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# Facility Energy Assessment Report


# Smart Energy Design Assistance Center (SEDAC)

## Putnam County High School

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|---|---|
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## Acknowledgements

The Smart Energy Design Assistance Center (SEDAC) would like to thank Putnam County School District for participating in the Public Sector Design Assistance Program and for providing access to information necessary to develop this report. Ryan Siegel, of SEDAC, was the engineer responsible for the analysis and is the primary author of this report. Additional assistance in report preparation by Robert Schlorff, Robert Nemeth, and Shawn Maurer are greatly appreciated. Other contributors to this report of SEDAC are also gratefully acknowledged.

## Executive Summary

The Putnam County High School is owned by Putnam County CUSD #535 and is located in Granville, Illinois. The facility is used as a high school and has approximately 89,000 sq. ft. of usable space. The building is used by 270 students and 50 staff members and is occupied from Mid-August through May.

This report identified 8 potential energy cost reduction measures for implementation. After a thorough evaluation of each measure, 5 of the measures are recommended based upon their feasibility for implementation and return on investment.

| Recommended Package of Energy Efficiency Measures | | | |
|---|---|---|---|
| **Simple payback (before incentives)** | 4.1 years | **Incentives Available** | $35,300 |
| **Annual Utility Cost Savings** | $20,200 | **Percent Annual Cost Savings Reduction** | 21% |
| **kWh Reduced/yr** | 99,200 | **Percentage kWh Reduction** | 13% |
| **therms Reduced/yr** | 10,300 | **Percentage therms Reduction** | 31% |

The recommendations in this report are designed to allow the facility to create an effective and financially prudent implementation plan to be used to help the building become more energy efficient. The report should be used as a tool to facilitate budgetary planning and obtaining funding/financing. Eligible public-sector incentives are described in this report as well as other opportunities for need-based grants and other funding sources. All information is current at the time of the assessment; for up-to-date information on funding or incentives, contact SEDAC any time at 800.214.7954. Alternatively, you may contact your utility. Implementing the recommendations in this report will reduce energy consumption, help improve occupant comfort and reduce vulnerability to fluctuations in future energy costs. This report can also help towards obtaining LEED® and ENERGY STAR building certification.

Each of the measures are discussed in detail in this report. Recommendations on HVAC, lighting, building envelope, and insulation improvements are included along with suggestions for additional cost reduction measures. Table E1 presents the facility's utility information, as obtained from Ameren Illinois documentation. Table E2 presents the results of the analysis performed on each measure.

### Table E1: Utility Information for October 2021 through September 2022

| Fuel | Utility | Rate Class | Peak Demand (kW) | Annual Consumption | | Annual Cost ($/yr) | Annual Cost (%) | Unit Cost* | |
|---|---|---|---|---|---|---|---|---|---|
| **Electricity** | Ameren IL | DS-3 | 268 | 792,962 | kWh | $62,546 | 66% | $0.079 | $/kWh |
| **Natural Gas** | Ameren IL | GDS-3 | N/A | 33,661 | therm | $32,008 | 34% | $0.95 | $/therm |
| **Floor Area** | 88,242 sf | | Totals | 6,071,686 | kBtu | $94,555 | 100% | | |
| | | | **Site Energy Use Intensity** | 69 | kBtu/sf/yr | | Energy Cost Intensity | $1.07 | $/sf/yr |
| | | | **Electricity Use Intensity** | 9 | kWh/sf/yr | | Natural Gas Use Intensity | 0.38 | therms/ sf/yr |

***Note: Unit Costs are blended averages which include all taxes and demand charges.**

## Table E2: Energy Cost Reduction Measure Analysis

| Measure # | Description | Potential Energy Savings | | | | Estimated Project Cost | Potential Incentive | SPB w/o &w/ Incentive (yrs)[1] | IRR[2] (%) | NPV[3] ($) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | kW | kWh | therm | $ | | | | | |
| 1 | Interior LED Lighting Upgrades | 8 | 12,800 | (100) | $900 | $11,300 | $5,600 | 12.4 | (4%) | ($4,200) |
| | | | | | | | | 6.2 | 10% | $1,400 |
| 2 | LED Exit Signs | 0 | 5,000 | 0 | $400 | $2,600 | $600 | 6.5 | 9% | $500 |
| | | | | | | | | 5.0 | 15% | $1,100 |
| 3 | Implement DCV | 0 | 12,400 | 7,500 | $8,100 | $25,000 | $6,600 | 3.1 | 30% | $37,300 |
| | | | | | | | | 2.3 | 43% | $44,000 |
| 4 | Hot Water Pipe Insulation | 0 | 69,000 | 2,900 | $8,200 | $28,700 | $22,400 | 3.5 | 26% | $35,000 |
| | | | | | | | | 0.8 | >100% | $57,400 |
| 5 | Hydronic Air Separator | 0 | 0 | 0 | $2,600[5] | $20,300 | $0 | 5.5 | 13% | $5,800 |
| | | | | | | | | 5.5 | 13% | $5,800 |
| 6 | Condensing Boilers | 0 | 0 | 8,000 | $7,600 | $151,000 | $9,300 | 20 | (11%) | ($92,800) |
| | | | | | | | | 19 | (10%) | ($83,500) |
| 7 | Heat Pump Water Heaters | 0 | 5,600 | 700 | $1,100 | $56,500 | $0 | 50 | (22%) | ($47,800) |
| | | | | | | | | 50 | (22%) | ($47,800) |
| 8 | Media Center Fenestration | 0 | 700 | 600 | $600 | $32,000 | $0 | 50 | (22%) | ($27,000) |
| | | | | | | | | 50 | (22%) | ($27,000) |
| | All Measures | 8 | 105,500 | 19,600 | $29,600 | $321,500 | $44,600 | 10.9 | (2%) | ($93,300) |
| | | | | | | | | 9.4 | 1% | ($48,700) |
| PKG | Recommended Measures (1-5) | 8 | 99,200 | 10,300 | $20,200 | $81,800 | $35,300 | 4.1 | 21% | $74,300 |
| | | | | | | | | 2.3 | 42% | $109,600 |

Notes:
1) "SPB" Refers to Simple Payback, or the amount of time that the projected energy savings will exceed the first cost of the project.
2) IRR (%) refers to Internal Rate of Return.
3) NPV ($) refers to Net Present Value.
4) Total values have been rounded from calculated values.
5) Estimated Labor Savings

# 1 Introduction

**The Public-Sector Design Assistance Program** is an energy efficiency program that provides millions of dollars in rebates to public facilities that make large-scale equipment improvements to their electric and natural gas systems. SEDAC supports the Public-Sector Design Assistance Program in advocating the efficient and effective use of energy by businesses and public buildings throughout Illinois. SEDAC's objective is to encourage communities, building owners and operators, design professionals, and building contractors to incorporate energy efficiency practices and renewable energy systems. SEDAC is managed by the University of Illinois at Urbana-Champaign.

