

The geothermal well field for Eastern Elementary lies between a soybean field and the school's parking lot. Engineers were able to reuse the piping from the old cooling tower to connect the wells to the school.

# Rural RENOVATION

## Performance Contract to Fund Change

BY JEREMY KELLY, P.E., HFDP

**THE DECAY OF SCHOOL FACILITIES** in underfunded areas usually runs unchecked if funds can't be found to improve them. Henry County Public Schools in rural Kentucky sought to halt this downward slide by searching for an alternative funding method. This led to using a guaranteed energy savings contract (or performance contract) as a funding mechanism for school improvements.

**H**enry County Public Schools is located in rural north-central Kentucky. The county has a population of 15,500 and the school district's enrollment is 2,159 students; both the population and enrollment have remained relatively stable with little growth. The district's facilities include three elementary schools, one middle school, a high school and a few miscellaneous buildings.

To fully appreciate Henry County's funding dilemma, it is important to understand how schools in Kentucky are funded. In Kentucky, the funding for capital improvements is regulated by the Kentucky Department of Education (KDOE). In an effort for all schools in Kentucky to have uniform and equitable facilities, the KDOE created a formula to determine the amount of capital construction funds available to each school

district. This formula consists of three main branches of funding: Student Population Based Funds, Property Value Tax Based Funds and KDOE issued funds for unmet capital construction needs.

There is a significant need to update aging school buildings across Kentucky, but traditional means to finance these projects are not available. As Kentucky's school buildings continue to age, this unmet need will

only grow larger. Each school district in Kentucky is required to develop a District Facilities Plan that evaluates the schools and provides a prioritized list of future construction needs. This plan also lists each school district's "unmet need," which is the difference between what their current needs will cost and what their current financial position will fund. Based on this assessment, the current unmet need across the Commonwealth of Kentucky is over \$6.5 billion. The district facility plan for Henry County, a small school district, currently lists their unmet need at \$34,179,000.

Even though Henry County was tapped out on its ability to fund capital construction, the district had immediate infrastructure needs. Henry County Middle School (HCMS) and Eastern Elementary School (EES) had aging HVAC systems that were energy inefficient, noisy, required significant ongoing maintenance expenditures, and did not meet current indoor air quality codes for ventilation.

Both are smaller schools with HCMS being 57,000 ft<sup>2</sup> and EES being 22,000 ft<sup>2</sup> with enrollments of 503 and 234, respectively. Because funding was not available through traditional avenues, the county turned to performance contracting to address its infrastructure needs (see "Performance Contracting"). The Energy Savings Coalition defines performance contracting as "The use of guaranteed savings from the operations and maintenance budget as capital to make needed upgrades and modernizations to your building environment, financed over a specific period of time."

Using the performance contracting alternative, the district was able to install new geothermal HVAC systems in both HCMS and EES, along with other improvements. Because performance contracting uses the savings from the improvements to fund the project, there was no added cost to the school district and the energy savings are guaranteed by the contractor. The



Henry County High School observes "Tractor Day" on the Tuesday of Future Farmers of America Week in May. On that day, the agricultural students drive their tractors to school.

energy savings from the project are proving to be better than anticipated, and the district is saving more annually than required to pay for the project; therefore, the project is having a positive impact on the district's bottom line. HCMS and EES were both poor energy performers in the past, but after the renovations have achieved Energy Star certification. Henry County Middle School earned an Energy Star score of 89 and Eastern Elementary School earned a score of 97.

Performance contracting begins with benchmarking all facilities to determine energy and other utility usage. *Table 1* is a baseline of the district's annual energy use. The school's energy use intensity (EUI) ranged from 54 kBtu/ft<sup>2</sup>-yr to 112 kBtu/ft<sup>2</sup>-yr. Any school that would score a 74 or below using the ENERGY STAR Portfolio Manager is potentially a candidate for performance contracting.

Henry County school district's primary goal for this project was to acquire desperately needed new HVAC systems installed in HCMS and EES. The secondary goals were to complete all construction during the summer of 2013 and improve

the learning environment with new finishes where possible. To support these goals for HCMS and EES, minimal work was required in the high school, bus garage and New Castle Elementary in order to generate the required energy savings. During the Opportunity Assessment phase of the project, engineers toured the buildings to develop various energy conservation measures (ECMs).

