

# Green Building: Essential Design Strategies for a Sustainable Future

Presented by:

Armstrong Ceiling Systems  
Oldcastle Glass®  
Sloan Valve



## CONTINUING EDUCATION

Use the learning objectives below to focus your study as you read **Green Building: Essential Design Strategies for a Sustainable Future**. To earn one AIA/CES Learning Unit, including one hour of health, safety, welfare credit, answer the questions on page 191, then follow the reporting instructions on page 191 or go to the Continuing Education section on [archrecord.construction.com](http://archrecord.construction.com) and follow the reporting instructions.

### LEARNING OBJECTIVES

After reading this article, you should be able to:

- Evaluate how to reduce environmental impact and building energy costs through sustainable design
- Identify performance characteristics of solar insulating glass
- Analyze the sustainability benefits of a recycling program for mineral fiber ceiling tiles
- Explain why water conservation is important to the environment
- Implement water conservation strategies with water efficient plumbing fixtures and valves, including high efficiency toilets, dual flush toilets, waterless urinals, and electronic faucets

# Green Building: Essential Design Strategies For a Sustainable Future

Leveraging Environmentally Efficient, Economic Solutions with Solar Insulating Glass, Ceiling Recycling Programs, and Water Conservation

*"This is an opportunity for bipartisanship, an opportunity to find our better selves, and in rising to meet this challenge, create a better brighter future – a future worthy of the generations who come after us and who have a right to be able to depend on us."*

- Former Vice President Al Gore, policy address on Solving the Climate Crisis, New York University School of Law, September 18, 2006

By: Barbara A. Nadel, FAIA

Buildings have an average lifespan ranging from 50 to 100 years. Recent studies indicate that buildings are the biggest source of energy use and greenhouse gas emissions, which in turn impact the world's climate changes. Most architects know that buildings can be designed to operate with far less energy than many U.S. buildings are currently consuming. Design professionals and the building industry are developing innovative approaches to improve energy efficiency and reduce annual operating costs to building owners through advanced technology and a variety of sustainable design practices.

"Benefits such as energy, water and operational cost savings, improved air quality, and increased productivity are drawing more attention to green building issues. Congressional leaders are discussing how to best support sustainability initiatives through legislation," says Don Horn, AIA, LEED-AP, Director, Sustainable Design Program, Office of Applied Science, U.S. General Services Administration Public Buildings Service, Seattle, Washington.

Architects are well positioned to educate the public, facility managers, building owners, and elected officials about the clear economic benefits of sustainable design. Environmental design best practices and goals are achieved through attention to proper siting, building form, glass properties and location, material selection, heating, cooling, ventilation, day-lighting, and increasingly, water conservation through efficient plumbing fixtures.

"Conservation of natural resources is an imperative for the socially responsible architect. Addressing sustainability requires that we

**Benefits such as energy, water and operational cost savings, improved air quality, and increased productivity are drawing more attention to green building issues.**



redefine boundaries of traditional practice. The idea of an isolated building on a site is no longer acceptable. Buildings belong to a larger community and must begin to support and sustain our environment," observes Harry Warren, AIA, Design Principal, Cannon Design, Grand Island, New York.

This article will explore avenues for increasing sustainability in building design through use of solar insulating glass, recycling programs for mineral fiber ceiling panels, and water conservation strategies with efficient fixtures. Case studies from public agencies and private sector practitioners will illustrate how these principles are being applied in civic facilities, universities, nonprofit organizations, and the hospitality industry.

## Solar Insulating Glass

Architectural glass is a highly visible building envelope design component, especially for commercial and public facilities. As sustainability and energy costs take on greater importance for building owners, environmental performance ranks high among the many design and specification criteria used by architects when reviewing architectural glass options.

Solar insulating glass delivers several significant advantages, such as reducing glare, increasing thermal control and environmental comfort for building occupants, and generating savings on heating, ventilation and air conditioning (HVAC) equipment, as well as long term annual operational costs.

## Characteristics of Insulating Glass

Insulating glass units are hermetically sealed combinations of two or more lites of glass separated by a dry airspace. They improve thermal performance, significantly reducing heat and air conditioning costs, and reduce interior condensation in cold climates. Insulating glass units are used in almost all exterior building applications, including fixed and operable windows, storefronts and curtain walls, sloped and overhead glazing and skylights, and in vision and spandrel (nonvision) locations.

