:00 p.m. on weeknights. The basement level contains the mechanical room and prisoner holding cells.

Historic Energy Use

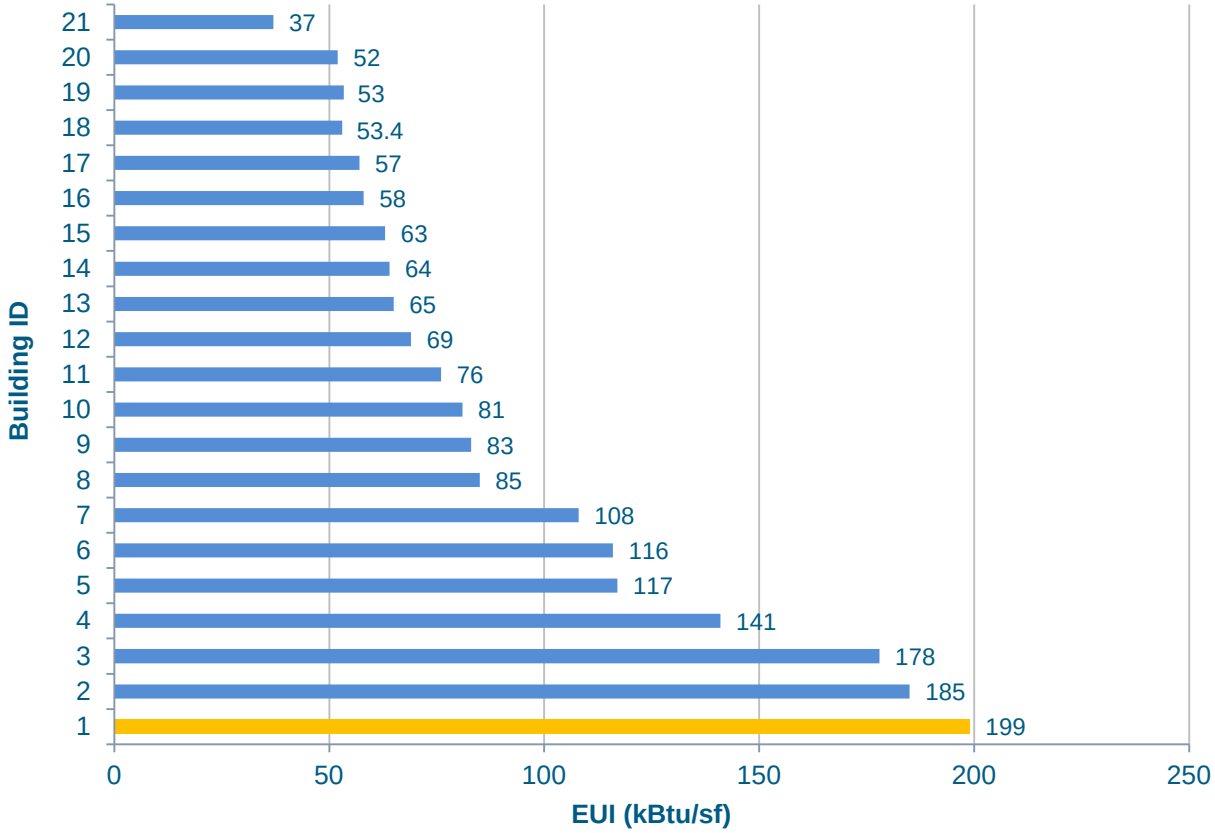
Annual Energy Costs

In 2011, the Borough of Lansdowne spent $39,040 on energy for the combined administration/police facility. Sixty-four percent of this expense ($25,051) was for electricity, and the remaining $13,988 was for natural gas used for space heating. The annual cost of energy per square foot was $3.66.

Annual Energy Use

The facility's estimated energy use intensity (EUI)—a common measure of total energy use per square foot—for the year 2011 was 199, which is high for similar facilities in Delaware County, as shown in Figure 1 below. This suggests significant opportunities for energy and cost savings.

