Energy Efficiency

Prepared by:

[INSERT ASSESSOR NAME]

[INSERT ASSESSOR TITLE]

[INSERT SCHOOL NAME]

[INSERT CITY], KY

[INSERT DATE OF REPORT]

Assessment Report  
**On-Site Opportunities**

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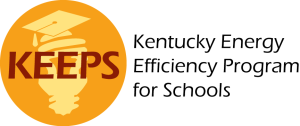
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EXECUTIVE SUMMARY

On [INSERT DATE OF ASSESSMENT], [INSERT ASSESSOR NAME] conducted an Energy Efficiency Assessment of [INSERT SCHOOL NAME] in the [INSERT DISTRICT NAME]. The [INSERT SCHOOLS SQUARE FOOTAGE] school is located in [INSERT CITY], KY. It was built in [INSERT YEAR] and serves [INSERT NUMBER] students. [INSERT SCHOOL NAME] consumed [INSERT ELECTRICITY KWH] of electricity costing [INSERT TOTAL ELECTRICITY COST] and [INSERT GAS CCF] of natural gas costing [INSERT TOTAL GAS COST] during the [INSERT BILLING CYCLE YEARS] billing cycle.

The purpose of the assessment was to evaluate existing energy-consuming systems and help identify opportunities for the school to become more energy efficient. The assessment includes an analysis of the following: utility rates, energy intensity benchmarking, retro-commissioning opportunities, operations and maintenance (O&M), heating, ventilation and air conditioning (HVAC) system and controls, lighting, plug load, computer power management, water heating and water consumption. **Table 1** summarizes the identified energy management opportunities.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 1: Energy Management Opportunities Summary | | | | | | | |
| EMO Description | Estimated Cost | Estimated Savings/Yr | kWh savings/Yr | kW savings/Yr | CCF savings/Yr | Est. MMBtu Savings/Yr | Est. Simple Payback |
| Retro-commission | $ | $ | X | X | X | X | x years |
| Implement O&M program | Not estimated | Not estimated | X | X | X | N/a | Not estimated |
| Modify thermostat settings | FREE | $ | X | X | X | X | INSTANT |
| Upgrade lighting system | $ | $ | X | X | X | X | x years |
| Install ENERGY STAR® computer power mngt. software | FREE | $ | X | X | X | X | INSTANT |
| Install beverage machine sensor(s) | $ | $ | X | X | X | X | x years |
| Unplug refrigerators for summer | FREE | $ | X | X | X | X | INSTANT |
| Install water heater timer(s) | $ | $ | X | X | X | X | x years |
| Replace water heater(s) | $ | $ | X | X | X | X | x years |
| Install low-flow water fixtures | $ | $[[1]](#footnote-1) | X | X | X | N/a | x years |
| Total[[2]](#footnote-2) | **$xxxxx** | **$xxxxx** |  |  |  | **x** | x years |

The savings in **Table 1** equate to the following reductions:

* $x.xx/ft2
* xxxx kBtu/student
* xx.x kBtu/ft2
* $xx.xx/student

1.0 UTILITY BILL AND ENERGY USE ANALYSIS

[INSERT SCHOOL NAME]’s electricity is supplied by [INSERT UTILITY NAME]. They are paying on the [INSERT RATE SCHEDULE] rate schedule. The natural gas is supplied by [INSERT UTILITY NAME] and paying on the [INSERT RATE SCHEDULE] rate schedule. After reviewing 12 months of gas and electric bills, it appears that [INSERT SCHOOL NAME] is on the [DETERMINE IF SCHOOL IS ON BEST RATE] available rate. [DESCRIBE OTHER POSSIBLE RATES]. See Appendix A.

1.1 Electrical Billing Opportunity

[INSERT ELECTRICAL BILLING OPPORTUNITIES]

**Figures 1A** and **1B** show the energy use profile for a CBECS elementary and middle high school with a similar climate[[3]](#footnote-3) and for INSERT SCHOOL NAME HERE respectively. **Figures 2, 3,** and **4** show how the energy (MMBtu) and costs at [INSERT SCHOOL NAME] are distributed over the course of a year. The energy usage increases with an increase in Heating Degree Days (HDD) and Cooling Degree Days (CDD).

INSERT ENERGY USE PROFILE GRAPH (LABELED **“FIGURE 1B”**) FROM PROFILE TOOL BESIDE RELAVENT GRAPH BELOW. DELETE THE OTHER UNNEEDED GRAPH NOT COMPARED.