Depending on the glass type used, insulating glass units can be designed for light and solar control, sound control, and ultraviolet screening (to reduce fading of materials and fabrics), hurricane, earthquake, and blast resistance, security, bullet resistance, and decorative applications. Insulating glass units are fabricated according to project specification. They can be constructed using a large variety of glass products to achieve desired aesthetic appearance, meet design criteria, building codes, and improve thermal control and building performance. Glass options include clear, low iron, Low-E, standard or high performance (spectrally selective) tints, reflective, silk-screened, spandrel, laminated, decorative, and wired glass. The glass lites of an insulating glass unit can be annealed, heat strengthened, tempered or laminated.

Standard one-inch insulating glass units generally consist of two lites of 1/4-inch glass and a nominal 1/2-inch air space. Custom insulating glass unit designs can be made in several glass thicknesses. Maximum sizes for insulating glass units are determined by several considerations including thickness, weight, aspect ratio, application, and load requirements.

Many insulating glass units are independently tested and certified according to North American standards for quality and performance, and pass the highest level (Class CBA) of the ASTM E773/E774 specification.

The tests are validated by the Insulating Glass Certification Council (IGCC), which sponsors the certification program in the U.S.

### Low-E Coatings

By combining low-emittance (Low-E) coatings, standard and high performance tinted glasses, reflective coatings, silk-screened patterns, and laminated glass products, a variety of insulating glass configurations are available to meet a range of performance and aesthetic requirements. They can be designed to reduce heat loss and solar heat gain entering the building, with a minimal reduction of visible light transmittance.

Soft coatings are applied to the glass as a sputter coat, and are easy to scratch. Hard coatings are applied on a float glass by the manufacturer, and the process is embedded in the end product. Coatings applied at the factory to tempered glass and baked in produce post-temperable high performance coated glass. Most of these coatings perform as well as hard coats.

"Post-temperable Low-E coating technology has dramatically matured over the past few years, affording unprecedented solar control performance benefits. It is now possible for an insulating glass unit to block 70 to 75 percent of the solar heat while passing 50 to 65 percent of the visible light. By utilizing advanced solar control insulating glass in buildings, architects can achieve impressive energy savings without compromising on aesthetics or design," says Daipayan Bhattacharya, Vice President of Business Development and Technology, Oldcastle Glass®, Inc., Santa Monica, California.

Low-emittance coatings are microscopically thin, virtually invisible, metal or metallic oxide layers deposited on a window or skylight glazing surface primarily to reduce the U-factor by suppressing heat flow. The principal mechanism of heat transfer in multilayer glazing is thermal radiation from warm surfaces to cooler surfaces. Coating a glass surface with a low-emittance material reflects a significant

amount of this radiant heat, thus lowering the total heat flow through the window. Low-E coatings are transparent to visible light, and opaque to infrared radiation. Different types of Low-E coatings have been designed to allow high solar gain, moderate solar gain, or low solar gain.

In the summer, Low-E glass filters long-wave solar radiation, reducing solar heat gain as a result of the sun's direct rays. During the winter, Low-E glass lets in warm, short wave rays, and helps block the warm air inside, rather than allowing it to escape through the pane, so less heating is needed to maintain a comfortable environment. In addition to energy savings, Low-E reduces the amount of transmitted ultraviolet light, which can damage carpets, fabrics, and drapes.

The Light to Solar Gain (LSG) ratio is a common glass performance characteristic that measures potential environmental impact and performance and is used to compare glass products. LSG considers the percentage of visible light a glass transmits and the solar heat gain through the glass relative to the incident solar radiation.

An analysis indicates the value of some solar insulating glass products outperform high-performance solar control Low-E glass. The higher the LSG value, the better the glass performs at transmitting daylight and reducing heat gain from the sun. When three types of glass were tested for LSG, solar insulating glass showed an LSG value of 2.01, compared to high-performance Low-E glass at 1.44, and clear insulating glass at 1.12.

### Colleges and Universities: Energy Management

The Minnesota State Colleges and Universities (MnSCU), representing 26 million square feet and one third of all the state's building square footage, is advancing energy efficiency on campuses through design and construction. "We are pursuing 'Benchmark, Monitor, Train, and Change' to get facility managers to seek areas where efficiency can be improved," says Sally Grans, AIA, System Director, Facilities Planning and Programming, Minnesota State Colleges and Universities, St. Paul, Minnesota.

Energy efficient practices being implemented include lowering overall campus temperatures, reducing temperature during unoccupied hours and in areas not used (by zoning); saving energy through Energy Star® programs, such as purchasing computers with sensors that trigger automatic shutdown when not in use; reducing energy using technology in plumbing, electrical (such as occupancy sensors), and HVAC systems; and operational equipment adjustments and routine maintenance (such as steam traps, filters, and pumps).