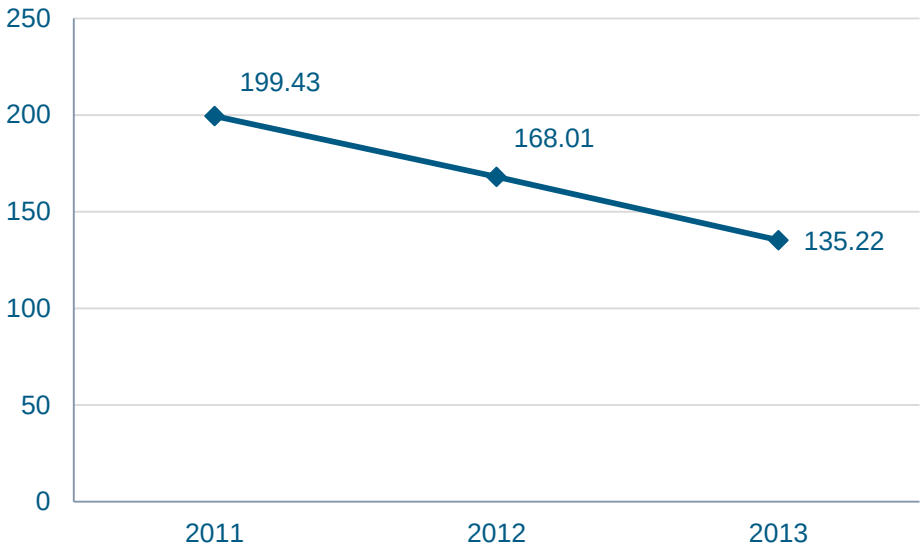
Figure 1: EUI Scores for Combined Administration/Police Buildings in Delaware County



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

Since 2011, the facility's EUI dropped 32 percent (to 135) due to an energy-efficient lighting upgrade funded by the County of Delaware via a DOE Energy Efficiency and Conservation Block Grant, as well as a boiler shutdown during the 2012–2013 summer cooling season.

Figure 2: Lansdowne Police/Admin Facility EUI Scores: 2011 - 2013



Source: Practical Energy Solutions for DVRPC 2014

CO_2 Emissions

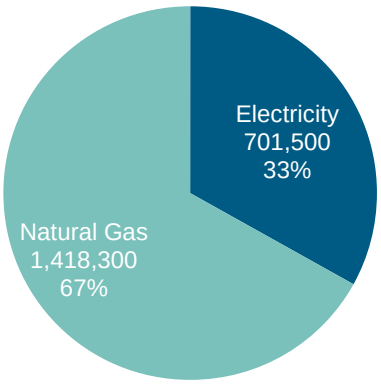
Total energy use at this facility is responsible for approximately 425,825 pounds of CO_2 emissions annually—the CO_2 emissions equivalent of 37 passenger cars per year. Sixty-one percent of emissions were due to electricity use; the remainder were due to natural gas use.

Energy End Uses

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

- On a Btu basis, 67 percent of all energy used is from natural gas, and the remaining 33 percent is from the use of electricity, as shown in Figure 3 below.

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

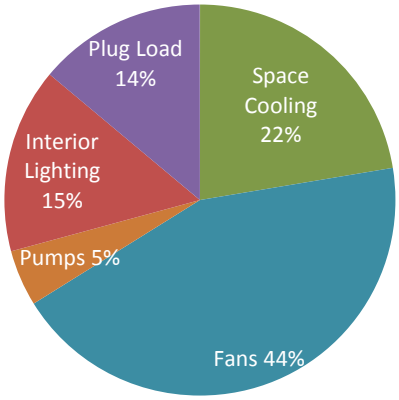


Source: Practical Energy Solutions for DVRPC 2014

- Nearly all natural gas is used for space heating; a small percentage (estimated at 2 percent of natural gas usage) is used for domestic hot water.

- Ventilation fans use 44 percent of electricity, and the RTU uses an additional 22 percent. Figure 4 shows all electricity end uses.

Figure 4: Electricity End Uses



Notes: Plug Load = computers, desk lamps, printers, faxes, copiers vending machines, other plug loads. Fans = air handler/ventilation. Data estimated using lighting and equipment power density data from ASHRAE 90.1-2007. The site visit focused on the windows and HVAC systems; detailed lighting and equipment inventories were not generated. **Source:** Practical Energy Solutions for DVRPC 2014

Scope of Analysis

On behalf of the DVRPC Circuit Rider Program, PES performed a focused assessment of the Lansdowne Borough Hall/Police Building to identify energy conservation measures for the building envelope and HVAC systems.

PES did not evaluate receptacle equipment or lighting systems. This is because, in 2012, the Borough upgraded its outmoded T-12 fluorescent lighting system to higher-efficiency T-8 fluorescent bulbs and fixtures. PES estimates that this upgrade will reduce annual electricity use by approximately 37,500 kWh, save $4,600 annually (based on the 2011 electric rate), and lower the facility's EUI by 16 percent, to approximately 168.01 kBtu per square foot.