The Smart Energy Design Assistance Center (SEDAC) has performed an energy savings and cost analysis for various energy cost reduction measures applied to the Putnam County High School, located in Granville, Illinois. The analysis is based on a site inspection conducted on October 11, 2022, engineering calculations, and typical industry assumptions. This report presents the results of the analysis along with the methods and assumptions used.

Engaging in energy-efficiency strategies to control costs is more critical than ever as organizations face the lingering recession and budget challenges. Organizations that take a systematic and strategic approach toward energy management will acquire a broad array of tangible and intangible benefits of interest to themselves and the public at large.

The elevation of energy management to critical importance is a result of many factors, including an increasingly complex and volatile energy marketplace, a growing awareness about the realities of climate change, recognition of the rising importance of intangibles in calculating market value, and an expanding awareness of the importance to restrict the carbon footprint of organizations. According to the U.S Green Building Council, most commercial buildings use 10 to 30 percent more energy than necessary and have ample opportunities to reduce their energy consumption levels.

Public entities known for aggressive and proactive environmental policies stand to reap many intangible benefits including improved community relations, an enhanced reputation as a socially responsible entity, and improved productivity/morale. Energy management practices also help to ensure the reliability of equipment, which reduces the risks and costs associated with equipment failures and downtime.

# 2 Building Description

## 2.1 General

The analysis of the building was based on engineering calculations, rule of thumb assumptions, and experience of the engineer. The sections which follow describe details of each building and important input parameters of the calculations.

## 2.2 Site Conditions and Building Details

The Putnam County High School is owned by Putnam County CUSD #535 and is located in Granville, Illinois. The facility is used as a high school and has approximately 89,000 sq. ft. of usable space. The building is used by 270 students and 50 staff members and is occupied from Mid-August through May. Custodial staff is present Monday through Friday 6AM to 9PM.

## 2.3 Building Envelope

**Roof:**

The roof of the high school is a low slope tar and gravel. Based on the profile of the skylights and the age of the school (built in 1976), it is anticipated that there is little insulation present. It is anticipated that the insulation consists of ½" hardboard which would provide an R-value of 0.34.

**Exterior Walls:**

The school is predominantly brick masonry with 6" concrete masonry block. Again, due to the age of the building, it is anticipated that there is little insulation present.

**Windows and Doors:**

The windows and doors are single pane in aluminum extrusions. These are not operable and several of them still have the wire reinforcement that was common prior to 2000 for fire safety before tempered glazing became the preference for safety. These are thermally unbroken and are estimated to have a U-factor of 1.

## 2.4 HVAC Systems

**Heating:**

Building heating is provided by a pair of Weil-McLain hot water boilers with an input capacity of 4.1 million Btu per hour each. The stated output is 3.3 million Btu per hour. The boilers were recently tested and tuned and were found to have an efficiency of only 70% which is down substantially from the 79.5% efficiency on the nameplate. Given the low efficiency, it is anticipated that these boilers may be original to the building and therefore 46 years old. This water is circulated through the building by a pair of 7.5 hp pumps to the various hot water coils, including reheat coils and heating coils in the air handlers. One pump operates at a time and the second is in standby. This system contains an air/dirt separator that has been found to not function adequately, so staff must bleed air manually periodically from the system at the various high points.

**Cooling:**

Cooling is provided by several different roof top units which were manufactured from 2004 to 2008 and include: a 40-ton Aaon unit, a pair of 26-ton Mammoth units, a 26-ton Aaon unit, a 20 ton Aaon unit, a 13-ton Aaon unit, an 8-ton Aaon unit, a 7-ton Aaon unit, and a 4 ton Lenox unit. A total of 170 tons of cooling serves 72,000 sf. Cooling is not presently available to the 16,000 square foot gymnasium.

**Ventilation:**
Ventilation is provided through the rooftop units and the gymnasium air handlers. According to the building automation system (BAS), there are CO2 sensors for the units that serve the auditorium, common area, offices, and Room 19. There are also two local exhaust systems in the shop room, which contains welding equipment. One of these uses adjustable capture devices, allowing for improved capture, and a VFD to allow the fan to operate at reduced speed when stations are not in use. SEDAC noted during the site visit that many of the capture devices were still on during the site visit, even though they were not currently in use.

**Control System:**
The building uses a cloud-based BAS, which integrates with KMC controllers. The control sequence has the capability to do night setbacks. However, the settings appear to vary substantially, ranging from 0 to as much as 12 degrees, with 5 degrees being typical. Varying setbacks would be anticipated depending on the thermal mass of the space and the speed of recovery.

**Kitchen:**
Meals are prepared in the high school kitchen for students at the high school and the adjacent primary school. This entails use of a high temperature commercial dishwasher with associated electric booster heater and a commercial garbage disposer. The cooking line includes a steam kettle, a countertop steamer, a 10-burner range with double ovens, and a double stack convection oven. The 20' exhaust hood has a local fan switch and was off during the site visit as there was no food preparation taking place. The serving line includes a multiple bay hot bar and a refrigerated cold bar. There is a newer walk-in freezer and an older walk-in cooler. The home economics classroom has a 3-door reach-in refrigerator, which replaced a series of residential refrigerators. That classroom also has a 1 door reach-in freezer.

