BEGINNER'S GUIDE TO GREEN BUILDING

by Rob Freeman Jr. LEED AP, GPRO O+M

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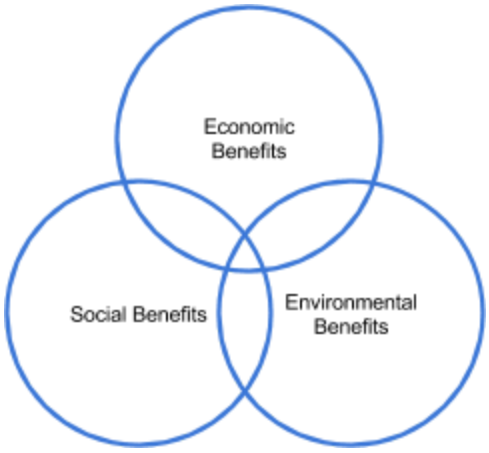
What is Green Building?

Green building is a real estate development approach that applies the concept of sustainability across the entire real estate lifecycle.

For some people, the term "sustainability" only brings to mind visions of tree hugging hippies and granola… But this is silly.



The fact is that green building is a "bad ass" endeavor with a serious scientific and economic rationale.

Green building strategies harness the power of energy efficiency and clean energy technologies to boost real estate performance from initial design and development to operations and maintenance, and ultimately, to deconstruction.

Study after study indicates that implementing commercial green building strategies can:

- Reduce building operating expenses
- Reduce tax liabilities
- Increase rents
- Boost occupancy rates and reduce tenant turnover
- Reduce greenhouse gas emissions
- Improve building occupant productivity and well-being
- Deliver higher Net Operating Income (NOI)
- Increase asset value
- Reduce cap rates

The strategies described in the **Beginner's Guide to Green Building** can be applied to any property to increase profit, improve occupant health and reduce environmental impact and provide a "Triple Bottom Line" of **economic**, **social** and **environmental** benefits.

The Beginner's Guide to Green Building also provides an overview of what you need to understand to earn a professional green building credential, such as the **LEED Green Associate**. The LEED Green Associate is a professional green building credential offered by the **U.S. Green Building Council (USGBC)**, the developer of the LEED rating systems.

Applying Green Building Basics

Anyone can learn and apply the five basic green building concepts to commercial, multi-family residential, industrial properties or data centers.

The five basic green building concepts covered in this guide are:

1. Sustainable Sites
2. Water Efficiency
3. Energy & Atmosphere
4. Materials & Resources
5. Indoor Environmental Quality

Whether you seek a professional green building credential or not, with this basic knowledge you can help your clients evaluate and improve the performance of their real estate or business operations.

In addition to the **LEED Green Associate credential**, USGBC offers the more advanced **LEED AP** (accredited professional) specialty credential. The LEED AP with Specialty is a more advanced green building professional credential with paths to focus on:

- New construction
- Existing buildings operations and maintenance
- Commercial interiors
- Homes

Fortune 500 companies are recognizing the value of employee sustainability knowledge as they increasingly adopt green building strategies such as renewable energy, green building certification, such as LEED, and clean energy technologies. LEED credentials are increasingly recognized in the commercial marketplace for their value and application in businesses of all kinds.

To learn more about becoming a LEED Green Associate and how to pass the exam, read the Free LEED Green Associate Study Guide on Poplar Network.

What is LEED?

LEED, short for **Leadership in Energy and Environmental Design**, developed by the U.S. Green Building Council, is a voluntary, consensus based standard for rating and certifying green buildings.

Although LEED is synonymous with green building and offers many benefits, you do not need to pursue LEED certification to implement the green building strategies in this guide.

However, because LEED's framework is established, it is useful tool even if you are not interested in having your building LEED certified.

LEED offers a good framework for understanding, implementing and measuring green building design, construction, operations and ongoing maintenance.

The **Beginner's Guide to Green Building** provides an overview of the basic aspects of the following LEED credit categories:

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality

While there are other green building rating systems[1], LEED is arguably the most well known and widely accepted. As of this writing, LEED has over 12 billion square feet of building space registered or certified, with 1.85 million square feet being certified each day.