2.0 ENERGY USE COMPARISON

Comparing similar buildings is a useful exercise in energy management. It gives the building a “score” so an energy manager can prioritize his/her efforts. ENERGY STAR® has created a system of comparing buildings of the same size, use profile (cooking, open on weekends, number of computers, etc.), and climate. The original data was compiled from Commercial Building Energy Consumption Survey (CBECS). ENERGY STAR Portfolio Manager® and ENERGY STAR Target Finder® both have the capability to benchmark the energy intensity of your school[[4]](#footnote-4).

[INSERT SCHOOL NAME]’s energy intensity is xx kBtu/ft2/year, which is higher than the average intensity for a school of the same size, climate and use profile, xx kBtu/ft2/year. An energy intensity of xx kBtu/ft2/year would assist [INSERT SCHOOL NAME] in earning ENERGY STAR® certification (see **Figure 5**).

3.0 ENERGY MANAGEMENT OPPORTUNITIES

This section identifies specific energy conservation opportunities for [INSERT SCHOOL NAME]. Potential costs and savings are estimated based upon information provided by the school, external sources such as vendors and observations made during the on-site visit. Engineering assumptions are made when necessary information is not readily available. Although many recommendations will include retrofits or equipment replacements, staff and student behavior and commitment to conserve energy are the necessary prerequisites for energy and related cost reduction. The following practices are already in place to help lower the facility’s energy consumption and should be continued:

* [DESCRIBE EXISTING ENERGY-CONSERVING PRACTICES]

3.1 Retro-Commissioning

Building commissioning is the systematic process of ensuring a building performs according to the design’s intent and the owner’s operational needs. Commissioning can be done on new or existing buildings (referred to as retro-commissioning). Retro-commissioning identifies the almost inevitable “drift” from where things should be and puts the building back on course. Retro-commissioning goes beyond evaluating individual components to ensure the entire system of components is operating as efficiently as possible. The results are compelling. According to ENERGY STAR® Building Upgrade Manual,[[5]](#footnote-5) “Retro-commissioning is the first stage in the building upgrade process”.

**Typical findings and opportunities found from retro-commissioning:**

* Adjust reset and set-back temperatures and temperature settings – adjusted over time for personal preference and to compensate inadequate system operation
* Staging/sequencing of boilers, chillers and air handling units
* Adjust and repair dampers and economizers
* Modify control strategies for standard hours of operation
* Eliminate simultaneous heating and cooling
* Air and water distribution balancing and adjustments
* Verify controls and control sequencing

Commissioning costs can vary considerably from project to project. Actual costs depend on the size and complexity of the project as well as the extent and rigor of the commissioning specified. However, a 2009 meta-analysis by Lawrence Berkeley National Laboratories observed a median cost of $0.30/ft2 of 561 retro-commissioned buildings. The report specifically found school buildings to have an average 3.3 year simple payback which equates to approximate annual saving of $0.09/ft2 (see **Appendix B**). Of consideration, a majority of the commissioned buildings studied resided in mild climates requiring less energy to condition buildings. Since Kentucky’s climate requires more energy for conditioning, the above savings are conservative.

The inset below estimates cost and annual savings for retro-commissioning [INSERT SCHOOL NAME] based upon the median cost of $0.30/ft2 and average school saving of $0.09/ft2/year.

**Estimated cost to retro-commission…..…...………………………………………...$xx,xxx**

**Estimated annual savings.….…………………………………………………..$xx,xxx/year**

**Estimated simple payback…….………………………………………...…..……….x.x year**

3.2 Operations and Maintenance (O&M) Program

At [INSERT SCHOOL NAME], the HVAC consumed an estimated xx% of total energy during the 2009 – 2010 billing cycle. HVAC systems present the largest opportunity for savings because they consume the most energy. Effective O&M is one of the most cost-effective methods for ensuring reliability, safety, and energy efficiency of the HVAC system. Studies have shown nearly one-third of the energy consumed in the average U.S. school is wasted[[6]](#footnote-6). O&M programs targeting energy efficiency can save 5% to 20% on energy bills without a significant capital investment[[7]](#footnote-7). Successful O&M programs have the support from upper management and proper funds are made available. A summary of HVAC benefits and maintenance actions can be found below[[8]](#footnote-8).

