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Community CONNECTION

BY DANIEL J. OVERBEY, AIA; AND WILLIAM M. BROWN, AIA

For the people of Chrisney, Ind., opportunity for social and economic investment has not been knocking. This community of fewer than 500 has been in a gradual economic decline over the past several decades. Having already lost its high school in the 1970s due to a push for school consolidation, the town took another blow in 2011 when an expansion of U.S. 231 rerouted the four-lane corridor around the town, which was once a thriving rural community in southern Indiana.



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Above Despite the seemingly impossible set of design and budgetary constraints, a net zero energy design concept helped make the Chrisney Branch Library a reality. It is the first net zero public library in the U.S.

Opposite The Chrisney Branch meets the town's need for a public library, Internet access, community meeting space, and a classroom for summer reading programs. The highly efficient building envelope and mechanical systems minimize energy consumption and put the project goal of net zero energy within grasp.

Located 15 miles from the nearest public library, the community saw its children slipping on reading scores because they lacked access to the library district's summer reading programs. Gradually, families were moving away from Chrisney, their children never to return.

The town realized it needed a library—a new source of pride and a center for community. What it ended up with was a net zero energy library.

Nearly a quarter of Chrisney's residents attended the first public meeting in 2007 to discuss the prospect of establishing a public library, but the town did not have the funds

to pay even a single staff person. The community leveraged its social capital to overcome the fact that it lacked a building, a site, funding, or support from their library district to construct a branch.

Community members supported the building project via donations, phone calls, letter writing campaigns and pursuit of grants. The community honed in on the notion of a library that could produce as much energy as it required to operate. The net zero energy concept was conceived as a way to appease the library district that did not want the operating expenses of a new building.

As momentum built, others stepped up to lend support. The town of Chrisney agreed to donate free water and sewer services for the life of the building.

“We received donations from all across the country and we had volunteers ready to work at the library at a moment's notice,” recalls Kim Litkenhus, Town Clerk-Treasurer. “We were so fortunate to have the

BUILDING AT A GLANCE

Name Lincoln Heritage Public Library Chrisney Branch (Chrisney Branch Library)

Location Chrisney, Ind.
(88 miles west of Louisville, Ky.)

Owner Town of Chrisney

Principal Use Library
Includes Public assembly, classroom, conference, circulation, lobby/reception, office, restrooms, electrical systems, mechanical systems

Employees/Occupants
1 full-time equivalent

Expected (Design) Occupancy
48 maximum
Percent Occupied 25% (approx.)

Gross Square Footage 2,413
Conditioned Space 2,382

Distinctions/Awards First net zero energy public library in the U.S.

Total Cost \$374,000 (does not include property cost, site work, or design fees)

Cost per Square Foot \$155 (includes the building, its mechanical system with geothermal heat pump, its electrical system, photovoltaics and all other associated systemic components)

Substantial Completion/Occupancy
April 2009



Biagi, Chance, Cummins, London, Titzer, Inc.

Top The on-site bifacial photovoltaic solar panel installation generates more electric power during a year than the library consumes.

Town of Chrisney, Lincoln Heritage Public Library, and North Spencer County School Corporation behind us every step of the way.”

The North Spencer County School Corporation was hesitant to share its existing elementary school media center with the general public due

ENERGY AT A GLANCE

Annual Energy Use Intensity (EUI) (Site) 16.7 kBtu/ft²

Electricity (From Grid) 16.7 kBtu/ft²

Annual Source Energy –3 kBtu/ft²

Annual Energy Cost Index (ECI) \$0/ft²
(monthly utility service charge of \$23 not included)

Annual On-Site Renewable Energy Exported 17.4 kBtu/ft²

Annual Net Energy Use Intensity –0.76 kBtu/ft²

Heating Degree Days (Base 65°F) 5,179 (Boonville, Ind.)

Cooling Degree Days (Base 65°F) 1,458 (Boonville, Ind.)

Annual Hours Occupied 1,100

Note: 2013 data.

WATER AT A GLANCE

Annual Water Use (Data not available since the town of Chrisney provides free water.)

to security concerns. However, when the school district was introduced to the net zero energy concept and informed of the Lincoln Heritage Public Library’s new interest in establishing a Chrisney branch as long as they did not have to pay for utilities and staffing, the school district donated a lightly wooded acre of land adjacent to the elementary school’s outdoor learning lab.