## 2.5 Lighting and Internal Loads

**Indoor Lighting:**
The indoor lighting is mostly LED fixtures. These replaced older fixtures a few years ago and have substantially reduced lighting cooling loads. The shop classrooms were skipped over during this upgrade. These classrooms are lit with industrial fixtures that use 3 T-8 lamps of 32 watts each. The majority of the lighting is controlled by manual switches. Occupant sensors have been installed in bathrooms and other spaces with intermittent occupancy.

**Outdoor Lighting:**
The exterior lighting was also upgraded to LED. Exterior lighting is fairly limited, which helps to keep costs down.

**Internal Loads:**
The school has a small amount of equipment that are additional loads, including some IT switches, sound equipment for the theater and gymnasiums, a few refrigerated beverage machines, and a handful of computers in the offices.

## 2.6 Domestic Hot Water

Domestic hot water is provided by a pair of 120-gallon natural gas-fired tank type water heaters with 200 kBtu per hour burners. The locker rooms are provided hot water with a 250-gallon electric resistance tank type water heater. There is a 50-gallon electric resistance tank type water heater in a janitor’s closet for a set of bathrooms. The domestic hot water piping is mostly uninsulated.

# 3 Energy Consumption Analysis

## 3.1 Electric and Natural Gas Utility Data Analysis

The building's energy consumption was obtained from utility bills provided by Putnam County CUSD 353. Utility bills were analyzed for a twelve-month timeframe from October 2021 through September 2022. Both electricity and natural gas are delivered by Ameren Illinois.

The facility paid a total of $62,546 for electricity and $32,008 for natural gas in this time period. The total utility cost for the facility from October 2021 through September 2022 was $94,555.

**Table 1: Utility Information for October 2021 through September 2022**

| Fuel | Utility | Rate Class | Peak Demand (kW) | Annual Consumption | | Annual Cost ($/yr) | Annual Cost (%) | Unit Cost* | |
|---|---|---|---|---|---|---|---|---|---|
| Electricity | Ameren IL | DS-3 | 268 | 792,962 | kWh | $62,546 | 66% | $0.079 | $/kWh |
| Natural Gas | Ameren IL | GDS-3 | N/A | 33,661 | therm | $32,008 | 34% | $0.95 | $/therm |
| Floor Area | 88,242 sf | | Totals | 6,071,686 | kBtu | $94,555 | 100% | | |
| | | | Site Energy Use Intensity | 69 | kBtu/sf/yr | Energy Cost Intensity | | $1.07 | $/sf/yr |
| | | | Electricity Use Intensity | 9 | kWh/sf/yr | Natural Gas Use Intensity | | 0.38 | therms/ sf/yr |

*Note: Unit Costs are blended averages which include all taxes and demand charges.

Figure 1 represents the comparison of electricity consumption (kWh) and annual cooling degree days (CDD). A degree day compares the outdoor temperature to a standard indoor temperature of 65 degrees Fahrenheit. The more extreme the outdoor temperature, the higher the degree day number. Therefore, degree-day measurements can be related to the amount of energy needed for space heating and cooling as compared to the outdoor temperature. The high school has a high base load of around 55,000-60,000 kWh per month regardless of outdoor conditions. Part of this may be due to the building's size of nearly 90,000 square feet. Typically, high base loads are caused by high lighting loads, which would not be anticipated since most of the building has been upgraded to LED. The other primary reason for high base loads is related to mechanical equipment, particularly air handlers and pumps. The likely reason for the high school's high base loads is that the air handlers operate on a long schedule. They also operate on a specific schedule regardless of whether any zones need heating, cooling, or ventilation. This may be addressed through retrocommissioning which will be discussed later in this report.

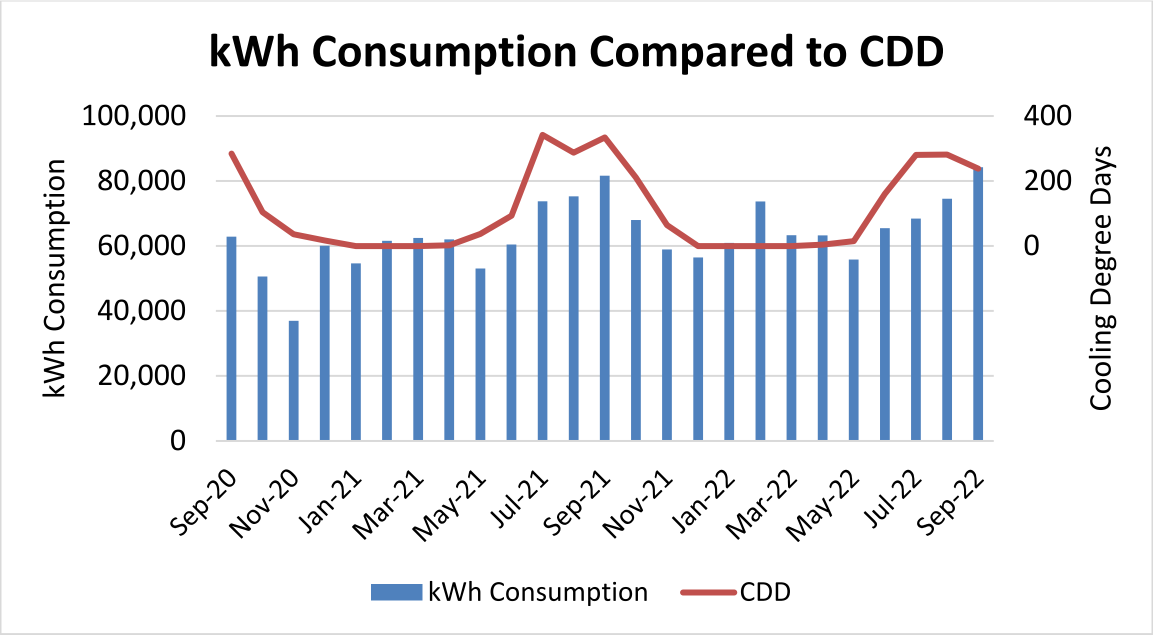



**Figure 1: Comparison of Regional Cooling Degree Days versus kWh**

Figure 2 represents the comparison of natural gas consumption (therms) and annual heating degree days (HDD). Natural gas consumption is highly correlated to outdoor weather, which is expected as building heating is the primary use of gas in the building. The other uses, such as domestic hot water and kitchen use, are fairly limited. The majority of the gas consumption is driven by the building envelope and ventilation.

