GREEN BUILDINGS


Hassan Elementary School, Rogers

Top 6 benefits of high-performance buildings

New study quantifies energy efficiency benefits of green buildings in Minnesota.

The impact of buildings on our lives is dramatic, yet it goes largely unnoticed. Buildings use a lot of resources and create many adverse environmental effects.

Buildings in the U.S.
Consume almost 2/3 of total electricity
Use 12% of total potable water
Generate 2.8 lbs./person of construction and demolition waste every day
Contribute 30% of total greenhouse gas emissions

Much of the impact of buildings is related to energy use. High-performance buildings are designed to achieve significant energy conservation. They use at least 30 percent less energy each year than buildings designed only to meet the base requirements of Minnesota Energy Code. High performance buildings that also integrate sustainable site design, indoor environmental quality, and resource conservation are considered "green" buildings.

A recent Minnesota study quantifies the benefits of 41 high-performance commercial buildings in the state. The study compares their high-performance design to the same (hypothetical) buildings designed to meet minimum requirements of the Minnesota Energy Code. The study quantifies the extent to which the 41 high-performance buildings are both saving energy dollars that otherwise would leave the state economy, and preventing pollution that otherwise would contaminate our air and water.

Many of these 41 high-performance buildings were not designed specifically to be "green" buildings. Nonetheless, they incorporate an integrated design approach that is characteristic of green buildings. Their design coordinates high-efficiency equipment with the building shell, orientation, insulation, ventilation, zoning and more, to create a high performance built environment. All the benefits of high-performance buildings are very likely to be benefits of green buildings as well. These benefits can be used as proxy measures of the minimum benefits likely to result from green buildings.

The Minnesota Office of Environmental Assistance contracted with The Weidt Group in April 2005 to perform this study. It includes a broad spectrum of commercial building types. The benefits identified by the study are substantial.

BUILDING TYPES included in the study

- Elementary School
- Middle/High School
- Retail
- Library
- Office
- College Classroom
- College Lab
- Mixed Use
- Hospital
- Recreation Center
- Police/Fire Station
- Laboratory

Read the study: High Performance Building Design in Minnesota
www.pca.state.mn.us/oea/greenbuilding/cost.cfm

Energy-efficient buildings

- √ Healthier air
- √ Less mercury in our fish
- √ Fewer greenhouse gases
- √ Lower energy costs
- √ Quick payback on investment
- √ More money stays in local economy

Hassan Elementary School

Completed in August 2005, this school in Rogers, Minn., is a recent addition to Elk River Schools' portfolio of buildings designed with sustainability in mind. The two-story design is resource efficient, while the traditional peak-roofed style fits in with the surrounding community and provides a more home-like feel. Classrooms are grouped along east-west corridors on either side of the open court to provide optimal daylight from both the north and south. Performance features include dimming T5 lights, desiccant energy recovery, high-efficiency boilers, and displacement ventilation. Designed to be 51% more energy efficient than required by Minnesota energy code, the building is projected to save more than $64,000 a year (based on 2004 energy costs). The building was designed by KKE Architects, Inc.; mechanical and electrical systems were designed by Johnson Controls.

Energy efficiency benefits OF GREEN BUILDING

1.

Less energy use means less pollution going in to the air we breathe: sulfur dioxide, nitrous oxides, and particulates.

An important benefit of green buildings is that their lower energy use results in less of the air pollution linked to asthma and heart disease. The results for the 41 high-performance commercial buildings included in the study are dramatic. Each year these buildings prevent additional air pollution (rounded to the nearest 100) totaling:

- 205,900 lbs. sulfur dioxide (SO_2)
- 229,300 lbs. nitrous oxides (NOx)
- 15,300 lbs. particulates

According to the American Heart Association, *"During the last decade… epidemiological studies conducted worldwide have shown a consistent, increased risk for heart and blood vessel problems, including heart and stroke deaths, in relation to exposure to present-day pollution, especially particulate matter."*

2.

Less energy use means less mercury released into the atmosphere to contaminate fish, ultimately harming humans and wildlife.