The library and the community raised over \$88,000 for a matching fund in six weeks. The unusual nature of the project helped the project rise to the top of the Indiana Office of Community and Rural Affairs (IOCRA) grant pile. Through the IOCRA Federal Block Grant, the project received \$447,000. Eventually, the Indiana Office of Energy Development provided an additional \$24,000 through an Alternative Power and Energy Grant.

Construction began in 2008, and the library opened in April 2009. The library’s five years of operation represent the successful achievement of net zero energy as well as hope for the future for this community.

Siting

Going beyond design rules-of-thumb and approximations based on perceived site obstructions from foliage, the design team used devices in the

CONNECTING RESIDENTS WITH KNOWLEDGE, FRIENDSHIPS

While the Chrisney Branch Library provides the traditional services of book loaning and preschool story time, it also connects residents to the Internet and to each other. Additionally, it draws visitors who are interested in learning more about the photovoltaic solar panels.

Chrisney Elementary students visit the library every Thursday to check out books and are invited for special events, such as a recent visit by an Abraham Lincoln impersonator. A summer reading program offers entertainment, crafts and prizes, and encourages students to build their reading skills while on summer vacation. Library plans for next year involve hosting community events such as a farmer’s market and musical performances under the PV array structure, known as the Learning Power Pavilion.

The library, which is staffed by volunteers, also serves as a wireless Internet hot spot and as a gathering place for teens and others in the community. Many residents do not have computers at home, so they use the library computers to search for jobs, file unemployment claims or check email.

“I think it’s allowed the people of Chrisney to connect with other individuals, an opportunity they might never have had before,” said Becky Hunter, Interim Director Lincoln Heritage Public Library. “It is a place where new friendships have been made, ideas have been shared and knowledge has been found.”

About 20 people visit the library each day. It is generally open four hours every day except Wednesday and Sunday, although plans call for expanding operating hours soon.

Source: Becky Hunter, Interim Director Lincoln Heritage Public Library

field to determine exactly what portions of the sky would be obstructed by trees and any other nearby objects. A detailed solar access study revealed that certain locations would allow more direct sun to reach the solar panels than others.

The design team sought to maximize solar access while minimizing



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The library, which is staffed by volunteers, also serves as a wireless Internet hot spot and as a community gathering space. The library plans to host more community events in the future, including a farmer’s market and musical performances.

tree removal. This led to a strategy to put the solar panels on a free-standing wood structure in the sun while siting the building in the shade of 100-year-old oak trees.

Building Structure

The 2,400 ft² facility met the town’s need for a public branch library that can also function as a community meeting space and classroom for summer reading programs. The building affords the functions of the library—complete with collection and reading space, a circulation desk, work areas, an office, restrooms and mechanical space. The pavilion is adjacent to the elementary school’s outdoor lab and serves as an open-air classroom and public meeting space.

The library uses a highly efficient building envelope with selective apertures to facilitate daylighting.

A modest conditioned volume helps reduce heating and cooling loads.

The basic R-25 wall construction consists of wood framing with polycynene foam insulation. Outboard of the framing is fiber cement lap siding over extruded polystyrene (XPS) rigid foam and oriented strand board (OSB) sheathing. The interior is sheathed with gypsum board. In addition to the insulated slab-on-grade foundation, the R-33 roof assembly consists of 12 in. of cellulose atop an 11 ft high gypsum board ceiling.

The design team used daylight studies to analyze the project’s solar access and interior illumination during various conditions and incorporated exactly the amount of glazing needed, and nothing more.

The result is a 19.5% glazing percentage with operable windows to allow natural ventilation during mild seasons. High ceilings and T-shaped window openings maximize high daylight sources that reduces glare and maximizes daylight penetration.

KEY SUSTAINABLE FEATURES

Water Bioswales; water-efficient, low-flow fixtures; instantaneous hot water.

Materials LEED specifications were used to create minimum requirements for recycled materials, regional materials, durable materials, low life-cycle cost, low toxicity, and contribution to an integrated strategy for net zero energy.

Diversion of Construction Waste Separate site dumpsters for recyclables.

Daylighting Glazing with a low solar heat gain coefficient; generous exterior windows and high ceilings to increase daylighting; and tubular skylights with remote dimming controls for presentations.

Individual Controls Occupancy sensors to monitor and control artificial lighting to maximize energy savings.

Carbon Reduction Strategies Daylighting, ground source heat pump system, foam insulation and efficient windows create a tight envelope, PV system generation exceeds building demand.

Other Major Sustainable Features Library is located in a grove of 100-year-old oak trees, which help reduce summer cooling demand. Carpeting, shingles, and siding manufactured from recycled materials. Natural ventilation. Optimized building envelope.



