REBUILDING IT BETTER: GREENSBURG, KANSAS

On May 4, 2007, a massive tornado destroyed or severely damaged 95% of Greensburg, Kansas. Since then, city and community leaders have been committed to rebuilding the town as a model sustainable rural community.

Experts from the U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) are working with city leaders, business owners, and residents to identify ways to incorporate energy efficiency and renewable energy technologies into the new buildings. Ultimately, these technologies could be replicated in other communities recovering from disaster.

USD 422 Greensburg K-12 School

The tornado destroyed Greensburg's original school, so the new school is being built green from the ground up. School leaders and the design/construction team worked closely together to design an environmentally responsible, student-focused academic environment that reinforces Greensburg's community-wide commitment to sustainability. The 130,000-square-foot, two-story facility will have the capacity to hold 375 students ranging from preschoolers to high-school seniors.

LEED® Platinum

The school is being built to attain the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) for Schools Platinum designation. NREL, with the support of DOE, provided technical assistance to determine the most cost-effective energy efficiency and renewable energy strategies to help several of the new Greensburg buildings achieve Platinum status and exceed 50% energy cost savings.

The new K-12 school in Greensburg, planned for completion in August 2010, is built to be 50% more energy efficient than a similar building constructed to standard code. The school uses numerous renewable energy technologies including a 50-kilowatt (kW) on-site wind generator and ground source heat pump system.

100% Renewable Energy, 100% of the Time

The Greensburg Wind Farm consists of 10 1.25 megawatt (MW) wind turbines that supply 12.5 MW of renewable power to the town. That's enough energy to power every house, business, and municipal building in Greensburg.

The town will use only about 1/4 to 1/3 of the power generated to reach its "100% renewable energy, 100% of the time" goal.

Excess power will be placed back on the grid and offered as renewable energy credits for other Kansas Power Pool and NativeEnergy customers.

The wind farm was completed in the spring of 2010. John Deere Renewable Energy built the wind farm and maintains the project.

Students and community leaders broke ground on the new school in October 2008.

Classroom daylighting can positively impact students' health and development.

Many of the efficiency measures used in the school were based on recommendations in the *Advanced Energy Design Guide for K-12 School Buildings*, an energy efficiency guide developed by DOE and NREL in collaboration with national professional societies.

Energy Conservation

To reach the 50% energy savings and LEED Platinum certification goal, the school design team incorporated a number of energy conservation and efficiency measures.

Lighting

- East to west building orientation captures the abundant natural daylight from the south and the north and helps warm the interior in the winter
- Regularly occupied spaces such as classrooms and corridors, along with the gym, are fully daylit to reduce artificial lighting
- Electronic timer light switches, indoor and outdoor photoelectric switches, and indoor occupancy switches determine how many lumens to use
- Skylights provide natural light to the corridors and help minimize electricity use during the day
- Glazing on aluminum-framed curtain wall systems allows natural light to penetrate deeper into the building in areas such as the gym

Building Envelope and Insulation

- Walls and portions of the roofing system are constructed with structural insulated panels (SIPs) rated from R-30 to R-40, which eliminate the heat/cold migration through the exterior building envelope that typically occurs with metal stud framing
- The wall envelope system was constructed in an extremely controlled environment off site, reducing both on-site waste and construction time
- Aluminum-framed curtain wall systems and door frames help eliminate moisture and save on construction costs
- South facing windows have overhangs to limit summer solar gains and allow for winter passive solar tempering

Heating, Ventilation, and Air Conditioning (HVAC)

- A hybrid closed-loop ground source heat pump system, combined with a fluid cooler, provides heating and

> “We’re excited about building an educational facility that’s second to none, right here in Greensburg, Kansas. Our school is certainly unique because of its energy efficiency and renewable energy features, but more importantly, we think its fresh, novel design will endow our kids with a vastly improved learning environment. We hope that our school will serve as an example of what’s possible—building sustainably while creating a pleasant environment conducive to learning—not only for this generation but also for generations to come.”
>
> Darin Headrick, Superintendent, Greensburg USD 422

The school’s ceilings are made of reclaimed wood salvaged from the old Menninger Clinic in Topeka, Kansas.

cooling by extracting both through 97 vertical wells, each 410 feet deep

- The all-electric heating and hot water system takes advantage of the abundant renewable electricity from the Greensburg Wind Farm
- A dedicated outdoor air system with energy recovery ventilators provides outdoor air based on demand-controlled carbon dioxide sensors

Wind Power

- An on-site wind generator produces 50-kW of power, or $700,000 worth of electricity over the turbine’s life cycle, and will pay for itself in 11 years
- Three 5-kW polymer electrolyte membrane fuel cells along with an electrolyzer to generate the hydrogen gas to power the fuel cells will provide back-up generation during an emergency or power outage, supplying wind-generated electricity to the electrolyzer

Sustainable Features

The new school’s numerous sustainable practices provide a healthy indoor and outdoor environment for students, faculty, and parents.

Sustainable Site

The school plans to share facilities with the adjacent recreational complex and the natural prairie site next to the school is ideal for an ecological outdoor classroom.

Water Efficiency

Rainwater is captured and stored on site for irrigation. Waterless urinals and low- or no-flow fixtures in all showers, faucets, and toilets reduce water use. Food debris will be collected and composted.

Bioswales—straight runoff channels filled with vegetation—are incorporated into parking areas to remove silt and pollution from surface runoff water. Permeable paving (gravel) further controls storm water runoff.