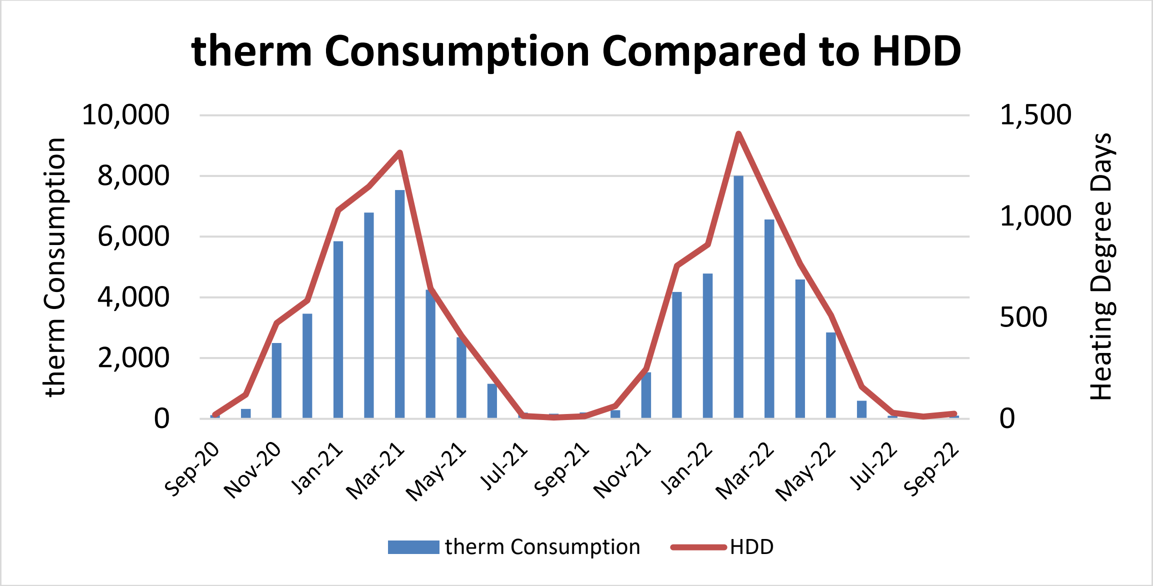



**Figure 2: Comparison of Regional Heating Degree Days versus therms**

## 3.2 Benchmarking

Benchmarking is a valuable tool for gauging energy usage relative to similarly classed facilities. Using the ENERGY STAR Portfolio Manager or Target Finder application, the facility's energy consumption can be compared to other facilities of similar size and use. Table 2 below shows the annual site energy consumption of a high school building compared to the national average of a similar type of facility, as well as a facility with an ENERGY STAR score of 75, which is the minimum requirement to apply for certification. The results indicate that Putnam County High School performs slightly above average, which is commendable. With a rating of 58, Putnam County High School is not eligible to apply for the ENERGY STAR. Implementation of the recommended measures will help Putnam County CUSD 353 improve the building's ENERGY STAR score and possibly qualify to become ENERGY STAR certified.

**Table 2: ENERGY STAR Target Results**

| ENERGY STAR Portfolio Manager | Site Energy ($kBtu/ft^2/yr$) | Total Annual Energy Costs ($) | ENERGY STAR Score |
|---|---|---|---|
| **Putnam County High School** | **68.8** | **$94,555** | **58** |
| **National Average** | 75.2 | $103,400 | 50 |
| **ENERGY STAR Rated** | 56.9 | $78,200 | 75 |

## 3.3 Breakdown of Energy Consumption

Determining where and in what quantities energy is used throughout the building helps to prioritize energy improvement efforts to maximum effectiveness. SEDAC also estimated how energy is used throughout the high school and how much it costs for each function. Figure 3 shows an energy use breakdown in terms of kBtu/yr for each end-use category. Figure 4 shows the energy cost for each of these categories. The proportions are different between the two graphs because the unit cost of natural gas is less than the unit cost of electricity.

Figures 3 and 4 help visualize energy and money flows and give an indication of possible areas for improvement. Most of the school's energy is used by the HVAC systems. Lighting energy use is reduced because of the LED upgrade implemented a few years ago. Improving the efficiency and operations of these areas can provide abundant savings. Measures address these areas later in this report.