Public-private partnerships also play a role in setting an energy efficiency agenda for public buildings. "MnSCU is part of a group working with a private energy consultant and examining the alternative fuel sources needed to offset new buildings in a climate-neutral setting. We hope to bring forward to the 2007 legislative session language that will reduce the greenhouse gases in the proposed bonding bill," Grans adds.

### Recycling Ceilings Preserves Natural Resources

The life cycle of a building and its related processes and byproducts are important components of the Leadership in Energy and Environmental Design (LEED®) green building rating system, sponsored by the U.S. Green Building Council (USGBC). The LEED®



The Light to Solar Gain (LSG) value far outperforms solar control Low-E glass. The higher the LSG value, the better the glass performs at transmitting daylight and reducing heat gain from the sun.

rating system is a nationally accepted benchmark for design, construction, and operation of high performance green buildings.

Recycling ceiling panels is an environmentally sound approach to reusing natural materials that illustrates how innovative products can contribute to protecting the environment, by preserving natural resources and reducing the environmental footprint. Industry experts estimate that more than 30 million square feet of ceilings have been recycled since 1999.

### Cradle-to-Cradle Cycles

Within the building industry, some manufacturers have implemented recycling programs that support cradle-to-cradle cycles, whose materials are perpetually circulated in closed loops. Maintaining materials in closed loops maximizes material value without damaging ecosystems. In contrast, cradle-to-grave products are dumped in landfills at the end of their useful lives. William McDonough, FAIA, of McDonough Braungart Design Chemistry, Charlottesville, Virginia, developed this approach to create products and systems that contribute to economic, social, and environmental prosperity.

Ceiling manufacturers have developed innovative approaches and products to advancing sustainability through a multi-phased, closed-loop process. The net result of such programs encourages industry innovation and reduces the environmental impact of building materials.

- **Design** of new ceilings includes renewable raw materials, reuse of post-consumer and post-industrial waste materials.
- **Manufacturing** recycles in-process scrap and process water, so that minimal water is discharged. When multiple manufacturing locations are available, transportation costs and environmental impact are reduced.
- **Installation** time can be decreased with minimal packing material. Packaging materials can contain 30 to 40 percent recycled content.
- **Indoor Environmental Quality** is enhanced when sustainable ceiling products are used, resulting in low emissions. Other potential advantages include acoustical performance, reduced glare, and lower energy costs.
- **Maintenance** is minimal because of easy replacement. Sustainable tiles are washable, soil resistant, and can inhibit or retard mold and mildew on the ceiling surface.
- **Reclaiming** old tiles for a recycling program is done by the manufacturer, who covers the costs.
- **Recycling** programs are national in scope, and can cover all ceilings and suspension systems, use recovered material to make new ceilings, and less virgin materials.

"An effective ceiling recycling program is designed to reduce the impact on the environment by redirecting used ceiling tiles from landfills back to the manufacturer, thereby creating a closed-loop process and offering a valuable end to what typically would have been thrown away," says Anita Snader, Associate Marketing Manager, Environmental Programs, Armstrong Ceiling Systems, Lancaster, Pennsylvania.

Disposing of old mineral fiber ceilings through a recycling program has several benefits. Owners can avoid landfill fees, dumpster, handling and transportation costs, if ceiling tiles are picked up by designated contractors. During demolition, removing old ceilings for recycling provides an early view of potential problems, structural issues, and abatement needs, and an orderly ceiling removal eliminates confusion and space limitations. Recycling makes less of a landfill impact, preserves natural and energy resources, and saves raw materials. Recycling old ceilings may be as fast as dumping them, with little adverse impact on demolition schedules.

### Sustainable Ceiling Products

Some mineral fiber ceilings, suspension systems, and recycling programs can help achieve sustainable goals, especially when applied to LEED® ratings and credits in new construction (NC), existing buildings (EB) and commercial interiors (CI), in the energy and materials categories.

To optimize energy performance, high light reflectance ceilings provide more workplace luminance with fewer luminaires, and they meet the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard by the required 20 percent for new buildings and 10 percent for renovations.