Once all ECMs were identified, they were modeled to calculate the potential annual energy savings and the savings that could be guaranteed. *Table 2* lists the savings of the various ECMs and *Table 3* indicates each school's guaranteed monetary savings. Quick payback ECMs at other buildings were bundled with the longer term payback ECMs (i.e., a major renovation) to create an overall project with an appropriate payback.

Henry County Middle and Eastern Elementary were both provided with new geothermal HVAC systems. A water source heat pump system previously served each school with EES using high cost propane for heating fuel. A geothermal vertical-bore well field replaced the evaporative coolers, boilers and heat exchangers at both schools. New high-efficient, two-stage water source heat pump units replaced the old single-stage units.

© Melissa Blankenship, publisher, Henry County Local, used by permission.

**Table 1** HENRY COUNTY SCHOOLS GAS/ELECTRICITY SAVINGS BASELINE ENERGY USE INTENSITY

School	Square Feet	Electric (kWh)	Natural Gas (CCF)	Propane (Gal)	Total (kBtu/ft <sup>2</sup> -yr)
Henry County MS	55,781	905,280	17,666	—	90
Eastern ES	21,642	406,800	5,168	—	112
Henry County HS	123,500	1,500,600	24,241	—	63
New Castle ES	56,815	641,000	—	11,645	54

**Figure 1** HENRY COUNTY MIDDLE SCHOOL ELECTRIC COST



**Table 2** ENERGY CONSERVATION MEASURES (ECMS) CALCULATED ANNUAL REDUCTIONS

ECM	kWh	kW	Natural Gas (CCF)	Propane (Gal)	Water (Kgal)	Sewer (Kgal)	Rate Change	Maintenance Change
Henry County MS*	208,630	578	13,626	—	3,494	3,494	—	\$20,000
Eastern ES*	89,665	721	—	11,6450	359	—	—	\$10,000
<b>Henry County HS</b>								
Gym fans**	-16,308	-23	7,067	—	—	—	—	—
Outdoor Lighting Upgrades	132,039	132	—	—	—	—	—	—
Automation System Upgrades	5,435	251	—	—	—	—	—	—
Field House Lighting	5,961	—	—	—	—	—	—	—
Utility Rate Change	—	—	—	—	—	—	\$11,407	—
Bus Garage HVAC Upgrades	—	—	1,237	—	—	—	—	—
Bus Garage Lighting Upgrades	19,402	—	—	—	—	—	—	—
<b>New Castle ES</b>								
Utility Rate Change	—	—	—	—	—	—	\$3,796	—
Automation System Upgrades	95,400	80	—	—	—	—	—	—

\*HVAC Renovation, Lighting Upgrades, Envelope Upgrades  
 \*\*This ECM improved thermal comfort, but had a negative electrical cost impact.

**Table 3** GUARANTEED ANNUAL MONETARY SAVINGS BY SCHOOL

	kWh Usage	kW Demand	Natural Gas	Propane	Water	Sewer	Rate Change	Total
Henry County MS	\$6,968	\$7,676	\$10,765	\$0	\$9,015	\$18,937	\$0	<b>\$53,361</b>
Eastern ES	\$2,995	\$9,559	\$0	\$19,680	\$1,368	\$0	\$0	<b>\$33,602</b>
Henry County HS	\$6,615	\$3,684	\$5,248	\$0	\$0	\$0	\$11,407	<b>\$26,954</b>
New Castle ES	\$2,868	\$956	\$0	\$0	\$0	\$0	\$3,796	<b>\$7,620</b>

At EES, the existing console unit ventilator style heat pumps were replaced with new ducted units above the ceiling. This resulted in improved room acoustics since the unit was above the ceiling and not in the room. The existing water distribution systems were replaced with new variable flow pumping systems. New dedicated outdoor air systems (DOAS) were installed with heat recovery wheels. These units drastically improved each school's indoor air quality. The existing piping systems, ductwork and

electrical service to the heat pump units were in good condition and able to be re-used.

The inefficient lighting systems in the classrooms and corridors were analyzed and replaced with optimal T-8 lighting systems. Motion sensors were installed for rooms to automatically turn off lights when the rooms are unoccupied. Vinyl composite tile flooring replaced carpet throughout the middle school and new lay-in ceilings were added throughout the elementary school, which brightened the schools

and improved the lighting performance.

New Web-based building automation systems were added, along with real-time monitoring of electricity use. This system allows the design engineers to verify the operation remotely and monitor performance and schedules.

