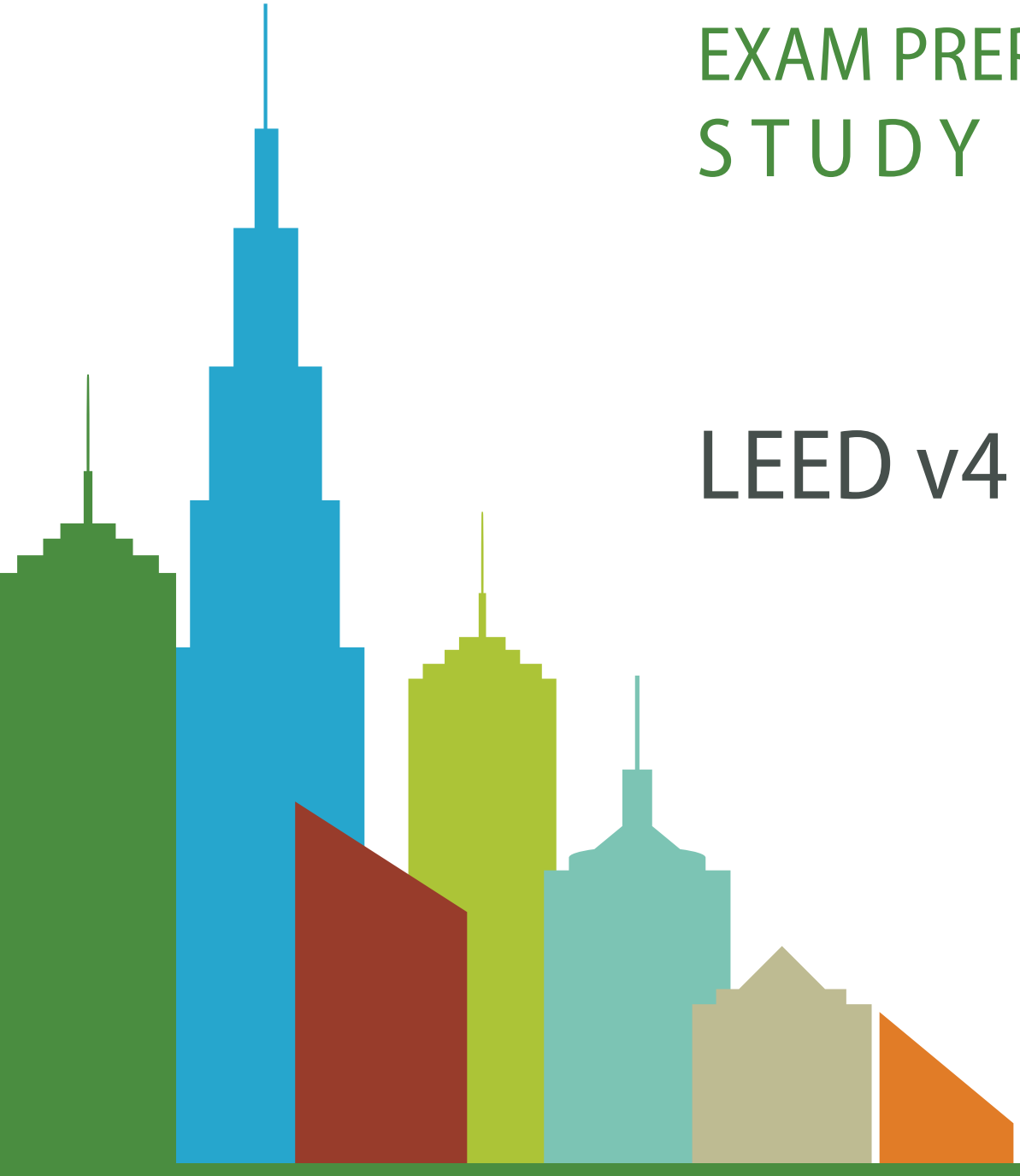
LEED®

GREEN ASSOCIATE EXAM PREPARATION STUDY GUIDE

LEED v4 Edition



GBES™
GREEN BUILDING EDUCATION SERVICES

Green Building Education Services, LLC
2560 King Arthur Blvd
Suite 124-107
Lewisville, TX 75056
214.614.8171
www.gbes.com

LEED Principles and LEED Green Associate Study Guide, Third Edition

Acknowledgements

Throughout this study you will learn from the leaders in the green building industry who work on LEED projects of all sizes all over the world. Real world experience is provided to you in examples and case studies to help your understanding of LEED. GBES would like to thank the many companies and organizations that contributed to this study:

3form USA
Autodesk
Bank of America
C/S Sun Controls
Cooper Lighting
Design Builder
Dockside Green (Windmill West)
EPA
Falcon Waterfree
GE
Headwaters Resources
Herman Miller
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Chapter 1 - Green Building Basics

Sustainability can be defined as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.

What are some of the things that come to mind when you think about green building?

Green building is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's life cycle. That life cycle respectfully analyzes and integrates site selection through design, construction, operation, maintenance, renovation and deconstruction. The practice expands and also complements the classical building design concerns of economy, utility, durability, and comfort.[1]

Note: The term "green building" is often used as a synonym for sustainable construction and high-performance building.

In short, high-performance buildings are designed and built to minimize resource consumption, reduce life cycle costs, maximize health and productivity for the building's occupants, and improve environmental performance.

Everywhere you turn these days you can't help but hear about green building, global warming, and rising energy prices. While we used to consider these issues someone else's problem, or something a future generation would have to worry about, now we are realizing the issues are impacting our daily lives and are our problem today. Energy prices have gone from 7.73 cents per kilowatt-hour in 1994 to a high of 10.35 cents in 2014. A cost increase of 2.6 cents may not seem like a large price increase until you convert into commercial real estate terms.

Consider a retail chain of stores paying to light, cool, and monitor its stores across the country. If the chain has 3 million square feet of space - this company is now paying 25% more for energy, every hour, every day, and those costs add up. This cost increase affects not only the stores, but also the customers who shop there and the vendors who supply the chain with products because the store must remain profitable to stay open. If the company could use less power and derive a significant savings from conscious energy consumption reduction, the company would have a much greater competitive advantage.

Impacts of Buildings and Construction

Commercial construction requires the greatest quantity of resources in the building industry. While this study looks at green building across several product types within construction, the impacts from commercial construction in the United States include:

- 72% of electricity consumption[2]
- 39% of energy use[3]
- 38% of all carbon dioxide (CO2) emissions[4]
- 40% of raw materials use[5]
- 30% of waste output (136 million tons annually)[6]
- 14% of potable water consumption[7]

Green building design and construction practices that meet specified standards will help resolve much of the negative impact that buildings have on their occupants and on the environment, but reducing impacts is not the end goal. Remember that building green is constantly changing and progressing. Today's new idea may become tomorrow's standard practice. There are projects that already have achieved net-zero energy use or have found a way to achieve water balance and only use the water naturally occurring on the project site for water needs. There are already projects that have achieved carbon neutrality through reduced energy use and on-site energy generation. Green is already moving to the next level by striving for regenerative design. These would be projects that do not end, but rather renew resources for future use.

Built Environment

The built environment is the human-made surroundings that provide the setting for human activity, ranging in scale from personal shelter and buildings to neighborhoods and cities. This goes beyond just building, but also includes transportation systems – roads, bridges, etc. The built environment accounts for two-thirds of all greenhouse gas emissions. Because the already existing built environment contributes to so much of the greenhouse gases it is important that those resources are made more efficient - perhaps by operating them more efficiently, i.e. buildings, and by using them more effectively, i.e. infrastructure. The built environment contributes 67% of all greenhouse gas emissions.[8]

Defining Green Building

Green buildings are specifically designed structures that reduce the overall negative impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, land, and materials
- Protecting occupant health and improving employee productivity

- Reducing waste and pollution from each green building
- Continuously looking for ways to improve performance

High-performance green buildings address sustainable development throughout the building's entire life cycle – from the beginning with the building's site selection and design all the way through to the end of the building's life.

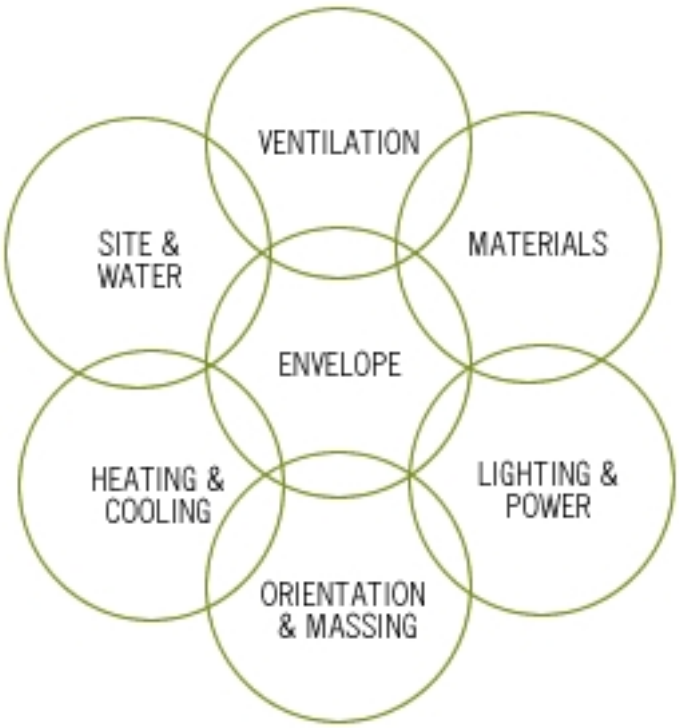
Sustainable buildings are significantly better than standard buildings. They use less energy, save money over time, provide better occupant health and comfort, and are better for the environment.

To achieve the many benefits of green building, *whole building design* was developed.

Whole Building Design

In the traditional planning and design process, building systems were viewed as separate elements - site, structure, systems and use, and design decisions were each based on budget and/or schedule considerations. Changes to a design in order to meet a certain budget or follow an accelerated schedule did not take into account the final performance of the completed building.

FIGURE 1.1 The interdependent building considerations of whole building design



The "house as a system" model, a favored approach in the green construction industry today, illustrates interconnectedness. Whole building design views all of a building's systems together as they operate interdependently. Sustainable design begins when projects are first imagined and requires thinking 'green' at every stage in the lifecycle. Owners, designers, engineers, and builders play vital roles in reducing the environmental impact of the built environment, starting with the decision to build new or renovate. An issue such as which way the building is oriented would have the project team asking such questions as:

- How is the sunlight going to enter the building?
- How will the orientation affect the heating and cooling loads?
- What impact will that have on the window glazing?

Whole building design is an integrative design and uses an integrative project team. It is this approach that will facilitate sustainable design for the future.

The Conventional Building Process

The conventional building process followed these steps, or steps that were very similar:

- Design
- Construction plans
- Bidding process
- Construction
- Commissioning and turnover
- Occupancy

In the conventional building process, specialists usually worked in isolation, focusing on their separate area of project expertise and interacting and working together ONLY when absolutely needed.

FIGURE 1.2 Team members working in isolation

An example would be the insulation used on the project – enough insulation would be installed to meet code and at the lowest cost. The HVAC system would be designed to cool the building based on area, without regard to what insulation was being used or which insulation would be most effective for the HVAC system. The contractors work in isolation, just concentrating on their own concerns, not the over-all building or the needs of its occupants or any relation to the environment.

Initial costs and operating costs can actually increase because of this approach.

The Integrative Process

An integrative process is an approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, construction, and ongoing operations.

The integrative process requires collaboration among key stakeholders and design professionals from conception to completion. A stakeholder may be the building owner, a major tenant, or an end user customer, like a college student who uses a building for classes. Decision-making processes and complementary design principles should be established early in the planning, satisfying the goals of multiple stakeholders while still achieving the overall objectives of the project. Stakeholder meetings may be hard to schedule or may include stakeholders opposed to new technologies or green strategies, but even if a project encounters stakeholders who resist this new way of planning a project, they can still be beneficial. Project teams can work to alleviate these concerns, which will lead to a happier stakeholder group at the project's delivery.

During the integrative process team members work together and communicate throughout the process of the building's design and construction. Professions that traditionally may not communicate do so, and the process evaluates how design decisions and components will affect (or be affected by) other site decisions and components.

The integrative process results in greater efficiencies, with some estimates showing that single projects employing integrative project teams can achieve savings of 2-10% in the cost of construction.[9]

FIGURE 1.3 Integrative Project Team Members

The project phases of an integrative process are different than the conventional process:

- Pre-Design
- Design
- Construction plans
- Bidding process
- Construction
- Commission the building

- Occupancy and Recommissioning
- Building end of life reuse or demolition/recycle

Pre-Design

First you need to make a plan. You don't go on vacation without making a plan. When are we leaving, what are we packing, how are we getting there, what are we going to see, where will we eat, how much money should we bring, what's our budget, etc.

Start with a project vision, and then define green building goals while getting input from stakeholders. Next, create a team and identify a budget. Brainstorm about opportunities to gain incentives and cooperation with government organizations. Create a timeline and methodology and decide on which measurement tools you will use to identify progress. Calculate the return on investment and don't forget to identify risks.

Probably the most critical phase of the integrative process is the pre-design phase. It is in this phase where the groundwork is laid for the entire project. Extra time and effort is part of the pre-design phase, but this helps keep the project on track and improves cost control.

The integrative process increases the level of effort during early design phases, resulting in reduced documentation time and improved cost control and budget management, all of which increase the likelihood that project goals, including schedule, life cycle costs, quality and sustainability will be achieved.

The pre-design phase will include several new steps:

Life Cycle Approach

At the very beginning of the pre-design phase it is important that all those involved are viewing the project through the lens of the life cycle approach. This approach does not just focus on the delivery of the completed project (like an office building) but goes much further to the life of the project and eventual reuse of the project or its demolition and hopefully recycling.

Develop a Clear Statement of the Project's Vision

Summarize what is trying to be accomplished. Here is an example from the *Guiding Principles for Siting Selection of Los Alamos County Municipal Building.*

> "Los Alamos County's new Municipal Building will be a functional, comfortable, attractive building for citizens and employees to conduct county business, as well as a state-of-the art energy efficient, cost-effective structure that

embodies and demonstrates Los Alamos County's commitment to sustainable development. The Municipal Building will be located on a site that supports this vision. The Municipal Building will have a positive impact on the future of Los Alamos County's downtown and be a source of pride for its Citizens."

Define the Green Goals of the Building

Based on the project's vision, define what you want to accomplish. For example: the building will promote the vision by enabling these objectives:

- The building will provide a healthy and effective contemporary office environment for employees.
- The building will be a state-of-the art energy–efficient structure and a leader in sustainability and green building design.
- Etc.

Here are some guidelines on making smart goals. Goals should:

- support the project vision
- be clear so all team members can relate and understand
- cover the entire project
- be achievable
- be measurable (qualitatively or quantitatively)
- be achievable in the space and time of the project (applicable)

Write down and report goals to the project team. Use an iterative process to constantly check goals against the project vision and to see if goals are being met.

Saving energy is a very high level goal and is a good thing to strive for. However down the road after the building is operating there must be some way to determine if the goal has been reached. To do this both metrics and targets are needed. Metrics are needed that measured the energy use of the building, and preferably the energy use of individual systems. How much energy was used in January of this year compared to January of last year? What is the difference year over year?

Targets must be clear so everyone can understand them. Saving 25% in energy use compared to a similar building is a specific target that is clear and understandable.

Both targets and metrics are needed, otherwise it cannot be determined if the goal was met. Targets use the metrics for measurement. And metrics without a target just creates data points.

Set Priorities

Not all goals may be achievable for the budget or schedule. The team will need to prioritize the green building goals. Setting critical milestones enable the project to stay on track. Critical milestones might be conceptual, schematic, design development, and/or construction documents, etc.

Select the Project Team

The project team is a collaborative group involved in design and problem solving during all steps of the project. The project team will incorporate people and trades from every aspect of the building process and even the building's end users. Every member of the team will need to be committed to the green building goals and the project's vision. Make sure to include some green building experts to help the project along if this is a new process and unchartered territory for a majority of the team members.

Assign champions/group leaders. The champion is someone who is motivated and able to lead the team in the direction of sustainability. Champions take on specific initiatives that advance sustainable growth and development. They may be internal or external to the project.

Research Green Technologies and Strategies

Do research on new green technologies and strategies. This doesn't mean every material will be the latest and greatest cutting edge technology. There are lots of materials and strategies that have been around for decades. But there are new ideas and systems that are emerging as green becomes a focus of the building industry. Consider which ones are most appropriate, as they relate to meeting the goals and priorities of the project.

Assign Small Task Groups

To help distribute the burden of research divide the project team into small task groups who research a selected green technology or strategy. These groups can later report back to the project team. This allows for subject matter experts or outside consultants to inform the project without taking the time of the whole team.

Define Green Building Budget Items

Green building has a few added expenses compared to traditional building. Project teams should determine relevant design fees and construction costs. Also address:

- Life-cycle cost analysis

- Design and cost advice from experienced green building professionals
- Contingencies for research of unconventional techniques or materials

Consider the life cycle cost of each green technology and strategy. A high-efficiency HVAC system may cost 10% more upfront, but the simple payback may be 5 years and after that the building will save 20% every year on energy bills. Is it worth it? The project team will need to decide.

Can HVAC systems be shared across multiple buildings on a single campus?

Can excessive heat from one building be used to warm another?

The project needs some green building expertise. If no one on staff has significant experience, you will need to find some outside to help walk you through the process successfully. This cannot be emphasized enough – don't try to go it alone. Consultants do not have to be expensive and will likely pay for themselves with their advice and LEED assistance.

Next, the chosen green technologies and strategies should be researched and analyzed. Consider each, and ask:

- Is this the best choice available?
- What are our options?
- Do we have installers with significant experience?
- Who else is doing this and what were the results?

Contingencies should be put in place in case something doesn't work out.

Review Applicable Laws and Standards

What is the measurement or standard for how we build a new building in general? The answer is the building code. And what is the building code? It is the law, but it's the minimum standard enforced by the local government.

Policies play an important role. Not just building-specific policies – there could be local policies, state policies, state requirements, rules, laws, and regulations that are out there, which projects will have to meet ..

Zoning and Local Codes

The project must meet local codes, zoning, and ordinances. For example, a site that is zoned residential may only allow a certain number of homes per acre of land. A site

zoned for office space may only allow for a building to be a certain number of stories in height. Local codes, zoning, and ordinances take precedent over LEED requirements. Building inspectors and local agencies will verify that all codes are being met throughout the construction process.

Zoning requirements are present in most jurisdictions, and many aspects of the building and site development will be impacted by the zoning in your area. Zoning typically has three categories of land use - residential, commercial, and industrial. If an area is zoned residential, a skyscraper or grocery store could not be built in the middle of a subdivision of homes. Zoning helps protect property values, but it has increased the use of the automobile. Over the past few decades, mixed-use developments have come into favor allowing residences to be built among offices spaces and basic services. Zoning ordinances may address:

- Minimum parking requirements
- Building height
- Floor area ratio - the relationship between the total building floor area and the allowable land area the building can cover
- Open space
- Density – how much built square footage can exist in the property boundary
- Landscaping restrictions, such as tree save areas

ICC

Many jurisdictions have adopted codes published by the International Code Council. The International Code Council, a membership association dedicated to building safety and fire prevention, develops the codes used to construct residential and commercial buildings including homes and schools. Most U.S. cities, counties and states that adopt codes choose the International Codes developed by the International Code Council. ICC has many codes, including building, plumbing, mechanical, and fire codes.

IgCC

The ICC introduced the International Green Construction Code (IgCC). The IgCC provides model code language to establish baseline regulations for new and existing buildings related to energy conservation, water efficiency, building owner responsibilities, site impacts, building waste, and materials and other considerations. The IgCC model code language becomes law when it is adopted by the appropriate state or local authority charged with governing construction. The adopting jurisdiction is charged with determining the final content of the code, and has the ability to calibrate the application of the code on a project-by-project basis.

ADA

Projects in the United States must also comply with the accessibility guidelines of the Americans with Disabilities Act (ADA).

Other Laws

The project team must also check for any potential green building laws that may exist. Some cities now require a certain amount of energy efficiency or even a certain level of LEED certification. Do your research in the pre-design phase, because the design decisions will need to address these requirements.

For projects located in historical districts, the project team might be limited on how the façade of the building can look or sometimes even the interior of the home or building.

Design

In the design phase for the integrative process there will be some additional steps:

- Develop a project budget that covers green building measures
- Test and select green technologies and strategies
- Check costs
- Finalize design decisions

Remaining Steps

After the design phase, the remaining steps look quite similar to traditional design:

- Construction plans
- Bidding process
- Construction
- Commission the building
- Occupancy and recommissioning

The main differences is that in each of these steps - construction plans through occupancy - the project team is always reviewing and verifying that green building goals are being met at every point in the process. Additionally the team is always working together and collaborating.

Let's revisit our previous HVAC example. Let's have the HVAC person and the insulation person do further joint analysis before the design begins -

- How much extra insulation can we add in order to reduce the size of the mechanical systems?
- How will doing so decrease our operating costs?
- What are the life cycle costs of the insulation?
- Are there more upfront costs, or are we actually cutting costs by using smaller equipment?
- What is the point of diminishing return?

Building Costs

Looking down the line to ultimately save dollars impacts the economic bottom line, because of the impact of rising fuel costs and energy costs. In the past when constructing a new building the long term costs were never taken into consideration.

Green building studies have shown the cost of building green can be the same as that of traditional building. Green building projects have hard and soft costs just like traditional building, but the project team also considers life cycle costs.

A life cycle cost (LCC) is the sum of all recurring and one-time (non-recurring) costs over the full life span or a specified period of a good, service, structure, or system. The life cycle cost includes the purchase price, installation cost, operating costs, maintenance and upgrade costs, and remaining (residual or salvage) value at the end of ownership or its useful life. Traditional building processes look only at design and construction costs, or first costs, and not life-cycle costs.

A life cycle cost differs from life-cycle analysis (LCA), which is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence. LCA addresses environmental impacts while LCC addresses economic impacts.

Soft construction costs are costs not directly related to building, construction, etc. These include architectural, legal, financing, engineering fees and other costs incurred before and after construction. These costs make construction possible but are not directly related to building the project.

Hard costs deal with fixed assets. They are directly related to improving real property.

Green building also differs from traditional design by considering the operating and maintenance costs of the building over its lifetime, not just the construction costs. A lifecycle cost analysis helps define the long-term operations and maintenance costs. For

example, if Carpet A costs $10,000 but only lasts 5 years, and Carpet B costs $20,000 but lasts 20 years, Carpet B is a better choice because it has lower lifecycle costs.

During the pre-design phase, project teams should set their goals for life cycle costs rather than "first cost" value-engineering. Value engineering takes a project and alters the building design and systems to fit a budget with changes often coming during implementation and construction. Ongoing operations and maintenance costs are not considered when first-cost value engineering takes place. For example, insulation may be reduced to save on building cost, not considering that increased insulation can save operational costs.

Integrative Process Compared to Traditional Project Delivery

Here is a summary of how the processes and building strategies compare:

	Traditional Project Delivery	Integrative Process
Teams	Hierarchical, working independently only as needed	Collaborative, integrative, assembled as early as possible before any designing
Process/Schedule	Linear, working in silos	Concurrent; shared information, iterative
Risk	Individual risk	Shared equally
Compensation	Individually based	Based on team success
Communication	Paper based	Digital and virtual; use of computer models
Materials/Strategies	Least expensive to meet code	Life cycle analysis, life cycle costing
Project phases	Design – occupancy	Predesign phase; green building goals are reviewed at every phase

Conventional building practice usually involves a linear project handoff from architect to engineer to contractor to occupant. By contrast, the integrative process front-loads the process, bringing the client, designers, engineers, contractors, occupants and operators together early in the design process to collaboratively establish project goals, strategize innovative approaches and resolve conflicts in advance. These disciplines then continue to work together in an iterative process toward the project's high performance goals.

Integrative Process and Project Teams

The integrative process of a project is what contributes to reaching the sustainability goals established by the project team. Every aspect of building design is considered cohesively, beginning in the pre-design phase, and continuing to the end of the building's lifecycle.

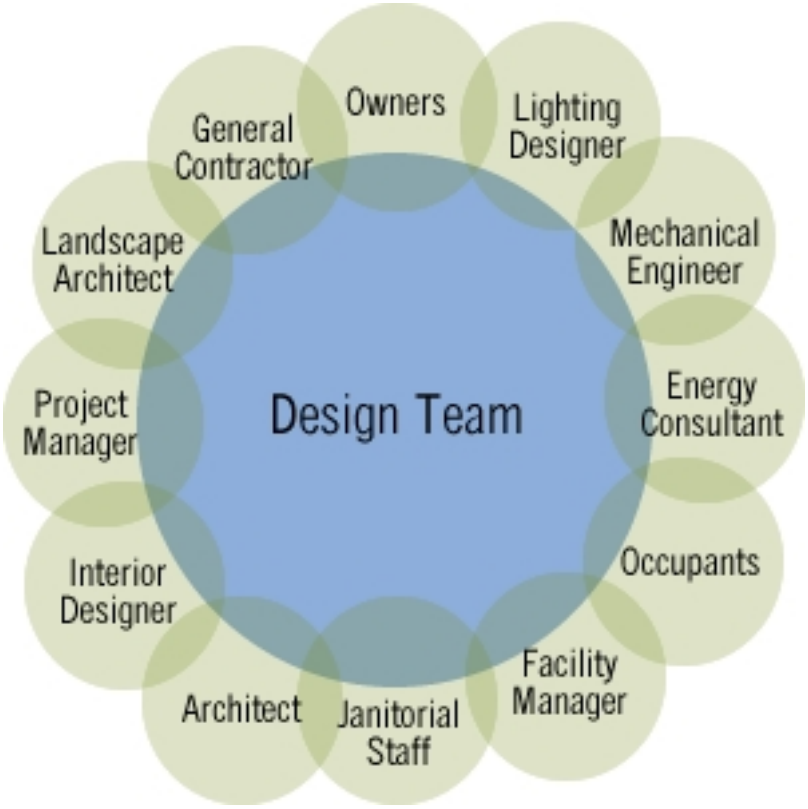
A fully integrative process is only possible with an integrative project team. Everyone involved in a building project has to be of like mind and work together to achieve the goals of an integrative process. This includes not only the people who are designing and

constructing the building, but also the people that own and manage the building and the people who will occupy it.

Communication is very important, and it needs to start as early in the design process as possible. The earlier that sustainable planning begins, the less costly the project will be and the more likely that the project will meet its goals. Ways to communicate with end users includes the use of surveys and roundtable discussions. These do not have to be complicated or expensive.

The integrated team works together for the duration of the project with ebbs and flows of responsibilities and involvement for each discipline. Innovative design solutions require the investigation of leading edge approaches and technologies and may require team members to stretch their current level of expertise. This can create a sense of vulnerability, so it is essential for the project lead, whether it is the project architect or design/build contractor, to establish a culture of collaboration and trust among team members at the onset of the process. This encourages team members to be open to new ideas and learn from others. The spirit of cooperation is greatly strengthened if the owner/developer is seen as a champion of the integrated approach and openly provides access to staff, financial decision makers and facilities personnel who will have ultimate responsibility for the building.

FIGURE 1.4 Design team members



The success of a project team depends on:

- Setting specific goals that can be measured and validated
- Developing strategies that will meet the goals
- Proper planning
- Creating processes that foster communication of all team members
- All team members being on board with the goals and being held accountable for reaching those goals
- Continuous monitoring of progress throughout the development process and ensuring goals are being achieved

Ultimately, the building owner is responsible for setting the goals for a project and their implementation. It is the responsibility of the design team to translate the goals and budget for the project into measurable benchmarks for design, construction, and operations so the project will be successful.

For example, consider the quality of a building's indoor air. Air quality is going to be affected by:

- The size and rate of the ventilation system
- The materials that are chosen for the interiors
- Where fresh air is pulled from outside the building
- Where cleaning chemicals are stored in the building (facility management)
- What pest control measures are used, etc.

That concern reflects just one issue - air quality - but it doesn't include everything that needs to be addressed. This decision involved the HVAC engineer, the architect, the facility manager, and vendors.

In colder climates, the integration between the building envelope and its HVAC systems is even more beneficial. The more high quality insulation that is installed in the exterior of the building, the less heating will be needed. Lower heating bills equal lower operating costs. In warmer climates, there are several design strategies available to reduce the cooling load needed. Often these integrative ideas do have offsetting costs, so it is important not to look at costs as just the upfront expenses but more as lifecycle costs.

Every member of an integrated team can provide input toward reaching sustainability goals. However, everyone must be on the same page throughout the building process.

The integrated team is not set up for a once-and-done meeting. The integrated team is not just the "integrated process team." The integrated team works from conception through the life cycle of the building.

As mentioned in goal setting, this team needs to have an iterative process of constantly checking progress against goals, reviewing the goals, reviewing the currently strategies and interaction to achieve the goals. The mental picture this type of activity should bring to mind is a circle. Building the project and attempting to reach goals on a linear line of tasks A-Z is not the modern view. Instead, an iterative process is a circle of activities that constantly work to achieve goals and adjust to project /environment/client changes as they happen.

Example: Bridgeton Revitalization Project

The Bridgeton Revitalization project in Bridgeton, New Jersey has created new affordable housing that is efficiently and aesthetically integrated into the town's existing historic district. The Bridgeton Revitalization project incorporated an integrative process in several ways. The project used a series of public meetings to solicit the active input of residents, neighbors and staff of the local housing authority at every scale of the project. Because this project took place in a historic district, it was also important to involve private stakeholders and experts early in the process to most efficiently coordinate large-

scale projects such as utility and street improvements. Perhaps most important, the Bridgeton Revitalization project adopted a whole building approach and encouraged all of the engineers, the builder and the architect to collaborate throughout the length of the project to ensure sustainable materials and systems were incorporated into all aspects of the project.

This process not only created greener affordable housing for the municipality, it also ensured that the people who would be living in or near the new buildings were actively involved in determining the form that the development would take. This is an example of how an integrative process can help address both environmental and social issues related to a new residential development and result in a successful project. Conflicts are inevitable but solutions are easier to find if all participants and stakeholders are included in the design process.[10]

Ongoing Operations & Maintenance

Meeting sustainability goals does not end after the building design is completed. Traditional buildings have similar needs. Contractors are scheduled to come in periodically and check a building's systems:

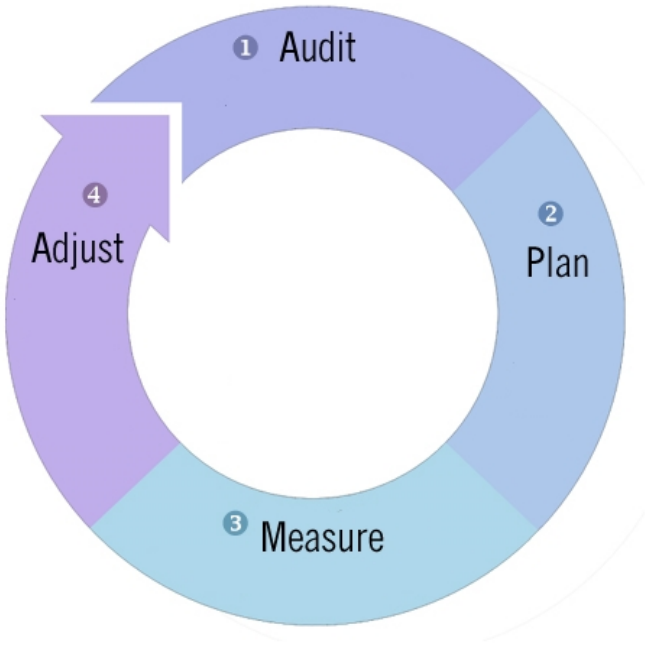
- Do the HVAC filters need replacing?
- Do the belts for the exhaust fans need replacing?
- Are the hot water boilers functioning properly?

These tasks are also examples of effective preventive maintenance and on-going commissioning.

This simple example is another instance where sustainable design differs from traditional design. Sustainable design goes well beyond preventative maintenance to include auditing, performance measuring, analysis, and optimization. All these steps can reduce costs by catching problems well before a system breaks or even if it does not ever break down. A system that is running 20% too much or is not performing to its design may lead to the equipment failing before its expected lifetime or the system consuming more energy than is needed.

The ongoing operations and maintenance of a high-performance building is a continuous process that needs to follow a plan that identifies and corrects building system problems to maintain peak building performance over time. This process is a continuous cycle of planning, auditing, measuring, analyzing, and correcting.

FIGURE 1.5 The continuous operations & maintenance cycle over the lifetime of a building



The Triple Bottom Line

How is true sustainability defined? The key indicator of true sustainability is the *triple bottom line*. You are probably already familiar with the traditional bottom line. In business, the bottom line is on the bottom of the financial statement. The bottom line indicates how much money the business/project/investment made. Every business places the bottom line at or near the top of any important decision- making process.

- Can I hire this prospective employee? How much is it going to cost, and how much money can the employee save the business or add to the business?
- Should we buy this equipment? How much does the equipment cost, and how much can it save the company, or how much new revenue can it generate?

The same decisions are made in development, design, and construction –

- Is this project going to make us money?
- Will we break even, or will we lose money?
- What's our profit margin going to be?

Nobody runs a business to lose money, or else the business cannot survive, and everyone will be out of a job.

When we think about sustainability we need to look beyond the traditional bottom line. True sustainability has three key aspects:

1. Economics
2. Environment
3. Social responsibility

These aspects make up the *triple bottom line*. The three aspects succinctly describe the goal of sustainability. In practical terms, triple bottom line accounting means expanding the traditional reporting framework to take into account ecological and social externalities in addition to financial performance. A social or ecological externality is an effect of building that may not be considered in the cost of the project. Project teams should now think of benefitting all stakeholders.

Note: You might hear the triple bottom line referred to in different ways:

Economic growth, ecological balance, and social progress: *The World Business Council for Sustainable Development*

Economic viability, environmental stewardship, social awareness: *USGBC*

The three P's: profit, planet, and people

The three E's: economics, ecology, social equity

The triple bottom lines defined are:

Economics -- Economic bottom line of a company that produces a long-term, positive economic impact.

Environment -- Sustainable environmental practices. Organizations should endeavor to benefit the planet as much as possible and consider negative externalities to the environment

Social Responsibility -- Improving the lives of those with whom the building interacts. The well- being of a building's workers, occupants, community members, neighbors, and other stakeholder interests should be interdependent.

FIGURE 1.6 The Triple Bottom Line

Consider the use of light bulbs in a building. Looking at just the bottom line for construction, a builder installs conventional and dim light bulbs to maximize the upfront profits of the building. Conventional light bulbs are cheap. When looking at the triple bottom line, however, what sustainable strategy should this builder use to address economic growth, the environment, and social responsibility over the life of the building? The builder should consider the use of brighter, compact florescent light bulbs (CFLs) or LEDs that use a fraction of the energy (but do have higher upfront costs).

Economic - LEDs require less energy consumption and do not need to be replaced as frequently, an aspect that does contribute to the economic bottom line over the life of the building

Environment – Using less energy allows the local utility company to burn less fossil fuel and generate less pollution.

Social – Brighter light bulbs create a better work environment for employees, and reduced pollution creates more breathable air in the surrounding communities.

Systems Thinking

Systems thinking is similar to integrative design in that in systems thinking project teams are supposed to view each part of the project in relationship to other parts of the project. In a sense a series of small systems are connected to become a more complex system in which the parts all affect each other. These nested systems can represent a building project, a community, or a city. Systems thinking tries to avoid designing a solution to

one problem that results in a problem in another system. Systems also can develop emergent properties, or where 2+2=5.

Emergent properties are characteristics of a system that only happen when the system is working and are not a result of the smaller subsystems. For example, the corporate culture of Southwest Airlines has been frequently studied and discussed in business schools. The fun and efficient working environment is an emergent property of the system of planes, people, and processes. Many other airlines might have the same subsystems, but not achieve that positive emergent property of the Southwest Airline's system.

To understand systems we must understand the types and how to affect them. There are different types of systems and the difference between them is determined by how the system relates to the world around it.

Closed Systems - A set of actions/materials with a closed loop. For example, plants growing in a field, grow, produce oxygen, take in water, then die and decay which helps plants grow.

Closed systems can be linked so one system uses the byproducts of another. Closed systems are considered to be the most sustainable because there is no "waste" or final end product. The system continues on and on independently.

Open Systems - Unlike closed systems, an open system is a system that constantly takes in items from outside the system, uses them and then released them as waste. This system has no feedback loop. Think of a normal home where groceries, products, or water come into the home, are used and then released as waste water or garbage.

Open systems are less sustainable because they require new inputs and create waste. Only if that waste can be used in another system can an open system become closer to a closed system and be more sustainable. An example of two open systems working to be sustainable could be a factory that produces a product, but gives scrap material to another factory to create a different product. Think of a lumber mill that creates 2x4s as one product and uses the wood chips and dust to create paper at another factory.

System thinking requires a project team to access how small systems work together in the larger system to be the most efficient as possible. For example a project team may assume that a recycling program is reducing waste, but if they are not careful to check the recycle removal process, the recycled material could be added to the waste stream. This can happen in office buildings when the cleaning staff is not properly trained on the recycling program. Sometimes recycled materials are sorted in the office but cleaning

teams simply treat all recycle material and trash as waste. In this situation teams need feedback to see if the system is working properly.

There are several ways to affect how a system works.

Leverage Points - leverage points are a point in a system where a small change can lead to large changes in results. This means small actions that can be free or a small cost might mean large savings or improvements on a project.

An example that shows an inexpensive way to change can be found at the U.S. Center for Disease Control. Researchers placed signs near elevators or escalators next to stairs that declare it is important to exercise your heart. The researchers observed a significant increase of people choosing to take the stairs due to the inexpensive sign. In construction an increase in a building's insulation may cause a significant reduction in energy use or using pervious paving may significantly decrease water runoff.

According to the *The Fifth Discipline: The Art and Practice of the Learning Organization*[11]

> "The bottom line of systems thinking is leverage—seeing where actions and changes in structures can lead to significant, enduring improvements. Often leverage follows the principle of economy of means: where the best results come not from large-scale efforts but from small well-focused actions. Our nonsystematic ways of thinking are so damaging specifically because they consistently lead us to focus on low leverage changes: we focus on symptoms where the stress is greatest. We repair or ameliorate the symptoms. But such efforts only make matters better in the short run, at best, and worse in the long run."

Positive and Negative Feedback Loops - Both positive and negative feedback loops effect a system. Feedback is essentially information or results of the system. This feedback can encourage the system or stop it. A feedback loop can't work unless information or results flow in the system.

Negative Feedback Loop - a system where the output may signal the system to stop changing, i.e. a thermostat - at a certain point the temperature feedback will tell the system to cut off. The information of temperature must be made available to the thermostat for this system to work.

Positive Feedback Loop – a system where energy is taken from the output of a system and reapplied to the input, or A produces more of B which in turn produces more of A. i.e. population growth – Adults make children whom in turn make more Adults.

As we see in the positive feedback example, this type of feedback actually increases the speed or encourages the system. Urban sprawl happens because people move to the suburbs, forcing cities to provide utilities and roads for the new communities. Once the new location is urbanized it can encourage people to move even further away since now what used to be far from the city is viewed as being quite close.

Key Terms

building codes
built environment
carbon neutrality
closed system
conventional design
externalities
hard costs
integrative process
integrative project team
International Code Council
life cycle assessment (LCA)
life cycle costing (LCC)
iterative process
leverage point
negative feedback loop
net zero energy
open system
ordinance
positive feedback loop
regenerative
small task groups
soft costs
system thinking
triple bottom line
value engineering
water balance
whole building design
zoning

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Chapter 2 – About LEED

In this section we will cover in detail what LEED is, how it is organized, project registration and certification, and what resources are available for you to learn more about LEED and to help you implement a LEED project.

USGBC

Before we can discuss LEED, we need to know where LEED comes from and how it was created.

Founded in 1992, the U.S. Green Building Council (USGBC) is a 501(c)(3) non-profit community of leaders working to make green buildings available to everyone within a generation.

USGBC has more than 15,000 member organizations from every sector of the building industry and works to promote buildings that are environmentally responsible, profitable, and healthy places to live and work. To achieve this it has developed a variety of programs and services and works closely with key industry and research organizations and federal, state and local government agencies.

USGBC also offers a host of educational opportunities, including workshops and Web-based seminars to educate the public and industry professionals on different elements of the green building industry, from the basics to more technical information.

Mission

USGBC's mission is "to transform the way buildings and communities are designed, built, and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life". USGBC accomplishes this mission through several means:

Advocacy: USGBC provides tools, strategies and resources for policy makers and leaders on local, state and national levels.

Resources: USGBC provides tools and resources for project teams interested in executing green building plans.

Education: USGBC educates the industry and public about best practices in green building and about green building in general. USGBC tries to teach fact from fiction in

regards to green building, so that people around the world have an accurate view of green building practices.

Committees, chapters, and conferences: The many avenues USGBC provides for people to participate from the local level to the national level gives everyone an opportunity to become involved or just to listen and learn.

Committees are made of volunteers whose job is to listen to what the industry is demanding and respond accordingly.

For more information about getting involved and signing up for a committee visit

www.USGBC.org/committees

Chapters are present in most major cities, with new chapters forming all the time. Your local USGBC chapter is a great way for you to network with people involved in green building and for you to become involved in what's going on in your area.

For more information about USGBC chapters or to join USGBC chapter, visit

www.USGBC.org/chapters

Conferences – "Greenbuild is the world's largest conference and expo dedicated to green building. Thousands of building professionals from all over the world come together at Greenbuild for three days of outstanding educational sessions, renowned speakers, green building tours, special seminars, and networking events. Buildings play a critical role in protecting and improving our environment and the health of the people who occupy them. USGBC's Greenbuild Conference and Expo provides an unparalleled opportunity to connect with other green building peers, industry experts, and influential leaders as they share innovations in the green building movement."[1] The 2013 Greenbuild expo had over 30,000 attendees.

For more information about the annual Greenbuild conference visit

www.greenbuildexpo.org

Principles

USGBC has six guiding principles[2] used for making the decisions that will guide the organization:

1. Promoting the Triple Bottom Line

2. Establishing leadership
3. Creating and restoring harmony between humans and nature
4. Maintaining integrity by using technical and scientific data to help guide decision making
5. Ensure inclusiveness by using a democratic process and giving everyone an opportunity to be heard
6. Exhibit transparency by having open standards

Members

The USGBC is a tremendously diverse non-profit membership based organization. USGBC members and volunteer leaders come from leading organizations in the building and design industries. As mentioned previously, USGBC has over 20,000 member companies. The following are some of the types of professions and companies that have joined USGBC:

- Building owners and end-users
- Real estate developers
- Facility managers
- Interior designers
- Architects
- Designers
- Engineers
- Utility managers
- Landscape planners
- Contractors
- Product and building system manufacturers
- Government agencies
- Nonprofits
- College Students and Faculty

As you can see that is a pretty diverse group and includes everyone and anyone that might ever be involved in a construction project.

For more information about USGBC membership or to join USGBC, visit www.USGBC.org/membership

LEED

LEED stands for **LEADERSHIP** in **ENERGY** and **ENVIRONMENTAL DESIGN.** LEED is a leading-edge system for certifying high-performance buildings and sustainable neighborhoods.

History of LEED

LEED was developed by USGBC, and the LEED Green Building Rating System is the USGBC's primary vehicle for promoting sustainable design and construction. The LEED standard was created through volunteer committees. From 1994 to 2013, LEED grew from one standard for new construction to a comprehensive system of interrelated standards covering all aspects of the development and construction process. LEED also has grown from six volunteers on one committee to more than 200 volunteers on nearly 20 committees and nearly 150 professional staff.

Why Was LEED Created?

LEED was created to accomplish the following:

- Define "green building" by establishing a common standard of measurement
- Promote integrative, whole-building design practices
- Recognize environmental leadership in the building industry
- Stimulate green competition
- Raise consumer awareness of green building benefits
- Transform the building market

LEED helps to evaluate a building's performance throughout the building's life cycle.

LEED Certification Benefits

LEED certification saves money over the life of the building. We looked at the financial benefits of green building earlier in the presentation: lower operating costs, increased building value, higher occupancy rates, and higher rents.

Quite simply, LEED certified buildings use key resources more efficiently when compared to conventional buildings which are simply built to code or a strict budget. LEED certified buildings have healthier work and living environments, which contributes to higher productivity and improved employee health and comfort. The USGBC has also compiled a long list of benefits of implementing a LEED strategy which ranges from improving air and water quality to reducing solid waste, benefitting owners, occupiers, and society as a whole.

Sometimes when LEED certification is pursued, the initial cost for design and construction will increase. One reason is that sustainable construction principles may not be well understood by the design professionals undertaking the project. This could require time to be spent on research. Some of the finer points of LEED certification (especially those which demand a higher-than-orthodox standard of service from the construction team) could possibly lead to misunderstandings between the design team, construction team, and client, which could result in delays. Also, there may be a lack of abundant availability of manufactured building components which meet LEED standards. Pursuing LEED certification for a project is an added cost in itself as well. This added cost comes in the form of USGBC correspondence, LEED consultants, and the hiring of the required Commissioning Authority (CxA) - all of which would not necessarily be included in an environmentally responsible project unless it were also seeking LEED certification. But keep in mind that when there are additional up front green premiums, the long term savings in the building operation costs is significant and payback periods are quick. Since tenants or residents desire these green buildings, it leads to higher rents or sales prices. This leads to a higher net present value for the project. Net present value is a calculation that takes into account future earnings and future expenses. By having a LEED certified project, an owner can expect higher earnings and lower expenses – meaning the building is worth more now.

Some of the other benefits of LEED certification include:

State and local government incentives - many government agencies give tax breaks for green building.

Projects may require it - many local, state, and federal government agencies, as well as developers are requiring LEED certification in order to win bids and award contracts. If your organization wants those contracts, you're going to need to know about LEED in order to do business. The General Services Administration (GSA) has recently increased its minimum requirement for new construction and substantial renovation of Federally-owned facilities to LEED® Gold. Until 2010, GSA required LEED® Silver.