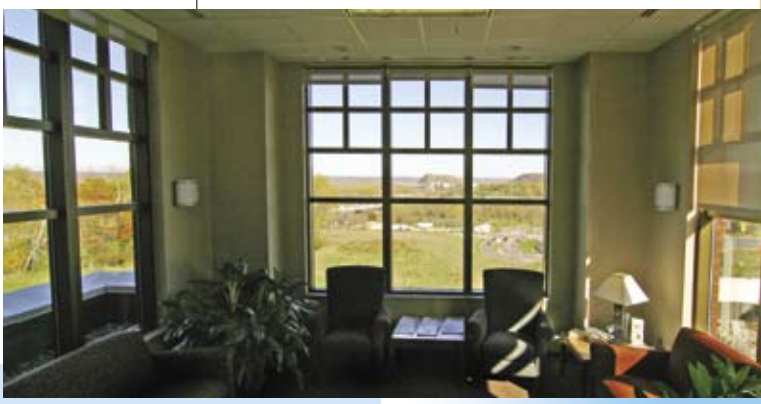
Another benefit of green buildings is that less mercury is released to the atmosphere. Atmospheric mercury mixes with rain and snow, and then falls into lakes and waterways. In the water, mercury undergoes chemical changes to contaminate the food chain. It builds up in the tissue of fish, and in the tissue of wildlife and humans who eat the fish.

The 41 high-performance commercial buildings in this study prevent a total of about 880 grams (1.93 lbs.) of mercury from being released to the atmosphere in Minnesota each year. This compares with about 1 gram of mercury typically entering a 20-acre lake each year. Even this small amount in lake water contaminates fish. For example, an adult walleye can have a mercury concentration 150,000 times as high as the water surrounding it. Fish consumption advisories are issued because mercury is a nerve toxin that impairs human ability to see, hear, walk and talk.

3.

Less energy use means less carbon dioxide, a heat-trapping gas with global warming potential, released to the atmosphere.

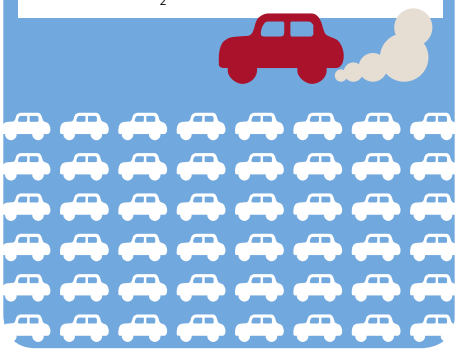
Green buildings have an important role to play in limiting emissions of greenhouse gases to combat the prospects of global warming. The 41 high-performance commercial buildings in this study prevent a total of more than 119.8 million pounds (59,900 tons) of carbon dioxide (CO_2) being released into the atmosphere each year. This is the equivalent of removing more than 12,200 cars from Minnesota roads.



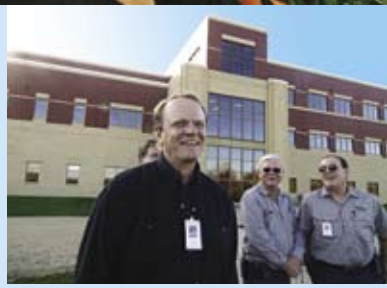
Air pollution prevented

To add perspective, we can compare the air pollution prevented by the 41 high-performance commercial buildings in the study to the air pollution emitted by an average car in 2005 (number of cars rounded to nearest 100).

Pollution prevented by these 41 green buildings compared to car emissions.
Prevented SO_2 = 445,700 fewer cars
Prevented NOx = 59,900 fewer cars
Prevented particulates = 15,800 fewer cars
Prevented CO_2 = 12,200 fewer cars



Fairview Red Wing Medical Center



Opened in December 2001, Fairview Red Wing Medical Center combines a clinic and 50-bed inpatient hospital in one high-performance facility. The site was selected for its views overlooking the Mississippi River. State-of-the-art HVAC equipment was selected with the intention of cutting costs through energy efficiency rather than staff reductions. High-efficiency equipment choices included chillers and cooling towers instead of DX refrigerant systems, indoor penthouses to house HVAC systems instead of rooftop package systems, VFDs on all HVAC motors, setback controls for occupancy levels, centralized high-pressure boilers for sterilization and humidification instead of electric resistance units, low-e glass, and a more efficient insulation package. Maintenance staff keeps these systems well-tuned, while also providing security services for the facility. Grumman/Butkus Associates' annual energy study ranked Fairview Red Wing Medical Center's energy usage in the lower 25th quartile among 107 hospitals included in the Midwest. The building was designed by Setter Leach & Lindstrom, Inc. (now Leo A Daly Company), with energy design assistance by The Weidt Group.

4.

Less energy use means big energy cost savings to building owners and tenants.

A major benefit of green buildings is the significant savings in annual energy costs that accrue over the lifetime of each building. The combined savings in annual energy costs for the 41 high-performance commercial buildings in this study total almost $6.25 million, based on 2005 energy prices. This translates to savings of $0.87 per square foot each year.