You can think of LEED as a puzzle with five major pieces, or categories, of sustainability. Within each LEED credit category, you'll find multiple strategies for efficiency and cost savings. The following five categories work together in the LEED rating system:[2]

1. Sustainable Sites
2. Water Efficiency
3. Energy & Atmosphere

[1] The U.S. Green Building Council (USGBC) developed the LEED rating systems and works with Green Business Certification Inc. (GBCI) to certify buildings. LEED's rating system applies to almost every building type, from residential to commercial. Other green building rating systems include Living Building Challenge, ENERGY STAR (EPA), BREEAM (UK), Green Star (Australia) and Green Globes.

[2] Technically there are more than five categories within LEED, but these are the major ones that we will focus on in the Beginners Guide to Green Building. These five categories are by far the most impactful and the source of 90% of the credits that determine how "green" a building is within the LEED rating systems. To learn more about how LEED works, please visit USGBC.org.

4. Materials & Resources
5. Indoor Environmental Quality

Each category offers an approach to building green. There are requirements for minimum levels of performance within the building, called **Prerequisites**, and additional optional strategies, called **Credits**, for exceeding performance within a category.

To earn a LEED rating, buildings are required to fulfill the prerequisites and earn additional credits within each category.

Credits are worth points which are accumulated toward a LEED rating and the points are weighted by environmental impact... The greater the positive impact on the environment, the more points may be earned. LEED ratings are available at incrementally higher levels of points:

- Certified: 40-50
- Silver: 51-60
- Gold: 61-70
- Platinum: 71-80+

1. Sustainable Sites

A sustainable site is a building site that is built or designed to minimize any negative impact on its surrounding environment. The common strategies for achieving a sustainable site are:

- Minimize Impact
- Maximize Density
- Restore Environmental Damage
- Leverage Existing Infrastructure

Minimize Impact

New and renovated green building construction sites should limit any disturbances to the surrounding area and/or seek to preserve native vegetation and local habitats.

Avoid negative impacts to sensitive or protected areas, such as natural water bodies, streams, lakes, rivers and wetlands[3], which support natural vegetation and help with stormwater filtration.

New buildings should be developed no less than 100 feet from sensitive areas. This distance helps to not only reduce impact, but also avoid potential legal issues related to the Clean Water Act.

Stormwater design is an important aspect of a sustainable site. Stormwater can impact the environment in two ways: quantity and quality.

Well designed stormwater quantity control features will keep site imperviousness to a minimum or improve perviousness, which allows water to be more easily absorbed into the ground and thereby reduces the quantity of stormwater runoff.

Stormwater quality can be improved by increasing the amount of vegetation in a surrounding area. Vegetation treats stormwater by filtering and removing unwanted debris that may be captured and carried by stormwater, traveling by gravity to local municipal drainage systems. Such debris may include trash, oil, fuel residue, pesticides, pet waste and other chemicals or pollutants, also known as "total suspended solids", or TSS.

Hard surfaces, such as asphalt, negatively impact stormwater absorption and can create heat Islands. Heat islands are an effect caused when hardscapes, such as asphalt, concrete, tar roofs, buildings and other materials capture and hold heat. That heat then radiates into the surrounding environment, potentially altering microclimates and wildlife habitats.

Microclimate changes can affect native species and biodiversity. You can avoid heat island impacts through a number of green building strategies, including green roofs, shading, vegetation and installing surfaces with a high solar reflectance (such as white roofs and lighter concrete hardscapes).

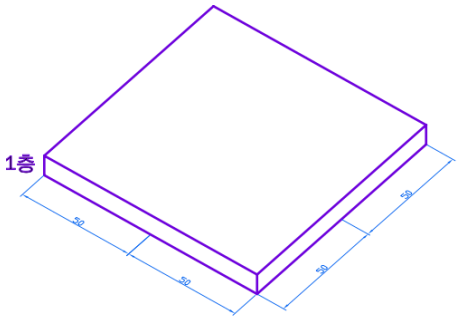
Light pollution occurs when artificial light unnecessarily intrudes on nighttime wildlife habitats. This phenomenon is most pronounced near urban centers and not only wastes energy, but also interferes with the circadian rhythms of native plants and animals.