LEED facilitates the integrative process from start to finish - LEED encourages design teams to use a holistic approach and to measure progress. Using LEED ensures that your building will have a low impact on its occupants and the environment and a positive economic impact over the lifecycle of the building. Rather than attempting to follow local green building programs that may vary from city to city, or using bits and pieces of different green building approaches, LEED addresses a complete range of green building issues and does so on a national level for consistency. If you build a LEED certified building in Florida and build a LEED certified building in Washington, you will be using the same guidelines. That saves your project time and saves your project money.

Third party validation of achievement – LEED is the mechanism through which project teams certify the performance of their buildings through an independent third party certification. LEED certification has become accepted as the standard that distinguishes a building as green.

Cost Savings on Utilities - A study conducted by the New Buildings Institute titled '*Energy Performance of LEED for New Construction Buildings*' analyzed 121 LEED-Certified office buildings in the U.S. and found that they use 24% less energy than similar buildings. Indoor and outdoor water use can also be reduced.

Good PR – Your project will receive marketing exposure through the USGBC Web site, case studies, media announcements, and a LEED certification plaque to mount on the building.

Increased Value – LEED certified buildings studies are able to charge higher rents for their optimal office environments, making the building itself more valuable for owners and stakeholders.

Why LEED?

The wonderful thing about LEED is that you can participate – your voice can be heard. If you find something in the Rating System you don't like or want added, then get involved in the process.

USGBC member committees develop the LEED Rating System via a robust consensus process that has been refined since its inception. The key elements of the LEED Rating Systems are:

- A consensus process that has a balanced and transparent committee structure
- Technical Advisory Groups to ensure scientific consistency and rigor
- Opportunities for stakeholder comment and review
- Member ballot of new rating systems and certain changes to existing rating systems
- A fair and open appeals process

LEED isn't driven by product manufacturer's trying to sell the latest technologies, politicians, or the finance industry. LEED comes from everyone that is involved.

LEED Rating Systems

LEED is a flexible system – not a one-size-fits-all approach. LEED not only applies to different building types (commercial vs. residential), but also beyond the building

footprint. Because of this flexibility, there are different versions of LEED depending on the project type.

There are rating systems that address multiple project types:

Building Design + Construction (BD+C)

Building Design + Construction applies to buildings that are being newly constructed or going through a major renovation.

LEED BD+C: New Construction addresses design and construction activities for both new buildings and major renovations of existing buildings. This includes major HVAC improvements, significant building envelope modifications and major interior rehabilitation.

LEED BD+C: Core & Shell is for projects where the developer controls the design and construction of the entire mechanical, electrical, plumbing, and fire protection system - called the core and shell - but not the design and construction of the tenant fit-out.

LEED BD+C: Schools is for buildings made up of core and ancillary learning spaces on K-12 school grounds. If can also be used for higher education and non-academic buildings on school campuses.

LEED BD+C: Retail addresses the unique needs of retailers - from banks, restaurants, apparel, electronics, big box and everything in between.

LEED BD+C: Hospitality is dedicated to hotels, motels, inns, or other businesses within the service industry that provide transitional or short-term lodging with or without food.

LEED BD+C: Data Centers is specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing.

LEED BD+C: Warehouses & Distribution Centers is for buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings, like self-storage.

LEED BD+C: Healthcare is hospitals that operate twenty-four hours a day, seven days a week and provide inpatient medical treatment, including acute and long-term care.

LEED BD+C: Homes and Multifamily Lowrise is for single-family homes and multi-family residential buildings of 1 to 3 stories. Projects 3 to 5 stories can choose the Homes

rating system that corresponds to the ENERGY STAR program in which they are participating.

LEED BD+C Multifamily Midrise is for multi-family residential buildings of 4 to 8 occupiable stories above grade.

Interior Design + Construction (ID+C)

LEED ID+C applies to projects that are a complete interior fit-out.

LEED ID+C Commercial Interiors is for interior spaces dedicated to functions other than retail or hospitality.

LEED ID+C Retail guides retailers interior spaces used to conduct the retail sale of consumer product goods. Includes both direct customer service areas (showroom) and preparation or storage areas that support customer service.

LEED ID+C Hospitality is designed for interior spaces dedicated to hotels, motels, inns, or other businesses within the service industry that provide transitional or short-term lodging with or without food.

Building Operations + Maintenance (O+M)

LEED O+M applies to existing buildings that are undergoing improvement work or little to no construction.

LEED O+M Existing Buildings is specifically projects that do not primarily serve K-12 educational, retail, data centers, warehouses and distribution centers, or hospitality uses.

LEED O+M Retail guides existing retail spaces, both showrooms, and storage areas.

LEED O+M Schools is for existing buildings made up of core and ancillary learning spaces on K-12 school grounds. It can also be used for higher education and non-academic buildings on school campuses.

LEED O+M Hospitality is for existing hotels, motels, inns, or other businesses within the service industry that provide transitional or short-term lodging with or without food.

LEED O+M Data Center is for existing buildings specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing.

LEED O+M Warehouses and Distribution Centers is for existing buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).

Neighborhood Development (ND)

LEED ND applies to new land development projects or redevelopment projects containing residential uses, nonresidential uses, or a mix. Projects can be at any stage of the development process, from conceptual planning to construction.

LEED ND Plan certification is available to your neighborhood-scale project if it's currently in any phase of planning and design and up to 75% constructed. USGBC designed this offering to help you or your developers market and fund your project among prospective tenants, financiers, public officials, etc. by affirming your intended sustainability strategies.

LEED ND Built Project is designed for neighborhood-scale projects that are near completion, or were completed within the last three years.

Multiple Certifications for the Same Building

Projects are not limited to just one rating system. A building could earn LEED BD+C: Core & Shell, then earn LEED ID+C: Commercial Interiors, and finally move on to LEED O+M: Existing Buildings.

A building can earn multiple certifications for the same building. The most common example is once a building has been built and earned a New Construction rating, the project team can start on the Operations & Maintenance certification.

Other examples:

- A Core & Shell project can move on to Commercial Interiors
- A New Construction project can move on to Commercial Interiors
- Commercial projects can move on to Operations & Maintenance

LEED Updates

LEED is continuously updated as markets, technology, and the world changes. Since the first rating system was introduced, LEED has evolved rapidly through the LEED development process. The LEED rating system of today is not the LEED of a year ago, and the LEED two years from now will be different still. That should not worry you that what you're planning on doing today will become obsolete or out of date in the near future. The first LEED certified buildings from eight years ago are still LEED certified – the award is never taken away. A project started under a specific version of the rating

system can continue in that version or move to a newer version if the project team desires.

Rating System Structure

LEED can be applied to any building at any point in the building's lifecycle. In order to measure if a building has met the definition of a high-performance green building as defined by LEED, every LEED rating system (except LEED for Neighborhood Development) has performance criteria in these major areas:

- Location and Transportation – does the location preserve environmentally sensitive places and take advantage of existing infrastructure, community resources, and public transit.
- Sustainable Sites – is the selected site able to maximize sustainability?
- Water Efficiency – what can you do to save on landscaping water use and interior water use?
- Energy and Atmosphere – how can you save energy, cut energy costs and encourage green energy development and use?
- Materials and Resources – are your building materials sustainable for the environment, and where does the waste go?
- Indoor Environmental Quality – how can you increase the productivity, satisfaction, and health of the occupants?
- Innovation – what can you discover that isn't in the rating system to add even further value to the project?
- Regional Priority – Are there regionally important issues such as water conservation in the Southwest?

Categories for LEED for Neighborhood Development

LEED for Neighborhood Development has different categories than the other rating systems:

- Smart Location and Linkage
- Neighborhood Pattern and Design
- Green Infrastructure & Buildings

Prerequisites and Credits

Within each credit category are credits and/or prerequisites.

Prerequisites

A fundamental of every LEED Rating System are the prerequisites. Prerequisites do not earn your project any points because they are required for the project to be considered.

The term "prerequisite" refers to a mandatory project characteristic, measurement, quality, value or function as identified within the LEED rating system. Prerequisites represent the key criteria that define green building performance. Each project must satisfy all specified prerequisites outlined in the LEED rating system under which it is registered. Failure to meet any prerequisite will render a project ineligible for certification.

Example

Here are the LEED BD+C New Construction Prerequisites:

- Sustainable Sites Prerequisite Construction Activity Pollution Prevention
- Water Efficiency Prerequisite – Outdoor Water Use Reduction
- Water Efficiency Prerequisite – Indoor Water Use Reduction
- Water Efficiency Prerequisite – Building-level Water Metering
- Energy and Atmosphere Prerequisite – Fundamental Commissioning and Verification
- Energy and Atmosphere Prerequisite – Minimum Energy Performance
- Energy and Atmosphere Prerequisite – Building-level Energy Metering
- Energy and Atmosphere Prerequisite – Fundamental Refrigerant Management
- Materials and Resources Prerequisite – Storage and Collection of Recyclables
- Materials and Resources Prerequisite – Construction and Demolition Waste Management Planning
- Indoor Environmental Quality Prerequisite – Minimum Indoor Air Quality Performance
- Indoor Environmental Quality Prerequisite – Environmental Tobacco Smoke (ETS) Control

You don't need to memorize these for the fundamentals of LEED - they are given for illustrative purposes only.

Prerequisites are ***required*** to achieve certification. One of the first steps on any LEED project is to make sure the project can meet the prerequisites. If the project cannot meet the prerequisites, the building *cannot* earn LEED certification. Make

sure your project can meet the prerequisites before you start down the path of certification.

Credits

Each sustainable category has a group of credits that defines a particular sustainability goal. The sustainability goal is referred to as the 'intent' of the credit. In fact, in the reference guide just below every prerequisite/credit name is a section titled 'intent' where the credit intent is defined. For example, the credit for reducing the amount of water used for landscaping by 50% has the intent of reducing potable water use. If your project team can meet the intent of a credit in a different way than the credit requires, you can sometimes still be awarded the credit. This is rare but it points out that the requirements developed by LEED are there to meet the intent of the credit.

Each LEED rating system has slightly different credits. Be sure you are using the correct rating system for your project, and do not confuse the requirements of one rating system for another. It is possible a credit for one rating system might have a different threshold for achievement than a different rating system.

Your project does NOT have to achieve all credits. Credits are *optional* elements. Your project only needs to achieve enough credits for the certification level the project is aiming for - certified, silver, gold, or platinum. Your project is also not required to submit any documentation for credits the project is not attempting. Some credits will not apply whatsoever to your project. For example, one credit for Sustainable Sites under the New Construction Rating System is awarded for locating the building near public transportation. If a project is located in a suburban area or in a city where there is little or no public transportation, this credit would not apply.

The phrase "Credit" means a non-mandatory project characteristic, measurement, quality, value or function as identified within a LEED rating system. Credits represent particular facets of sustainable design that contribute to overall green building performance. No single credit is mandatory; credits are selected and pursued at the option of a LEED project team.

Just remember - all of the credits are optional. Project teams need to choose enough credits to achieve their desired certification level. Project teams can mix and match credits until they reach the desired number of points.

Satisfying Prerequisites and Earning Credits

Each credit/prerequisite will have one or more requirements that must be met. By meeting these requirements for credits the project earns points. For example, a project might earn points for using less water for landscaping. Some credits have thresholds that

must be met, such as 'Use 50% less water for landscaping'. If you're wondering '50% less than what?', that level of detail would be covered in the requirements of that particular credit. Other credits are based on industry standards, such as HVAC standards set by ASHRAE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers). Still other credits have requirements for policies that must be implemented over time. A team may have to develop standard operating procedures (SOPs) that regulate activities in a uniform manner over the life of the certification. LEED credits and prerequisites are developed over time by the volunteers on the different LEED committees. This allows input on the rating system by concerned parties.

What you need to remember is a project must meet all prerequisites first, and points are awarded for meeting the requirements of various credits within each credit category.

Each credit for the rating system includes information on:

Intents

Intents express for the prerequisite or credit what the environmental goal is. An example is that LEED has several credits related to carpooling, telecommuting, or locating near mass transit. All these credits are trying to meet the Intent of reducing automobile use.

Requirements

The requirements section outlines what a project team must do to achieve a prerequisite or credit, based on the members and committees that write and vote on the requirements. The requirements may not be the only way you could think of to achieve the Intent of each credit or prerequisite, but they are the only way from the standpoint of the LEED Rating System.

Behind the Intent

This section describes just what the name implies. It usually points out what environmental damage is being done by something that a LEED credit or prerequisite is trying to change.

Back to our reduction in automobile use example: This section may outline the environmental effects of automobile use and how much it costs businesses, families or the country and then go on to describe the environmental and economic benefits of reducing automobile use.

Related Credit Tips

This section will list other credits whose requirements may be influenced or affected by the current credit. For example, locating near mass transit will help reduce the needed size of a parking lot, which is also related to the intent of having more open space. It is important to understand these relationships because the more credits that can be done at once the more efficient a project will be with time and resources.

Referenced Standards

Many credits will reference a standard – such as an EPA rule on water fixtures. These standards usually must be met as part of the requirements section. Sometimes project teams are allowed to meet local standards as long as they are equal to or more stringent than the referenced standard.

Local, state, and federal rules ALWAYS take precedent over LEED requirements and referenced LEED standards. If a LEED Credit says 'do X', first review any relevant laws, codes, local ordinances, and statutes to make sure there isn't a conflict.

Step-by-Step Guidance

This section is extremely helpful as it will outline steps projects teams can take to achieve the requirements. Teams don't have to use all the strategies or ideas or even any, but this section outlines common methods of achieving results. There is also a lot of explanation in this section that can help a person who does not understand the meaning of the requirements.

In earlier versions of LEED the timeline and teams responsible for different credits was not as clearly laid out. This topic covers who should be involved at different times in the credit achievement process. For example, if an architect is designing a green roof, the general contractor would need to find and verify appropriate roofing materials. This section is a reminder that even though one person on a team might make a decision, it usually takes many others to implement the decision

Exemplary Performance

Not every credit will have this option, but if it does, this section will go over what is required to earn Innovation in Design (or Operations) credits using the exemplary performance option. We will go over this in much greater detail in the Innovation section.

Calculations

If a credit has a calculation or equation, these will be listed and explained, often with examples.

Required Documentation

This section outlines what paperwork, proof, and sign off authority is required for each credit. Review the documentation requirements so if something such as photos are required, the team makes a note to take them at the appropriate time.

The details about the requirements for each credit are covered in the more advanced courses rather than this fundamental course on the LEED credits categories. The LEED Green Associate exam will not test knowledge on the specifics of particular credit requirements. If you want to learn more about a particular rating system please review the appropriate reference guide or take an in-person or online training class for the advanced courses.

LEED Pilot Credit Library

Pilot credits are credits that are being tested for an updated version of LEED. Project teams can attempt these credits under the Innovation category. The USGBC uses project teams' feedback on these credits to determine if the credits will actually be used in up-coming version of LEED.

Project Certification

The 'greenness' of a LEED project is based on a 100 point scale with an additional 10 bonus points.

There are four levels of LEED certification:

- Certified: 40-49 points
- Silver: 50-59 points
- Gold: 60-79 points
- Platinum: 80+ points

No specific products or design strategies are credited. The entire project or building is credited and eventually certified, rather than specific products. The intent is that the building as a whole uses a variety of design strategies and products that together contribute to a "green" building. Two Gold rated buildings may use completely different systems and strategies.

A project must satisfy three requirements for certification:

1. Meet the Minimum Program Requirements
2. Satisfy all Prerequisites

3. Satisfy a combination of Credits that achieve a certain number of points for the desired certification level.

These three requirements will be covered in more detail later in this section.

Credit Weightings

Points are available in each of the LEED credit categories, and the points are weighted to best address the social, environmental, and economic outcomes identified by USGBC.

LEED credits have different weightings depending on their ability to impact different environmental and human health concerns. More points are awarded for those credits that have a greater impact. The LEED impact categories answer the question: "What should a LEED project accomplish?"

- Reverse Contribution to Global Climate Change
- Enhance Individual Human Health and Well-Being
- Protect and Restore Water Resources
- Protect, Enhance and Restore Biodiversity and Ecosystem Services
- Promote Sustainable and Regenerative Material Resources Cycles
- Build a Greener Economy
- Enhance Social Equity, Environmental Justice, and Community Quality of Life

For more information about credit weightings, see the LEED v4 Impact Category and Point Allocation Process Overview.

Example: New Construction

Under the LEED BD+C New Construction rating system, the available points in each category are as follows:

Category	Points
Location and Transportation	16
Sustainable Sites	10
Water Efficiency	11
Energy and Atmosphere	33
Materials and Resources	13
Indoor Environmental Quality	16
Total	**100**
Bonus Points	
Innovation	6

Regional Credit	4
Total	**110**

As you can see, more points are awarded towards certification for having a really energy efficient building vs. having a really water efficient building. Generally, increased energy consumption will have a much more negative impact on the environment than excessive water use, thus a project can earn more points in the Energy and Atmosphere category compared to the Water Efficiency category.

The 10 bonus points are available for innovation credits. Four of the ten points address specific regional issues.

Now let's look at an LEED O+M: Existing Buildings rating system example:

Example: Operations & Maintenance

Category	Points
Location and Transportation	15
Sustainable Sites	10
Water Efficiency	12
Energy and Atmosphere	38
Materials and Resources	8
Indoor Environmental Quality	17
Total	**100**
Bonus Points	
Innovation & Design	6
Regional Credit	4
Total	**110**

Compared to the LEED BD+C: New Construction rating system, the differences are considerable – for Operations & Maintenance, the Materials and Resources category has fewer points while the Energy and Atmosphere category has more points. This makes sense because a building that is in the operations and maintenance part of the life-cycle, the environmental impact from the materials and resources is not as great (since the building is already complete) compared to the energy usage of the building over a period of decades.

Minimum Program Requirements

Projects must comply with the Minimum Program Requirements (MPRs). MPRs help define what types of buildings the rating systems are used to evaluate. For example, a

10’ x 10’ shed can’t be LEED certified because it wouldn’t meet the MPRs. The purpose of MPRs are to:

- Provide guidance on what types of projects are eligible for certification
- Protect the integrity of the LEED program
- Reduce the number of issues that come from the certification process

There are specific MPRs to some of the rating systems, so make sure you check out the reference document for details. All projects must:

Must be in a permanent location on existing land

The LEED rating system is designed to evaluate buildings, spaces, and neighborhoods in the context of their surroundings. A significant portion of LEED requirements are dependent on the project’s location, therefore it is important that LEED projects are evaluated as permanent structures. Locating projects on existing land is important to avoid artificial land masses that have the potential to displace and disrupt ecosystems.

The structure can’t be a modular home or be moved to another location in the future

Must use a reasonable LEED boundaries

The LEED rating system is designed to evaluate buildings, spaces, or neighborhoods, and all environmental impacts associated with those projects. Defining a reasonable LEED boundary ensures that project is accurately evaluated.

The project can’t exclude some project areas or include extra project areas for the purposes of skewing calculations to achieve more points (gerrymandering).

Must comply with project size requirements

The LEED rating system is designed to evaluate buildings, spaces, or neighborhoods of a certain size. The LEED requirements do not accurately assess the performance of projects outside of these size requirements.

All LEED projects must meet the size requirements listed:

LEED BD+C and LEED O+M Rating Systems: The LEED project must include a minimum of 1,000 square feet (93 square meters) of gross floor area.

LEED ID+C Rating Systems: The LEED project must include a minimum of 250 square feet (22 square meters) of gross floor area.

LEED Neighborhood Development Rating Systems: The LEED project should contain at least two habitable buildings and be no larger than 1500 acres.

LEED for Homes Rating Systems: The LEED project must be defined as a "dwelling unit" by all applicable codes. This requirement includes, but is not limited to, the International Residential Code stipulation that a dwelling unit must include "permanent provisions for living, sleeping, eating, cooking, and sanitation."

Projects that do not comply with the MPRs may have their certification revoked.

For full details and up-to-date information on the MPRs of the rating systems visit:

usgbc.org/credits

Phases of the Certification Process

Now let's look at the certification process for commercial projects. The certification steps are generally the same as the ones here. More information can be found at usgbc.org/leed/certification

1. Registration
2. Application
3. Preliminary review
4. Preliminary review response (clarifications)
5. Final review
6. Accept or appeal
7. Appeal review (if applicable)
8. Certification or denial

Let's look at these steps in more detail.

Planning - Charrette

The LEED process begins with holding a Charrette. A Charrette is a type of workshop where participants combine brainstorming, discussion, and strategy development to create a shared vision, goals and understanding of the next steps for a project, organization or community. During the Charrette, LEED goals are communicated to all team members, and LEED credit feasibility is evaluated. The integrative process is discussed as well as credit synergies (see Synergies section) and how the team plans to communicate during the building and design process.

Participants in the Charrette usually include the owner, architects, engineers, consultants, contractors, landscape architect, commissioning agent, etc. Basically anyone involved with the construction or use of the building is a candidate for participation. One of the goals of these meetings is to get everyone's buy-in. If the owner, building tenants, or anyone involved on the project team is not really interested in green building, the project will face additional hurdles.

The outcome of the Charrette should include a first draft of the LEED scorecard (which will be covered in more detail later), a preliminary rating, and defining the roles of each member of the project team.

As was mentioned in the introduction to green building – if a project team doesn't have experience developing high-performance buildings – find someone who does. Consultants are available to guide first-timers through the process including leading the Charrette. Classes are also available to learn more about the LEED process. Take advantage of these resources to ensure project success the first time.

The LEED reviewers are very proactive in helping teams with trouble and heading projects in the right direction. **Success is the key and it's not just a pass / fail, and then say goodbye**. There is that impetus to help projects move along. A lot of trepidation and fear goes into getting ready to put that registration in and get that process started, but go with the flow. Really develop the team and talk to the stakeholders to get everyone excited. That's the process that's really the key to the success of the building.

Registration

The next step towards LEED certification is registering your project. Projects are registered online at leedonline.com. After project registration the project team will receive additional tools and communications to guide the team through the certification process.

There are some eligibility restrictions for registration. All single family homes and low-rise residential construction must use the LEED for Homes Rating System. Multi-family projects between 4 and 6 stories may use either LEED for Homes or LEED BD+C New Construction.

Registration Fees

You can register your project at leedonline.com
The registration fees are:

- $900 for members
- $1,200 for non-members

Registration during the pre-design phase is highly recommended. The earlier you register, the more time the project team has to design and implement the credits required for certification. Registering early also allows the project team to do a *split design & construction review*, which we will describe shortly.

Certification Fees

Keep in mind the $900/$1,200 initial fee is just a flat registration fee that is paid up front at the time of registration. The certification fee is based on the size of the project and the rating system that the project was registered under. Certification fees are paid at the time a project team submits their application for review. For up-to-date information on certification fees visit the USGBC website.

Example Fees

Building Design and Construction Fees	ORGANIZATIONAL LEVEL OR NON-MEMBERS	SILVER, GOLD AND PLATINUM LEVEL MEMBERS	MEMBER SAVINGS
REGISTRATION	$1,200	$900	$300
PRECERTIFICATION REVIEW (optional, LEED CS only)			
Flat fee (per building)	$4,250	$3,250	**$1,000**
Expedited review (reduce from 20-25 business days to 10-12, available based on GBCI review capacity)	$5,000		
COMBINED REVIEW: DESIGN & CONSTRUCTION			
Project gross floor area (excluding parking): less than 50,000 sq ft	$2,750	$2,250	**$500**
Project gross floor area (excluding parking): 50,000-500,000 sq ft	$0.055/sf	$0.045/sf	**$0.01/sf**
Project gross floor area (excluding parking): more than 500,000 sq ft	$27,500	$22,500	**$5,000**
Expedited review (reduce from 20-25 business days to 10-12, available based on GBCI review capacity)	+ $10,000		
SPLIT REVIEW: DESIGN			
Project gross floor area (excluding parking): less than 50,000 sq ft	$2,250	$2,000	**$250**
Project gross floor area (excluding parking): 50,000-500,000 sq ft	$0.045/sf	$0.04/sf	**$0.005/sf**
Project gross floor area (excluding parking): more than 500,000 sq ft	$22,500	$20,000	**$2,500**
Expedited review (reduce from 20-25 business days to 10-12, available based on GBCI review capacity)	$5,000		

Notice that fees depend upon membership status and the square footage of the building.

Multi Building Projects

Some projects may involve several buildings being constructed or planned at once. These projects might be in a corporate campus or a college campus. LEED has a Volume Program or Campus Guidance to help project teams in this scenario.

The Volume program is for organizations planning to certify an entire portfolio of building projects (25 or more) using the BD+C and O+M rating systems. LEED Volume is a simplified, speedier process. It is best for projects designed for uniformity - prototypes that are identical in design or operations such as franchises or bank branches.

The Campus Program is for organizations planning to certify multiple buildings on a single campus site and under the control of a single entity (like a corporate or educational campus, or a commercial development).

Project Administrator

At the time a project is registered, the project team will need to identify the LEED Project Administrator. The project administrator has several responsibilities, including:

- Setup of the project team members
- Entering team member assignments for credits
- Submitting the application for review

The project team is responsible for selecting who will administer the project. The project administrator does not have to be a LEED AP.

Team members are responsible for the documentation of the credits they have been assigned in LEED Online.

Application

After project registration, the project team and project administrator can collect the information needed for the credit submittals. Each rating system will have its own set of forms that must be completed and submitted for documentation and verification. These forms are filled out online using LEED Online.

The credit forms are also referred to as letter templates, credit templates, submittal templates, or submittal documentation. Sample forms are available on the USGBC website. Please take a moment to review them to familiarize yourself with how they appear and are used.

LEED Online

After project registration, the project administrator will have access to LEED Online. The project administrator then gives access to other team members, assigning them to various credits. LEED Online is a central repository for all project information. This tool allows team members to:

- Submit all documentation online, including documents and pictures. USGBC requires an overall project narrative along with drawings and photographs of the site plan, floor plan, building section, primary elevation, and rendering of the project, all of which can be uploaded using LEED Online.
- Update credit templates
- View and submit Credit Interpretation Requests (CIRs)
- Contact customer service
- View and respond to reviewer comments

Each project is associated with a particular building system which can receive credits. Supportive documentation can also be uploaded to LEED Online. All team members submit project documentation using LEED Online only.

Via LEED Online, project members, USGBC staff, and other invited individuals can review the documentation forms and express concerns or issues. After the application has been reviewed, team members with access can visit the project to see if the application has been approved or needs additional documentation.

Project Review

Once a project's payment has been received, the review process can begin. With the exception of the LEED for Operations & Maintenance rating system, project teams have the option of a *combined* design & construction review or a *split* design & construction review.

Split vs. Combined Reviews

The combined design & construction review is just that – all documentation for the LEED project is submitted and reviewed at one time. There is no advantage to this type of review. When a project decides to pursue LEED certification after the project has started, sometimes this option works best.

A split review allows project teams to submit some of the project documentation during the design phase. The design phase review is a review of those credits USGBC can reasonably adjust based on design phase documentation. This gives project teams insight into what credits can be *anticipated* for certification.

Example: Consider a project site located in an urban area such as San Francisco where 53% of people take public transportation. Even before the project breaks ground, you can anticipate your project would earn points for selecting a site that has accessibility to public transportation, just based on the location of the property. This and several other sustainable designs can be determined in the design phase.

The split design and construction review is preferable because it gives project teams advance notice of some of the LEED credits that may be *awarded*, and insight to see if the project is on track to achieve the desired level of certification. If the LEED review committee *denied* some of the credits submitted during the design phase, the project team has ample time to meet the requirements of the credits or submit alternative credits to make up the difference.

Another advantage of a split review is that it forces project teams to document early and document often. If a project takes two years to complete, how likely is it team members are going to remember how all the requirements were met over the past two years on the project? Are you going to be able to find those receipts or that data sheet from a certain product that was purchased nine months ago? That's a lot of information to keep track of and why you need to:

document early, document often

Credit/Prerequisite Statuses

During the project review process credits/prerequisites are updated with one of the following statuses:

- Anticipated – the project team can reasonably assume the credit will be achieved (*Note that only during the design phase of a split review are credits marked as anticipated.*)
- Clarify – more information is needed
- Awarded – the credit/prerequisite requirements have been met and points are earned
- Denied – the credit/prerequisite has not met the requirements

No credits are earned and no points are awarded during the design phase. Points can only be earned AFTER the construction phase.

Review Process

Here are the steps for each type of review. The steps listed in **bold** are done by the project team while the other steps are done by USGBC.

Under the combined review, the review phases are as follows.

1. Preliminary review
2. **Preliminary review response (clarifications)**
3. Final review
4. **Accept or appeal**
5. Appeal

When a split design & construction review is done the review phases are:

1. Preliminary design phase review
2. **Preliminary design phase response (clarifications)**
3. Final design-phase review
4. **Accept or Appeal**
5. Design-phase appeal
6. Preliminary construction-phase review
7. **Preliminary construction-phase response (clarifications)**
8. Final construction-phase review
9. Accept or Appeal
10. Construction-phase Appeal

Make sure you review the following website for in-depth coverage of the Certification Process and Review Timeline

Certification or Denial

Once USGBC has received the completed application and fee, the LEED reviewer will do a final review and will formally rule on the full application. USGBC awards the appropriate certification level based on the number of credits achieved.

Appeals

If a project team feels that sufficient grounds exist to appeal a credit or prerequisite denied in the final LEED review, the project team may submit an appeal.

TIP: Don't get caught with too few credits for your application. If your project is aiming for silver certification (50 points), you want to aim for earning around 55 points while the project is in the design phase. Why? Because if the project is aiming for exactly 50 points and one point is denied, the project would earn 49 points and not earn Silver certification. If the project tries for 55 points the project could be denied up to 5 points and still earn Silver certification.

Award

Once the results are accepted, LEED certification is awarded to the building. A plaque for the building is issued, usually for mounting on the building itself.

Updates and errata

LEED is constantly evolving. The time of registration determines what requirements a project must meet. When a project is registered for certification, the prerequisites, credits, errata, and credit rulings current at the time of project registration will continue to guide the project throughout its certification process. For example, if a project is registered in 2014 with an expected completion date of 2016 the LEED Rating System has some minor updates made in 2015, the project would continue to use the rating system established in 2014. Often the project has the option of migrating to the updated rating system if they choose.

Occasionally errors end up in printed documentation such as the reference guides. Make sure you do the following before your pre-design meetings:

1. Review USGBC's website for any updates or errata
2. Have the latest reference guide at the start of a project

LEED for Neighborhood Development

USGBC understands that neighborhoods take much longer to build than a single project building or home. USGBC has split the application process for ND into three stages. Essentially these stages are review of design, review of approved plan, final certification. In more detail they are:

Stage 1: Conditional Approval of a LEED for Neighborhood Development Plan – This "enables project teams to assess the likelihood of achievement of the SLL prerequisites."[3]

Stage 2: Pre-Certified LEED for Neighborhood Development Plan – USGBC's determination that…the completed project should satisfy all prerequisites and a minimum number of points outlined in the LEED for Neighborhood Development Rating System such that it should be eligible to receive LEED certification at a particular level"[4]

Stage 3: LEED Certified Neighborhood Development – "USGBC's determination that a Completed Project, as represented in the LEED certification application submitted to USGBC, satisfies all prerequisites and has achieved a minimum number of points outlined in the LEED for Neighborhood Development rating system to achieve a particular level of LEED certification"[5]

Extra Categories

LEED for Neighborhood Development has extra categories.

- Smart Location and Linkage - Location, transportation alternatives, and preservation of sensitive lands while also discouraging sprawl
- Neighborhood Pattern and Design - The creation of vibrant, equitable communities that are healthy, walkable and mixed use
- Green Infrastructure & Buildings – Building green buildings that are water and energy efficient.

Project Resources

There are many resources available to further your knowledge of LEED and the green building industry in general. Many of these resources will be critical to implementing a successful LEED project.

Reference Guides

Each LEED rating system has its own reference guide. These guides are an essential resource for anyone working on a LEED project or preparing for one of the LEED credentialing exams. The reference guide is the detailed "User's Manual" that explains the LEED credits in sufficient detail and is available for purchase on USGBC's website. Reference guides will contain valuable information about the LEED process specific to the rating system, the credit categories as they relate to the rating system, and terms and definitions as they apply to LEED.

Make sure the latest version of the reference guide is used. Out-of-date versions could have variations in credit thresholds from the latest rating systems. To avoid this you can use the web-version of the reference guide which is always up-to-date.

Case Studies

Case studies are a great way to learn from what other project teams have done. USGBC provides a searchable database of case studies to learn from. Case studies can be searched for by region, by rating system, and by certification level. Case study details include:

- Project overview describing the benefits from the green building strategies
- Process
- Financing
- Land use
- Site description

- Energy
- Materials
- Indoor environment
- Green strategies
- Images
- Ratings &awards

Consider searching for projects similar to your own, and you might find some design strategies to consider.

Visit USGBC's website and check out some of the available case studies

Note that after your search for projects, you need to click on Detail to display the case study.

Home / LEED / Project Certification / LEED Projects Directory

Customer Support

USGBC has customer support for LEED projects. If you have any questions about your LEED registered project you can contact USGBC via LEED Online.

LEED Online

LEED Online was reviewed earlier in this section. LEED Online is the repository for all LEED project documentation. Using LEED Online, team members and the project administrator can access the credit templates used for submission through their web browser. USGBC's staff and project members have access to the project documents.

LEED Scorecard

The LEED score card is a critical component early on in the LEED integrative process. The score card (also called the LEED checklist) lists all of the credits for the specific rating system and helps the project team track which ones are ideal for the project to attempt and those that are 'maybes' and need to be further investigated.

Establishing a viable, realistic LEED credit strategy is the first step towards a successful low-cost LEED certified project. The credit strategy is usually developed during the 'charrette' we discussed earlier. The design and construction team, future building occupants, and facility management staff should attend this session. The checklist should be utilized early on to identify which LEED points make the most sense for your project. The credit checklist is the basic tool that can be used to develop your credit strategy, and it can serve as an outline for the team throughout the project during the design and construction process.

In the charrette, project teams will begin by focusing on those credits that are low hanging fruit. Low hanging fruit = low cost fruits = easy and low-cost credits. These are the design choices that are easy to take off of the tree. Some of these credits are just going to be no-brainers and easy to implement. Others that are higher on the tree might take more time and energy.

The typical LEED scorecard has a yes column, maybe column and no column. In the charrette the project team walks through each credit. Once completed the preliminary rating, or targeted LEED certification, is known.

You can find a credit checklist for each rating system online, free of charge to both members and non-members. Go download a scorecard to see what is in it. You will need Microsoft Excel to open the file up. Visit:

www.usgbc.org/resources/list/checklists.

Credit Templates and Calculators

The LEED credit templates are online webpages that help streamline the certification process. The templates are used for documenting compliance with the credit and prerequisite requirements through LEED Online. The credit templates explain all of the necessary submittal documentation required and make it easy for all members of the project team to fill them out correctly. Each template lists the requirements for the credit, as well as listing any supporting files or documentation that will be needed to achieve the credit. The templates:

- Streamline preparation of LEED applications
- Provide declaration of credit achievements
- Function as a project management tool, and help allocate responsibility
- Include calculators when needed

The templates prompt team members for data and declarations of performance and indicate when the documentation requirements for credits are filled. For some credits, all that is required is a signature indicating compliance with the credit requirements. Other credits may require filling in detailed forms or providing additional documentation. Be sure the credit templates are accurate and information is gathered and updated throughout the certification process. Don't wait until construction is almost complete to get started. For example, the declarant is the person with the technical knowledge and authority to sign off on a credit template. This person must have had significant responsibility for what is required in the credit and is sometimes limited to a certain person or persons on

the project team. If you wait until completion of the project before working on the paperwork, the appropriate declarants may no longer be available.

For the credits that require calculations, the templates have built in calculators to indicate if specific requirements have been met. For example, a credit may have requirements for having a certain amount of the roof to be a green roof. The template would have inputs for the total roof area in square feet and the area of the green roof in square feet. The template would then calculate the percentage of the roof that is a green roof based on the given areas. It is in this way the templates also serve as a repository for collecting data.

Every team member has access to their respective credit templates. Each team member completes and provides documentation, while the project administrator submits completed templates and documents to USGBC.

Team members and the project administer can access the templates for their project via a web browser. One template is provided for each credit/prerequisite. If a particular credit is not attempted, no documentation needs to be completed for that credit.

Credit Interpretation Rulings (CIR)

What do you do if you have a question about a credit?

One feature that is available through LEED Online is Credit Interpretation Requests and Rulings (referred to as "CIRs"). CIRs are used to clarify a single question the project team may have and can be submitted any time after project registration. Often the reference guide will not specifically address the issue at hand and more information is needed. To address these issues, USGBC has created the Credit Interpretation Ruling process. Depending on the kind of question being asked, either USGBC staff or various technical committees will respond to the question and make an official Credit Interpretation Ruling.

Only LEED project team members have access to view CIRs for the project's they are assigned to.

When to Submit a CIR

The CIR and ruling process is used for technical and administrative guidance on how LEED credits apply to their projects and vice versa. If a project team is unsure about particular requirements or if a particular strategy will help earn the credit, a CIR should be researched and submitted when the question comes up.

CIR Process

If a question on a credit does come up, follow these steps:

1. Consult the reference guide for a detailed description of the credit intent, requirements, and calculations. Evaluate whether the project meets the intent of the credit. The project contact reviews the intent of the credit or prerequisite in question to self-evaluate whether the project meets this intent.
2. Contact LEED customer service to see if the question can be answered.
3. Submit a formal CIR. There is a fee of to submit each CIR.

Submissions

There are fees for submitting a CIR, so only submit a CIR if you have trouble determining the approach for a credit requirement. Only project teams with registered projects have access to submit CIRs.

When submitting a CIR, only one credit should be referenced in the request. Supplemental attachments to the request such as project drawings, photos, or cut sheets are not allowed.

Rulings

Within two to five weeks the Credit Ruling Committee posts its decision on the Credit Rulings Page. If the committee is concerned that the decision may have broader implications, the CIR may be passed on to the LEED Steering Committee for additional review.

CIR rulings do not affect the existing requirements of credits within the rating system, including adding/removing requirements or changing credit thresholds. Requirement changes occur during revisions to the rating system not through the CIR process. Just remember:

CIRs are for clarification, not for changes

No credits or points are awarded by the CIR process. The CIR process is used for clarification of a single issue only and to provide feedback on the request. The project team must still demonstrate credit compliance in order to achieve the credit.

Example CIR

A team wants to meet the requirement of individual temperature/comfort control with air diffusers. These are not mentioned in the requirement. So the team goes through Step1, checks the reference guide, Step 2, searches for a previous CIR that fits, Step 3 contacts customer service for an answer, and then finally submits the question of whether the air diffusers would be accepted. They are, and the team is able to achieve that point.

LEED Interpretations

Slightly different from the CIR process is the new formal LEED Interpretations process. LEED interpretations differ from CIRs because they can be precedent setting and applied to many projects over multiple rating systems. Project teams must opt into the LEED Interpretations process, which can take longer than the CIR process. Here is a comparison table from the USGBC's FAQ file on LEED Interpretations:

CIRs compared to LEED Interpretations

	CIR	LEED Interpretation
Length of time	Shorter	Longer, due to setting precedents
Cost	Lower	Higher due to more stringent review process
Applies to	Project only	Other buildings, rating systems, and/or projects

USGBC Policies

To prevent misuse of the LEED and USGBC brands, and to make sure their message is spread accurately, USGBC has an extensive set of guidelines for logo and language usage. It's common (and incorrect) for people new to the industry to ask 'What is the LEEDS certification?' or 'How do I get certified?' LEEDS with an S is an incorrect use of the LEED name. Also, people do not get certified, buildings do.

These guidelines also prevent manufacturers from making erroneous claims about products. Here are a few do's and don'ts:

LEED Certification and LEED Registered Projects

"LEED certification" with lowercase "c" is used to describe the certification process.

"LEED-certified" with lowercase "c" is used to describe a project that has been certified.

"LEED Certified" with capital "C" (and no hyphen) is used to describe a project that has been certified to the base level: Certified.

When a project is certified, the correct wording is "project 'A' is LEED Silver" or "project 'A' is LEED certified to the Silver level" or "project 'A' is LEED Silver certified." Due to repetition, the wording "project 'A' is LEED Certified certified" is not recommended. "Certified" to reference both certification and level is sufficient.

USGBC Naming

USGBC Name: The official organization name is the U.S. Green Building Council. "USGBC" is the official acronym. Use the complete name on any first reference. Subsequent references in copy may use USGBC. NOTE: When using "USGBC" as a noun, do not precede with "the." For example: Contact USGBC for more information.

There are many USGBC brands and naming conventions. To read about them check out the Public Relations Guidelines for LEED-certified Projects.

Professional Credentials

There are three levels of LEED accreditation for people. Buildings are certified, people are accredited.

LEED Green Associate: "For professionals who support green building design, construction, and operations, the LEED Green Associate credential denotes basic knowledge of green building principles and practices and LEED."[6]

LEED AP: The LEED Professional Credential that signifies an advanced depth of knowledge in green building practices and specialization in a particular LEED Rating System: Building Design + Construction, Operations + Maintenance, Interior Design + Construction, Homes, or Neighborhood Development.[7]

LEED Fellow: The LEED Fellow designates the most exceptional professionals in the green building industry, and it is the most prestigious designation awarded. LEED APs who have demonstrated exceptional achievement in key mastery elements related to technical knowledge and skill are eligible for the honor of becoming a LEED Fellow. They have also made significant contributions in teaching, mentoring, or research with proven outcomes. LEED Fellows have a history of exemplary leadership, impactful commitment, service, and advocacy in green building and sustainability.

Case Studies & Examples

Throughout this study, examples and case studies of real-world LEED projects are included. These case studies are provided to help reinforce the strategies and concepts presented.

Case Study: Dockside Green

LEED Rating: LEED for New Construction Platinum
Location: Victoria, British Columbia
Courtesy of: Dockside Green

Dockside Green is the first community ever to target LEED Platinum certification for buildings developed in a master planned community. Once completed, it will include 26 buildings totaling 1.3 million square feet, and be home to about 2,500 people in three neighborhoods - Dockside Wharf to start, followed by Dockside Commons and Dockside Village. Dockside Green was a pilot project for the LEED for Neighborhood Development Rating System - effectively setting the benchmark for LEED for Neighborhood Development certification.

We will be looking at this case study at the end of each section and highlighting how different sustainable strategies were implemented in Dockside Green. While there have been eco-residential and eco-industrial developments in the past, none, to our knowledge have incorporated such a wide range of uses as Dockside Green. Located in Victoria, British Columbia, Canada on 15-acres of former industrial land on the city's inner harbor, Dockside Green is the largest re-development of city land in Victoria's history.

A model for holistic, closed-loop design, Dockside Green will function as a total environmental system in which form, structure, materials, mechanical and electrical systems will be interrelated and interdependent - a largely self-sufficient, sustainable community where waste from one area will provide fuel for another. Here you will find a dynamic environment where residents, employees, neighboring businesses and the broader community will interact in a healthy and safe environment reclaimed from disuse and contamination.

Contrary to popular belief, developers and investors do not have to forfeit profitability to achieve sustainability. Quite the opposite, the project team believes that environmentally and socially conscious developments, balanced with a triple bottom line approach, make long-term business sense.

Triple Bottom Line

Dockside Green's development plan emphasizes the creation of a healthy and inclusive community that supports new economic opportunities and a high quality of life with minimal impact to the environment.

Dockside Green's strategy recognizes that triple bottom line components should never be treated as separate targets independent of one another. Instead, the project team believes in taking an integrative approach; intertwining economic, environmental and social objectives so that each enhances the attributes of the others, making it difficult to distinguish which specific triple bottom line component a particular tactic is addressing.

Integrative Process

Dockside Green adopted an integrated approach to design, tailoring it specifically to the Dockside lands and the Victoria West community by recognizing the need to apply integrated design principles to the whole site – not just individual components and characteristics. A holistic, closed-loop design approach is the only way to enhance synergies and achieve the sustainability goals.

Whole Systems Costing

Dockside Green strives to move the concept of whole-system costing beyond building design to include site and community infrastructure costs. For example, a sound green building strategy like ecological rainwater management will reduce infrastructure costs while reducing the emission of greenhouse gases and heat-island effects, thus creating natural habitat and improving human health. The ability to exploit whole-system thinking will be critical to success: ecologically, socially and financially.

Waste Is Food

Dockside Green's development plan creates opportunities for specific functions and systems to feed off each other by embracing the principle of "waste is food". In other words, waste resulting from one use can provide fuel for other uses. By implementing holistic, closed-loop thinking and design principles, the project team can improve and potentially compound Dockside Green's economic, environmental and livability dividends.

Stakeholder Meetings

Part of integrative process is to take into account those who will have use of the project. Dockside Green has created community liaison groups which will be forums to address issues affecting the project and the surrounding community and soliciting innovative ideas and solutions wherever possible. The feedback received from community stakeholders will impact Dockside Green's activities, performance, and, ultimately, result in a better product.

References

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Key Terms

CIR

certification

certification levels

construction phase

credit

design phase

GBCI

LEED Online

LEED Pilot Credit Library

LEED Project Administrator

LEED Rating System

LEED Score Card

logo usage (USGBC, LEED, etc)

Minimum Program Requirements (MPRs)

preliminary rating

prerequisite

reference guide

stakeholder meetings

standards

target certification level

USGBC

Chapter 3 – Location and Transportation

Creating sustainable buildings starts with selecting a proper location. The location of a building affects a wide range of environmental factors, including energy use, land use and preservation, erosion and rainwater management, access to public transportation, and many others.

The National Park Service describes traditional development as a method that "reflects the view that earth's resources are for human use," while sustainable development "accentuates the indigenous natural and cultural assets while respecting resource constraints."

This statement is an excellent explanation of the goals of the Location and Transportation section.

Location

Location, transportation alternatives, and preservation of sensitive lands while also discouraging sprawl contribute to smart location and linkage – how the site is linked to its surroundings. Site selection is the choice of a site – choose the right site and protect it during construction. By doing this, the project will go a long way toward good sustainability practices. Site area includes the total area within the project boundary defined as both constructed and non-constructed areas.

