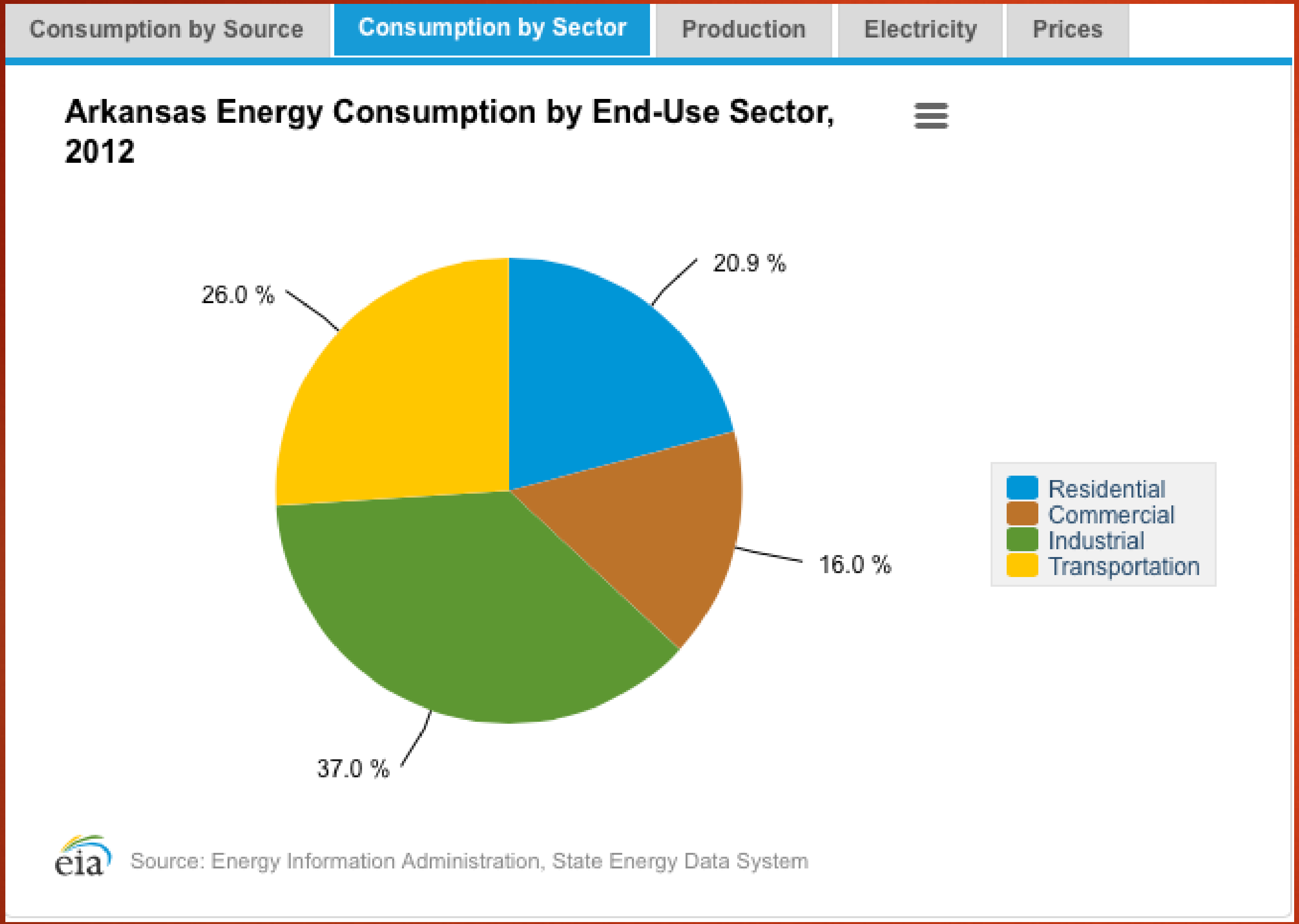
EXHIBIT D

Getting To Zero

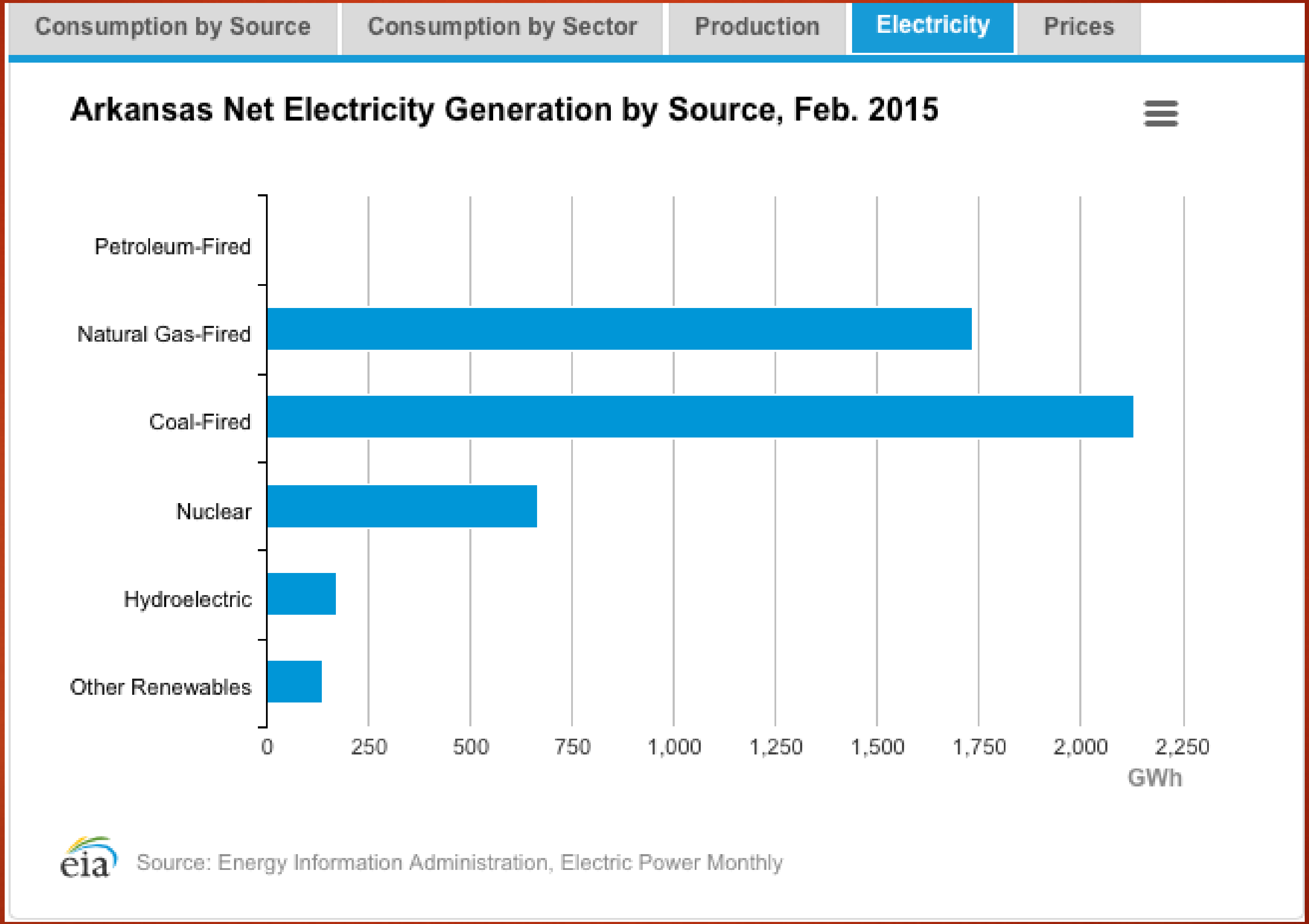
COST EFFECTIVE METHODS OF ACHIEVING NET-ZERO READY BUILDING DESIGN

Residential and Commercial Energy Use

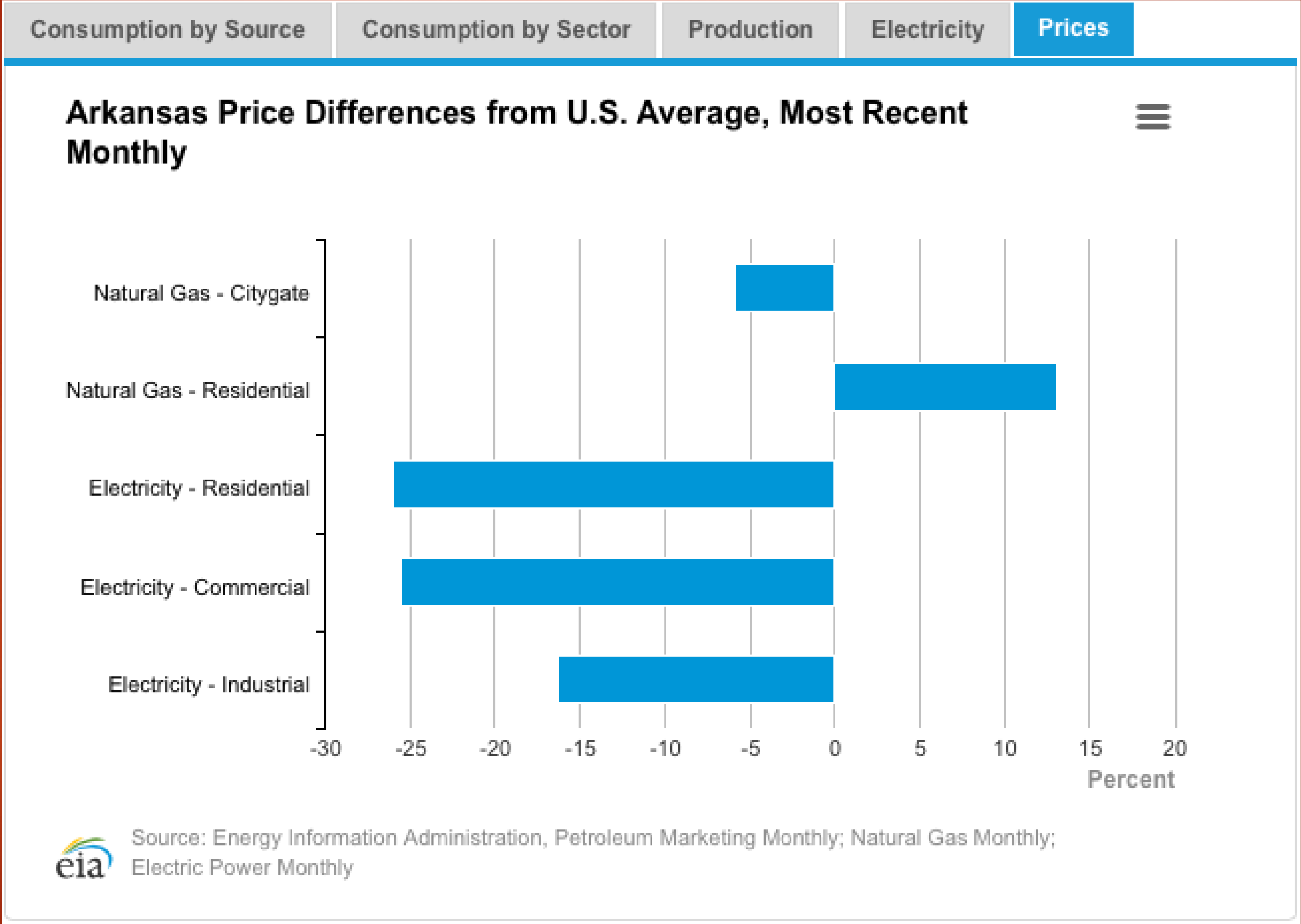


- According to the DOE commercial buildings including offices, schools, hospitals, restaurants, hotels and stores consume nearly 20% of all energy used in the U.S.
- That translates into more than $200 Billion spent each year to power millions of square feet that is often designed or operated inefficiently.
- **Why am I here today? To tell you it doesn’t have to be that way!**

Arkansas By the Numbers



Arkansas By the Numbers



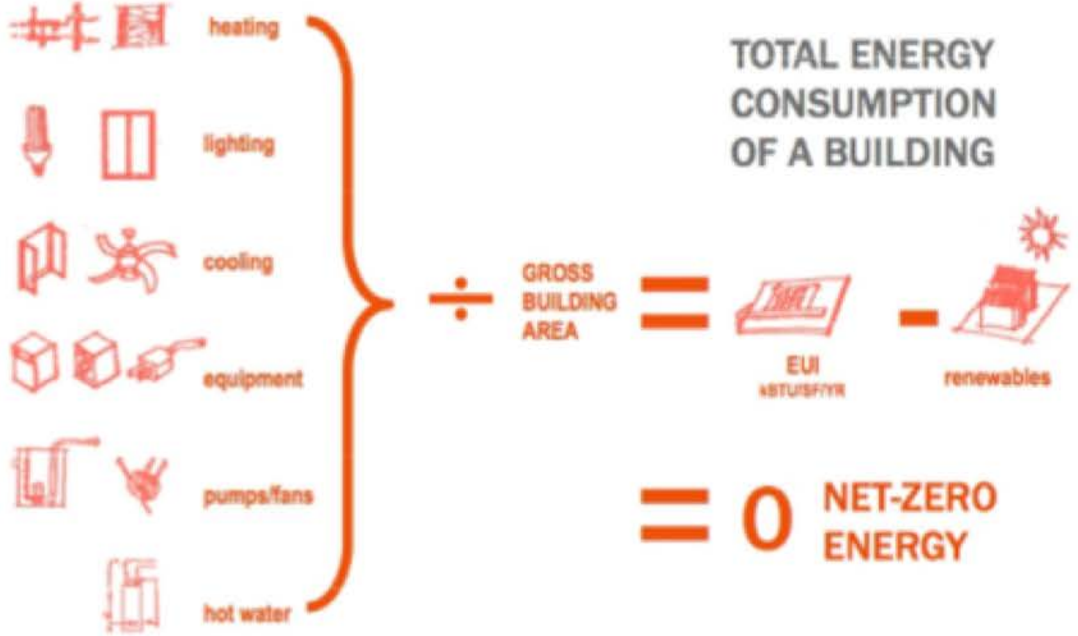
Arkansas By the Numbers

- As of 2014 Coal-fired electric power plants in Arkansas supplied over half (53%) of the state's electricity.
- With increased legislation driving power providers away from building new coal-fired electric power plants, I think many Arkansans have no clue the effect this could have on the price of electricity for our residents.
- We have become accustomed to paying roughly 25% less than the national average for residential and commercial electricity. Many people in our region will have a very difficult time absorbing the increased cost of power that we will see in the coming years.

WHAT IS NET-ZERO ENERGY (NZE)?

NZE buildings have a fully off-set carbon footprint. A building is a Net-Zero annual user of energy if:

The amount of power generated by on-site renewables (wind, solar, etc.) = The amount of energy consumed by the building.



Any Building can be NET ZERO if you have enough ZEROs in your checkbook!