Sustainable site strategies reduce the nighttime impact of non-emergency lighting by using lamps with cutoff features and by limiting artificial lighting in natural habitats.

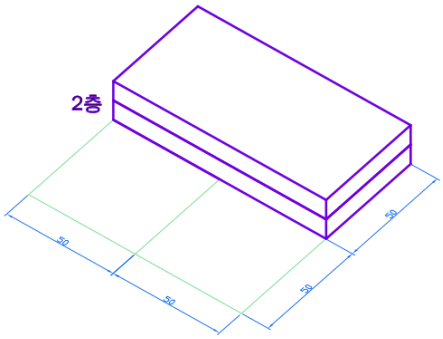
[3] http://water.epa.gov/lawsregs/guidance/wetlands/definitions.cfm

Maximize Density

Buildings can limit sprawl and optimize land use by building up, rather than out.



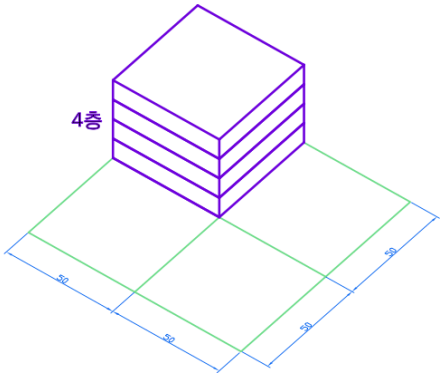
Green buildings maximize a building's Floor Area Ratio (FAR). FAR is the ratio of a building's total floor area (gross floor area) relative to the building's footprint. For instance, the illustration to the right shows a building with a FAR increasing from 1 at the top to 4 at the bottom.



By limiting the amount of land used by buildings while increasing density, developers can increase livability, walkability, transportation efficiency and access to basic services in urban areas.

Restore Damaged Sites

Brownfields are sites damaged by environmental contamination and their rehabilitation improves environmental quality in surrounding areas.



With the redevelopment of existing brownfields, infill or abandoned sites, developers can help to minimize sprawl and suburban land use.

Leverage Mass Transportation Access

Sustainable sites are often located in already developed areas, such as an established town, city or urban area, where the building can leverage existing infrastructure and neighborhood connectivity.

Developers should opt for sites that allow them to make the most of existing infrastructure. Ideally, such sites are connected to mass transit, or alternative means of transportation like walkways or bicycle facilities.

By building within half a mile to a mile walking distance of mass transit and/or commuter infrastructure, construction projects encourage walking and alternative transportation use.

Where practical, offer building occupants access to bicycle storage, showers and changing facilities to encourage cycling as a primary form of transportation.

Green vehicles, such as electric cars, need proper infrastructure. Green buildings can provide preferred parking for green vehicles and low emitting vehicles, and install fueling stations for electric vehicles (EVs) or provide vehicle-sharing programs.

2. Water Efficiency

While water covers 70% of the Earth's surface, less than 1% of our water is available for human consumption. Up until now, the availability and affordability of water has not been a problem for most of America, and drinking water continues to be relatively inexpensive... but for how long?

Compared to conventional buildings, green buildings can achieve up to 40% in overall water savings by incorporating indoor and outdoor water conservation technologies and strategies.

Common strategies for achieving inside and outside water efficiency are:

- Water Efficient Appliances, Fixtures and Toilets
- Water Efficient Landscaping
- Drip Irrigation Systems
- Greywater Recycling Systems

The Way We Use Drinking Water is Broken

The way most plumbing and sewer systems are designed is antiquated. These systems are designed to use potable (drinking) water for everything. The result is our drinking water is used indiscriminately, whether it is for human consumption, washing dishes, toilet and urinal flushing, showering, landscaping, building mechanical heating and cooling operations, and so on.

This makes no sense.

For most of the aforementioned processes, drinking water should *not be used*. A well designed green building plumbing system should flush toilets using either very little water, or no water, or greywater, which is lightly treated water derived from handwashing, showering and rainwater.