Site selection or the location of the project cannot be overstressed. *Location* in terms of green building includes the natural, infrastructural and social characteristics. The climate of the project, the connections to nearby areas, or the community reaction to the project all will have vast impacts on the project and how well the project can fit within the greater built environment.

If you are working only on the interior of a building, you may choose optimal space rather than a site. However, site selection can affect the way in which the rest of the project has to be designed for LEED certification. Among other things, site selection has an impact on:

- Energy conservation strategies, such as sunlight for daylighting, shade for natural cooling, or winds that may impact the building envelope
- Landscaping and vegetation, which impact erosion, rainwater management, irrigation, and landscape maintenance costs
- Proximity to public transportation and the ability to curb automobile use

Smart Growth

Location, transportation alternatives, and preservation of sensitive lands while also discouraging sprawl promote **smart growth**. This smart growth approach seeks to:

- protect undeveloped land
- reuse/restore previously developed sites
- reduce automobile use or promote alternative transportation
- develop efficient rainwater management
- reduce heat island effect
- provide stewardship of nature and the site's surroundings
- reduce light pollution or minimize light trespass from the building and site

Some examples of smart growth techniques are[1]:

1. Mix land uses
2. Take advantage of compact building design
3. Create a range of housing opportunities and choices
4. Create walkable neighborhoods
5. Foster distinctive, attractive communities with a strong sense of place
6. Preserve open space, farmland, natural beauty, and critical environmental areas
7. Strengthen and direct development towards existing communities
8. Provide a variety of transportation choices
9. Make development decisions predictable, fair, and cost effective
10. Encourage community and stakeholder collaboration in development decisions

Example: Belmont Dairy in Portland, Oregon

With the Belmont Dairy project, developer The Belmont Limited Partnership cleaned up and rehabilitated an abandoned dairy building to provide a variety of housing choices and retail services that led the revitalization of a neighborhood retail district in southeast Portland, Oregon.

In 1997, one half of the old Foremost Dairy building was converted into 19 market-rate loft apartments and 26,000 square feet of retail space, including a specialty grocery, a restaurant, and several shops. Attached to the dairy is a new apartment building that contains 66 units of affordable housing. Phase 2 of the project, completed in 1999 on the site of a former truck maintenance yard, contains 30 rowhouses at twice the density of conventional rowhouse developments in the city. Typical Portland rowhouse plans are long and thin and two fit, back-to-back, on a normal block with an alley in between. Belmont Dairy's three-story

rowhouses have a square floor plan. The rowhouses are oriented into two C-shaped clusters around a central, landscaped courtyard. The garages are located inside the Cs and hidden from the right of way, which means that, instead of seeing a wall of garage doors, pedestrians walking by see front porches, balconies, and bay windows. Some residents of the rowhouses have taken advantage of the area's business zoning by incorporating offices on the first floor of their homes or in their garages.

Since the 30-plus units per acre overall residential density of the project is far higher than the surrounding neighborhood, the developers met early and continuously with the neighborhood association and other stakeholders. The rowhouse portion of the project was designed as a transition from the high-density development on Belmont Street to the single-family homes two blocks away. The developers' efforts to explain the benefits of the design and willingness to address community desires resulted in the project receiving strong community support during the entitlement process.

At Belmont Dairy, compact development combined with good design creates a livable community where residents can walk to services available on Belmont Street and take a 10-minute bus ride to downtown Portland, one-and-a-half miles away.[2]

Protect Habitat

LEED prefers project teams to choose or manage sites in ways that benefit the environment and the people using the facilities. As we go through strategies for achieving sustainable sites, you'll see that some sites are just not going to fit the goals of green building. Select a good site and you'll not only benefit the environment, but your project as a whole will benefit as well.

If a project team has a choice of building on undeveloped land (called a *greenfield* site) that is currently or could be used for agriculture or on a site that has been previously developed, it would be a better green building plan to reuse the existing site. The benefit of this design choice is that the undeveloped land has a positive impact on the environment because of the presence of trees, streams, and native plants or species. For example, agricultural areas are regularly being developed but land that is good for farming with high-quality topsoil is a finite resource. Another negative impact of greenfield development is the encroachment and division of natural habitats. Selecting sites that are adjacent to or within existing developments can reduce fragmentation of habitat.

The following areas would not be considered optimal, and project teams should avoid building on them:

- Prime farm land
- Wetlands

- Public parkland
- Areas below flood plain
- Areas that are a habitat for threatened or endangered species
- Land close to lakes, streams, or other bodies of water
- Greenfield sites

Resources

Use multiple sources to help you identify potential sites. There may be online Geographical Information Systems for your area. These GIS systems can show parcels of land, ownership, existing infrastructure, etc. Also online and local maps can help a project team determine local connections to public transportation or regional impacts. The use of consultants or experts such as ecologists, engineers, or even economists might be helpful in identifying a great sustainable site. Real estate developers and agents have access to and knowledge of many of these resources.

Redevelop Brownfield Sites

USGBC defines a brownfield as a previously used or redeveloped land that may be contaminated with hazardous waste or pollution. It's a contaminated site that has the potential to be reused once any hazardous substances, pollutants, or contaminants are remediated. On the plus side, the federal, municipal or state government may offer an excellent deal to the buyer and/ or tax incentives on the property if the buyer agrees to clean it up. There may be hazardous materials involved, such as asbestos or lead and the owner has to see to their removal and remediation. The project team will have to determine whether to proceed with building on this type of site by asking if the costs and savings involved are worth it.

Note that a site can be classified as a brownfield by "perceived contamination": the *potential* presence of pollutants. One example of perceived contamination is an abandoned factory or storage facility that residents in the area think is contaminated even if it is not.

Example: Atlantic Station

Located in Atlanta, Georgia, Atlantic Station is the largest brownfield redevelopment project in the United States. Opened in 2005, its 138 acres (558,000 m) of mixed-use land development is on the former site of the Atlantic Steel Mill, which after years of industrial use and contamination was remediated by its two developers along with AIG Environmental, Inc. Over 12,000 dump truck loads of contaminated soil were hauled from the site. At completion, the redevelopment project will include 15,000,000 square feet (1,400,000 m) of retail, office, residential and hotel space as well as 11 acres (45,000 m) of public parks.

On this property, the 171 17th Street building was awarded LEED Core & Shell gold pre-certification. This building is a 500,000 sf (46,450 m) office tower.

Because Atlantic Station was a brownfield site, any building developed in Atlantic Station automatically receives a hefty packet of pre-documented, pre-approved LEED credits that can be applied toward future LEED certification.

In 2006 Atlantic Station pre-registered over 8,550,000 (794,295 m) square feet of commercial space for LEED certification. This represents 83% of the potential commercial square footage of the project.

Use Infill Development

The best way to protect undeveloped land is to reuse an existing building or site. An infill location can be a previously developed site, one that was previously built on, has been graded, or contained a parking lot, roadway, or other structure. Another infill location might be a site in-between existing structures, essentially a gap in the built environment. This may be in the heart of a city or on a site in the suburbs.

Building on a previously developed site usually means there is existing infrastructure like roads, utilities and other services. Reducing the need for new infrastructure preserves undeveloped locations and saves on construction costs. Tenants can look for space in existing buildings rather than requiring new construction; an especially good choice would be to choose a LEED-certified building.

Reusing a building and/or site will affect many areas of your LEED project, and you will learn more about the benefits as we move through this study.

Develop in Dense Areas

An optimal site would be in a densely developed area such as a city center. These locations usually have sufficient infrastructure to accommodate additional development, and selecting these locations limits urban sprawl. Urban sprawl can be defined as low density, dispersed development at the edge of a city that usually relies on automobile use. An important factor in selecting a sustainable site is the extent of automobile use. Any decision to reduce urban sprawl will limit the number of automobiles that will be used because of your development.

Projects should be located near a diversity of land use. Densely developed areas are usually on public transportation lines so people do not have to travel by automobile to get to their destinations. To determine if a project is located in a dense area, a density radius is calculated from the project site.

The development density is a measure of the average square footage of all buildings within a density radius. The density radius calculation is used to draw a circle around the site and to determine all properties within the radius that will be included to determine the density. Undeveloped public land, such as parks and waterways, and public roads and right-of-way areas are excluded.

Density Radius

Development density can also affect local water supplies. The EPA conducted an analysis of rainwater runoff from different development densities to determine variances between the scenarios. According to the EPA analysis:

- Higher-density properties generate less storm water runoff
- For the same amount of development, higher-density development produces less runoff and less impervious cover than low-density development
- For a given amount of growth, lower-density development impacts more of the watershed.

We'll discuss water later in this section.

Neighborhood Pattern and Design

The creation of vibrant, equitable communities that are healthy, walkable and mixed use contribute to good neighborhood pattern and design.

Increase Diversity of Uses

A site near diverse uses is similar to a site located in a dense development –urban sprawl is reduced, greenfields are protected, and existing infrastructure can be used. Good ideas to promote walkability include basic grid pattern streets vs. cul-de-sacs or gated areas, mixed types of housing, building uses, and locating near diverse uses. Sites with connectivity are within walking distance of *diverse uses*. Diverse uses are common services that people might use regularly. People must be able to walk between the project and the service without being blocked by walls, highways, or other barriers (this is called pedestrian access). LEED encourages building near a variety of basic services, not just one type of service such as twelve clothing stores in a strip mall.

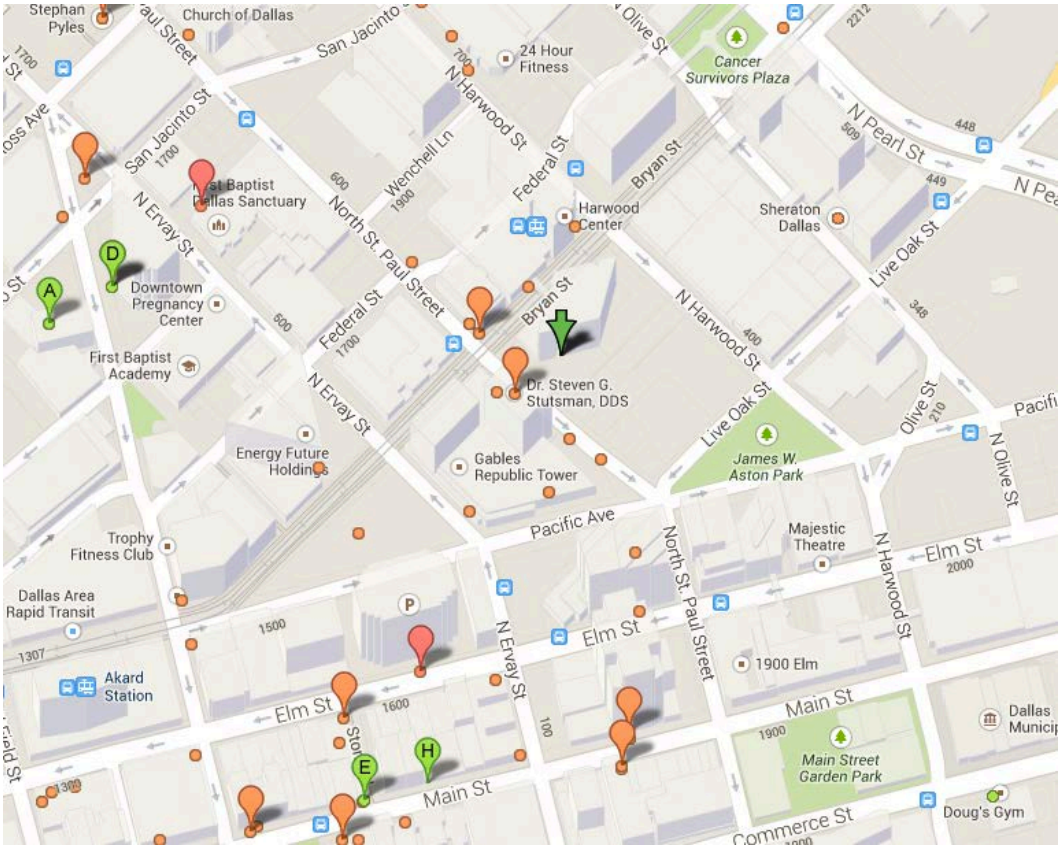
Your project might be able to provide a missing service or need such as office space or housing in an area that lacks a diversity of services or structure. When looking for an appropriate site, consider how your project's service or type might meet the need of a community that allows for more walkability and transportation efficiency. For example, consider an office park that has no restaurants. Most employees will likely drive to another location for lunch. If a restaurant or two is added to the park the diversity of uses is increased and people will be able to walk to lunch and reduces vehicle distance traveled.

Uses have been discussed as they relate to the obesity epidemic. If your project is part of a mixed-use development, don't forget ideas like community gardens or space for a farmers market. Other ideas for diverse uses can be community centers where children can play. LEED encourages shared use of some types of services like gyms, pools, theaters, etc so your project team could earn points for planning ahead on diverse uses.

Here are some examples LEED defines the following as diverse uses:

- Bank
- Church
- Supermarket / convenience store
- Day care
- Dry cleaner / laundry mat
- Fire station
- Salon
- Hardware store
- Library
- Medical / dental office
- Park
- Pharmacy
- Post office
- Restaurant
- School
- Theatre / museum
- Community center
- Gym

Diverse uses within 1/2 mile (800 meters) walking distance of the project site:



A good way to determine what diverse uses exist around the project is to use Google Maps. Diverse uses are determined by measuring ½ mile (800 meters) walking distance from the building's main entrance. This type of map will be needed for your project documentation.

Compact Development Strategies

Some of the environmental impacts of site development can include:

- Loss of topsoil
- Increased rainwater runoff
- Destruction of ecosystems
- Disturbance of wildlife
- Loss of plants and trees that absorb CO2

By reducing the size of the development footprint and maximizing the area that is undisturbed, many of the negative impacts a building has on a construction site can be avoided. Clustering buildings helps to preserve open space and wildlife habitats. Building at the edge, rather than in the middle, of the open space (i.e. meadow) can preserve undisturbed areas. Keeping roads and service lines short also reduces the development footprint. Making the development footprint small also helps protect ecological features such as streams or natural rock formations. These ecologically appropriate site features will help maintain the natural landscape. For example, in Arizona, a project team could focus on protecting existing native plants, non-vegetated areas, and even natural bodies of water to preserve the site area. A team not respecting this historical, natural landscape could just remove all ecological site features and plant turf grass and non-native plants. This would have a negative effect on water use, runoff, and the local plants and animals that need a natural habitat.

Plan Ahead

In large cities, every new subdivision usually begins by bulldozing all of the trees. After the sewers, roads, and houses are constructed, the developers plant the smallest and cheapest trees they can buy as required by code. For every tree cut down, one must be planted. But replacing a 50 year old 100-ft tree with a year old 5 ft. tall sapling isn't quite a fair trade. The better approach is to plan ahead and perhaps hire an arborist to do a survey then build around the trees that can be saved. It takes more time and will probably cost more, but the lots with the trees will sell at a premium, and the neighborhood will be more desirable.

Share Resources

Look at the neighboring buildings to find opportunities to share resources. For example – if the building is going to include space for a company gym, does the building next door have an underused gym that could be shared?

Choose a LEED-certified Building

For projects that are not constructing a building but are looking for interior space, choose a LEED-certified project. Even if the project requires renovation of the interior, starting with a

LEED-certified building means that many environmental measures have already been adopted. This might be a LEED BD+C: Core and Shell building or a LEED: BD+C New Construction that has space for lease.

Transportation

Transportation to and from work contributes about 50% to a project's total greenhouse gas emissions and 33% of greenhouse gas emission in the United States. Greenhouse gas emissions from transportation are caused by the linkages to the project, what type of fuels the vehicles consume, and engine technology. To reduce automobile use one must encourage more efficient modes of transportation. There are many ways to discourage automobile use on almost every LEED project. Some of the rating systems offer credits for pedestrian access and bicycle accessibility.

Each rating system except LEED O+M: Existing Buildings looks at the infrastructure that's being created for the future to encourage efficient modes of transportation. Operations & Maintenance is the only rating system that considers actual behavior. In LEED BD+C: New Construction for example, bicycle accessibility is designed and put in place. The number of bicyclists is tracked in LEED O+M projects.

Compressed Work Week

Compressed work weeks received a lot of news coverage when gasoline prices were above $4/gallon, but they are not new. There are two common forms usually called the 4/10 or 9/80. A four-ten work week means that workers work 10 hour days for 4 days and then receive one day off. All employees might receive the same day off, such as a Friday, but they may be dispersed throughout the week so the company can remain open. A nine-eighty week is similar except that workers work 9 hours a day for 9 days and then receive a day off. A company doing this might give its employees every other Friday off and allow the Thursday workdays to be one half hour shorter to make up for the extra hour that nine days at nine hours would give over two standard 40 hour workweeks.

The compressed work week has several advantages:

- They are usually very popular with employees as they get a weekday in which to run errands, take a long weekend vacation, or spend more time with their children.
- Both employees and companies get to save on energy costs. If the company closes for one day during the week, it does not have to power, heat, or cool the building. Employees save energy and reduce their carbon footprint by not having to commute to the office.
- Employers sometimes find that employees are more productive. Since the workday is longer, it gives employees time to complete work with distractions like lunch taking

up a smaller percentage of the day. Since employees enjoy the compressed work week, it can increase job satisfaction which helps productivity.

Utah became the first state to mandate a four-day work week for most state employees. The change has saved the state nearly $3 million. The change will also help the state reach its goal of cutting its total energy use by 20% by 2015.

Telecommuting

Allow employees to telecommute at least once a week. This option is best discussed early in the building planning process. The developer may not always have this authority, but he may ask stakeholders about this option.

Many companies build office buildings with the intent of their employees "hoteling." Hoteling is where employees have no assigned office space; they come into the office as needed and log into any work station. Hoteling allows companies with workers who telecommute to have fewer stations because there is no need to reserve a station for each worker.

Reward Carpooling/Modifying Parking Fees

Building management can create incentives for building users to carpool. There are non-cash incentives such as preferred parking spaces. Preferred parking includes those spaces closest to the building after handicap spaces. Another non-cash option is employee recognition or even providing emergency transportation assistance to ensure carpoolers have a way to get home or to their children's school if something were to come up in the middle of the day. Other ideas are to reward carpoolers with discounted parking (if parking is charged) or to reward carpoolers with cash or points for every day they ride together.

Charging for parking can discourage people from driving to and from work alone. This will not work in all situations, but requiring employees to pay may encourage the use of carpooling and mass transit.

To help out with carpooling, a ride share board that is posted in common areas can help connect potential carpoolers.

Note: Carpools must contain two or more people. This may seem obvious, but we have received hundreds of questions on carpooling equations in LEED. Many times the confusion about these equations happens because people forget that at least two people must be in a car to be considered a carpool.

Locate Near Mass Transit/Provide Access

A building located near mass transit allows more people to take public transportation to work and keep their automobiles off the road. Fewer automobiles create less pollution and require fewer parking spaces at the site. A transportation survey for future building occupants can determine their transportation requirements.

Locate buildings near mass transportation lines such as bus or train routes. In some cities this isn't possible if the infrastructure isn't in place, or if the infrastructure is poor. Cities like Houston have little public transportation. Cities like Boston or San Francisco have extensive rail lines that are used by the majority of residents.

For areas where mass transit isn't close by, consider a shuttle service to help employees reach transportation. An example is a live-work-play mixed-use community that provides a shuttle every 30 minutes to a mass transit hub a few miles away.

Example: Foundry III

LEED Rating: LEED for New Construction Gold
Location: San Francisco, California
Courtesy of: Wilson Meany Sullivan

Foundry III is one of four buildings on four facing corners that comprise the unique urban campus that is Foundry Square. Foundry III occupies a prime position in San Francisco's South Financial District. The 24/7 lifestyle of the neighborhood boasts shops, restaurants, and attractive housing opportunities.

Saving time and energy will be a simple choice for Foundry III residents who can walk one block to the bus lines. Major mass transit arteries are within two blocks. The building provides bike lockers, covered bike parking, and on-site showers in addition to preferred garage parking for carpools and vanpools.

Bicycle Networks

Select project sites within proximity to bicycle networks, and provide bike racks and shower facilities to give occupants the option of biking to work. This is a low-cost option that can become popular with the building's occupants depending on the location of the building. For commercial projects LEED requires bike racks to be secure.

Alternative Fuel Vehicles

Low-emission or alternative fuel vehicles reduce air pollution. These vehicles do not rely on gasoline or diesel for power. Alternative fuel vehicles may be electric cars, or cars powered by hydrogen, ethanol, natural gas, or biofuel. Cars that are eligible are classified as either:

- Zero Emission Vehicles (ZEVs) by the California Air Resources Board (CARB)
- Cars that have earned a Green Score of 45 or more from the American Council for an Energy Efficient Economy

If a company has a fleet of cars for workers to use, or provides a car to employees, the company may consider providing low-emission or alternative fuel vehicles.

Car Share Programs

Car sharing is an alternative to car rental and car ownership. Cars are located throughout cities in convenient locations. People who sign up for the program can reserve the cars and use them for a short period of time. The benefit of a car sharing program is the quantity of automobiles produced is reduced thus saving on the materials needed to build them.

Minimize Parking

Large swaths of asphalt have many negative environmental effects including:

- Increasing the amount of rainwater runoff
- Increasing heat islands
- Destruction of natural areas

Create the smallest parking area for occupants' needs. LEED encourages having the minimum amount of parking as required by local code. Project teams should consider underground parking or sharing parking lots with neighboring properties when possible. If parking is limited, there might be less automobile use.

Keeping driveways and roadways as narrow as possible also minimizes the environmental impacts and can have the economic benefits of fewer materials for installation and lower maintenance costs.

Case Study: Emory University Whitehead Biomedical

LEED Rating: LEED NC Silver
Location: Atlanta, Georgia
Courtesy of: HOK

This biomedical research building is among the nation's most environmentally responsible facilities. HOK's design for the 325,000-square-foot, eight-story building earned a Silver certification. The eight-story Whitehead Research Building is the largest facility on Emory's

campus (except for the hospital) and is the biggest biomedical research building in the southeastern United States.

The site had been occupied by a greenhouse and cooling tower. Redeveloping this site for the Whitehead Research Building increased local density and preserved existing green space.

One goal of Emory's master plan is to create a campus in which cars are unnecessary. The university moved parking to the campus perimeter and putting alternative transportation strategies in place.

For this project, Emory built a parking garage a few miles from the campus. A shuttle road served by alternatively fueled vehicles -- both compressed gas and electrical -- allows Emory to carry people from the parking deck to campus.

The building's rainwater harvesting system captures water from the roof and outdoor plaza and moves it to a large retention vault beneath the plaza. The water then is filtered and reused for on-site irrigation.

This solution was simple and cost-effective, according to Emory Project Manager Laura Case. Case states "We already were required by the county to build a detention vault to slow rainwater runoff from the roof and site. When we decided to go for LEED certification, it didn't take much additional effort to make the size of this underground detention vault three feet deeper so it would hold about 70,000 gallons of water. We also added a filter, a pump, and a bit of piping to hook this catchment area into the site's irrigation system."

Case Study: Dockside Green

LEED Rating: LEED for New Construction Platinum
Location: Victoria, British Columbia
Courtesy of: Dockside Green

Site Selection

A history of industrial use left the Dockside site with significant contamination of its surface soils, currently covered with pavement, gravel and some minor vegetation. Through a variety of innovative remediation techniques, the project will transform this former brownfield into an internationally recognized sustainable community, full of green space and green architecture. Dockside Green's site remediation involved the removal of hazardous waste (mostly contaminated surface soil resulting from the site's long history of industrial use) and risk assessment of other contaminants. The hazardous waste material was treated offsite so the soil can be used elsewhere.

Alternative Transportation

Dockside Green has committed to several steps that will make lower automobile use a reality.

Car Share Program

In partnership with the Victoria Car Share Co-operative, Dockside Green will offer a vehicle-sharing program. Exceeding the LEED requirement and a recent traffic reduction study recommending one shared vehicle for every 150 residences, the project plans include providing a total of ten vehicles – one for every 90 residences. The fleet will include a mix of neighborhood electric vehicles that run on green electricity with recharging stations on site, and smart cars.

Harbour Ferry

The project is accessible to the Harbour Ferry which will take users to a variety of stops along the Inner Harbour.

Mini-Transit

To further reduce traffic, a mini-transit van will be operated to and from key points in downtown as well as a commercial shopping centre off of Bay Street. The buses will hold 20 to 25 people and will run during the day and possibly at night depending on demand.

BC Transit

Bus routes will be posted on the Dockside Green community website and there will be a program to help increase ridership among residents.

Bicycle

In accordance with LEED, bicycle racks and shower facilities will be provided for 5% of all commercial, office and industrial occupants, with numerous secured racks throughout the site to allow for easy movement within the community. Bicycle racks will also be supplied for each residential unit. As an added aesthetic bonus, on-grade bicycle racks will be designed to also serve as public art.

Preservation and/or Enhancement of the Galloping Goose Trail

The Galloping Goose Trail, an important regional connector, will run through Dockside Green along Harbour Road, offering key pedestrian and bicycle linkages south to the city centre (via the Johnston Street Bridge) and north through Point Ellice Park. The Dockside portion of the trail will include a designated bike path, enabling unimpeded cycling in either direction, as well as a generously proportioned pedestrian promenade, ideally suited to strolling or jogging.

Pedestrian

Dockside Green is designed to be very pedestrian-friendly with sidewalks along both sides of Harbour Road and an intricate trail system crisscrossing the development. The trails will be surrounded by artful landscaping, tranquil water features, relaxing benches and inviting plazas.

Mixed-Use

On the whole Dockside Green also reduces auto use just by having a diverse mix of uses within the community. It will include a sustainable mix of residential, work/live, live/work, light industrial and retail/commercial spaces within a park-like setting.

Key Words

alternative-fuel vehicles
bicycle racks
brownfield
building footprint
carpool
car share program
compressed workweek
development footprint
development density
density radius
diverse use
erosion
fuel-efficient vehicles
greenfield
Green Score
infill
location
low-emitting vehicles
mass transit
pedestrian access
preferred parking
previously developed
smart growth
telecommuting
undercover parking
underground parking
undeveloped
ZEV

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Chapter 4 - Sustainable Sites

Site Assessment

A site assessment assesses site conditions before design to evaluate sustainable options and inform related decisions about site design.

You can think of it as the integrative design for the site. Project teams need to ask – what is happening on the site in terms of soil, habitat, what are the options for space preservation, what are the human uses of the facility? A site assessment is part of the integrative process that helps to incorporate the assets of the site and its historical contexts.

Project teams look at the site features and take those features into the design considerations and how the site conditions influence the project design. An assessment reviews the sites:

Topography: contour mapping, unique topographic features, slope stability risks.

Hydrology: flood hazard areas, delineated wetlands, lakes, streams, shorelines, rainwater collection and reuse opportunities.

Climate: solar exposure, heat island effect potential, seasonal sun angles, prevailing winds, monthly precipitation and temperature ranges.

Vegetation: primary vegetation types, greenfield area, significant tree mapping, threatened or endangered species, unique habitat, invasive plant species.

Soils: prime farmland, healthy soils.

Human use: views, adjacent transportation infrastructure, adjacent properties, construction materials with existing recycle or reuse potential.

Human health effects: proximity of vulnerable populations, adjacent physical activity opportunities, proximity to major sources of air pollution.

When a project team understands these features as they are found on a site, they can influence the project's design and the performance of many other aspects of the project.

Site Design

The whole building design practice of site planning considers both the site and the function of the building to determine the site's ability to support the building while minimizing environmental impacts. The project team must take into account the whole development footprint. The development footprint is more than just the building, but all areas that will be affected by the project's activity. It includes the building, access roads, parking lots, sidewalks, other hardscapes, and any other type of building like a storage shed, etc. Make the site development dense – meaning that project teams should try to keep the building footprint to a minimum and maximize open space.

The building footprint is the area taken up by the building structure but does not include parking lots, landscaped areas, etc. Even if you are not in a densely developed area – like a downtown location in a city – project teams can minimize the building footprint for dense development onsite.

The LEED project boundary is the portion of the project site submitted for LEED certification. For multiple building developments, the LEED project boundary may be a portion of the development as determined by the project team.

Preserve Open Space

Open space is an area that is both vegetated and pervious. Open space areas are usually defined by local zoning requirements. If local zoning requirements do not clearly define open space, LEED defines open space as the area of the property minus the development footprint. Open space must be within the LEED project boundary. Sometimes a green roof can contribute to open space requirements depending on the project and the specific credits.

In this section many design strategies are related to open space because of the many environmental benefits related to having open space. Increasing the amount of vegetated area that is pervious helps reduce heat islands, improve rainwater management, and protect ecosystems.

Minimize Construction Impacts

The loss of valuable topsoil is one of the biggest environmental impacts of the site during the construction process. Construction vehicles, grading, and even foot traffic all contribute to erosion. Unprotected topsoil, particularly on sloping areas, is vulnerable to significant erosion and sedimentation. During a storm, topsoil can be washed into nearby streams, other water bodies, or stormwater systems. Protecting the site from erosion during construction can have a positive effect on local water quality. This is a prerequisite in many of the rating systems and is required by code in most places.

Prior to construction, there must be a plan to address construction activities and prevent erosion and sedimentation. Most locales have at least a minimum requirement for a sediment fence to be installed around the project site to prevent soil runoff and excessive erosion. By limiting site disturbance, stabilizing any exposed areas, and controlling the flow of water on the site, erosion can be prevented. This is far less expensive and better for the environment than correcting problems after they have occurred.

Among the methods to limit erosion and sedimentation are:

- Mulching
- Erosion control blankets
- Sediment (silt) fencing
- Berms and constructed ponds
- Seeding
- Straw bales

Restore Sensitive Areas

Restoring natural areas on your project site will benefit both the environment and society. A project that works within its natural surroundings can benefit nature by having a lush project site that provides a habitat for local animals and benefits people who will enjoy the views and open areas.

If an area has been damaged or previously built upon planting the space with native or adaptive plants can restore the area and ecosystems. Native and adaptive plants are those that are indigenous or native to the area and plants that are adapted to the local environment. They don't include an invasive plant or noxious weeds. Invasive plants do adapt, but they also happen to take over an area and push out native plants. A good example of this is Kudzu. Brought from Japan to the United States as a forage crop and erosion control plant, it has now taken over vast areas of land in the southern United States, costing over $500 million a year in control techniques and lost cropland.[1] Native and adaptive plants that are not invasive will restore damaged areas to the natural landscape, and require much less irrigation since they are prepared for the climate and rainfall in the region.

Rainwater Management

The goals of green building can be reached by restoring natural areas. Sustainable site design includes responsible stewardship of water runoff, vegetation, wildlife, and climate.

Reduce Runoff

Runoff consists of rainwater and melted snow that run off streets, lawns, farms, and construction and industrial sites. In many cities, runoff and sewage are combined into one drainage system where the entire quantity must be treated. A heavy rainfall can cause the system to overflow, resulting in sewage backing up and overflowing into streets, streams, and rivers. Cutting back on the quantity of rainwater entering a combined system results in a reduction in water that needs to be treated by already overburdened sewage treatment plants and reducing the energy that is used to treat sewage. For example, on natural sites (sites with no prior development) rainwater can seep into the ground and be naturally filtered by the soil, ultimately replenishing aquifers.

Rainwater management is of concern for two main reasons: one related to the volume and timing of runoff water (flood control and water supplies) and the other related to potential contaminants that the water is carrying which can contribute to water pollution. Runoff can lead to sedimentation. Sedimentation is where pollutants from natural or human activities add particles to water bodies. Think of water running off a newly fertilized lawn, an oil streaked parking lot, and a small acre of farmland. If the water with the chemicals runs into the watershed, it can harm local streams, lakes, and the plants and animals (including humans) that depend on that water. This is called *nonpoint source pollution*, where pollutants enter a river from multiple land uses that can't be specifically identified. Non-chemical pollutants, like topsoil, can age lakes while also robbing the land of the benefits of topsoil. Reducing rainwater runoff and filtering rainwater before it leaves the site can prevent sedimentation.

Runoff from parking areas and buildings can contain oil, chemicals, and other pollutants that can contaminate the water supply. Runoff can require additional infrastructure which can actually divert water from where it would naturally end up, thus shifting the balance of nature in the area.

To reduce the quantity and quality of rainwater runoff limit the number of impervious surfaces, reuse rainwater, or adopt some low -impact strategies. Consider creating a rainwater management plan that documents which strategies the project team will use.

Reduce Impervious Surfaces

LEED defines an impervious surface as having a perviousness of less than 50%. If you took 10 gallons of water and dumped it on the ground and 6 gallons ran into the street and down a stormwater drain while the remaining 4 gallons were absorbed into the ground, that's a rudimentary picture of an impervious surface.

One non-technical way to reduce impervious surfaces is to group the parts of the development to allow for more open space. Building designs that have smaller footprints

and more open space have fewer impervious surfaces for rainwater runoff. . Where hardscapes areas must exist, consider breaking them into smaller segments and placing vegetated areas in between. Instead of having a single large parking lot, create strips of vegetation that are low enough to capture rainwater between rows.

For hardscapes areas such as roads, parking lots, and walkways, pervious (*permeable*) paving or *open grid paving* are alternatives to concrete or asphalt surfaces. Permeable paving surfaces keep the pollutants in the soil or other material underlying the roadway, and allow water seepage to recharge groundwater while preventing stream erosion. Whether porous asphalt, concrete, paving stones or bricks, all these pervious materials allow precipitation to percolate through areas that would traditionally be impervious to the soil below.

Some permeable pavements can require maintenance because grit or gravel can block the pores. This is commonly done by industrial vacuums that suck up all the sediment.

Reuse Rainwater

Rainwater can be used for irrigation or processes inside the building. Innovative collection features can be made to look like pieces of art, and the water can be used for process water, toilet flushing water and more. Cisterns can be used to store rainwater for later use. Water reuse is covered in the Water Efficiency Section.

Low Impact Development

If rainwater must leave the site, the water should not run so quickly as to cause erosion of surrounding areas. Rainwater cleaned of pollutants will ensure that water resources for the community remain usable.

Rain gardens, or planted areas, enable sites to downsize the storm sewer connection because the site captures the water on site.

Bioswales and vegetated filters are landscape features that can be installed to filter water by either running the water through vegetation, which naturally filters out the water, or by running water through compost or rocks.

Dry ponds (detention ponds) can also be used to store excess rainwater. Dry ponds are basins whose outlets have been designed to detain rainwater runoff for some minimum time (e.g., 24 hours). The rainwater will slowly seep into the ground or discharge as determined by the pond design to allow pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool of water. A wet pond (retention pond) is a pond designed to hold a specific amount of water indefinitely.

All of these ideas to capture or reuse the storm water on site keep the rainwater from being dumped into the municipal treatment system and/or out of surrounding streams and rivers.

Example: Ariel Rios South Building Courtyard

LEED Rating: n/a

Courtesy of: EPA

The Ariel Rios South Building Courtyard project is part of a larger effort to beautify the EPA Headquarters complex and demonstrate more environmentally sound building and landscaping techniques. This plan exhibits many of the practices that mitigate the effects of rainwater runoff and reduce combined sewer overflows into rivers, streams and coastal waters.

The Ariel Rios South Courtyard features two biofilters (often called rain gardens) and permeable concrete and permeable pavers, which allow rainwater to filter into the ground rather than wash off the surface and into storm drains and combined sewers. In addition, the South Courtyard has a cistern to recycle rainwater for irrigation. Sustainable planting is part of the courtyard landscape. Plants absorb rainwater and provide valuable wildlife habitat. Other sustainable best management practices include reuse of an historic granite curb as a bench, recycled farm tool plant signs, and recycled glass in the cistern cover and artwork.

Example: Environmental Center of the Rockies

When it learned that 70 percent of pollutants reaching nearby Boulder Creek were the result of nonpoint sources, the Land and Water Fund of the Rockies (the LAW Fund) took initiative and enacted corrective measures. They had already retrofitted a building to house the new Environmental Center of the Rockies using "green" architecture strategies, which included reflective windows, a new roof made from recycled materials, and roof mounted solar collectors. The LAW Fund saw the Environmental Center with its highly visible, urban setting as a perfect place to take sustainable design a step further. They decided to "green" the landscape surrounding the building and retrofit its parking lot using Low Impact Development (LID) techniques. The project created an aesthetically pleasing setting that performs natural rainwater functions and conserves water.
The LAW Fund, with the help of Denver's Wenk Associates and Joan Woodward, professor of landscape architecture, created a "closed loop" landscape that captures and treats runoff on-site instead of conveying it to city waterways. To accommodate the site's location in a semi-arid climate (annual average precipitation depth is about 18.6 inches) the design focused on detention and infiltration practices that incorporate native drought-resistant plants. The system uses integrated management practices such as retention grading, vegetated swales, and bioretention cells (rain gardens) to capture and treat

runoff. It uses these features in conjunction with a smaller parking lot, disconnected roof leaders, water harvesting, and landscaping that emphasizes native vegetation. These practices work together to:

- conserve water and energy
- decrease rainwater runoff discharge to city sewers and
- decrease transport of water-born pollutants from the facility[2]

Heat Island Effect

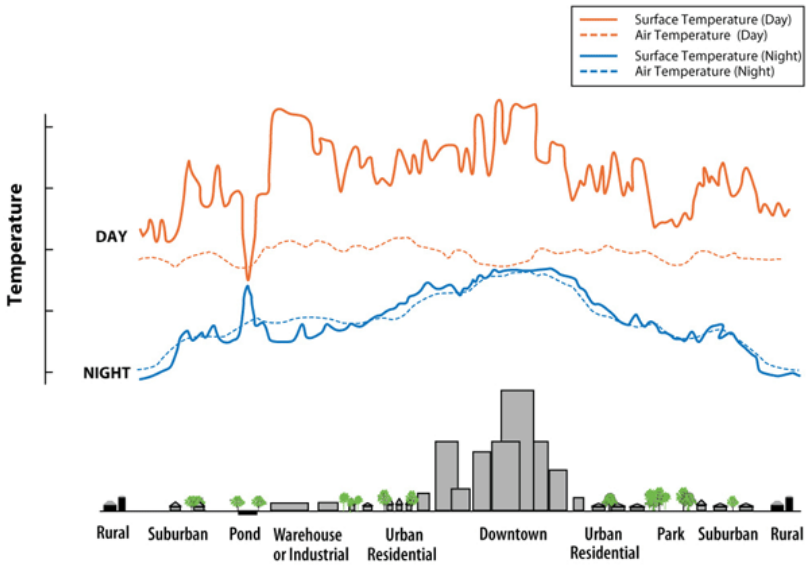
Heat islands are temperature differences between developed and undeveloped areas. The *heat island effect* is created when developed areas have higher temperatures than surrounding rural areas. An urban heat island effect is caused by sunlight heating up dark colored surfaces such as roads and rooftops. Urban heat islands effects can also be created by narrows streets and tall buildings reducing the air flow through the city, as well as vehicle exhaust. Huge quantities of heat are generated in buildings that have dark rooftops and absorb heat rather than reflect it. Outside, we all know how much hotter a blacktop parking lot is than a grassy field.

Urban heat islands refer to the elevated temperatures of up to 10 degrees in developed areas compared to more rural surroundings.

Urban heat islands not only create discomfort, but they also contribute to smog. In Los Angeles, the probability of smog increases by 3% for every degree the temperature rises above 70 degrees.[3]

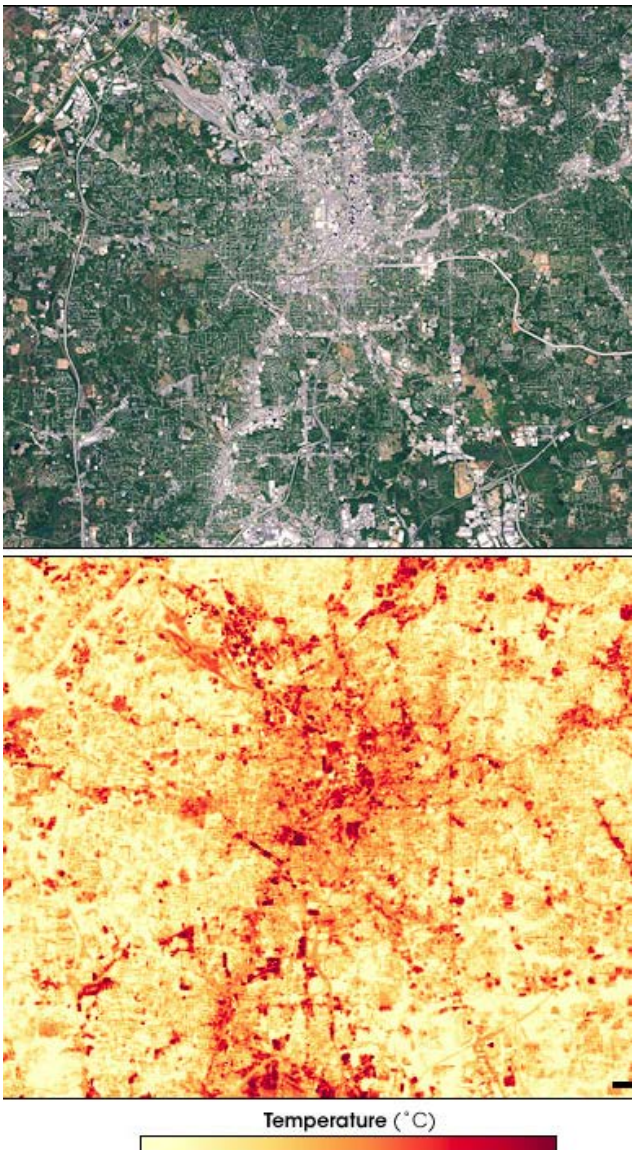
Atlanta is about 10 degrees warmer in the summer than its surrounding non built areas. The impact is not just discomfort; health problems can be attributed to more ground level ozone and more smog. During the summer, the Atlanta news rates the air quality for the day and issues warnings to stay inside on days when it is especially poor. Sustainable design aims to keep the air conducive to good health.

This chart graphs the different daytime and nighttime temperatures for different surface types.



For the reasons stated previously, heat islands negatively affect those who live in these developed areas, as well as wildlife and plants. More energy is needed to cool buildings, and the increased energy use leads to increased pollution from power plants. A 2005 study[4] estimated that the heat island effect can cause 5-10% of the peak energy demand for cooling buildings in cities. Higher temperatures can also lead to smog or ground level ozone which is detrimental to human health.

This photo is of Atlanta from the NASA Earth Observatory Collection. The photo shows the city of Atlanta as a regular photo and the photo underneath shows the heat differences ranging up to 12 degrees Celsius. This temperature difference has been shown to affect the weather by changing rain patterns. According to NASA climatologists, "The heating of the surface and the overlying air creates instability in the atmosphere that encourages air to rise. As it rises, it cools, and water vapor condenses into rain that falls downwind of the city. Studies of regional rainfall patterns in the U.S. Southeast have shown that rainfall downwind of major urban areas can be as much as 20% greater than it is upwind areas."[5]



There are several strategies to reducing heat islands:

- Minimizing the development footprint
- Undercover / underground parking
- Using hardscape materials with high reflectance
- Installing surfaces with that have a high solar reflectance (SR) or solar reflectivity index (SRI)
- Installing green roofs
- Providing shade from trees, structures covered by solar panels, or architectural devices with high SRI material
- Using open-grid paving

Solar Reflectance

The solar reflectance index (SRI) is the most effective measure to determine how a roofing material will reject solar heat.

For non-roof materials such as vegetation, architectural shading devices, and materials that have more thermal mass but are less reflective, the solar reflectance (SR) measurement is used instead.

Projects also need to consider the aged value of a material's SRI or SR – how the material is going to perform years down the road. Materials get dirty; they get worn down, and perform less as time goes on.

Solar reflectance measures a surface materials ability to reflect sunlight on a scale of 0 to 1, with black paint having a solar reflectance of 0, and white paint having a solar reflectance of 1.

Another energy use factor is emissivity. Emissivity measures how much heat or infrared radiation a material is able to shed back into the atmosphere. The emittance of a material refers to its ability to release absorbed heat. Scientists use a number between 0 and 1, or 0% and 100%, to express emittance. Most roofing materials have emittance values above 0.85 (85%). This includes aggregates, cementitious material, and glass. Aluminum or bare metal are types of materials with low emittance.

The combination of both solar reflectance and thermal emittance gives a more accurate and complete picture of a surfaces' ability to reduce the energy consumption associated with air conditioning. The solar reflectance index (SRI) is a combined metric of these two factors. A general rule of thumb is the higher the number on a scale of 0 to 100, the better. Materials with a high SRI value are white coatings, white cement tile, and a white coating on a metal roof. Materials with a low SRI value are gray asphalt shingles, unpainted cement tile, and red clay tile.

Link Between Energy Savings and Emissivity

While solar reflectance is the most important roof characteristic for energy savings in warmer months, emissivity can also contribute to a cool roof. In warm and sunny climates highly emissive roof products can help reduce the cooling load on the building by releasing the remaining heat absorbed from the sun.

There is also evidence that low emissivity may benefit those buildings located in colder climates by retaining heat and reducing the heating load.

Building/Infrastructure Size

The best strategy to reduce the heat island effect is to minimize the development footprint. Smaller parking lots, roads, and roofs result in fewer areas of darker material to absorb sunlight. The harder or more unnatural surfaces will cause more heat than a site where there are fewer hardscape surfaces or where they are grouped. This is a good way to practice the green building concept – if the site does not create many surfaces that later have to be covered or shaded, then less work is needed to limit the heat island effect. This also meets the goal of rainwater management. The goals are similar in that fewer hardscape surfaces will reduce rainwater runoff and help the team achieve a more sustainable design.

The building footprint can also be reduced to allow for more open space. Build a taller three-story building instead of a wider two-story building. Consider the zoning issues during design:

Floor area ratio

The floor area ratio (FAR) is the ratio of the total floor area of buildings on a certain location to the size of the land of that location, or the limit imposed on such a ratio.

FAR = the total building square footage (building area) divided by the site size square footage (site area).

The easiest way to explain this is with some examples:

Example 1: Consider a big box retail store with a large parking lot. The actual building may take up only 1/4 of the project site and the other 3/4 is paved for parking spaces. The FAR would be 0.25.