- The trick is lowering the overall consumption of your building first before making the determination if renewable power generation products make economic sense.
- Don't just throw a lot of money at Solar PV or Wind products to generate the amount of power you are using. Reduce consumption first because this will translate to a linear reduction in the amount of generation equipment required.

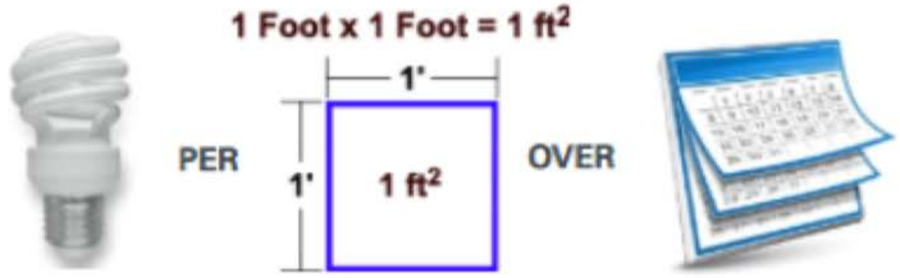
WHY ARE SCHOOLS IDEAL CANDIDATES FOR NET-ZERO ENERGY?

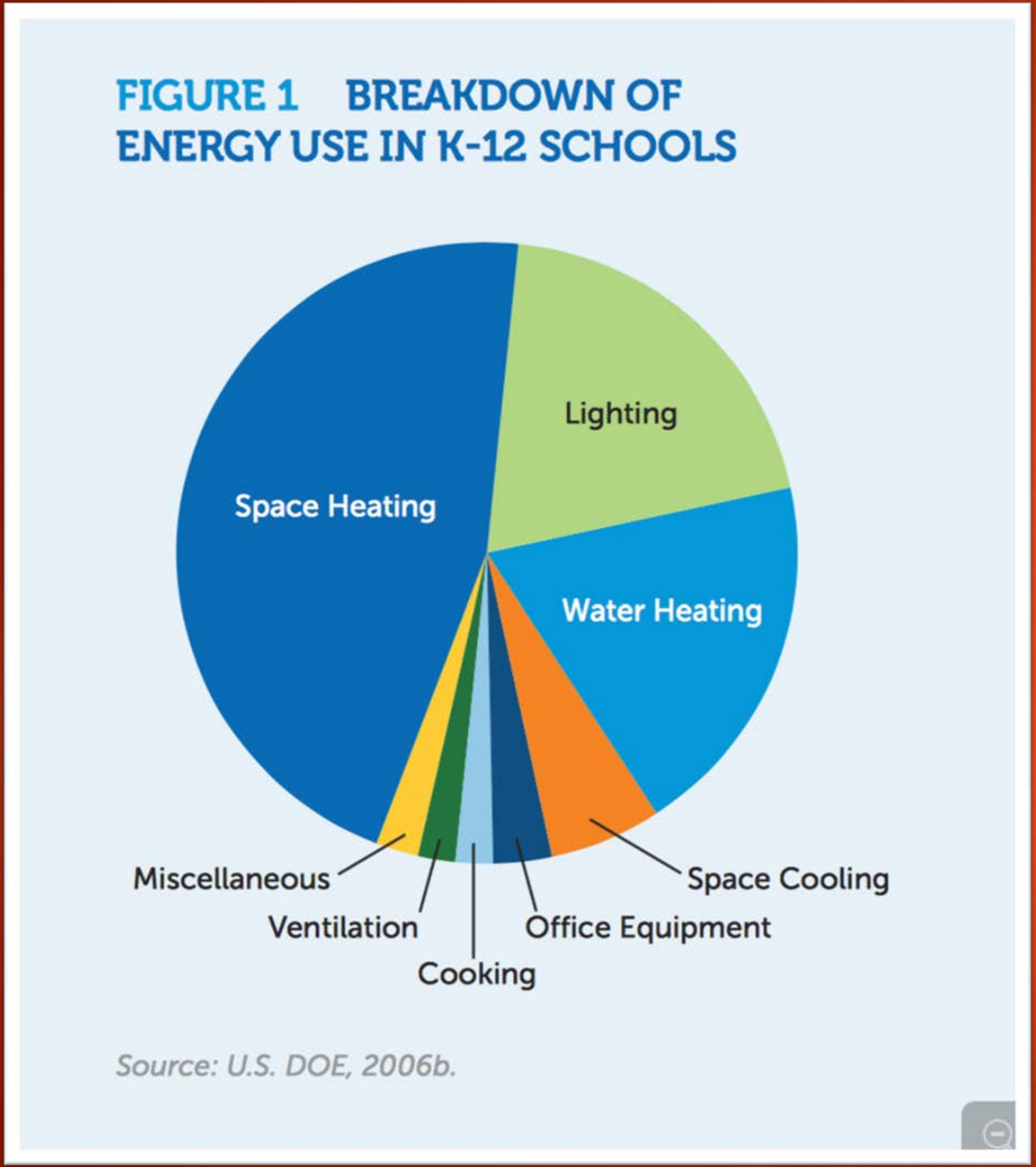
Photovoltaic solar panels generate the most amount of electricity during the summer months, when the school building is consuming the least amount of energy – even with ongoing summertime programs. Electricity prices are also highest in the summertime, so more revenue is generated. Schools' operating dollars are some of the most precious of all public tax dollars – and are increasingly under strain. Beyond dollars, the benefits of environmental and energy stewardship enrich the curriculum and the community.

How are Buildings Compared?

HOW IS ENERGY USE MEASURED?

All of the power consumed in Discovery Elementary School – whether electricity, natural gas, or propane – is converted into BTUs. An **Energy Use Intensity (EUI)** number is the total number of BTUs (in thousands) consumed over one year and then divided by the total square footage of the building.





- In the average US School Heating, Cooling and Hot Water Generation make up roughly 75% of the total energy used by the school.
- Knowing that, where do you think the largest opportunity for improving energy consumption in a school might be?
- With our patented Hot Water Generation System we can essentially eliminate the water heating portion of this pie.
- In the average Net Zero or Net Zero Ready school this pie looks much different.

Benefits of Energy Efficiency in Schools

- Reduce energy costs.
- Improve indoor air quality
- Increase attendance.
- Improve student performance
- Demonstrate leadership.
- Reduce greenhouse gas (GHG) emissions and other environmental impacts.
- Enhance educational opportunities.
- Increase economic benefits through job creation and market development.
- Increase security and safety.
- Other benefits.

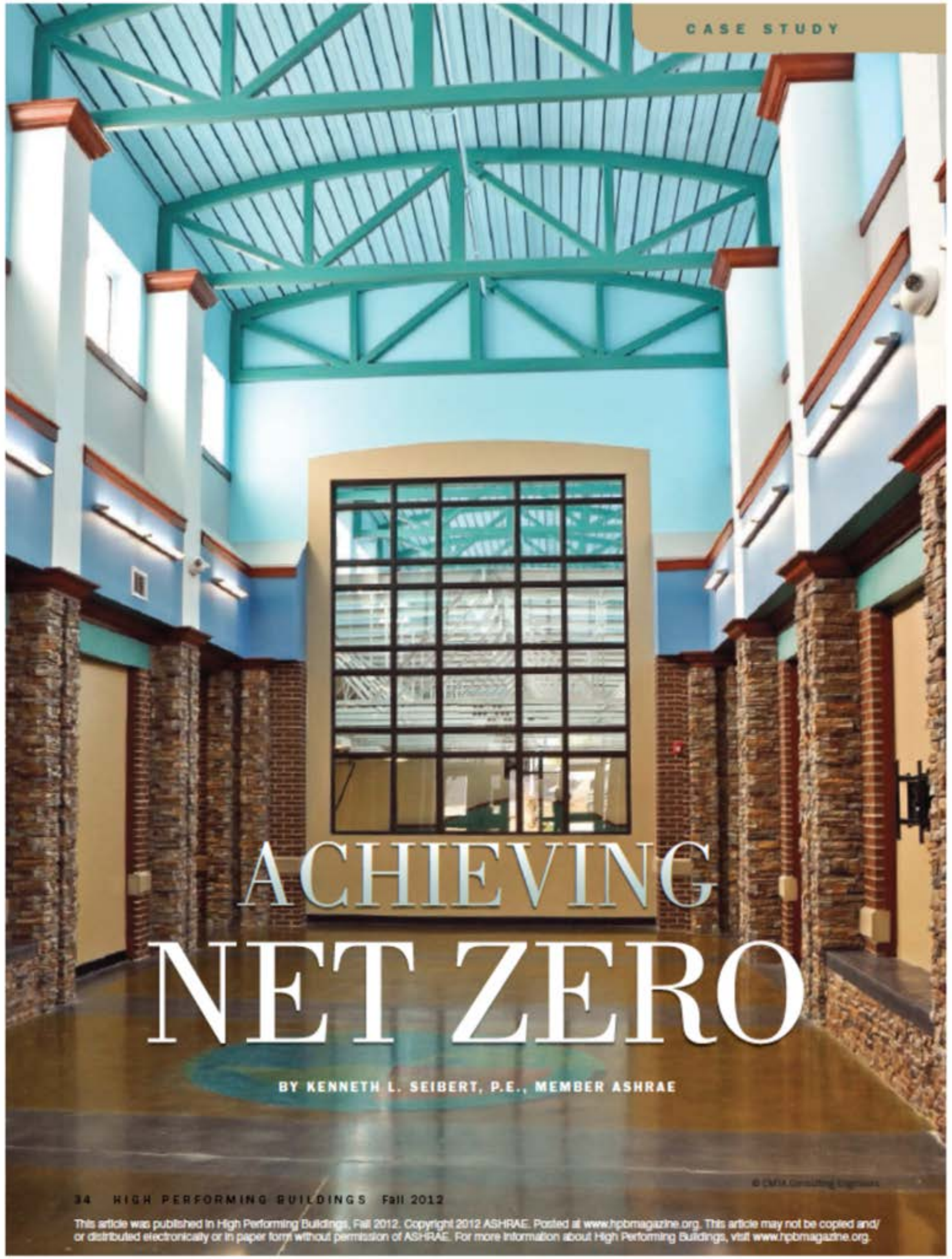
K-12 Schools

Richardsville Elementary School

(Richardsville, KY)

Richardsville Elementary School

(Richardsville, KY)



ACHIEVING NET ZERO

BY KENNETH L. SEIBERT, P.E., MEMBER ASHRAE

"How would one design a net zero energy school and how much would it cost?" Mark Ryles, AIA, then facilities director for the Kentucky Department of Education, asked this question in fall 2007, right after Plano Elementary became the state's most energy efficient school. This question launched a collaboration involving MEP engineers, architects, state regulators, utility companies, school board members, school facility managers and school staff to design the first full-scale net zero energy school in the United States.

The south side of the building has exterior lightshelves to direct sunlight further into the classroom.

Richardsville Elementary, originally built in 1946, is located in the Warren County Public School District (WCPS) in south central Kentucky. The district has a long history of energy management, being one of the first school districts in the state to hire a full-time energy manager. WCPS had five ENERGY STAR schools when Plano Elementary opened in 2007. Plano was rated at 99 and had an annual energy use intensity (EUI) of 26.8 kBtu/ft².

After such an achievement, investigating net zero seemed the next logical step. During preparations to replace Richardsville's aging building, designers researched current technologies, performed energy modeling and discussed building envelope and site orientation. They decided photovoltaics were the best way to make Plano's exemplary design work as net zero.

However, a PV system with enough capacity to produce Plano's 26.8 kBtu/ft²·yr was too expensive for Warren County's construction budget. Therefore, the team designated a new EUI target of 17 kBtu/ft²·yr as the basis for a financial model that indicated a 15-year simple return on investment (ROI) (See 2009 Financial Model sidebar, Page 43).

Setting the EUI and ROI goals were a critical first step in the collaboration process. The collaborating partners realized that they had to change their design paradigms and usual building construction techniques to reach the goal, as well as ask for waivers of agency regulations.

This project demanded innovative energy reduction strategies such as dedicated outdoor air systems (DOAS) with dynamic reset, new IT systems, and even alternative methods to prepare lunches.

The architect supported the project with a building massing model

Opposite Visitors coming into the main entrance of Richardsville Elementary look down the central hallway toward a large window overlooking the gymnasium/cafeteria. This forms the central spine of the building and has clerestory windows to admit natural light. The floors are made of concrete that does not require waxing.

BUILDING AT A GLANCE

Name Richardsville Elementary School

Location Richardsville, Ky. (9.3 miles north of Bowling Green, Ky.)

Owner Warren County Public Schools

Principal Use Elementary school
Includes Gymnasium and cafeteria

Employees/Occupants 460 students, 35 staff

Occupancy 84%

Gross Square Footage 72,285
Conditioned Space 72,285

Distinctions/Awards
First Net Zero Energy School in the United States;

American School and University Magazine, Special Citation, 2008 and 2011; and Andromeda Award, Alliance to Save Energy (Warren County Public Schools), 2009

Total Cost $14,927,000
Cost Per Square Foot $206.50

Substantial Completion/Occupancy
September 2010

For more details on Plano Elementary, see the Fall 2009 issue of *High Performing Buildings* magazine or go to http://tinyurl.com/boapl2c.

Above left A 140 kW crystalline array mounted on a parking shade structure and a 208 kW thin-film array mounted on the roof provide the school's renewable energy.

Above right The roof is covered with a thin-film solar array. This 208 kW array has been operational since February 2011.

© CMTA Consulting Engineers

aimed to reduce heat transfer from the outdoors. The engineer developed energy reduction strategies and energy modeled the project, beginning at the schematic phase to ensure the targeted energy performance would be achieved.

Renewable Energy

Solar photovoltaics were selected as the renewable energy source to offset the energy used by the school. The solar PV system did not bid until later stages of construction to obtain the lowest cost.

A 208 kW thin-film PV system was located on the roof, and a shade structure built in the parking area accommodates 140 kW of crystalline panels. The full PV system became operational in January 2012.

Figure 1 shows that the building has been operating at net zero energy since January 2012. From September to December 2011, only 60% of the solar PV system was operational, resulting in a net EUI of 0.39 kBtu/ft² for the last 12 months. However, since the PV system became fully operational, power generation has exceeded consumption by 26.5%.

The PV system was designed for a 20-year life-cycle, and it was expected that surplus power would be generated in the initial years.

FIGURE 1 NET ZERO ENERGY MWH SUMMARY

Read Date	MWh Consumed	MWh Generated	MWh Difference
8/16/2012	36.4	54.8	(18.4)
7/11/2012	26.6	56.0	(30)
6/11/2012	28.0	57.5	(29.5)
5/16/2012	38.2	45.0	(6.8)
4/16/2012	29.8	35.3	(5.5)
3/15/2012	30.6	31.9	(1.3)
2/14/2012	33.8	19.5	14.3
1/16/2012	26.0	14.9	11.1
Subtotal (100%PV)	248.8	314.9	(66.1)
12/14/2011	29.2	7.5	21.7
11/17/2011	31.8	12.2	19.6
10/17/2011	34.6	19.3	15.3
9/15/2011	41.2	23.5	17.7
Subtotal (60%PV)	136.8	62.5	74.3
Total	**385.6**	**377.4**	**8.2**

MWh summary documenting eight months of operation with the power generation system at 100% and four months at 60% operation.