**Summary of low cost or no cost energy-savings maintenance actions:**

* Ensure systems run only during occupied periods
* Clean burners and air conditioner coils
* Replace and clean air filters and keep economizer dampers clean
* Check ducts for leaks at joints and flexible connections
* Check hot and cold duct and pipe insulation and seals for inadequate insulation
* Fix faulty equipment
* Verify and adjust refrigerant charge on packaged air conditioning systems
* Check, adjust, calibrate, and repair all controls, such as thermostat controllers and valve and damper operations. Monitor, calibrate and repair enthalpy controls and mixed-air controls to maintain efficient operation
* Repair or replace all defective dampers
* Check, adjust, or replace fan belts
* Lubricate all bearings and other friction points, such as damper joints
* Inspect fan wheels and blades for dirt accumulation and clean them as required
* Adjust or repair packing glands and seals on valve stems and pumps
* Ensure that no oil or water enters the main air supply for the control systems
* Have a qualified technician perform annual maintenance on the hot water boiler. This step alone can reduce energy consumption by 10-20%, reduce emissions and increase occupant comfort.

**Regular maintenance of the HVAC system has a number of benefits:**

* Energy savings
* Extension of equipment life to avoid premature replacement and reduce life-cycle cost
* Enhanced indoor air quality and ventilation
* Elimination of contaminant sources, increased occupant comfort improved reliability and reduction in emergency equipment issues
* Avoidance of classroom disruptions with equipment operating at maximum efficiency
* Integration into pest management through cleaning procedures
* Empowerment of maintenance staff to take charge through demonstrated energy savings.

3.3 HVAC & Controls

[DESCRIBE EXISTING HVAC SYSTEM AND CONTROLS]

A typical school is occupied 3,000 hours/year (there are 8,760 hours in a year). Two thirds of the year the building is virtually unoccupied. Significant savings can be realized by setting back the HVAC and lights during unoccupied times. Studies have shown average thermostat savings to be 1% (of the annual heating and cooling cost) per degree setback for eight hours/day[[9]](#footnote-9). The inset below provides potential savings if the thermostat settings (HVAC controls) were adjusted as outlined in **Appendix B**.

*(optional paragraph)* It is recommended to replace all single set thermostats with tamper proof programmable thermostats. Tamper proof thermostats allow individuals to adjust the temperature by a few degrees without affecting the programmed setbacks. A code is used to override the tamper proof programmable thermostat.

*(optional paragraph)* [INSERT SCHOOL NAME] is charged for peak demand. It is important to stagger the schedule of the programmable thermostats so the peak demand for the month is not set when the units turn “ON” in the morning. It is recommended to split the tonnage in portions, evenly spaced throughout the school. For example, program one portion of the units to resume occupied temperature at 5 am, the second portion of the units resume occupied temperature at 5:45 am, and the last portion 6:30 am.

**Estimated cost to adjust thermostat settings…..…...………………………………...FREE**

**Estimated cost to install programmable thermostats………………………………..$x,xxx**

**Estimated cost to install lockout covers……………………………………………....$x,xxx**

**Estimated annual savings…………………………….…………..…………...…$x,xxx/year**

**Estimated simple payback…………………………….……………...…………..…x.x years**

3.4 Lighting

The lighting system during the [INSERT BILLING CYCLE YEARS] billing period consumed xx% of the total energy used for the year and xx% of the total [INSERT SCHOOL NAME] operating cost. A similar CBECS school’s lighting uses xx% of the total energy. The percentage difference is due to hours of usage and the efficiency of the lighting lamps.

[DESCRIBE EXISTING LIGHTING SYSTEM AND TOTAL COST]

It is recommended to retrofit all of the fluorescent fixtures to T8 lamps and electronic ballasts, which can generate 32% in energy savings. It is also recommended to replace the existing 400 Watt metal halide fixtures in the gym with 6 lamp T8 fluorescent high bay fixtures, which can generate 49% in energy savings. [INCLUDE OTHER LIGHTING RECOMMENDATIONS SUCH AS EXIT SIGNS] Typically K-12 schools monthly peak demand charge will be set while the lighting system is on. Therefore, a lighting upgrade will save energy (kWh) and reduce peak power (kW). The estimated savings below account for demand savings. Some lighting retrofits, like the gym, have a quicker payback then the classrooms. See **Appendix B** for details.