Mineral fiber ceilings offer several benefits under the Materials and Resources LEED® category:

- **Construction Waste Management:** A closed-loop recycling program reclaims and reuses old mineral fiber ceilings from renovation projects.
- **Recycled Content:** Ceilings that contain high levels of recycled content, either post-industrial waste or post-consumer products, fall into this category. The amount of recycled content varies by product; however, the range includes mineral fiber (22 to 82 percent), fiberglass (40 percent), wood (45 percent), metal (25 percent), and suspension systems (25 percent).
- **Local/Regional Materials:** Multiple plant locations reduce the environmental impact of transportation from manufacturing facilities to building projects.
- **Rapidly Renewable Materials:** Mineral fiber ceilings contain cornstarch, a rapidly renewable material. Some ceiling tiles reuse post-consumer and post-industrial waste. Among the materials often used for recycled ceiling products are cornstarch, mineral wool (from a steel industry by-product), recycled paper (such as newspapers and telephone books), perlite (a naturally mined material, and recycled ceilings (from renovation projects).

### Bamboo: Innovative Use of a Renewable Material

Vertically grained bamboo ceiling panels feature the inherent characteristics of natural bamboo to help create a warm ambiance and a memorable design statement. As a rapidly renewable resource, bamboo panels are sustainable, and can contribute to LEED® credits under the Materials and Resources category.

The natural look of bamboo ceilings is suitable for retail, hospitality, healthcare, higher education, office environments, lobbies, entrances, and conference rooms. Some bamboo ceiling products offer narrow reveals that minimize the grid, creating a more monolithic appearance than with other suspended ceilings. Perforated and unperforated options are available, with perforated ceilings providing acoustical control when used with an acoustical infill pad.

### Minnesota's Sustainable Design Guide

The State of Minnesota's Sustainable Design Guide ([www.msdc.umn.edu](http://www.msdc.umn.edu)) educates architects, building owners, occupants, educators, students, and the public, and describes many environmental goals for state projects. "These Guidelines and the new State of Minnesota Buildings, Benchmarks, and Beyond are a constant reference for us, as illustrated in our DNR Windom Consolidated Headquarters, which was a pilot project discussed on the website," says Edward J. Kodet, FAIA, Principal, Kodet Architectural Group, Minneapolis, Minnesota.

"We routinely use sustainable materials in our educational facilities, including those from recycled materials, with low environmental impact, and those requiring minimal environmental costs to manufacture. We maintain a log of materials and their response to environmental impact," Kodet says.

*As a rapidly  
renewable resource,  
bamboo panels are  
sustainable.*

CLICK FOR ADDITIONAL REQUIRED READING

The article continues online at <http://www.archrecord.com/resources/conteduc/archives/0611green-1.asp>  
To receive AIA/CES credit, you are required to read this additional text. The quiz questions below include information from this online reading.

AIA/ARCHITECTURAL RECORD  
CONTINUING EDUCATION Series

LEARNING OBJECTIVES

After reading this article, you should be able to:

- Evaluate how to reduce environmental impact and building energy costs through sustainable design
- Identify performance characteristics of solar insulating glass
- Analyze the sustainability benefits of a recycling program for mineral fiber ceiling tiles
- Explain why water conservation is important to the environment
- Implement water conservation strategies with water efficient plumbing fixtures and valves, including high efficiency toilets, dual flush toilets, waterless urinals, and electronic faucets

INSTRUCTIONS

Refer to the learning objectives above. Complete the questions below. Go to the self-report form on page XX. Follow the reporting instructions, answer the test questions, and submit the form. Or use the Continuing Education self-report form on *Record's* web site—[archrecord.construction.com](http://archrecord.construction.com)—to receive one AIA/CES Learning Unit including one hour of health safety welfare credit.