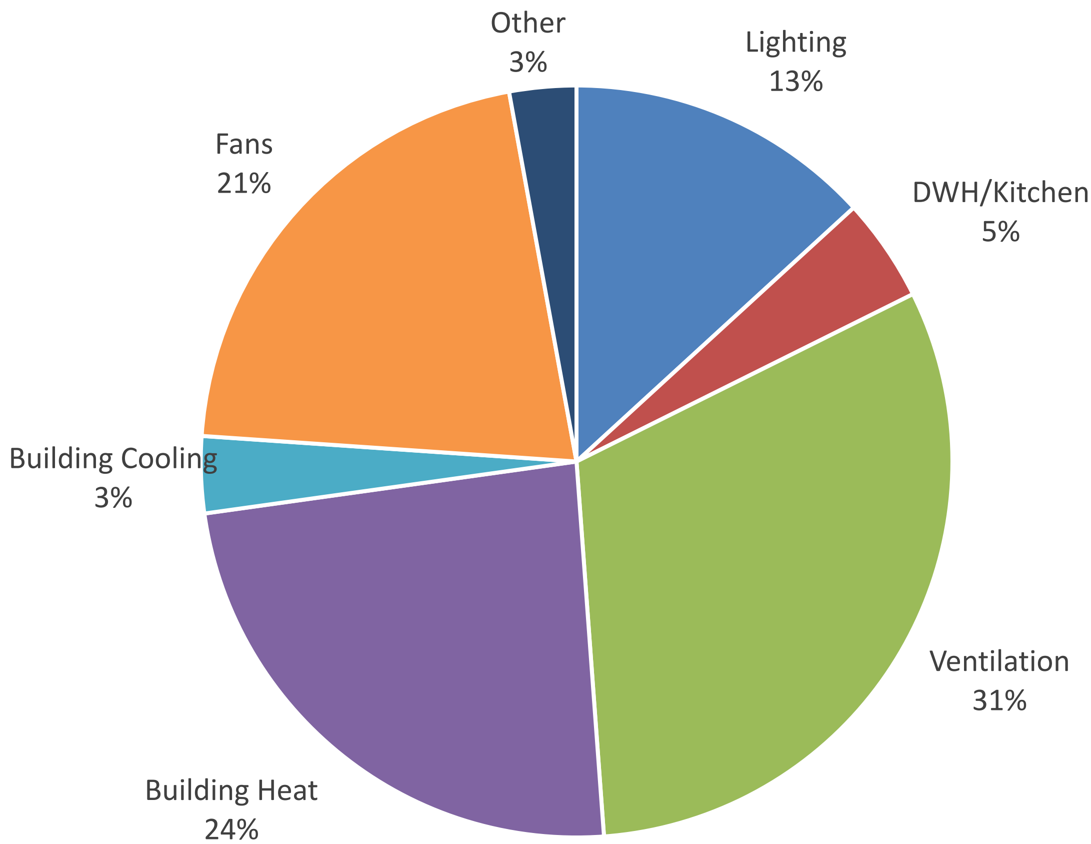



**Figure 3: Energy Use Breakdown**

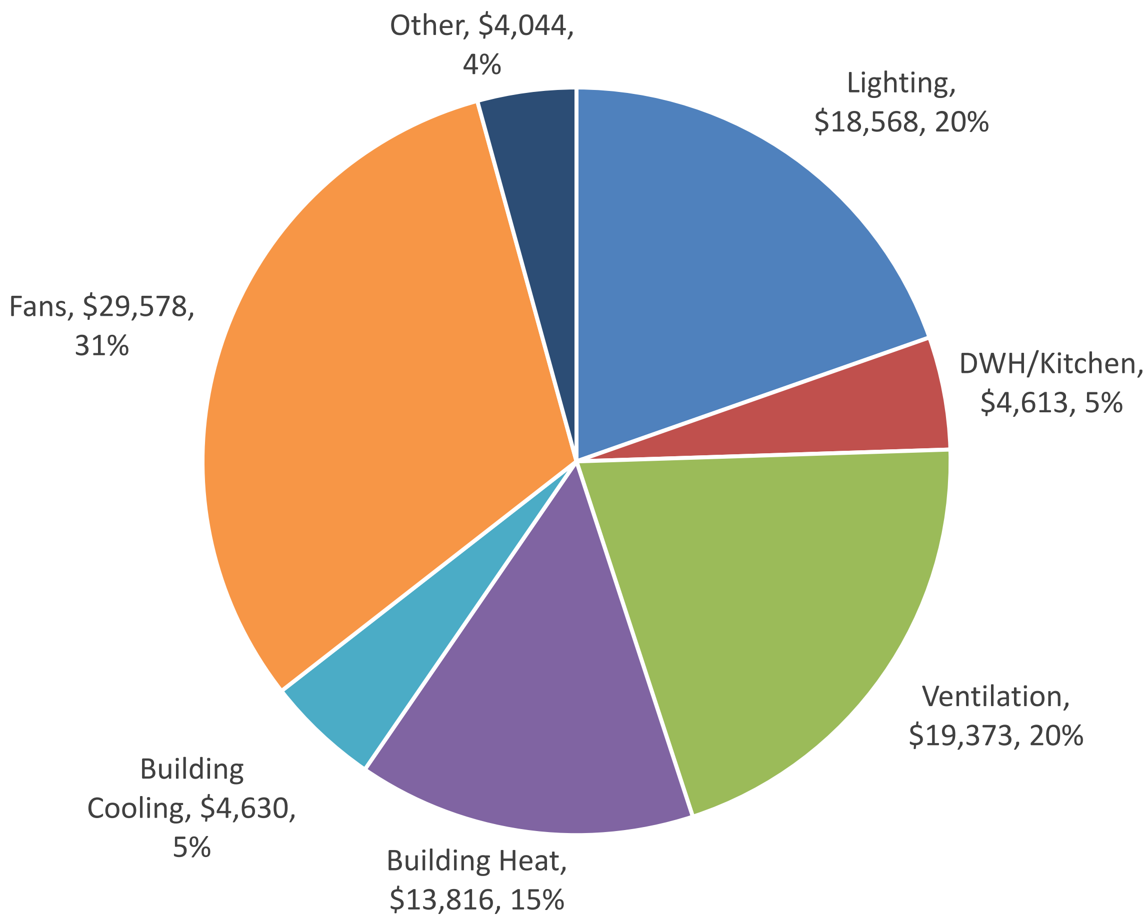



**Figure 4: Energy Cost Breakdown**

# 4 Energy Cost Reduction Measures

## 4.1 Measure–1 Interior LED Lighting Upgrades

### Issues and Observations:

Most of the lighting throughout the high school was replaced with LED fixtures. The shop classrooms were not upgraded and are equipped with industrial fixtures with 3 T-8 lamps of 32 watts each.


### Recommendations:

It is recommended that these fixtures be upgraded with LEDs. The simplest and most cost-effective way would be to use tubular LED retrofits. SEDAC recommends using Type B lamps which do require some rewiring to bypass the ballast but will avoid the ballast compatibility issues that Type A lamps have. Additionally, this removes the ballast as a future point of failure in the fixture.

if the fixture tombstones are in poor condition, a likely more costly, but desirable, alternative would be to replace the fixtures or to install a strip light retrofit kits. These may have better performance and avoid the need to reuse the existing fixture tombstones but do come at additional cost.

Based on the economics, this measure is recommended.