Crosswinds Arts and Science Middle School

Completed in November 2001, Crosswinds Middle School in Woodbury is operated by the East Metro Integration District. The building was designed as a dense aggregation of structures to maintain the flow of the wetland across the site. Native perennial plants and grasses, combined with limited use of lawn grass, minimize site maintenance. Brick and metal panels provide a durable, low-maintenance building exterior. A curved metal roof creates clerestory lighting and allows daylight to fall within the central area of each of the six focused instructional "homebase" units. High-performance features include a high-efficiency boiler, passive desiccant energy-recovery units, premium-efficiency pump motors, VAVs, daylight sensors, and operable windows for passive cooling and fresh air. The building was designed by Cuningham Group Architecture, P.A. Mechanical engineering was provided by Wentz Associates, electrical engineering by Kaeding & Associates, and energy design assistance by The Weidt Group.

Crosswinds Arts and Science Middle School, Woodbury

5.

Paybacks for high-performance features average less than 3 years.

Designing commercial buildings to be high performing pays for itself in a very short time, and then the savings continue each year for the life of the building. The Minnesota study confirms that paybacks are very short for high performance integrated energy design features. For each building type evaluated in the study, the mean and median simple paybacks were less than 3 years. Of the 16 buildings for which payback data was available, only two buildings exceeded 3 years. Nine of the 16 buildings ranged around a one-year payback.

Simple payback for high-performance buildings

Building type*	mean	median
Libraries	2.1 yrs.	2.1 yrs.
Middle/High Schools	2.6 yrs.	2.1 yrs.
Offices	2.0 yrs.	2.3 yrs.
Retail	1.6 yrs.	1.6 yrs.

**with payback data for more than one building*

Incremental first costs averaged $1.18 per square foot for the 16 buildings that had first cost data available. Ten buildings kept incremental first costs under a dollar per square foot, while still achieving annual energy cost savings of more than 30 percent.

6.

Less energy use keeps those savings in Minnesota to support the local economy.

A little-recognized impact of green building is its benefit to the local economy. Money spent on energy generated from fuels imported to Minnesota leaves the state and is a net drain on the local economy. The energy-efficient design of green buildings frees up annual energy savings for investment in Minnesota. The median energy cost savings for the 14 high-performance elementary/middle/high schools included in the study is more than $58,000 annually, based on 2005 energy prices. These are saving that can be spent on classroom instruction every year. For the five high-performance retail buildings in the study, the median annual energy cost savings is more than $162,000. These savings go directly to the bottom line, increasing profitability that helps fuel business expansion and job growth.

Karges-Faulconbridge, Inc. (KFI)

KFI reused the shell of a former grocery store to create their engineering firm's headquarters. Benefits included ease of winter construction and up-front shell cost savings of $40/square foot. KFI replaced much of the parking lot with natural prairie grasses, wildflowers, and a raingarden—increasing green space on the 3.6-acre lot by 54%. KFI piloted the LEED-Existing Buildings rating system and is the first LEED-EB certified building in Minnesota to receive a gold rating.

Many different technologies are demonstrated in the facility. A closed-loop, ground-source heat pump system heats and cools the building. Displacement ventilation in the open office areas enhances the indoor air quality and reduces fan energy. Radiant ceiling panels in bathrooms transfer the heat directly to surfaces. Infrared heating is used in the high bay areas to heat the large thermal mass of the building. A passive desiccant energy recovery wheel captures waste heat from the building exhaust air stream and controls humidity. The building transformation used an integrated sustainable design process with KFI (mechanical & electrical design), Pope Associates (architectural design), McGough (general contractor), and The Weidt Group (Xcel Energy- energy design assistance modeling).