AUTHOR'S NOTE ON NZEB

Due to of the groundbreaking nature of this project, this article has been published prior to having one year of full data on the power generation system. Because the school opened in September 2010, more than 12 months of energy consumption data is available; however, the full renewable energy system did not become operational until January 2012.

Figure 1 shows the MWh summary documenting eight months of operation with the power generation system at 100% and four months at 60% operation. Since the power generation system began full output, generation has exceeded consumption by 26.5%.

Looking at the previous 12 months, consumption exceeded generation by only 2.2%, which included the four months with only 60% capacity. Using this data, even without the full 12 months of 100% solar PV output, it is clearly evident this building is operating as a net zero energy building.

ENERGY AT A GLANCE

Annual Energy Use Intensity (EUI) (Site) 18.2 kBtu/ft²
Electricity (From Grid) 18.2 kBtu/ft²

Annual Source Energy 60.5 kBtu/ft²

Annual Energy Cost Index (ECI) $0.30/ft² credit

Annual On-Site Renewable Energy Exported (From PV) 17.8 kBtu/ft²

Annual Net Energy Use Intensity 0.39 kBtu/ft²

Savings vs. Standard 90.1-2004 Design Building 52.8%

ENERGY STAR Rating 100

Heating Degree Days (base 65°F) 2,710

Cooling Degree Days (base 65°F) 2,650

Average Operating Hours per Week 45

WATER AT A GLANCE

Annual Water Use 421,000 gallons

© Sherman-Carter-Barnhart

The gymnasium serves as gym and cafeteria. The cafeteria setup is pictured here. The clerestory windows that form the spine of the building and admit daylight into the main hall and gymnasium/cafeteria can be seen at the top of the photo. None of the overhead lights were on when this picture was taken.

Because the output of the panels deteriorates over time, the system was designed so at year 10, generation would match consumption. *Figure 2* graphs the production of each PV system over the last 12 months.

Energy Consumption

The net zero operation has grabbed public attention, but the low energy consumption is a source of pride for the design team. During the past 12 months, actual building energy consumption has been 18.2 kBtu/ft², while the design energy goal was 17 kBtu/ft².

The school is equipped with a power monitoring system that can measure and trend HVAC, lighting, kitchen, plug load, and IT power consumption individually (*Figure 3*). *Figure 4* compares Richardsville's energy consumption to baseline energy use according to ASHRAE/IESNA Standard 90.1-2004 and data from ASHRAE's *Advanced Energy Design Guide (AEDG) for K–12 School Buildings: Achieving 50% Energy Savings Toward a Net Zero Energy Building*.

Energy Reduction Strategies

Envelope. Energy benchmarking data from past projects provided clear evidence that an efficient thermal envelope can have a substantial impact on energy performance.

Richardsville Elementary was constructed with insulated concrete form (ICF) walls. The district had first used ICF walls in the construction of Alvaton Elementary, and the thermal performance, along with the thermal mass it provided, is a proven strategy to reduce HVAC energy.

A rectangular shape was chosen early to minimize heat transfer surface areas. The ratio of exterior wall-to-floor area is 38.9%, window-to-floor area is 26.9% and roof-to-floor area is 62.7%. The same ratios for the prototypical school modeled in ASHRAE's 50% school buildings AEDG, by comparison, are 49%, 34% and 100%, respectively. The architects' building design minimized the exterior heat transfer surfaces, which helped achieve the energy performance goals.

Lighting Strategies. The lighting energy consumption is 3.8 kBtu/ft²·yr. The primary strategies to reduce this energy use were minimizing the lighting energy intensity and

NEW VS. OLD VIDEO

New vs. Old Richardsville Elementary Schools battle in a five-minute video that stars two Richardsville students. The video is a parody of the "Get a Mac" PC vs. Mac ad campaign that ran from 2006 to 2009 (http://tinyurl.com/5t2tzvo).

The New Richardsville Elementary School constantly foils Old Richardsville Elementary School by touting all of the sustainable features of the new school, including its being built to be net zero energy.

In the end, Old Richardsville School decides he wants to attend the new school, too.

View the New vs. Old Richardsville Elementary School video at http://tinyurl.com/cw5par2.

naturally daylighting the classrooms. The average lighting energy intensity of the school is 0.68 W/ft^2, 43% lower than the code maximum 1.2 W/ft^2.

The rectangular shape did not compromise the daylighting design. The building floor plan is aligned on an east/west spine. All classrooms are located on the south and north exposures to capture the best daylight. The gymnasium and cafeteria are located in the center of the school, and the central spine has a raised clerestory to allow them to also be naturally lit.

Each upper-level, south-facing classroom is lit with four 2 ft by 4 ft light fixtures with three 32 watt, super T8 lamps and one 16 ft linear direct/indirect fixture with eight 32 watt, super T8 lamps.

The south-facing classroom daylighting design includes interior and exterior lightshelves to allow natural light into the classroom while minimizing direct glare at student desks, and tubular daylighting devices in the back of the room to supplement the daylight.

The upper-level, north-facing classrooms have six 2 ft by 4 ft light fixtures with three 32 watt, super T8 lamps.

In addition to the view glass, four supplemental tubular daylighting devices provide a source of natural light. A digital addressable control system modulates the artificial lighting output to supplement natural light as needed.

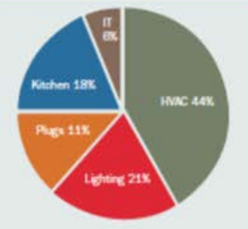
© Nudura Corp. Used by permission.

Richardsville was constructed using insulated concrete form (ICF) walls that enhance the building's thermal envelope.

The lower-level classrooms have the same lighting layout with the exception of the tubular daylighting devices.

HVAC. The HVAC system consists of geothermal water source heat pumps with a dedicated outdoor air system (DOAS), which consumes 7.8 kBtu/ft^2 · yr. The installed cooling capacity is 120 tons, which equates to 1 ton per every 602 square feet. The goal was to right-size the HVAC equipment and cost shift the savings to support energy-conservation technologies.

FIGURE 3 ENERGY USE BREAKDOWN



KEY SUSTAINABLE FEATURES

Water Conservation The school is exceeding its design water use goal of 600,000 per year (40% savings per LEED 2.0). Actual use is 421,000 gallons per year.

Recycled Materials Recycled a portion of the old school's gym floor.

Daylighting South facing classrooms have interior and exterior lightshelves. North facing classrooms have tubular daylighting devices.

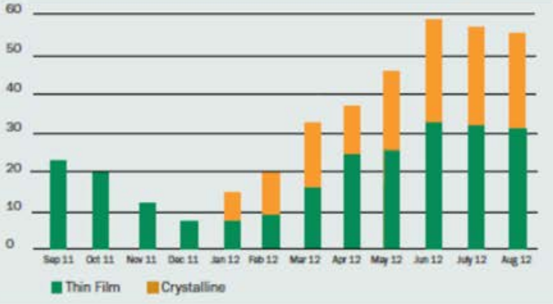
Individual Controls HVAC and lighting.

Photovoltaics 208 kW thin-film rooftop system, 140 kW crystalline panels parking lot array

Carbon Reduction Strategies Solar PV, geothermal HVAC, daylighting, demand control ventilation, ICF walls, energy efficient kitchen.

Other Major Sustainable Features Interactive "green screen" allows students to monitor the building's performance and allows teachers to integrate building into the curriculum; energy efficient kitchen; outdoor classroom with weather station; green interior finishes.

FIGURE 2 SOLAR PHOTOVOLTAIC GENERATION (MWH)



© CMTA Consulting Engineers

The north-facing classrooms don't have lightshelves. In addition to the view glass, four supplemental tubular daylighting devices provide a source of natural light.

The heat pumps have dual compressors on a single refrigerant circuit, which maximizes energy efficiency when the equipment is operating at part-load capacity. (Variable speed compressors provide better efficiency but were not available in 2009.)

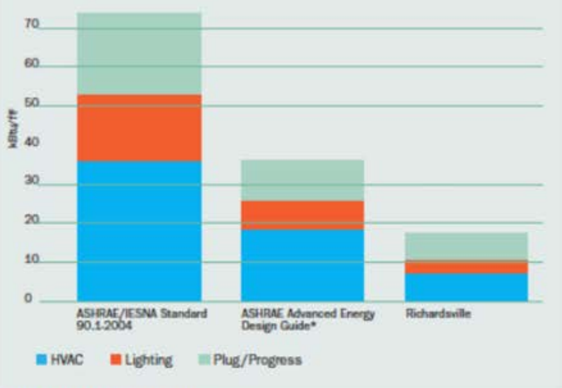
A distributed water pumping system was used in lieu of central pumps with variable frequency drives. A small water pump installed adjacent to each heat pump recirculates water through a low pressure drop building loop to the geothermal borefield. This approach ensures variable water flow operation is obtained and reduces installed pump horsepower to 0.12 W/ft^2.

Improving the energy efficiency of the DOAS was mandatory to achieving the goal. Power monitoring data from Plano Elementary, also a geothermal project, indicated that 40% of HVAC energy was consumed by the DOAS. A variable flow, outdoor air system with dynamic reset was selected for Richardsville.

A constant volume system can significantly over-ventilate the school because of the many "swing" spaces such as the library, art, music, science, gym, cafeteria, etc., with the requirement that each space must be designed for full capacity when dynamic reset is not used. If all spaces at Richardsville were designed to ASHRAE Standard 62.1-2004, the occupancy would total 1,340, when the known maximum occupancy, including staff and visitors is 625.

ASHRAE Standard 62.1-2004 includes the dynamic reset provision to allow ventilation rates to modulate as room occupancy or building population changes. Measuring CO_2 indoor and outdoor levels can be used as a

FIGURE 4 BASELINE ENERGY USE COMPARISON



* 50% AEDG for K-12 school buildings

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Above The gymnasium floor is made from sustainable bamboo. The parquet floor from the old gymnasium was recycled for the free-throw areas. Clerestory windows distribute enough daylight into the gymnasium for the overhead lights to remain off.

Above left Truly a "teaching tool," Richardsville Elementary's themed hallways—Geothermal, Solar, Water Conservation, and Recycling—integrate the school's energy-saving features into the curriculum as students learn conservation principles from the building itself.

BUILDING ENVELOPE

Roof
Type Metal roofing with two, 3 in. layers of R-17 polyisocyanurate insulation
Overall R-value 34.9
Reflectivity/Emittance 69%/87%

Walls
Type 6 in. and 8 in. thick insulated concrete form walls
Overall R-value 28
Glazing percentage 26.8%

Basement/Foundation
Slab Edge Insulation R-value 24
Basement Wall Insulation R-value 24
Basement Floor R-value 0

Windows

	View Window	Daylighting Window
Effective U-factor for Assembly	0.29	0.47
Solar Heat Gain Coefficient (SHGC)	0.38	0.78
Visual Transmittance	0.7	0.81

Location
Latitude 36.8°N
Orientation East/West

BUILDING TEAM

Building Owner/Representative Tim Murley, Superintendent

Architect Kenny Stanfield, AIA, Sherman-Carter-Barnhart

General Contractor RG Anderson Company, Inc.

Mechanical Engineer Mark Seibert, PE, LEED AP, CMTA, Inc.

Electrical Engineer, Lighting Design Brian Baumgartle, PE, LC, LEED AP, CMTA, Inc.

Energy Modeler Kosuke Kato, PE, LEED AP, CMTA, Inc.

Structural, Civil Engineer and Landscape Architect Sherman-Carter-Barnhart

basis for estimating occupancy, in addition to using occupancy sensors.

This project uses a system that centrally tests the air quality in each space. A pneumatic air system returns air from each occupied space to have it "tested" at a common location. This air quality testing system communicates with the BAS. As CO_2 levels increase, the VAV box increases airflow to the space and reduces airflow as the CO_2 levels decrease. When no occupancy is sensed, the classroom is placed in the unoccupied mode.

Other Green Strategies

Designing a net zero energy building aligns with other sustainable goals such as daylighting, reducing energy consumption and green power production. Other strategies included water conservation, green finishes and using the building as a teaching tool.

Water. WCPS focuses on water conservation. This project was designed for 40% water use reduction primarily by using low-flow fixtures. Actual water use was 421,000 gallons per year, substantially lower than the modeled use.

The design included permeable pavers and bioswales to reduce and filter storm water runoff. Native, drought-resistant landscaping was also used.

Finishes. Finishes were another priority. Stained concrete floors, which reduce maintenance costs, are used throughout the school. Richardsville was the first school in the district to try this. The gym floor is bamboo with the free-throw lanes made from the parquet flooring from the original school's gym.

Teaching Tool. A "geothermal hallway" exposes the piping manifolds and equips the pipes coming to and from the wellfield with a temperature gage so students can monitor the performance of the system. The "solar hallway" has a battery charging station where students can see the energy transferred from the solar panels to the laptop computer batteries.

The "water conservation hallway" allows student to monitor the amount of rainwater collected and filtered through the site's bioswales. The "recycling hallway" contains bins for all recyclable materials collected. An outdoor weather classroom allows students to monitor year-round the impact the weather has on the building's performance.

© CMTA Consulting Engineers

Light-duty cooking appliances make it possible to use Type II range hoods in the kitchen, which significantly reduce kitchen energy use.

Behavior Changes

The kitchen and IT systems consume significant energy, but have been off limits to energy reduction strategies on past projects. When Richardsville's owner was shown energy data indicating these systems are consuming 32% of the building energy in the district's most efficient school, he was supportive of kitchen and IT changes to reach the energy goal.

'ENERGY FREE' LUNCHES

The school has adopted the saying, "A healthy kitchen is a green kitchen." Accordingly, it sometimes serves a brown bag lunch. In addition to brown bag staples such as sandwiches, fresh fruit, and crackers, the school offers a popular "salad in a bag." Students pour in salad dressing and eat the salad out of the bag.

Source: http://tinyurl.com/cbkncap

2009 FINANCIAL MODEL

A financial model showing the ROI for an NZE school as compared to the "typical" school was necessary to obtain buy-in from the school district, state agencies and legislators. The building, less the PV system, would have to be constructed within the typical budget assigned by the State Department of Education for a new 550-student elementary school. The cost to construct the solar PV power generation system was budgeted at $2.8 million and would require a 15-year simple payback. That would not be possible if the construction cost of the solar PV system were offset only by the revenue from the power it produced.

The financial model would be based on the total energy cost of Richardsville Elementary compared to the total energy cost of a new school built to the latest energy code. This financial model integrates the energy reduction strategies and generated renewable energy into the ROI. ASHRAE's 50% AEDG for K–12 school buildings suggests the average annual energy use is 73 kBtu/ft², but the Kentucky Department of Energy advised that new schools in Kentucky were typically consuming 65 kBtu/ft²·yr, so the latter EUI was used as the basis for comparison (*See below*).

