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Net Zero Schools in Kentucky: Models for the Future Come from Surprising Places

(Architect: Sherman Carter Barnhart Architects; Photo courtesy of CMTA, Inc.)

This week, I asked a close friend to guess which state boasted the nation's first net zero public elementary school. "California?" he ventured. "Vermont?" "Massachusetts?" No, no, and no. How about Kentucky, the nation's third largest coal producer, with $5 bn in annual coal revenues and the nation's fourth lowest electricity costs (at just over 7 cents per kilowatt-hour)?

Almost everybody thinks about ambitious energy policy as coming from the right or left coasts, where avoided costs are higher and environmental fervor is often stronger. You only have to look at the location of Prius ownership to see that bias reflected. But if you have been paying attention to the Kentucky Governor Steve Beshear's energy plan, "Intelligent Energy Choices for Kentucky's Future," you might have guessed that the first net zero elementary school would be claimed by the

Bluegrass State. It is a very ambitious strategy, and includes seven specific goals to be reached by the year 2025:

1) improve energy efficiency to meet 18% of 2025 demand

2) increase renewables three-fold to 1000 MW

3) develop biofuels to supply 12% of vehicle fuels consumed

4) develop a coal-to-liquid capability that can convert 50 mm tons of coal to 4 billion gallons of liquid fuel by 2025

5) increase gas supplies (including coal to gas) to supply 100% of natural gas requirements

6) insert carbon management technologies in 50% of coal-based applications

7) evaluate the use of nuclear power as a potential key element in Kentucky's energy future

Clearly, some of these goals will be easier to achieve than others. Carbon capture and coal gasification may be difficult to achieve as they are capital-intensive, and rely on significant investor interest and improvements in technology. But some goals are well within the State's power to achieve, and Kentucky is moving quickly to make them happen.

Take efficiency, for example. In 2011, 34,000 Kentuckians received rebates for participating in efficiency programs. 106 industrial, commercial and institutional facilities also got involved. And 60 municipalities implemented efficiency projects. In the education arena, 100% of schools participated in efficiency programs of some kind in 2011, and 67% of the Commonwealth's local school districts became Energy Star partners (up from 5% the year prior). The school efficiency program involved the hiring of 35 Energy Managers, and yields $3.3 million in annual avoided costs. Even taking into account the Energy Managers' salaries, this has clearly been a net positive for the districts.

However, Kentucky's crown jewel is surely its net zero Richardsville Elementary School in Warren County. A net zero building is an edifice that produces the same amount (or more) energy as it consumes. Net zero buildings will become increasingly more common as renewable technologies (such as solar and wind), and efficient end-use technologies (such as LED lighting and high efficiency climate control systems) drop in price. But technologies and prices alone are not the real key to creating net zero buildings. The real trick is to apply the holistic thinking required to view a

building as a "living" entity that involves integrated planning for the interactions of various systems and the needs of the people inside the building.

In a net-zero building, like the Richardsville School, one generally **has** to think about these interactions. This is because the affiliated renewable energy systems are relatively costly. It becomes imperative to design the most cost-effective and efficient building so that one can downsize the required renewable energy source. So in the case of the Richardsville Elementary School, an effort was made to reduce the average energy use from 60.5 kBtu per square foot to 18.2 kBtu.

This involved investment in technologies such as natural day-lighting, and efficient lamps, a geothermal heating and cooling system, and insulated concrete form walls with high heat retention "R" values. The Richardsville School was also equipped with a power monitoring system that measures and trends energy usage in various areas such as IT, the school kitchen, the heating and cooling system, and plug load. As a consequence, Richardsville was able to greatly reduce overall consumption and maintain those low levels. As architect Kenny Stanfield of Sherman-Carter-Barnhart Architects noted, renewables and end-uses "need to be an integrated approach. You start with the subtraction of efficiency, and then move to the addition of the solar."

The solar array necessary to meet that demand was a $2.75 million 208 kW combination of thin film and crystalline photovoltaic systems (50% funded by the ARRA, 50% by the Commonwealth and with technical support through the U.S. State Energy Program) that included 2000 rooftop panels and 700 more on a parking shade structure. Its output on a sunny day is equal to 2500 kilowatt-hours (kWh) and 245 megawatt-hours (MWh) annually. Bundled together, the combined efficiency and solar investments have a 15-year simple payback period.