## 4.2 Measure–2 LED Exit Signs

### Issues and Observations:

Many of the exit signs were upgraded with LEDs at some point. However, there were several that were not upgraded and still use several small incandescent bulbs. These are estimated to consume 22 watts each. Beyond the energy consumption, the bulbs have a short life which leads to frequent servicing of the exit signs.


### Recommendations:

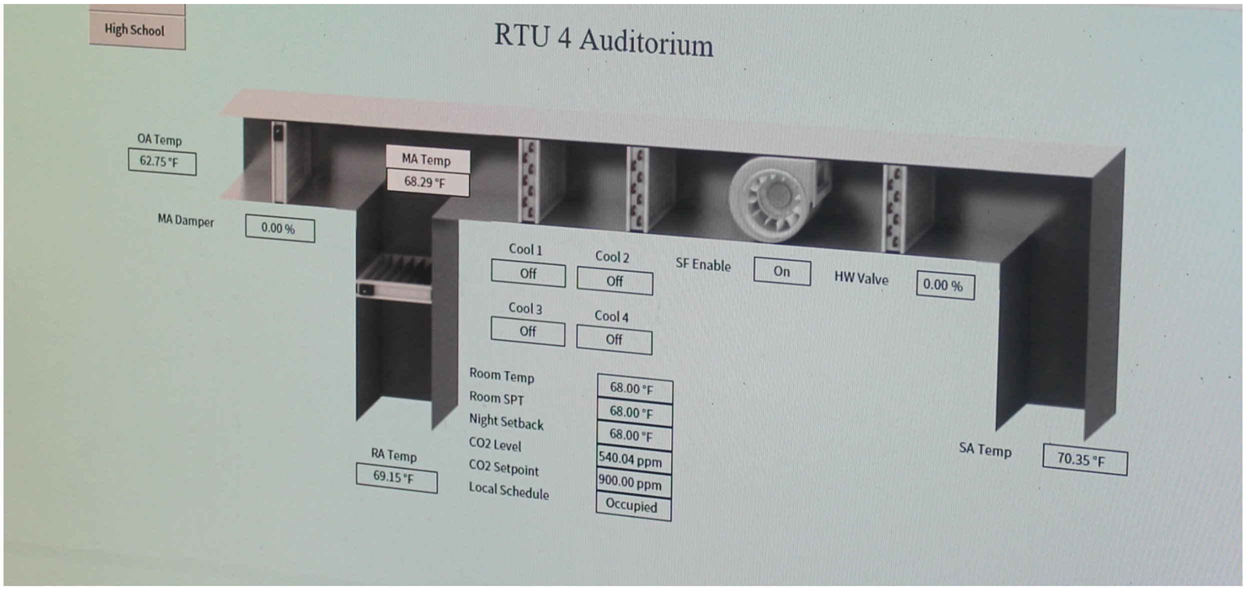
It is recommended that these signs be replaced with LED models. This will not only reduce energy consumption, but also will reduce maintenance frequency. Facilities are increasingly using green exit signs rather than the traditional red signs, as green signs stand out better. This may or may not be allowed depending on the jurisdiction.

Based on the economics, this measure is recommended.

## 4.3 Measure–3 Implement Demand Controlled Ventilation

### Issues and Observations:

Four of the air handlers have CO2 sensors in the return duct with a set point of 900 ppm. The remaining air handlers rely on fixed ventilation damper positions which were set based on the maximum theoretical occupancy of the spaces served by the unit or by rules of thumb that are not tailored to the individual units such as 15% or 30%.




### Recommendations:

It is recommended that the remaining air handlers be outfitted with CO2 sensors and that demand controlled ventilation be implemented for the air handlers. To avoid short cycling the outside air dampers, it is recommended that the outdoor air damper begin opening at 800 PPM and be fully open at 1,100 PPM.

Based on the economics, this measure is recommended.

## 4.4 Measure–4 Install Hot Water Pipe Insulation

### Issues and Observations:

The domestic hot water system is uninsulated throughout the school. This leads to substantial heat loss. It also requires the circulation pumps to operate for much longer to keep the hot water lines charged so that occupants do not have to wait too long for hot water.


### Recommendations:

It is recommended that all the hot water piping be insulated. At a minimum, they should be insulated in compliance with the International Energy Conservation Code. For domestic hot water (105-140F), the Code calls for at least 1” of insulation for lines smaller than 1.5” and 1.5” of insulation for lines that are 1.5” and larger.

SEDAC frequently finds that insulation above these values is often cost effective. The savings calculation is based on 2” of insulation. Installing insulation above level this would increase the savings further.

Based on the economics, this measure is recommended.

## 4.5 Measure–5 Replace Hydronic Air Separator

### Issues and Observations:

Putnam County High School had been experiencing issues with air getting trapped in high points of the hydronic system. This causes the lines to become air bound and prevents hot water from reaching the air handler coils. To alleviate this issue, an air and dirt separator was installed in the system. This is a unit of larger pipe diameter that should create an area of low pressure, allowing air to come out of suspension. It has not been as effective as the building operator would like and air must still be periodically purged out of the system.


### Recommendations:

It is recommended to install an air separator with a coalescing media installed. This works similarly to the one previously installed by creating low pressure to allow air to come out of suspension. Air attaches to and accumulates on the surface of media until it has enough buoyancy to rise to the top of the chamber and can be vented. It is important to maintain and keep the chamber air vent clean so that the air can escape. Otherwise, it will accumulate and return to the system. The High School may also add supplemental automatic air bleeders at the high points in the system to minimize the need for manual bleeding.

Based on the economics, this measure is recommended.

## 4.6 Measure–6 Replace Boilers with Condensing Models

### Issues and Observations:


Putnam County High School has a pair of non-condensing Weil McLain boilers that are estimated to be original to the building. They have a nameplate efficiency of 79.5% and were recently tuned. However, testing showed that, even with tuning, they were only able to achieve 70% efficiency. Applying this value, they have an input capacity of 4.1 million Btu per hour and an estimated output capacity of 2.9 million Btu per hour. Correlating natural gas consumption to outdoor weather yields a required gas estimate of 1.2 million Btu per hour or an input of 1.3 million Btu per hour at 90% efficiency. The minimum input value is 1.4 million Btu per hour or 1/3 of the maximum.