Example 2: A one story building takes up the entire project site. This would be a FAR of 1.0. Usually there is not a FAR of exactly 1.0 because the project has sidewalks and easements for the utility lines. A FAR of 0.8 or 0.9 would be more common.

Example 3: A two story building takes up 1/2 the lot. If the site is 20,000 SF and each floor is 10,000 SF (*there are 2 floors*) the FAR of 1.0.

Example 3: A two story building is built over the entire lot OR a four story building is built on 1/2 the lot. This is a FAR of 2.0.

The floor area ratio can be used in zoning to limit the amount of construction in a certain area. For example, if the relevant zoning ordinance permits construction on a parcel, and if construction must adhere to a 0.10 floor area ratio, then the total area of all floors in all

buildings constructed on the parcel must be no more than one-tenth the area of the parcel itself.

One of the objectives of green building is to build 'up' rather than 'out', thereby having a smaller building footprint to maximize open space and promote biodiversity. For example instead of having a 1 story building with a 10,000 SF footprint design a 2 story building with a 5,000 SF footprint. Both designs have 10,000 SF of total floor area but the 2 story building has a smaller footprint.

Undercover / Underground Parking

Parking lots are large contributors to the heat island effect, but they don't have to be. Having parking located underground, perhaps under the building or even underground elsewhere on the site reduces the heat island effect. Underground parking should have a vegetated or soil cover or a cover that has a high reflectance.

Green Roofs

Green roofs, or *vegetated roofs*, are one of those design strategies that have multiple benefits and can positively impact several LEED credits. Many projects are installing green roofs as one method of rainwater management.

Green roofs have been used in Europe for over 30 years, so there is already a wealth of information on their development and maintenance. When considering the life cycle costs of a roof, a green roof can last two or even three times longer than a conventional roof.[6] It also can provide views of rooftop gardens for building users. Depending on plant selection, some green roofs do not require watering and can absorb up to 70% of rainwater.[7] By absorbing rainwater, they reduce runoff and provide natural rain water filtration. Green roofs also provide insulation and acoustic dampening, and several studies have shown they reflect heat even better than reflective roof coverings.

A green or vegetated roof can combat the heat island effect, help provide insulation to reduce energy costs, and help with building acoustics. Green roofs require a bit more planning up front to ensure proper support from the building design, but actually can last much longer than a conventional roof and have lower maintenance costs, thus greater life cycle benefits.

If a project requires a big investment in storm sewer construction or upgrades, consider investing in a green roof or other rainwater retention strategies. It may be more affordable to construct a green roof instead.

Another credit area a green roof can help with is open space. For buildings that have no landscaping areas, such as the case for many urban buildings that butt right up against the street, LEED allows a green roof to contribute to meeting open space requirements.

Shading

To keep commercial buildings, homes, or parking lots cooler, a landscape design should incorporate trees or other vegetation that can provide shade. Shaded areas are cooler than non-shaded ones for two reasons. First, the plants absorb and reflect sunlight and prevent that light from heating the objects under the shade. The second--and less known reason--is because plants do something called evapotranspiration. This long word combines "evaporation" with "transpiration." We know what evaporation is, but transpiration is how plants transfer water to the atmosphere. Evapotranspiration is an energy-absorbing process,[8] so it actually cools the surrounding area. Projects in dry climates want to use plants that have low evapotranspiration rates which require less water than plants with high rates.

Shade doesn't have to come from trees; many landscaping features can use vegetation to protect buildings, parking lots, and hardscape areas from solar heat gain.

Not all shade or vegetation has to do with avoiding heat. Trees that are green year round can help block wind in colder northern climates.

Solar panels can also create shade. In some projects in California the parking areas have been fitted with "solar trees" that provide shade for the vehicles underneath, while absorbing the sun and producing usable energy.

Cool Roofs

A reflective roof covering can deflect heat. The materials to create a reflective roof can be anything from white cement tile, a white membrane, white-coated gravel, or even soy-based polymers. Cool roofs don't have to be white as we've shown in these photos. New colors are now available that do a great job of reflecting solar heat.

The most common commercial roof covering is EPDM rubber roofing, which is also used to waterproof roofs. Black EPDM is very resistant to UV and ozone and has excellent sustainability and life. White EPDM is cooler and more energy efficient and reflects UV rays.

Courtesy of Sika Sarnafill

A reflective roof will lower energy costs in all climates, but some building owners have seen energy use reductions of 40% during times of peak energy use.[9] Some of this reduction comes from HVAC units cooling air with a smaller temperature difference than those on dark roof surfaces. In the summer, temperatures on dark surfaces can reach 180 degrees or higher, meaning HVAC units on those surfaces must work a lot harder to cool the air to an acceptable temperature.[10] A surface with a high reflectance will have a much lower temperature, reducing the HVAC workload and save energy that would be spent on cooling indoor spaces.

Courtesy of Sika Sarnafill

Cool roofs should be considered in climates where there is a lot of direct sun on the roof and temperatures are high. In northern climates a reflective roof would not be the best design idea because a dark colored roof would help absorb the sun in cooler temperatures and help offset heating costs. To yield the most efficient design choice, project teams should generate an energy model of the system. In areas such as California, cool roofs are required by code.

If the parking is under a building, it is best to have the roof of the building be a cool roof to maximize the positive effect of underground parking. Undercover parking is where the parking lot may be on the ground level, but the parking spaces are covered with a structure to provide shade to the cars and parking lot. The cover will not help reduce the heat island effect unless is it coated or covered with a high reflectance material. Basically, a black asphalt parking lot covered by a structure that is painted black will not do much good, but one covered with a structure with a white coated top would make a large improvement.

Another option for roof covering is solar panels. Solar panels will absorb solar energy and can provide shade underneath if used in shade applications.

Cool Pavements

Conventional paving materials can reach peak summertime temperatures of 120–150°F (48–67°C). This extra heat is transferred to the air and results in additional evaporation of rainwater after periods of rain. Pavements that are more reflective – those with a higher SRI – can be installed to alleviate the negative properties of lower SRI materials such as black asphalt.

Paved surfaces from roads, highways, parking lots, and buildings cover 43,500 square miles in the lower 48 states,[11] an area roughly the size of Ohio. An area that large is a huge heat island that causes excessive rainwater runoff.

Site design plays a role in the heat island effect. The harder or more unnatural surfaces will capture more heat than a site where there are fewer hardscape surfaces and more natural vegetation.

Open-grid Pavement

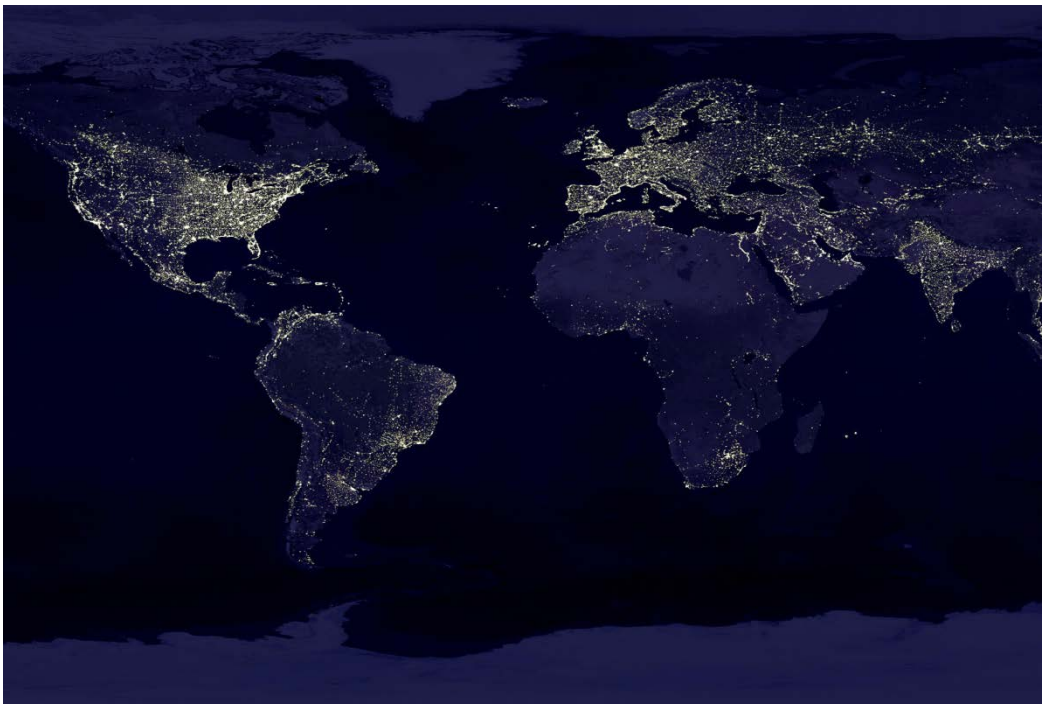
Open grid pavement is a material that has open cells to allow vegetation to grow through it. This pavement has the added benefit of allowing rainwater to percolate through the open cells. For LEED, only pavement that is at least 50% pervious is allowed to be counted as open-grid pavement.

Site Management

Property management is very influential; there are so many more existing buildings than there are buildings under construction. Proper building management can make a significant difference on the ongoing sustainability of a site.

Prevent Light Pollution

Light pollution is excessive or intrusive artificial light, as can be seen in this photo from NASA.



Light pollution obscures the stars in the night sky for city dwellers, interferes with astronomical observatories, and, like any other form of pollution, disrupts ecosystems and has adverse health effects such as sleep disorder. Light pollution can be divided into two main types: 1) annoying light that intrudes on an otherwise natural or low-light setting and 2) excessive light (generally indoors) that leads to discomfort and adverse health effects.

Lighting Design

Good lighting design involves reducing three forms of light pollution: uplight, glare, and light trespass. Often it is assumed that a lot of light is needed to ensure safety, but proper lighting design will result in levels of lighting that both ensure safety and reduce light pollution.

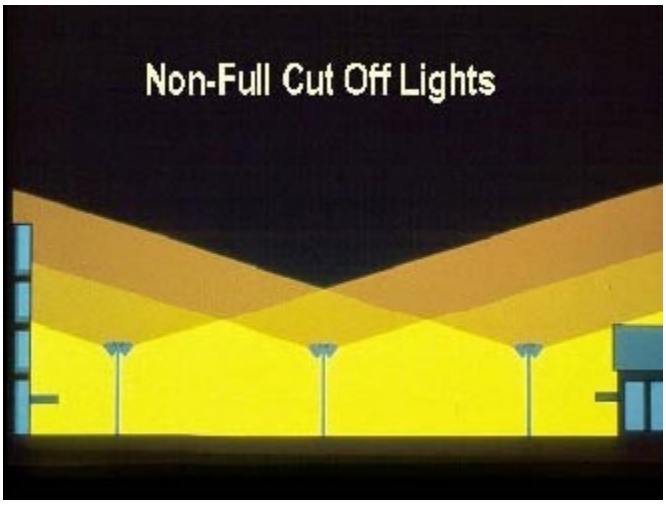
The backlight, uplight, glare (BUG) method is used in LEED for light pollution reduction. By selecting exterior lighting with specific BUG ratings the project team can easily reduce light trespass by simply purchasing lights with certain ratings instead of having to perform extensive lighting calculations.

Lighting Controls

Automatic light shut offs can ensure that lights are not left on after work hours or when they are not needed. This will not only reduce light pollution but also save energy on a project. Of course, it is a good idea to install a manual override to the shut off system for employees or students who may be working late.

Light Fixtures and Placement

The type of light fixture can make a difference in reducing light pollution. There are full cutoff, fully shielded, and partially shielded lamps that help direct light down and prevent it from escaping from a project site. Lighting specifications are set by the Illuminating Engineering Society of North America (IESNA).



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Old fixtures send light out in every direction and up into the sky where it is unnecessary. Low intensity lights are also good options. It is better to have lights that are not in direct line of sight to the exterior of the building. If they are in a direct line of sight position, light will be wasted by exiting the building. This is called light trespass, where light escapes the project and goes beyond the project border. Be sure to check for light exiting the property on the horizontal plane as well as light escaping upward.

Building Exterior Management

Are the cleaning chemicals used outside of the building non-toxic so when they are washed off by rain the chemicals don't harm the environment and water supply? This question can apply to walkway maintenance, external window cleaning, and other hardscapes. Use non-toxic cleaners, sealants, and paints.

Snow and Ice Removal

Many snow and ice removal products contain harsh chemicals. Use non-toxic products where possible or use the minimum amount necessary to do the job.

Landscaping

Manage landscaping efficiently. Landscaping not only includes irrigation water, but also the amount of fertilizers and maintenance equipment needed. Management can choose equipment that is quiet and efficient. Noise is another form of pollution that can disturb building occupants and neighbors.

Integrated Pest Management

LEED recommends integrated pest management to improve sites. These plans preserve the environment while supporting the building operations and integrate into the landscape.

LEED considers weeds and other unwanted plants to be pests. An example is Kudzu, the fast-growing vine that has overtaken large pieces of land in the south by choking out native plants. Pest management includes smart site management by managing what attracts pests – like trash cans or certain plants. In addition, , ensuring that plants are not growing right up to the building and including native and adaptive plants are natural ways to defend against pests.

Case Study: Dockside Green

LEED Rating: LEED for New Construction Platinum
Location: Victoria, British Columbia
Courtesy of: Dockside Green

Site Restoration

The existing shoreline along Point Ellice Park will be cleared of invasive shrub and rubbish and replaced with indigenous plantings and natural rock settings that will allow pedestrians direct access to the shoreline.

Light Pollution Reduction

In accordance with the Royal Astronomical Society of Canada light abatement recommendations, all site lighting will be full cut off and designed to eliminate nighttime light pollution. The project uses fixtures that provide downward lighting to enhance safety and save energy while retaining the natural beauty of the night sky.

Key Words

adapted vegetation

albedo

building footprint

development footprint

dry pond

emissivity

erosion

floor area ratio

greenfield

hardscape

heat island effect

IESNA

impervious surfaces

integrated pest management (IPM)

invasive plants

landscape area

LEED project boundary

light pollution

light trespass

low impact development

native vegetation

open-grid pavement

open space

pervious paving

rain garden

sedimentation

site assessment

solar reflectance (SR)

solar reflectance index (SRI)

rainwater management

undeveloped

wet pond

zoning

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[10] Duro-Last Roofing, Inc. White Equals Green Brochure 11/08 / DL#02-0009

[11] National Geophysical Data Center in Boulder, Colorado, 2004

[12] Battle Point Astronomical Association, http://www.bpastro.org

Chapter 5 - Water Efficiency

Seventy percent of the Earth's surface is covered by water, but less than 1% of that water is fresh water. Only 1% of that 1% is accessible for human use.[1]

According to the United Nations Environment Program, if our present patterns continue, two out of every three people will live in water-stressed conditions by the year 2025. A recent U.S. government survey showed at least 36 states expect to have local, regional, or statewide water shortages by 2013.

Each day roughly 340 billion gallons of fresh water are withdrawn from rivers, streams, and reservoirs. Sixty-five percent of the water consumed is discharged back into the water supplies after use.[2]

While the U.S. population doubled between 1950 and 2000, its water demand tripled.

Water efficiency helps protect our *aquifers* and the supply of renewable fresh water. The goals of the water efficiency credits are to

- reduce the quantity of water needed for a buildings and landscaping
- reduce municipal water use
- reduce the need for treatment of waste water

Reducing the quantity of water needed for a building and reducing the municipal water use go hand in hand. It is very unlikely that a building is not going to use any municipal water, so it is important to reduce the amount of water the building will use; this will often limit the use of municipal water. Potable water, which is water that is suitable for drinking, is one of the resources LEED is trying to conserve. Potable water comes from wells or municipal water systems. Non-potable water is not suitable for human consumption.

Water conservation strategies are typically no more expensive than traditional building methods. Buildings that use water efficiently can reduce operating costs through lower water use and sewage fees. For those strategies where the cost may be higher, the payback is usually quick. We'll take a look at some of these strategies in this section.

For both energy efficiency and water efficiency LEED requires an efficiency first approach. After efficiency, then look for other ways to reduce use. For example with outdoor water irrigation if the design only calls for using rainwater irrigation, that doesn't improve the efficiency of the irrigation system resulting in less water use. First design

the landscape to use less water, than look at ways to reuse water to further reduce demand.

Some projects take water management very seriously and try to only use the site's precipitation for both indoor and outdoor water needs. This achievement is called water balance.

Outdoor Strategies

In the summer, the amount of water used outside for landscaping can exceed all of the indoor water use for the entire year. The typical suburban lawn consumes an estimated 10,000 gallons of water above and beyond rainwater each year.[3] The intent here is to limit or eliminate the use of natural surface and subsurface waters (from lakes, rivers, and underground aquifers) used for landscape irrigation, and to water only when it is necessary.

Landscape Design

The first place to start saving water on irrigation is in the design of the landscape. The goals of proper landscape design should include:

- Lower water bills
- Limit or eliminate potable water usage
- Decreased energy use due to less pumping and treating of water
- Little or no lawn mowing (which also saves energy)
- Less air pollution – a typical gas-powered lawnmower produces as much pollution in one hour as a car being driven 340 miles
- More water available for other uses (such as showers, sinks, hoses)
- Less time and work needed for maintenance so gardening is simpler

Appropriate Plant Selection

When water restrictions are implemented, native plants will tend to survive, while more conventional plants may not. In the previous section about Sustainable Sites, native plants were mentioned as contributing to several credit strategies. Along with Water Efficiency, native plants help with:

- Green roof landscaping
- Rainwater management
- Restoring damaged areas
- Open space
- Water use reduction for the outdoors

Native plants are those that grow naturally in an area or that have been in an area for many years. Native plants require less water, fertilizer, and pest control. These plants can be trees, shrubs, flowers, or grasses.

Adaptive plants are non-native plants that perform well in the local climate. Native and adaptive plants require less water and are more disease resistant because they are suited to the region's usual rainfall, soil, and temperature. Project teams will need to choose plants that will perform best in the given soil conditions and with the given amount of sun and shade in the area where the plants will be located. Similar plants should be grouped together to maximize water efficiency.

Avoid the use of *invasive plants*, which are plants that grow quickly and aggressively, spreading and displacing other plants.

Perennial flowers are preferred to annuals, because perennials will come back year after year and will require less watering.

Xeriscaping

Irrigated land is land that requires artificial irrigation (watering other than rain). Xeriscaping is the type of landscaping and gardening that reduces or eliminates the need for supplemental irrigation. Eliminating irrigation is incredibly efficient and usually means land is taken back to a historic context. Xeriscaping is based on seven common sense principles:

- Proper planning and design
- Soil analysis and improvement
- Appropriate plant selection
- Practical turf areas
- Efficient irrigation
- Use of mulches
- Appropriate maintenance

There are many companies that can consult on xeriscaping in your area. Xeriscaped areas may not look like a typical grass lawn, but are beautiful and visually interesting.

Mulching

Installing 1-3 inches of mulch around plants keeps a plant's root system cool and moist in warmer weather. Mulching also helps prevent evaporation. Some cities provide free or low cost compost and/or mulching to residents.

Reduce Turf Grasses and Monocultures

Golf-course like landscaping looks great but is a water hog. A beautiful landscape can be achieved without the need for vast amounts of the turf grasses that deplete water supplies. You can still have an amazing landscape that emphasizes non turf-grass plants.

Turf grass is an example of a monoculture, or a single species of plant. Monocultures do not promote biodiversity.

Outdoor Water Reduction Practices

Irrigation practices play a major role in water conservation efforts and help protect aquifers.

Drip Irrigation

Drip irrigation minimizes the use of water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, or tubing. Drip irrigation is a type of micro-irrigation system (low-pressure irrigation systems that spray, mist, sprinkle or drip). Originally designed to increase crop yields by delivering water more slowly to root systems, drip irrigation can also achieve water conservation by reducing evaporation since water can be applied directly to the plant roots. Conventional irrigation has an irrigation efficiency of about 65%. Drip irrigation has an irrigation efficiency of 90%. That means on average, 90% of the water is being delivered to the plants when using drip irrigation.

Drip irrigation is the most water efficient form of irrigation because there is no surface runoff water. Plants can only absorb so much water at a time. Running a conventional overhead sprinkler 20-30 minutes to give plants a good soaking is a waste of water.

Drip irrigation is sometimes faulted for being slightly more expensive than conventional systems. Simple payback can be used to track water savings and compare. Simple payback takes the cost of an item or strategy and divides that number by the yearly savings that product or strategy creates. If a drip irrigated native landscape costs $15,000 more than a conventional landscape but saves a property manager $5,000 a year, the project will have a simple payback period of 3 years.

Scheduling

A single ‘deep’ watering for an extended period of time is much better than watering every day for a fraction of the time. Deep watering forces the plant’s roots to push further down into the soil where more moisture can be found over time.

Water the landscape during the coolest part of the day (generally in the morning), and avoid watering on windy days.

A good groundskeeper will help projects schedule and use resources appropriately for the landscape. He or she will know what plants need water & maintenance and will know how to control any outdoor pests attacking the landscaping.

Weather Based Irrigation Controllers

Weather-based irrigation controllers can save nearly 24 billion gallons per year across the United States—more than 7,000 hoses constantly running for a full year.[4]

Weather- or sensor-based irrigation control technology uses local weather and landscape conditions to tailor irrigation schedules to actual conditions on the site or historical weather data. Instead of irrigating according to a preset schedule, advanced irrigation controllers allow irrigation to match the water requirements of plants. These new control technologies offer significant potential to improve irrigation practices in homes, businesses, parks, and schools.

Newer soil moisture sensors have the benefit of detecting when plants need moisture. A rain sensor is great for turning off the watering system on rainy days. But if it rains for three hours on Monday and is sunny on Tuesday, a simple rain sensor would not factor in the three hours of rain on the previous day -- resulting in the sprinkler system still turning on, wasting water.

Water Audits

A landscape installed today will not have the same water requirements that it will have three years from now, or even one year from now. Newly installed plants need more water to become established. Over time plants will grow deeper roots and require less water. Perform at least an annual review of how much water is being provided to different areas of the landscape in order to evaluate the needs of the area and to reduce water use.

Landscape Maintenance

The single biggest factor in the health of a lawn is mowing. The cutting of grass week after week during the growing season is stressful to the grass. We have all seen people cut their grass too short after skipping a week and end up with a brown burned mess for the rest of the summer.

Raise Mowers

A common rule is the hotter the weather, the higher the lawn should be cut. If turf grass is included in the landscape design, raising the height of the mower blades will reduce the amount of clippings and the need for watering. Longer grass protects the soil from being scorched by the sun and prevents the germination of weeds.

Leave the Clippings

You rarely see a commercial property bagging grass clippings because of the sheer quantity of grass involved. However many homeowners bag the clippings and then set them out for garbage collection. Not only does this practice add waste to landfills, it is actually detrimental to the grass. Forty percent of the nutrients that grass needs are lost when clippings are taken away and not left to compost naturally.

Maintain the Watering System

Check sprinkler heads periodically to prevent watering of streets and parking lots. Poorly installed sprinkler heads and damage caused by landscaping maintenance can undermine the best of intentions. Too many sprinklers shoot water into paved areas in the middle of a hot day. Verify that sprinkler heads are pointed in the right direction to prevent valuable water from being sprayed onto hardscapes and then evaporating.

Use Rainwater and/or Graywater

Municipal water use for landscaping can be reduced if not eliminated by choosing alternative water sources. Both rainwater and graywater, considered *non-potable*, are excellent alternatives. Non-potable water is water that does not meet EPA's drinking water standards but can be used for onsite water reuse strategies.

Rainwater

Rainwater can be collected in cisterns, barrels, or storage tanks. This approach is called *rainwater harvesting*. For commercial applications a rooftop collection system can be added. Rooftop rainwater collection systems have the added benefit of using gravity, not a mechanical pump, to distribute the water. For residential applications a, simple barrel can be installed next to a downspout.

At the beginning of a project, figure out how much water the site can collect from the roof in a typical month (or year) and think about how that water could be used in and around the building.

Keep in mind that using reclaimed rainwater limits the amount of rainwater flowing into the drains and into neighboring properties or streets. This helps with the rainwater management issues from the Sustainable Sites category.

Graywater

Gray water is water that can be used twice. Graywater is untreated household waste water which has not come into contact with toilet waste. Graywater is different from blackwater - untreated wastewater from toilets and urinals. Graywater comprises 50-80% of residential wastewater. Like rainwater, graywater can be piped to storage tanks for later use. Graywater can come from:

- bathtubs, showers, bathroom sinks
- washing machines and laundry tubs

Graywater does not include:

- potable water (already treated water from municipal supplies or wells)
- waste water from kitchen sinks
- water from dishwashers
- waste water from toilets and urinals (blackwater)

If gray water is filtered properly, reusing it for irrigation and further conveyance is safe from a health perspective.

Make sure you check local codes before reusing graywater or rainwater. Different cities have special rules about how and if this water can be used. Sometimes a permit is required. Graywater in one city may be considered blackwater in another city. Blackwater cannot be used for irrigation and also does not have one standard definition.

Consider the project type when considering the strategies to incorporate. A high-rise residential project will have a high amount of graywater available from the residents' showers and washing machines. That water is a great source for landscaping or to recirculate into the system for flushing toilets.

Example: Premier Plaza 1 & 2

LEED Rating: LEED EBO&M Registered
Location: Atlanta, Georgia
Courtesy of: Sustainable Options, LLC

Two 11-story Class-A Office Buildings on the northern edge of Atlanta, GA are utilizing reclaimed rainwater supplemented with a natural spring for 100% of their irrigation. The parking deck, when designed and built in the 1980's, had a large lower compartment to

help retain some of the water from a nearby springhead during construction, that was then pumped out so not to jeopardize the parking deck's infrastructure. In the last two years, the building owner dammed up the outflow from the sidewall of the now realized cistern and installed a pump. The result was over 80,000 gallons of water in the cistern in the bottom of the parking deck. This is more than enough water for the entire year's irrigation needs for this particular site. The owner, Ackerman & Co. is looking into sharing this water with neighboring properties. The water in the cistern is regularly circulated, and the tank is filled by reclaimed rainwater and the nearby spring. The domestic water supply line for irrigation was completely cut off.

Indoor Strategies

Reducing water use within a house or building is an easy way to earn LEED credits, and can be achieved with little if any additional cost over standard plumbing fixtures.

- Toilets account for 25% of daily water use in the U.S.
- One-half of all toilets in U.S. homes are older, less efficient models
- 1.6 billion gallons of water are wasted in the U.S. every year because of inefficient toilets
- One leaky faucet, leaking at a rate of 60 drips per minute, wastes over 2,000 gallons of water annually[5]

The Energy Policy Act of 1992 (EPAct) established water conservation standards for water closets, shower heads, faucets, and other uses to save the United States an estimated 6.5 billion gallons of water per day. Older toilets use four to eight gallons of water per flush, while all new toilets must have a maximum flush volume of 1.6 gallons.

Plumbing fixtures intended for the use of a family or individual – like those in homes, individual hotel / hospital rooms, etc are private or private use fixtures.

All other fixtures not intended for private use are considered public or public use fixtures.

While the EPAct was a good starting point, there are many other ways to exceed this standard and realize even greater water savings. In this section we'll look at the fixtures that are available to your projects. Some of these fixtures, such as waterless urinals, have been around for over a decade, but are just now gaining broader acceptance in the marketplace.

Dual-flush Toilets

A dual flush toilet has two buttons/levers. One provides a half flush, and the other a full flush. The choice of button depends on the type of waste. These types of toilets can reduce water usage of up to 67% compared to other standard and older toilets.

Dual flush toilets are still on the pricey side, but there are conversion kits that allow you to replace the toilet flush valves of existing toilets at the fraction of a cost a brand new toilet.

High-Efficiency Toilets

Replacing older, less efficient toilets with 1.28-gallon High-Efficiency Toilets (HETs) can save up to 16,500 gallons of water per year, per toilet.

More than 50% of the toilets in use today consume at least 3.5 gallons per flush.[6] New high-efficiency toilets have equivalent performance while using no more than 1.28 gallons of water. In a home that has an average of 10,000 flushes per year, this means a savings of 22,000 gallons of water compared to a 3.5 gallon toilet, or 3,200 gallons compared to a 1.6 gallon toilet.

In residences, toilets use about 30% of all indoor water. Under the EPAct of 1992, new toilets must not use more than 1.6 gallons per flush (gpf). High-efficiency toilets (HETs) go beyond the standard and use 1.28 gpf, a 20% savings. To identify HETs, look for the *WaterSense* label.

WaterSense

WaterSense is a program sponsored by the United States Environmental Protection Agency (EPA) that helps consumers identify high-performance, water-efficient toilets that can reduce water and wastewater use, costs, and conserve the nation's water resources. The WaterSense label is used on fixtures and fittings that are certified by independent laboratory testing to meet rigorous criteria for both performance and efficiency. Only products that complete the third-party certification process can earn the WaterSense label.

Treating blackwater (waste water) consumes a lot of electricity. If just 1% of American homes replaced an older toilet with a new WaterSense-labeled toilet, the country would save more than 38 million kilowatt-hours of electricity—enough electricity to supply more than 43,000 households for one month.[7]

Waterless Urinals

The waterless urinal is one of those rare products that can save money and time while improving hygiene and protecting the environment.

Replacing a standard urinal with a waterless urinal would save an average of 40,000 gallons per year. That's enough water to fill two swimming pools, eight tanker trucks, or enough to supply a typical household 580 days of water. Additional environmental benefits include reduction in energy required to deliver and treat waste water and reduction of CO2 emissions/carbon footprint.

The US Army *requires* waterless urinals nationwide as the new standard on its bases.

Many companies offer a selection of 0.5 gpf or even ultra low flush 0.125 gpf urinals for increased efficiency where some water is desired.

Benefits of Waterless Urinals

- No water used
- No flush valves
- Lowered maintenance: Faster to clean and requires less cleanser
- Vandal resistant: No water supply, valves, or sensors to be tampered with
- Eliminates flooding: With no water supply, it can't overflow and cause floods

Benefits	
$0 water/sewer	40,000 gallons x 100 urinals = 4 million gallons
$0 valve maintenance	$75 x 100 urinals = $7,500
Eliminates emergencies	Fewer restroom disruptions
Reduces custodial costs	Faster to clean Reduction in use of cleaning supplies

Waterless urinals are also more hygienic, since they have touch-free operations. They are also odor-free and have less bacteria growth because of the absence of moisture. Studies by both manufacturers and independent third parties confirm that waterless urinals are more sanitary. The entire unit is made of porcelain and requires no special drain lines.

In building construction there are usually no added costs to use a more efficient fixture, so it's an easy decision to make. The fixtures already comply with the federal standards. In an existing building, trying to reduce the water consumption becomes more of a cost issue if all of the plumbing fixtures that were installed 20 years ago need to be replaced.

Example: Dolphin Stadium

Location: Miami, Florida
Courtesy of: Falcon Waterfree

Used an average of 160 times each during a single football game, the 900 flushable urinals at Dolphin Stadium in Miami Gardens, Florida were draining the facility of more than water. Chief Engineer Frank Everton estimates that his staff spent at least 30 to 45 minutes servicing each urinal twice a year. This was due in part to the water in Miami which is high in calcium and left a residue on flush-valve gaskets, causing them to crack and leak at a repair cost of about $50 each. Another factor in the high maintenance costs of the urinals was vandalism.

By replacing the standard urinals with the water free urinals, Dolphin Stadium has:

- conserved water
- eliminated leaks or urinals that constantly flushed
- eliminated clogs
- reduced annual property management maintenance cost
- prevented vandalism

Composting Toilet Systems

Composting toilet systems don't actually require water and treat waste with microbiological processes. While not practical for a high rise building, composting toilets can be used for varied project types. Composting toilets and waterless urinals are the most efficient types of fixtures because they require no water.

Example: Hike Inn

LEED Rating: LEED for Existing Buildings Gold
Location: Dawsonville, Georgia
Courtesy of: Hike-Inn

The Hike Inn is Georgia's newest state park. It is a LEED Gold certified hotel that is committed to conservation. There is no way to reach the inn other than a five mile hike. The inn uses 5 composting, odor-free toilets that save over 200,000 gallons of water a year.

Low-flow Showerheads and Faucets

Swapping your 2.75 gpm showerhead with a 1.75 water-conserving showerhead can save more than 7,700 gallons of water per year (based on 7 minute showers per person per family of four).

Gallons per Minute (gpm)	Likely if your Home was built	Savings in gallons Per year (gpy)
5.0	Pre 1980	0
2.75	1980 to 1993	17,400 gpy from 5.0 gpm
2.5	1994 to the present	19,300 gpy from 5.0 gpm 1,900 gpy from 2.75 gpm
1.75	Present	25,100 gpy from 5.0 gpm 7,700 gpy from 2.75 gpm 5,800 gpy from 2.5 gpm

Based on average household of four, each showering once a day for 7 minutes, 365 days a year.

Courtesy of Kohler

Faucets with Low-flow Aerators and/or Motion Sensors

A faucet with a 1.5 gpm low-flow aerator can save 30% more water over a faucet with a 2.2 gpm standard aerator.

WaterSense faucets offer 1.5 gpm water-saving aerators and have a 45% water savings over older, less efficient 2.75 gpm faucets. For the average household, this can mean over 14,700 gallons of water saved each year and a reduction in monthly water bills.

Motion/automatic control sensors installed on faucets help control the amount of water used, thus not allowing for a constant flow and saving water.

Gallons per minute (gpm)	Likely if your home was built	Savings in gallons per year (gpy)
3.0	Pre 1980	0
2.75	1980 to 1993	2,900 gpy from 3.0 gpm
2.2	1994 to the present	5,900 gpy from 3.0 gpm 2,900 gpy from 2.75 gpm
1.5	Present	17,700 gpy from 3.0 gpm 14,700 gpy from 2.75 gpm 11,800 gpy from 2.2 gpm

Based on average household of four, each using a faucet 8.1 minutes a day, 365 days a year

Courtesy of Kohler

Install Water Meters

With many indoor strategies, projects are either making estimates on water use or estimating savings. Installing water meters for different areas, called submetering, will help in measurement and verification of water usage. Usually meters measure cold potable water use.

Use Rainwater and/or Graywater

The water used to flush a toilet doesn't need to be as clean as the water you drink from a faucet, yet the clean and treated water is what flows through 99% of our toilets.

Recycled graywater from showers and bathtubs can be used for flushing toilets in most jurisdictions. Such a system could provide an estimated 30% reduction in water use for the average household, while on a commercial scale – the savings are even greater. .

The Uniform Plumbing Code, adopted in some United States jurisdictions, prohibits graywater use indoors.

Process Water Strategies

Processed water covers fixtures and systems that aren't covered by the Energy Policy Act. In LEED, examples of processed water include:

- Makeup water for mechanical systems
- Systems that use water in laboratories or hospitals
- Commercial cooking applications – food steamers, ice machines, dishwashers, etc.

Processed water is not directly addressed by each of the rating systems. For example, you would not find the credit in LEED for Homes, but it would be part of LEED BD+C: Healthcare or LEED BD+C: Schools.

In a building like a laboratory, the process water can account for a much larger amount of water than the water from sinks, toilets, and showers.

Substituting non-potable water for processed water is one way to reduce water use, especially for things like mechanical system makeup and blow-down water. Captured water or reclaimed water can be used to meet the needs for process water.

Cooling Towers

Cooling towers are used to regulate temperatures in buildings. They can help absorb heat from machinery or HVAC systems into cold water which then becomes hot water. This heat can be released through evaporation into the air or through other cooling techniques. Without proper oversight, cooling towers can use significant quantities of potable water.

Chemically controlled cooling tower management must be water efficient and safe. An evaporative cooling tower can conserve up to 20% of the water use of a standard cooling tower, depending on climate and configuration.[8]

Effective monitoring of cooling towers can create a more efficient system. Staff can monitor bleed-off rates, makeup water use and heat loads to optimize the system.

Water Reduction Measurements

Remember that LEED promotes an 'efficiency first' strategy to water reduction. First choose strategies that improve efficiency, such as selecting WaterSense and ENERGY STAR products. Then look for ways to further reduce demand such as using alternative water sources – graywater, rainwater, reclaimed water, and further reductions through design.

For LEED, all water reduction measurements are based on a baseline case compared to the designed installed case. The baseline case uses the fixture flush and flow rates of a conventional building. The design case uses the fixture flush and flow rates of the planned building design, taking into account the more efficient plumbing fixtures. For example, a green building that has been designed to include waterless urinals may use 25% less water than a comparable building.

Required Water Use Reduction

One of the features of LEED is the water efficiency prerequisite. Project teams are required to reduce water usage inside of the building by at least 20% (irrigation is not included).

Alternatively for LEED v4 projects - if all newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labeling are WaterSense labeled (or a local equivalent for projects outside the U.S.) the project team doesn't have to do any calculations, they just have to select WaterSense products.

To calculate the percent reduction, the project team first calculates a baseline water demand, or baseline case. A baseline case is where models and calculations are done to discover what a conventional building's water use would be. The baseline water usage is based on estimated occupant usage (Full Time Equivalent calculations) and the water fixtures and fittings, such as:

Commercial Fixtures, Fittings, and Appliances	Baseline Water Use
Toilet	1.6 gallons per flush (gpf)
Urinal	1.0 gallons per flush (gpf)
Lavatory faucet	2.2 gallons per minute (gpm)
Residential Fixtures, Fittings, and Appliances	
Toilet	1.6 gallons per flush
Lavatory faucet	2.2 gallons per minute
Kitchen faucet	2.2 gallons per minute
Showerhead	2.5 gallons per minute

The flush and flow rates are based on the EPAct 1992 standard.

Water reduction calculations for the LEED Rating Systems are based on a reduction of the total water consumption, rather than just a single fixture or fitting.

Indoor strategies depend on efficient plumbing fixtures and fittings. A plumbing fixture or fitting is either permanently or temporarily connected to the building's water distribution system and includes water closets, urinals, lavatories, sinks, showers, and drinking fountains.

FTEs

The water use reduction prerequisite as well as some other LEED credits use a variable called Full-Time Equivalent (FTE) for calculating baselines and design case values. Building occupants are identified by type:

- Full-time staff
- Part-time staff
- Transient occupants (students, customers, visitors)
- Residents

FTE is a way of calculating the number of residents in a building, the number of full time and part-time office workers, and the number of transient occupants. The number of FTE occupants is based on a standard 8-hour occupancy period. An 8-hour occupant has an FTE of 1.0. A part-time worker that works 4 hours per day has an FTE of 0.5 (their hours per day divided by 8).

For a classroom, the FTE calculations would include both the teachers and students. Students are a type of transient occupant, or a type of occupant that does not use the facility consistently. Students, shoppers, and museum visitors are all types of transient occupants.

FTE calculations may include multiple shifts depending on the credit, so be sure to understand how the calculation is used each time.

When thinking of indoor water strategies, remember that even small water savings will be multiplied by how many FTEs are in the building.

The detailed calculations of the baseline water demand and the design, or installed cased water demand, along with the fixture and flow calculations based on FTEs are beyond what you need to know in this study, , but we include them here because they are terms that that will come up as you work on LEED projects.

Case Study: Bank of America Tower at One Bryant Park

LEED Rating: LEED for New Construction Platinum
Location: New York City, New York
Courtesy of: Bank of America

Bank of America and its co-developer, the Durst Organization, achieved LEED Platinum certification for their bank headquarters. The building is 52 stories and 2.1 million square feet in size.

Unlike most large buildings, the tower will generate a significant portion of its power on site through a 5.1 megawatt cogeneration system. It also will save about half the energy used by most buildings its size; will filter out about 95% of the particulates in the air drawn into the building; will use less expensive night-time power to produce ice used to cool the building; and will conserve millions of gallons of water every year through methods such as green roofs and waterless urinals.[9]

The projected savings are 10.3 million gallons a year on city water, or 40% less than what would otherwise be used. The breakdown of water savings is:

- 2.3 million gallons per year savings from rainwater
- 0.9 million gallons per year from cooling coil reuse
- 2.6 million gallons per year from steam condensate
- 1.1. million gallons per year from lavatories
- 3.4 million gallons per year from waterless urinals

The water savings equate to a dollar value of $60,000 a year at current rates.

Strategies Used

The building incorporates many of the water saving strategies previously discussed, supporting an unprecedented green project.

Rooftop Rainwater

Ninety-five percent of the storm rainwater water collected onsite is reused. Rainwater is collected and stored on the roofs and at points throughout the 52 floors. The water is used for flushing and uses a gravity-based system. No mechanical pumping is needed to deliver water from the base of the building up to the top floor and then flushed back down to the base. The water is already stored at the point it is needed from the supply of rain stores.

Indoor Reservoir

Five tanks that were constructed in the building's core can hold up to 330,000 gallons of water. The reclaimed water is filtered and disinfected and then used for flushing toilets, cooling tower makeup or steam production.

Low-Flow Toilets, Waterless Urinals, Automated Faucets

Waterless urinals were installed, though at the time the project needed to obtain a variance from the city to permit the installation. Waterless urinals had not been seen in

projects before. Automated low-flow faucets reduce flow to just 0.5 gallons per minute, much less than the 2.2 gallons per minute allowed by New York code.

Groundwater Cooling

During the summer months, the project team taps the cold water reservoirs and pumps the cool water into the lower levels of the building for cooling. Once the heat transfer takes place, the warmer water is then pumped into the building's storage tanks for reuse.

Case Study: Dockside Green

Dockside Green has made a significant commitment to reduce water use, to reuse water, and to prevent water from leaving the site.

Reduce Potable Water Use

Dockside Green's potable water use in residential and commercial/office buildings will be approximately 60% to 65% lower than conventional developments, achieved largely through the use of reclaimed water for toilets and low-flow fixtures - such as dual-flush toilets, 1.5gpm showerheads, 0.9gpm sinks, 0.5gpm lavatories and waterless urinals. The amount of water saved for the entire development is equivalent to the annual water use of 580 homes. This approach has resulted in duel benefits or synergies. For example, energy-efficient front-loading washers are gentler on clothes, use less water and require less heat for drying, thanks to a high-speed spin cycle feature. Similarly, investment in energy and water efficient dishwashers and shower heads save energy costs because less heat is required for domestic hot water needs. In addition, installing individual water measurement meters in each suite for accurate monitoring of water consumption, heat and energy as well as the ability to control temperature remotely.

Water Treatment

The development will treat 100% of its sewage on site and use the treated water for flushing toilets, landscape irrigation and water features. Residual treated water will recharge the naturalized waterway that flows across the site and collects rainwater as it flows towards the inner harbor. It is estimated that over 38 million gallons of potable water will be saved by treating and re-using the water on site. The city will not bill residents for the sewage component charge of the water bill nor for the use of treated water.

The entire development is anticipated to save over 70 million gallons of potable water per year – the equivalent of the Greater Victoria region's water use on the driest day of the year. The dollar savings from water efficient fixtures, the reuse of treated water and no sewage charge from the city are projected to exceed the operating costs of sewage treatment on site.

Metering

Monitors in each suite will not only show temperatures, but also show how much water has been used.

Storm Water Treatment

Storm water will be treated through green roofs and flow via a series of connected naturalized creeks and waterways to achieve LEED requirements and create a delightful, lush and 'living' urban environment.

Key Terms

adaptive plant
aquifer
baseline water demand
blackwater
composting toilet
conventional irrigation
drip irrigation
dual-flush toilet
ENERGY STAR
EPAct of 1992
Full Time Equivalent
Full Time Equivalent occupant
graywater
HET
installed design case
invasive plant
low flow fixtures
native plant
nonpotable water
plumbing fixtures
plumbing fittings
potable water
potable water use reduction
process water
rainwater management
rainwater harvesting
recycled water
submeter
transient occupants
water closet
waterless urinal
WaterSense
Xeriscaping

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Chapter 6 - Energy and Atmosphere

In all of the different LEED rating systems, the Energy and Atmosphere category contains the most points available. The reason is the importance of energy conservation. Increased energy use and the burning of fossil fuels are linked to global warming and air pollution. This category of sustainability specifically looks at the energy use in a building: use less energy and support the use of more environmentally friendly energy sources.

The whole building approach to building design not only saves energy over time, but the size of the equipment needed for heating and cooling is also reduced. The use of smaller pieces of equipment saves money up front and lowers any added costs that may occur from other sustainability choices that are implemented. It's easier to save energy by reducing the demand and the loads needed than to buy expensive high-efficiency equipment.

The Energy and Atmosphere category seeks to reduce the energy use of buildings and homes, use renewable energy sources, and reduce greenhouse gas emissions.

Goal Setting

Before it can save energy, a project team needs to determine how much energy to save.

How much energy *can* you save? How much *should* you save? For LEED certification, your project needs to reduce energy use by a certain percentage over a comparable baseline building. We know that compact fluorescent light bulbs use less electricity and generate less heat than incandescent bulbs because we can compare the two kinds of bulbs. A whole building design needs the same thing – a basis for comparison in order to determine the building's energy efficiency. When designing a new home or building, or updating an existing one, an important first step is to find a baseline.

Common measures for energy use are energy use per square foot, such as Btus/SF, or energy use by time, kilowatt hour/year, or per person, Btus/per capita. Use these common energy use intensity measures to set goals for your projects.

Homes

For homes, utility bills serve as a good baseline. Site energy is the amount of thermal and electric energy a site consumes as determined by utility bills.

Buildings

EPA's TargetFinder "helps architects and building owners set aggressive, realistic energy targets and rate a building design's estimated energy use." TargetFinder is also used to determine EPA's ENERGY STAR rating for buildings.

TargetFinder uses building survey information collected by the federal government. The Commercial Buildings Energy Consumption Survey (CBECS) is a "national sample survey that collects information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures."

With TargetFinder, project teams enter their building size, type, zip code, and some other variables depending on the type of building. The tool allows the team to set an energy target and then compare the project's design energy and cost to the target energy cost through the design process. The target can then be measured against a variety of design strategies. The program outputs how much energy the average building in the area consumes and how much a high-performance building in the area would consume. This gives the project team a comparison target (hence the name TargetFinder).

Early targeting in the design process allows a project team to forecast the project's energy costs and savings. If the project team knows the projected annual energy cost for a building using conventional building practices is $X, and developing a high-performance building will save $Y per year in energy costs, that's beneficial in discussing the premium "green" hard dollars prior to any construction.