According to the EPA[4], more than half of publicly supplied water in America is consumed in our homes. Of this consumption, a 1999 study by the American Water Works Research Foundation found that:

[4] http://www.epa.gov/WaterSense/pubs/supply.html

- 26.7% of water is used for toilet flushing
- 21.7% is used for clothes washers
- 16.8% is used for showering
- 15.7% is used by faucets
- 14% is wasted due to leaks
- 5.3% is from other unknown sources

The average commercial real estate property in the U.S. uses 30% of its water outdoors to maintain grass and landscaping. Toilets use the second highest percentage of potable water at 19%, followed by clothes washers at 15%, showers at 12%, and faucets at 11%.

Water Efficient Appliances, Fixtures and Toilets

One strategy for reducing potable water use in toilets and certain appliances is using water conserving fixtures like waterless urinals and low flow faucets. Another is using non-potable water like greywater, rainwater or treated wastewater for flushing.

Water reduction from indoor water fixtures is measured against a baseline determined by the Energy Policy Act of 1992, the Uniform Plumbing Code and the International Plumbing Code. The baseline for low consumption states that low flow showerheads must run at less than 2.5 gallons per minute. Faucets must also run less than 2.2 gallons per minute for private homes, and less than 0.5 gallons per minute for public building faucets. Regular toilets use 1.6 gallons per flush and urinals use 1.0 gallons per flush.

Using toilets that improve upon these efficiency levels, such as dual flush toilets, composting toilets and waterless urinals, can save a tremendous amount of potable water.

Fixtures that are labeled WaterSense are verified by third-party testing and certification as meeting EPA specifications for water efficiency and performance. WaterSense labeled products include, but are not limited to, toilets, sink faucets, urinals, showerheads and irrigation controllers.

Water Efficient Landscaping

You can achieve a beautiful landscape for your building, while also reducing exterior water use, by planting drought tolerant and native species that require less water.

Outdoor areas can also be designed for high plant density to reduce water use. When it does come time to water plants, use efficient irrigation technologies to vastly reduce landscaping water consumption.

Drip irrigation can deliver water to the exact areas where it is needed, such as at the roots, whereby less water is lost through evaporation.

The amount of drinking water used for a building's mechanical processes behind the scenes (such as cooling towers, chillers, boilers, water heaters and evaporative coolers) can be more significant than for daily occupant use. In some cases, the water from these building operations processes may be reused for landscaping and other applications.

Rainwater falling on your property should be captured and stored at every opportunity for future landscaping.

Drip Irrigation Systems

Hydropoint, a provider of smart water management technologies, claims that 58% of urban water consumption goes to watering turf grass, such as lawns. Other sources put the use of potable water for irrigation in the United States at 75%[5]. However, because we do not use "smart" technologies to monitor water use or water delivery, our landscapes are over-watered by 30-300%.

Drip irrigation systems save water by irrigating, fertilizing and aerating trees, shrubs, plants and bushes directly at the roots. Drip irrigation requires a shorter watering period, which can conserve between 20-70% more water compared to traditional irrigation methods (depending on the system and landscaping). Drip irrigation can also facilitate the growth of deeper root systems, which help prevent erosion and conduce more efficient fertilizer delivery.

[5] Managing the Rising Costs of Water: http://www.multihousingnews.com/features/green/controlling-the-rising-costs-of-water/1004034001.html

Greywater Recycling Systems

A greywater recycling system can help reduce your water bill, because you are using the same water more than once. Greywater systems collect used water from non-toilet fixtures, such as sinks, showers and washing machines, and reuse it for other applications. Greywater recycling systems are considered green because they reduce the use of potable water use for non-potable applications, which minimizes impacts on rivers and aquifers.

Some graywater systems treat the water before it is reused, and others do not. If treated, graywater may be used for washing. If untreated, it is typically used for non-potable applications, such as toilet flushing and limited irrigation and building processes.

Unless it is processed using an extreme filtration method, recycled graywater, and even recycled rainwater, is typically not considered safe to drink.

3. Energy and Atmosphere

Buildings in the U.S. use 73% of our electricity and consume 41% of our energy (such as natural gas, coal, liquid fossil fuels, nuclear and renewables)[6]. According to the EPA, 30% of this energy is used unnecessarily[7]. Buildings also account for 38% of the country's CO2 emissions.
Building owners and operators should pay particular attention to the Energy & Atmosphere category because of the return on investment (ROI) opportunities that are possible.