QUESTIONS

1. Which statement describes the characteristics of solar insulating glass?
  - a. Small hairline cracks can form under severe cold conditions
  - b. It expands under prolonged high temperatures
  - c. It reduces glare, increases thermal control and environmental comfort for building occupants
  - d. Special window film is applied to the glass to reduce condensation in cold weather
2. What is the commonly used term that describes characteristics measuring environmental impact and glass performance?
  - a. Solar Heat and Radiation Gain Coefficient
  - b. Light to Solar Gain Ratio
  - c. Visible Solar Light Transmittal Factor
  - d. Infrared Radiation Exponent
3. Which term describes materials that are perpetually circulated in closed loops?
  - a. Cradle-to-grave cycle
  - b. Cradle-to-cradle cycle
  - c. Industrial recycling
  - d. Reclamation of industrial waste
4. Bamboo ceilings do not provide acoustical control due to their sound transmission ratings.
  - a. True
  - b. False
5. Which does not describe advantages of disposing of old mineral fiber ceilings through a recycling program?
  - a. During demolition, removing old ceilings provides an early view of potential problems
  - b. Owners can avoid dumpster fees, handling and transportation costs
  - c. Recycling always requires long lead schedules for designated pick-ups
  - d. Creates less of a landfill impact
6. What materials are most commonly used for recycled ceiling products?
  - a. Mineral wool, vermiculite, cedar wood chips
  - b. Baking soda, soy byproducts, vermiculite
  - c. Crushed glass, telephone books, calcium sulfite
  - d. Cornstarch, newspaper, perlite
7. Federal water energy mandates require which standard for toilet fixtures?
  - a. 1.6 maximum gallons per flush
  - b. 3.6 liters per flushometer
  - c. 1.28 minimum gallons per flush
  - d. 1.3 maximum gallons per flushometer
8. Which of the following is true for hardwired and battery operated faucets and flushometers?
  - a. Battery operated products are driven by solar power
  - b. Hardwired and battery operated fixtures have the same first costs
  - c. Hardwired flushometers and faucets are best suited for new construction
  - d. Batteries are generally changed on average every 5 years, based on 10,000 activations per month.
9. Which statement does not describe a High Efficiency Toilet?
  - a. Flushes at 1.28 gallons per flush or less
  - b. Offers two low water use flush settings
  - c. Uses a minimum of 20 percent less water than a standard toilet
  - d. Is a non-field adjustable fixture
10. Which of the following is true about water efficient fixtures?
  - a. Dual flush toilets offer a low water use flush setting of between .8 to 1.6 gallons per flush
  - b. Dual flush toilets save water by offering two settings, for manual and automatic
  - c. Waterless urinals use cartridges that are replaced after about 10,000 uses
  - d. A pressure assisted toilet uses a flushometer to create a siphonic flushing action

Barbara A. Nadel, FAIA, principal of Barbara Nadel Architect, in New York City, frequently writes about design and technology. She is the author and editor-in-chief of *Building Security: Handbook for Architectural Planning and Design* (McGraw-Hill, 2004).

CIRCLE 70 ON READER SERVICE CARD OR GO TO [ARCHRECORD.CONSTRUCTION.COM/PRODUCTS/](http://ARCHRECORD.CONSTRUCTION.COM/PRODUCTS/)

***“When organizations understand sustainability, the staff are also educated and install water efficient fixtures at home too,” says Novak.***

## Water Conservation

Energy usage and the consumption of non-renewable fossil fuels have drawn attention for their roles in sustainability design, but water is another fragile resource that many design teams often overlook.

Reducing consumption of potable water and protecting water quality are important to sustainability goals. With growing population and

water demands, many aquifers are being depleted faster than they are being replenished. Weather pattern changes also affect water availability in many parts of the U.S.

The Great Lakes and their connecting channels form the largest fresh surface water system on earth. These freshwater seas hold an estimated six quadrillion gallons of water, about 20 percent of the world’s fresh surface water supply and 95 percent of the U.S. supply. As the global water crisis increases, so does pressure on exporting Great Lakes water. Some consideration has been given to the sale of water as a commodity to fast-growing, water-poor areas such as the American Southwest. These range from proposals for minor diversions out of the basin to mega-projects that would see large scale alterations to the natural flows from as far away as James Bay, Ontario, Canada, through the Great Lakes basin to the American Sunbelt states.

According to sustainability consultant Celeste Allen Novak, AIA, LEED-AP, Principal, Encompass Architecture, Ann Arbor, Michigan, who works with nonprofit organizations near the Great Lakes, “In the past three years, The United Way of Southeastern Michigan has provided building performance assessments to nonprofit groups. The goals are to encourage organizations to minimize waste in their facilities, raise environmental awareness, and achieve significant savings that can be used to deliver more services for Detroit’s underserved residents.”

By educating nonprofit groups about energy efficient fixtures and sustainable design options, Novak helped them save money, and demonstrated how to be better stewards of the environment. As a result, many nonprofits are installing water efficient fixtures. “By converting to low flow fixtures, three groups saved from 27 to over 50 percent off their water bills. When organizations understand sustainability, the staff are also educated and install water efficient fixtures at home too,” says Novak.

### Efficient Use of Water

The challenge for water conservation reflects the need to achieve water efficiency, maintain performance expectations, and reduce costs. Conserving water provides significant cost savings for municipal water systems. Water conservation programs help water systems avoid or postpone expensive infrastructure projects, such as developing new water source supplies, building new treatment plants to handle increased capacity, and expanding infrastructure. The savings achieved through conservation can be redirected to other critical needs.