Materials

All building materials were chosen with sustainability and reclamation in mind. The cost-effective and easy-to-maintain polished concrete flooring is manufactured with low volatile organic compounds (VOCs). Some interior walls are constructed of regional concrete masonry unit burnished block that requires no painting, further reducing VOCs. Ceilings are made of reclaimed Douglas fir board paneling.

The outside of the building features more than 3,500 board feet of reclaimed wood salvaged from cypress trees destroyed in another natural disaster: Hurricane Katrina. The wood is accented by Kansas limestone cladding. Rain screens help improve indoor air quality, increase energy efficiency, and eliminate moisture problems.

The temporary steel building occupied by students and faculty during construction of the new school will be reclaimed and made into a city recreational facility.

Air Quality and Indoor Environment

Operable windows in all classrooms, most offices, and other rooms allow for natural ventilation. Through a partnership with the Clorox Company, the school will use Green Works® natural plant- and mineral-based cleaning products. Brita® water stations, also donated by Clorox, will be located throughout the building.

A hybrid closed-loop ground source heat pump system provides heating and cooling to the school and will not only decrease electricity use, but also corresponding carbon dioxide emissions.

Design Team

Owners:
USD 422 School District,
local government

Builder and Construction Manager:
McCown Gordon Construction

Architects:
BNIM Architects
ATS&R Architects

Structural Engineering:
Structural Engineering Associates

Mechanical, Plumbing, and Electrical Engineering:
BGR Consulting Engineers

Landscaping:
BNIM Architects

Civil Engineering:
Professional Engineering Consultants

Energy Modeling:
NREL, BGR Consulting Engineers

Commissioning:
Dome-Tech, Inc.

Acoustical Design:
Acoustical Design Group

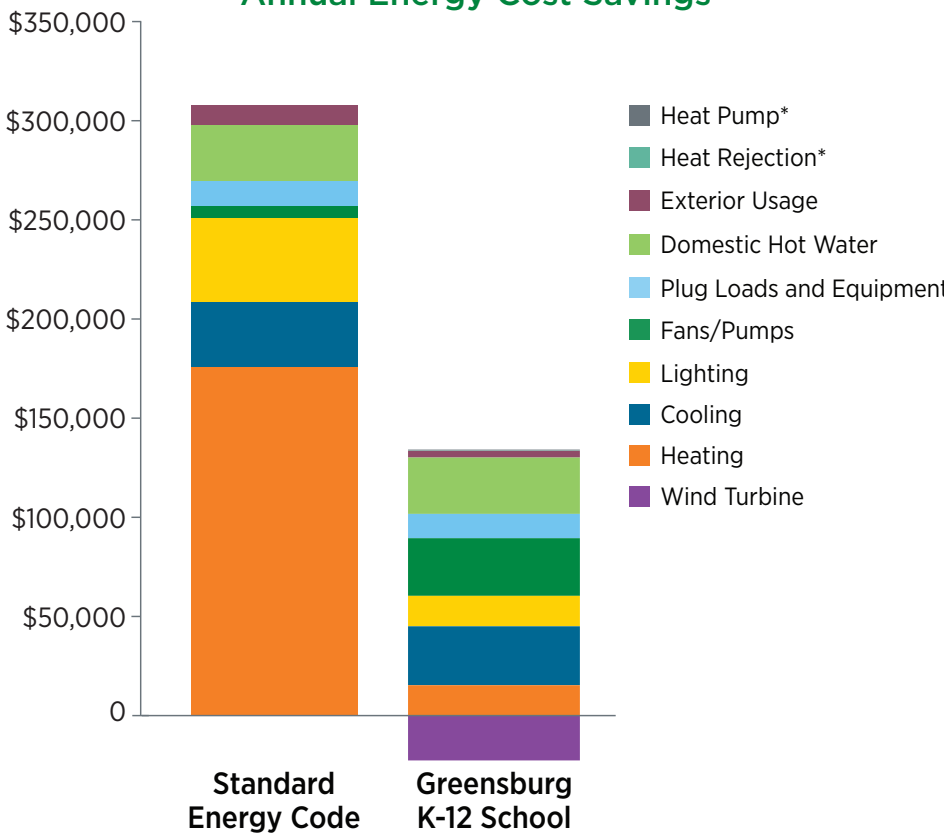
Food Service Design:
Montgomery Hoffman Associates

Technology Design:
Gibbens Drake Scott

Results

Thanks to the high-efficiency HVAC and heat recovery system, the efficient building envelope, and the Greensburg Wind Farm helping to deliver power, the school doesn't need an expensive boiler backup system, or the gas service, piping, and equipment flues associated with natural-gas-fired heating equipment. These savings offset the cost of the heat recovery system and high-efficiency equipment and make the school an electricity-only site.

Annual Energy Cost Savings



Energy analysis modeling indicates that annual energy costs for an ASHRAE-compliant building of the same size and shape (Standard Energy Code column) would be about $308,000. The right-hand column represents the expected annual energy costs for the school—a reduction of more than 50%. Applying the savings from the 50-kW on-site wind turbine, the school can achieve an additional 10% in annual electricity savings for a total savings of approximately 50% to 60%.

Stay updated on the school's construction progress and LEED Platinum goals by visiting the Greensburg Sustainable Building Database at http://greensburg.buildinggreen.com/.

**Projected costs for the new school heat pump is $433 and heat rejection is $209.*

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U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

For additional information please contact:
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1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov/informationcenter

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This document is one in a series of documents outlining the options for and benefits of rebuilding green after a disaster. The series draws on lessons learned by teams from the U.S. Department of Energy and its National Renewable Energy Laboratory as they helped the townspeople of Greensburg, Kansas, rebuild green after a devastating tornado. To see the other documents in this series, visit www.buildings.energy.gov/greensburg/.

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