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LEED credits regarding materials and indoor environmental quality served as a guide for the design and specification of the library's interior spaces.

MEP Systems

Energy modeling of the building envelope determined the most cost-effective, energy-efficient building systems. A ground source heat pump (GSHP) using two 400 ft vertical closed-loop wells provides a simple, energy-efficient solution for mechanical heating, cooling and ventilation.

High efficiency fluorescent light fixtures provide nighttime illumination and supplement the daylighting strategy during overcast days. Occupancy sensors monitor and control electric lighting to maximize energy savings.

Low-flow plumbing fixtures and an instantaneous electric heater for domestic hot water reduce the library's relatively small and infrequent need for potable water.

While the project did not pursue LEED certification, good indoor air quality was achieved by adhering to

the rating system's indoor environmental quality credit guidelines for materials specifications, including low-VOC finishes. Operable windows with screens allow for natural ventilation. No combustion was involved in the HVAC system, which eliminated the potential for associated by-products.

Renewable Energy

The Chrisney Branch Library uses bifacial photovoltaic panels to provide electric power for the facility. The 8.9 kW PV (grid-tied, no battery storage) array is sized for 101% of the anticipated annual energy load. Inverters direct excess captured solar energy to the public utility's electric grid.

By constructing a separate PV array (mounted atop the Learning Power Pavilion) in the sun and keeping the building in the shade, much less summer cooling is required. The array creates a community meeting space and serves

BUILDING ENVELOPE

Roof

Type 12 in. of cellulose atop 5/8 in. gypsum board ceiling in vented attic; wood truss frame, sheathing, asphalt shingles

Overall R-value R-32.86

Reflectivity 0.12 (medium brown asphalt shingles)

Walls

Type 0.6 in. gypsum board; 2 × 6 wood (southern pine) stud with 5.5 in. polycynene foam insulation; 0.5 in. oriented strand board (OSB) sheathing; 1 in. extruded polystyrene (XPS) rigid insulation; 0.3 in. fiber cement siding lap siding; 6.25 in. width

Overall R-value R-25.23 (weighted against framing percentage)

Glazing Percentage 19.5%

Basement/Foundation

Slab Edge Insulation R-value R-7.5

Under-Slab Insulation R-value R-7.5

Windows

Effective U-factor for Assembly 0.28 fixed frame; 0.27 casement

Solar Heat Gain Coefficient (SHGC) 0.28 fixed frame; 0.26 casement

Visual Transmittance 53% fixed frame; 48% casement

Location

Latitude 38.0136° N

Orientation Building orientation is rotated 30° west of magnetic north; adjacent pavilion with solar panel canopy is oriented toward solar south

BUILDING TEAM

Building Owner/Representative
Lincoln Heritage Public Library

Architect, Energy Modeler, Landscape Architect
Browning Day Mullins Dierdorf Architects, Indianapolis

General Contractor
Craftsman Construction, Inc., Huntingburg, Ind.

Mechanical, Electrical, Civil Engineer, Lighting Design
Biagi, Chance, Cummins, London, Titzer, Inc., Evansville, Ind.

Structural Engineer
Wilkie Structural Engineering, Evansville, Ind.

Solar Panel Consultant
Morton Solar & Wind, LLC, Evansville, Ind.

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Above The desire to maximize solar access while minimizing tree removal led to siting the solar panels on a free-standing wood structure in a clearing, while nestling the building within the shade of nearby oak canopies.

Below right The Learning Power Pavilion is adjacent to the elementary school's outdoor lab and serves as an open-air classroom and public meeting space.

as an outdoor classroom for the adjacent elementary school outdoor learning lab. The creation of this multifunctional outdoor space solidified the value of the land donation from the school corporation and helped attract project funding.

Performance

Data published in July 2010 demonstrated that over the first 12 months of typical operation, the Chrisney Branch Library was operating at net zero site energy, producing approximately 17% more energy than it consumed. Since then, the facility has continued to perform at an energy surplus.

In 2013, the on-site photovoltaic solar panel installation produced 12,341 kWh of electricity, while the property consumed 11,805 kWh, an energy surplus of approximately 4.3%. In 2012, the property produced 12.6% more energy than it consumed.