HVAC

HVAC: Findings

This facility has an AAON RN-31 packaged RTU that provides air flow and direct expansion (DX) cooling (nominal 31 tons, 11 EER[3], 356 MBH[4]). The RTU is equipped with energy-saving features such as two-stage cooling, variable frequency drives on supply and return fan and dry-bulb economizer control, and it is in very good condition. A photo of the AAON RTU is provided in Figure 5. The RTU delivers tempered air (55°F) year-round. The ductwork contains variable air volume (VAV) boxes, which regulate air volume into individual spaces in response to a thermostat to help keep temperatures balanced throughout the building.

Figure 4: AAON Packaged Rooftop Unit (RTU)

Source: Practical Energy Solutions for DVRPC 2014

During the winter months, hot-water coils in the VAV boxes heat the tempered air to between 90°F and 110°F to condition the air in each room as needed. A Weil-McLain LGB-9 natural gas-fired boiler (842 MBH output, 81 percent thermal efficiency) provides hot water to the coils.

During cooling season, the VAVs continue to modulate the 55°F air flow, in order to cool the rooms in response to the cooling setpoints. If the room becomes overcooled despite restricted air flow, the VAVs' reheat coils will heat the incoming air. In addition, on hot, humid days, the DX equipment often subcools the air below 55°F to remove moisture; the VAV coils must provide heat on these days as well. This "reheat" method is inefficient and is rarely installed today, as it requires a significant amount of energy due to simultaneous use of heating and cooling.

The police department's cell area in the basement is served by a separate heating-only air handler with hot-water coils.

A Metasys BAS has the capability to provide a high level of centralized control. However, because a single air handler in the RTU serves both the administrative and police areas, and because the police area requires 24/7 conditioning, the facility manager cannot put the HVAC system into unoccupied mode. The entire building must be conditioned 24/7 to accommodate approximately two night-shift police officers, even though the officers use just a small portion of the building at night and on weekends.

[3] energy efficiency ratio
[4] thousands of BTUs per hour

HVAC: Recommendations

The primary energy conservation opportunity involves revising the HVAC systems and BAS to allow temperature setbacks in unoccupied portions of the building. This will eliminate many hours of unnecessary whole-building conditioning. Specifically, PES recommends the following:

- Installing ductless split-system heat pumps in areas that need 24/7 coverage; these include the squad room, the sergents' area, two detective offices, the police reception area, the meeting room, and the lobby. These systems provide high-efficiency electric cooling and heating to individual spaces. They are highly configurable, easy to install, and relatively inexpensive because no ductwork is necessary, and they require only small penetrations in the building envelope for refrigerant lines. To prevent redundant operation of the new heat pumps and the central HVAC system during daytime hours, PES recommends installing wall-mounted thermostats in a locked box.

- Using the BAS to put the HVAC system into unoccupied mode at night and on weekends. With a separate HVAC system installed to provide 24/7 heating and cooling to the 24/7 areas, the rest of the building can be set to unoccupied mode at nights and on weekends. In unoccupied mode, the space temperature is "set back" or "set up" 10°F or more (depending on heating or cooling season), outside air dampers are fully closed to eliminate ventilation loads, and the system fan cycles only as necessary to meet the unoccupied setpoints rather than operating continuously. This measure will dramatically reduce heating, cooling, and fan operating times—yielding annual energy cost savings of nearly $7,500.

- Enabling the BAS to control the RTU supply and return fans and hot water pumps, so they may be cycled to meet the unoccupied setpoints. The BAS does not currently have this capability, and fans and pumps run continuously year-round. A controls contractor may be needed to enable this feature in the BAS, and it may require additional software, hardware, and wiring.

Table 2: Savings: HVAC/BAS Revision

#	Measure Description	Annual Energy Savings	CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Estimated Project Cost	Simple Payback [yrs]	Savings Over 15 Years
1	Ductless Split-System Heat Pumps/BAS Refinement	42,077 kWh 2,293 ccf	53,017 26,963	$7,454	$52,000	7	$59,630

Notes: Project cost based on high-end, flash-injection technology mini split system, which are desired by the Borough to ensure performance during extreme outdoor temperatures. Estimated cost of standard units is $29,000 (four-year simple payback). Cost of BAS revision not included. Costs may vary. Contractor quotation recommended. Cost savings based on current energy prices. Savings will change as energy prices change. **Source:** Practical Energy Solutions for DVRPC 2014

Building Envelope

PES investigated the major accessible building envelope components including exterior walls, windows, and doors. The primary opportunity for energy conservation involves upgrading windows throughout the building.