### Considerations:

Boilers have a particular operating range. While the current boiler has a turn down ratio of 3:1, more modern boilers have a range of 5:1 or even better. Presently, redundancy is provided by a second full size boiler which requires the district to purchase 100% excess capacity. Modern designs typically recommend having multiple boilers of less than full capacity. An example would be 3 boilers of 50%-60% of needed capacity. This limits the excess capacity required to be purchased and installed to provide redundancy. This also allows the system to have better turn-down than any individual boiler. It is anticipated that the High School would install 3 boilers of 800,000 Btu per hour each, providing an output range of 150,000 to 750,000 Btu per hour each and a system capacity range of between 150,000 and 2.2 million Btu per hour.

It is recommended that when the district replaces the boilers, the new system should consist of more than two condensing boilers.

## 4.7 Measure–7 Install Heat Pump Water Heaters

### Issues and Observations:

Putnam County High School generates domestic hot water in 3 different locations. The first is a 50-gallon electric resistance water heater in a janitors' closet. The second is the boiler room with a pair of 120-gallon gas fired water heaters with a stated efficiency of 80%. The third is in the gymnasium above the locker rooms which has a 250-gallon electric resistance water heater.

### Considerations:

Heat pump water heaters extract heat from their surroundings to put it in the water. This allows them to provide some cooling and dehumidification to their surroundings which may be useful in normally warm boiler rooms. They are made in smaller versions of 50-80 gallons, geared toward residential installations. They are also made in larger versions of 120 gallons, geared toward commercial installations. Some of these can have the heat pump ducted to allow the heat to be extracted from and cold air returned to spaces other than where the water heaters are located.
Compared with the gas units with a COP of 0.8, the electric resistance units with a COP of 1.0, heat pump water heaters can have a COP of 4.0 or more. Heat pumps also do not have the risk of generating carbon monoxide and eliminate the need to penetrate the envelope for the flue pipe and makeup air.

## 4.8 Measure–8 Replace Media Center Fenestration

### Issues and Observations:

The Media Center has a large section of single pane, aluminum-framed fenestration that faces east to an open field 125 feet away. It also includes two sets of double doors. These double doors have noticeable gaps in the weather stripping as illustrated in the photo. The glazing is also the reinforced with wire, originally meant for fire protection, However, this is not safety rated for use in school environments because of the risk of injury from impact. The fenestration has been covered with heavy curtains to help manage the morning solar gain. While effective at keeping the sun from heating occupants and causing glare, it also limits the daylight entering the space. The solar energy is still making it through and being absorbed by the curtains. This space was originally open to the rest of the school and has been enclosed and divided over time and so the egress requirements may be different than when the two sets of double doors was selected.

### Considerations:

When replacing this fenestration, using insulated low-e glazing along with thermally broken frames will substantially reduce the energy loss and gain through the fenestration. Additionally, the school may consider replacing some of the area with insulated opaque wall. Instead of installing double doors, single doors should be used because weather stripping on these doors is easier to maintain. Depending on occupant loading, more than two single doors may be required, but the decreased maintenance is beneficial. Additionally, single doors are easier to secure and reduce the potential for non-destructive covert unauthorized entry to the building. which is beneficial for less visible entrances which are more attractive to vandals.

To reduce the exposure of the fenestration to solar gain along with winds, it would be sensible to consider planting a row of protective vegetation such as arborvitae to create a dense screen or hedge. This would be beneficial even if the fenestration is not replaced.

## 4.9 Potential Measures Not Quantified

### Retrocommissioning

The HVAC systems are controlled through a building automation system. The BAS relies on receiving correct information from the building sensors in order to operate the building appropriately. In response to comfort complaints, schedules and settings, such as night set back, are often adjusted over time. This typically increases energy consumption through additional run time or conditioning to meet the new settings. These may be made as a temporary measure to make occupants comfortable, but not returned to the previous setting.

Technology and control schemes evolve over time; retrocommissioning seeks to update the programming to current standards, including optimum start and optimum stop. One sequence to consider is to allow the air handler to turn off if none of the spaces requires heating, cooling, or ventilation. It was common practice for the air handler to run continuously during scheduled hours regardless of any need for heating, cooling, or ventilation.

Additionally, retrocommissioning should include functional performance testing to verify that dampers and valves open and close as designed. This should include verifying that the actuator geometry is set to deliver the required torque pressure to achieve the design air tightness, particularly the outside air damper. Retrocommissioning should also investigate the programming to reduce the risk or occurrence of simultaneous heating and cooling or the potential for conflicting signals which would cause the systems to operate longer than they should.

# 5 Incentives

Listed below are various additional opportunities to consider. Please note that the incentive information provided is current at the time the assessment is completed. For up-to-date information on available incentives, contact SEDAC any time at 800.214.7954. Alternatively, you may contact or your utility.

### 5.1.1 Utility Incentive Offerings

The Ameren Illinois Rebate Program offers rebates for energy efficiency improvements that save electricity. Categories of rebates include lighting, HVAC, water heating, specialty equipment, water-saving devices, variable frequency drives, new construction, retro-commissioning, compressed air leak survey & repair, and custom projects. More information and applications can be found here: https://amerenillinoissavings.com/business/find-incentives-on-energy-efficient-equipment/.

Lighting upgrade rebate programs include the Instant Incentive Program and the Small Business Direct Install (SBDI) Program. Instant incentives are available through their online store with quantity limits or through authorized distributors without quantity limits. The SBDI Program is available through registered trade allies and avoids the paperwork of standard and custom incentives. SBDI services include a lighting assessment and project quote, including installation. The SBDI program has higher incentive levels than standard incentives; the incentives may cover up to 100% of the material and labor costs.

Instant Incentives: https://amerenillinoissavings.com/instant-incentives/.

Small Business Direct Install: https://amerenillinoissavings.com/business/industry-solutions/small-business/.