Henry County High School's HVAC system had been converted to a geothermal system through a recent project. ECMs for this school included renovating the outdoor lighting systems, integrating all of the HVAC equipment into the building



“The actual combined energy savings for all schools **exceeded expectations.**”

**Clockwise, from above** Henry County High School was originally constructed in 1950. The high school has had several additions and renovations over the years, with the most recent in 2010 adding 46,553 new square feet and renovating 123,826 square feet of existing space.

Lay-in ceilings were added throughout the elementary school, and new ducted heat pump units above the ceilings replaced the existing console unit ventilator-style heat pumps.

Henry County School District achieved significant energy savings with this project and the District was able to fully fund the \$3 million project via a Guaranteed Energy Savings Contract.

Henry County Middle School, New Castle, Kentucky, reduced its electricity use by 32% and its natural gas use by 85%, achieving an Energy Star score of 86.

Carpeting was replaced with vinyl composite tile flooring throughout the middle school to brighten the area and improve lighting performance.



All photos this page: WMB Photography

automation system, new 18 ft diameter gymnasium fans for better air recirculation, new gym temperature control system and real-time monitoring of electrical usage.

HVAC systems become more expensive to maintain as they age. Taking this into consideration, *Tables 2 and 3* include maintenance cost savings for Henry County Middle School and Eastern Elementary School. These savings were quantified by estimating the cost to maintain two 25-year-old HVAC systems for the next 20 years as compared to a brand-new system for 20 years. For example, the maintenance costs during the second 100,000 miles a car is driven is almost always much more expensive than maintenance costs for the first 100,000 miles. The geothermal system

**Clockwise, from top** The Henry County High School gymnasium is one of the largest in the state of Kentucky with a capacity of 5,000 people. The gym was originally built in 1962. As part of the energy savings project, low velocity, high volume fans were installed over the stands on both sides of the facility.

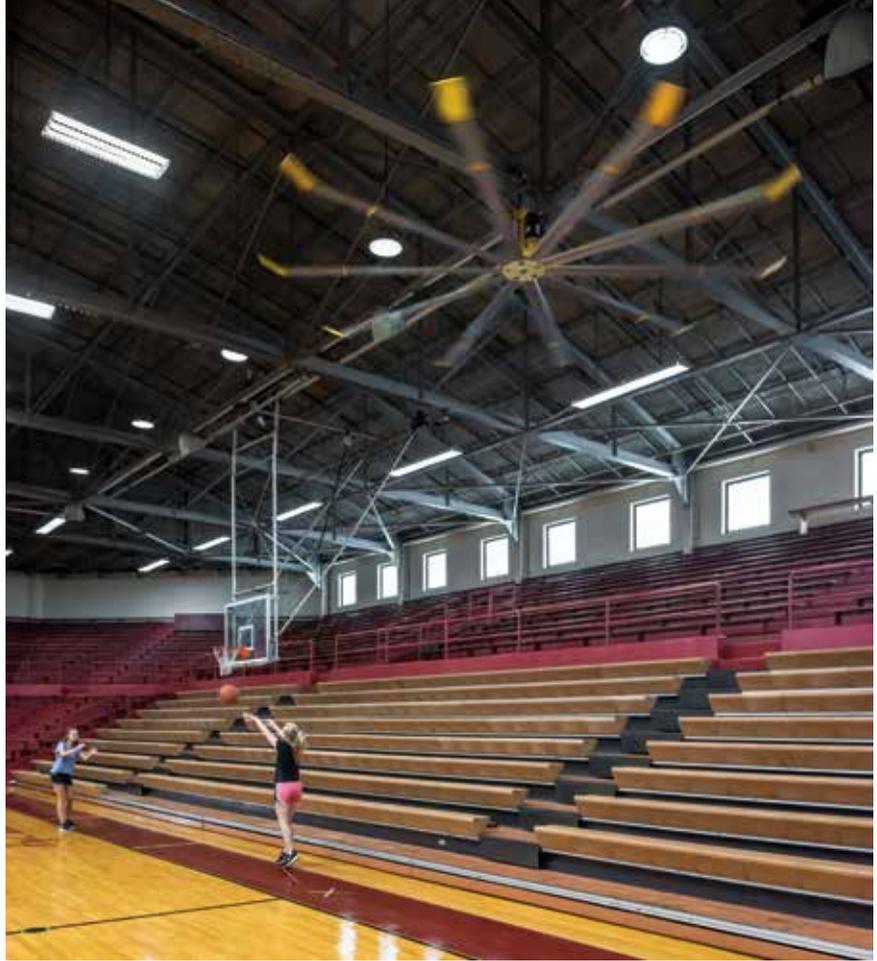
A new packaged rooftop unit was installed for the middle school cafeteria/auditorium, allowing this space to be occupied for functions without enabling the entire geothermal heat pump system.