Reduce Energy Demand

In the United States, buildings account for[1]

- 36% of total energy use
- 65% of electricity consumption
- 30% of greenhouse gas emissions

Reducing energy use includes the goal of reducing the electricity needed while obtaining the same or nearly the same results from the building's systems. How can we keep the temperature in the building comfortable while using less power? How can the parking lot be secure at night while using less foot candles to light the walkways and the parking lot?

Energy Star Portfolio Manager

Energy Star Portfolio Manager is an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment. Whether you own, manage, or hold properties

for investment, Portfolio Manager can help you set investment priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance.[2]

Energy Audit

For existing buildings, start on reducing energy use by having an energy audit performed. This is especially encouraged for homes and has been encouraged by government programs like Home Energy Saver. But on a large commercial building, an energy audit will show where the energy hogs are in your building right away, i.e. inefficient cooling towers. An energy audit starts by determining how energy is used and then making suggestions for improvements (low/no cost versus capital intensive) that will reduce energy use and energy costs.

An example might be energy used to heat water in a hot water heater. Some energy is escaping into the atmosphere around the heater, so the audit may recommend a water heater blanket. The blanket will reduce the amount of energy needed to heat the water and reduce the cost of heating water in that home.

Building Orientation

The orientation of the building to the sun and prevailing winds affect heating, lighting and cooling costs. Proper orientation provides opportunities for maximizing solar power (which we will discuss later in this section). When maximizing the southern exposure, buildings can take advantage of the sun for daylight and passive solar heating. By minimizing western exposures when the sun's heat is most intense, cooling costs can be minimized. Each site and region of the country will have its own orientation needs, which will affect the use of prevailing winds, daylighting, passive solar, and radiant heating.

Sophisticated 3D computer simulation tools and energy modeling software are available to model how a building will perform with a range of design variables such as building orientation (relative to the daily and seasonal position of the sun), window and door type and placement, overhang depth, insulation type and values of the building elements, air tightness (weatherization), the efficiency of heating, cooling, lighting and other equipment, as well as local climate.

These simulations help the designers predict how the building will perform before it is built, and enable them to model the economic and financial implications on building cost benefit analysis, or even more appropriate--life cycle assessment.

Site Location

A building that can be placed in the shade of trees or another structure will remain cooler, thereby reducing the required cooling load. A building's surroundings can also help block out wind.

Right Sizing

It is common sense to know that the bigger the building, the more resources it will likely use than a smaller building. We've discussed stakeholder meetings and charrettes. In those meetings project teams must seriously consider current and future needs to appropriately size a building. Do not attempt to build projects that are larger than actually needed.

LEED makes no adjustment for size on commercial buildings, but in LEED for Homes points are adjusted across all categories depending on the square footage of the home. Even though Homes is the only rating system to do this adjustment, other projects can reduce material and energy use by right sizing the projects.

Ozone Depletion

While reducing electricity use is a significant step in reducing the pollution generated by homes and buildings, the credit category of Energy and Atmosphere also has a goal of reducing ozone depletion and climate change.

'Good' ozone occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface and forms a layer that protects life on earth from the sun's harmful rays. The less ozone the Earth has, the less protection we get from UV rays. Increased UV can reduce crop yield and disrupt the marine food chain. For humans, increased UV can lead to the development of cataracts and skin cancer. The quantity of UV from the sun that reaches the Earth doesn't change.

CFCs

Since the late 1970s, the use of chlorofluorocarbons (CFCs) has been heavily regulated because of their destructive effects on the ozone layer. CFCs, hydrochlorofluorocarbons (HCFCs) and other ozone-depleting substances were widely used as refrigerants. Halons are chemicals used in fire suppression systems that also negatively affect the ozone layer. The destructiveness of these chemicals is measured by their ozone depletion potential (ODP) and global warming potential (GWP).

In the U.S., 99% of buildings are existing buildings; of those, 50% are older buildings that have old, inefficient, leaky chillers that use CFCs. Replacing or retrofitting these units could save energy while reducing the negative environmental effects of CFC use.

Montreal Protocol

In 1987, the Montreal Protocol was signed and the signatory nations committed themselves to reducing the use of CFCs and other ozone-depleting substances. The Montreal Protocol on Substances That Deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The phase out for developed countries began in 1991. Most CFC use and production was phased out by the United States by December 31, 1995. Some other substances and derivatives were phased out in 2010, and the less active HCFCs will be phased out in 2030. Many undeveloped countries continue to use these ozone depleting and global warming chemicals. The treaty states:

> "Recognizing that worldwide emissions of certain substances can significantly deplete and otherwise modify the ozone layer in a manner that is likely to result in adverse effects on human health and the environment, ... Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge ... Acknowledging that special provision is required to meet the needs of developing countries"

Refrigerant Properties

When mechanical refrigeration is needed, many natural refrigerants exist for refrigeration, as well as refrigerants that have lower ozone depletion potential (ODP) and global warming potential (GWP).

Ozone Depletion Potential (ODP) is a number that refers to the amount of ozone depletion caused by a substance.

Global Warming Potential (GWP) is a number that refers to the amount of global warming caused by a substance.

Some refrigerants may have a lower ODP, while others have a lower GWP. Select a refrigerant that has both low ODP and GWP when practical.

There are five *natural refrigerants* that are benign to the earth's atmosphere. They are:

- CO2 – Carbon dioxide
- H2O - Water
- NH3 - Ammonia
- HC – Hydrocarbons, such as propane, butane, ethane, isobutene, and isopentane

- Air

Natural refrigerants are not as effective as refrigerants like HCFCs, so it requires more energy to achieve the same amount of cooling. Buildings burn more energy, and thus more fossil fuels, to keep the indoor space the same temperature as a more efficient refrigerant that has higher ODP and GWP values.

ODP and GWP of Common Refrigerants

Chlorofluorocarbons	ODP	GWP	
CFC-12	1.0	10,720	**Worst**
CFC-11	1.0	4,680	
Hydrochlorofluorocarbons			
HCFC-22	0.04	1,780	
HCFC-123	0.02	76	
Hydrofluorocarbons			
HFC-23	~0	12,240	
HFC-134a	~0	1,320	
Natural Refrigerants – Hydrocarbons (HC)			
Ethane	0	3.0	
Propane	0	3.0	
Butane	0	3.0	
Natural Refrigerants – Other			
Carbon Dioxide (CO2)	0	1.0	
Ammonia (NH3)	0	0	
Water (H2O)	0	0	
Air	0	0	**Best**

As you can see from the table, natural refrigerants have the lowest ODP and GWP, followed by HCFCs. CFCs have the worst impact on ozone depletion and global warming (hence they were banned under the Montreal Protocol). CFC-12 is the worst refrigerant, while using natural ventilation – (no refrigerants, or just air) – is the best.

Refrigeration Design

For LEED, new buildings may not use CFC-based refrigerants. When designing the refrigeration system, consider a system that will last a long time and have less impact on climate change. In mild climates, a building that requires no refrigerants is the ideal choice (*See the Spring Creek Fire Hall case study earlier in this section*). This is not practical in hot southern climates, but in northern areas proper building design and natural ventilation may eliminate a mechanical cooling system completely.

For basic refrigerant design within the LEED Rating Systems, there is a prerequisite for Fundamental Refrigerant Management which requires zero use of CFCs.

Beyond basic refrigerant design (called Enhanced Refrigerant Management in the rating systems) LEED projects can choose to:

- Use no refrigerants (known as natural ventilation)
- Install an HVAC system that uses refrigerants that minimize or eliminate the emissions of compounds that contribute to ozone depletion and global warming (refrigerants with low ODP and GWP)
- Make sure fire suppression systems and fire extinguishers are halon free.

Halons are used as fire extinguishing agents, both in built-in systems and in handheld portable fire extinguishers. Halon production in the U.S. ended on December 31, 1993, because they contribute to ozone depletion[3].

Phase-out Plans

For existing buildings, project teams must complete a CFC phase-out plan. Buildings that were not designed for energy efficiency have HVAC systems that have an indirect impact on global warming potential and can damage the environment because of their contribution to the emission of greenhouse gases from power plants. For existing buildings, LEED projects need to replace or retrofit CFC-based refrigeration systems

There are some exceptions to this rule depending on the rating system. For existing buildings that have older CFC based systems, the project must implement a *phase-out plan* that phases out the use of refrigerants within 5 years of the projects' completion. If a third party audit reveals a replacement or retrofit is not economically feasible (defined as having a simple payback greater than ten years), then they system may be exempt from the rule. For any system that is phased out or will not be replaced, the annual leakage rate of CFC-based refrigerants must be no more than 5%.

For more information on refrigerants and LEED, see The Treatment by LEED of the Environmental Impact of HVAC Refrigerants from USGBC.

Demand Response

Demand Response (DR) is a set of time-dependent program activities and tariffs that seek to reduce electricity use or shift usage to another time period. DR provides control systems that encourage load shedding or load shifting during times when the electric grid

is near its capacity or electricity prices are high. DR helps to manage building electricity costs and to improve electric grid reliability.

By enrolling in electricity load curtailment programs such as demand response, owners and operators can lower demand on our energy infrastructure and help prevent widespread blackouts. They can also reduce their energy costs and carbon footprint, as well as earn incentive payments for their curtailment. Promoting this as a step toward green building operations and improved corporate social responsibility is an additional benefit.

The intent of demand response programs is to motivate end users to make changes in electric use, lowering consumption when prices spike or when grid reliability may be jeopardized. In order to encourage building operators to reduce electric use, incentive payments are often issued. Demand response programs are most often administered by utility companies.

Once enrolled, an audit of the facility(s) is performed to determine what demand response load is available. From the assessment, a list of operational changes for load curtailment is generated and discussed with the customer, who decides which should be implemented during a demand response event.

Using an existing energy management system connected via an internet gateway, a facility's non-critical load is intelligently and automatically reduced by implementing predefined operational changes, such as cycling HVAC equipment, increasing air-conditioning setpoints, turning off or dimming a portion of facility lighting and/or controlling the use of other energy-intensive processes.

During a demand response event, site conditions are constantly monitored in real-time to protect business operations, worker productivity, occupant comfort or the customer experience. If, at any time, maximum building temperature, maximum CO2 concentration or minimum lighting levels are reached, the site automatically reverts to its normal operations.

Incentives for participating, which are issued by program administrators, range from a credit on the customer's utility bill to a check issued following an event or reduced kilowatt-hour rates for overall power. In some programs, building owners receive 'capacity' payments for agreeing to participate in demand response if requested, regardless of whether an event is actually called.

Water Use

Water reduction might not seem like a way to save power, but it takes energy to heat water, pump water, and treat water. Using the water saving techniques we discussed in the Water Efficiency section will also help.

Tankless Water Heaters

On-demand or tankless water heaters are products that do not constantly heat and store the hot water like conventional water heaters. Only when a hot water fixture is activated does the on-demand system heat the water and deliver it.

Energy Efficiency

Energy efficiency is the use of technology that requires less energy to perform the same function.

Building Envelope

The building envelope protects the building occupants and plays a major role in regulating the indoor environment. An inefficient building is like a person wearing a t-shirt in winter: it's hard to keep warm. A high-performance building is like a person wearing a ski jacket and a hat. . Consisting of the building's foundation, walls, roof, windows, and doors, the envelope controls the flow of energy between the interior and exterior of the building. A well-designed envelope allows the building to provide comfort for the occupants and respond efficiently to heating, cooling, ventilating, and natural lighting needs.

In 2005 the U.S. Department of Energy estimated that 40% of the energy used to heat and cool the average building was lost to air leaks in building envelopes. Since buildings account for nearly 40% of annual energy consumption in the U.S., that comes out to 16% of total U.S. energy usage being leaked right out of buildings. Building envelope problems can lead to:

- high heating and cooling bills
- drafts or uneven temperatures
- poor indoor air quality
- building deterioration
- insects, noise, odors

Many older buildings were constructed with the minimum amount of insulation as required by the local code, or have no insulation in the floor, ceiling, or walls.

For a new project, opportunities relating to the building envelope begin in the pre-design phase. An optimal building envelope may provide significant reductions in heating and cooling loads—which in turn can allow downsizing of mechanical equipment. When the right strategies are integrated through good design, the extra cost for a high-performance envelope may be paid for through savings achieved by installing smaller HVAC equipment.

When renovating existing facilities, facility managers have much less opportunity to change most envelope components. However reducing outside air infiltration into the building by improving building envelope tightness is usually quite feasible. During renovations to the roof membrane, extra insulation can typically be added to the roof membrane with little difficulty. Windows and insulation can be upgraded during more significant building improvements and renovations.

Thermal Mass

The thermal mass of a building is an effective passive design technique. The thicker the concrete, brick, or stone is on the exterior of the building, the less electricity will be needed by the mechanical system to keep the building cool inside. During warmer parts of the day the exterior of the building slowly absorbs the heat while the temperature stays constant inside. At night when the surroundings are cooler, the heat is released. Keep in mind during a hot summer if the outdoor temperature never gets below 75 or 80 degrees at night, the building may not have a chance to give off the absorbed heat.

You might have experienced thermal mass while walking through an underground parking garage on a hot day. The parking garage was much cooler than the outdoor air, even though no cool air was being pumped into the garage.

Heating & Cooling

In the United States, heating, ventilation and air conditioning (HVAC) systems account for 30% of the energy used in commercial buildings and nearly 50% of the energy used in residential buildings.[4] For commercial buildings the Department of Energy predicts energy use to grow by 1.7% per year until 2025,[5] so cutting HVAC energy use is a good idea. Most buildings have oversized HVAC equipment that has never been optimized.

One campus project reduced its office spaces' electrical consumption by 55% and its natural gas consumption by 85%. The project will reduce energy costs by more than $1M per year and yield a return on their investment in *less than 1 year*.[6] On this project no major HVAC equipment was upgraded, simple monitoring and some design changes produced these impressive results.

It is important to select an HVAC configuration which meets functional requirements while effectively minimizing energy use. In Section I we discussed the integrative project team members and how the size of the HVAC unit could be decreased if the team worked together to optimize the building envelope, orientation, insulation, etc. This saved on the cost of the unit and conserved the electricity needed to power the unit. Using whole building design allows the project team, including the architect and mechanical engineer, to optimize the integrated system for maximum performance and minimum operating costs. The operating costs of HVAC systems are typically much higher than the initial costs, so there is an impressive economic benefit in the form of the system life-cycle cost when all factors are considered. Make a point to address the design early in the planning process and review the progress and any changes throughout the building process.

For existing buildings consider the age of chillers which consume a large portion of HVAC costs. The design team must calculate if it is more cost effective to replace the old chiller with a newer and more efficient model. Older systems weren't designed with sustainability in mind and may have been poorly maintained, leading to higher operating costs. It may also be cost effective to retrofit rather than replace a chiller.

Design

The design and choice of HVAC equipment also has a big impact on Indoor Environmental Quality (IEQ). A poorly designed system can have a negative impact on occupants' health, comfort, and productivity. Have you ever been in an office or room that was too hot or too cold? Some buildings' temperatures are so cold on 90-degree days that workers need to wear jackets and sweaters at their desks. We'll look at this more in the IEQ section.

ASHRAE

Several LEED credits and prerequisites require meeting the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE (pronounced "ash-ray") publishes a widely recognized series of standards and guidelines relating to energy consumption and HVAC systems & issues every three years.

For example, in LEED ASHRAE 90.1 can be used to calculate the baseline building energy performance.

Example: Herman Miller MarketPlace

LEED Rating: LEED-NC Gold
Location: Zeeland, Michigan
Courtesy: Trane, Herman Miller

The goal of this project was to create a prototype office environment that showcases practical applications of Herman Miller products and systems, while serving as a working office for 450 Herman Miller employees during a 40-hour workweek.

The rooftop units have a design that allows the cooling units to operate at 100%, 80%, 60% or 30% of capacity. The rooftops units have two-stage gas heating sections with long-life stainless heat exchangers. The tight building envelope and the gains in internal heat mean that the heating sections operate only for a few hours each year. The rooftop units include a control system that interfaces with the building controls.

Both the rooftop units and the dehumidification modules are important to plant efficiency. This system reduces the necessary size of the rooftop units because they reduce the latent load, or heat produced by removing water from the incoming outdoor air. In this way, Herman Miller could install smaller rooftop units and reduce both first cost and system energy use.

The building design features exposed cabling and ductwork. This was done to facilitate rapid changes in building systems to accommodate future needs.

Air Filters

HVAC systems have air filters to clean impurities from the air and protect the HVAC equipment from dust. Choosing the right air filter and replacing it at regular maintenance intervals will go a long way in saving money. If filters have lower resistance to air passing through them, the system will use less energy to move the air while at the same time also provide better air quality for the building occupants.

Natural Ventilation

If the climate is appropriate, natural ventilation can provide fresh air and regulate indoor temperatures. Natural ventilation is not usually beneficial in hotter climates where the outdoor air temperatures are high for most of the year. In an area such as South Texas where the temperature is routinely 80 degrees or more between March and September the number of opportunities to use cool outdoor air to provide comfort within the building are minimal.. The best uses are where outdoor temperatures and humidity are within comfortable ranges for longer periods throughout the year.

Some systems can have a computer system installed that monitors the outdoor temperature and automatically opens windows for natural ventilation.

Example: Spring Creek Fire Hall

LEED Rating: LEED NC Silver
Location: Canada

Courtesy of: Hughes Condon Marler

Spring Creek Fire Hall is located on a steeply sloped mountainside near the Whistler Ski Resort in Canada. The 6,500 sq ft building consists of three major components: a three-bay truck storage area, a hose/training tower, and live/work quarters. The primary and most visual response to the context and green agenda called for a mountain-like planted roof, which naturally retains excessive storm water and promotes summer cooling.

This building did not require an air conditioning system, and relies on natural ventilation and cooling during the warmer months. An air intake located on the lower level of the tower brings in outside air and creates a natural stack effect for ventilation.

Underfloor Air Distribution

Underfloor heating and cooling, sometimes called "raised flooring," places the ventilation ducts underneath the floor rather than in the ceiling area. These types of systems have been used for many years in Europe and in many data centers in the U.S. Only recently have these systems gained acceptance for commercial applications in the U.S.

Underfloor systems can also improve indoor air quality as clean, conditioned air is delivered directly into occupants' breathing zones.

Many residential buildings, restaurants, and sporting facilities have achieved LEED certification but are not applicable for access floors. In multi-use mixed occupancy and commercial office LEED buildings, raised floors were used in 23% or over 17 million square feet of the LEED-certified projects.[7]

Example: Harvard School of Public Health

LEED Rating: LEED for Commercial Interiors Certified
Location: Boston, Massachusetts
Courtesy of: Tate Access Floors

Harvard School of Public Health (HSPH) was founded in 1922 to advance public health through learning, discovery and communication. Sustainable design goals were recently adopted by the project team and became prime factors in planning the new HSPH facility.

The underfloor air distribution system provides a healthy, productive environment proven to increase indoor air quality, create a more comfortable environment through individually-controlled air diffusers, and contribute to increased productivity. Modular wiring enables the HSPH to reduce the cost of workspace reconfiguration and maintain a facility that can accommodate changing requirements. The design team assumed that the long-term payoffs of the green building approach would far outweigh the initial higher

costs of implementation; however, the total project cost with an underfloor air distribution system turned out to be less than conventional overhead systems.

Efficiencies of Scale

In right sizing, we discuss the right size of one building. In efficiencies of scale the concept means that at a certain size, cost or energy saving can be found. For example a corporate office park or hospital system might benefit from having one overall HVAC system than a separate system for each building. When considering material purchases, perhaps bundling purchases with other LEED projects might allow projects to get bulk discounts on certain green items.

Lighting Design

Lighting is often the largest contributor to a building's energy use, so lighting design and control are critical to reducing energy consumption. Energy is used both to power the lights and provide additional cooling to compensate for the added heat generated by lights. To address these issues early in the design process it is important to determine what kinds of natural and artificial lighting will be used. In some climates the lighting load can be a building's greatest operating expense.

Daylighting, which is the use of natural light in a building, plays a significant role in the amount of artificial lighting that is needed to light the interior of a building. Daylighting will be covered in the Indoor Environmental Quality section.

Light Bulb Choice

Standard incandescent lamps are the light bulbs that you are probably used to seeing in your home. These bulbs are inexpensive to manufacture and have been around for over 100 years. As a result the incandescent lamp is widely used in residential lighting, commercial lighting, portable lighting such as table lamps, car headlamps, flashlights, and for decorative and advertising lighting.

In cold weather the heat from incandescent lamps contributes to building heating, but in hot climates this heat increases the energy used by air conditioning systems.

Incandescent light bulbs are gradually being replaced in many applications by compact fluorescent lamps, high-intensity discharge lamps, light-emitting diodes (LEDs), and other devices, which produce more visible light with less electricity. Some jurisdictions, such as the European Union are in the process of banning the use of incandescent light bulbs in favor of more energy-efficient lighting.

Fluorescent Lamps

Compared to incandescent lamps, fluorescent lamps use less power to generate the same amount of light and generally last longer, but are bulkier, more complicated to dispose of, and more expensive.

Older, linear fluorescent lamps (known as a T-12, the 12 is the diameter in eighths of an inch) should be changed out with newer T-8 or T-5 lamps. The newer lamps generate less heat and consume less electricity. The newer lamps require replacing the ballasts in order for installation; however as we will see in this next example the payback is quick, resulting in tremendous environmental savings.

Example: Kaiser Permanente

Kaiser Permanente, a leading integrated health plan organization headquartered in Oakland, California, wanted to reduce energy costs in six multi-level parking garages at its Los Angeles campus. Kaiser partnered with Monterey Lighting Solutions to devise an energy-efficient lighting system upgrade. The result was a retrofit installing energy efficient fluorescent fixtures that yielded a 67% energy savings.

The retrofit included a one-for-one exchange of its existing canopy lights with Cooper Lighting fixtures. Kaiser's existing fixtures consumed over 188 input watts per fixture drawing over 1.8M kWh annually. With 24/7 operation, the parking garages' annual operating energy costs exceeded $200,000. The new lighting system used only 62 input watts per fixture without sacrificing lighting or security. The lighting system upgrade provided annual energy savings exceeding $130,000 and a payback period of less than 2 years.

Lighting Controls

The lighting controls in a building play a significant role in energy reduction, and in creating a high-performance building. Today's technology goes well beyond the traditional home or building lighting control options of "on" or "off." There are wireless switches that can power themselves, sophisticated software tools that control all of the building's lighting, newer bulbs that light more with less energy, and different types of sensors. There are great lighting solutions for all design budgets. All lighting controls decrease the power demand of lighting, while also reducing the building's thermal load.

Most lights don't just light the room - they also give off some heat. That heat will either help in the colder months by reducing the heating load, or create a need for more cool air in the warmer months. Both issues need to be considered when the project team analyzes the whole building energy use.

Let's look at some of the lighting control options available for your projects.

Photosensors

Strategically positioned photosensors can monitor the amount of natural daylight in a space and adjust the amount of artificial light as needed. In the rooms that have adequate lighting during the day, photosensors would detect that no artificial lighting is needed.

Photosensors automatically adjust the light output of the fixtures based on the level of illumination detected. While some photosensors just turn lights off and on, others can also dim lights, yielding even greater savings.

Timers

Lighting that is set to a timer can be controlled to turn on and off at a specific time. Automatically turning off lights in unoccupied areas is a great energy saver. For example, in an academic building, turning off all of the lights in the classrooms one hour after the last class ends and turning them on one hour before the first class begins can save significant energy and lighting costs throughout the night. Timing the lights to stay off during the weekends, holidays, and when school is not in session further reduces costs. Don't forget that these systems need some type of manual override. In an office application it may be common for some people or groups to have to work late into the evening, and they will need to see what they are doing.

Occupancy Sensors

Superior to timers, occupancy sensors ensure that lights are turned off when occupants leave. There is no more concern about manually turning off the lights or using timers with automatic shutoffs. If no motion is detected in an area, an occupancy sensor can turn off the lights. Occupancy sensors can also be tied into other parts of the building to adjust heating and cooling systems when occupants are not present, further reducing energy use.

Advanced Controls

Advanced lighting controls are centralized, facility-wide control systems designed specifically for energy management applications. Such systems are generally integrated with a facility's information technology networks and provide addressability and control down to an individual light. It's now possible to integrate lighting control systems with other building automation systems.

Example: South Middle School

South Middle School, part of Arlington Heights School District #25 in Arlington Heights, IL, needed to find a way to offset rising electricity costs and demand associated with a new HVAC system. An integrated solution was used that combined occupancy sensing, daylight dimming and manual control to help reduce energy costs and adequately light the interior of a building. This topic will be covered in the Indoor Environmental Quality section.

Appliances

Choosing ENERGY STAR appliances further reduces energy use, and it is easy to find ENERGY STAR appliances that cost no more than comparable appliances.

ENERGY STAR labels appear on appliances, home heating and cooling systems, home electronics, lighting, personal computers, home office equipment, and new homes. The energy efficiency criteria have been established by the U.S. Department of Energy and U.S. Environmental Protection Agency.

Average refrigerators need 20% savings over the minimum standard to earn the ENERGY STAR label. Dishwashers need at least 41% savings. Most appliances, as well as heating and cooling systems, have a yellow EnergyGuide label comparing the annual cost of operation to that of other models.

Appliances can also harm the environment through leaking refrigerants. Keeping the leakage rate to a minimum on all appliances should be a goal of LEED buildings. Leakage rate describes how appliances lose their refrigerant charge over a 12 month period as a percentage of the appliances full charge.

Building Automation System

A building automation system (BAS) can help reduce energy use by monitoring and regulating the many systems in a building. A BAS is computer based monitoring system that allows managers to optimize how systems function. These systems can be very specific. Systems can call managers if a fire alarm goes off or if a retail store might be having a break in. Real estate property managers can evaluate temperatures within buildings and evaluate if a warehouse is getting too cold or too warm. The key is that all systems tie into one monitoring program – more information gives those making the decisions a real time view of what is happening in a building or series of buildings.

Net-Zero Energy

Net-zero energy projects use no more energy from the electrical grid than can be produced from on-site renewable energy systems. An example of this strategy is Wisdom

Way community in Greenfield, Massachusetts. Each of the 20 environmentally friendly homes are near zero net energy for low- and middle-income home-owners. The Wisdom Way community offers a range of homes from 1,140 sq. ft. with two bedrooms to 1,773 sq. ft. with four bedrooms. The homes are rectangular with double-wall construction and dense-blown and loose cellulose insulation. Each home utilizes solar-water heating and photovoltaic solar power, which generates from 2.8 to 3.4 kilowatts. Two of the homes are fully accessible for residents with physical disabilities. Wisdom Way's homes are so well insulated that even the smallest boilers and furnaces available produced too much heat. Hence, each home is heated by a small natural gas space heater (12,000 BTU) on the first floor.

Use Renewable Energy

Renewable energy is energy that is naturally replenished and generated from natural resources—such as sunlight, wind, water, biofuel, and geothermal heat.

Because it is impossible to "run out" of renewable energy, these energy sources are much more sustainable and environmentally beneficial than fossil fuels. The ecological impacts are also significantly less than fossil fuels. The upfront costs of on-site systems are usually a significant investment, but over the life cycle of the building, the costs are significantly less than using power supplied by fossil fuels.

Renewable energy for LEED projects can come from either on- or off-site sources. First we will look at on-site sources of renewable energy and then at off-site sources.

Solar Power

Solar power is a clean and renewable way to generate electricity by harnessing the power of the sun. Solar technologies are broadly characterized as either passive or active, depending on the way they capture, convert and distribute sunlight. Active solar techniques include the use of photovoltaic panels or solar thermal collectors (with electrical or mechanical equipment) to convert sunlight into useful outputs. Passive solar techniques include orienting a building to the sun and selecting materials with favorable thermal mass or light dispersing properties.

Active Solar

Active solar technologies are employed to convert solar energy into usable direct light and heat, cause air-movement for ventilation or cooling, or store heat for future use. The most widely used active solar technology is photovoltaic (PV) modules. PV technology uses solar cells to convert sunlight directly into electricity. This kind of solar technology has no moving parts to wear out, provides clean non-polluting energy, and is quiet.

Typically, an array of PV modules is incorporated into the roof or walls of a building. Roof tiles with integrated PV cells can now be purchased. Arrays can also be retrofitted onto existing buildings; they are usually fitted on top of the existing roof structure. Alternatively, an array can be located separately from the building but connected by cabling to supply power for the building.

Example: Jacuzzi Vineyard

LEED Rating: Non-LEED Project
Location: Sonoma, California
Courtesy of: Mitsubishi Electric

On February 22, 2008, the Jacuzzi Family Winery began generating clean energy from its new 124kW solar electric system. The solar system provides electricity needed for the watering, fire, and processing systems.

The Mitsubishi solar system will produce an estimated 185,130 kWh annually. By choosing solar energy, the system will keep nearly 98 tons of harmful greenhouse gases from entering the environment annually (2,940 tons over the life of the system). Over the next 30 years, the air pollution saved will be equivalent to the amount generated by driving 6 million miles.

The entire solar electric system is expected to pay for itself in six years. By taking advantage of the federal tax credit, California state rebates, and accelerated depreciation, the vineyard was able to reduce the total system cost by nearly 75%.

Solar Thermal Systems

Solar powered water heaters may be used to heat water for residential, business and industrial uses. Heating swimming pools, underfloor heating, or energy input for space heating or cooling are more specific examples. This technology should be considered when the project site has a predictable and continuous hot water load.

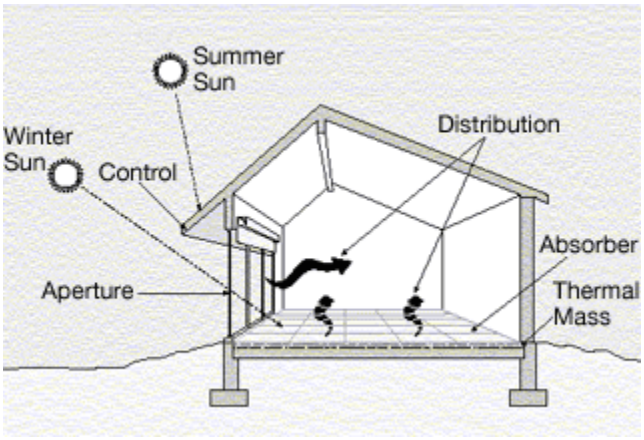
Solar thermal systems are generally composed of solar thermal collectors and a fluid system to move the heat from the collector to its point of usage. The system may use electricity for pumping the fluid and have a reservoir or tank for heat storage and subsequent use.

In many climates, a solar heating system can provide up to 85% of domestic hot water energy.[8]

Passive Solar

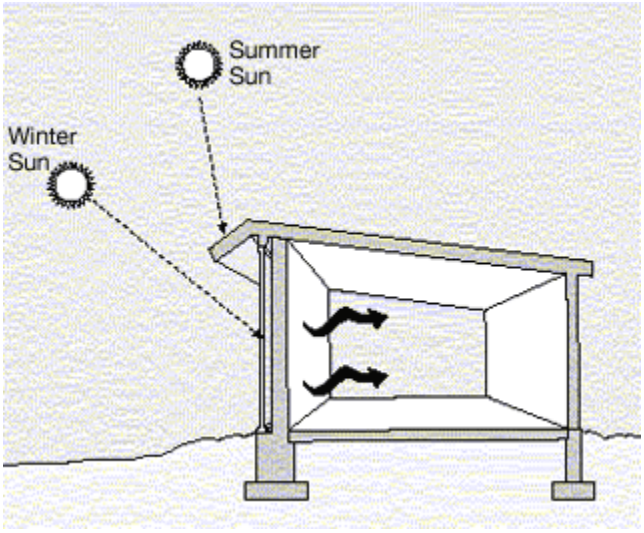
Passive solar design uses the structure's windows, walls, and floors to collect, store, and distribute the sun's heat in the winter and reduce a building's energy demand for cooling in the summer. When these features are tailored to the local climate and environment they can produce well-lit spaces that stay in a comfortable temperature range.

Incorporating passive solar design elements into buildings and homes can reduce heating bills by as much as 50%.[9]



Courtesy of DoE

In this illustration a simple roof overhang blocks out the sun during the summer when the sun is higher in the sky. During the winter when the sun is lower on the horizon, the sun's rays can enter the building and provide warmth, offsetting heating costs.



Courtesy of DoE

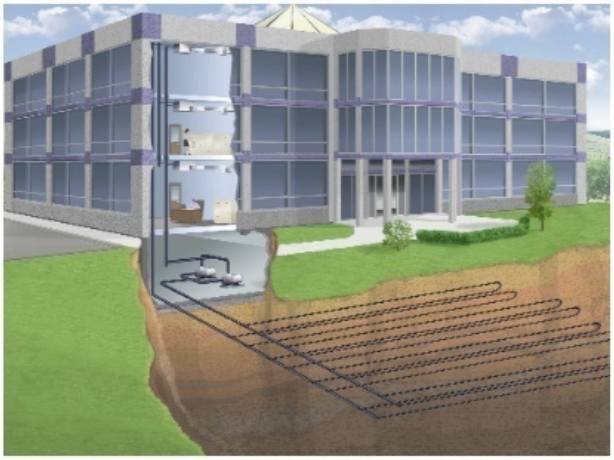
Passive solar and geothermal strategies are encouraged by LEED but not allowed as a percentage of renewable energy used. These techniques will reduce the amount of energy needed on a project, but the team will have to use other sources of renewable energy if it wants to earn a point for using on-site and off-site renewable energy.

Geothermal Heat Pumps

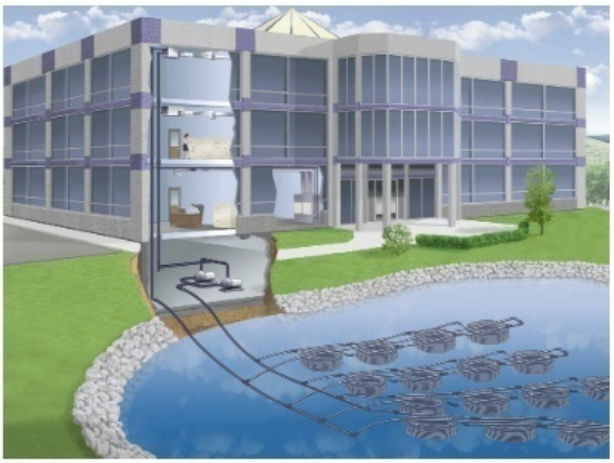
A geothermal heat pump system is a heating and/or cooling system that uses the earth´s ability to store heat in shallow ground or water thermal masses.

Geothermal heat pumps are also called GeoExchange, earth-coupled, ground source or water-source heat pumps.

Geothermal heat pumps draw energy from shallow ground, that is, the upper 10 feet (3.0 m) of Earth's surface. The energy in this layer of ground originates from the constant stream of solar energy to the Earth. Despite the name, the energy does not come from the center of the Earth. Genuine geothermal energy from the center of Earth is available only in places where volcanic activity comes close to the surface.



Example of a horizontal loop system

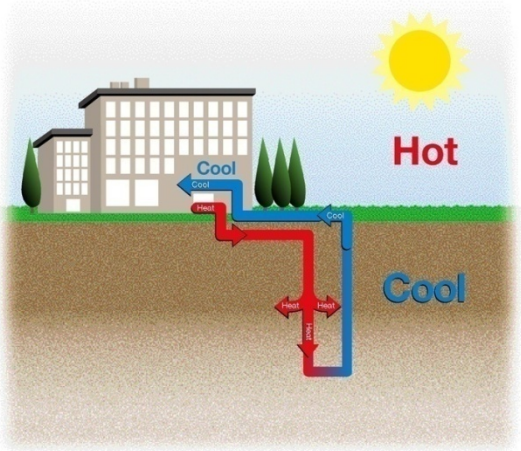


Example of a pond loop system

Courtesy of McQuay

Cooling

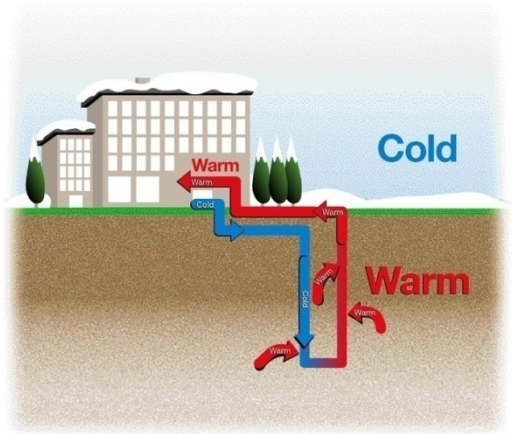
In the cooling mode, the Earth acts as a heat sink enabling the circulating fluid to transfer the excess heat, absorbed by the unit, from the building zones to the ground where it is absorbed and stored for future heating requirements.



Courtesy of McQuay

Heating

In the heating mode, the Earth acts as a heat source, allowing the circulating fluid to extract natural heat from the Earth and transfer it to the space where it can be used for heating.



Courtesy of McQuay

Compared to a conventional heating or cooling system, Geoexchange systems use 25%–50% less electricity. The system costs are returned in energy savings in 5–10 years. According to the EPA, "Geothermal heat pumps can reduce energy consumption—and corresponding emissions—up to 44% compared to air-source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment. GHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GHPs very effective in humid areas."[10]

Geoexchange systems do not require chillers, cooling towers, or boilers, and the closed loop water circulating system requires very little maintenance. System life is estimated at 25 years for the inside components and 50+ years for the ground loop. Approximately 50,000 geothermal heat pumps are installed in the United States each year.[11]

Example: Whitmore Lake High School

LEED Rating: LEED for New Construction Silver
Location: Ann Arbor, Michigan
Courtesy of: McQuay

Whitmore Lake High School has a geoexchange system for heating, ventilating and air conditioning (HVAC) using 67 McQuay water source heat pumps. The 430-ton HVAC system delivers conditioned air to classrooms and other spaces, reducing energy costs by 38% compared to a 2004 base line energy model.

School officials wanted to minimize operating costs – especially as the cost of natural gas began to rise during the planning stages. The school board recognized that any additional first costs for the geoexchange system would be offset by the savings in energy costs. As a result of the board's foresight, the school saves about $80,000 per year in operating costs. In the first year alone, that was more than double the added cost to construct the geoexchange system versus a conventional HVAC system.

Off-Site Renewable Energy

Off-site renewable energy, often called "green power" or "clean power," comes from sources such as wind farms, solar power, hydroelectric, and geothermal third-party sources. Green power is considered better for the environment because of the reduced carbon emissions during generation or collection that result in less pollution.

Purchasing Off-Site Renewable Energy

Consumers and businesses have several ways to obtain green power:

1. Purchasing green power directly from the power provider
2. Purchasing green power indirectly from the power provider
3. Purchasing green certificates

Direct purchasing

In areas where electricity markets are open, consumers can purchase their power directly from a green power provider. Even though only one set of electric lines comes into the home or building, the supplier of that electricity can be selected in some markets. This is similar to the telephone market which was deregulated years ago, where consumers can select which telephone carrier they want to use.

Indirect purchasing

In areas where electricity markets are closed and customers must purchase the power provider assigned to their area, customers can sometimes elect to pay a small premium to the utility company so that the power the utility company purchases comes from a green source. This is also called "green pricing."

When energy is purchased from the electricity network, the power reaching the consumer will not necessarily be generated from green energy sources. The local utility company, electric company, or state power pool buys its electricity from electricity producers that may be generating from fossil fuel, nuclear or renewable energy sources – but green power is still hitting the grid because of your purchase.

When the consumer decides to purchase green energy indirectly, the consumer joins the utility provider's green pricing program. By joining, the consumer obligates the utility provider to increase the amount of green energy purchased for the energy pool and this decreases the amount of non-green energy the utility provider purchases. Since not all utility providers have a direct purchase program, an indirect purchase of green energy still supports energy from renewable sources and the companies that provide it.

Renewable Energy Certificates

Renewable Energy Certificates (RECs) represent the environmental attributes of electricity produced from renewable energy sources sold separately from commodity electricity. Commodity electricity is electricity that is sold without regard to how it is produced and is sold at the same price no matter what its origin.

RECs can be purchased regardless of whether your utility provider is supplying direct or indirect green power. RECs do not require switching power providers. RECs represent the environmental value of renewable energy generated, and stimulate the development of renewable generation sources. In the United States they constitute proof that 1 megawatt-hour (MWh) of electricity was renewable (generated from an eligible renewable energy resource). The certificates can be traded separately from the energy produced.

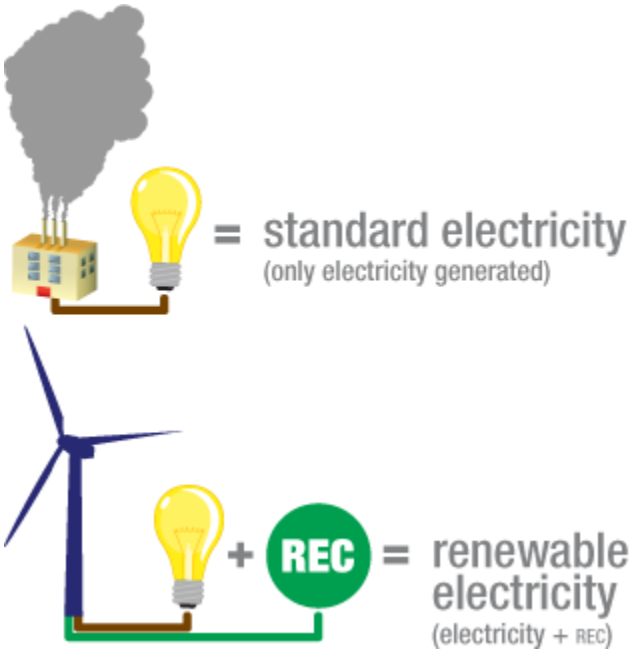
Green certificates are also called *Green tags*, *Green Certificates* or *Tradable Renewable Certificates (TRCs)*.

"When a renewable energy facility operates, it creates electricity that is delivered into a vast network of transmission wires, often referred to as 'the grid.' The grid is segmented into regional power networks called pools. To help facilitate the sale of renewable electricity nationally, a system was established that separates renewable electricity

generation into two parts: the electricity (or electrical energy produced by a renewable generator) and the renewable 'attributes' of that generation. (These attributes include the tons of greenhouse gas that were avoided by generating electricity from renewable resources instead of conventional fuels, such as coal, nuclear, oil, or gas.) Since the energy is sold to whomever receives it, the renewable ("green") attributes are sold separately as (RECs)."[12] So the REC does not mean you purchase that hour of power, since you are already purchasing the power you need from your utility company, but the REC is purchasing the benefits from the renewable energy that has been created. This encourages renewable energy generation even if a project is not able to directly use the green energy. RECs have no geographic constraints, because they are sold separately from electricity. A project in Maine can purchase RECs from any other state.

Green-e Energy is the nation's leading certification program for renewable energy. LEED typically recognizes renewable energy if it's been certified by the Center for Resource Solution or meets Green-e requirements.

Green-e certifies renewable electricity products that meet the program's strict environmental and consumer protection standards. For example, Green-e certifies only "new" renewable energy from facilities put online since 1997 and does not certify renewables that were mandated by government. Consequently, companies know their dollars are making a real difference. Green-e also requires electricity providers to disclose information about their product to their customers in a standardized, easily comparable format.



Courtesy of Green-e

Example: Whole Foods

LEED Rating: Non-LEED Project
Courtesy of: Whole Foods

Whole Foods Market made a landmark purchase of renewable energy credits from wind farms in December 2005 to offset 100% of the electricity used in all of its stores, facilities, bake houses, distribution centers, regional offices and national headquarters in the United States and Canada. This purchase of more than 458,000 MWh per year of wind energy credits is the largest corporate purchase of RECs or green power in the history of the United States and Canada, making Whole Foods Market the only FORTUNE 500 Company purchasing RECs to offset 100% of its electricity use.

With this record purchase, Whole Foods Market avoided generating more than 700 million pounds of carbon dioxide pollution in 2006. To have the same impact, more than 60,000 cars would have to be taken off the road or over 90,000 acres of trees would have to be planted.

Carbon Offsets

Carbon offsets help allow a building owner to contribute money to organizations that decrease carbon emissions. Carbon offsets are credits for reductions in greenhouse gas emissions made at another location, such as wind farms which create renewable energy and reduce the need for fossil-fuel powered energy.

A carbon offset is a unit of carbon dioxide equivalent that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere. Carbon offsets are quantified and sold in metric tonnes of carbon dioxide equivalent (CO_2e).

Common Types of Off-Site Renewable Energy

Wind Energy

Wind energy comes from wind turning turbines that generate electricity. Wind turbines are constantly being improved, and there is a lot of investment and support for expanding wind energy. Wind energy is healthy for the environment, but has some negative issues. Wind is not always constant, but customers demand continual power so wind systems need a backup power supply. Wind energy must be transported from windy areas to the places where it is needed. Installing the large turbines and transporting the power has caused some “not in my backyard” responses from local residents who are being asked to allow turbines or power lines near their homes.

Hydro Energy

Hydro energy comes from water running downwards from lakes or streams. Canada is the highest user of hydro energy – mostly from hydroelectric dams - and the United States is second.[13] Like most forms of energy, hydro energy has positives and negatives. The advantage is that it is very clean and usually costs less than processing fossil fuels. The downside is that dams must be built which can disrupt the ecosystems in the local environment.

Biofuel

A biofuel-based electrical system creates energy from renewable biological sources such as woodchips or agricultural waste – this material can be called biomass. Biomass is plant material that can be converted to heat to produce electricity. For the requirements of LEED, biofuels include untreated wood waste (e.g., mill residues), agricultural crops or waste, animal waste and other organic waste, and landfill gas.[14]

Wave and Tidal Power Systems

Google made news when it patented "water-based data centers." Running servers and keeping them cool requires a tremendous amount of power. Google's data centers would gain energy from Pelamis Wave Energy Converters that create power from the motion of ocean waves.

Waves and tides are natural and recurring motions. This motion can be harnessed to create electricity.