**Table 3: 2022 Ameren Incentives**

| Ameren Offerings | Information |
|---|---|
| Linear T-8 LED 4' Tube | $10/lamp (SBDI) |
| LED Fixture Replacing T-8 lamps | $0.70/watt reduced (SBDI)<br>$0.50/watt reduced (Standard) |
| LED Exit sign replacing incandescent sign | $23/sign (SBDI) |
| Demand Controlled Ventilation | $0.15/square foot controlled |
| Custom | $0.24/kWh saved<br>$2.00/therm saved |

### 5.1.2 Contractors and Installers

Visit the Ameren Illinois Energy Efficiency Program Allies website for a list of mechanical and lighting contractors, engineers, architects, energy service companies, wholesalers, distributors, and retailers that can help get your energy efficiency project implemented.
https://amerenillinoissavings.com/business/business-contractors/

## 6 Conclusion

This report by the Smart Energy Design Assistance Center evaluated 8 energy cost reduction measures for potential application by the high school to reduce electrical and natural gas consumption and thereby save on utility costs. After thorough evaluation, 5 of the measures are recommended for implementation based on their effective rates of return.

The facility management and operators should be commended for their ongoing efforts to reduce energy consumption. As noted in Section 3 – Energy Consumption Analysis, high school site energy use of 68.8 kBtu/ft2 is better than the Energy Star U.S. National Median Reference Value. By also participating in a Smart Energy Design Assistance Center Program energy audit, the facility is exhibiting a sharpened focus as an organization dedicated to energy management practices. Undergoing an energy audit analysis sends a very strong message to one's community of a solid commitment to energy efficiency and sustainable business practices.

SEDAC recommends that the energy savings initiatives identified in this report be implemented to decrease the building's overall energy consumption. A total reduction of 99,200 kWh and 10,300 therms is possible through the implementation of the suggested measures shown in Tables E2. This represents an approximate 21% utility cost savings and 23% energy savings. SEDAC recommends implementing this measure package, which includes:

- Measure-1: Interior LED Lighting Upgrades
- Measure-2: LED Exit Signs
- Measure-3: Implement Demand Controlled Ventilation
- Measure-4: Install Hot Water Pipe Insulation
- Measure-5: Replace Hydronic Air Separator

The suggested measures will significantly reduce the electrical and natural gas consumption of the facility while providing an estimated annual total gas and electric utility savings of $20,200 (at current costs).

The items included in this report are the primary elements of creating and managing a sustainable building; they are to serve as guides to implementation.

To demonstrate its effectiveness to the State of Illinois, SEDAC is asked to compile quarterly reports that document implementation of energy efficiency measures. We ask that you keep us apprised of all work towards implementation of our recommendations; this information will allow us to accurately reflect subsequent savings. We will also contact you periodically to discuss, answer questions, and review status.

Thank you for the opportunity to be of service. Please do not hesitate to contact us if we may be of further assistance.

# 7 Customer Interest Form

Below is a selection form that will allow SEDAC to gauge the interest of the client in implementing each individual measure. Please fill this out and return to SEDAC.

| Measure ## | Measure Description | Interest in Implementing? | | Estimated Completion Date |
|---|---|---|---|---|
| | | YES | NO | |
| 1 | Interior LED Lighting Upgrades | | | |
| 2 | LED Exit Signs | | | |
| 3 | Implement Demand Controlled Ventilation | | | |
| 4 | Install Hot Water Pipe Insulation | | | |
| 5 | Replace Hydronic Air Separator | | | |
| 6 | Replace Boilers with Condensing Models | | | |
| 7 | Install Heat Pump Water Heaters | | | |
| 8 | Replace Media Center Fenestration | | | |

## Appendix A – Pre and Post Implementation Comparison

Section 3 of this report; Energy Consumption and Analysis, provided the following benchmarking for Putnam County High School.

**Table 4: Utility and Benchmark from October 2021 through September 2022**

| Fuel | Utility | Rate Class | Peak Demand (kW) | Annual Consumption | | Annual Cost ($/yr) | Annual Cost (%) | Unit Cost* | |
|---|---|---|---|---|---|---|---|---|---|
| Electricity | Ameren IL | DS-3 | 268 | 792,962 | kWh | $62,546 | 66% | $0.079 | /kWh |
| Natural Gas | Ameren IL | GDS-3 | N/A | 33,661 | therm | $32,008 | 34% | $0.95 | /therm |
| Floor Area | 88,242 sf | | Totals | 6,071,686 | kBtu | $94,555 | 100% | | |
| | | | Site Energy Use Intensity | 69 | kBtu/sf/yr | | Energy Cost Intensity | $1.07 | $/sf/yr |
| | | | Electricity Use Intensity | 9.0 | kWh/sf/yr | | Natural Gas Use Intensity | 0.38 | therms /sf/yr |

Table 5 shows benchmarking if Putnam High School were to implement the recommended package of this report.

**Table 5: Post Implementation of Package of Measures - Utility and Benchmark**

| Fuel | Utility | Rate Class | Peak Demand (kW) | Annual Consumption | | Annual Cost ($/yr) | Annual Cost (%) | Unit Cost* | |
|---|---|---|---|---|---|---|---|---|---|
| Electricity | Ameren IL | DS-3 | 260 | 693,800 | kWh | $54,800 | 71% | $0.079 | /kWh |
| Natural gas | Ameren IL | GDS-3 | N/A | 23,400 | therm | $22,200 | 29% | $0.95 | /therm |
| Floor Area | 88,242 sf | | Totals | 4,707,000 | kBtu | $77,000 | 100% | | |
| | | | Site Energy Use Intensity | 53 | kBtu/sf/yr | | Energy Cost Intensity | $0.87 | $/sf/yr |
| | | | Electricity Use Intensity | 7.9 | kWh/sf/yr | | Natural Gas Use Intensity | 0.27 | therms /sf/yr |

The EUI reduces by 16 kBtu/sf/yr to 53 kBtu/sf/yr and the energy cost per square foot reduces by $0.20/sf/yr to $0.87/sf/yr for an annual cost savings of $17,600. This represents a 19% reduction in utility expenditures.

It is also anticipated that implementing the recommended measures will allow Putnam County High School to achieve Energy Star Certification.