When Richardsville Elementary was being designed, the Tennessee Valley Authority was setting up a program to encourage renewable energy generation on site. The final program pays $0.12/kWh more than the selling price for each kWh of renewable energy generated. The $0.12/kWh applies only to the actual energy usage cost and excludes the demand charge. In return for the higher usage price paid by TVA, Warren County Public Schools relinquished the solar renewable energy credits (SRECs) to TVA.

The school is operating net zero with respect to cost and has accumulated a credit of $21,663 over the past 12 months. The credit will be returned to the school district on an annual basis. In 2009, when this model was generated, the solar cost was budgeted at $8/kW. Because solar PV costs have fallen significantly, a similar 2012 financial model would indicate an ROI closer to 10 years.

Year	Typical School 65 kBtu Energy Cost	Richardsville 17 kBtu Energy Cost	Richardsville PV Revenue	Annual Savings (Savings Plus Revenue)
1	$109,039	$46,080	$84,183	$147,142
2	$112,310	$47,462	$86,708	$151,556
3	$115,679	$48,886	$89,310	$156,103
4	$119,150	$50,353	$91,989	$160,786
5	$122,724	$51,863	$94,749	$165,610
6	$126,406	$53,419	$97,591	$170,578
7	$130,198	$55,022	$100,519	$175,695
8	$134,104	$56,673	$103,534	$180,965
9	$137,127	$58,373	$106,641	$185,395
10	$142,271	$60,124	$109,840	$191,987
11	$146,539	$61,928	$113,135	$197,746
12	$150,935	$63,785	$116,529	$203,679
13	$155,464	$65,699	$120,025	$209,790
14	$160,127	$67,670	$123,626	$216,083
15	$164,931	$69,700	$127,334	$222,565
	$2,027,004	$857,037	$1,565,713	$2,735,680

Students show University of Kentucky President Dr. Eli Capilouto the school's "green screens," which exhibit the school's real-time energy performance.

ENERGY TEAM

Tour groups at Richardsville Elementary School are greeted by the Energy Team, a group of 4th, 5th, and 6th graders. They have led tours for university presidents, legislators, government officials, school facility managers, architects and engineers, and the general public.

One visitor this year was University of Kentucky president Dr. Eli Capilouto, who visited after receiving a letter from a second grader at the school.

The Energy Team also shares information about energy and energy conservation with their classmates, leads the school's recycling efforts, and takes part in community events related to energy conservation.

—Warren County Public Schools website

Kitchen. Food service staff spent time in a test kitchen to learn alternative methods to prepare food that consumed less energy, while maintaining taste and quality. Kitchen staff learned to prepare hot food primarily with combi-ovens (ovens operating by both conventional heating and microwaves) and 40 gallon tilting kettles (a large, relatively shallow, tilting pot used for braising, stewing, and, occasionally, steaming).

This equipment allows the use of Type II range hoods in lieu of Type I. Building codes allow the exhaust and makeup air quantities to be considerably reduced for Type II range hoods. The kitchen has consumed 3.3 kBtu/ft^2 for the last 12 months.

IT. Kentucky's classroom technology standards for an elementary school required one computer classroom and six student workstation computers in each classroom. All technology was hard-wired.

The design team petitioned the state to eliminate the computer classroom and all classroom workstation computers, and allow Richardsville to be the first truly wireless school in Kentucky. Significant first cost savings were realized by removing the 1,000 ft^2 computer classroom and the power/data wiring infrastructure for the classroom computers. These savings were cost shifted into wireless technology and seven laptop carts.

The laptop carts allow teachers more flexibility to work with computers anywhere in the school and not be tethered to a single classroom. Energy savings were another bonus of the wireless school. The server rooms and plug loads consume only 3.1 kBtu/ft^2 · yr.

Conclusion

Richardsville is an example of the success that can be accomplished when a goal is set and all team members are willing and passionate participants. The school's net zero energy status has attracted visitors from around the U.S., and students lead these tours explaining the sustainable features of the school.

While all projects may not be able to fund renewable energy systems and achieve NZE status, Richardsville Elementary School shows that deep energy reduction can be achieved when all team members work together to plan and implement strategies that drastically reduce energy consumption. ●

LESSONS LEARNED

The power monitoring system proved helpful during measurement and verification. It was used to trend power consumption, system by system, during occupied and unoccupied hours. The hourly trend reports made it easy to verify if equipment was shutting off as intended.

The HVAC energy use during unoccupied periods appeared high. After cross-referencing the energy use with the school's BAS system, most equipment appeared to be shutting down at the correct times. Working with the heat pump manufacturer led to the realization that the reciprocating compressors have 40 W crankcase heaters that operate continuously. The heat pump units have dual compressors, so many units actually have two heaters, totaling 80 W. After discussion with the compressor manufacturer, these heaters were disabled.

Fifty watt ultraviolet lights were provided in all heat pump units for improved air filtration and air quality. These were shipped by the manufacturer to operate 24/7. The UV light operation schedule was changed to be operated only when the supply air fan was running.

Energy use during the unoccupied hours in the kitchen was higher than expected. A post-occupancy tour revealed that there was a portable ice cream cooler in the cafeteria not included in the original design, but was vendor-provided and intended to be a source of revenue for the school. However, the thermal envelope of the portable freezer was poor, and the unit's compressor operated at 90% percent runtime. The source of revenue proved a net loss to the district, increasing the cost of the school's energy consumption by $650/yr. The ice cream cooler would have required $43,000 worth of PV panels to maintain net zero operation. To reduce the extra energy needed to operate the ice cream freezer, it is only turned on during the lunch period. The ice cream to stock the portable freezer is stored in the walk-in freezer the rest of the time.

ABOUT THE AUTHOR

Kenneth L. Seibert, P.E., Member ASHRAE, LEED AP, is president of CMTA Consulting Engineers, Louisville, Ky.

Marion Junior High School

MOST ENERGY EFFICIENT SCHOOL IN STATE OF ARKANSAS

BUILT AT NEAR CONVENTIONAL CONSTRUCTION COSTS **($133/SQ. FT / 2009)** ($175/ SQ. FT / 2015)

ENERGY USAGE: (22 KBTU/SQ. FT/YEAR @ $133/SQ. FT.)