Ongoing Performance

In the beginning of this section, we discussed finding your target energy use. Since then we have discussed many strategies for achieving your target by reducing energy use and using renewable energy. Now, how do you go about figuring out what the best design is for a project and if you will reach the target? Another useful piece of software is the energy modeler. Whole building analysis can be done with software for building energy analysis and design. These software tools take inputs and determine the energy behavior of a building's systems over time (even down to the hour of the day). Performing an energy analysis early in the design phase of a project allows the project team to select the most efficient and cost effective systems for the building and see how the interrelated systems can achieve maximum benefits.

Goal Verification

For new construction a comprehensive commissioning process is essential to reduce energy use. For an existing building a recommissioning process is essential. Commissioning is the process of verifying that the building's energy related systems are

installed, calibrated, and performing according to the project and owner's requirements. Commissioning is a prerequisite in many LEED rating systems. The project team must make sure the building is functioning as intended based on the design. It is easy to think that because something was included in the specifications that it was implemented and installed correctly. However, even if the project was perfectly designed and the goals set, the project teams need to make sure the systems function and deliver the desired performance.

A retrocommissioning cycle for Existing Buildings is "a systematic process for investigating, analyzing, and optimizing the performance of building systems by improving their operation and maintenance to ensure their continued performance over time. This process helps make the building systems perform interactively to meet the owner's current facility requirements."[15]

Recommissioning is an important part of the commissioning cycle. It applies to buildings that have been commissioned before, because one commissioning is not enough. Over time systems can get out of their optimal setups and may require maintenance. Preventative maintenance, which is routinely scheduled inspection, cleaning, or repair, will also help keep systems in order and save energy.

It is estimated that as much as 20% of the energy used in an average commercial building is wasted due to poorly commissioned systems.[16] This is why commissioning is both critical and required by LEED – to ensure that the whole-building design process results in the building operating as designed.

Building systems can underperform for several reasons:

- The building was not properly configured
- The design did not account for all sources of building efficiency
- The building is not properly maintained
- Poor employee training
- The use of the building has changed over time

Case Study: Dockside Green

Energy Performance Designed to Save

The buildings at Dockside Green are designed to use 45-55% less energy than the Canadian Model National Energy Code. This save residents money while reducing harmful, greenhouse gas emissions.

Energy Efficient Appliances

Investment in Energy Star efficient appliances resulted in an average 47% energy saving over the Canadian Model National Energy Code base energy rating for appliances. The high end, energy efficient, front-loading washers and condensing dryers not only save energy but operated quietly and protect clothes from the damage of over-drying.

Energy Efficient Lighting

The project uses compact fluorescent lighting, LED lighting in corridors, occupancy sensors and some solar lighting in landscape areas to reduce electrical costs from lighting. The design allows for an abundance of daylight into each building.

Metering

Meters are provided in each suite to measure:

- Domestic hot and cold water use
- Heating bills
- Electricity usage

The meters provide real time information to residents on their energy usage allowing them to make personal adjustments to save money.

Measurement and Verification

Dockside Green will provide environmental reports that measure actual results against projected targets, outline accomplishments and identify areas for improvement.

Commissioning

There are numerous studies that show noncommissioned buildings are generally 5 to 15% less energy efficient because systems were not fine tuned and/or parts were incorrectly installed or not working properly.

The project will retain the services of an independent commissioning agent to verify that mechanical systems are designed and working properly upon construction completion. The commissioning agent will revisit the building within a year of occupancy to recommission the mechanical systems to ensure they are working properly.

BioMass Heat Generation

Rather than burning wood waste, the project will use a thermochemical gasification process to create a synthetic gas that will be burned to produce heat. The input "chemicals" for thermochemical gasification - wood, water and air - are heated in a low-

air environment until the wood undergoes gaseous decomposition. The resulting gaseous products are then scrubbed and cleaned and burned to produce heat for a heating water boiler. The boiler will supply the majority of Dockside heating requirements with some peak load supplied by the backup/peaking gas boilers.

No smoke is produced in the process- just green energy and clean, odorless flue gases. To avoid noise disturbances, the gasification plant and the engines will be housed in an acoustically isolated building and the entire system will be backed up by Natural Gas boilers.

Individual buildings will be charged for heat generated by the system for heating and domestic hot water needs. Heat will also be sold to off-site customers displacing natural gas use.

Greenhouse Gas Neutral

Though not required for LEED Dockside Green is attempting to become Greenhouse Gas Neutral, or having no net emissions from a building energy perspective. The main contributor to this goal is the use of the biomass heat generation process.

Renewable Energy

Besides the biomass heat generation, the project will also incorporate other renewable energy sources within the community, such as solar water heating and photovoltaic power, with a strong emphasis on working with local and Canadian-based suppliers.

Key Terms

active solar strategy
ASHRAE 90.1
biofuel-based electrical systems
biomass
building automation system (BAS)
building envelope
CFLs
Chlorofluorocarbons (CFCs)
commissioning cycle
demand response (DR)
demand response (DR) event
energy audit
ENERGY STAR® rating
ENERGY STAR Portfolio Manager
environmental attributes of green power
EPA Clean Air Act
existing building commissioning or retrocommissioning
fundamental refrigerant management
geothermal energy
geothermal heating systems
Green-e
green power
GWP
Halons
hydro energy
Hydrocarbons (HCs)
Hydrochlorofluorocarbons (HCFCs)
Hydrofluorocarbons (HFCs)
leakage rate
load shedding
Montreal Protocol
natural refrigerants
natural ventilation

ODP

offsite renewable energy

ongoing commissioning

onsite renewable energy

ozone

ozone depletion

passive design

passive solar strategy

peak demand

phase-out plan

photovoltaic or solar energy

preventive maintenance

recommissioning

refrigerants

renewable energy

Renewable Energy Certificates (RECs)

simple payback

solar thermal systems

wave and tidal power systems

wind energy

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Chapter 7 – Materials and Resources

Sustainable materials are materials that reduce demands on ecosystems during their life cycle. This includes the materials' processing – such as harvesting and production – and the entire product life cycle through use and disposal. Conventional building construction and operation consumes large quantities of wood, water, metals, and energy from fossil fuels.

Sustainable buildings impact the triple bottom line through the use of materials in these primary ways:

- Reducing waste
- Building with environmentally preferable materials
- Creating a sustainable purchasing program

In this section, we will discuss the types of materials that should be considered for a high-performance building and how to reduce the life-cycle impacts of those materials.

Keep in mind that products and materials cannot be LEED certified – they can only help projects earn LEED points.

In the IEQ section we will look at how we want these products to avoid toxic or other harmful emissions.

Conservation of Materials and Waste Management

Waste management provides a way to protect the environment and conserve resources for future generations through a systems approach that seeks to reduce materials use and their associated environmental impacts over their entire life cycles, starting with extraction of natural resources and product design and ending with decisions on recycling or final disposal.

Reducing waste is an integral factor to improving the environment during the building process and after occupation. In this section several strategies to reduce waste are described.

Construction Waste Management

In 1996, 136 million tons of construction & demolition (C&D) debris was generated – 57% by non-residential construction[1]. Most of this waste could have been recycled,

thereby reducing the demand for virgin materials. Waste reduction by recycling C&D debris can also turn a cost into a savings for builders. Instead of paying haulers to dispose of C&D debris from a job site, the materials can be sold to a recycling facility, or given to a recycling facility in exchange for free hauling.

There are more than 6,000 centers around the country that run specialized programs for reusing building materials. These programs are run by groups such as Goodwill, the Salvation Army, and Habitat for Humanity[2] and include using unneeded materials in schools.

Reducing waste that would otherwise be disposed of in landfills or incinerated can be done during construction and post occupancy. A significant amount of waste is generated during the construction process. In the home building process, if a 7'6" board is needed and the carpenter has an 8' board, the extra 6" goes to the dump. When materials arrive at a job site wrapped in cardboard and plastic, the cardboard and plastic are thrown into a big dumpster and sent to a landfill. There are tons and tons of construction, demolition and land clearing debris (CDL) generated that have value:

- Brick
- Metal
- Wood
- Carpet
- Wallboard
- Glass
- Plastic
- Cardboard
- Lighting accessories
- Top soil
- Fill dirt
- Rock

For LEED, excavated soil and hazardous waste are not counted towards construction waste management calculations. Doing so skews the percentage of waste diverted since these materials can add significant weight/volume to the quantities.

Recycling opportunities vary from region to region. Some cities have well established recycling programs that make recycling easy. LEED buildings in Dubai, Alaska, Hawaii, and other places may not have a recycling infrastructure in place. Furthermore, the types

of materials accepted vary by location, so be sure to find out what can and cannot be recycled before embarking on a CDL plan.

Before construction begins, a construction waste management plan should be developed that identifies potential waste streams and where waste diversion can be put in place – salvage this waste, reuse it, and recycle it. If the waste can be taken out of the building and reused elsewhere, it avoids waste disposal in landfills and incinerators. Be sure the plan is actually put into practice and that the team tracks the waste through reports from the waste haulers to check that the waste management plan is actually working.

The next best option would be to send the waste back through a recycling program, where it would be ground up and used in a manufacturing process to make new material. The better the plan and execution, the less material ends up in landfills. Contractors and waste haulers may accomplish this in a couple of ways. One option is having on-site separation where the site has a series of dumpsters. The general contractor is responsible for policing the subcontractors to get the various recyclable wastes into the right places. This option is better if the specialty contractors follow the rules and the dumpsters can be monitored.

Comingled Recycling

A more common method is to send the waste in one container to a facility where it can be separated into different recyclable components. This process is called comingled recycling. Comingled recycling requires less space, because only one container is needed. Additionally, people are more likely to recycle because it is easier to throw materials into one container than to sort them out and place them in the correct recycling bin. Research shows participation and recycling levels increase when sorting is not required. Commingled recycling is more efficient because collection trucks can hold more materials in a single load.

Solid Waste Management Hierarchy

Because no single waste management approach is suitable for managing all waste streams in all circumstances, EPA developed a hierarchy ranking the most environmentally sound strategies for municipal solid waste. The hierarchy places emphasis on reducing, reusing, and recycling the majority of wastes.

- *Source reduction* is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount or toxicity of trash created.
- *Reuse* stops waste at its source because it delays or avoids that item's entry into the waste collection and disposal system.

- *Recycling* converts materials that would otherwise become waste into valuable resources.
- *Waste-to-energy* is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, anaerobic digestion, and landfill gas (LFG) recovery.

Source Reduction

According to the EPA, source reduction has the greatest impact on reducing waste because it begins at product design. Source reduction ties into environmentally preferable purchasing. This means buying "products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose".[3]

The comparison of these products applies to raw materials, manufacturing, packaging, distribution, use, reuse, operation, maintenance, and disposal.[4]

Environmentally preferable products are:

- Recyclable
- Energy efficient
- Low in embodied energy
- Low in toxic substances or have none
- Characterized by reduced packaging
- Water efficient

Keep these goals in mind when purchasing furniture, fixtures, and equipment – which includes lamps, electronics, etc for the project.

While LEED has no product certification to indicate which products are environmentally preferable, the discussion on sustainable materials in this section has requirements for the make-up of products that contribute to earning LEED credits.

Use Less Material

A simple way to reduce material use is to design using less material in the first place.

- Make the project building or house smaller
- Make the neighborhood more compact
- Place the office building in a dense area

- Ensure projects have flexible space so new space doesn't need to be added as activities change over time

Projects can use more modern framing techniques that are as safe as older techniques but spaces studs further apart or uses structural insulated panels that include the framing and insulation in one piece. Of course, observe local codes first.

Use less material can also apply to ongoing operations as well. We will discuss that in the next section.

Example: Allsteel Resource Center

LEED Rating: LEED for Commercial Interiors Certified
Location: Boston, Massachusetts
Courtesy of: HOK

HOK designed a resource center for the office furniture company Allsteel in Boston. In addition to displaying products, the showroom serves as a meeting place for architects, designers, and real estate and facility management professionals.

To conserve materials, a large portion of the showroom space has no suspended ceiling. Where ceilings are used, they have mostly been manufactured locally and are lighter (fewer raw materials) than standard acoustical tiles and drywall.

So eliminating drop ceilings is one easy way to reduce materials. In retail or office areas, polishing, stamping, and staining the concrete eliminates the need for flooring materials and flooring installation.

Reuse – Buildings

Adaptive reuse refers to the process of reusing an old site or building for a purpose other than which it was built or designed for. Along with brownfield reclamation, adaptive reuse is seen by many as a key factor in land conservation and the reduction of urban sprawl. Adaptive reuse can also refer to the design of a new building with consideration to what it could be used for in the future. For example in the design of an office building, could the walls be designed to more easily accommodate apartments in 20 years?

Existing buildings make up 99% of building stock. In dense urban areas, there may be plenty of opportunities to find a property that can be upgraded into a high-performance building. The costs of major renovation can be offset by reduced construction and materials cost of a new shell. The environment benefits through the reduction of raw materials needed for a brand-new building.

Cities such as New York City or Boston, where the downtown is already built out, and old historic districts offer many opportunities to take advantage of existing buildings. Consider reusing:

- Envelopes
- Interior/exterior walls
- Ceilings
- Flooring
- Roofs
- Framing

Example: SmithGroup

LEED Rating: LEED for Commercial Interiors Registered
Location: San Francisco, California
Courtesy of: SmithGroup

SmithGroup's vision for a new office was transforming an 83-year-old San Francisco landmark building into a progressive and high-performance facility.

The finished space serves as a showpiece for innovative design strategies, reflecting that sustainable design can be beautiful. A two-story interconnecting stair, which embodies the spirit of the office, allows visual connectivity between floors and encourages collaboration. Exposed original brick walls, steel beams, and concrete floors respect the building's historic past while creating an aesthetic ambience that sets the tone for the office design.

Reuse – Salvaged Materials

Reused materials do not become waste, so they don't end up in landfills. Reusing materials can also be considered a way of reducing waste; however, reused materials have their own strategies.

Salvaged, refurbished, and reused materials can all contribute to reducing the demand for virgin materials. The Greener Building 2008 Impact Report stated, "We evaluated the environmental impacts of materials reuse in terms of savings in embodied energy, concluding that materials reuse in LEED buildings has saved the equivalent of 70,000 barrels of oil, a number that will grow to nearly 800,000 barrels equivalent by 2020."

Potential ideas for using salvaged materials include:

- Salvaged brick used for walkways

- Salvaged wood for flooring, cabinets, desks, design features, etc.
- Salvaged tiles
- Salvaged doors

Some people confuse reused materials with recycled materials. One way to think about reused materials is to ask, 'Is the material being used in a similar fashion to the way it was used in its original life?' For example, if timber from an old timber-framed building is being used for framing, or bricks are being reused again as bricks, then this is salvaged or refurbished material. Adaptive reuse of materials changes its future use from its past use. Think about how the material was used in its original form vs. the new form.

LEED does not encourage the reuse of windows or window glazing because older exterior windows/glazing are energy inefficient. Older plumbing fixtures should also not be reused because they have higher water demands.

Example: Office Furniture

Embodied energy is a term that describes all the energy it took to create a product. An example is office furniture made from refurbished products; this can cut costs and help the environment. New cubicles, desks, etc, consume a lot of energy for production, and can use a lot of raw materials. The re-use of existing office furniture eliminates these concerns while simultaneously extending the lifespan of the furniture and diverting it from the waste stream. Office furniture, especially cubicles and partitions, generally don't have a lot of wear and tear, and once refurbished can look like new. Ultimately, buying used or refurbished office furniture has a lower environmental impact and can save on costs. The energy savings from remanufacturing one office workstation (five panels) could power 10 average American households for one whole day.[5]

On a project for Fleet Bank, the recycling and reuse of Fleet's existing assets resulted in a savings of over $500,000 for the furniture portion of the project.[6]

The act of recycling is different than using recycled materials in construction. We discuss this later in this section.

Waste-to-Energy

Waste-to-energy is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery.

Energy recovery from waste is part of the non-hazardous waste management hierarchy. Converting non-recyclable waste materials into electricity and heat generates a

renewable1 energy source and reduces carbon emissions by offsetting the need for energy from fossil sources and reduces methane generation from landfills.

Renewable energy sources such as wind, biomass, and solar can be used to supplement coal and oil to produce energy. The carbon dioxide (CO2) emissions associated with combustion of plant or animal-based products (paper and forest products, yard trimmings, food discards) are considered to close the loop in the natural carbon cycle.

Regions of the world where populations are dense and land is limited (e.g. many European countries, Japan), have greater adoption of combustion with energy recovery due to space constraints. Combustion facilities operate in conjunction with air emission standards.

Maintain Occupancy Rates

If you haven't had any experience in what happens with leasing companies that deal with office space, here is a typical example: A new tenant comes in looking for a certain amount of space. In a new building the space typically doesn't have walls or offices installed yet, because the tenant decides where the offices and walls will go. If the tenant leases 5,000 square feet, he/she might ask for six offices, two conference rooms, a kitchen, etc. A contractor builds out that space according to the tenant's specifications. If the space has been previously leased out, the new tenant may ask for walls to be torn down, new walls to be put up, and any number of things to be re-arranged. All of these changes are negotiated as part of the lease agreement.

If a building tenant moves to a new location every five years, a new space will most likely have to be built out in the new location, and the tenant who moves into the old space will probably want changes to the floor plan layout as well. All of the moving and updating of the interior spaces consumes materials and energy. Tenants who stay in one location for a long time have the effect of causing less energy to be expended on building changes. If a tenant commits to a 10-year lease, instead of a five-year lease, or the property manager is able to provide a great building experience so tenants stay in the building, then the property owner will reduce all issues related to any space changes by half. Construction debris, indoor air quality, inconvenience for existing tenants, increased energy costs, etc., will all be significantly reduced. Encouraging occupants to maintain their leases for longer periods is another way to impact the triple bottom line.

Environmentally Preferable Materials

Sustainable designs should give preference to materials that reduce environmental impacts over their life cycle. We will cover several different product attributes that LEED uses to define a sustainable material. In the LEED rating system, specific products

do not contribute to earning project points – it is the sustainable attributes of the product that LEED considers.

For example, consider a project being built in Boston. ABC Company obtains glass from the Boston recycling plant and turns the glass into countertops, where the countertops consist of 75% recycled content. The entire countertop is not necessarily a sustainable product, but the 75% recycled content in the countertop contributes towards the recycled materials LEED encourages projects to use.

Products that have the ISO 14000 environmental labels are intended to encourage the demand for and supply of products that cause less stress on the environment.

Materials found in the Construction Specifications Institute (CSI) Divisions 3-10 are counted in the materials' credits for LEED.

In LEED, furniture for the project can be counted if the furniture is included in all of the Materials and Resources credits.

Life Cycle Assessment / Life Cycle Costing

Life cycle assessment (LCA) is a measurement of a product's environmental impact throughout its life cycle, beginning with extraction through manufacturing, shipping, use, and then reuse or end of life. The goal of LCA is to compare the full range of environmental and social damages assignable to products and services and to be able to choose the least burdensome ones.

Some companies offer software programs or websites where materials or services can be evaluated according to their life cycle analysis, thereby providing a comparison of the environmental impact of materials.

Additionally, while performing a life cycle assessment it would be valuable to perform life-cycle costing (LCC). LCC determines the cost of a product or system over its life time including payback periods, operational and maintenance costs, replacement, cost savings, etc. This can help teams choose LEED strategies. For example, vegetated roof systems require much less maintenance and have a longer life than traditional roofs. The LCC will show the cost advantages of choosing a green roof. Here are other costs that are typically the subject of a LCC review:

- Initial, acquisition, and construction
- fuel
- operation, maintenance, and repair
- disposal
- finance

- intangible benefits or costs[7] (such as community interaction, charity work)

Cradle to Cradle

A *cradle-to-grave* product is one that accepts disposal as part of a product's life cycle.

Cradle-to-cradle products are environmentally preferred. Through the cradle-to-cradle cycle the materials are perpetually circulated in closed loops – essentially a waste-free product. Both the product and any byproducts have value. Maintaining materials in these closed loops maximizes their value without damaging the environment. Cradle-to-cradle design considers opportunities for the reuse of the product. This principal is also known as 'waste is food.' If products are designed according to C2C design principles, they can be manufactured and sold for less than alternative designs. They eliminate the need for waste disposal such as landfills.

One Cradle-to-Cradle certified product is the Herman Miller Aeron Chair. The chair met C2C standards for material choice, recyclability and disassembly. 94% of the materials in the chair are recyclable.

Product Transparency

Environmentally preferable materials provide disclosure to buyers. Disclosure is knowledge-seeking and means transparency of product supply chains, ingredients and life-cycle impacts.

What does transparency mean? Well if you look on the side of a box of cereal or a bottle of ketchup, you can see what ingredients are in it. Do you want the ketchup that has high-fructose corn syrup, real sugar, or just tomatoes and salt? You get to read the label and decide. Transparency in materials is giving you the information so you can decide. It doesn't say what's better for you – the high fructose corn syrup, the real sugar, or neither, it just tells you so you can pick. Disclosure also helps verify claims from labels, such as recycled content, BPA-free, zero-VOC and so forth.

Environmental Product Declaration (EPD)

Fundamental is the idea of life-cycle assessment – looking at the entire lifecycle of a product or material and trying to quantify that material across a whole range of indicators: energy, water, raw materials, pollution.

Transparency comes from publishing an Environmental Product Declaration (EPD), which is a standardized way of quantifying the environmental impact of a product or system. Typically, an EPD will include information about a product's impact on global warming, ozone depletion, water pollution, ozone creation, and greenhouse gas

emissions. An EPD can also include other impacts that are of particular interest to the discloser, such as human toxicity risk and corporate social responsibility.

The International Standards Organization (ISO) standards are used for EPDs in LEED.

An EPD doesn't make a product good or bad. An EPD just states 'here's what the effects of this product are on the environment and people'. A product may perform better in some environmental categories than others, as listed on the EPD. The EPD helps project teams compare products to choose those that do less harm. EPDs act as neither product ratings nor ecolabels; rather, they help architects, designers, specifiers, and other purchasers better understand a product's sustainable qualities and environmental repercussions. As such, EPDs equip manufacturers with a valuable tool for differentiation and empower customers to make more informed purchasing decisions.

Corporate Disclosure

Corporate sustainability reports (CSRs) help to identify products/manufacturer's that have been verified to be extracted or sourced in a responsible manner.

Material Ingredient Disclosure

Health Product Declaration (HPDs) provide a full disclosure of the potential chemicals of concern in products by comparing product ingredients to a wide variety of "hazard" lists published by government authorities and scientific associations.

The HPD itself does not indicate if a product is healthy - it merely reports on the material ingredients. Armed with this information project teams can compare the materials in different products and see if any of the products contain unhealthy materials or in what quantities.

EPD vs. HPD

What is the difference between an EPD and an HPD?

HPD is a format for reporting product contents and health information about products and materials. EPDs include information not in HPDs such as: the environmental impact of raw material acquisition, energy use and efficiency, emissions to air, soil and water and waste generation.

Locally Produced Materials

Some European companies build prefabricated homes that are energy efficient, well insulated, and can be delivered in pieces for assembly. However, having the home built

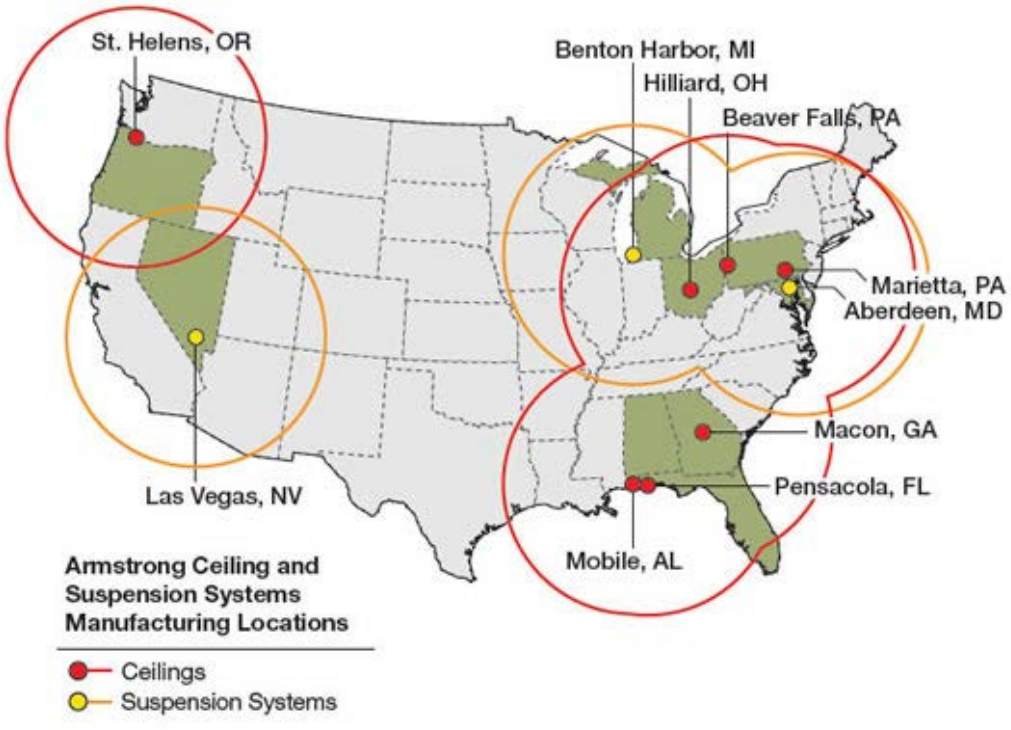
in Europe, shipped in pieces to a U.S. port, and then transported on to Ohio consumes a lot of energy.

Regionally harvested, processed, and manufactured products reduce transportation costs by avoiding overseas shipping costs, long rail transport, or long-distance trucking costs. Reducing transportation costs reduce the energy needs for that transportation. Besides reducing shipping and delivery costs, buying locally helps local businesses.

LEED gives credit when certain percentages of materials are extracted and manufactured within a radius of the project site.

Example: Wood extracted in Canada and then shipped to North Carolina for the purpose of creating cabinets for a project in North Carolina would not count. The wood would have needed to be extracted closer to North Carolina.

Example: A chair is made from different types of wood. Some of the wood was extracted from 50 miles away, and some from 750 miles away. Only the portion of the wood in the chair that was extracted from 50 miles away would count as a locally harvested and manufactured material, assuming the chair was manufactured within the radius of the project site.



Courtesy of Armstrong Ceiling

Certified Wood

According to the Food and Agriculture Organization of the United Nations, half of the world's forests have already been altered, degraded, destroyed, or converted into other land uses[8]. Much of the remaining forests today suffer from illegal exploitation or poor management. The Forest Stewardship Council (FSC), established in 1933 in response to these concerns over global deforestation, is an international non-profit, multi-stakeholder organization that promotes responsible management of the world's forests.

FSC's mission is to "*promote environmentally appropriate, socially beneficial and economically viable management of the world's forests."*

LEED projects using wood certified by FSC can earn points in the Materials and Resources category. FSC-certified wood looks just like other wood and comes with a Chain of Custody (CoC) certification. FSC-certified wood can range from structural and dimensional framing, sub-flooring, doors, and finishes. It is important that project teams get CoC documentation to demonstrate that that wood has been harvested through a FSC certified source.

Once a forest is certified, it is important to be able to trace the products that come from it throughout the supply chain to ensure that any claims concerning the origin of the product are credible and verifiable. FSC Chain of Custody is a tracking system that allows manufacturers and traders to demonstrate that timber comes from a forest that is responsibly managed in accordance with FSC principles. CoC tracks the flow of certified wood through the supply chain and across borders through each successive stage – including processing, transformation, and manufacturing – all the way to the final product.

Recycled Materials

Each year in the United States, industries produce over half a billion tons of residuals that can potentially be used for construction.[9] These products come from coal combustion, construction and demolition, spent foundry sand, and used tires. Recycled materials have the environmental benefit of reducing the need for virgin materials. These materials are also then deviated from landfills.

Environmental Benefits

Since many industrial materials are used to replace non-renewable virgin materials that must be mined and processed for use, industrial recycled materials conserve natural resources and reduce energy use and pollution associated with these activities. For example, substituting coal fly ash for Portland cement in concrete saves energy and greenhouse gas emissions associated with producing cement. The beneficial use of

industrial materials results in less material being sent to disposal facilities, which saves landfill space, and further reduces greenhouse gas emissions and other pollutants.

Economic Benefits

Industrial materials are often less expensive than virgin materials, so they make good economic sense for builders and project owners. Furthermore, reusing or recycling construction and demolition (C&D) materials on site can reduce material hauling and disposal costs. These savings, applied to the total project cost, make it possible to do more work with the same budget. In addition, C&D recyclers will often charge less to accept recyclable materials that have already been separated from non-recyclable materials –a practice that can be encouraged at the building site by using separate containers for various materials.

Types of Recycled Materials

There are several types of recycled materials for LEED.

Pre-consumer material is material from industry scraps that was diverted from the waste stream and used for other purposes. Examples include sawdust, wood shavings, wood chips, and print overruns. Excluded are materials that are re-incorporated into the same manufacturing process that generated it.[10] An example of what would not qualify is scraps of metal saved from a cutting process that are melted down and returned to the same manufacturing process. When the material is incorporated into a new product it is called pre-consumer content – the percentage of recycled material in the new product. An example is a newspaper made with 25% pre-consumer content.

Post-consumer material is a waste type produced by the end consumer of a material stream; that is, where the waste producing use did not involve the production of another product. Examples include construction and demolition debris, yard waste, and materials from curbside recycling programs (aluminum cans, newspapers, plastic bottles, milk jugs).[11] The percentage indicates the percentage of post-consumer material included in the product. For example – a plastic bottle with 50% post-consumer content.

Post-consumer fiber is fiberous waste from municipal waste streams. Examples would be paper or paperboard. Another term that might be used about fiber is recovered fiber, which includes both pre and post consumer fiber.

Recycled materials are defined by ISO 14021.

Example Materials

Pre-consumer materials	Post-consumer materials

Sawdust	Aluminum cans
Wood chips	Water bottles
Tree bark	Newspapers
Magazine overruns	Construction debris
Fly-ash	

Example: USGBC Headquarters

LEED Rating: LEED for Commercial Interiors Platinum
Location: Washington, D.C.
Courtesy of: 3form USA

Any building built for the United States Green Building Council needs to be LEED Platinum certified. To achieve the maximum number of LEED credits, all new materials must meet green criteria – contain recycled material – and communicate an overall commitment to sustainability.

The objective for one of the meeting rooms was to carve out an elliptical meeting space using recycled or reclaimed material for a responsibly green corporate model. Some of the features of the meeting room were:

- Reclaimed wood beams
- Recycled stainless steel
- 3Form's high design/low impact resin panels made of recycled material

Steel

Steel is the country's most widely recycled material. Due to the large quantities of scrap incorporated into the steel-making process, LEED allows project teams to assume steel contains at least 25% recycled content. If a project team wants to use a value greater than that, documentation would be needed of the actual recycled content.

Supplemental Cementitious Materials

Supplemental cementitious materials (SCMs) are another recycled material you will hear about frequently. Fly ash is a common type of this material.

When coal is used in a power plant, it is first ground into a very fine powder and blown into the power plant's boiler. Carbon and hydrogen in the coal are consumed, leaving non-combustible molten particles rich in silica, alumina, and calcium. These particles solidify as fly ash – microscopic, glassy spheres that are collected from the power plant before they can escape into the environment. This recovered resource can be used to

replace a portion of cement in concrete or added to mortars, stuccos and a host of other building materials.

A ton of fly ash can be used to replace a ton of cement in making concrete. Using a ton of fly ash instead of cement reduces carbon dioxide production by a ton.

If all of the fly ash generated in the United States each year were used to replace cement in producing concrete, the reduction in carbon dioxide released because of decreased cement production would be equivalent to eliminating 25 percent of the world's motor vehicles.[12]

Example: Technology Enterprise Facility III

LEED Rating: LEED for New Construction Silver
Location: Vancouver, British Columbia
Courtesy of: Read Jones Christoffersen

The Technology Enterprise Facility is a sustainable six-story research building at the University of British Columbia.

RJC acted as both the building science and structural engineer for the project. An integrated design team, collaborating from the early stages, produced a uniform structural system comprising concrete slabs and discontinuous shallow wide beams with higher live loads that allow for flexibility. The building wall consists of masonry veneer, curtainwall, metal panels, and a conventional roof assembly.

RJC chose to "green" the concrete by using high volume fly ash to reduce cement content and thereby minimize the environmental impact of construction. RJC's EcoSmart-funded report on the use of high-volume fly ash on this building has attracted delegates from around the world to study the Canadian use of high-volume fly ash concrete.

Fly ash was used as a partial replacement and resulted in no additional cost or impact to the schedule.

Durable Goods

Durable goods are not specifically defined or addressed by LEED, but ultimately using more durable materials will reduce future demand. If a particular carpet lasts longer it means the building owner will not have to tear the carpet out and replace it frequently. A durable goods waste stream includes those durable goods that have fully depreciated and can't be used in normal business anymore. When buying durable goods, don't forget about what to do with them once their useful life is over. This is the cradle-to-cradle mentality discussed earlier.

Sustainable Purchasing

Besides the materials needed for building construction, many items will need to be purchased during the ongoing operation of a building. A sustainable materials purchasing program places a priority on products and services that have a lesser or reduced impact on the environment when compared to similar competing products. The program should address ongoing consumables, like office paper and printer cartridges, as well as durable goods like computers and furniture. Consider the following products:

Low Elemental Mercury Light Bulbs

Mercury is present in many of today's low energy light bulbs such as compound florescent light bulbs. Mercury is toxic and the light bulbs have to be properly disposed of and cannot go into the regular waste disposal process. If bulbs break at the project site, the area will have to be carefully cleaned. To reduce this risk purchase bulbs with very little or no mercury. Despite mercury, CFL bulbs still help the environment.

Certified Products

Purchasing for business or families gives opportunities to put sustainable purchasing into action. There are many third party certifications that can help identify sustainable products.

- Fairtrade Labeled products include fruit, coffee, flowers, wine, tea, sugar, and many other products.
- Food Alliance certifies farms, ranches and food handlers for sustainable agricultural and business practices.
- Marine Stewardship Council Blue Eco-Label certifies sustainable fishing
- USDA Organic regulates the standards for any farm, wild crop harvesting, or handling operation that wants to sell an agricultural product as organically produced
- Protected Harvest certifies farmers' use of stringent environmental growing standards.
- Rainforest Alliance Certification promotes and guarantees improvements in agriculture and forestry.

Be careful that green products are actually good for the environment and meet the claims producers make on the products. Greenwashing occurs when products are made to seem better for the environment than is true.

Waste Management

Once a project is complete the responsibility of waste management and proper use of materials and resources does not end. Projects should have a solid waste management policy that identifies a goal diversion rate and covers strategies to reduce the waste leaving the project. Some strategies are covered below.

Recycling

LEED requires projects to have in place a recycling program for materials used around the building. Soda cans, water bottles, paper, cardboard, etc., are everyday items that can be recycled. One of the prerequisites of LEED is recycling. At a minimum a LEED project must recycle:

- paper
- corrugated cardboard
- glass
- plastics
- metals

Similar to the construction process, the development of the recycling process and identifying which materials can be recycled is determined by the local recycling programs available. Most urban areas have well-established recycling programs. Since recycling is a LEED requirement, the team will need to figure out how best to implement the program.

Also similar to construction waste management, the recycling can be comingled (all in one container) or multiple containers can be provided for each type of recycled material. Hazardous materials such as batteries, lamps containing mercury, and food waste may not be included in a comingled container.
If space is an issue in the building, can crushers and cardboard bailers can be used to reduce the volume of recycled materials.

Recycling can also cover durable goods such as furniture, electronics, and appliances. If an office or other project is about to renovate and replace durable goods work to find a recycler or donor who would take and recycle or reuse these durable goods. Charity organizations can help find users for appliances and used furniture. There are many recyclers of electronics that may even pay to recycle computers and other electronic items. If a project is about to undertake a recycling program for durable goods, it might be good to notify the community or other nearby projects so they can participate as well. The more participation the more durable goods that are recycled.

Compost

Some projects my benefit from doing composting either on-site or off-site. School or office cafeterias may create a lot of compostable waste. Sites with grass or trees can compost dead grass and leaves as well. If done on-site, compost can be turned into mulch. Off-site composting may be even easier. Many cities take lawn waste to turn into mulch which the city then sells back to the community. Oil recyclers can take used restaurant oil to repurpose for other products.

Waste Stream Audit

We've discussed setting goals and measuring the results multiple times. A waste stream audit in an existing building can be a measure and verification of the company's recycling program. A waste stream audit is simple but might not be for the squeamish. All waste from the project must be checked and categorized. The team can decide on how many categories, but they should include recyclable items, compostable items, and true waste. No matter the number of categories, in the end the waste accounted for should equal 100%. This should be done occasionally to check and ensure recycling items are in fact being recycled and that any waste education in the project is being followed by occupants.

Both the recycling program and the sustainable purchasing program are areas that should be monitored in the ongoing operation of a building for compliance.

Case Study: Dockside Green

Use of Local Products (Regional Materials)

Local products will be used on site for construction activities, site utilities, and demonstration projects, as well as being made available for purchase on site. Showcasing local products will increase exposure for local businesses and establish Dockside Green as an excellent development resource - a great example of what can be done with locally-produced, ecologically-responsible products. What's more, the decision to use locally produced goods not only benefits local businesses, it has the added environmental benefit of reducing CO2 emissions from transport.

Environmentally Preferable Materials

Dockside Green is committed to utilizing recycled content, sustainably harvested materials, and rapidly renewable resources; while at the same time minimizing construction and household waste.

- Carpets are carefully selected based on low emissions and environmental qualities.

- The project will use more expensive carpet tiles for corridors in the residential builds as this will reduce long term maintenance and waste for condo owners. In addition tiles are purchased from Interface global, a sustainable business leader utilizing their "Cool Carpet™" program which means their products are greenhouse gas neutral.
- Bamboo flooring and cabinets will be used in the development with upgrade options for other environmentally friendly products like cork flooring.
- The project will also be using some salvaged wood products to promote sustainable harvesting practices.
- Replacing cement content with fly ash will reduce CO2 emissions for the development by 35 to 40 percent.
- The wood frame town homes use Triton Wood. Triton harvests standing forests flooded by hydro reservoirs. With 45,000 major dam reservoirs around the world with an estimated 300 million trees, submerged forests represent a significant source of non-living timber that can be used for a wide variety of industrial and consumer applications.
- Buildings will include recycling rooms for organic waste with collection being undertaken by a local organization. This composting program will make garbage disposals unnecessary, saving the water and energy otherwise required to operate them.
- The project has a goal to recycle or reuse 90% of construction waste on site and the project will report on actual results when construction is completed.

Key Terms

adaptive reuse
building reuse
certified wood
chain-of-custody
comingled recycling
construction and demolition (C&D) debris
construction waste management
construction waste management plan
comingling recycling
cradle-to-cradle
cradle-to-grave
durable goods
furniture, fixtures, and equipment
FSC wood
ISO 14021
Life-cycle assessment (LCA)
Life-cycle costing (LCC)
materials reuse
off-site salvaged materials
ongoing consumables
organic waste
postconsumer content
postconsumer fiber
post-consumer material
pre-consumer material
rapidly renewable materials
recycling
recycled material
regionally (locally) harvested or extracted and processed materials
reuse
salvaged material
solid waste management policy
source reduction

sustainable purchasing program

waste disposal

waste diversion

waste-to-energy

waste reduction

waste stream

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[5] National Center for Remanufacturing and Resource Recovery
[6] Davies Office Refurbishing
[7] Sieglinde Fuller, *Life-Cycle Cost Analysis* (LCCA)National Institute of Standards and Technology (NIST), 2010
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Chapter 8 - Indoor Environmental Quality

Indoor environmental quality (IEQ) refers to the quality of the air and environment inside buildings, based on pollutant concentrations and conditions that can affect the health, comfort, and performance of occupants. Indoor air can be two to five times more polluted than outdoor air.[1] The variables that affect the indoor environment include:

- Temperature
- Humidity
- Lighting
- Acoustics
- Air quality
- Control systems

In total, the indoor experience is known as the indoor environmental quality. IEQ problems can lead to liability issues, poor occupant health, missed work days, and expensive repairs to remedy problems. Imagine someone selling a home and a potential buyer discovering black mold in the basement. Either the seller is going to pay for that cleanup, or the house isn't going to sell. All aspects of the building process are involved when it comes to good IEQ: design, construction practices, materials selection, housekeeping, operations and maintenance, staff training, occupant habits, etc. All of these factors impact the indoor environment and regular building occupants.

Regular building occupants for residences include everyone who lives in the residence, but for commercial buildings, it is a person who works 10 or more hours per week in the building. This can also apply to students who spend many hours in educational facilities each week.

All aspects of managing a building can be consolidated into the concept of risk management. There are a lot of risks about employing and having occupants in the building. This is why there are liability policies for buildings in case one falls down the steps. There's also a risk management process if a chemical spill occurs within the building. It could affect a lot of people.

Costs

What is the greatest cost to a building owner? The answer is the people in the building, everything from salaries to benefits. A happy employee is a productive employee, and a healthy employee is a productive employee. That affects the economic bottom line. What are some strategies by which you can keep people happy? Give them a view to the outside, let them open and close their own windows, give them healthy air to breathe, let them adjust their temperature, lighting, etc. Consider how to keep building occupants, employees, and tenants happy so that they don't leave and go somewhere else. It can cost upwards of $30,000 for a company to replace and train a worker who leaves voluntarily. And that's a minimum. What are the costs of losing a tenant because the indoor environment is uncomfortable?

When making the case for green buildings, in regard to the economics, one of the key arguments is that green buildings create a better indoor environment. A better indoor environment results in higher productivity and improved economic performance based on the productivity of the workers. The intent of IEQ is to provide systems that will insure the quality of the indoor environment. The pieces are in place to facilitate this quality indoor environment and then to eliminate or reduce potential contaminants that might be introduced to the environment.

Consider this: The national average cost in terms of salaries and benefits per square foot per year is $318.[2] The average cost of the rent or mortgage is around $20. The energy costs for the same square foot is $2.25. So the people are more than ten times the rent, and more than a hundred times the cost of the energy. Ask yourself if it makes more sense to make an investment in the indoor environment, especially good breathable air, or have a small savings in energy? Small changes in performance by people have a big return on investment, considering that the people cost 100 times as much as the energy.

Benefits of better indoor environmental quality include:

- Reduced liability
- Reduced employee absenteeism
- Reduced employee turnover
- Reduced occupant complaints
- Reduced vacancy costs
- Increased tenant satisfaction and retention
- Increased marketability of the property

The strategies for achieving points in this credit category include:

- Improve indoor air quality
- Increase occupant comfort

Improve Indoor Air Quality

During the 1970s, energy conservation measures were put in place to minimize the introduction of outside air into office buildings. A side effect of recirculating the indoor air was that indoor pollutants no longer were being flushed back outside – pollutants built up inside the building. Sources of indoor air pollution include natural sources, building materials, products, and occupant activities. Health effects from indoor air pollution range from immediate to long-term and treatable to severely debilitating or fatal.

People spend an average of 90 percent of their time indoors, so it is important they breathe good clean air. The term "sick building syndrome" (SBS) describes those situations in which building occupants experience acute health and comfort effects linked to time spent in a building, but where no specific illness or cause can be identified. The complaints may be localized in a particular room or zone or may be widespread throughout the building. In contrast, the term "building related illness" (BRI) is used when symptoms of diagnosable illnesses are identified and can be attributed directly to airborne building contaminants.[3] Complaints can range from odors in the room to illness and being absent from work.

Asthma, which affects 6 percent of the U.S. population, and allergies, which affect 20 percent of the population are other prevalent problems that can be aggravated by poor indoor air quality (IAQ).

IAQ or air quality should not be confused with IEQ, which refers to the total indoor environment, including the air quality.

It is important to have an indoor environmental quality management plan that lays out strategies and rules to ensure a proper indoor environment. Strategies should include:

- Specifying less harmful/low-emitting materials
- Protecting building materials during construction
- Scheduling construction activities to minimize occupant exposure

- Isolate areas of work to prevent contamination of clean/occupied spaces
- Ventilating the space to remove air contaminants

The intent of improving indoor air quality is to reduce human health risks by reducing exposure to indoor air contaminants. There are two strategies to improve indoor air quality in LEED:

- Avoid the use of materials high in pollutants and volatile organic compounds (VOCs)
- Improve ventilation

Source Control

One of the most effective ways to remove air contaminants is to not allow them indoors at all. The process begins in the design phase of a project and continues through the operations and maintenance cycle – our whole building design and integrative team approach. Source control can be very cost efficient.

Air contaminants can take many forms:

- Dust and contaminants from the building process
- Secondhand smoke
- CO2
- Material off-gassing
- Radon
- Chemicals
- Particulates

We will look at each of these and some of the requirements and strategies to reduce or eliminate them.

Protecting the Site During Construction

IAQ issues begin with the construction process. Prior to construction, contractors and project team members should incorporate an IAQ management plan into both bid and construction documents. This helps to ensure that all trades are knowledgeable of their indoor air quality responsibilities. In regard to job site practices during construction, the contractor should closely monitor the construction process to meet the goals established in the IAQ management plan. The plan could be as little as a few pages and would address such things as:

- Good housekeeping principles
- Cleaning spills immediately
- Proper ventilation
- Dust control and mitigation
- Requiring Personal Protective Equipment (PPE) such as respirators
- Wrapping or covering ducts
- Preventing fiberous material like carpet and insulation from getting wet

The Sheet Metal and Air Conditioning National Contractors Association (SMACNA) has a set of indoor air quality guidelines that are used to help manage air quality issues resulting from construction and renovation.

Many aspects of this plan already are being done by contractors, but they need to be documented and policed. It's rare to go into a new home being built and see the ducts on the floor uncovered after the ducts have been installed or see nails and sawdust left at the end of each workday. Proper management of the construction site goes a long way toward helping the quality of the indoor air for years to come.

Checking the Air

A project team should make sure to remove many of the contaminants and dust resulting from the construction process. Even if no products that off-gas are used for the project, something might slip through the construction process and into the air.