Windows

The existing windows were installed in 1989 and are single-hung, double-glazed units with metal frames. They are generally in fair to poor condition and show signs of poor installation and low-quality materials. Poor energy performance is evidenced by lack of air-sealing around the window frame, damaged gaskets between glazing layers, and significant thermal bridging through the frame. Figure 6 below shows two images captured during the site visit. The photo on the right is an image taken by the infrared camera. The circle centered in the photo measured 58.2°F, while the temperature at the seal of the window and on the panes measures closer to 44°F, indicating significant air infiltration and insufficient thermal barrier.

Figure 5: Insufficient Window Frame Sealing (L), Exterior Infrared Photo Showing Heat Escape (R)

Source: Practical Energy Solutions for DVRPC 2014

Due to the poor condition and quality of the existing windows, PES recommends replacing them with new ENERGY STAR-qualified windows (U-0.32 Btu/hr-sf-°F, SHGC-0.4) rather than simply installing interior storm windows. New windows will significantly improve thermal and solar heat gain performance, while nearly eliminating drafts and improving the aesthetics of the building façade.

Table 3: Savings: Window Replacements

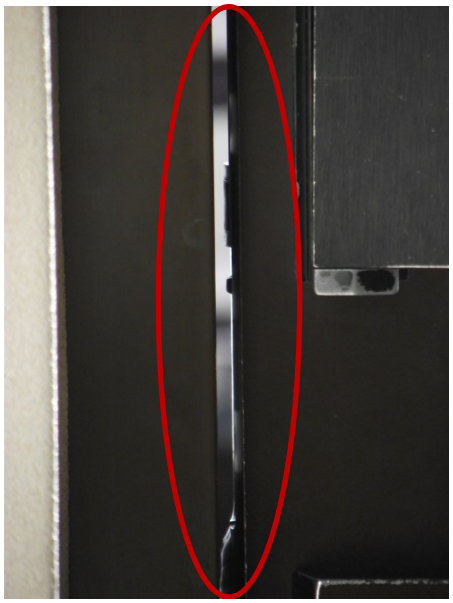
#	Measure Description	Annual Energy Savings	CO_2 Savings [lbs]	Energy Cost Savings [$/yr]	Estimated Project Cost*	Simple Payback [yrs]
2	Replace Windows	2,087 kWh	2,630	$916	$23,879	26
		652 ccf	7,668			

Notes: The two large wood-framed, street-facing windows in the first floor conference room were not considered as part of this measure. These windows had recently been repaired but require further work to address water damage. *Reflects cost for double-hung, argon-filled vinyl frame windows with U-factor ≤.40. Calculations reflect recommended U-factor of .32. Cost includes installation at prevailing wage rates. Cost savings based on current energy prices. Savings will change as energy prices rise or fall. **Source:** Practical Energy Solutions for DVRPC 2014

Doors

PES noted that at least one metal exterior door has insufficient weatherproofing and door sweeps, and there are sizeable air gaps around the frame, as shown in the red oval outlined in Figure 6 below. In many cases, this is a relatively simple fix requiring new weather-stripping around the door frame and, if needed, a door sweep on the bottom. We recommend installing a high-quality vinyl weather-stripping product with a metal backing that is mechanically attached to the door. Adhesive-backed weather-stripping is insufficient and should be avoided.

Figure 6: Air Gap, First Floor Exterior Door



Source: Practical Energy Solutions for DVRPC 2014

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Publication Number: 15024F

Date Published: April 2016

Geographic Area Covered: Lansdowne Borough

Key Words:

Energy, natural gas, electricity, energy management, heating ventilation air conditioning (HVAC), reheat, ductless split, window, 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 Lansdowne Borough Hall/Police Building. The Lansdowne Borough Hall/Police Building (10,301 ft^2) built in 1903 is a multi-use facility containing the township's administrative offices, council meeting room, and police department. PES analyzed the building's HVAC system and building envelope for energy improvement opportunities. 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. In order to accommodate the night shift police officers, the entire building is conditioned 24/7 because the building is served by a single air handler. PES recommended improvements to the operation of the reheat system and to install a separate HVAC system in police areas so the remaining building space could be set to unoccupied mode on nights and weekends. Further, PES helped the township estimate the costs and energy savings associated with a much-needed windows upgrade at the building. Overall, these energy conservation measures will cut electricity use by an estimated 28 percent and reduce natural gas use 26 percent, saving the borough approximately $8,370 in annual energy costs (2011 prices). These measures will also reduce CO_2 emissions due to fossil fuel use by more than 90,000 pounds of CO_2 per year.

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