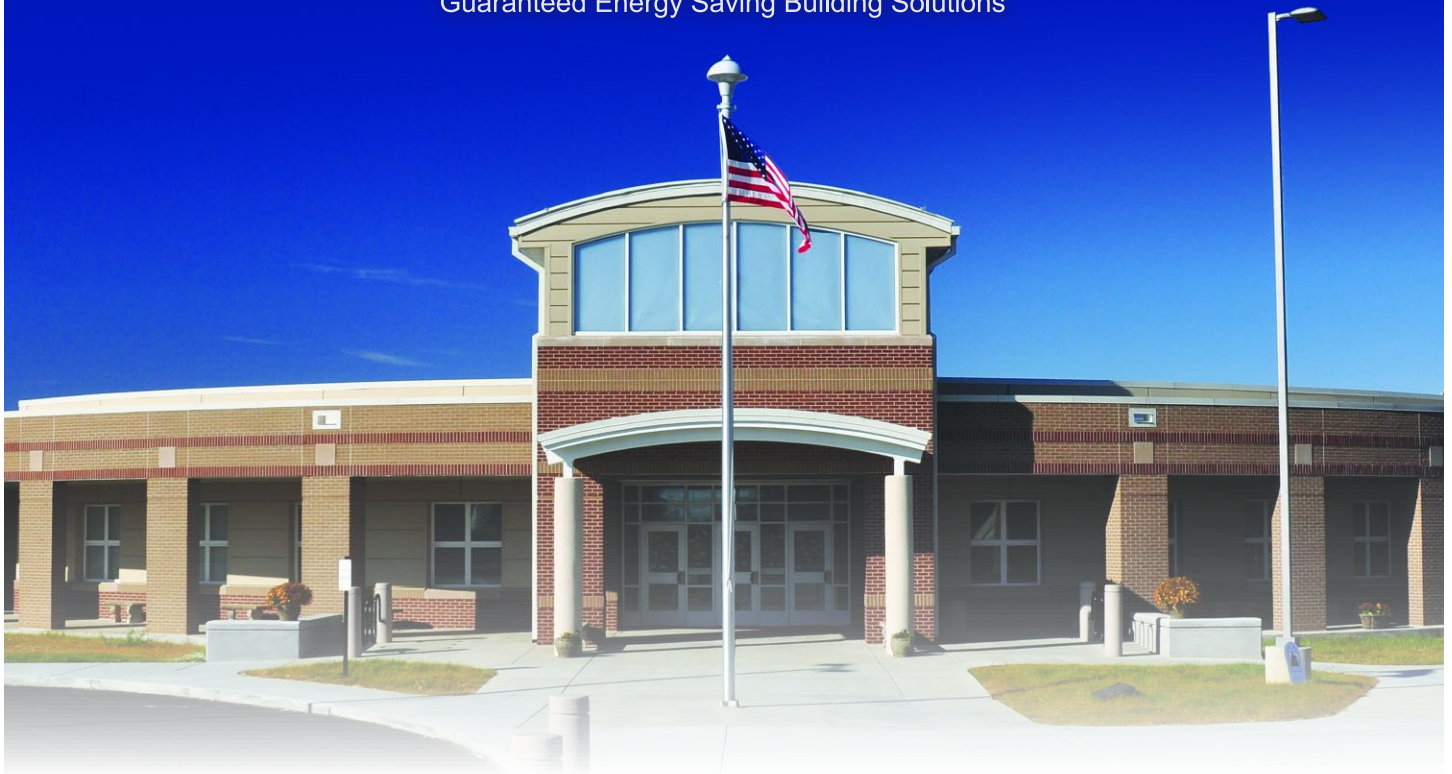




Guaranteed Energy Saving Building Solutions



# FORENSIC ANALYSIS of ENERGY EFFICIENCY

*A Net-Zero-Energy Case Study of Richardsville Elementary School, Bowling Green KY*

Don't you love all the TV shows where the crime labs use the latest high-tech forensics to solve the case? Sometimes trying to find out what produced a successful, energy-efficient construction project is very similar, as each of the manufacturers or contributing subcontractors begins to present evidence that the success of the project was due to the use of their superior and most excellent widget. Unfortunately, there are other projects where that same widget was used and the overall project failed to achieve a significant amount of energy efficiency. So, is there something, anything, that can consistently and accurately guarantee a project will achieve a high level of energy efficiency? Let's apply some forensic analysis to the subject.