“Reflecting current environmental trends, the plumbing industry has evolved from addressing excessive uses of water to advocating more conservative water efficient strategies. Several types of fixtures, valves, technologies, and products are available that meet or exceed energy mandates, and promote hygiene and sustainability,” says Peter Jahrling, Director, Design Engineering, Sloan Valve Company, Franklin Park, Illinois.

Water saving fixtures typically conform to the Energy Policy Act of 1992, but many are available which exceed these requirements. There are many plumbing technologies,

fixtures, and styles that support conservation, energy savings, and sustainability to varying degrees, using low and high technology approaches. Several plumbing products use electronics to enhance product performance, hygiene, and water conservation, while reducing maintenance, especially for commercial and industrial applications. Automatic sensors and controls, as well as flow restrictors, are available to limit water usage in faucets. Low flush or waterless urinals and dual flush toilets can reduce water consumption for waste removal.

### Electronic Water Efficiency Devices Provide Options

Automatic valves offer hygienic benefits because they operate electronically, and unlike manual valves, don’t need to be touched. Valve is the vernacular term for flushometer, which is a device for flushing toilets and urinals that utilizes pressure from the water supply system, rather than the force of gravity to discharge water into the bowl. Flushometers are designed to use less water than conventional flush toilets.

Choices of hardwire and battery products are available for flushometers and faucets, and an assisted power turbine or passive solar cell. Electronic faucets provide energy savings for heating water on demand for hand washing, through a dispensing device in the sink. These faucets are energized by excess energy in a light solar panel, extending the battery life inside the fixture by as much as seven to ten years. The battery is located above the vanity counter, also known as the deck.

Turbine generators, which may be located below the counter, augment power for flushometers and faucets. Hardwired, battery operated faucets and flushometers use transformers, which rely on a low voltage power source to the plumbing fixture. Hardwired products are generally more expensive at first cost because an electrician is required for installation. The additional labor costs needed to bring power to the fixture may be offset by longer product life cycle and lower maintenance.

In contrast, battery units, which are not driven by turbines or solar power, must be changed more often. Depending on the manufacturer, batteries last an average of three years, based on 8,000 activations per month and units using alkaline batteries.

There are tradeoffs when reviewing use of hardwired and battery-operated fixtures. Battery powered products are suitable for renovations, because hardwiring isn’t required. The batteries are not harmful to the environment, and do not contain toxins or mercury. However, based on frequency of use, batteries may need to be changed more often.

Hardwired units are more permanent, and are best suited for new construction, rather than retrofits, because their components and electrical loads can be factored into building and power systems. When reviewing selection of hardwired or battery-powered fixtures, life cycle analysis should consider first costs, level of renovation or new construction, power source, and maintenance.

Hardwired units can be a drain on the power grid, but at fractions of a cent per day per fixture. In the long run, this is minimal, depending on usage. Based on an average of 8,000 activations per month per transformer, in 2006, electrical costs can range from two to four dollars a year per fixture. In most cases, the life cycle costs for battery and power-assisted units are comparable. Usage and owner preferences often prove to be decisive factors.

### Water Efficient Plumbing Products

According to the U.S. Environmental Protection Agency (EPA), on average, 50 to 70 percent of residential water is used outdoors for watering lawns and gardens. Inside, toilets use the most water, averaging 20 gallons per person per day. Federal energy mandates call for 1.6 maximum gallons per flush.



High Efficiency Toilets (HET) use a minimum of 20 percent less water than standard 1.6 gallons per flush (gpf) toilets. Thus, any toilet that flushes at 1.28 gpf or less is considered high efficiency. HETs are also known as low consumption, non-field adjustable fixtures, and are suitable for residential and commercial applications. These toilets are available with 1.2 to 1.3 gpf with commercial flushometers, and 1.0 gpf with pressure assisted toilets.

A pressure assisted toilet utilizes the power of the flushometer valve to create a powerful siphonic flushing action. Water fills a sealed tank inside the chinaware tank, creating pressure by displacing air within this sealed tank. When the push button or trip level is activated, the water under pressure rapidly thrusts or pushes waste and water through the bowl. The entire flushing process occurs very quickly, in about four seconds.

Dual flush toilets are manual fixtures that save water by offering a separate, low water use flush setting for liquids (between .8 to 1.1 gpf) in addition to the standard 1.6 gpf for solid waste. The user selects the appropriate flush for liquid or solid waste to conserve water. These toilets are suitable for residential markets, with flushometers often used in commercial applications.