Marion School District Project Team

PKM ARCHITECTS

Pat Kelley Magruder – Project Architect
Located: West Memphis, AR

HALTOM ENGINEERING
MECHANICAL ENGINEERS

Jeff Haltom– Mechanical Engineer
Located: Downtown Memphis, TN

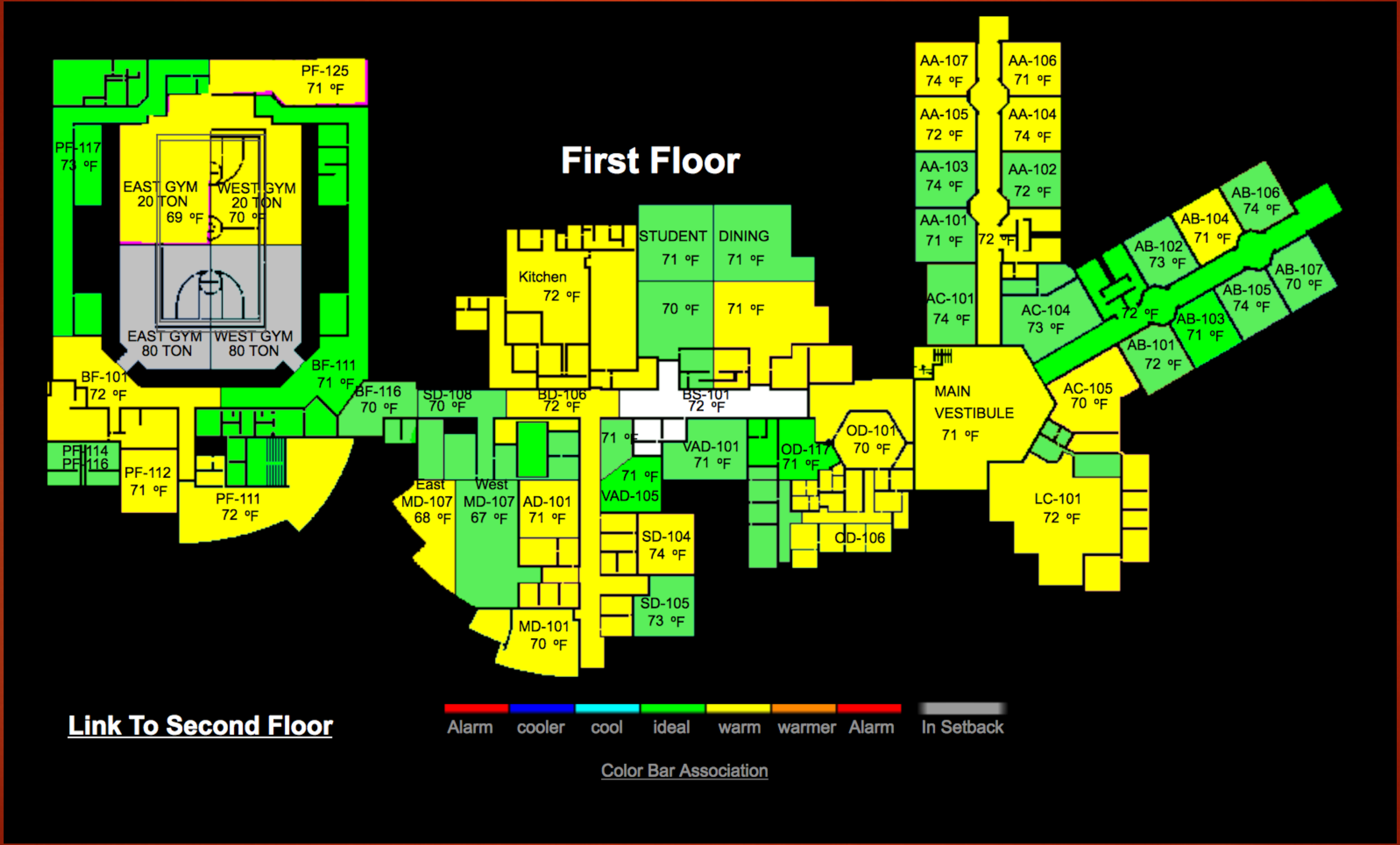
BALDWIN & SHELL CONSTRUCTION COMPANY

Baldwin & Shell– Project Architect
Located: Little Rock, AR

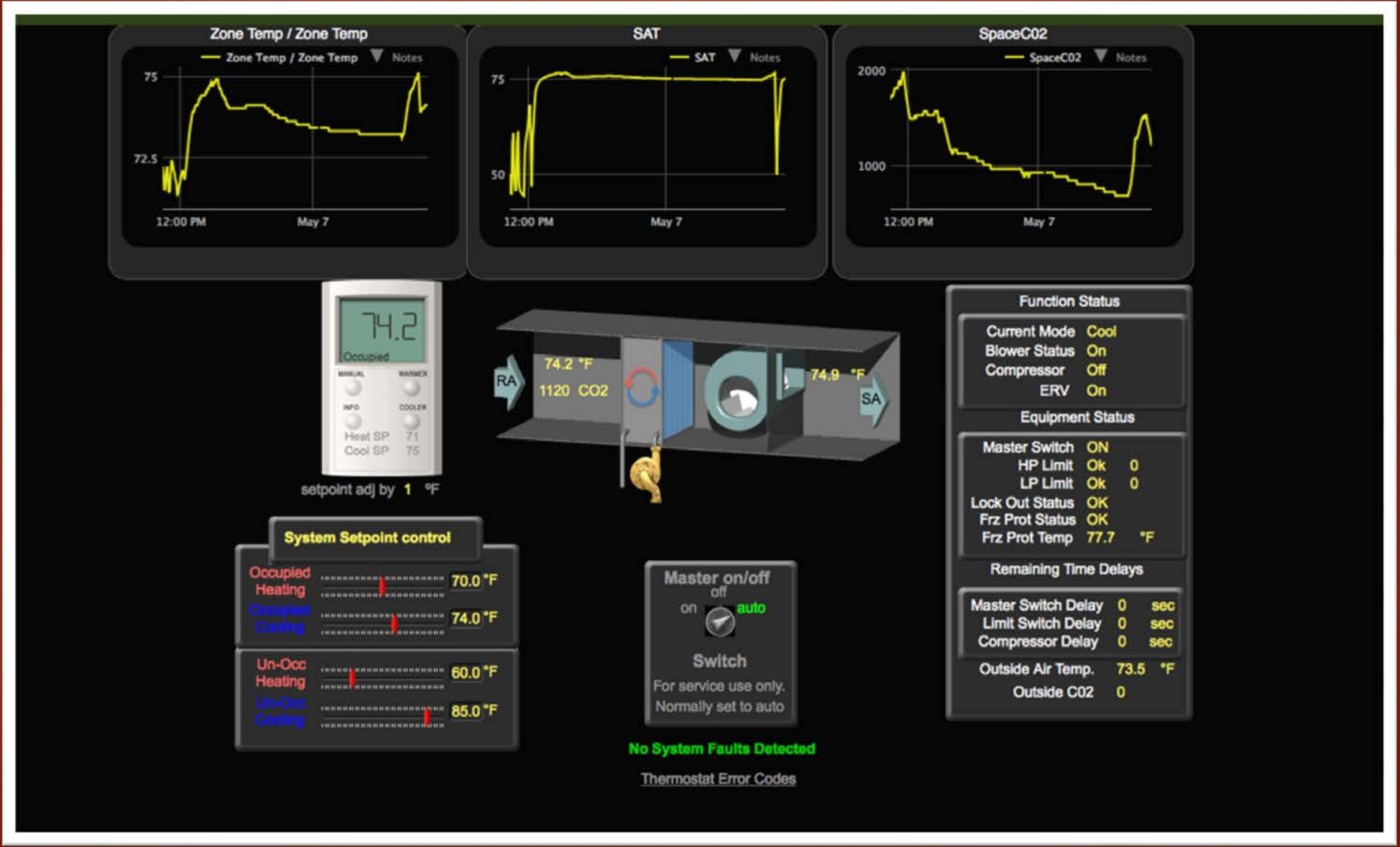
Hydro-Temp
GEOTHERMAL NATURALLY

Hydro-Temp– HVAC Equipment Manufacturer
Located: Pocahontas, AR

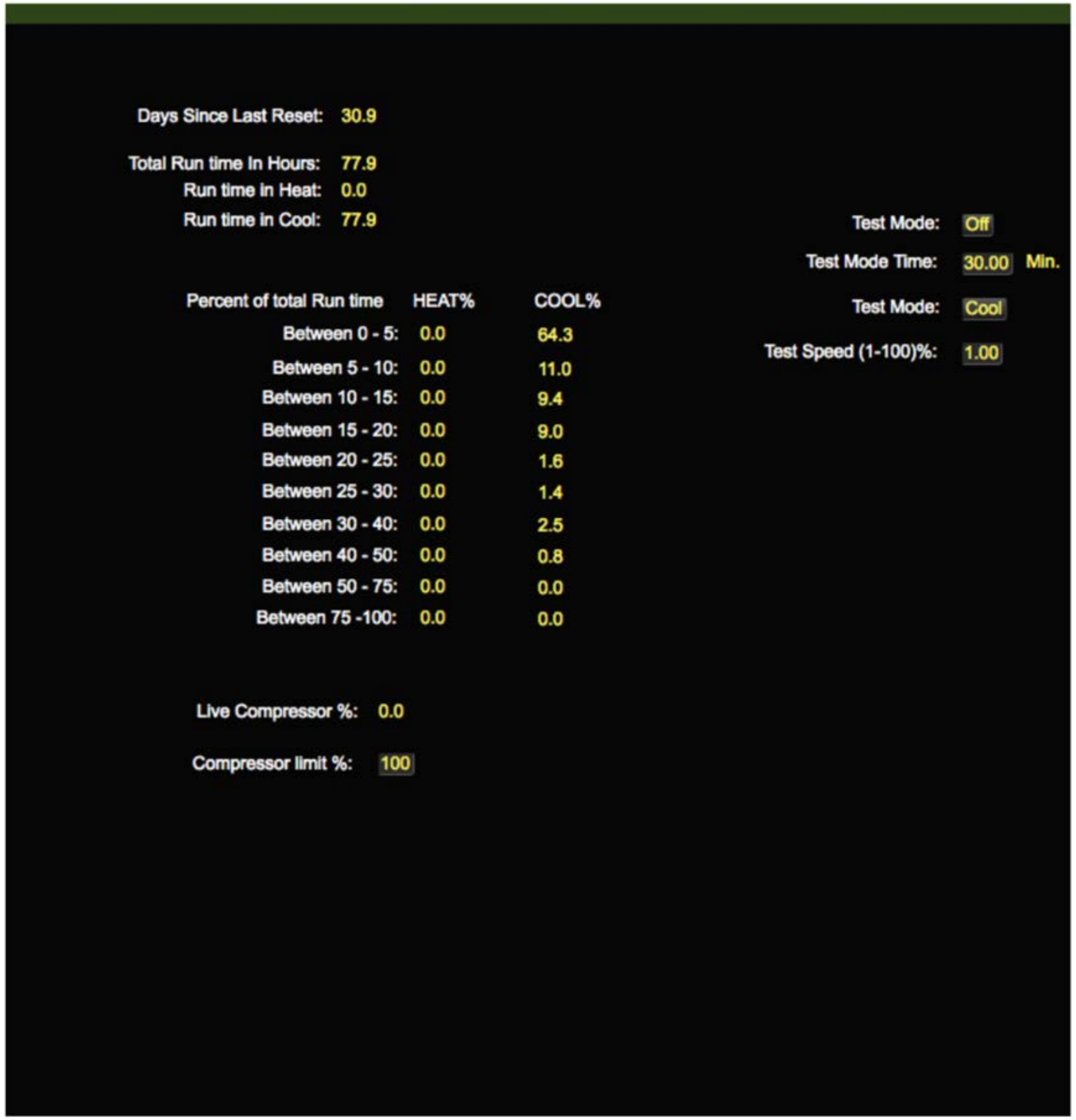
Marion Junior High School



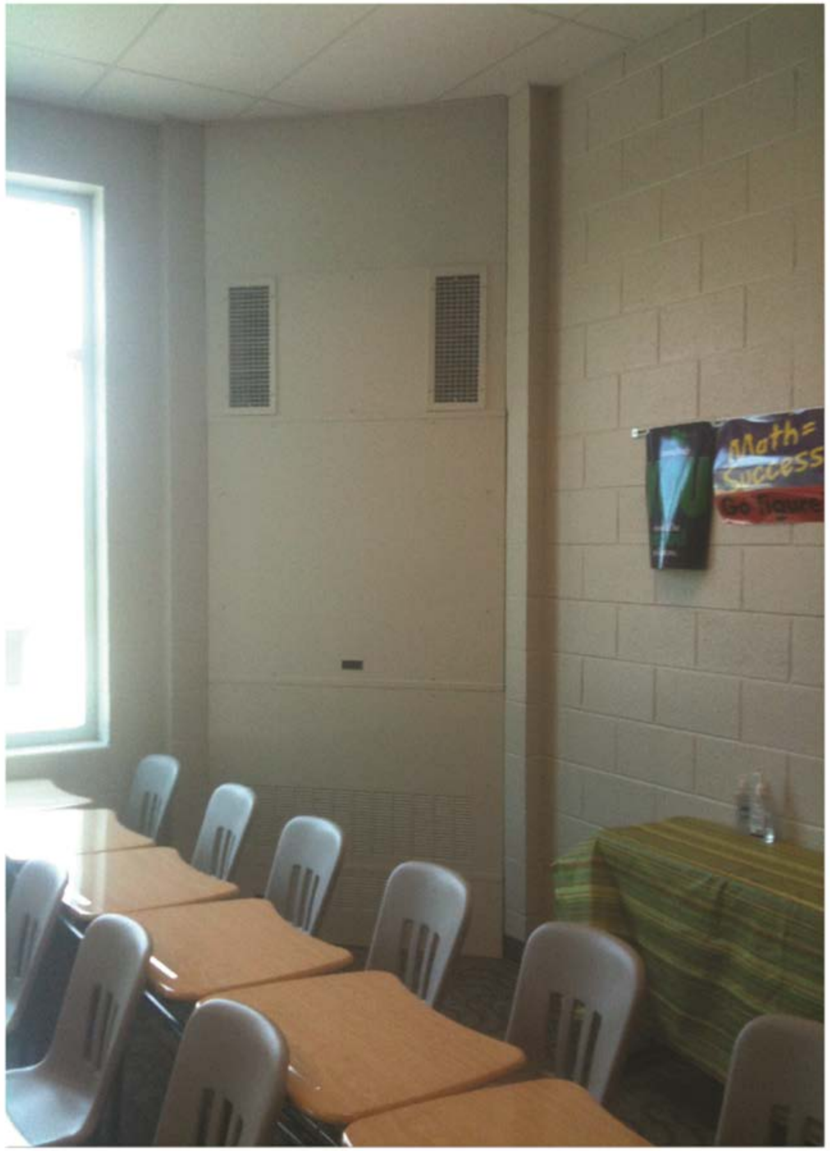
Marion Junior High School



Marion Junior High School



Percent of total Run time	HEAT%	COOL%
Between 0 - 5:	0.0	64.3
Between 5 - 10:	0.0	11.0
Between 10 - 15:	0.0	9.4
Between 15 - 20:	0.0	9.0
Between 20 - 25:	0.0	1.6
Between 25 - 30:	0.0	1.4
Between 30 - 40:	0.0	2.5
Between 40 - 50:	0.0	0.8
Between 50 - 75:	0.0	0.0
Between 75 -100:	0.0	0.0



Lets Compare Marion Jr High School to a similar Arkansas High School

GREENE COUNTY TECH HIGH SCHOOL COMPLETED: **2011**

GCT HS FINISHED COST: **$ 37,100,000**

GCT HS TOTAL SQUARE FOOTAGE: **240,000 SQ. FT.**

COST PER SQ. FT. : **$155**

MARION JUNIOR HIGH SCHOOL COMPLETED: **2009**

MJHS FINISHED COST: **$ 26,000,000**

MJHS TOTAL SQUARE FOOTAGE: **196,000 SQ. FT.**

COST PER SQ. FT. : **$133**

ARLINGTON PUBLIC SCHOOLS

DISCOVERY ELEMENTARY SCHOOL

PROJECT DATA

Grades:	**Pre-K–5**	**Budget:**	**$36,257,611**
Students:	**630 (max capacity: 684)**	**Low Bid:**	**$32,305,807**
Square Footage:	**97,588 GSF**	**Average Bid:**	**$33,390,872**
Limits of Disturbance:	**15.5 acres**	**Building Cost/SF:**	**$273**
		Building + PV Cost/SF:	**$289**

SETTING A NEW STANDARD FOR A NEW CENTURY

Arlington Public Schools' Discovery Elementary School is one of a series of school projects that will help strategically transform 21st century education in Arlington County, Virginia. As the first new elementary school in the County in 11 years, and the first new project as part of a 10 year Capital Improvements Program, the project's primary objective is to set a new standard for the new century – in sustainability, efficiency, flexibility, and in the design of learning environments. Net-Zero Energy (NZE) design was a primary contributor to all of these goals.

Considerations for site footprint, solar orientation, building construction, and energy use were given top priority in the iterative design process. With a capacity of 650 students in grades Pre-K through 5, the 98,000 GSF building is designed for an Energy Use Index (EUI) of 23 kBTU/sf/year – one third of the energy use of a typical County elementary school. This ultra-low EUI makes on-site photovoltaic energy generation possible within a traditional school budget.

MASSING & MATERIALS

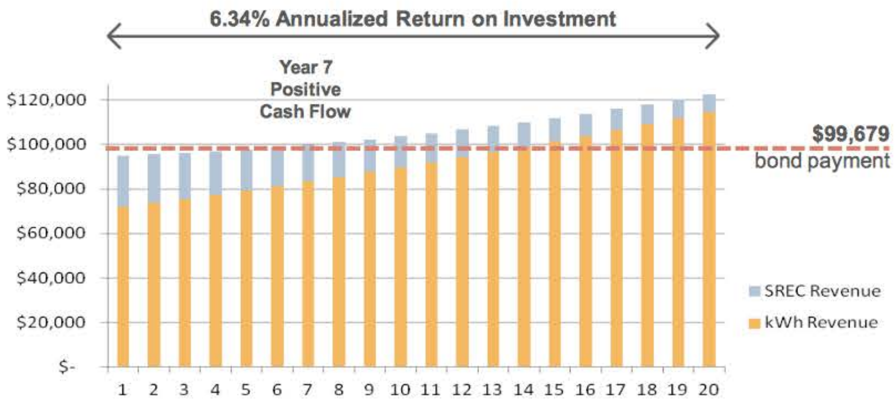
The mass of the two-story building is broken down into smaller components, which help minimize the visual impact of the building's volume. The east and west ends of the building are articulated as multiple, two story masses, reflecting the scale of neighborhood homes. On the south side, the early childhood classrooms are grouped into "kinder-houses," and the building's public space is defined by a large roof canopy with a cedar soffit – serving as the school's "front porch" with covered outdoor dining and play spaces. These massing strategies have been balanced with the need to provide enough roof area to contain all of the photovoltaic panels required for Net-Zero Energy operation. Exterior materials are residential in nature and scale, with select color accents on factory-finished metal.

Discovery Elementary is anticipated to become the first Net-Zero Energy school in the Mid-Atlantic, and the largest in the United States.

23 kBtu/sq.ft/year @ $273/sq.ft

CASH FLOW

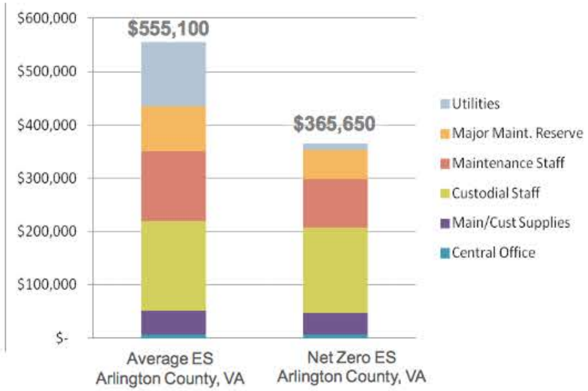
The full cost of the photovoltaic (PV) system is $1.5M, which requires about $100K of the yearly bond payment. PV revenue will cover this payment by year 7 and provide a 6.3% annualized return over 20 years. When this is added to other energy conservation savings, **the new school will cost $47K less to operate than an average APS school in Year One.** Money is returned to the system's operating budget, while allowing school inhabitants and community members to enjoy the environmental benefit of a fully offset carbon footprint!



Year	Energy Conservation Savings	Solar PV Income Generated	Annual Cash Flow
1	$ 51,986	$ (4,639)	$ 47,347
2	$ 53,546	$ (4,116)	$ 49,430
3	$ 55,152	$ (3,479)	$ 51,673
4	$ 56,807	$ (2,732)	$ 54,075
5	$ 58,511	$ (1,876)	$ 56,635
6	$ 60,266	$ (913)	$ 59,353
7	$ 62,074	$ 154	$ 62,228
8	$ 63,937	$ 1,323	$ 65,259
9	$ 65,855	$ 2,593	$ 68,448
10	$ 67,830	$ 3,962	$ 71,793
11	$ 69,865	$ 5,430	$ 75,296
12	$ 71,961	$ 6,995	$ 78,956
13	$ 74,120	$ 8,656	$ 82,776
14	$ 76,344	$ 10,413	$ 86,756
15	$ 78,634	$ 12,264	$ 90,898
16	$ 80,993	$ 14,210	$ 95,203
17	$ 83,423	$ 16,250	$ 99,673
18	$ 85,926	$ 18,384	$ 104,309
19	$ 88,503	$ 20,612	$ 109,115
20	$ 91,158	$ 22,933	$ 114,092
Total	**$ 1,396,893**	**$ 126,423**	**$ 1,523,316**

TOTAL COST OF OWNERSHIP

The school has no boiler or chiller to maintain, no mechanical equipment above ceilings or on the roof, and no complicated lighting control systems. The residential-style heat pumps can be serviced by a maintenance staff with a diversity of skill sets and are floor-mounted for ease of access and filter-changing. LED lights typically do not require changing for up to 20 years. The flooring systems do not require stripping and waxing, and all high-traffic exterior play areas have artificial surfaces, reducing the cost of landscape maintenance. Combined with zero energy costs, the total annual cost of ownership with these savings drops by approximately $200K!



Discovery Elementary School is all-electric, including the kitchen and hot water systems. By offsetting all of its energy costs through photovoltaic generation, the building hedges against future energy inflation. In fact, the more electricity prices go up, the higher the return on the investment for the school.

A new school building is a massive investment for any community. Discovery Elementary will provide an effective return on investment for the life of the building – in tax dollars; in ease-of-operation; in teacher recruitment; and most importantly, in the lives of students.