**Estimated material cost……………..…………………………..……..………………$x,xxx**

**Estimated contractor installation cost………………...………………………………$x,xxx**

**Estimated utility company rebate……………………..……………….…….………….$xxx**

**Estimated annual savings………………………………...……………..…………$xxx/year**

**Estimated simple payback for material (after rebate)……………...……..….......x.x years**

**Estimated simple payback for contractor installed (after rebate)………..……...x.x years**

Lighting may be the simplest to comprehend, however, it only accounts for about xx% of the energy consumed at the school, while the HVAC consumes xx%. It is recommended to use the early momentum of the energy management team to tackle the largest energy consuming systems. Retro commissioning and O&M are good places to start. Upgrading the lighting systems with the quickest payback is a good second step.

3.5 Plug Load

At [INSERT SCHOOL NAME], plug load (cooking, refrigeration, office equipment and computers) consumes xx% of the total energy usage and costs approximately $x,xxx annually (see **Figure 6)**. A similar CBECS school’s plug load consumes xx% of the total energy use (see **Figure 1**).

INSERT PIE GRAPH (**Figure 6)** FROM PLUG LOAD SPREADSHEET TOOL HERE

Computers

Computers are the largest consumer of energy within the plug load category. See **Appendix B** for details on the energy consumed by other school appliances and electronics.

Even if computers are shut down at nights and on weekends, at least half the energy consumed by computers may be wasted because they are on continuously through the school day. The ENERGY STAR Power Management® program[[10]](#footnote-10) provides free software (EZ Wizard tool and EZ GPO tool) that can automatically place active monitors and computers into a low-power sleep mode after 15 or 30 minutes through the local area network. This software can be employed even to “wake-up” computers during the nighttime for scheduled Kentucky Department of Education (KDE) updates. *(optional sentence)* Macintosh computers that participate in the U of L Dataseam Research Program are not able to be turned OFF. The processing power from these computers is used for research during nights and weekends.

[INSERT SCHOOL NAME] has xxx computers. It is recommended to download and install the ENERGY STAR® Power Management program. The following inset provides annual savings if the school’s computers are programmed to enter sleep mode when not used.

**Estimated cost for computer management………………..……………..…………...FREE**

**Estimated annual savings….…………………………………………………….$x,xxx/year**

**Estimated simple payback….………………………………………………..……INSTANT**

Beverage Machines

A typical beverage machine consumes $150-$200 a year. A vending machine sensor is a low-cost “plug and play” device that can reduce the annual operating cost by 10-53%, with an average of 19%[[11]](#footnote-11). A vending machine sensor uses passive infrared technology to determine if the area surrounding the machine is occupied. If the room is unoccupied for 15 minutes the compressor and lights will power down. The unit will monitor the room temperature and re-power the vending machine every 1.5 to 3 hours so the beverage temperature stays within a pre-determined range. If a person enters the machine’s vicinity, the unit will power up immediately.

There were [INSERT NUMBER] beverage vending machines observed at [INSERT SCHOOL NAME], consuming a total of $x,xxx/year in energy cost. It is recommended to install a vending sensor device on each beverage vending machine. The estimated cost for one sensor is $170. Contact the National Energy Education Development (NEED) Project for subsidized vendor machine sensors.

**Estimated cost of vending sensors..…………....………………………………………$xxxx**

**Estimated annual cost savings…….…………………………………...…….…….$xxx/year**

**Estimated simple payback………………………………………………..…...…….x.x years**

Refrigeration

Food refrigeration (not including beverage machines) at [INSERT SCHOOL NAME] cost $x,xxx annually. It is recommended to unplug the refrigerators during the summer break which accounts for 20% of the school year. If some food items must remain, it is recommended to consolidate into one unit and unplug the remaining empty units. See **Appendix B** for annual refrigerator energy usage and cost.

3.6 Water Heating

**Estimated cost of unplugging refrigerators..…...…….………………………………FREE**

**Estimated annual cost savings…….…………………………………...…….…….$xxx/year**

**Estimated simple payback……………………………….………………...……...INSTANT**

As seen in **Figure 1**, an estimated xx% of the energy used at [INSERT SCHOOL NAME] is used to heat water at an annual cost of $x,xxx. A low-cost maintenance measure to improve the efficiency of the water heaters is periodic flushing, which removes sediments from the system and increases heat transfer efficiency. Energy is wasted if the water heater temperatures are set higher than appropriate for end use. For each 10°F reduction in water temperature there are 3% - 5% energy cost savings[[12]](#footnote-12). ENERGY STAR® recommends a water temperature of 120°F for general use. [DESCRIBE WATER HEATER TEMPERATURE SETTINGS AT SCHOOL] Check with your local Health Department for temperature requirements before adjusting settings.