Waterless urinals offer several benefits, especially in airports, sports facilities, and public venues with high volumes and low maintenance needs. The costs may be justified by the price of water. They can reduce maintenance, water, and repair bills, and create hygienic, odor-free restrooms. Typically, waterless urinals contain a replaceable and biodegradable liquid-sealed cartridge, installed in the base of the urinal, which is replaced after about 7,000 uses. Multiplying each use by 1.6 gallons of water (to compare with low-flow toilets) or by 3.5 (to compare with older units) can result in a savings of 9,600 to 24,500 gallons of water.

### Greywater

Reusing greywater is an emerging water efficiency trend. Greywater consists of 50 to 80 percent of residential wastewater, generated from washing dishes, laundry, and bathing. It is not fresh like white water, which is potable, nor heavily polluted like blackwater, with toxic chemical and biological contaminants. Greywater is easier to treat and eliminate than blackwater, but is still considered a health and pollution hazard if released into the natural environment untreated.

In recent years, dwindling reserves of groundwater and overloaded or expensive sewage treatment plants have generated interest in reuse and recycling of greywater, especially for irrigation. However, the potential health and environmental risks have not been fully researched or understood by most authorities. The benefits of greywater reuse include less strain on treatment plants, effective use in topsoil, less energy and chemical use, plant growth, and reclamation of otherwise wasted nutrients. Greywater reuse is popular in California, Florida, and desert areas, where freshwater is at a premium.

### Government Water Efficiency Initiatives

Water efficiency initiatives promote sustainability in several ways that benefit municipal water systems, governments, consumers, and taxpayers, including:

- **Producing long-term savings by extending the useful life of water system infrastructure, and lowering costs of new investments.** Instead of building an oversized treatment plant, water systems can save money by building smaller plants and offering customers incentives to retrofit plumbing fixtures. The system benefits from increased treatment plant efficiency and reduced energy costs.
- **Withstanding droughts.** Year round water efficiency programs help communities plan for peak demands and reduce the need for drastic policies during droughts. Improved water efficiency allows treatment plants to produce high quality water a lower cost.
- **Protecting the environment.** Reducing water waste and consumption decreases the need to impound streams and rivers, thus preserving aquatic systems as wildlife habitat, and reduces energy consumption.

Reduced volume showers are available and reflect newly adopted government standards. Water Sense® is an EPA-based program ([www.epa.gov/watersense](http://www.epa.gov/watersense)) that provides water efficiency information to consumers, businesses, utilities and communities. California's WaterStar® Initiative is a water-efficient product rating and labeling program, that supports and complements the EPA's Energy Star® program.

### Federal Buildings Illustrate Water Saving Technologies

The U.S. General Services Administration (GSA) is a leader in sustainable design, and requires all its new federal buildings since 2003 to achieve LEED® green building certification. More than 17 of GSA's new buildings, renovations, and leased facilities have achieved LEED® ratings, and nearly 100 others are registered and working toward certification, says GSA's Don Horn, AIA, LEED-AP. Several case studies illustrate best water conservation practices being applied in federal buildings.

The Carl T. Curtis Midwest Regional Headquarters for the National Park Service in Omaha, Nebraska, incorporates waterless urinals, low-flow urinals, and dual-flush toilets, for a 38 percent reduction in water use over conventional means. The placement of water savings fixtures was carefully planned to educate visitors to new alternatives, and for building occupant convenience. Water conservation was only one of many green features which earned the GSA lease-construction project a Gold LEED® rating from the U.S. Green Building Council.

Capturing and reducing rainwater also helps reduce the use of potable water. A storage tank, filtering system and dual plumbing lines can create a system to use rainwater, rather than treated drinking water, for flushing toilets and meeting other functional needs. The U.S. Environmental Protection Agency (EPA) Science and Technology Center in Kansas City, Kansas, uses rainwater to reduce water consumption by 40 percent for flushing toilets and urinals, and to offset potable water use in the cooling tower by 15 percent. This building achieved a Gold LEED® rating, and was developed under a lease through GSA to meet EPA's needs for a modern, efficient laboratory.