PROJECT TEAM

VMDO Architects
Architect-of-Record

CMTA Engineers
Mechanical & Lighting Engineering / Net-Zero Engineering

2rw Consultants
Power, Plumbing & Fire Protection Engineering

Bowman Consulting
Civil Engineering

Fox & Associates
Structural Engineering

Oculus
Landscape Architecture

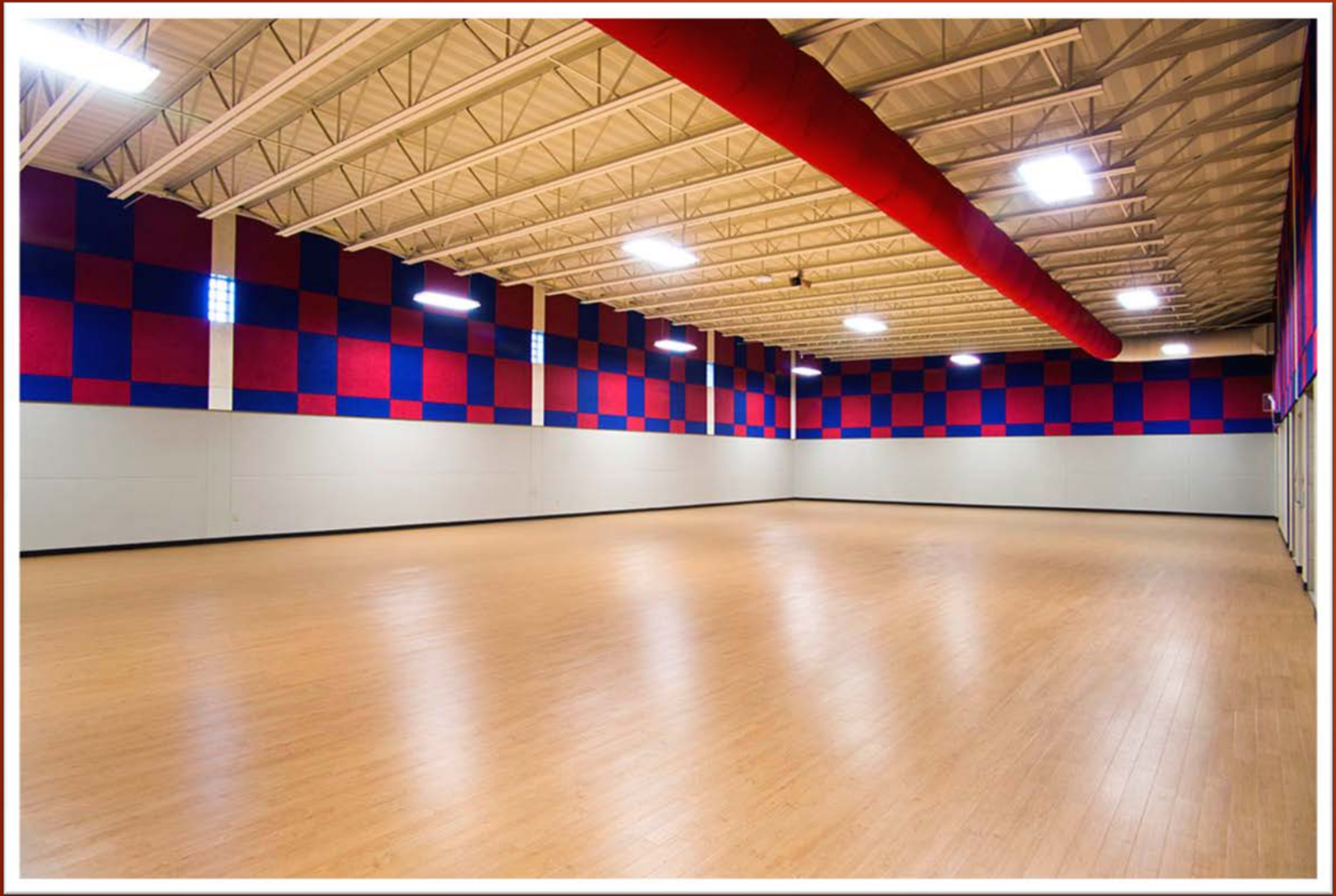
EIS, Inc.
Food Services

Downey & Scott
Cost Estimating

Toole Design Group
Transportation Consultant

Avondale Elementary – FEMA Safe Room

Avondale Elementary – FEMA Safe Room



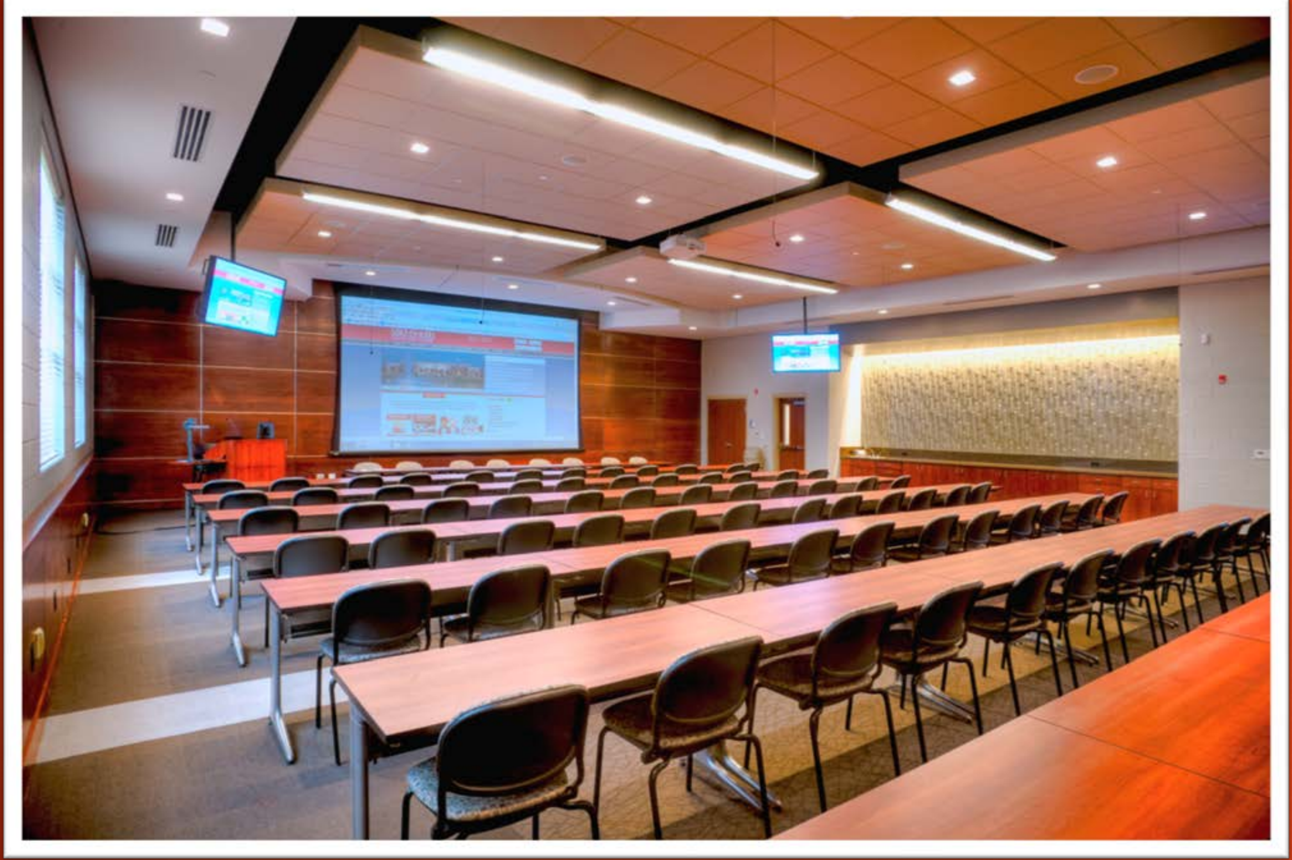
Post Secondary

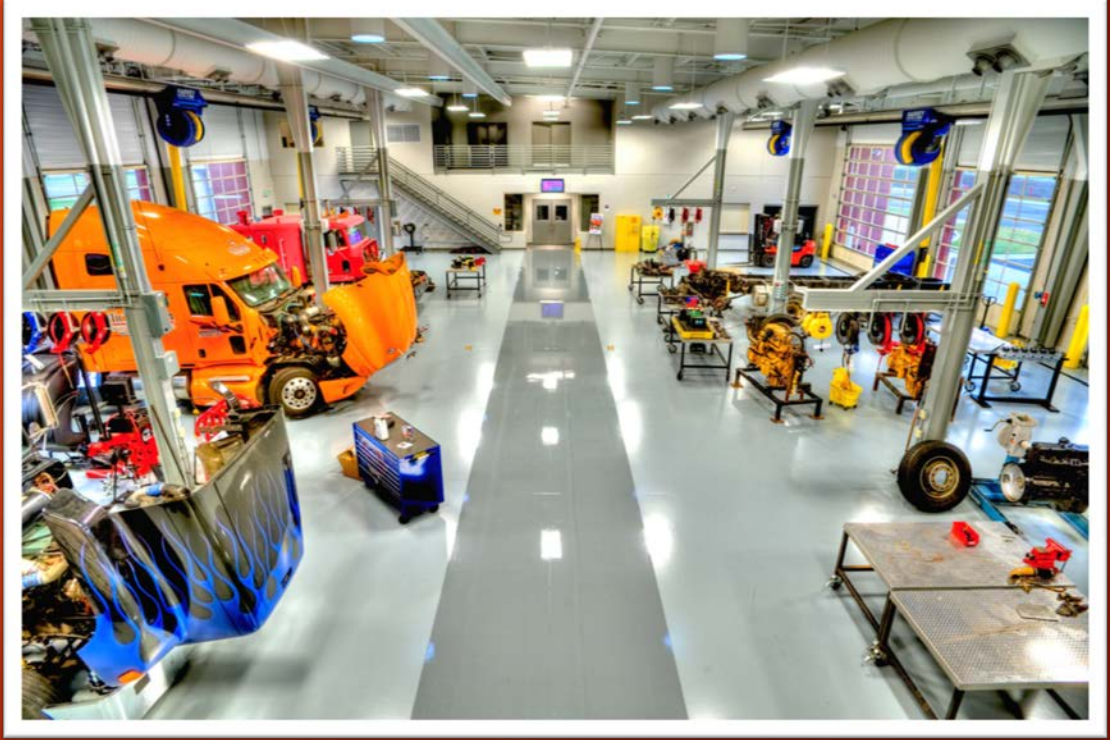
Black River Technical College

Marion Berry Renewable Energy Center

Marion Berry Renewable Energy Center

U.S. GREEN BUILDING COUNCIL
LEED SILVER
USGBC



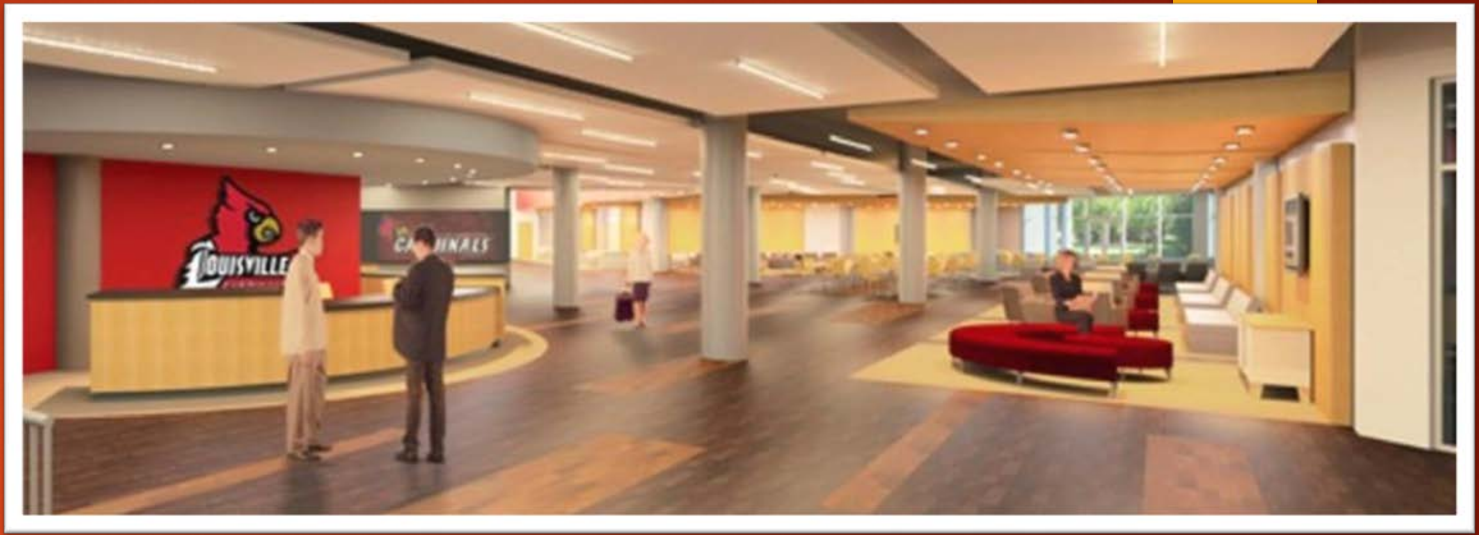


University of Louisville – New Student Recreation Center

UNIVERSITY OF LOUISVILLE

University of Louisville – Future SAC East Renovation

UNIVERSITY OF LOUISVILLE



Beginning Summer 2015, the east first floor of the Student Activities Center will begin renovations as Intramurals moves to the new Student Recreation Center. When completed the renovated east first floor of the Student Center will serve as a significant meeting area for the University Community.

Health Care

Kosair Children's Hospital

ASHRAE

Shaping Tomorrow's Built Environment Today

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Grocery Stores: 50%
The Advanced Energy Design Guide for Grocery Stores applies to grocery stores with gross floor areas between 25,000 and 65,000 ft^2 with medium- and low-temperature refrigerated cases and walkins.
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Medium to Big Box Retail Buildings: 50%
The Advanced Energy Design Guide for Medium to Big Box Retail Buildings is designed to provide recommendations to achieve 50% energy savings when compared with the minimum code requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004. Energy ...
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K-12 School Buildings: 50%
For elementary, middle, and high school buildings, which have a wide variety of heating and air-conditioning requirements. Options for daylighting, an important component in schools, are included.
Download

Large Hospitals: 50%
The Advanced Energy Design Guide for Large Hospitals was created for a "standard" mid- to large-size hospital, typically at least 100,000 ft^2 in size, but the strategies apply to all sizes and classifications of large hospitals.
Download

Small Office Buildings: 30%
For office buildings up to 20,000 ft^2, the bulk of office space in the United States. This guide provides benefits and savings for the building owner while maintaining quality and functionality of the office space.
Download