High-performance LED lighting, HVAC, insulation, building envelope improvements and **commissioning** can deliver returns on investment of more than 20%, even in newer buildings. Furthermore, renewable energy, such as solar and wind, can boost these returns even higher when combined with green building financing techniques. Each step in efficiency and on-site renewable energy reduces your building's use of, and dependence on, foreign oil and fossil fuel energy. Whether they're

[6] By comparison, the Industrial and Transportation sectors of the economy use 25% and <1% of the electricity, and 30% and 29% of the energy, respectively.
[7] http://www.energystar.gov/buildings/about-us/facts-and-stats

deployed separately or all at once, each of these strategies can reduce a building's greenhouse gas emissions.

As a result, LEED awards the most points to buildings within the Energy and Atmosphere category. One particular credit in this category, "**Optimize Energy Performance**" allows projects to earn as many as 20 points.

The key strategies in Energy & Atmosphere are:

1. Optimize Energy Performance
2. Commissioning
3. Measurement and Verification

Optimize Energy Performance

The Optimize Energy Performance credit within LEED provides multiple strategies for building owners to achieve increasing levels of energy efficiency.

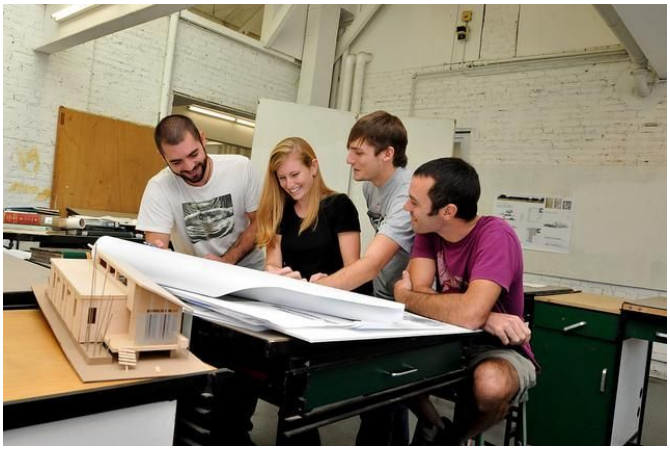
Strategies you may use include specifying or upgrading to efficient HVAC and LED lighting systems, installing motion sensors, using climate-responsive building design to reduce heating and cooling loads, installing energy efficient appliances, installing a **Building Management System (BMS)** or Building Automation System (BAS) and using appropriate **insulation**.

Because new buildings do not have a historical record of energy use, LEED project teams will typically work with a whole building energy simulation, which uses computer software to model how efficiently the building will perform when it is in operation.

Commissioning

Commissioning is the process of verifying building performance. It is a quality assurance process that not only ensures that a building is designed and constructed according to the owner and architect's basis of design specifications, but also will also keep operations and maintenance costs down over the life of the building.

But commissioning is not meant to provide a post-occupancy snapshot of performance alone. Commissioning planning should begin in the design phases of a building and continue on through construction and operations.



According to the Whole Building Design Guide (WBDG), building owners can "improve new building energy performance by 8% to 30%" by commissioning a building's key systems (renewable energy, mechanicals, HVAC, lighting and so on).

WBDG also states that "*for every $1 invested in commissioning, owners can achieve savings in operations of $4 over the first five years of occupancy...*" which is obviously a very high return on investment.

Other indirect cost savings from commissioning include potential improved worker productivity, due to a safer and healthier facility. Estimated average costs for commissioning are $0.30/SF for existing buildings and $1.16/SF for new construction[8].

The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) develops standards for building performance measures. You will see them referenced in LEED throughout Energy & Atmosphere, and other categories.

The goal of commissioning according to ASHRAE Guideline 0[9] is: "*to provide a uniform, integrated, and consistent approach for delivering and operating facilities that meet an owner's ongoing requirements"* and *"to reduce the cost of delivering construction projects and increase value to owners, occupants, and users.*"

The term "**commissioning**" refers to the evaluation of a new building's systems. The term "**Retro-commissioning**" refers to the commissioning of an existing building that did NOT have undergo commissioning when it was constructed. The term "**recommissioning**" refers to the follow up commissioning of an existing building that underwent initial commissioning at least once before.