Prior to allowing occupants in the building, it needs to be free of any contaminants. A couple of strategies for doing this are:

- Flush out
- Air quality testing

A building flushout is where outdoor air is vented through all of the indoor spaces for a period of time. The dust and contaminants are flushed out of the building, equipment, and ducts. The old way of doing this was called a bakeout, in which the interior of the building was heated. Later, it was discovered that heating all of the contaminants wasn't accomplishing anything at all. In fact, the contaminants and toxins were off-gassing and the fabrics and upholstery were absorbing the contaminants.

Air quality testing is just that – testing the air in the various spaces to make sure the contaminants are at acceptable levels. If the air isn't acceptable, the space should be flushed out to clean the air.

Secondhand Smoke

Eliminating secondhand smoke (referred to as Environmental Tobacco Smoke (ETS) in LEED) is a prerequisite for building certification because of its importance. Exposure to secondhand smoke can cause lung cancer in nonsmokers and results in approximately 3,000 lung cancer deaths per year in nonsmokers.[4] Secondhand smoke also can increase the risk of heart disease.

The best strategy is to prohibit smoking in a building, and not allow any smoking outside within 25 feet of any air intake or door. In many places, smoking is now banned in the general areas of occupied buildings.

For residential buildings, LEED requires partitioning of the rooms and no smoking in common areas. Generally, in a residential project, if smoking is allowed in the units, a blower door test must be performed to confirm that air cannot leak between the doors and between adjacent units. This prevents any smoke from one unit leaking to another.

For buildings that might have smoking rooms, such as an airport, slab-to-slab partitions and dedicated exhausts to the exterior are needed to prevent any contaminated air from reentering the system. The exhaust system must create negative air pressure to keep air from escaping from doors when the doors open.

CO2 Monitoring

Accurate monitoring of CO2 levels ensures that occupied spaces are receiving enough ventilation. Levels of CO2 above predetermined and normal setpoints may indicate the ventilation is not performing as designed, and that additional contaminants may be present due to poor ventilation. Install CO2 monitors and ensure they are correctly calibrated.

Material Off-gassing

Make sure that the materials in the building aren't affecting the air quality.

LEED defines "in the building" as starting with the vapor barrier, so an exterior paint would not be considered in any calculations.

There is increasing concern about the impact of formaldehyde and other volatile organic compounds (VOCs) on human health. A typical home contains 185 gallons of adhesives, either as pure adhesives or as part of other products[5] so it is an important consideration given that we are exposed to these emissions so frequently and for long periods of our day.

Long-term exposure to VOCs in the indoor environment can contribute to sick building syndrome (SBS). Many building materials such as paints, adhesives, wall boards, and ceiling tiles emit formaldehyde, which irritates the mucous membranes and can make a person uncomfortable. There are also many sources of VOCs in office buildings, including new furnishings, wall coverings, and office equipment such as photocopy machines that can off-gas VOC particles into the air. There are specific LEED credits related to:

- Adhesives and sealants
- Composite wood which is wood made from several materials
- Paints & coatings
- Flooring
- Furniture & furnishings
- Rooms containing equipment such as copiers

Some products require no VOCs to qualify, while other building materials have specific limits.

Most products that are acceptable to LEED need to meet a 3rd party standard:

Referenced Standard	Product
South Coast Air Quality Management District (SCAQMD)	Adhesives, sealants, primers Wood finishes, floor coatings
Green Seal	Aerosol adhesives Architectural paints and coatings Interior anti-corrosive and anti-rust paint
Green Label Plus (Carpet and Rug Institute)	Carpets
Green Label (Carpet and Rug Institute)	Carpet cushion
FloorScore	Vinyl, linoleum, laminate, wood, ceramic, rubber flooring
GREENGUARD	Furniture and seating

Remember that materials need to meet these standards only if the project is pursuing those specific IEQ credits.

Radon

Radon is a cancer-causing natural radioactive gas that you can't see, smell, or taste. Its presence in a home or office can pose a danger to the health of the residents and occupants. Radon is the leading cause of lung cancer among nonsmokers and the second leading cause of lung cancer in America. LEED for Homes has a credit related to radon and using radon construction techniques to reduce radon infiltrating into the residence. Radon gets into a house through:

- Cracks in solid floors
- Construction joints
- Cracks in walls
- Gaps in suspended floors
- Gaps around service pipes
- Cavities inside walls
- The water supply

Courtesy of EPA

Green Cleaning

Green cleaning products are products that have a lower negative impact than their non-green counterparts, while performing equally well and at a comparable cost.

Green or environmentally preferable products are defined in Presidential Executive Order 13101 as "products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose."

Each year in the approximately 3,700,000 commercial and institutional buildings in the United States cleaning products contribute to:

- 8 billion pounds of cleaning chemicals
- 4.5 billion pounds of janitorial paper products
- 1 billion pounds of janitorial equipment[6]

Green cleaning focuses on achieving what is best for the facility, the occupants, and environment rather than just the financial bottom line.

Green cleaning is not limited to only the products used, but the strategies with which the products are used. A green cleaning program should be comprehensive and include:

- Where the chemicals are stored
- What chemicals are used and in what quantities
- Training in the use of the chemicals
- Indoor pest control plans
- Equipment use

Example: Sidwell Friends School

Sidwell Friends School is well known because many children of United States presidents have attended. Currently, Sasha and Malia Obama are attending, and former attendees include Chelsea Clinton and Amy Carter.

The school has made a focus of green cleaning by:

- Training all contracted cleaning staff on green cleaning prior to and during their employment.
- Energy-efficient equipment that has less environmental impact—low moisture processes, quieter operation, higher filtration, and lower emissions.
- Cleaning products that are Green Seal Certified

- 100 percent recycled paper towels and toilet tissues that are Green Seal Certified

Entryways

Doorways are a prime point for contaminants entering a building. Consider adding metal grates or walk-off mats at every entrance to remove dirt, water, and contaminants from shoes. This helps keep the indoor air clean and reduce the cleaning chemicals used for cleaning floors at entry points.

Improve Ventilation

Fresh air or air quality is one important part of IEQ. Good indoor air quality comes from mechanical or naturally ventilated systems that function appropriately.

Spaces can be ventilated naturally by opening windows and doors. This is more common in cooler climates where hot humid air is rare in the summer. Mechanically ventilated spaces usually have fans that deliver air through a series of ducts. Buildings that use both natural and mechanical ventilation have mixed-mode ventilation.

By increasing the quantity of fresh air entering a building, the ratio of poor air is reduced. Current code minimums do not supply enough fresh air and are not good enough for occupant well-being – if they were, terms like sick building syndrome probably wouldn't exist. LEED for New Construction awards a separate credit if you exceed the code minimums for outside air intake.

The purpose of ventilation is to dilute the level of pollutants in the air. Generally, when the rate at which the outdoor air increases, indoor air problems decrease. To dilute and eventually remove indoor contaminants, HVAC systems must bring in adequate amounts of outdoor air. Because of the costs to heat cold air in the winter and to cool hot air in the summer, most project plans just recirculate the indoor air. This results in indoor contaminants accumulating. For a best practice, continuous amounts of fresh air should be added to the system.

Minimum Air Quality

Every LEED-certified commercial and institutional building must comply with certain aspects of the ASHRAE 62.1 standard, or local codes if the local code is more stringent. This ASHRAE standard sets minimum ventilation rates and IAQ levels and specifies that ventilation systems are designed to reduce the potential for adverse health effects.

Compared to a building with poor indoor air quality, even meeting just the minimum as required by the ASHRAE standard is a vast improvement over nothing at all.

There are many regulations about indoor environmental quality, starting with the ASHRAE standards. Projects should follow these standards not only because they're a LEED prerequisite but as a designer or a builder you want to make sure that you're not going to get into trouble from indoor air quality lawsuits. Indoor air quality is an area that is rife for lawsuits and complaints. Air quality is addressed by OSHA standards, the Department of Labor, and EPA guidelines.

Moisture control is another factor. When a building has high moisture, the building can get mold and mold spores in the air. Relative humidity will tell if moisture in the air is getting out of control. The human body is comfortable when relative humidity ranges between 20 and 60 percent.[7]

Since monitoring the incoming ventilation air can indicate outdoor air quality, one of the issues of building in a city where the air quality is poor, is that just bringing in fresh air may not be enough to maintain good air quality in the building. Testing that air and putting extra filtration in place if pollutants are found will reduce the adverse effects. Make sure monitors and sensors are correctly calibrated as part of on-going maintenance.

Testing the building exhaust as it is produced would give a sense of what's coming out of the space, and it would be a good indication of whether or not the space has good indoor air quality.

Increase Ventilation

Increasing the quantity of outdoor air will increase the quality of indoor air. If too little outdoor air is entering a building, contaminants will build up and occupant health will suffer. Providing more fresh air is a key factor in reducing contaminants indoors.

When increasing the ventilation in a building, the energy costs go up and a larger HVAC system may be needed. An important design decision, and one that often is discussed and debated, is the added energy cost vs. the added air.

If adding air increases energy use, there is a negative impact on the environment if the energy comes from fossil fuels. If a minimal amount of air is used, are occupants going to have health issues? You might consider the comparison from the introduction, where we outlined the cost of an employee per square foot vs. the cost of energy per square foot. .

Example: Bank of America Tower at One Bryant Park

LEED Rating: LEED for New Construction Platinum
Location: New York City, New York
Courtesy of: Bank of America

In the new Bank of America Tower:

- Fresh air enters the building at least 100 feet above the ground level, thereby eliminating any ground source pollution from automobile exhaust.
- 95 percent of the air particles are filtered from the air entering the building, making the indoor air cleaner than the outdoor air.
- The supply air shaft from outside brings in more fresh air than required by code.
- The filtered air is filtered once again before being vented to each floor.
- The air exhausted from the building is also cleaner than the outdoor air.

Air Filters

Don't overlook the quality of air filters in regard to ventilation of a building or even your own home. At the heart of good indoor air quality is proper air filtration. A better quality filter – and yes, they do cost more – will go a long way. Air filters are rated on the MERV system – which stands for minimum efficiency reporting value. The higher the MERV rating the more particles are removed. Air filters are used to reduce the amount of dust that reaches the wet coils, keeping the HVAC system clean. Dust can serve as food for mold on the wet coils and ducts and can reduce the efficiency of the coils. Clogged filters slow the air flow and can cause uneven air flow as well as higher bills. Proper installation and maintenance are keys to reduced HVAC operating costs and good IAQ.

Filter upgrades are among the least expensive alternatives to improve IAQ. And switching to filters that have a lower pressure drop can lead to energy savings. By using lower pressure drop filters, the HVAC system motor has less resistance to deliver the air to the ventilation system, thus energy – and money – is saved.

Increase Occupant Comfort

In addition to air quality, the comfort of the occupant plays an integral role in successful IEQ. Earlier in this section, we discussed the benefits of a healthy productive employee. Additional strategies for good IEQ include:

- Allowing natural light into the space (daylighting)
- Providing views for occupants
- Providing individual controls for heating/cooling/lighting
- Good acoustics

Daylighting

Architectural daylighting design is at the heart of sustainable building design. When properly designed and effectively integrated with the electric lighting system, daylighting can offer significant energy savings by offsetting a portion of the electric lighting load.

All buildings receive some amount of daylight; however, the term "daylit" refers to buildings specifically designed or retrofitted to efficiently capture and distribute daylight as their primary lighting source.

Besides added visual appeal, numerous studies have shown the positive mental and physical effects that daylight has on the human body.

Daylighting can be active or passive. Passive daylighting is a system of collecting sunlight using static, non-moving, and non-tracking systems such as windows, light shelves, most skylights, and light tubes. These devices rely on their position to capture sunlight most effectively. The orientation of the building and the fenestrations also are important design considerations. Active daylighting systems rely on tracking or following the sun throughout the day using a mechanical mechanism.

There are many means to incorporate daylight into a space, including:

- Skylights
- Lightshelves
- Suntubes
- Larger window areas and appropriate interior wall space planning

Daylighting Benefits

"The cost of people in buildings is often 75–100 times greater than the cost of utility bills,"[8] according to Steve Ternoey, a respected author and principal of LightForms, LLC, a California architectural firm specializing in daylight design estimates. When salaries and affected revenues to the company are factored in, the savings and increased productivity can far exceed the building's energy costs.

Daylighting can result in a reduction in cooling capacity and use by lowering a significant component of internal heat gains. Daylighting can replace electric light 70–80 percent of daylight hours – in many cases, for less than $.015 per kWh over the life of the building. For buildings that operate during the day, like schools, factories, retail stores, and offices, this can mean tremendous energy savings for buildings.

Daylighting Issues

Ground surfaces, pavement, adjacent buildings, wide windowsills, and objects all can cause glare. Excessive glare can be uncomfortable, thus avoiding excessive light must be addressed in the design process.

The heat load can increase, depending on the strategy used to allow daylight into the building. For example, some skylights allow both light and heat to enter a building, while more sophisticated skylights allow only light into a building.

Daylighting Controls

A building designed for daylighting that does not also have an integrated electric lighting system will be a net energy loser because of the increased thermal loads – basically because indoor lights will not be used less and will continue to give off heat. Only when the electric lighting load is reduced will there be offsetting savings in electrical and cooling loads. The benefits from daylighting are maximized when both occupancy and lighting sensors are used to control the electric lighting system.

Skylights

Skylights are horizontal windows or domes placed at the roof of buildings. Skylights provide natural sources of light and contribute to reduced dependence on electric lighting.

Example: Villages at Carver Family YMCA

LEED Rating: LEED for New Construction Certified
Location: Atlanta, Georgia
Courtesy of: Velux

The YMCA had an existing natural lighting system, but it required ongoing maintenance and did not harvest daylight very well. The lighting consultant quickly realized that a different system would have to be installed in order to guarantee a leak proof design and the ultimate daylight harvesting system.

The roof monitor system chosen had a design that would harvest a great amount of light but also would diffuse the light by passing the light through a white laminated glazing and having it bounce off the back of the roof monitors. The new natural lighting design not only looks attractive from the exterior but also provides an incredible natural lighting environment inside the gym. Lights can be turned off during most of the day, resulting in significant energy savings and a much better environment for exercising.

Light Shelves

Light shelves reduce energy costs while bringing daylight deeper into the building's interior. A light shelf is a horizontal light-reflecting overhang placed above eye level with a transom window placed above it. This design, which is most effective on southern orientations, improves daylight penetration, creates shading near the window, and helps reduce window glare. While exterior shelves are more effective shading devices than interior shelves, a combination of exterior and interior will work best in providing an even illumination gradient.

Example: Medical Center of the Rockies

LEED Rating: LEED Silver Registered
Location: Loveland, Colorado
Courtesy of: Kawneer

Based in Loveland, Colorado, the Medical Center of the Rockies sets a new standard for sustainable building that supports both human and environmental health – and minimizes the bottom line.

This state-of-the-art hospital was designed to be energy-efficient and welcoming. A grand atrium brings in natural light, using an integrated curtain wall equipped with both sunshades and light shelves. The combination of products reduces solar heat gain and bounces indirect light inward. For thermal efficiency, the team used a ribbon window and curtain wall system for the patient rooms; the oversized windows create an open, healthful environment.

Sun Tubes

Another type of device used are light tubes (also called solar tubes or sun tubes) placed into a roof and admitting light to a focused area of the interior. These somewhat resemble recessed light fixtures in the ceiling. They do not allow as much heat transfer as skylights because they have less exposed surface area. It is easier to retrofit light tubes into existing buildings, especially those with deep roof constructions.

Views

A high quality visual environment is another factor in good IEQ. A view of the outdoors provides a connection between the occupant and nature and is another way proven to increase occupant comfort and productivity. A view of a tree, a pond, or a field is preferred over a view of a wall or cube three feet in front of you.

Even interior rooms can have an impact on mood. Look at the pictures below and consider what room is more appealing visually, and in what room you would prefer to spend your time? Redundant cube farms and rooms lacking color are a common site in most work areas. Cube farms do provide work space for a lot of people, but even these can be made to provide better views. Lower cube walls that allow people to see to the windows in the buildings would be an improvement over nothing at all.

Occupant Control

Occupant control is a significant factor in occupant comfort. Everyone is different and has unique temperature and lighting preferences. Control systems, and more generally how those systems are operated, can impact the company's financial and productivity bottom line. The control systems also need to be designed properly and function in an appropriate way. Remember: proper commissioning tests will ensure maximum performance.

Temperature Control

Projects need to have the goal of healthy IEQs and ensure a majority of occupants have thermal comfort when inside the project. Thermal comfort is determined by several factors. Conditions for thermal comfort are described in ASHRAE 55-2004. ASHRAE defines these characteristics as

- temperature (air, radiant, and surface)
- humidity

- air speed
- outdoor temperature design conditions
- outdoor humidity design conditions
- clothing
- expected activity

In most buildings, occupants have control over their temperature by how much extra clothing they put on or take off at the office. Extra layers of clothing are worn when the office temperature is too cold, and short-sleeved shirts are worn when the temperature is too hot. Employees who have to bundle up in the summer due to air conditioning and are too hot in winter clothing when the heat is on are not going to be as productive as comfortable employees. Also, having it too cold or hot for the occupants wastes energy as the extra heat or cold is not appreciated.

Setting the thermostat at 72 degrees doesn't mean it will be 72 degrees next to a window, or 72 degrees in the corner office facing away from the sun.

Operable windows can be used to provide thermal comfort to those who sit near the window.

Other methods of temperature control are individual thermostats for offices and group multi-occupant spaces- such as conference rooms or classrooms.

For those who are cold, radiating heat panels can be installed under desks. This may be a great solution for those in the office who wear skirts and sandals and are cold while their suit wearing coworkers enjoy the blowing air conditioning.

Occupant Surveys

Get creative in occupant comfort. There are many inexpensive solutions that don't necessarily have to be installed building-wide. Surveys of occupants in the building can also pinpoint areas where changes are needed to improve comfort. Ask about the comfort criteria mentioned above – temperature, air movement, humidity, and lighting, then make any necessary changes to the building operating plan to increase occupant comfort.

Survey occupants about project cleanliness. These types of surveys are called custodial effectiveness assessments.

Is the green cleaning program working?
Are occupants ever exposed to contaminants?

Lighting Control

The brightness and glare of overhead fluorescent lighting can be greatly discomforting to anyone who works inside on a computer for an extended period of time. Task lighting allows a user to illuminate an area where a specific task must be performed to the user's desired lighting needs. Consider a cube farm of 50 cubes where all of the overhead lights are either on or off. The likelihood that each of the 50 cubes is positioned exactly under a light according to the user's preferences is zero. Traditional building design installs the lighting first without regard to where any occupants may be positioned. The best lighting design puts the lighting where the user wants it and at each user's desired illumination level. It's easy to understand why: In modern offices, as work moves from being done on desks to being read on computer screens, less ambient light is needed.

Task lighting has the advantage of meeting the lighting needs of the user for his critical visual tasks like reading or using the computer without lighting the entire space. If one employee comes into the office over the weekend at our 50 cube office, instead of lighting up the entire room, the employee needs to light only a single task light at his/her desk. Small ideas add up to big savings.

Acoustics

Acoustics are an important element of indoor environmental quality. Acoustical issues are relevant to all building types; however, the acoustic performance is only required by LEED for Schools, as teachers can't teach and students can't learn in noisy classrooms.

Better acoustics can be accomplished by:

- Creating soft surfaces by using sound absorbing materials made from recycled products
- Using white noise to mask other sounds
- Paying attention to the geometry of a space. There are designs that improve acoustics (like a concert hall) and designs that make for poor acoustics (high ceilings in a classroom)
- Avoiding the use of small diameter ducts with high velocity airflow, as these ducts tend to be noisier
- Designing rooms with privacy and concentration in mind, such as study rooms in libraries
- Enclosing or separating spaces where privacy and concentration is important

Case Study: San Mateo County Sheriff's Forensic Lab

LEED Rating: LEED for New Construction Silver
Location: San Mateo, California
Courtesy of: HOK

The one-story building provides a bright, open workplace while meeting strict security requirements. All regularly occupied areas of the building are daylit, and offices have operable windows.

Other strategies for improved IEQ include:

- Architectural sun control
- Daylight harvesting and advanced lighting controls with occupancy sensors and photocells
- Natural ventilation via operable windows in office areas
- Large roof overhangs on the southwest side to reduce glare and maximize daylighting
- Variable air volume (VAV) boxes that are connected to windows and close off the air conditioning when a window is opened
- Control of the lighting levels in offices and labs through computers
- Southwest facing windows with low-emissivity coatings to reduce glare and solar heat gain
- A building flush-out that removed air contaminants, resulting in the indoor air being cleaner than the outdoor air prior to occupancy.

The sustainable strategies for IEQ were measured, and it was found that the building morale was higher.

Case Study: Hearst Tower

LEED Rating: LEED for New Construction Gold
Location: New York City, New York
Courtesy of: Sherwin-Williams

Hearst Tower uses 26 percent less energy than conventional buildings, thanks in part to high-performance, low-emission glass, which minimizes heat gain. Internal walls were kept to a minimum to facilitate natural illumination, with daylight sensors dimming lights when natural lighting is sufficient.

The primary design goal was to create a new environment that embodies daylight and visibility – an open work environment to promote interaction and collaboration among employees.

The construction of the tower itself incorporated environmental conservation. Eighty-five percent of the steel was recycled, and the unique design of the tower's "diagrid" frame used approximately 20 percent less steel than a conventional perimeter frame.

Environmentally friendly materials were chosen for the building's interior. Brian Schwagerl, vice president of real estate and facilities worldwide for the Hearst Corporation, says "One of the simplest things you can do to make a building green is to pick paints that have low VOCs (volatile organic compounds)."

Most of the interior space of the Hearst Tower was painted with a zero VOC, low-odor, silica-free coating with antimicrobial properties to resist mildew.

Schwagerl also says, "We looked at this project as a home renovation. We view corporate employees as part of the Hearst family. Why wouldn't you put the best products in your home?"

Case Study: Dockside Green

Fresh Air Ventilation

Dockside Green's buildings provide 100% fresh air through either a central or individual heat recovery ventilators. The system utilizes heat recovery from the exhaust system and preheats incoming air, saving energy costs while providing fresh air.

Low VOC Products/ No Formaldehyde

The project uses low or no volatile organic compounds (VOC's) paints, sealants and adhesives as well as avoids the use of ureaformaldehyde composite wood products. The project also includes low emitting carpets.

Additionally, the children's play area will be built with non-toxic and natural materials to safeguard children from any potential long-term health risks.

Green Cleaning

To improve indoor air quality and encourage optimal functioning of Dockside Green's water treatment system, the project team will encourage maintenance staff and community members to use green cleaning products exclusively,

providing each residential, commercial and industrial unit with an initial, complimentary six-month supply.

Key Terms

ASHRAE 55

ASHRAE 62.1

carbon dioxide (CO2) levels

comfort criteria

construction IAQ management plan

daylighting

environmental tobacco smoke (ETS) control

glare

green cleaning

GREENGUARD

Green Seal

Indoor air quality (IAQ)

indoor environmental quality management plan

mechanical ventilation

minimum efficiency reporting value (MERV)

mixed-mode ventilation

natural ventilation

pollutants

SMACNA

thermal comfort

ventilation

volatile organic compounds (VOCs)

References

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[4] Health Effects of Exposure to Secondhand Smoke, EPA
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Chapter 9 - Innovation in Design (ID)

Innovation is a flexible category used to award points for performance and creativity. The category is flexible because the points in this section are not necessarily earmarked for specific items completed or designed. Innovation in Design points can be awarded for:

1. Exemplary performance– which is exceeding the credit requirements
2. Innovative performance – which is demonstrating a quantifiable environmental benefit using an approach not found in the LEED Rating System
3. Having one LEED AP participant on the project team

Prerequisites cannot earn points for Innovation in Design.

Exemplary Performance

Performance above and beyond the LEED requirements is rated "exemplary." An example of exemplary performance is to meet the next step in a series of requirements. We will look at a couple of examples in this section to make this clear.

Exemplary performance points are not available for all credits in the rating systems. There are specific areas where the rating system will allow a project team to earn these extra points. If a project exceeds requirements on a credit that does not have an exemplary point option – then the project will not be eligible for an ID point. Even though not all areas of LEED have this option, many areas are so interrelated that if you overachieve in one area, you might earn an ID point in another.

These next examples use the LEED BD+C: New Construction Rating System.

Example #1

Sustainable Sites credit Site development Protect or Restore Habitat can earn a project one point for using native or adapted vegetation to restore 30% (including the building footprint) of all portions of the site identified as previously developed.

If a project team increases the on-site restoration to 60% (a doubling of the credit requirements), one Innovation point can be earned.

Example #2

Water Efficiency Credit Indoor Water Use Reduction can earn a project 1 to 6 points for using less water than the building baseline:

Percent Reduction	Points
25%	1
30%	2
35%	3
40%	4
45%	5
50%	6

Achieving a 55% reduction in water use would earn one Innovation point. Note that the 55% reduction doesn't earn seven points for the credit. The points earned would be:

WE Credit Indoor Water Use Reduction – 6 points
Innovation Credit – 1 point

Example #3

Here are some credits that can earn exemplary performance:

- Increasing the use of alternative transportation
- Rainwater management
- Reducing the heat island effect
- Reducing indoor water use
- Increasing energy performance
- Increasing on-site renewable energy
- Increasing green power use
- Increasing the use of environmentally preferable materials

Innovative Performance

The LEED rating system cannot cover every green building idea or be revised to cover every new technology – so the system allows for innovative performance. Innovation is used to describe new and unique ways of exceeding green building or operating goals in a significant and, most importantly, measurable way that is not covered in the LEED system.

One example is USGBC has assessed the Green Advantage certification program against their established requirements for recognition in LEED and found Green Advantage to be in compliance. As such, LEED project teams who comply with the Innovation credit requirements are eligible for award of one Innovation point for LEED v4 BD&C projects

Innovative strategies must meet three criteria:

- The strategy must demonstrate a quantifiable environmental performance benefit
- The strategy must be applied comprehensively (wherever possible on the project). For example, one project used a snow melting system to eliminate the use of chemicals to melt snow. Using the snow melting system on 10% of the walkways and chemicals on the remaining 90% would not be considered comprehensive.
- The strategy must be transferable to other projects so that other project teams can replicate the strategy, while also being a superior design choice compared to standard building design.

Before your design process begins, check out the Innovation Credit Catalog available from USGBC to see what other project teams have come up with.

Examples

Remember that innovative performance strategies mean more than just achieving a higher level of performance than what is required in the LEED Rating System.

Some previous examples used on projects are:

- Relocating/transplanting trees onsite
- Wood use reduction of 20%, as compared to a baseline building
- A food composting facility
- A snow melting system that does not use chemicals
- Borrowing (and achieving) a LEED Credit from a different rating system (i.e. Green Cleaning from LEED Operations & Maintenance if the project was for LEED for New Construction.

An innovative strategy that is awarded on one project does not necessarily mean another project will receive credit for the same innovative technique. Identical strategies among projects are evaluated independently during the review process.

Education Program

In keeping with the goal of the USGBC to make green buildings available to everyone in a generation, an education program is a great way to be innovative. Education is not in the LEED rating system but it is truly innovative and the most widely submitted innovation strategy for an ID point. This concept uses the building as an educational tool. In LEED for Schools it is currently the fifth ID point.

The goal is to inform building users and visitors about the positive environmental and human health benefits of green building as well as educating them about green building strategies incorporated on the project. An education program can be any combination of giving tours of

the building, adding signage, doing a case study, or even writing a manual on the green aspects of the building.

Divert Waste

Your project could work with the community to divert waste from landfills. If your project has a large recycling program, it could encourage community members to drop off their recyclable materials or organize other programs that would divert waste from more than just the project area. If a property management team is planning on sending in old computers for recycling and control of toxic materials, the property management team could publicize a computer collection drive in surrounding office buildings or neighborhoods. This can create good will for the companies supporting the recycling program, divert toxic waste out of landfills, and give those who would otherwise not recycle their computers an easy way to do so.

LEED AP on Staff

LEED APs help streamline the application and certification process. The rating systems allow one ID point for having a LEED AP on staff. Having a LEED Green Associate on staff does NOT earn an ID point, and having a LEED AP on staff is not required for building certification.

LEED Accredited Professionals are experienced building industry practitioners who have demonstrated their knowledge of integrative process and their capacity to facilitate the LEED certification process on the LEED Accredited Professional exam. The exam tests an individual's understanding of green building practices and principles and familiarity with LEED requirements, resources, and processes. The accreditation program recognizes expertise in green building and LEED to help meet the growing demand from the public and private sectors for green buildings.

To earn one ID point, have a LEED AP doing principle work on the project. This means the LEED AP must be involved in a substantial capacity on the project. Not only does this help to promote LEED, but more importantly the benefit comes from the knowledge of the LEED AP. A LEED AP will understand the requirements of the rating system and be able to promote the whole building approach to achieving LEED as well as encourage the team members to work together on an integrative process or management plan.

Having more than one LEED AP on a project does not earn the project more than one point. While it is good to have more experienced professionals, no additional points are awarded. Even though there are six ID points, having six LEED APs on the project would only earn one point.

Review & Acceptance

Because some of the innovative credits are wildcards – a project team can't know if the credit will be approved if the strategy has never been submitted before. Your project team should have alternate credits in mind in case the submitted ID credit is denied. In the beginning of this study we discussed submitting more points than needed for the project's target level of certification in case some credits/points are denied. This is especially true with innovative strategies. If the ID credit is denied, the project team could submit another ID creditor just skip it.

ID Point Limits

There is a limit to how many points you can earn in the innovation in design or innovation in operations section. The project will be limited to the number of points allowed by the rating system.

Case Study: Dockside Green

As a world leader in on-site efforts to protect natural resources, Dockside Green wants to share their learning and experience both locally and globally. Using a variety of communication channels, including the Internet, speaking engagements and strategic relationships with organizations, Dockside Green hopes to share their strategies, successes and opportunities for improvement. Even the case study included in this study helps educate the public about the Dockside Green project. As well, on-site signage and public art will play a crucial role in educating Dockside Green's residents and visitors about site features and the benefits of sustainable lifestyle choices.

Key Terms

exemplary performance

innovative performance

principle participant

quantifiable benefits

LEED AP

Chapter 10 - Regional Priority

Regional Priority a great example of how the USGBC is able to listen to its members and stakeholders in the real estate industry. Regional Priority acknowledges that different regions in the world have different needs and has selected existing credits in the rating systems that should be a priority.

The intent of the regional priority credits and points is to encourage teams to attempt LEED credits that address specific environmental priorities in the project's region.

Example

Regional Priority credits are listed by country, state and zip code. For example the 97212 zip code in Portland, Oregon has the following credits as regional priorities for LEED BD+C: New Construction version 2009:

- Sustainable Sites Credit Brownfield Redevelopment.
- Sustainable Sites Credit Site Development - Protect or Restore Habitat
- Water Efficiency Credit Innovative Wastewater Technologies
- Material and Resources Credit Building Reuse
- Material and Resources Credit Materials Reuse
- Material and Resources Credit Certified Wood

A new construction project building in this zip code could achieve a regional priority point by achieving one of the listed credits. The team could earn one point for achieving Sustainable Sites Credit Brownfield Redevelopment and would also earn one point for the regional priority of this credit for a total of two points.

Sustainable Sites Credit Brownfield Redevelopment: 1 point
Regional Priority: 1 point
Total: 2 points

Regional priority credits give you an idea of the area. For example, the credits listed for zip code 97212 mentions reuse and restoring habitat. This means that the area has many existing buildings and may need some redevelopment to handle abandoned sites or increase vegetation in the area.

Restrictions

Regional priority credits are only available to projects within the United States. Even though 6 regional priority credits are listed, teams can only earn up to 4 points in this category. During the initial project charette, discuss the regional priority credits and if your team can achieve them. The extra 4 points may be enough to put the project over the threshold for the next certification level.

Chapter 11 - Synergies

What is synergy? The term *synergy* implies that two individual parts can work together to create something more than just the sum of the two. In effect, synergy is almost like 2+2 = 5. In this study we have reviewed how LEED efforts can affect the environment, employee health, and construction costs, to name a few areas. The goal of a project should be to maximize positive synergies between design decisions for improved employee health, lower environmental impact, and construction costs while also avoiding conflict or negative synergies. To be in a position to make good choices, this section will review how to understand possible credit synergies and provide some insight into the decision-making process.

Whole-Building Design Process

Whole-building design, as previously mentioned in this study, is the ideal way to work with LEED credits to create synergies. To create effective synergies, a team must use the whole-building design process as soon as possible in the project. Even if a building has been built and is undergoing a major renovation, the team still has the ability to use a whole "project" design process. A thorough understanding of LEED credits will enable your team to consider the best combination of credits and points while also meeting the needs of the building owner or client before the first shovel hits the ground.

Credit Categories

Remember that all LEED rating systems have similar credit categories. The credits in these categories may vary, but the intents of the credits are so similar that you can apply overall knowledge of these shared intents to any LEED project.

Here is a very brief keyword review of the intents of each credit category:

Location and Transportation: Site Selection, Reuse, Restore Brownfields, Alternative Transportation

Sustainable Sites: Site Assessment, Conservation, Restoration, Rainwater Management, Heat Island Reduction

Water Efficiency: Outdoor and indoor water use, performance measurement

Energy and Atmosphere: Reduction, efficiency, renewables, ongoing performance

Materials and Resources: Reuse, waste management, life-cycle impacts, purchasing

Indoor Environmental Quality: Ensure Excellent Indoor Air Quality (IEQ) and Comfort, Reduce Toxins & Pollutants

Innovation in Design: Exemplary Performance, New & Innovative Practices, LEED APs

Common Synergies

We will go through this chart and highlight where synergies exist in each area. Numerous opportunities are available, especially as new technology enters the market. After this review, you will have an opportunity to review a case study to identify potential synergies.

	LT	SS	WE	EA	MR	EQ
LT						
SS		x				
WE						
EA						
MR						
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Synergies within Location and Transportation

You don't always get to pick your site, but here are some synergies in the location and transportation category.

Site Reuse/Habitat Protection

Using a previously developed site means that an undeveloped piece of land is not affected by construction activities or the resulting building. The land saved from development could be prime farmland, wetlands, or other sensitive areas. Site reuse also prevents urban sprawl. Cities like Dallas and Atlanta have few zoning restrictions, and with job growth attracting more people than the current transportation system can handle, traffic congestion in these cities is some of the worst in the country. Some average commute times in Atlanta are now over an hour each way. Moreover, businesses are so widespread that it is hard to service all areas using public transportation. People without this public transport option are forced into automobiles, creating more pollution, congestion, and a lower quality of living. In contrast, the city of Milwaukee is compact enough that 45% of workers get to their jobs in less than 20 minutes. Although other reasons for urban sprawl exist, site reuse is one method of reducing it.

Redevelopment/Government Incentives/Community Benefits

Urban redevelopment or Brownfield redevelopment normally means you are developing in a dense development area. These projects sometimes receive incentives from

local/state government to offset any remediation costs associated with the site. A great example is Atlantic Station in Atlanta, Georgia. The community previously consisted of an old, unused steel mill in the downtown area. Now the community has business space, retail areas, and living space—all of which bring in tax revenues and improve the overall appearance and use of the surrounding community.

Site Selection/Transportation

Many potential options exist for building within an urban landscape, but to choose a site near public transportation can help in many LEED areas. It can reduce the number of people who drive to work, thereby reducing the need for parking spaces, which can reduce the heat island effect. Many employees view convenient public transportation as a benefit to their jobs. If fewer people are on the roads, the need for infrastructure spending on new roads, etc., can be reduced. Consequently, this single decision can positively impact your building in many ways and positively impact the local community.

Building Reuse

A site with a building that can be reused has many potential synergies. We will discuss this more as we get into Materials and Resources.

	LT	SS	WE	EA	MR	EQ
LT	X					
SS						
WE						
EA						
MR	X					
EQ						

Location and Transportation Synergies with Indoor Environmental Quality

A site location may impact indoor environmental quality due to views and surrounding air attributes.

Site and Contaminates/Views

The project team can work to choose a location that will provide both views for employees as well as choose a location where outdoor contaminates will be minimized. Although "views" do not necessarily mean a good view or a view of nature, a site with the ability to give employees views of the city, rivers, and green trees is better than a site that will provide views of brick walls or the inside of the parking garage.

Dr. Tina Marie Cade, an associate professor of Horticulture at Texas State University, conducted a survey throughout the Midwest that discovered that employees who worked

in offices with either green plants or windows offering views of green spaces felt better about their jobs and the work they performed than those without the views or plants.

	LT	SS	WE	EA	MR	EQ
LT						
SS						
WE						
EA						
MR						
EQ	X					

Synergies within Sustainable Sites

Here are some synergies of sustainable sites.

Building Footprint/Habitat Protection

A small building footprint really develops synergies in many credit categories. In the sustainable sites category, consider how a smaller footprint allows for more open space, protection of natural habitats, and even the reduction of light pollution. Light pollution may be reduced by making parking lots smaller or placing them underground. If the building is taller versus wider, it may be easier to prevent light trespassing beyond the edge of the project site.

Site Selection/Building Footprint and Rainwater Runoff/Treatment

A site with lots of open space and a small building footprint usually has less rainwater runoff to handle due to onsite infiltration. A site with natural vegetation will be able to filter rainwater naturally through plants and the structure of the topography. Projects in dense areas can use rainwater collected from the roof inside the building or install a vegetated roof that will reduce runoff as well as provide views for employees.

Heat Island Effect / Rainwater Management

Installing a vegetated roof will reduce the heat island effect as well as reduce the amount of rainwater leaving the site. Vegetated roofs can also add insulation to the building, reducing the heating and cooling requirements, and thus saving energy.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X				
EA						

MR						
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Sustainable Site Synergies with Water Efficiency

The location and topography of a site will impact the project team's strategies when it comes to water efficiency.

Protect & Restore Open Space/Water Efficient Landscaping

Using native and adaptive plants as part of your sustainable site can earn major points in water efficiency. The best landscaping would be one that could thrive without regular irrigation. However, if irrigation is necessary, optimize potential water usage by utilizing micro irrigation methods. Landscaping is also a good place to use stored rainwater or graywater from the building and site collection cisterns.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X				
EA		X				
MR						
EQ						

Sustainable Sites Synergies with Energy and Atmosphere

Site Selection (Building Orientation) and Energy Use

Building orientation on a site can significantly impact energy use as it will play a role in providing natural light that reduces the need for electric lighting. In warmer climates, the orientation and design of the building can be done to reduce exposure to harsh sunlight and thereby reduce requirements for air- conditioning. In cooler climates, taking advantage of heat gain can reduce the need for heating.

Reduce Light Pollution/Energy Use

Light pollution can negatively impact nocturnal species and even have adverse effects on humans. Excess light wastes energy, as do lights left on when no one is around who needs the light.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				

WE		X	X			
EA		X				
MR		X				
EQ						

Sustainable Sites and Materials and Resources

The site of the property, the availability of salvaged materials, and the potential for recycling, among other issues, will impact which materials are used.

Sustainable Sites & Local Materials

Local and regional materials are materials that can have less environmental impact. Choosing a site in close proximity to these materials will be advantageous for the project by reducing transportation fees and reducing the pollution associated with longer transportation of faraway materials. This may not be a synergy available for your project. If you have to build in Hawaii, fewer suppliers will qualify for the local/regional LEED credits on the project than a project located in the heart of the United States (e.g., St. Louis, Missouri).

Projects can reuse buildings. Refurbishing warehouses, historic buildings, and other buildings instead of creating new buildings is one way to reduce disturbances to land, generate less waste, and increase reused and salvaged material. Historic theaters have been turned into playhouses. Historic homes have been turned into office space. Warehouses have been turned into lofts, restaurants, art galleries, and more. Recrafting an existing building—especially in areas in which new land is scarce—is a great way to bring green building into a structure that would otherwise continue to be conventionally run or just remain an eye-sore.

Materials and Resources/Heat Island

During the whole building design process, many materials can reduce the heat island effect when properly incorporated. Light-colored concrete with high amounts of fly ash that is sourced and produced locally will meet several credits in Materials and Resources while also reflecting sunlight and reducing heat island areas. Other materials, such as coatings on windows and white roof coatings, will also reflect light as well.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X				
MR		X				

EQ		X				

Synergies within Water Efficiency

Almost any attempt to be more water efficient will impact another area of water use.

Increased Efficiency/Reduced Demand

Increasing fixture efficiency can reduce the water demand from city supplies and aquifers, which reduces operating costs through lower water and sewer fees.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X			
MR		X				
EQ		X				

Water Efficiency and Energy and Atmosphere

A synergy that may not be obvious is the one between reduced water use and reduced energy use. Think of the energy used to heat water for manufacturing processes, showers, or bathroom faucets—using less water will impact the energy used to provide it. You don't have to power a sprinkler system if you don't need irrigation. A regular showerhead will conservatively use 25 gallons of water for a 10-minute shower. A low-flow shower head will use 18—a savings of 7 gallons per shower. Use low-flow fixtures in an eight-story apartment building and not only are thousands of gallons of water being saved, but the energy needed to heat those gallons is also being saved.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X			
MR		X	X			
EQ		X				

Water Efficiency and Materials and Resources

If you are going to purchase items to make your building more water efficient, why not use items made from recycled materials or that are made locally?

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X			
MR		X	X			
EQ		X	X			

Synergies within Energy and Atmosphere

The Energy and Atmosphere category seeks to reduce the use of energy and use renewable energy sources both on and off site to provide and supplement the required amount of energy. Reducing demand and finding an efficient way to reach that demand level can benefit the project.

Energy and Atmosphere is also concerned with systems performing as effectively as possible. This is especially true in Existing Building Management.

Synergies can come from energy use reduction and monitoring activities.

On-Site Renewable Energy— Reducing Energy Demand

Using energy created on site will reduce the demand on the public energy grid. It will likely save the company money and may in fact generate its own revenues when excess energy is sold to utility companies. On the other hand, creating a building with less energy demand will require less on-site renewable energy.

Measuring Performance—Reducing Energy Demand

Many points are given in LEED for lowering energy use from a baseline. Measuring systems' performances and adjusting them when out of alignment will reduce wasted energy.

Purchasing Renewables/Reducing the Demand for Non-Renewable Energy

It may be debatable if it is better to plug your electric car into an outlet powered by a coal burning power plant or just burn gasoline in a normal car, but purchasing green energy comes with no such debate. Utility companies and other green organizations provide green energy for sale. This energy may come from a wind farm or solar power plant. The energy is transferred into the power grid, and, although the source of the electricity used in your light bulb may be different, by purchasing green power, you are investing in these systems and not buying power from conventional sources.

The Energy and Atmosphere category addresses both the using of less conventional power and using more green power. Purchasing green power credits affects both goals.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X	X		
MR		X	X	X	X	
EQ		X	X			

Energy and Atmosphere and Materials and Resources

We've discussed material choice and how it affects the heat island effect. In a similar way, materials can affect how much energy is used on a project. A home or building constructed with an insulated foam frame and poured concrete will have a higher insulation rating than a home or building constructed with wood and fiberglass insulation. A better insulated structure will use less energy for heating and cooling due to the superior building envelope.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X	X		
MR		X	X	X	X	
EQ		X	X	X		

Energy and Atmosphere and Indoor Environmental Quality

Energy efficiency and occupant comfort go hand in hand. A building that provides task lighting allows its occupants to control the amount of lighting they need to work. Better lighting results in better productivity. Task lighting can reduce the amount of light needed for a building as only individual areas need to be illuminated instead of entire spaces. Cutting down on the lighting needs will reduce energy use—one of the greatest expenses in operating a building.

Daylighting is another huge consideration that involves many sustainable design choices. Orienting the building in a certain direction allows more natural sunlight to enter the

building. The natural sunlight provides improved lighting options for the building occupants and reduces energy use.

Underfloor air systems were discussed in the Energy and Atmosphere section. Again, a happy, comfortable employee is a more productive employee. Employees who can easily control their surrounding temperatures with the underfloor air system will likely be more productive. As with lighting, if only certain spaces need to be heated and cooled, the HVAC costs decrease, and there is overall energy savings.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X	X		
MR		X	X	X	X	
EQ		X	X	X		

Synergies within Materials and Resources

Materials and Resources may have some of the highest rates of synergies in the LEED system.

- A refurbished desk from a local company can contribute to regional materials and materials reuse.
- Recycled rubber tires from a local salvage yard used for mulch can contribute to recycled content materials and regional materials as well as indirectly help reduce irrigation needs.
- Doors made of certified wood and steel can contribute to certified wood use and recycled content materials (the steel).

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X	X		
MR		X	X	X	X	
EQ		X	X	X	X	

Materials and Resources and Indoor Environmental Quality

Low VOC materials and Indoor Environmental Quality provide a tremendous incentive to choose materials that are low in volatile organic compounds—materials that give off much fewer pollutants and contaminants. These choices can be made for both existing buildings as well as new construction projects.

Since the team is going to want to purchase and install low VOC materials, why not see if you can find materials that are also recycled, salvaged, or produced locally? Using salvaged or refurbished low VOC items would also reduce a project's waste stream.

For existing buildings, consider these options when replacing furniture, carpet, repainting, or other maintenance items. When buying light bulbs for occupant-controlled lighting choose light bulbs that have low mercury content and can be recycled.

	LT	SS	WE	EA	MR	EQ
LT						
SS		X				
WE		X	X			
EA		X	X	X		
MR		X	X	X	X	
EQ		X	X	X	X	X

Synergies within Indoor Environmental Quality

Occupant Comfort and Thermal & Lighting Control

One of the main goals of Indoor Environmental Quality is to ensure building occupants are comfortable in their surroundings and that their environment has as few contaminants as possible. We've discussed the amount of time people spend at work and in buildings as part of their daily routine, making IEQ a major contributor in whether occupants are productive and happy in the workplace. Lighting, views, and thermal temperatures and controls all contribute to the goal of comfortable employees. Missing opportunities in one of these areas can reduce the satisfaction of employees—consider a wonderfully lit office with views of a park, but 90% of the occupants consider the office space too hot.

Reduce Contaminants/Quality IEQ

Cleaning with environmentally friendly products helps employees avoid breathing in harmful chemicals. Installing the right materials will do the same.