In 2010, Warren County Public Schools of Bowling Green, Kentucky, completed construction on the Richardsville Elementary School, the first Net-Zero-Energy school in the country. Calling this project a success is

too trivial for a building that ranked in the 99th percentile, relative to the ENERGY STAR program, based on an overall energy consumption of 18 kBtu's per square foot per year. How was this achieved? There was an assortment of important building components that played a crucial part.

The first consideration is to assure that all the perimeter areas of the conditioned space provide an effective potential for energy efficiency. The wall system was a foam-based insulated concrete form product made by Nudura. This high-efficiency system was a monolithic slab comprised of concrete sandwiched between foam insulation. The roof insulation was a commercial-grade application of rigid spray foam. Foam insulation was also used at the slab edges. Windows with a U-value of 0.41 were used, and the overall percentage of glass area was kept down to below 8% of the wall area. Great effort was made to caulk and seal the building to achieve as much air-tightness as possible. In short, the project was

designed with a very good thermal envelope using foam insulation that minimized the effects of all three forms of heat transfer: convection, conduction and radiation.



Nudura® insulated concrete forms (ICFs) and closed cell spray foam insulation created a tight, energy efficient thermal envelope for the project.

Once you have defined an efficient thermal envelope, you then select a high-efficiency HVAC system to take advantage of that potential. Since the goal was to have the lowest energy usage ever achieved on a school, the decision was made to use geothermal heat pumps. Using geothermal heat pumps not only provided a higher level of HVAC efficiency, but also enabled the project to totally eliminate the need for a boiler by utilizing a patented priority-on-demand hot water generating system. This yielded even greater energy savings, as well as maintenance savings. The selection of the geothermal heat pumps was important and units with very unique capabilities were chosen. The pumps of choice were the GeoWise capacity-on-demand units manufactured by Hydro-Temp Corporation, of Pocahontas, Arkansas.

The final element of all good projects is the engineering of the complete system. The MEP Engineering firm led by Ken Siebert, PE, provided an excellent design. Ken's firm, CMTA, which is headquartered in Louisville, Kentucky, pulled together all of the project engineering as the Engineer of Record for this project.

An architect, Kenny Stanfield of Sherman Carter Barnhart, which is located in Louisville, Kentucky, played a crucial role in overseeing all of the pieces being put together on this award-winning project so nothing was allowed to fall through the cracks.

All of these crucial elements are what we call "Intel-

ligent Efficiency Engineering," and were brought to light at a district school meeting several years before by EnergyWise Structures, a mechanical engineering and NASA spin-off company from McKinney, Texas, that specializes in approaching every structure in a holistic manner.

What happens if any one of the elements of the system is overlooked? Years ago, I explored a career in auto mechanics and took a course in rebuilding engines. I had a Pontiac LeMans at the time and decided to blueprint the engine as my project. Each moving part was machined to precise tolerances and meticulously balanced. The valves were machined and special rollers with heavy springs were used. An Iskey ¾ racing cam, along with a racing distributor and coil, punched up the power. The intake and exhaust ports were ground and polished. When the engine was put back in the car, I expected a great increase in performance, but for some reason, it just didn't seem to perform as I thought it would. I ended up going back to college, abandoning the idea of being a mechanic, and selling my project to a close friend. He took the single-barrel carburetor off and put on a Holly four-barrel. He told me stories of pulling up next to some really hot cars and "blowing their doors off" with the tame-looking LeMans. All the difficult and expensive work I did was stymied by overlooking just one item!