The school also included a major education component. Stanfield commented that the design architecture included hallways with themes for geothermal heating, energy efficiency, solar, recycling and water conservation. These included designs on the floors. The education community and school board supported the project, with the strong backing of the superintendent, so that the project was actually integrated into the curriculum. Stanfield recalled, "everybody got excited about the project. We had the kids with hardhats on the construction site, and we explained to them what we were doing and why. Now – I'm not kidding – every kid can tell you what a solar tube is. Kids give the tours to visitors. When a kindergartner can

explain geothermal, that's pretty amazing." He noted that his firm is currently working with the State's educational authorities to make five other schools net-zero ready. "We are taking advantage of all the energy savings strategies, for now, while we wait for declining solar costs. After all, the solar is pretty much plug and play."

This educational component is important to Jane Beshear, the First Lady of Kentucky. A former high school teacher, she is passionate about the benefits of energy efficiency. She got started when visiting an Energy Star school several years ago. A student gave her an LED light bulb as a gift. "I told him I was going to take it back to the Governor's Mansion and change what we do there." The bulb became the impetus for an energy retrofit, and a focal point of the frequent tours that troop through the building. "We've changed every light. We installed low-flow faucets. We have an opportunity to be a role model."

But the First Lady is even more enthusiastic about the opportunities for education in energy efficiency. "When I took the tour of Richardsville, the students explained everything that had been done in the school. Everything they've done is used as a teaching tool. Our children are a whole new generation that is changing. If they do it at school, they do it at home. It's about personal responsibility."

The net zero School is just one focal point. Another is a project on the Capitol Campus, where an unused building was converted into an education center. Among some of the features: The tiles are made from recycled materials; the lights are LED; the insulation is made from recycled blue jean denim; and the reflective roof (part of which has its own rooftop garden) captures gray water for re-use in a garden below with native plants. As far as energy production, the Center has a small wind turbine, solar thermal hot water, and 6 kW of solar photovoltaic panels.

Skeptics may (and will) argue that solar is too expensive, that it required a stimulus grant to make economic sense, that such tax money may be better spent elsewhere, and it is subsidized and supported by the rest of the grid. In the short term, that thread of logic makes sense. But that argument would also ignore the ongoing dynamic at play with a host of developing technologies: today's snapshot of costs and efficiencies is just that.

A report issued today by the National Renewable Energy Laboratory (NREL) highlights the declining cost of solar energy. "Tracking the Sun" notes that the 2011 installed costs for solar fell an average of 11-14% from the prior year, to about $4.9/W for large projects. The first half of 2012 saw an additional

estimated 3-7% price decline. Since 1998, average prices have fallen by 5-7% annually. Most of this gain has come from module pricing. But a trend that has been tough on the solar panel companies such as Solyndra, First Solar, and SunPower has been a boon to consumers.

An additional 30% cost reduction has resulted from efficiency gains in areas such as inverter and installation costs, as well as overhead and marketing. It is highly unlikely that any of this would have happened without the stimulus of government programs. Furthermore, experience from other countries suggests that cost efficiencies may yet have room to improve. While the median installed price for a small residential system in the US was 6.0 cents/W, the same system was estimated to cost 3.2cents/W in Germany, and 4.0 cents/W in Australia.

In general, we can expect electric energy prices to rise from today's rates (Kentucky has experienced nearly a 5 percent increase in electric prices every year for the past five years). At the same time, it is realistic to assume a continuing decline in price for efficient end-use technologies such as efficient LED lighting and energy monitoring systems. Renewables will decline as well. Taken together, these trends suggest that Kentucky's Richardsville school is a harbinger of a coming trend.

This October, the school district received their annual 'electric bill' from the local utility: a check to the district in the amount of $37,227.31 for the surplus energy sent from the school's solar system to the grid. First Lady Beshear points out that in a net zero school, administrators can weather an electricity rate increase without cutting programs, staff, or the overall quality of education. "Instead of spending money on utilities, they can use it in the classroom. And money is scarce." Surprisingly (perhaps only to some), coal-rich Kentucky has provided a model the rest of the country may well follow.