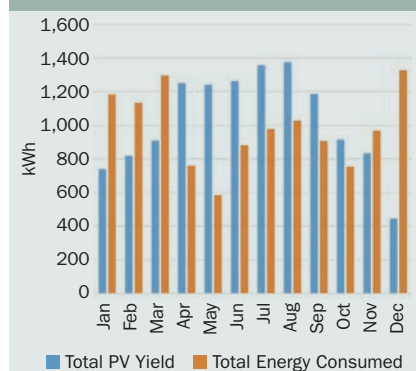
Per the simple payback calculation method referenced by the EPA ENERGY STAR Small Business Guide, a conventionally built library in this climate region would have an annual energy bill of nearly \$2,400, including the charge from the public utility to install their service. Considering the Chrisney Branch Library was funded by grants and donations, the simple payback for the net zero construction cost premium was about three years.

The library celebrated the five-year anniversary of its opening in April 2014. The library has not experienced any problems with maintenance or operation of the solar pavilion, according to the district director.

Net Zero on a Budget

Not only has the net zero project resulted in reducing monthly operation costs (the utility charges

FIGURE 1
ENERGY PRODUCTION VS.
CONSUMPTION, 2013



a monthly service fee), it was constructed in a cost-effective manner while meeting federally funded building requirements. The building, mechanical and electrical systems, including the geothermal and photovoltaic panels and their associated components, were constructed for \$155/ft².

These savings were achieved by using a simple rectangular layout, conventional residential framing techniques familiar to local builders, and cost-effective interior and exterior finishes. The project cost was below that expected cost for a public library. A national



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Daylighting is a key energy use reduction strategy for the library. Pictured here are the diffusers of the tubular skylights, which feature remote dimming controls for presentations.

construction cost guide listed costs per square foot for a 7,000 ft² library to be in the range of \$176/ft² to \$220/ ft² (2008 dollars).

The team’s collaborative efforts also contributed to the

below-average construction cost of a net zero energy building. The integrative design approach resulted in improvements to the building envelope insulation, the decision to locate the building in the shade, and the team’s ability to leverage daylighting to downsize the HVAC and PV systems. These savings paid for improvements in the building envelope.

The library has also drawn visitors who check out the library’s PV-covered Learning Power Pavilion and consider using solar power for something similar in new home construction or in a retrofit. Others check out Chrisney’s Sunny Portal website (<http://tinyurl.com/Chrisney>), which provides daily and monthly energy consumption and solar production data for the library.

LESSONS LEARNED

Budgeting Net Zero Energy. The limited budget of the project required the design team to be judicious with design features, building systems and overall project complexity. Knowing this project would be bid by local residential builders, it was designed as a simple rectangular slab-on-grade wood-framed home, but also designed to meet the state and federal code requirements for a commercial building. By setting the net zero energy goal at the outset of the project, the team was better able to balance the construction costs against that of the on-site photovoltaic system.

Design Performance Modeling Makes a Difference. With a gross floor area of approximately 2,400 ft² and a meager design budget, the project team did not have the financial resources to hire a specialized energy modeling firm to run a comprehensive energy analysis on the library’s design. However, the team was experienced enough to realize a strategy of taking advantage of every opportunity to optimize all building systems in an integrated manner. Simple design rules-of-thumb would not suffice. The design team decided

to take advantage of an emerging field of commercial and noncommercial software platforms that have been designed to make detailed performance analyses more accessible to design professionals. By using such software platforms, the design team was able to integrate design performance modeling into the project’s workflow, which allowed iterative analyses that led to refined siting, daylighting, thermal performance, and on-site energy strategies.

User Group Plays Critical Role. Over the course of the project, the design team and owner became aware of the virtues of understanding how the building’s systems work. If mismanaged, design features such as operable windows and plug loads can become major hindrances to the project’s energy performance goals. Staff was educated regarding best use of operable windows, and ENERGY STAR laptops with relatively low power consumption were selected for library patrons. The community embraced the high performance goals of the library and ensured that key personnel were knowledgeable about the various building systems and could train future staff.

For More Information, see “Net-Zero Energy Within Budget: The First Net-Zero Energy Public Library in Indiana,” by Daniel J. Overbey; William M. Brown; and Nicholas D. Worden, presented at the 2010 International High Performance Buildings Conference (<http://tinyurl.com/lepddnl>).

Conclusion

Despite the seemingly impossible set of design and budgetary constraints, the Chrisney Branch Library was eventually willed into existence, becoming the first net zero energy public library in the U.S. Three separate 12-month samples have verified that the building produces more energy than it consumes. While the project is a demonstrative case study for an integrative design team and early-stage design performance modeling, the Chrisney Branch Library is first and foremost a story of community perseverance. ●

ABOUT THE AUTHORS

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