Commissioning is typically accomplished by an independent third party called a Commissioning Agent, or CxA.

[8] February 2011 article in the ASHRAE Journal by Dr. Evan Mills.
[9] https://www.ashrae.org/standards-research--technology/standards-addenda

For new building development, owners should involve the CxA early on in the planning and design process (ASHRAE refers to this as the "project inception" stage) rather than waiting until after construction. This way, the CxA can ensure that the owner's requirements are implemented in the building design, as well as participate in the development of the building system's operation and maintenance (O&M) manuals. Surprisingly, this will save time and money in the long run.

ASHRAE Commissioning Objectives:

The basic objectives of commissioning, noted in ASHRAE Guideline 0, are to:

- Clearly document the Owner's Project Requirements (OPR)
- Provide documentation and tools to improve the quality of deliverables
- Verify and document that systems and assemblies perform according to the Owner's Project Requirements
- Verify that adequate and accurate system and assembly documentation is provided to the owner
- Verify that operation and maintenance personnel and occupants are properly trained
- Provide a uniform and effective process for delivery of construction projects
- Deliver buildings and construction projects that meet the owner's needs, at the time of completion
- Utilize quality-based sampling techniques to detect systemic problems, as such sampling provides high value, efficient verification, accurate results, and reduced project costs; and
- Verify proper coordination among systems and assemblies, and among all contractors, subcontractors, vendors, and manufacturers of furnished equipment and assemblies

While LEED requires commissioning as a prerequisite to certification, no current building codes or regulations require it.

For these reasons, many governmental organizations have adopted commissioning into their construction requirements.[10]

Commissioning requirements are also included in numerous green building rating systems, including LEED, Green Globes, and ASHRAE Standard 189.1.

[10] Including the General Services Administration (GSA), US Army Corps of Engineers (USACE), Naval Facilities Engineering Command (NAVFAC), and the Air Force Civil Engineer Center (AFCEC).

Measurement and Verification

When building occupants are aware of their energy use, they are more likely to take sustainable measures. Indeed, the "Prius Effect" is a behavioral phenomenon that describes the changes in behavior toward maximizing efficiency when we are presented with real time feedback about our energy use performance.

Measurement and verification (M&V) involves measuring actual energy use and comparing it to predicted energy use. Because energy models are often used in designing buildings and predicting performance, M&V plans are necessary to verify those predictions and identify any variations, above or below, the building's baseline. This allows managers to objectively evaluate quantitative data and attribute performance, or lack of performance, to specific factors.

Strategies for monitoring building system performance include utilizing "dataloggers" or other devices that can collect data points to alert in the event of unusual energy or water spikes. Smart measurement devices can also be connected to a Building Management System (BMS) or Building Automation System (BAS) that delivers real time data in a dashboard format.

Like driving a Prius, the dashboard creates a feedback loop that can be used to take corrective action, if needed.

4. Materials and Resources

According to the Worldwatch Institute[11], 40% of our raw materials usage can be attributed to buildings. Buildings are also thought to be responsible[12] for as much as 30% of our total waste output.

As such, the development of healthy buildings requires us to make many choices regarding sourcing, reusing, reducing, recycling and managing construction materials, in addition to the construction waste that is produced as a result. Strategies to be considered in the Materials & Resources category include:

[11] http://www.worldwatch.org/node/866
[12] http://go.usgbc.org/Intro-to-LEED.html

- Construction Waste Management
- Building and Materials Reuse
- Storage, Collection and Sale of Recyclables
- Use of Materials with Recycled Content
- Regional Materials
- Certified Wood

Construction Waste Management

To confront the massive amounts of waste that buildings can produce, construction waste management efforts focus on three paths to improvement:

1. Divert construction debris from landfills and incineration facilities by recycling or reselling
2. Reuse materials appropriately on-site.
3. Redirect recyclable materials back to manufacturing processes

Construction waste can also be recycled for later use in other projects, or donated to nonprofit organizations or charities like Habitat for Humanity. All three options ensure that construction waste materials have a second life, making the entire lifecycle of buildings more sustainable.