The geothermal pumping system at Henry County Middle School replaced the evaporative coolers, boilers and heat exchangers. New high efficient two-stage water source heat pump units replaced the old single stage units.

A new dedicated water source outdoor air system was installed to improve indoor air quality and eliminate excessive energy when Eastern Elementary School is unoccupied.

Because Henry County High School had recently been renovated, Energy Conservation Measures (ECMs) were limited to renovating the outdoor lighting systems, integrating all of the HVAC equipment into the building automation system, new 18 ft diameter gymnasium fans for better air recirculation, a new gym temperature control system and real time monitoring of electrical usage.

Geothermal well drilling at Eastern Elementary School.



CMTA Consulting Engineers

All but center photo: WMB Photography

# Performance Contracting

The Energy Savings Coalition defines Performance Contracting as “The use of guaranteed savings from the operations and maintenance budget as capital to make needed upgrades and modernizations to your building environment, financed over a specified period of time.” The pie charts shown in *Figures 3 and 4* help to illustrate this definition. As a building owner reduces its building utility and maintenance costs, these annual cost reductions can be cost shifted to support capital improvements so that the cost impact is neutral. Building utility costs can be energy, water, sanitary or storm drainage costs.

The most common type of performance contract is lighting upgrades. The energy efficiency of today’s lighting systems is significantly better than those of 10 to 20 years ago. Replacing light fixtures is easy and has an attractive ROI. Other examples of common performance contracting projects are HVAC system replacements, DDC HVAC system controls, motor efficiency improvements, heat recovery systems and variable speed controls for fans and pumps. Thermal envelope improvements such as window replacements, infiltration reduction and better attic insulation are common.

In addition to energy saving strategies, water conservation is usually included in these projects. Toilets and urinals may be replaced with a low gallon per flush type and irrigation water reduction strategies are integrated.

The financing period varies with the goals of the client. Typically, a project is financed and guaranteed over a 10- to 20-year period. Some energy reduction strategies such as thermal envelope improvements have a longer ROI so a longer finance period is necessary.

As with all contract delivery methods, there can be drawbacks to performance contracting or particular issues that should be addressed on the front end for a successful project as follows:

1. Client education is important, especially as it relates to the guarantee option chosen. Many performance contracting company projects use Option D, Calibrated Simulation as the primary guarantee. This uses an energy model as the basis of the energy savings in lieu of actual meter readings. Modeled energy savings can vary substantially from actual.
2. Most all performance contracts assume energy costs will continue to inflate. If the energy costs do not inflate at the rate assumed, the cost savings may not support the project costs.
3. Be realistic about the maintenance savings. Overstated maintenance savings will affect the client’s cash flow.
4. Performance contracting should align with a building owner’s master plans. If ECM items are completed in areas slated for future renovations, the construction cost may not be recovered from savings.

According to the National Association of Energy Service Companies, an estimated \$50 billion has been spent for performance contracts since 1990. The federal government has been a major proponent of this type of project financing. Performance contracting is regularly used in state and local governments, higher education, K-12 and health care.

Based on past history and current economic conditions, performance contracting will continue to increase in volume as traditional funding for public and private projects decline.

further reduces the maintenance cost compared to the existing water source heat pump system as the geothermal system no longer has boilers, cooling towers or tower chemical treatment systems. The maintenance savings were escalated 3% annually.

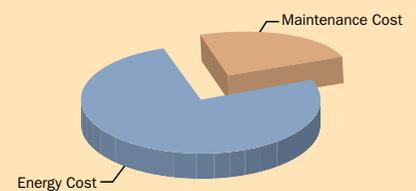
*Tables 2 and 3* also include utility rate change savings. All of Henry County’s schools are served by the same local electrical utility company. With this utility company, multiple rate schedules are available to the customer depending on their usage profiles. Each school’s existing and projected electricity profile was modeled for all qualified rate schedules and a different schedule was identified that reduces the energy costs of Henry County High School and New Castle Elementary School.