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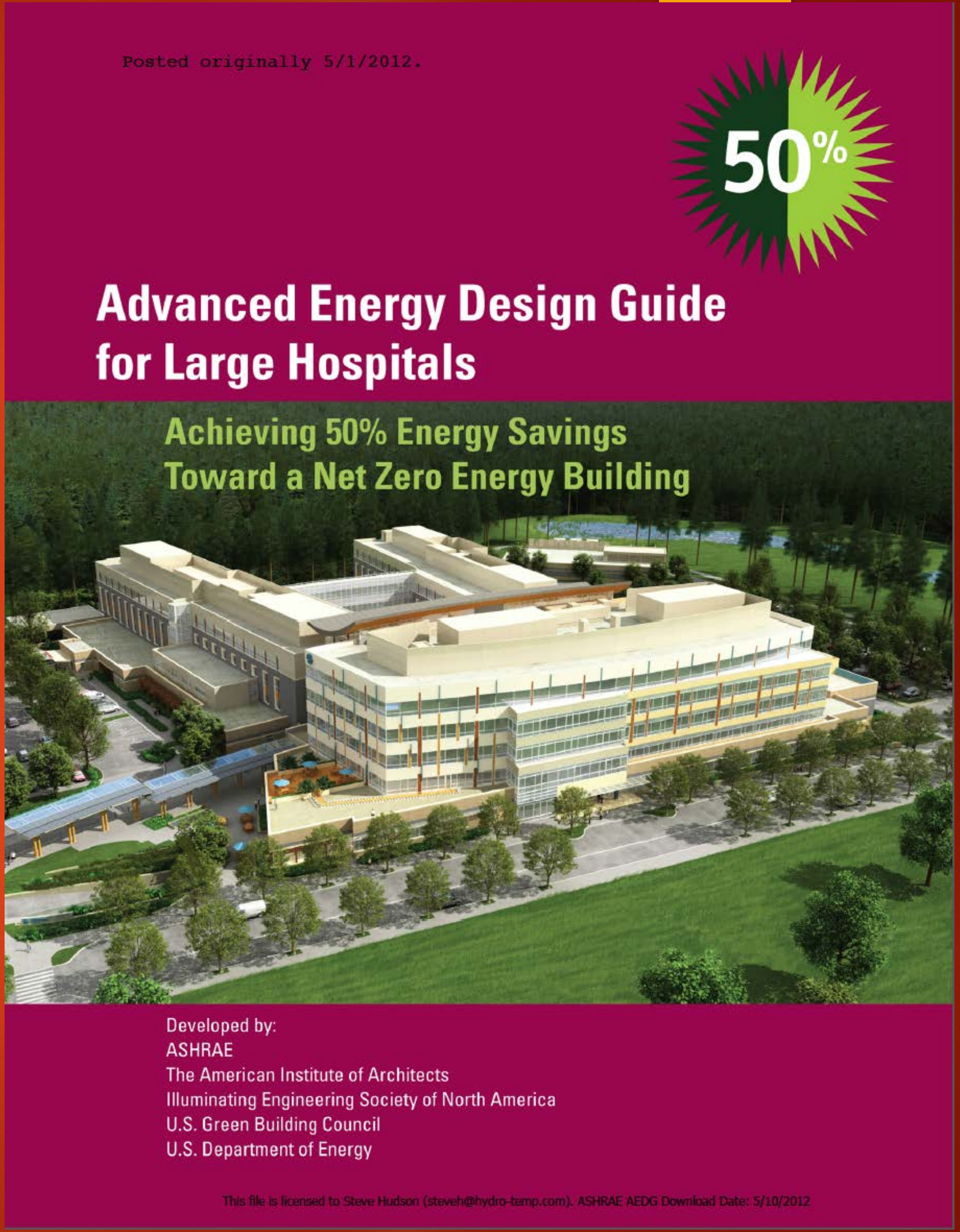
For retail buildings up to 20,000 ft^2, the bulk of retail space in the United States. This guide addresses typical uses: retail (other than shopping malls); strip shopping centers; automobile dealers; building material and hard...
Download

K-12 School Buildings: 30%
For elementary, middle, and high school buildings, which have a wide variety of heating and air-conditioning requirements. Options for daylighting, an important component in schools, are included.
Download

Small Warehouses and Self-Storage Buildings: 30%
For warehouses up to 50,000 ft^2 and self-storage buildings that use unitary heating and air-conditioning equipment, which represent a significant amount of commercial warehouse space in the U.S.
Download

Highway Lodging: 30%
For typical hotels found along highways having up to 80 rooms, generally four stories or less, that use unitary heating and air-conditioning equipment. These represent a significant amount of commercial hotel space in the U.S.
Download

Small Hospital and Healthcare Facilities: 30%
For small hospitals and healthcare facilities up to 90,000 ft^2 in size, which require a wide variety of heating and air-conditioning equipment. Options for daylighting, an important cost-saving measure, are included.
Download



Kosair Children's Medical Center

Kosair Children's Medical Center is located in Louisville, KY, and was built as a satellite pediatric medical center for the existing downtown hospital. The facility was occupied in 2009 and was constructed to meet current hospital design standards. It is a 70,000 ft^2 building that includes a surgery department, emergency room, radiology area, laboratory, and central sterile and support spaces. The emergency and radiology departments are in constant operation.

Geothermal System

A project priority was to construct a sustainable facility with emphasis on minimizing energy consumption. A geothermal heat pump system was chosen to achieve this energy goal. It is the first healthcare facility in Kentucky to be 100% geothermal, utilizing all individual heat pump units for room temperature and humidity control. The heat pump units are generally located in mechanical rooms or penthouses to allow good service access. All heat pump units three tons and greater are provided with dual compressors piped to a single refrigerant circuit to improve part-load efficiency.

A dedicated outdoor air system (DOAS) is provided to supply conditioned outdoor air to all rooms. The unit has an integral heat recovery wheel and supplemental cooling/heating water coil to provide final tempering of the discharge air. Water-to-water geothermal heat pump chillers supply either chilled or hot water to the coil as dictated by outdoor air conditions. The air-distribution system includes constant-air-volume (CAV) boxes to deliver code-required outdoor airflow to all rooms. Time schedules are programmed so the outdoor airflow is reduced when areas are unoccupied.

The geothermal bore field supports 220 tons of installed HVAC equipment tonnage. The geothermal field is comprised of 84 vertical bores, each 400 ft deep. The bore field supply water temperature varies from the mid 80s in August to the mid 50s in February. A distributed water-pumping system recirculates the water between the geothermal bores and building heat pump units. Each heat pump unit has an individual water recirculating pump that runs only when its respective heat pump compressor is operating.

Heat pump units that serve patient treatment areas have prefilters and final filters to meet hospital air-filtration guidelines. Low pressure drop air filters were specified, and special attention was paid to duct layout to allow the heat pump fan to deliver proper room airflow.

(continued next page)

Kosair Children's Medical Center
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Energy Performance

The medical center is currently operating at 116 kBtu/ft^2 annually. To control energy consumption, heat pump systems offer several advantages over traditional healthcare HVAC systems. First, reheat energy waste, which occurs in all variable- and constant-volume air-handling systems is eliminated. The compressors only operate when room cooling or heating is necessary. Second, fan energy is reduced because system total static pressure is significantly lower than the standard healthcare VAV system. In addition, geothermal heat pump systems allow for distributed energy generation. Central steam boilers are eliminated along with the inefficiency of central steam production. Domestic hot water is generated via geothermal domestic water heaters. Central sterile equipment and HVAC humidifiers have point-of-use steam production. The exterior wall system is an insulated concrete form assembly.

Life-Cycle Costs

Energy performance of this facility, while great, must be balanced with the system first cost and maintenance costs. The healthcare organization that built this facility also built a full-service hospital a year earlier on the same campus. That facility used a traditional VAV system with central boilers and chillers. The geothermal heat pump system proved to be approximately the same cost to construct on a per-square-foot basis.

A walk-through of the building was performed with the maintenance staff. Since the staff services both facilities, they have experienced the time it takes to maintain each facility during the first two years of operation. The heat pump units have required only minimal service since installation, and the original concern over filter maintenance has proven unwarranted. The geothermal system has required extra time to retrain the staff, which would not have been required if a traditional system was installed. Integrating the heat pump factory controls into the healthcare systems direct digital controls has been more difficult than expected. A detailed analysis of maintenance requirements is warranted to provide factual data and a true comparison.

Example Patient Room Layouts
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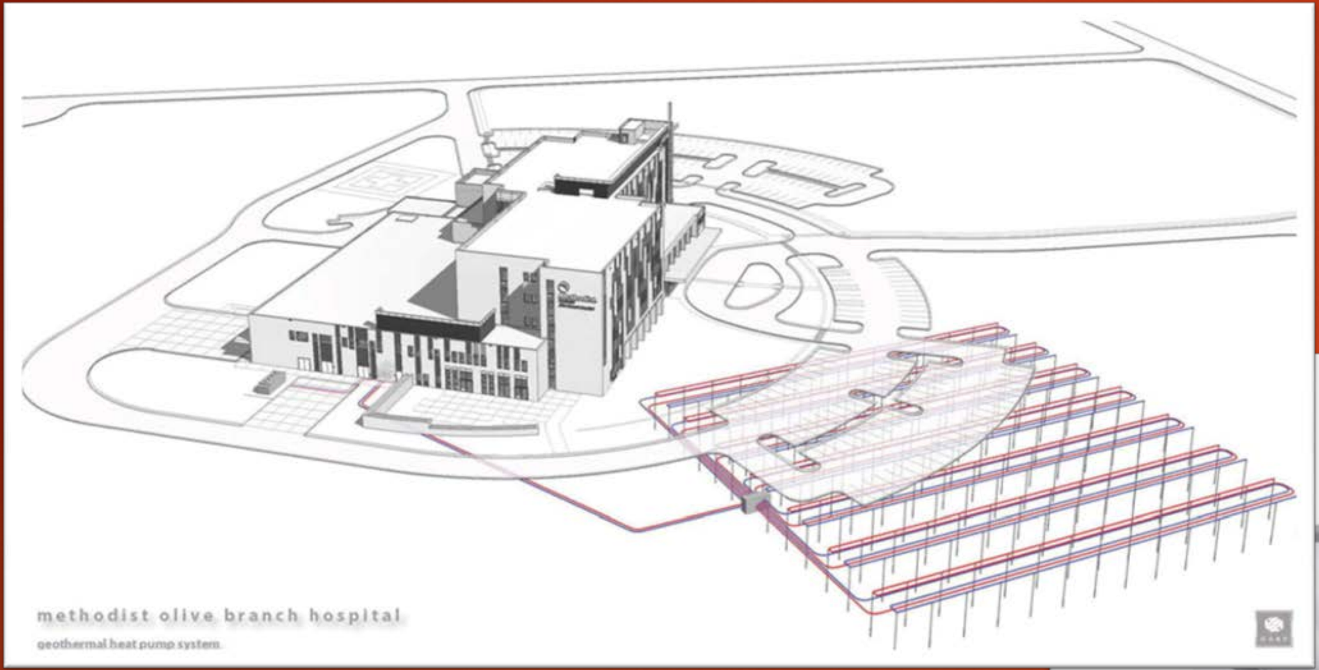
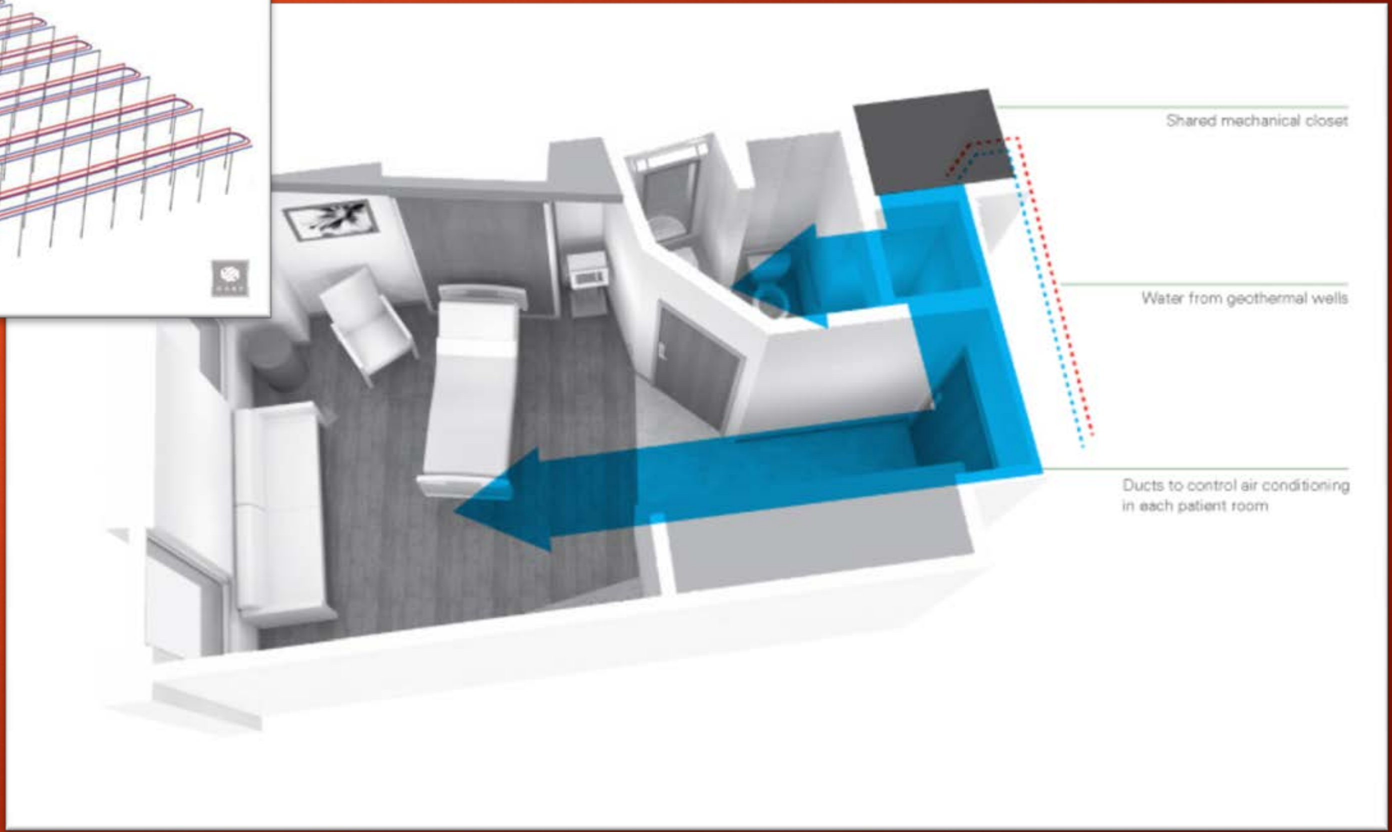
Methodist Olive Branch Hospital

First in-patient healthcare facility in the U.S. to attain LEED for Healthcare Gold Certification.