Building and Materials Reuse

It is common to confuse reused and recycled materials. Reused, or salvaged, material is "waste" that is saved and used again in its original form, while recycled material is waste that has been turned into a new product.
Every year, approximately 170,000 new commercial buildings are constructed, and nearly 44,000 commercial buildings are demolished. Reusing elements from previously constructed buildings can help conserve resources, reduce waste and lower the environmental impacts of new buildings.

By reusing building elements (like existing walls, floors and roofs) and interior structural materials, green buildings can help divert the 170 million tons of waste that goes to landfills due to construction, renovation and demolition.

Materials reuse -- i.e. using salvaged, refurbished, or reused materials -- helps to reduce waste and the demand for virgin materials.

Storage, Collection (and Sale) of Recyclables

As a prerequisite, LEED certified buildings are required to reduce waste in landfills by recycling metal, glass, paper, plastic and cardboard.

In order to facilitate recycling, it is important to include signage. Signage discourages contamination, designates an accessible and appropriately sized recycling areae, provides security for high value materials and provides protection from the elements.

By collecting and storing recyclable materials, your building occupants will be reducing the incremental impact of waste.

It can also make you money.

For example, Miller Coors[13], the nation's largest brewery, invested approximately $1 million on the infrastructure and equipment necessary to achieve "Landfill Free" status.

The investment provided a 100% ROI, or approximately $1 million per year in new, incremental revenue, from the sale of recycled materials. This value considers the market prices for glass, paperboard, plastics, metal and brewing byproducts, such as spent grain.

Use Materials with Recycled Content

Some building materials, like those sold by Miller Coors, can be made from recyclables. Examples of materials with recycled content include cement, countertops, furniture, rebar, steel and paint. Building materials may have two types of recycled content:

1. Post-Consumer recycled content
2. Pre-Consumer recycled content

Post-consumer recycled content, also known as consumer waste, is generated by households or commercial, industrial and institutional facilities. This waste material can no longer be used

[13] http://www.millercoorsblog.com/journey-to-landfill-free/

for its intended purpose. Some examples include newspaper, construction and demolition debris, plastic bottles, soup cans, steel, etc.

Pre-consumer recycled content is material diverted from the waste stream during the manufacturing process. This is manufacturer waste, never owned by a consumer. Some examples include shavings, sawdust, walnut shells, fly ash, over-issue publications, textile clippings and obsolete inventories[14].

Regional Materials

Another measure of a product's sustainability is the total distance it has traveled in its journey from extraction to manufacturing to the project site. Transporting materials requires energy and produces greenhouse gas emissions. The more distance traveled, the more energy used and greenhouse gases emitted.

LEED encourages the use of materials that are extracted, harvested or recovered, and also manufactured within 500 miles of the project site. The goal of using regional materials is to support use of indigenous resources, help local economies and reduce transportation impacts.

Certified Wood

Wood is a large component of many building projects, but it is also a long-cycle renewable material. Long cycle means it takes a long time to replace it once it is gone. In order to minimize clear cutting and deforestation, green buildings aim to use wood products that are sourced through environmentally responsible forest management.

The LEED rating system rewards the use of Forest Stewardship Council (FSC) wood. FSC Certified wood products are designed to meet our current building needs without compromising the health of the world's forests for future generations.

FSC responsible forest management principles include: compliance with laws, tenure and use rights and responsibilities, indigenous peoples' rights, community relations and worker's rights, environmental impact, sustainable management plans, monitoring and assessment and maintenance of high conservation value.

[14] USGBC LEED v4 BD+C Reference Guide

The prioritization of these principles ensures wood is grown and harvested in a sustainably responsible way.

5. Indoor Environmental Quality

The health and wellbeing of a building's occupants is an equally important focus in green building. Buildings that have access to daylight and views, that use low emitting materials, that provide ample natural or mechanical ventilation, and that actively monitor indoor air and operate efficient HVAC systems are poised to achieve better indoor air quality.