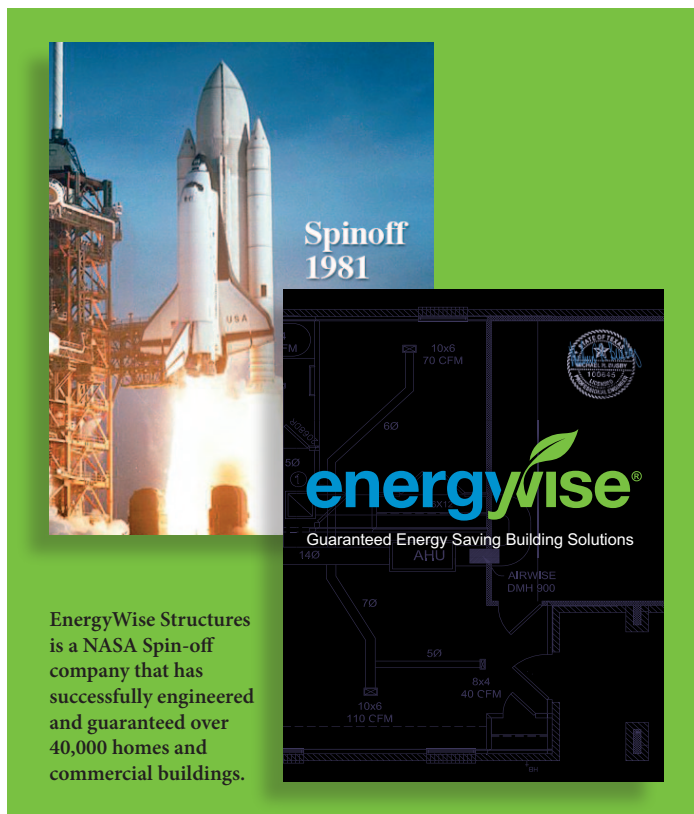
The world's only Capacity-On-Demand heat pumps by GeoWise® contributed greatly to the school's net-zero-energy rating. These unique heat pumps use less than half the energy required by other leading competitive brands.

The point of this forensic analysis of energy efficiency is to make it perfectly clear that each and every component is essential, and it is the correct analysis of each component through the HVAC engineering, with meticulous attention to detail whereby thermal "holes" are plugged,

that gives the assurance of energy efficiency. Many of the energy efficiency think tanks are coming to the same conclusion. The American Council for an Energy-Efficient Economy (ACEEE) calls it “Intelligent Efficiency”:

“The key to understanding the rise of Intelligent Efficiency is to stop thinking about energy efficiency simply in terms of individual devices (or products) and to start thinking about it in terms of complex systems. System efficiency opportunities produce energy savings that dwarf component-based efficiency improvements by an order of magnitude. System efficiency is performance-based, optimizing the performance of the system overall; its components and their relationships to one another.”

With the Systems Approach, a holistically engineered project of the thermal envelope, carefully selecting each product and element to contribute its part, is matched to an HVAC system selected for the affordable level of efficiency and then analyzed for correct sizing according to the thermal demand of the structure. This Systems Approach is the foundation of the EnergyWise program and it assures that each and every project will have a high level of energy efficiency—guaranteed. The crime of killing energy efficiency has once again been solved by forensics.



**Spinoff 1981**

**energywise**  
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EnergyWise Structures is a NASA Spin-off company that has successfully engineered and guaranteed over 40,000 homes and commercial buildings.

The image features a NASA shuttle launch on the left, the EnergyWise logo in the center, and a technical HVAC diagram on the right. The diagram includes labels such as '10x8 70 CFM', '50', '60', '70', '10x8 110 CFM', 'AIRWISE DMH 900', and '60x1 40 CFM'. A circular seal at the top right of the diagram reads 'NASA SPINOFF TECHNOLOGY'.

To wrap up the Richardsville project, it should be pointed out that one of the Hydro-Temp recommendations regarding the geothermal installation was that each individual heat pump needed to have its own water pump that would operate in an “on-demand” mode. It’s important to note that the vast majority of schools using geothermal installations utilize large centralized water pumps that operate 24 hours a day, 365 day a year. That’s the way it has always been done, even though it is extremely inefficient. It was a small recommendation that simply means the majority of the time these large water pumps are running when they do not need to. What Hydro-Temp demonstrated to them was that it is not uncommon for the electrical usage for these central water pumps to have a higher energy consumption rate than the total electrical usage of all of the geothermal units combined! The Warren County Public School System agreed. The result was an overall energy consumption of only 18 kBtu’s per square foot per year in the Richardsville School; the lowest usage ever. Energy savings like that go a long way toward solving operational budget problems.

Any good forensic story has a footnote: The Warren County Public School District always planned to make this project Net-Zero, and had allotted approximately \$9,000,000 for an array of photovoltaic (PV) units.



Their allocation was based on the energy usage of 76 kBtu’s per square foot per year, which is actual energy consumption for the EnergyStar and LEED-rated schools they had previously built. Thanks to the EnergyWise Structures Approach and Intelligent Efficiency Engineering, the Richardsville School saved roughly \$7,000,000 on the PV system with an actual energy consumption of just 18 kBtu’s per square foot per year. Even with a PV system that is a fraction of the size and cost of the originally allocated system, there were several months last summer when the system generated extra power that netted over \$4,000 per month for the school. Now that is energy savings! That is why the FIRST step toward Net-Zero should be a step toward building an EnergyWise Structure. — EW