The water heater(s) at [INSERT SCHOOL NAME] are electric; this presents an opportunity to install a timer that will turn the units “OFF” during unoccupied times. Electrical timers are fairly inexpensive costing about $100 each. The University of Florida IFAS Extension Office estimates a water heating energy savings of 5-12%, based on turning the heater “OFF” at night[[13]](#footnote-13). The savings estimation below uses $50/timer and a conservative 5% annual savings.

At [INSERT SCHOOL NAME], domestic hot water is circulated by a recirculation pump which significantly reduces the wait time for hot water at the point of use. The existing pump operates 24/7, throughout the year. Annual savings from installing an electrical timer (about $100 each) to limit the recirculation pump to operate only when the building is occupied depends upon the number of hours the building is occupied. For [INSERT SCHOOL NAME HERE], a xx% reduction of recirculation hours would result in annual savings of $xxx.

**Estimated installed cost for timer(s)………………………………...…..………………$xxx**

**Estimated annual savings for water heater timer (5% energy reduction)……...$xxx/year**

**Estimated annual savings for pump timer (xx% energy reduction)……………$xxx/year**

**Estimated simple payback……………………………………………….....…….…x.x years**

Water heaters have an expected life of 15 years. The water heaters at [INSERT SCHOOL NAME] are heated by [ENTER FUEL TYPE] and are [INSERT AGE] years old. Upon replacement, consider a 2.0-2.5 COP electric heat pump water heater. Upon replacement, consider a 0.96 EF on-demand, tankless condensing gas water heater system. The estimated savings below to replace the existing system are supported by calculations in **Appendix B**.

**Estimated installed cost for [INSERT WATER HEATING REPLACEMENT].…$x,xxx**

**Kentucky appliance rebate (if applicable)………..………………………………….…$xxx**

**Estimated annual savings…………………………………………………….....…$xxx/year**

**Estimated simple payback…….…………………………………………..……..….x.x years**

In addition, solar water heating may be another retrofit option. According to Kentucky Solar Partnership,[[14]](#footnote-14) a solar water heating system retrofit for a standard Kentucky school of 500 students with “in-school” cooking and dishwashing and using the existing storage tanks can cost approximately $9,000, with a 12 year simple payback. Because every school is different, exact cost and annual savings will vary and an installation company should be contacted for exact figures. Although not necessary cost-effective, solar water heating does utilize renewable energy and provides an educational tool for teachers.

**4.0 ADDITIONAL MANAGEMENT OPPORTUNITIES**

**4.1 Water Conservation**

Water usage is a cost often overlooked, but should be viewed as a commodity to be conserved. Faucets, showers, toilets, urinals, kitchen dishwashing, water fountains, lawn irrigation and cooling towers consume the most water within schools.

The most popular low-cost measures for conserving water include installing low-flow faucet aerators, showerheads and dishwashing pre-rinse spray nozzles. Standard faucet aerators typically have a 2.2 gallon per minute (gpm) flow rate whereas low-flow aerators are 0.5 gpm and cost about $3 each. Standard showerheads have a 2.5 gpm flow rate and their low-flow counterparts are 1.25–2.0 gpm and cost between $25 and $50 each. Typical pre-rinse nozzles use 1.6–5.0 gpm (2006 or newer standard nozzles are 1.6 gpm max). Low-flow nozzles are considered to be less than 1.6 gpm at 60 psi and cost between $50 and $100 each. Note: if the school’s water pressure is below 60 psi, there will be noticeable performance reduction in the low flow spray nozzles.

Higher cost water conserving measures include replacing toilets and urinals. Although the initial cost for high-efficiency toilets (1.28 gallons per flush (gpf) or less) and urinals (1.0 gpf or less) is expensive and the payback drawn out, it is important to remember that these appliances’ expected lifespan greatly exceeds the payback.

Considering cost-effectiveness, install low-flow bathroom faucet aerators (~0.5 gpm), low-flow showerheads (~1.5 gpm) and low-flow pre-rinse spray nozzle for dishwashing (~1.0 gpm) for immediate payback. Appendix B gives annual savings if low-flow fixtures/appliances are installed. Savings encompass gallons of water, costs (at tap and sewer) and energy from reduced hot water demand.