Effective stormwater management and low-impact development practices can help to protect water quality and recharge local aquifers. Optimizing stormwater strategies on-site can avoid storm sewer infrastructure costs and avoid concentrations of pollutants downstream. The Federal Campus in Oklahoma City, built by GSA, has a parking lot of permeable paving to allow water to slowly absorb into the ground below. Trees throughout the parking lot will benefit from the moisture and provide shade to prevent increased temperatures from the paved surface, thereby reducing the urban heat island effect. Landscaping around the building perimeter consists of native prairie grasses and plants requiring no irrigation after they have been established. A smaller section of turf grass is maintained at the main entrance.

"Sustainable practices must reflect the environs in which a structure is placed, including storm water management. In Minnesota, we must be able to design solutions that are specific to this region, where there is an abundance of rainwater and lakes," says Edward J. Kodet, FAIA.

***Sustainable practices must reflect the environs in which a structure is placed.***

### Energy Savings in Public Buildings

Minnesota State Colleges and Universities (MnSCU) has found innovative ways to conserve energy through commissioning, and monitoring use with life cycle software. "In the past five years, we've used third party financing for 18 major HVAC, lighting and related projects to save energy. We've spent about \$500,000, and in the next 10 years, we estimate a payback of over \$1.3 million. Energy management systems are installed at 37 of our 53 campuses. MnSCU is actively commissioning all new buildings, and is in the process of recommissioning existing structures to improve their energy functions. Our agency just

received two federal grants to recommission existing 40 year old campuses," says Sally Grans, AIA.

MnSCU uses software that calculates life cycles of existing structures, by building, and system. From this, a database is developed that indicates the deferred maintenance backlog, and future renewal needs for system replacements, such as roofing, HVAC, and windows.

### Sustainable Hotel in California

San Francisco's Orchard Garden Hotel will be California's first hotel to be LEED® certified under the LEED-NC rating system for new construction. According to William J. Higgins, AIA, principal of Architecture International, Mill Valley, California, "The hotel's sustainable features include low flow water fixtures, low organic gas emissions (from paint, carpets, and varnishes), recycled interior finish products, Forest Stewardship Council certified maple wood furniture, and a green education center for the public."

In addition to following sustainability strategies for LEED-NC, the Orchard Garden Hotel will use several environmentally sound operational strategies. "The hotel has chosen citrus-based cleaning products that clean as well as harsh chemicals, but are healthier for staff and guests. They will also use recycled paper with soy-based ink, offer an open-air rooftop deck, and a smoke-free environment. This will be San Francisco's first hotel to use a guestroom key card system that controls each room's lighting, heating, ventilation, and air conditioning. This system, used widely in Europe and Asia, is expected to save 20 percent in energy consumption," adds Higgins.

### Puerto Rico: Tropical Climate Sustainability Initiatives

In San Juan, Puerto Rico, architects are educating the public and government officials about the benefits of sustainability. "We have met with political leaders to include sustainability as part of a public policy on building design and construction. Legislation is

now under consideration to initiate the use of the LEED® rating system for government buildings. The U.S. Green Building Council Caribbean Chapter is discussing the possibility of introducing the use of net metering as a way to make solar electric generation a feasible proposition to the local power utility. Forty states and the District of Columbia have begun net metering programs in the U.S. and we don't see why Puerto Rico can't do the same," says Fernando Abruna, Ph.D., FAIA, Abruna & Musgrave, Arquitectos, San Juan, Puerto Rico. Abruna teaches a Sustainable Studio at the University of Puerto Rico School of Architecture, where he works with the USGBC chapter of Emerging Green Builders, to expand student participation and awareness of sustainability best practices.

"In Puerto Rico and the Caribbean region, a hot, humid tropical island climate, we are more accustomed and tolerant of higher humidity levels than people coming from other drier environments. The redefinition of comfort zones on a regional, rather than a national, basis should be able to address natural ventilation in tropical climates like ours in the Caribbean, and in Hawaii, for example, so that LEED® credits can be achieved under this scenario. Such a revision in the criteria would make lower energy consumption in mechanical air conditioning systems more feasible," Abruna observes.

### Toward a Sustainable Future

Attention to solar heat gain, material recycling, and water conservation provides design professionals with many opportunities to advance sustainability in building projects. By understanding the technology and characteristics of solar insulating glass, recycling programs for mineral fiber ceilings, and the environmental benefits of installing water efficient fixtures and valves, architects and building owners can realize short term savings in capital construction costs, and long term savings in annual operational costs.

Public agencies and nonprofit groups can then redirect these financial resources toward other important civic needs. The benefits of sustainable design and energy efficiency are among the many reasons to advocate a lasting environmental policy worthy of the generations who come after us.

Milwaukee School of Engineering  
Courtesy of Oldcastle Glass®