Methodist Olive Branch Hospital

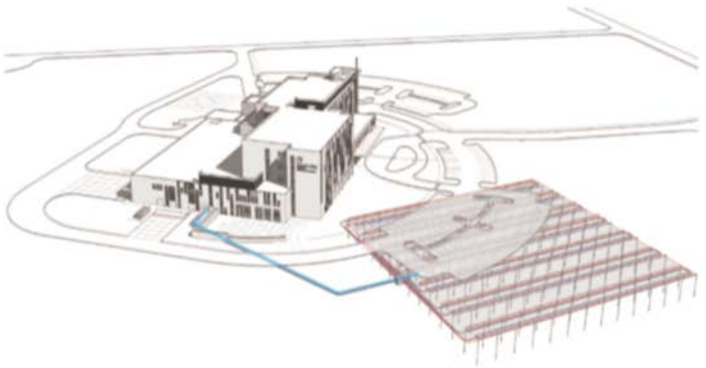




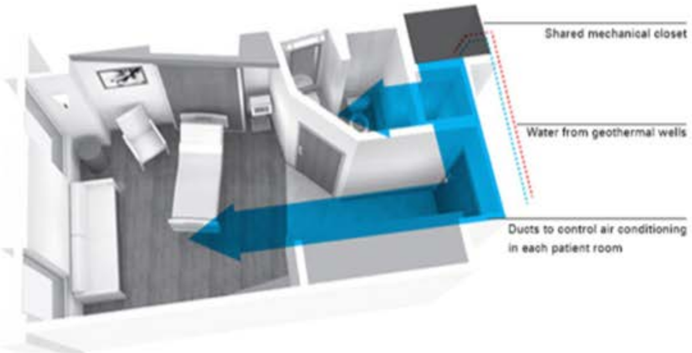
Looking at the numbers and accolades surrounding Methodist Olive Branch Hospital (MOBH), you might assume that the project's costs and construction schedule far exceeded that of an average small hospital. The 100-bed hospital in Olive Branch, MS is projected to receive an Energy Star rating of 95 and is on track to be the world's first hospital to earn the LEED Gold for Healthcare Certification. It is one of only a handful of hospitals nationwide to feature a state-of-the art geothermal heat pump system, and to include photoelectric glass, which automatically adjusts its tint based on sunlight levels. Perhaps most remarkably, all of that was achieved on a budget of $100 million ($317/sf) and ahead of a fast-track, 24-month schedule. In this post, I would like to take a look at two major design elements that made those achievements possible- the geothermal HVAC system and the specialized glass and lighting system.

Geothermal Heat Pump

Methodist Le Bonheur Healthcare challenged the Integrated Project Delivery (IPD) team of GS&P, Smith Seckman Reid and Turner Construction to create an innovative hospital that reflects the organization's exceptional commitment to sustainability. Our team carefully evaluated a number of HVAC systems to determine the most energy-efficient and cost-effective option, and ultimately selected a ground source heat pump system supported by an on-site geothermal bore field. MOBH is among the first in the country to use such a system.



186 ground source heat pumps take advantage of the earth's natural heat sink with 204 geothermal wells to regulate the source water's temperature.



To provide patients a level of control over their room's temperature, each patient room has its own water source heat pump, stored in a shared closet with specially-designed doors to minimize noise.

By The Numbers

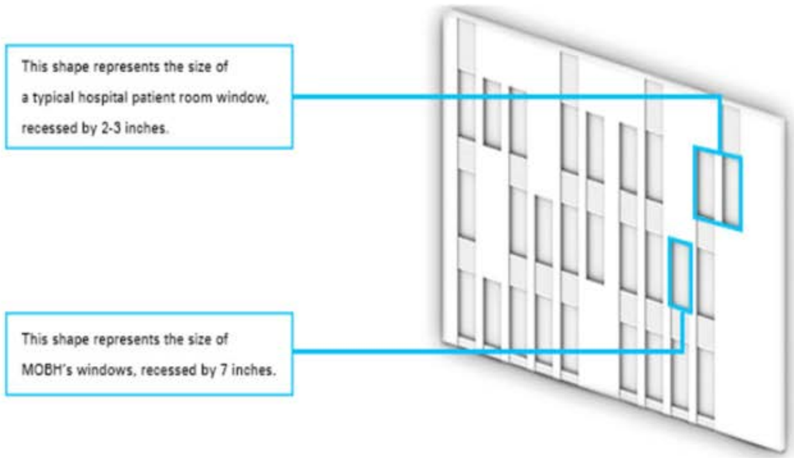
- **7X**: Water is roughly seven times more efficient than air at transferring energy, allowing MOBH to realize tremendous energy savings over traditional air handler/VAV systems
- **124 vs. 245**: MOBH earned an Energy Use Intensity (EUI) of 124 kBtu/sf, versus 245 kBtu/sf for a typical hospital.
- **25%**: The geothermal strategy is projected to return an annual energy savings of 25% with a 5-year return-on-investment.
- **14'-4"**: Spatially, the system eliminates the need for chillers, boilers and air handlers and dramatically reduces ductwork. While the addition of the closets slightly increased the overall square footage, the elimination of main trunk ducts allowed GS&P to reduce floor-to-floor heights to 14'-4", ultimately making the strategy more economical.
- **$216,000**: The ground source heat pump system alone will save Methodist $216,000 a year in operating costs.

Specialized Glass and Lighting Systems

As we continued to seek out green design innovations, we discovered one right in the hospital's backyard. A local manufacturer had just begun producing photoelectric glass, and MOBH is a pilot showcase for the product. The two-story lobby is glazed with dynamic, photoelectric glass, which changes from clear to opaque based on the amount of sunlight hitting light sensors mounted on the lobby roof. This reduces glare and solar gain and reduces the amount of energy needed to heat and cool the large space.

From left to right: The lobby with clear glass at dusk, semi-transparent glass, and opaque glass.

Electrical lighting in the lobby is controlled by an automated system that maintains an appropriate level of footcandles to ensure that electricity is available when it is needed and conserved when it is not. The footcandles automatically dim as daylight provides adequate ambient light and brighten as the windows darken.



To further reduce solar gain, we reduced the width of the typical patient room window and opted instead for two windows of standardized sizes. This allowed for the same amount of natural light, but significantly increased the glazing-to-frame ratio. The windows were also recessed an additional 7 inches, allowing the façade itself to act as a sunshade. These strategies resulted in a 22% decrease in the amount of direct sunlight hitting the glass, dramatically reducing solar heat gain in all patient rooms.

Overall, these sustainability strategies contributed to achieving 18 EA cr.1: Optimize Energy Performance LEED points, and an annual energy cost reduction total of $318,000. They also contribute significantly to the patient experience. With the geothermal pumps located in their rooms, patients can enjoy more personalized control over their environment, which, according to several evidence-based design studies, helps to lessen anxiety and improve healing. Adjustments to windows and the glass used in them help to avoid uncomfortable heat buildup or troubling glares, without negatively impacting patient's exposure to natural light and outdoor views. Each of these factors plays a role in achieving Methodist LeBonheur's ultimate goal of creating the best possible patient experience for the residents of Olive Branch and ensuring that they no longer have to drive across state lines to find convenient and high-quality care. Personally, I can say this was one of the most enjoyable projects I have worked on- every member of the IPD team was committed to creating a smart, sustainable, cost-effective facility and I am very proud of the end result.

TAGS: **Alternative Energy Sources** **Architecture** **Building Performance** **Design** **Energy** **Energy Efficiency** **ENERGY STAR** **Healthcare** **Integrated Project Delivery** **IPD** **Sustainability** **Zooming In**

Nov. 2014 Air Conditioning, Heating, and Refrigeration News

Air Conditioning | Heating | Refrigeration

the NEWS

Alternative HVAC Systems Popular in Hospital Applications

Health Care Facilities Embrace Nontraditional Equipment

By Joanna R. Turpin

November 3, 2014 No Comments

KEYWORDS air curtains / energy management / geothermal system / VRF system

Geothermal systems make sense for hospitals as they offer impressive energy savings and increased levels of comfort. *(Photo courtesy of Hydro-Temp)*

From the Ground Up

When decision makers at Methodist LeBonhuer Health embarked on the development of a new facility to serve the growing area of Olive Branch, Mississippi, they identified a number of guiding principles to which every element of the project needed to support. These included a focus on the healing environment, patient safety, efficiency in delivering care and operating the facility, flexibility for future growth and changes in modalities, and an overall concentration on patient satisfaction.

In order to meet those goals, a design team consisting of Gresham, Smith, and Partners; Smith Seckman Reid; and Turner Construction, along with Methodist Le Bonheur Healthcare, conducted an in-depth life-cycle cost analysis of several HVAC systems and concluded a geothermal heat pump system from Hydro-Temp would be the most sustainable — as well as the most cost-effective — choice for the 200,000-square-foot Methodist Olive Branch Hospital.

Once the determination was made to go with geothermal, installing a large bore field with existing site restrictions proved to be a challenge. The required bore field size was reduced nearly one-third by going with a hybrid geothermal system, which includes a combination dry/wet fluid cooler, along with a pumping package and predictive bore field temperature controls by Greensleeves Energy Solutions. The fluid cooler operates primarily during off-peak hours, as required, based on bore field temperatures.

Ultimately, 196 geothermal wells were installed in a bore field on the hospital site, supporting 211 geothermal heat pumps throughout the hospital with outside air provided by dedicated outside air system (DOAS) units. The DX DOAS units have energy recovery with sensible/enthalpy wheels or plate exchangers, which provide filtered, dehumidified, and thermally neutral air. Energy efficiency was optimized using variable-speed compressors in the heat pumps. Split DX HVAC systems were provided for critical equipment room environments.

This hybrid arrangement just goes to show that geothermal systems can make sense for just about any health care facility, said Henry Gross, managing partner, Hydro-Temp. "It is very rewarding to be able to work closely with specifying engineers who are open to working through new design possibilities. It's all mindset — even though ground loops are not complicated, it is important for the engineers to understand the nuances of a ground loop."

Geothermal comes with significant benefits, including impressive energy savings and increased levels of comfort, said Gross. "The system does not work against a high temperature, so the compressor runs more efficiently. That usually means the discharge air temperatures can be a lot cooler, and you can get more dehumidification in air conditioning mode. With our variable-speed equipment, we can set the discharge air temperature for about 55?F in the cooling mode, which will really wring out the air and increase comfort in the space. In the heating mode, we set the discharge air temperature for around 100?F, so that it doesn't feel too cool or too hot."

For those who think geothermal systems cost significantly more than traditional boiler/chiller systems, think again, said Gross. "The first cost is almost a wash. Obviously, with geothermal, you do need to have space, but, typically, the piping can go under a hospital's parking lot. And life-cycle cost is much lower with geothermal because the ground-loop temperatures keep the compressor discharge pressures much lower, so the compressor doesn't have to work as hard as it does on an air-source unit. Maintenance is much easier, as well."

Most hospital administrators are always looking for ways to improve energy savings without sacrificing patient comfort, and, as can be seen here, there are many HVAC solutions available that will help them achieve those goals.

Publication date: 11/3/2014

Future Shriners Hospital

Next Target: Correctional Facilities – Why?

Because we can change the economics model of how correctional facilities operate. Designed properly we can almost eliminate the largest component of many correctional facilities monthly utility bills, Hot Water Production.

With our PATENTED Hot water generation system, as a by-product of air conditioning we have a tremendous quantity of hot water available to us at little or no cost.

My understanding is this is one of the big ticket costs in operating a jail. We could potentially take an area that has all of the control electronics for monitoring inmates, cool that area 24/7 as it already is, and as a byproduct of this daily cooling we will produce a tremendous amount of hot water at little to no cost.

Where does Arkansas Stand in terms of leading energy efficient design

- #1 Most Efficient HVAC unit is manufactured in Arkansas.
- Advances in Solar PV technology advancing in Northwest Arkansas
- School in Marion Arkansas without any special assistance is performing at Net-Zero levels and is likely the most energy efficient school of its type in the State of Arkansas.
- #1 Most efficient safe room in the country is likely in West Memphis Arkansas (Avondale Elementary – Marion School District)
- Marion Berry Renewable Energy Center is likely most energy efficient building of its type in the country. (ASU – Mid South / MSCC)
- Future Marion Performing Arts Center is modeling to become the most efficient building of its type in the country.

Marion School District is building some of the most energy efficient buildings in the state with the leadership from:

- School Administration
- PKM Architects
- Haltom Engineering
- Baldwin & Shell Construction
- Hydro-Temp

DUKE ENERGY®

SunSense Schools

SunSense® Schools
Help bring solar energy to our schools.

The SunSense® schools program helps schools in the Duke Energy service territory to manage energy costs while promoting energy education. The program:

- Provides new solar photovoltaic (PV) systems to schools designated as Enhanced Hurricane Protection Area (EHPA) shelters, at no cost to the school.
- Supports renewable energy education, energy efficiency and environmental stewardship by providing teachers and students with interactive learning experiences and training materials.

Applications are available! To enter your school for the opportunity to receive a free PV system, see the "Apply" tab below.

See a complete list of all SunSense Schools recipients.

How It Works | Energy Education | Apply | FAQ

Free PV systems for schools

Each year Duke Energy will select up to 11 schools to receive fully installed PV systems. Selection is competitive with priority given to EHPA-designated schools; however, all public schools that are current Duke Energy customers may submit an application. Refer to the Apply tab for a list of Key Dates for 2015.

K-12 public schools

- Up to 10 schools each year can receive a system of up to 10 kW with battery backup option.
- Selection will favor schools that demonstrate a commitment to energy efficiency and renewable energy education.

Public post-secondary schools

- One school each year can receive a system of up to 100 kW.
- Selection will be based on attendance, energy consumption, energy education plans and other criteria.

Minimum Requirements

To be eligible to receive a PV system through the SunSense schools program, schools must:

- Be a public educational facility.
- Be a current Duke Energy customer with a metered account.
- Have an appropriate site available at the school for a ground-mounted PV system and must have facilities that meet the requirements for the interconnection of the PV system to the Duke Energy power system.

Among K-12 schools, priority will be given to schools designated as Enhanced Hurricane Protection Area (EHPA) shelters. Based on Florida statutes, EPHA shelters are determined by the Florida Division of Emergency Management.

Selection Criteria
Applications will be evaluated and scores awarded using the following key categories:

Elementary through High Schools (K-12)

- 40% – Commitment to energy efficiency and renewable energy education
- 20% – Location that maximizes geographic distribution throughout Duke Energy service territory
- 20% – Number of students
- 20% – Shelter capacity

Post-Secondary Schools (Colleges, universities, trade schools)

Post-secondary schools will be selected based on criteria such as attendance, energy consumption on main campus and plans to use the solar array as an educational and research tool.

DUKE ENERGY®

How It Works | Energy Education | Apply | FAQ

Energy education at schools with solar PV systems

The solar PV systems are installed at selected schools with the goal of enhancing understanding and awareness of renewable energy among students, faculty and school administration.

Hands-on learning using the included data collection systems will provide the selected schools with the opportunity to become the centerpiece of a strong focus on renewable energy and energy-efficiency that can be expanded into the community.

Energy education at K-12 schools

Schools in the Duke Energy service area that are not eligible or selected to receive solar PV systems can still benefit from the SunSense schools program. By using educational materials available through the program you'll have access to:

- Classroom materials that support hands-on learning
- Curriculum aligned with Sunshine state standards
- Teacher training to help you include energy efficiency and renewable energy in the classroom.

Educators: If you'd like to participate in the energy education program, email us at sunsenseschools@duke-energy.com. Please include information about your school and about the type of educational support that you would find most useful.

Community funding for energy education

Duke Energy residential customers can help fund energy education in their community schools by enrolling in the SunSense Schools Residential program when they sign up for our EnergyWise Home^{SM} program.

To learn more, visit the SunSense schools residential program Web page.

My goal is for the world to come to Arkansas to see how common folks come up with uncommon solutions to issues we are faced with each and every day.

QUESTIONS?

THANK YOU

FOR HAVING US!

-Slides available upon request

Contact Info:

Steve Hudson
Managing Partner – Hydro-Temp Corporation
(870) 892-8343

NOTABLE PROJECTS