**Estimated cost of installing low-flow aerators and spray nozzle..…...……….……...$xxxx**

**Estimated annual cost savings…….…………………………………...…….…….$xxx/year**

**Estimated simple payback………………………………………………...…...…....x.x years**

A typical water bill consists of a charge for the water and a charge for the sewer discharge. The charges tend to be about equal in cost. In most situations water consumed is also discharged to the sewer. Irrigated fields and cooling towers (evaporation) are examples of when more water is consumed than discharged. In these cases a deduct meter can be installed to log the quantity of water that does not have a discharge fee. Deduct meter costs range from $300 - $1,000 installed. The simple payback is quick, especially on irrigation fields.

**4.2 Range Hoods**

It is also important to turn the kitchen exhaust hood OFF when there is no cooking. Exhaust hoods can be an energy penalty in three ways: the energy cost of the fan motor, the energy cost of exhausting conditioned air, and the energy cost of pre-conditioning the make-up air.

**4.3 Building Envelope**

The energy efficiency of a building envelope depends on type and color of structural materials, quality of insulation, structure orientation and sources of shade, windows, doors and overall tightness. [DESCRIBE SCHOOL BUILDING ENVELOPE MATERIALS INCLUDING WALLS AND WINDOWS] [DESCRIBE NOTICABLE PROBLEMS WITH BUILDING ENVELOPE SUCH AS GAPS, BROKEN PANES, AND OTHER SIGNIFICANT AREAS FOR IMPROVEMENT] Given the age of the building, it is unlikely that the walls and ceiling are adequately insulated. However, unless repairs or renovations are planned, it would not be cost effective to add insulation because it would require major construction. Similarly, replacing windows and doors, with and an estimated 30 to 50 year simple payback, would also be cost prohibitive. However, sealing gaps with caulk and weather stripping can result in a 2-3% reduction in energy use with a nearly immediate payback.

5.0 CONCLUSION

The following energy savings opportunities have been identified (**Table 2**). In addition, it is critical to implement an O&M program to keep the building in optimal condition.

COPY AND PASTE EMO SUMMARY TABLE FROM EXECUTIVE SUMMARY HERE and CHANGE FROM TABLE 1 TO TABLE 2

The savings in **Table 2** equate to the following reductions:

* $x,xxx annual reduction in electricity costs[[15]](#footnote-15)
* $x,xxx annual reduction in natural gas costs2
* x,xxx MWh annual reduction of electricity consumption
* xx MMcf annual reduction in natural gas consumption
* x.xxx metric tons of Carbon Monoxide (CO)3
* xxx metric tons of Carbon Dioxide (CO2) equivalent greenhouse gases[[16]](#footnote-16)
* x.xx metric tons of Nitrogen Dioxide (NO2)3
* x.xxx metric tons of Particulate Matter (PM)3
* x.x metric tons of Sulfur Dioxide (SO2)3
* x.xxxx metric tons of Volatile Organic Compounds (VOC)3

1. Estimated savings include water heating savings and water consumption/sewer savings [↑](#footnote-ref-1)
2. The totals in Table 1 do not include estimated savings from implementing an effective O&M program, which can be significant. [↑](#footnote-ref-2)
3. 2003 Commercial Buildings Energy Consumption Survey (CBECS) data results for elementary, middle and high schools with similar climate to Kentucky. [↑](#footnote-ref-3)
4. http://www.energystar.gov/index.cfm?c=new\_bldg\_design.bus\_target\_finder [↑](#footnote-ref-4)
5. http://www.energystar.gov/index.cfm?c=business.EPA\_BUM\_CH5\_RetroComm [↑](#footnote-ref-5)
6. http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess\_o-and-m-guide.pdf [↑](#footnote-ref-6)
7. http://www1.eere.energy.gov/femp/pdfs/omguide\_complete.pdf [↑](#footnote-ref-7)
8. http://chps.net/manual/index.htm#BPM [↑](#footnote-ref-8)
9. <http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12720> [↑](#footnote-ref-9)
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13. http://edis.ifas.ufl.edu/fy1025 [↑](#footnote-ref-13)
14. www.kysolar.org [↑](#footnote-ref-14)
15. Assumes retro-commissioning savings to be proportional to CBECS average k-12 school heating (40%) and cooling (14%) energy consumption [↑](#footnote-ref-15)
16. Source: KY Division of Air Quality and U.S. Department of Energy (DEDI Calculator) [↑](#footnote-ref-16)