Strategies for optimal Indoor Environmental Quality include:

- Minimum Indoor Air Quality Performance
- Environmental Tobacco Smoke Control and Outdoor Air Delivery Monitoring
- Low Emitting Materials

Minimum Indoor Air Quality Performance

LEED-rated buildings must, at the very least, meet the requirements for ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality. ASHRAE 62.1 establishes minimum standards for indoor air quality, as measured by a building's ventilation system, in contributing to the comfort and well-being of building occupants.

Environmental Tobacco Smoke Control and Outdoor Air Delivery Monitoring

Minimizing exposure to environmental tobacco smoke is critical to maintaining high indoor air quality. In states that do not outright prohibit smoking indoors, the LEED rating system seeks to eliminate or drastically minimize indoor occupant exposure to environmental tobacco smoke.

Strategies for minimizing occupant exposure to tobacco smoke include prohibiting smoking in the building, designating sealed smoking rooms and prohibiting smoking in common areas.

The dangers of tobacco smoke are being recognized and policies to reduce second hand exposure are being adopted throughout the U.S.[15]

Outdoor air delivery monitoring is a large part of ensuring indoor environmental quality because it can also help to improve occupant comfort and wellbeing.

The intent of outdoor air delivery monitoring is to ensure that air in the breathing zone (about 3 to 6 feet above the floor) is safe and carbon dioxide free.

Low Emitting Materials

Buildings should function as a safe haven, protecting occupants from exposure to potentially hazardous particulates and chemical pollutants. Unfortunately, many adhesives, sealants, paints, coatings, carpets, flooring systems, composite wood and agrifiber products emit Volatile Organic Compounds (VOCs).

Controlling VOCs by using low emitting materials can reduce the quantity of harmful chemicals in indoor air.

Low or no VOC materials must comply with standards like South Coast Air Quality Management District, Green Seal, Carpet and Rug Institute Green Label Plus, Green Label and FloorScore Standard. All of these standards help to protect occupants from volatile organic compounds.

Wood products, such as particle board or composite wood, must contain no added urea formaldehyde, which is a known carcinogen.

Lighting, Thermal Comfort and Natural Views

Light has profound physiological and psychological impacts on building occupants, which in turn affect productivity and satisfaction levels.

Contact with natural daylight boosts circadian stimulation, better calibrating physical and mental function to our natural responses to the rhythms of light. Circadian dysfunction, on the other

[15] States that have statewide bans on smoking in all enclosed public places include: Arizona, California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, North Dakota, New Jersey, New Mexico, New York, Ohio, Oregon, Rhode Island, South Dakota, Utah, Vermont, Washington and Wisconsin.

hand, can cause cardiovascular problems, immune dysfunction, cognitive and functional deterioration and depression[16].

Individual lighting and thermal controls in private and multi-occupant spaces can increase worker performance. Connecting occupants with the outdoors by providing daylighting and views can enhance occupant productivity and wellbeing. With LEED, to achieve thermal comfort design, a building's HVAC systems and envelope must meet ASHRAE Standard 55-2004 Thermal Comfort Conditions for Human Occupancy.

Environmental biologists have found that windows that admit daylight and provide ample views can dramatically affect occupants' mental alertness, productivity and psychological well-being.

What's more, exposure to full spectrum sunlight enables the synthesis of vitamin D, which promotes nerve and muscle function, as well as cell growth regulation. Exposure to daylight has been linked to better production of melatonin, which controls sleep cycles and thus helps people achieve higher levels of concentration and better short-term memory recall.

Suffice it to say that exposure to daylight leads to better worker performance.

A Final Word of Caution

Just because a building is labeled green, does not necessarily mean that it is green. Green buildings can be much more efficient than conventional buildings… But the operative word here is "can".

For instance, if you own a Toyota Prius, everyone will think you have "gone green". But you floor the accelerator everywhere you go, your gas mileage (and energy efficiency) will be horrendous. The same holds true for green buildings with certifications like LEED or ENERGY STAR... A building may be certified, but if the occupants are "flooring" the proverbial accelerator every day, the building will not perform as a green building should.

Good luck!

-Rob

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[16] National Institutes of Health http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3994881/

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