High Performance Buildings: Key Energy Savings Strategies

	Average % Savings Breakdown			
Categories	Office	Retail	Schools	Comments
Improved insulation levels	2%	1%	2%	Commercial buildings have high internal load requirements, reducing the energy required for heating. Improved insulation levels save less than residential projects and are not as cost effective.
Improved window glazing	4%	1%	4%	Similar comment as above. Retail savings opportunities are less due to low glass area-to-floor area ratios.
Calibrated daylight controls	12%	12%	3%	Daylighting is a high-performance strategy that has not reached market saturation. The future of improved savings for this category is high, once various market barriers are reduced including design and construction trade familiarity, and control technology improvements. (Vaidya et. al. 2005)
Lighting controls	8%	7%	15%	Due to the diverse operation of space occupancy and lighting design levels, school buildings have higher opportunities to reduce lighting energy consumption using occupancy sensors and dual-level lighting controls, as compared to offices and retail building types.
Improved lighting design	15%	33%	9%	High savings for retail in this category is the result of the type of retail projects in the sample set. Large "big box" retail buildings can easily meet the requirements of the current energy code, due to lower industry standard light level requirements.
Improved heating efficiency	3%	2%	4%	Based on energy costs, natural gas rates as compared to electric rates per unit of site energy have been much lower over the sample period reviewed, providing less opportunities for large dollar savings. Technology improvements in high efficiency gas equipment range from 5 to 10% better than the code.
Improved cooling efficiency	14%	3%	6%	Improved cooling efficiencies are greatest for offices since they operate through out the summer months as compared to school buildings.
Load responsive HVAC design	35%	11%	15%	Use of variable-frequency drives on air-handler systems is significant. In the future, for many buildings, this will be a code requirement.
Conditioning of outside air	7%	21%	41%	New school IAQ criteria require high ventilation loads providing larger opportunities for energy recovery strategies as compared to office and retail building types.
Refrigeration	0%	11%	0%	Retail with refrigerated case work provides many opportunities for improved savings.

For more detailed information on these strategies, see the study *High Performance Building Design in Minnesota*. Visit www.pca.state.mn.us/oea/greenbuilding/cost.cfm.

High-performance buildings featured in this study *(partial list*)*

Dittmann Center
1520 St. Olaf Ave.
Northfield, MN 55057

Winona State Science Bldg.
400 Winona St.
Winona, MN 55987

Burroughs Community School
1601 West 50th St.
Minneapolis, MN 55419

WMEP Interdistrict Downtown School
10 South 10th St.
Minneapolis, MN 55403

Jordan Park Community School
1501- 30th Ave. N.
Minneapolis, MN 55411

Nellie Stone Johnson Community School
807 27th Ave. N.
Minneapolis, MN 55411

Monticello High School
5225 School Blvd.
Monticello, MN 55362

Hopkins West Junior High School
3830 Baker Road
Minnetonka, MN 55305

Karges-Faulconbridge, Inc.
670 W. County Road B
St. Paul, MN 55113-4527

General Mills JFB Technical Center
9000 Plymouth Ave. N.
Golden Valley, MN 55427

Eagan Community Center
1501 Central Parkway
Eagan, MN 55121

College of St. Catherine
St. Paul Library
2004 Randolph Ave.
St. Paul MN 55105

Fairview Red Wing Medical Center
701 Fairview Blvd.
PO Box 95
Red Wing, MN 55066

Hassan Elementary School
14055 Orchid Ave.
Rogers, MN 55374

Providence Academy
15100 Schmidt Lake Road
Plymouth, MN 55442

Crosswinds Arts and Science Middle School
600 Weir Drive
Woodbury, MN 55125

Arlington High School
1495 Rice St.
St. Paul, MN 55117

Crossroads Elementary
543 Front St.
St. Paul, MN 55117

Lakeview School
875 Barstad Road
Cottonwood, MN 56229

** This list is based on owners who gave permission to be identified in the study.*

Notes

1. The Weidt Group analyzed data from buildings that received Xcel/NSP Energy Design Assistance (provided free to buildings 50,000 sq. ft. or more in the early design phase). The building performance data is based on a subset of over 170 building projects The Weidt Group had modeled from 1994 to 2005. The study results reflect only buildings designed to perform at least 30 percent better than Minnesota energy code, that participated in the Xcel/NSP program, and whose data could be verified. There are other high-performance buildings in Minnesota that were not included in the study because they reside outside Xcel Energy's service territory. The modeling was based on energy simulations using DOE2.1E and incorporating the local DOE-2 TMY weather file. The conversion of pollution savings from gas and electric energy generation was based on the current Xcel Energy aggregate generation blend of air emission for each pollutant source. The conversion to energy cost savings was based on the design year of each building. The Weidt Group subsequently provided multipliers (for gas savings, and an average virtual rate for electric savings that accounts for demand electric) to convert all energy cost savings amounts to reflect 2005 energy prices.

2. 2005 average annual emissions for a light duty passenger vehicle: 0.462 lbs. SO_2, 3.83 lbs. NOx, 0.971 lbs. particulates, and 4.9 tons CO_2.

Minnesota Pollution Control Agency
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www.pca.state.mn.us/greenbuilding • 651-296-6300 • 800-657-3864

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