The total construction cost for the project was \$3,125,000. *Table 4 (Page 20)* shows the financial proforma of the annual cost and savings over the 20-year financing period. The “guarantee” for a performance contracting project is that the annual savings will exceed the annual cost over the life of the project’s financing. For Henry County’s project the utility and operational savings must annually have

**Figure 2** INTERNATIONAL PERFORMANCE MEASUREMENT AND VERIFICATION PROTOCOL (IPMVP) OPTIONS

Options	Description	Typical Applications
<b>A</b> Partially Measured Retrofit Isolation	Savings are determined by partial field measurements of the energy use of the system(s) to which an ECM was applied. Some, but not all, parameters may be stipulated.	Lighting retrofit where pre- and post-retrofit fixture wattages are measured. Operating hours of the lights are typically agreed upon.
<b>B</b> Retrofit Isolation	Savings are determined by field measurement of the energy use of the systems to which the ECM was applied.	Variable speed drive on a pump. Electricity use is measured by a kWh meter installed on the electrical supply to the pump motor.
<b>C</b> Whole Facility (Utility Bills)	Savings are determined by measuring energy use at the utility meter level. Bills may be corrected for weather.	Several ECMs affecting many systems in a building. Utility bills are used.
<b>D</b> Calibrated Simulation	Savings are determined using building simulation. This option is rarely used, and is used primarily when there is no pre-retrofit utility data available.	Multifaceted energy management program affecting many systems in a building but where no base year data are available.

**Figure 3** OPERATIONS BUDGET BEFORE IMPROVEMENTS



**Figure 4** OPERATIONS BUDGET AFTER IMPROVEMENTS



a neutral or positive impact on the general fund. If not, the performance contracting firm is obligated to pay the owner the difference at the end of the year except when the previous years' surpluses offset the difference. *Table 4* is a summary of these annual costs and savings over the 20-year financing period, which indicates a cumulative net positive cash flow of \$117,869. The bond payments were escalated through the financing period to match the escalating energy and operational savings.

The energy savings shown in *Table 2* were escalated at an annual rate of 4% throughout the contract term. Kentucky has traditionally been a state with low electricity costs, but this has changed over the last 10 years. *Figure 1 (Page 14)* shows that since 2009 the local utility company's cost of electricity (\$/kWh) has been increasing at an average rate of 8.65% compounded annually. The local utility received a 9.6 % rate increase for 2015. Any rate increases in excess of the 4% are actually additional savings to the district for making these energy efficiency upgrades.

Kentucky's performance contracting legislation requires the use the International Performance Measurement and Verification Protocol (IPMVP) as the basis for determining the performance of the systems. As noted in *Figure 2 (Page 17)*, there are four acceptable guarantee options.

This protocol also provides a means to account for variables out of the contractor's control such as usage, occupancy, and weather. Because Henry County Middle School and Eastern Elementary School were complete renovations, the actual meter readings (Option C) were used as the basis for the guarantee. This made the performance measurement very black and white and easy for all parties to determine the performance. The baseline energy was the average of the previous

**Table 4** FINANCIAL PROFORMA

Cost Inputs		Savings Inputs	
Total Bond Issue	\$3,125,000	Second Year Additional Maintenance/M&V	\$3,000
Interest Rate	2.89%	Maintenance Escalation Rate	3.00%
# Years	20	First Year Maintenance/Operational Savings	\$30,000
Construction Cost	\$3,027,789	First Year Energy Savings	\$121,536
Bond Issuance Cost	\$97,211	Energy Escalation Rate	4.00%

Year	Bond Payment	M&V	Total Cost	Energy Savings	Operational Savings	Total Savings
2014	\$141,395	N/A	\$141,395	\$121,536	\$30,000	\$151,536
2015	\$147,040	\$3,000	\$150,040	\$126,397	\$30,900	\$157,297
2016	\$151,340	\$3,090	\$154,430	\$131,453	\$31,827	\$163,280
2017	\$160,590	\$3,183	\$163,773	\$136,711	\$32,782	\$169,493
2018	\$164,740	\$3,278	\$168,018	\$142,180	\$33,765	\$175,945
2019	\$173,840	\$3,377	\$177,217	\$147,867	\$34,778	\$182,645
2020	\$181,490	\$3,478	\$184,968	\$153,782	\$35,822	\$189,603
2021	\$188,905	\$3,582	\$192,487	\$159,933	\$36,896	\$196,829
2022	\$196,085	\$3,690	\$199,775	\$166,330	\$38,003	\$204,334
2023	\$203,030	\$3,800	\$206,830	\$172,984	\$39,143	\$212,127
2024	\$209,740	\$3,914	\$213,654	\$179,903	\$40,317	\$220,220
2025	\$216,215	\$4,032	\$220,247	\$187,099	\$41,527	\$228,626
2026	\$227,455	\$4,153	\$231,608	\$194,583	\$42,773	\$237,356
2027	\$238,343	\$4,277	\$242,620	\$202,366	\$44,056	\$246,422
2028	\$248,878	\$4,406	\$253,283	\$210,461	\$45,378	\$255,839
2029	\$254,060	\$4,538	\$258,598	\$218,879	\$46,739	\$265,618
2030	\$267,395	\$4,674	\$272,069	\$227,635	\$48,141	\$275,776
2031	\$275,110	\$4,814	\$279,924	\$236,740	\$49,585	\$286,325
2032	\$287,360	\$4,959	\$292,319	\$246,210	\$51,073	\$297,283
2033	\$298,990	\$5,107	\$304,097	\$256,058	\$52,605	\$308,663
<b>Total</b>	<b>\$4,232,000</b>	<b>\$75,351</b>	<b>\$4,307,351</b>	<b>\$3,619,109</b>	<b>\$806,111</b>	<b>\$4,425,220</b>

**Table 5** COMBINED ENERGY SAVINGS FOR ALL SCHOOLS

School	Baseline Utility Cost	Guaranteed Utility Cost	Actual Utility Cost	Total Savings	Excess Savings
Henry County MS	\$138,925	\$93,119	\$65,979	\$72,946	\$27,140
Eastern ES	\$51,978	\$23,011	\$15,014	\$36,964	\$7,997
Henry County HS	\$113,495	\$98,804	\$102,107	\$11,388	-\$3,304
New Castle ES	\$53,427	\$50,534	\$50,051	\$3,376	\$483
<b>Total</b>	<b>\$357,825</b>	<b>\$265,467</b>	<b>\$233,151</b>	<b>\$124,674</b>	<b>\$32,316</b>

## Lessons Learned

- Geothermal test wells are important to enable understanding of the geology prior to construction and plan for bore depth as well as casing requirements. The geothermal vertical bores at Eastern Elementary School had to be reduced from 400 ft to 325 ft because the test well hit natural gas at 350 ft.
- Utility companies often have multiple rates available, which sometimes have significant savings. Don't assume the utility company is reviewing the account and has the schools on the correct rate.
- Understanding how a school district procures its utilities is vital to reduce the long-term cost to the district. There have been a number of situations where a new electrical service is installed for a facility like a baseball field because it is the cleanest and simplest solution. However, depending on how the rate structure is set up, we have seen instances where the cost per kWh reaches over \$0.50 because of ratchets, and high demand rates. If the same facility was fed from a building nearby, the rate could be only \$0.06 to \$0.08 per kWh because it won't contribute to the monthly demand maximum—potentially savings thousands of dollars a year.

two years' actual energy consumption. The scope of the renovations at Henry County High School and New Castle Elementary were minimal so the guarantees utilized were less holistic and included pre- and post-retrofit measurements with agreed to operating hours to validate energy savings at these two schools (Options A and D).

The actual combined energy savings for all schools exceeded expectations.

*Table 5* shows the performance results for the 2014 calendar year. Actual energy savings were \$32,316 higher than the guarantee based on actual meter reading of all the schools.

This project has had a positive effect on the environment. The first year CO<sub>2</sub> reduction at EES was 479 tons and 715 tons at HCMS. Energy reduction ranged from 11% at the high school where minimum renovations

were accomplished, to 69% at Eastern Elementary School. All schools are now Energy Star certified with Eastern Elementary, a 55 year old structure, receiving an Energy Star score of 97 and listed as one of the top 20 performing schools in Kentucky.

This project resulted in two schools that have new geothermal HVAC systems and four existing schools are Energy Star certified. The school district was able to address its most critical unmet infrastructure needs that it otherwise could not have funded.

It also avoided the traditional way of funding that would have resulted in a large annual bond cost for the next 20 years. This project demonstrates that performance contracting can be a creative alternative to accomplishing infrastructure renovation projects using money that is already being spent on energy and maintenance. ●

---

### ABOUT THE AUTHOR

**Jeremy Kelly, P.E., LEED AP, HFDP**, is a principal with CMTA Energy Solutions, a division of CMTA, in Louisville, Ky.