Credit Conflicts

Potential conflicts can exist within sustainable design and the LEED Rating System. These conflicts actually occur with any environmental project. Consider buying a rapidly renewable material, such as bamboo flooring, from a very distant location such as China. Buying the bamboo is a positive environmental step because slow growth hard woods are not being used as flooring. The environmental negative is that transporting the bamboo from China uses much more fossil fuel (for transport) to reach the job site than purchasing local hard woods. Every project team will encounter such conflicts as they pursue the best choices possible. In the end, it is up to your team to determine how to prioritize environmental and employee benefits over the negatives.

Here are some common conflicts:

Increased Ventilation vs. Energy Use

In LEED, points are given to both increasing ventilation for improved indoor air quality and reducing the amount of energy the building will use. It is a common problem that increasing ventilation by operating the HVAC at a higher rate, the owner may need to purchase larger HVAC equipment or run equipment more often. Both larger and more frequently used HVAC equipment will use more energy than lower ventilation rates require.

One possible solution is to remove heating and cooling from the concept of ventilation. Does it require an air conditioner to circulate air for ventilation purposes? Not necessarily. Doesn't working ventilation into the HVAC equipment mix outside air with recirculated air? Yes. One solution may be what the industry terms Dedicated Outside Air Systems. These systems move ventilation outside of the responsibility of heating and cooling and allow the HVAC to run only as required for heating and cooling purposes. The technology of how this works is beyond the scope of this study, but this example demonstrates that alternatives exist to this classic LEED conflict.

Daylighting vs. Glare and Heat

Daylighting can improve employee productivity and reduce the need for indoor lighting. Reducing indoor lighting can reduce heat from lights as well as the need to cool an area due to indoor lighting. At the same time, glare control is listed as one major problem with daylighting. Daylighting strategies must take into account how daylight will affect the workers' ability to see their computer screens or their view across their space. Daylighting in very warm climates may cause those near the perimeter of the building to become warm and need additional cooling. This same heat can be a great benefit for those in cooler climates. When done correctly, daylighting is a great benefit to all projects; however, poor design can increase energy costs and cause employee discomfort.

Renewable/Recycled vs. Transportation

Logistically coordinating transportation of materials that are beneficial to the environment to the job site will involve tradeoffs. An extraordinary example of this is when Toyota flew a hybrid vehicle from Japan to Great Britain to deliver the luxury car to Paul McCartney as a gift after sponsoring one of his tours. The transportation costs were the equivalent of driving the car 300 times around the world. A more sensible option would have been to put the vehicle on a boat for delivery. Regardless, this example just shows how easy it can be to think about the environment without thinking about the environment.

LEED is becoming more widespread and well known daily. Too many manufacturers are out there to cause a Toyota-like mistake. Yes, a project could get bamboo flooring from China, but the project could instead use refurbished timbers from a nearby building that will be demolished or use brick from an old warehouse for flooring. Concrete, obviously being batched near the project site can be used for flooring and can also contain a high amount of recycled fly ash. There are so many great options for sustainable design that a team should "think outside the box" for good local materials.

City Revenues vs. Environmental Savings

The authority over the project—whether a city, unincorporated zone, or state rules and regulations—can sometimes be at cross purposes with environmental efforts. One example is the city of Saratoga Springs, New York. The city saw water use decline. Since the city earns revenues on the sale of water and the people of Saratoga Springs were using less, the city raised taxes on water sales between 5 and 6%. This essentially removed the citizens' financial benefit of using less city water. The positive news is that many cities and states are becoming increasingly aware of how positive environmentally sound buildings can be for their communities.

The "What Ifs"

When discussing credit synergies and environmental choices "what if" questions inevitably arise. These can range from the serious—"What if my plumbing contractors get upset that the waterless urinals require less plumbing and therefore less work and will that affect their pricing?"—to the everyday—"What if everyone has to flush the low flow toilets twice, are we really going to save water?"

Other "what if" questions we've heard include:

> What if someone washes diapers in the laundry, would that mean you can't use the graywater from the laundry?
>
> What if my company does it this way?

What if the fluorescent light bulbs give people headaches?

What if people don't want to bike to work?

What if my building doesn't have those features?

It is important to remember that when working on a LEED project, it is the LEED rules, regulations, and intents that matter. If LEED defines graywater as water from the laundry, than there is no need to wonder what is being washed. If LEED states a process must be done this way, then your company's process needs to be adapted. If some issues with vendors arise or if the project team is unsure about certain environmental actions, it is important to remember the overall goals for LEED and work to accomplish them. "What if" questions will arise; the project team will need to assess and handle them as they arise, deferring to LEED when possible and creating a work-around if you cannot.

Prioritize

Ultimately, it is up to the project team to decide what tradeoffs it will make on the project. No hard and fast rule exists that makes one thing environmentally perfect over something else. Every building and house is different. One last example is using glass dishes that must be washed in hot water versus disposable plates made from starch that will biodegrade. If the project team is willing to earn a point for reduced water use, then the disposable dishes may be the right choice. If the project team seeks to earn a reduction in waste point, then the glass dishes may be best. No authority can say that one decision is 100% right over the other decision. Of course, other factors must be considered besides the LEED points involved: Do your clients or employees want to eat off disposable plates? Do many people eat at your building at all? Can you turn the starch plates into mulch for the landscaping? The best solution might be if team can solve both water use and waste problems; the team may be able to earn an innovation credit for its efforts.

Summary

Some conflicts may emerge when trying to choose the best environmental decision for your projects. There is not a master list to determine what the best choice is in any given situation. The best way to handle these conflicts is using outside-the-box thinking coupled with a determined effort to meet stakeholder needs. Utilizing synergies throughout the whole building design process allows project teams to achieve sustainability (LEED credits) through logic and creativity. In the end, the building exists to serve the people who use it, own it, and live around it.

Case Study: SYSCO Corporate Home Office

After reviewing this case study, we will present the same chart we have been using in this section. Attempt to map out where synergies would occur, and then we'll review potential synergies.

LEED Rating: LEED NC Gold
Location: Houston, Texas
Project Size: 630,000 GSF
Courtesy of: HOK

At the project's inception, a series of design workshops was held. These workshops involved the entire project team of core consultants, including architect, interior designer, landscape architect, civil engineer, MEP designer, lighting designer, contractor, and project development manager. The focus of these workshops was to educate the team on sustainable design issues and opportunities, establish clear goals, align cross-disciplinary strategies in support of these goals, commit to using LEED as the framework for evaluating, tracking, and documenting strategies, and assign responsible parties to all the goals based on the preliminary checklist.

Site

The design team focused on preserving existing site conditions, primarily by restoring 79.4% of the non-building site area with native plantings and managing the rainwater quality and quantity. By creating a well-developed site illumination plan that ensured that no light would trespass past the property line, light pollution was reduced, further minimizing the site's impact. To curtail the urban heat island effect, more than 80% of the roof area was covered by an Energy Star-rated, R-30 insulated roof, and more than 50% of the parking spaces were located underground. The site also supported alternative transportation with bicycle storage and shower facilities as well as preferred parking for alternative fuel vehicles and car/van pools.

Water

With water being such a valuable commodity in southern portions of the United States, the design team was challenged to maximize water efficiency on the campus. By working with native, adaptable, and drought-tolerant plantings, the team minimized irrigation needs, with more than 40% of the site area needing no irrigation. The high-efficiency, drip irrigation system for the remaining 60% of the site area, coupled with these planting measures, allowed for a 77% decrease in potable water consumption. Low-flow fixtures inside the building reduced water consumption in the building by more than 30%.

Energy

A rigorous north-south orientation, high-efficiency, dual-paned, low-E glazing, and fixed exterior shading devices minimized solar heat gain and the energy needed to cool the space during the summer months. During the cooler winter months, the same north-south orientation and additional insulation helped maintain the heat. Mechanical designs, including high-efficiency lighting fixtures with daylight controls and underfloor air distribution systems, were also installed. In total, the building was 35% more efficient than a typical office building when compared to ASHRAE standards.

Materials

The design and construction teams were able to divert more than 68% (over 13,000 tons) of construction waste from the local landfill. In the construction of the new space, the design team also chose materials that were recycled (15%), locally manufactured (more than 25%), and locally sourced (15%).

Indoor Environmental Quality

During construction, the contractor adopted an indoor air quality management plan and worked diligently to minimize exposure of construction workers and end-user occupants to air pollutants. The interiors team specified low-emitting materials, including adhesives, sealants, paints, coatings, carpet, composite wood, and agrifiber products, to reduce exposure to harmful chemicals. Thermal and lighting controls for all workstations and shared group spaces, daylighting for more than 75% of spaces, and direct line-of-sight views for more than 90% of spaces added to a higher quality of life for the end users.

Activity

Notice that the project started with a whole building design approach and really worked to integrate several synergies and strategies to meet the common goals of the project team. This integrated approach meant the project team was able to submit for LEED Gold status and still stay within the budget and program requirements.

We will give you a few minutes to review the case yourself and write down a few of the synergies you can identify in the text. They don't have to be specifically spelled out, but after reviewing possible synergies, what synergies do you think may exist in this project?

Review

You may have come up with more on your own, but consider these synergies based on the case study.

Site Selection

- Using native plants reduced the need for irrigation water

- Having a light pollution reduction plan likely reduced wasted energy
- Energy Star-rated roof coverings promoted insulation and helped reduce the heat island effect
- Having parking spaces underground allowed more site area free for plants (open space) and helped reduce the heat island effect and aided in rainwater management.
- Access to public transportation, car/van pools, and bike racks reduced the need for parking spaces as well

Water Efficiency

- Native plants can reduce the need for irrigation water; the drip irrigation system does this as well.
- Low-flow fixtures reduced water use, but may also reduce energy use.

Energy Efficiency

- The site management of the building helped reduce energy costs during both summer and winter.
- Shading devices not only reduced heat gain, but may have also reduced the heat island effect.
- Added insulation reduced the need to run the HVAC, which may have made employees more comfortable.
- The underfloor air distribution system was not only efficient, but also allowed workers to determine how warm or cool their areas should be kept.
- Reducing the amount of energy the building used could also reduce the amount of green power the project may purchase.

Materials and Resources

- The project team really worked inter-Materials and Resources synergies. The choice of materials not only reduced waste, but also promoted the use of recycled, locally sourced, and manufactured materials.
- We also see how the project team's material choices, such as insulation, roof covering, and fixture choices, affected other areas of the project.

Indoor Environmental Quality

- Efficient lighting, daylighting, and thermal controls can improve employee productivity and satisfaction. In addition, daylighting reduces the need for lighting. Thermal controls may reduce the amount of heating or cooling needed, saving energy.

- Reduced pollutants in the air can reduce employee sick days and give workers a higher quality of life.

Chapter 12 - LEED Green Associate Exam

The LEED Green Associate credential denotes basic knowledge of green design, construction and operations. The two hour LEED Green Associate exam is also a prerequisite for all the LEED AP with specialty exams

In this section we will look at the specifics of the LEED Green Associate Exam, including how to register for the exam and a breakdown of the exam objectives.

Candidate Handbook

The best source of information for LEED Green Associate exam is the LEED Green Associate Candidate Handbook, available at usgbc.org. This guide will have the most up-to-date information and describes in detail information about the exam, including:

- Exam Registration and Scheduling
- Confirming, Canceling, and Rescheduling an Exam
- Accommodations for Candidates With Disabilities
- Exam Specifications and References
- Studying for the Exam
- Examination Day
- Taking the Exam
- Test Center Regulations
- Exam Scoring
- What Happens After the Exam

If you have not done so already, please visit USGBC.org and download the candidate handbook and read through it before proceeding.

Next we will answer some of the common questions people ask about the exam.

Eligibility Requirements

There are no eligibility requirements for the LEED Green Associate exam.

How Do I Register?

To register to take the exam visit www.usgbc.org/leed/credentials

1. You will need to create an account with USGBC if you don't already have one.

2. Once you pay your exam fee you will be able to continue with the exam registration process at Prometric.

If you have any questions about the process or encounter any issues registering contact USGBC's customer service at usgbc.org/contactus

Schedule Ahead

Schedule in advance for when you want to take the exam. How soon you are able to get an appointment depends on your location and how busy the testing center is. You might be able to get an appointment the next day, or you may have to wait three weeks.

Where Do I Take the Exam?

GBCI contracts with Prometric to administer the exams. The exam is administered by Prometric testing facilities in the U.S. and in other areas of the world. Every major city has a Prometric testing center – there are about 275 testing center locations in the United States.

Visit prometric.com/gbci to locate the testing center closest to you.

How Much Does the Exam Cost?

The LEED Green Associate exam costs are:

- $150 for USGBC national members/full-time students
- $200 for all other candidates

Testing Center Rules

Proper ID is required

You must present your government-issued photo ID each time you enter the exam. This can be a passport, driver's license, or military id.

Nothing in your pockets

Nothing may be brought into the exam room with you. At some sites, small lockers are provided for candidates to secure purses, wallets, keys, cellular telephones, pagers, etc. Lockers will not accommodate briefcases, laptop computers or large purses and bags.

No, no, no

No papers, books, food, beverages, bags (including pocketbooks and purses), or electronic devices are allowed in the exam room.

No eating, no drinking, and no tobacco use is permitted exam room.

Scrap paper

Scrap paper and pencils will be provided by the test site staff and will be collected at the conclusion of your exam. Unauthorized paper may not be brought into or removed from the exam room

Leaving the room

You may not leave the exam room without the test proctor's permission. You will need your ID to both leave the room and get back in to continue your test.

About the Exam

You will have two hours to take the exam.

Tutorial

You will have an additional 10 minutes for a tutorial on how the exam software works. If you use the exam simulator from Green Building Education Services, you will already be familiar with the software. .

Exam Format

There are 100 questions on the exam.

Questions are multiple choice and some have more than one answer, such as choose 2 of 4, or choose 3 of 5.

The question will indicate how many answer choices you will need to select. If there are two correct answers, the question will indicate 'Choose 2'. If you do not choose 2, you will be given a warning to fill in another choice or remove a selection.

The question format is similar to what you would see on the SAT or other standardized test. All questions contain between 4-6 possible answer choices. You may be asked to select 1, 2 or 3 answers out of the 4-6 choices given. The question will tell you how many answer choices you must make.

Questions may be "marked" for later review

Students can move forward, backward, and leave questions unanswered during the exam. At the end you will be given a summary of all 100 questions and given a status for each question:

- Complete
- Marked
- Incomplete

At the end of your exam if you have extra time, you can go back and review those questions that you marked or questions that are incomplete.

Partial Credit

This question is consistently asked and is posted frequently on various forums: If a question is asking for two out of four answer choices and I get one of the two answers right, do I get partial credit. The answer to that question is NO, you do not.

Are all exams the same?

The exam you take will not be the same exam your friend takes. Exams are not created that way because if someone fails an exam and retakes it, exam developers do not want the exact same exam being given again (otherwise it becomes too easy to pass). Good exam developers will create a pool of several hundred questions. Your exam will have 100 randomly selected questions from the total questions created. This isn't to say USGBC has written thousands of questions – they may have written only 200. That particular information is proprietary. The reason our practice tests have so many questions is to cover any topic we think you might see on the exam based on the exam objectives.

Study Materials

The Candidate Handbook lists resources that the subject matter experts referenced to develop exam questions. The handbooks states:

> "The primary sources for the development of the LEED Professional Exams are the LEED Rating Systems. The following list of references are not meant to be comprehensive. When combined with the test specifications, the candidate has the material from which the exam is based."

The references listed in the handbook are:

- Green Building and LEED Core Concepts Guide. 3rd Edition

- Reference Guide Introductory and Overview Sections. LEED Building Design + Construction Reference Guide. v4 Edition
- LEED v4 Impact Category and Point Allocation Process Overview
- LEED v4 User Guide

You do not need to go digging through the vast LEED Rating System documents or purchase the LEED Core Concepts Guide or the USGBC Study Guide. This book and the practice test questions cover all of the exam objectives in the Candidate Handbook.

You do not need to purchase a reference guide to study for the LEED Green Associate exam. The reference guides are used for the specialty exams.

Here are additional resources that address subjects found in the exam objectives.

- Green Building Codes Overview
- USGBC Advocacy Campaigns
- LEED Rating Systems
- LEED Credit Library
- USGBC Glossary
- Cost Of Green Revisited
- Sustainable Building Technical Manual: Part II
- The Treatment By LEED ® Of The Environmental Impact Of HVAC Refrigerants

How Do I Know When I'm Ready?

How will you know when you are ready for the actual exam? If you can't measure your readiness, there is no way you will know. A practice test will measure your readiness and tell you in what areas you are strongest and weakest. The LEED exams are challenging. You need at least two things to pass this exam – extensive knowledge of the fundamentals of green building and the environment, and the ability to recall that knowledge in a high pressure exam situation where you only have 2 hours to complete the 100 questions. Some of you have been out of school for 20 years and haven't taken any type of exam in a long time. Use a good practice test to get yourself used to the types of questions you will see on the exam and to practice answering them in less than two hours. Practice tests also help you memorize important information.

Please don't waste your time and money buying a practice test from somebody who passed the LEED exam and decided to make a few bucks writing test questions, or worse – using free practice test questions found on the Internet.

You might save $20 on the practice test, only to lose $200 by having to retake the exam when you fail it the first time. Plus, you will have to keep on studying. Buy your practice tests from a reputable company that has your best interest in mind, employs LEED experts, and specializes in LEED training. Even if you don't buy from us, don't waste your time and money buying 1,000 questions for $20 from someone that doesn't know the first thing about exam development or people who give away free products just to get your email address so they can send you spam.

How Long Should I Study For?

The amount of time you will need to study for this exam is completely arbitrary. Every person studies and learns differently. We all knew someone in high-school or college who could cram an entire semester's knowledge over a weekend and then pass a final exam on Monday with an A. And some people who paid attention and studied all semester would fail the same exam.

The amount of time you will need to study depends on how you learn, how quickly you absorb information, and how comfortable you are with the material. Based on the feedback we receive from our practice test users, the average time a person spends preparing for the exam is 4-8 weeks.

If you are using our practice tests, once you score consistently in the 80-90 percent range, you will be well prepared.

Test Day

Arrive early

On your test day, arrive 15-30 minutes early if desired, but arrive on time. Don't let traffic jams make you miss your exam.

Before the Exam

Tutorial

After you sit down at the Prometric testing facility, you will be given 10 minutes to take a tutorial on how the software works. This will include rudimentary things like how to use a mouse, how to click the next button, how to check an answer, etc. If you have used the Green Building Education Services practice tests, you already know how the exam software works and can go through the tutorial in about 60 seconds.

If you want to take the tutorial ahead of time, check out the Prometric tutorial from their website, free of charge:

http://www.prometric.com/demos/usms/starthere.htm

After quickly running through the tutorial, you have 9 minutes where you can write notes on your scrap paper before the test begins. Write down anything you have memorized that you think will help you on the exam. It is perfectly legal to make notes at this time. You can't take the notes with you when you leave, but many students use this time to write down as much information as possible.

During the Exam

Read each question carefully

You might be nervous or feel stressed out. Take your time to read the question carefully to make sure you understand what is being asked. Note the differences between these questions:

Which strategy is appropriate for increasing water efficiency?
Which strategy is not appropriate for increasing water efficiency?

If you read too fast or are carelessly, you might miss that 'not' which completely changes the correct answer choice.

In our online practice test we have a feature that lets customers 'Send Comments' about the question they are reviewing. Ninety percent of the questions customers ask are a direct result of not reading the question carefully.

Answer every question

If you leave a question blank, you get no points for it. At least take an educated guess. Go through the exam one time, and mark any questions for review later. Time permitting, you can go back through the exam and review the marked questions.

Use other questions/answers to jog your memory

Some questions and answer choices might remind you of something you have studied. That information might apply to another question on the exam. Make a note and review it at the end of your exam.

Some questions don't count against your score

Of the 100 questions you will see on your exam, 15 of the questions do not count towards or against your final score. You will not know which questions they are so do your best to answer everything.

Unscored items are used to gather performance data to inform whether the item should be scored on future exams.

After the Exam

Scores are revealed a few moments after the test is completed and submitted. All candidates receive diagnostic information on their performance in the seven major test subject areas.

A scaled scoring process is used on the LEED exams. Scores can range from 125 to 200 but candidates must achieve a minimum score of 170 to pass the exam.

A 170 is needed to pass, but since questions are scaled, this does not translate to an exact number of questions. This does NOT mean that you need to get 70 out of 100 questions correct. If someone tells you differently, they do not know how exams are developed.

After the Exam: Pass

Prometric staff will print out a copy of the exam results and mark them with an imprint. Certificates are printed and mailed six to eight weeks after the exam date to the address you entered when creating your account.

You can choose to have your professional information published in the USGBC Directory through your USGBC account.

After the Exam: Fail

To avoid losing all the information you memorized from studying, schedule your retake exam within 2 weeks. When preparing for the next time, focus on the exam sections in which you did poorly.

Exam candidates will be charged the full exam fee for each exam session scheduled.

Exam Objectives

There are nine knowledge domains in the LEED Green Associate Exam. These domains are:

1. LEED Process (16 questions)

2. Integrative Strategies (8 questions)
3. Location and Transportation (7 questions)
4. Sustainable Sites (7 questions)
5. Water Efficiency (9 questions)
6. Energy and Atmosphere (10 questions)
7. Materials and Resources (9 questions)
8. Indoor Environmental Quality (8 questions)
9. Project Surroundings and Public Outreach (11 questions)

In the LEED credentialing program there are three levels – basic, advanced, and extraordinary. The LEED Green Associate Exam addresses the basics of green building, as they apply to all of the LEED Rating Systems. You could think of it as the 'least common denominator' of all the Rating Systems. If you compare the LEED credentialing program to traditional education, you could think of LEED Green Associate as your high-school SAT. The LEED AP specialty exams would be your GMAT or GRE, and the LEED Fellows would be like a PHD. The higher up you go the more details you will need to know about LEED.

In a credentialing program with multiple tiers, the lowest, or basic tier always covers subjects 'about an inch deep and a mile wide'. That is, you won't get a question that can only be answered by a detailed reading of the reference guides. Remember – the reference guides were NOT listed as a source of study material in the candidate handbook. That's because that level of knowledge isn't required. As you move up to the advanced LEED AP specialty exams and start working on LEED projects, the exams become more focused. Instead of the material being an inch deep and a mile wide, it becomes a mile deep and a foot wide. The LEED Green Associate exam covers broad green building areas addressing the core concepts of LEED.

The great thing about the exam objectives published by the USGBC is the amount of insight they provide into what you will need to study. Just looking at the exam objectives you can find over fifty terms to become familiar with.

Review the glossaries referenced and be able to define the terms.

As we look at each exam objective we will pose questions you should be able to answer.

Definitions

Before we look at each objective - a word about green building terminology.

In order to talk the talk about green building, work on a green building project, or discuss energy efficiency and environmentally preferable design strategies, you should be able to define and speak intelligently about every keyword listed in this guide, every glossary word, and every term or definition listed in the Candidate Handbook. It is very unlikely you could discuss 'demand response', if you can't define what demand response is and where you would use it in a project. Likewise, when you think of open space you probably picture an area with turf grass. Do you know how LEED defines exterior open space? It isn't defined as an area with turf grass.

Learn your terms and definitions first.

LEED Process

In this domain all aspects of the LEED process are covered. Topic areas include:

- Organization fundamentals
- Structure of LEED rating systems
- Scope of each LEED rating system
- LEED development process
- Impact categories
- LEED certification process
- Components of LEED Online and Project Registration
- Other rating systems

Organization fundamentals

Know the purpose of USGBC and what its goals are.

- What is the mission of USGBC?
- What roles does GBCI perform?

Structure of the LEED rating systems

Understand what credit categories are, prerequisites, credits, and minimum program requirements.

- What is the difference between a prerequisite and a credit?
- How many points do prerequisites earn?
- What are Minimum Program Requirements?
- What is the difference between a prerequisite and a MPR?
- What is Regional Priority used for?

- What is the minimum number of points a project must earn for certification?

Scope of Each LEED Rating System

Select which rating system would be appropriate for a given project description. The residential project types are important to know because the rating system you use depends on the height of the project.

- Which LEED Rating System will you select? Would you use the LEED BD+C: New Construction or the LEED ID+C: Retail Rating System? Each rating system applies to a type of project and has specific requirements that must be met.
- What rating system should be used for a tenant space?
- What rating system would be best for a 3-story residential building?

LEED Development Process

This section makes sure you understand how LEED is developed and by whom, as well as how LEED is updated and changes over time.

- Who approves the LEED rating systems?
- What makes LEED transparent?
- How often is addenda published?

Impact Categories

Make sure you read the overview of the LEED v4 impact category and point allocation process.

- How are credit points determined?
- How do credit weightings evolve?
- What are the LEED impact categories?

LEED Certification Process

For this objective you need to know the tools and components used when working on a LEED project.

- What is LEED Online used for?
- How do you register a project?
- What is a LEED Scorecard?
- When is the LEED Scorecard used?
- What does the LEED reviewer do?
- What is a CIR?

Other Rating Systems

Know what other rating systems are out there and how they compare or complement LEED.

- What is the International Green Construction Code?
- What is ASHRAE 189.1?

Requirements to Earn the LEED AP Credit

Each rating system awards points for having one LEED AP as a principal on a project. That means you can't have a part-time LEED AP or someone who only focuses in one area of the project. The rating system documents contain the full requirements for this credit.

- What credit can you earn by having a LEED AP on a project?
- What does the LEED AP do?
- Who can be a LEED AP?

Integrative Strategies

This domain addresses:

- Integrative process
- Integrative project team members
- Standards that support LEED

Integrative Process

A big focus in LEED is on the integrative process – what is and who is involved, and what problems it solves.

- What happens in a LEED charrette?
- How does the integrative process differ from conventional building?
- What additional steps are there in an integrative process?

Integrative Project Team Members

While all team members should be part of the integrative process, some will be more involved than others during different parts of the project

- What is the role of the facility manager?
- Who should be invited to the LEED charrette?

- What role does a LEED AP have on a project?

Standards that Support LEED

Many LEED prerequisites and credits have requirements that are based on meeting third party standards. For example, one part of the ASHRAE standards addresses HVAC. LEED doesn't have its own HVAC standard; it just references the ASHRAE standard. LEED most often references ASHRAE standards 90.1, 62, and 55.

ASHRAE Standard 90.1 sets minimum requirements for the energy-efficient design of buildings, including HVAC and lighting systems.

ASHRAE Standard 62 establishes ventilation requirements for acceptable indoor air quality.

ASHRAE Standard 55 establishes acceptable thermal environmental conditions for occupancy.

Become familiar with these and all standards found in this study and to what areas of the project the standards are referenced.

- What do the ASHRAE standards do, and where are they used?
- What is the Green Seal standard, and what type of material does it address?
- What is SMACNA and where is it used in the construction process?
- What standard is used for certified wood?
- Etc.

Location and Transportation

This domain addresses:

- Site selection
- Alternative transportation

Site Selection

Locating a project in a dense area near diverse uses addresses ways to reduce pollution by reducing the number of single occupant drivers. This objective focuses on the area around the site and providing pedestrian access.

- What are examples of diverse uses?
- What are strategies to reduce parking?

- What project locations are best for reducing impacts to the environment?
- How is pedestrian access provided?

Alternative Transportation

This objective addresses transportation demand and access to mass transit.

- How can single occupancy driving be reduced?
- What are examples of alternative transportation?

Sustainable Sites

This domain addresses:

- Site assessment
- Site design and development

Site Assessment

Understand the importance of doing a site assessment.

- When should a site assessment occur?
- What would a site assessment reveal?

Site Design and Development

This exam objective covers all of the different impacts the design decisions will have once a site is selected.

- What strategies will prevent construction activity pollution prevention?
- What are the benefits of rainwater management?
- How can you reduce light pollution?
- What is a heat island?
- What is SRI?

Water Efficiency

This domain addresses:

- Outdoor water use
- Indoor water use
- Water performance management

Outdoor Water Use

This objective tests the different strategies for reducing water use on a project.

- How can you reduce landscape irrigation needs?
- What is rainwater harvesting?
- What type of water should be used for irrigation?

Indoor Water Use

You will hear about the types and quality of water repeatedly in LEED, because there are many synergies between the water credits and other credit categories.

- What is an example of a waterless fixture?
- What is the flow rate of a standard shower?
- What is graywater?
- What is blackwater?

Water Performance Management

This objective addresses metering of water consuming systems.

- What are submeters used for?
- What building systems should be metered?

Energy and Atmosphere

This domain addresses:

- Building loads
- Energy efficiency
- Alternative and renewable energy practices
- Energy performance management
- Environmental concerns

Building Loads

Understanding the systems that consume energy in a building helps project teams focus on those systems that can have the most impact.

- What is process energy?
- What systems consume the most energy in a building?

Energy Efficiency

After reducing energy demand, energy efficiency should be promoted to use less energy while doing the same amount of work.

- What is the difference between reducing energy demand and increasing energy efficiency?
- What role does commissioning have in a building?
- What is the payback period for commissioning?

Alternative and Renewable Energy Practices

This exam object covers the different types of renewable energy and energy reduction.

- What is a REC?
- Who certifies green power?
- Who triggers a demand response event?
- What are carbon offsets measured in?

Environmental Concerns

This exam objective focuses on chemicals that cause ozone depletion and global warming and how the use of these chemicals can be reduced or eliminated.

- What are halons?
- What are CFCs?
- What does ozone protect?

Materials and Resources

This domain addresses:

- Reuse
- Life-cycle impacts
- Waste
- Purchasing and declarations

Reuse

Understand the best thing you can do for the environment is reuse materials.

- What is the environmental benefit of reusing a building?
- What is a social benefit of reusing materials?

Life-cycle Impacts

Describe what a life-cycle assessment is and how it would be used by the project team to influence the decision making process.

- What information does a life-cycle assessment provide?
- What are examples of materials that have a reduced impact on the environment?
- What is an example of designing for flexibility?

Waste

Be able to identify ways to reduce construction waste.

- What types of materials can be recycled or reused?
- What is source reduction?
- What goes into a construction waste management plan?
- What is a waste stream audit?

Purchasing and Declarations

Understand the product documentation available and use it to make better material choices.

- What is an environmental product declaration (EPD)?
- What information is included in a health product declaration (HPD)?
- What documentation provides transparency for a product?

Indoor Environmental Quality

This domain addresses:

- Indoor air quality
- Lighting
- Sound
- Occupant comfort, health, and satisfaction

Indoor air quality

Understand the human benefits of good indoor air quality and how to achieve good indoor air quality.

- What should be included in a green cleaning program?

- What should a contractor protect during construction?
- How can dirt be kept out of a building?
- What must occur for tobacco smoke control?

Lighting

Know the importance of lighting in a building both in terms of energy use but occupant productivity.

- What are strategies to increase daylighting?
- What must be addressed for a good daylighting design?

Sound

Describe the benefits of acoustics to occupants.

- What does a good acoustic design help with?
- What design decisions improve acoustics?
- What rating system requires good acoustics?

Occupant comfort, health, and satisfaction

Understand the strategies used to keep occupants happy and healthy.

- What types of systems provide occupant controllability?
- What are examples of good thermal comfort design?
- What is the benefit of providing controllability of systems?

Project Surroundings and Public Outreach

This domain addresses:

- Environmental impacts of the built environment
- Codes
- Values of sustainable design
- Regional design

Environmental Impacts of the Built Environment

This section has questions on the ‘why’ of green building

- What is the triple bottom line?

- What design decisions would positively impact the social aspect of the triple bottom line?
- Why do we need green buildings?
- How much energy do buildings use?

Codes

Every project will have state and local codes that need to be followed. You don't need to learn all the codes in your city. You do need to know that there *are* codes, and that local codes always take precedent over any LEED rules.

Be sure to read the Green Building Codes Overview document provided by USGBC.

Values of sustainable design

- What are hard costs, life cycle costs, and soft costs?
- What type of cost is the purchase of the site?
- What is life cycle costing?
- What is life cycle assessment?
- How does the cost of a green building differ than that of a conventional building?

Regional Design

- What climates are not good for a high reflectance roof?
- What are regional priority credits?

Important Standards

ANSI - American National Standards Institute - ANSI serves as an administrator and coordinator of the United States private sector voluntary standardization system. The Institute remains a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations. ANSI facilitates the development of American National Standards (ANS) by accrediting the procedures of standards developing organizations (SDOs). These groups work cooperatively to develop voluntary national consensus standards. Accreditation by ANSI signifies that the procedures used by the standards body in connection with the development of American National Standards meet the Institute's essential requirements for openness, balance, consensus and due process.

Related Credit Categories
All. ANSI overseas thousands of standards and guidelines.

ASHRAE - The American Society of Heating, Refrigerating and Air-Conditioning Engineers - The mission of ASHRAE is to advance the arts and sciences of heating, ventilating, air conditioning and refrigerating to serve humanity and promote a sustainable world. Many of ASHRAE's standards are used in LEED.

ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size establishes a test procedure for evaluating the performance of air-cleaning devices as a function of particle size. The standard classifies the sizes of particles into ranges. These ranges are then used to determine a filter's Minimum Efficiency Reporting Value (MERV). MERV ratings go from 1-16, with 1 filtering the least and 16 filtering the most. LEED usually requires MERV 8 or better during construction and MERV 13 or better for occupied buildings.

Related Credit Categories
Indoor Air Quality, Increased Ventilation, Construction IAQ Plan, IAQ Best Management Practices

ASHRAE 55 - Thermal Environmental Condition for Human Occupancy specifies the combinations of indoor space environment and personal factors that will produce thermal environmental conditions acceptable to 80% or more of the occupants within a space.

Temperature
Thermal radiation
Humidity
Air speed;
Personal factors: activity and clothing

Related Credit Categories
Thermal Comfort Design, Thermal Comfort Verification, Controllability of Systems, Indoor Environmental Quality, Increased Ventilation, Occupant Comfort, etc.

ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality addresses indoor air quality issues and prescribes minimum ventilation rates so as to reduce the potential for adverse health effects. The standard specifies the design of mechanical or natural ventilation systems that will prevent uptake of contaminants, minimize growth and dissemination of microorganisms, and, if necessary, filter particulates. The standard also specifies proper makeup air inlet and exhaust air outlet locations relative to potential sources of contamination.

Related Credit Categories
Indoor Environmental Quality, Environmental Tobacco Smoke, Increased Ventilation, IAQ Best Management Practices

ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
This standard establishes minimum requirements for the energy efficient design of buildings. Topics covered include the building envelope, HVAC, service water heating, power, lighting and other equipment.

Related Credit Categories
Energy Use, Minimum Energy Performance, Lighting, Ventilation, Light Pollution

ASTM - American Society for Testing and Materials is a source for technical standards for materials, products, systems, and services. ASTM appears in LEED in relationship to evaluating products, such as finding a product's emissivity or solar reflectance index number. ASTM also has standards related to leakage rates of air and light transmittance through an object.

Related Credit Categories
Heat Island Effect, Daylight and Views, Indoor Environmental Quality, Environmental Tobacco Smoke, Brownfield Sites, Energy Efficiency, Ventilation Rates

CFRs - US Code of Federal Regulations - is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. LEED uses CFRs to define farmland and wetlands.

Related Credit Categories
Site Selection

Clean Air Act, Title VI, Rule 608 - Under Section 608 of the Clean Air Act of 1990, the EPA established regulations on the use and recycling of ozone -depleting compounds.

Related Credit Categories
Energy and Atmosphere, Fundamental and Enhanced Refrigeration Management, Ozone

Commercial Buildings Energy Consumption Survey (CBECS) - is a national sample survey that collects information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures. Commercial buildings include all buildings in which at least half of the floorspace is used for a purpose that is not residential, industrial, or agricultural, so they include building types that might not traditionally be considered "commercial," such as schools, correctional institutions, and buildings used for religious worship. In LEED, project teams use the CBECS to compare their building's energy use to other similar buildings' energy use.

Related Credit Categories
Minimum Energy Performance, Optimize Energy Performance, Energy and Atmosphere,

EcoLogo - provides customers with assurance that the products and services bearing the logo meet stringent standards of environmental leadership. There are thousands EcoLogo Certified products and in LEED is referred to in sustainable purchasing and green cleaning.

Related Credit Categories
Sustainable Purchasing, Green Cleaning

Energy Policy Acts of 1992 (EPAct) - created standards and laws to increase clean energy use and improve overall energy efficiency in the United States. This act covers building codes, utilities, HVAC, lighting, renewable energy and water flow of fixtures

Related Credit Categories
Water Efficiency, Water Use Reduction, Process Water Use Reduction, Indoor Environmental Quality, Renewable Energy, On-site Renewable Energy

ENERGY STAR - is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices. ENERGY STAR-qualified products include electronic office equipment such as computers, copiers, fax machines, digital duplicators, notebook computers, mailing machines, external power adapters, monitors, printers, scanners, etc. ENERGY STAR-qualified office products meet energy consumption specifications and use 30% to 75% less electricity than standard equipment.

Related Credit Categories
Energy and Atmosphere, Sustainable Purchasing

ENERGY STAR Portfolio Manager - The Portfolio Manager helps track and assess energy and water consumption within individual buildings as well as across an entire building portfolio.

Related Credit Categories
Energy and Atmosphere, Measurement and Verification, Energy Performance, Water Efficiency

FloorScore Testing Program - Resilient Floor Covering Institute's FloorScore program tests and certifies flooring products for compliance with indoor air quality emission requirements adopted in California.
Flooring products included in the program are vinyl, linoleum, laminate, wood, ceramic, and rubber flooring, wall base, and associated products.

Related Credit Categories
Indoor Environmental Quality, Low-Emitting Materials

Forest Stewardship Council - is an international certification and labeling system for products that come from responsibly managed forests and verified recycled sources. FSC has 3 labels for FSC-certified wood products:

100% FSC-all wood is from well managed forests
Mixed Source FSC- both wood from FSC certified forests, recycled, and other noncontroversial sources
Recycled FSC - 100% recycled content

Related Credit Categories
Certified Wood, Materials and Resources

Green-e - energy certification program is a voluntary certification and verification program for renewable energy products. Green-e certifies products that meet environmental and consumer protection standards. Three types of renewable energy options are eligible for Green-e certification: renewable energy certificates, utility green-pricing programs, and competitive electricity products.

Related Credit Categories
Energy and Atmosphere, Renewable Energy, Green Power

Green Label and Green Label Plus Testing Programs - Created by the Carpet and Rug institute, these programs set VOC limits for carpet (Green Label Plus) and carpet cushion (Green Label).

Related Credit Categories
Indoor Environmental Quality

Green Seal - Green Seal is an independent nonprofit organization that promotes the manufacture and sale of environmentally responsible consumer products. In LEED Green seal usually is used as the standard for low VOC materials and green cleaning.

Related Credit Categories
Materials and Resources, Indoor Environmental Quality, Low-Emitting Materials, Sustainable Purchasing, Green Cleaning

IESNA (Illuminating Engineering Society of North Americas) - specifies lighting power densities for external lighting to help reduce light pollution.

ISO 14000 - product oriented standards include Environmental Labels and Declaration, Life Cycle Assessment, and Design for Environment. These standards are intended to be applicable for assessing the environmental performance of products and services as well as providing guidance on improving their environmental performance.

ISO 14021 - International Standards Organization - This standard regulates self-declared environmental claims. For example, this standard regulates how companies can declare the recycled content of a product.

Related Credit Categories
Materials and Resources, Recycled Content

Montreal Protocol - This is the name of an international treaty that has the goal of phasing out CFCs and HCFCs in refrigerants for new and existing equipment. This relates to ozone depletion.

Related Credit Categories
Energy and Atmosphere, Ozone

South Coast Air Quality Management District (SCAQMD) - The South Coast Air Quality Management District is a public agency in southern California with the mission to maintain healthful air quality. It has several rules. Some apply to the use of adhesives, adhesive bonding primers, adhesive primers, sealants, and sealant primers or any other primers in buildings while others deal with coatings or conducting employee surveys.

Related Credit Categories
Indoor Environmental Quality, Sustainable Sites, Alternative Transportation

WaterSense - is a partnership program sponsored the EPA, helping consumers identify water-efficient products and programs.

Related Credit Categories
Water Efficiency, Energy and Atmosphere, Water Use Reduction

Wingspread Principles on the U.S. Response to Global Warming: a set of principles people and organizations can sign to show support for addressing the issue of climate change

Glossary

acid rain: precipitation that is unusually acidic. It has harmful effects on plants, aquatic animals, and infrastructure. Acid rain is mostly caused by human emissions of sulfur and nitrogen compounds which react in the atmosphere to produce acids. In recent years, many governments have introduced laws to reduce these emissions.

adaptive plant: non-native plants that use less fertilizer, pesticides and water in a given landscape. These plants have adapted to the local climate and are not considered invasive plants or weeds.

adaptive reuse: adaptive reuse is the process of adapting old structures for purposes other than those initially intended. This saves on new materials needed. Example: warehouse turned into condos. Also refers to the design of a new building with consideration to what it could be used for in the future.

agrifiber product: products made from agricultural fiber such as wheat board and straw board

air conditioning: a system or process for controlling the temperature, humidity, and sometimes the purity of the air in an interior space (office, warehouse, residence).

air quality standards: The level of pollutants prescribed by regulations that are not to be exceeded during a given time in a defined area. (EPA)

airborne pollutant: Any substance in air that could, in high enough concentration, harm man, other animals, vegetation, or material. (EPA)

albedo: a material's ability to reflect sunlight measured on a scale of 0 (black) to 1 (white). A value of 0.0 indicates that the surface absorbs all solar radiation and a value of 1.0 represents total reflectivity.

alternative fuel vehicle: any method of powering an engine that does not involve solely petroleum (e.g. electric car, petrol-electric hybrid, solar powered)

ambient temperature: temperature of the surrounding air or other medium (EPA)

aquifer: an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well. Aquifers are critically important in human habitation and agriculture. Deep aquifers in arid areas have long been water sources for irrigation. Many villages and even large cities draw their water supply from wells in aquifers.

ASHRAE: The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE; pronounced ash-ray) is an international technical society for all individuals and organizations interested in heating, ventilation, air-conditioning, and refrigeration (HVAC&R).

baseline building performance: total building energy costs (including all plug loads) annually. This value is intended to be used to compare against design cases to compute energy savings from a proposed design.

baseline vs. design: the comparison between a standard gage and the estimated in a building's design scenario. In LEED, the baseline usually refers to the EPAct 1992 water flow and flush rates.

baseline vs. actual use: the comparison between a standard gage and an actual result. In LEED, the baseline usually refers to the EPAct 1992 water flow and flush rates while actual use would represent an existing building

biodegradable: capable of being decomposed by natural agents, especially bacteria

biodiversity: the variation of life forms within a given ecosystem or for the entire Earth. Biodiversity is often used as a measure of the health of biological systems.

biofuel: solid, liquid or gaseous fuel derived from relatively recently dead biological material and is distinguished from fossil fuels, which are derived from long dead biological material

biomass: a renewable energy source, refers to plant matter grown to generate electricity or produce biofuel. It excludes organic material which has been transformed by geological processes into substances such as coal or petroleum.

bioswale: are landscape elements designed to slow the flow of rainwater and increase ground water recharge while also removing silt and pollution from surface runoff water. They consist of a depressed drainage course with gently sloped sides and filled with vegetation, compost and, or soils.

blackwater: treatment and definitions of blackwater vary - in some jurisdictions, blackwater is wastewater generated from toilet flushing; in others, it includes water from kitchen sinks or laundry facilities. It is distinct from greywater or sullage, the residues of washing processes. Check with local codes for the area's definition of blackwater.

British Thermal Unit (Btu): a term used in the United States to describe the heating or cooling capacity of a system or fuels. The BTU is understood to represent BTUs per hour

when referring to power. The Btu derives its measurement from the amount of energy it takes to raise the temperature of one pound of water by one degree Fahrenheit.

brownfields: previously used or redeveloped land that may be contaminated with hazardous waste or pollution (USGBC). The land has the potential to be reused once any hazardous substances, pollutants, or contaminants are remediated.

building codes: a set of rules that specify the minimum acceptable level of safety for constructed objects such as buildings and non-building structures. Building codes protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. Building codes are applied by contractors and architects and enforced by the issuing authority, such as city inspectors.

building commissioning: is the process of verifying, in new construction, that all the systems and subsystems are efficiently designed and installed properly to achieve the owner's project requirements and as designed by the building architects and engineers.

building density: floor area of the building divided by the total area of the site, computed as square feet per acre.

building envelope (building shell): the exterior surface of the building including all walls, windows, floor, and roof. It is what separates a building's inside from the outside.

building footprint: The area of the building as defined by the perimeter of the structure. Parking lots, walk ways, and landscaping are not included

building related illness: when symptoms of diagnosable illness are identified and can be attributed directly to airborne building contaminants. (EPA)

built environment: the human-made surroundings that provide the setting for human activity, ranging in scale from personal shelter and buildings to neighborhoods and cities

byproduct: material, other than the principle product, generated as a consequence of an industrial process or as a breakdown product in a living system. (EPA)

carbon dioxide (CO_2) : A colorless, odorless gas that is present in the atmosphere and is formed when any fuel containing carbon is burned. It is breathed out of an animal's lungs during respiration, is produced by the decay of organic matter, and is used by plants in photosynthesis.

carbon dioxide concentrations / monitoring: the monitoring of CO_2 gasses in the air for the purposes of assessing indoor air quality

carbon footprint: an assessment of the greenhouse gases (which includes more than just CO2) emitted by a particular organization, project, or activity.

carbon neutrality: achieving net zero carbon emissions by balancing the carbon footprint with an equivalent amount of sequestered or offset greenhouse gases.

carpool: when two or more people share a ride in the same vehicle

charrette (pronounced [shuh-ret]): an intense collaborative session where participants make a concerted effort to solve a problem or plan the design of something.

chiller: part of a refrigeration system, a machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle

chlorofluorocarbons (CFCs) : Any of various halocarbon compounds consisting of carbon, hydrogen, chlorine, and fluorine, once used widely as aerosol propellants and refrigerants. Chlorofluorocarbons are believed to cause depletion of the atmospheric ozone layer.

closed system: A system with a closed loop, and is thought of as more sustainable. For example, plants growing in a field, grow, produce oxygen, take in water, then die and decay which helps plants grow. Closed systems can be linked so one system uses the byproducts of another.

commingled recycling: when all recyclables for collection are mixed but kept separate from other waste.

commissioning : systematic process of assuring that a building and its systems performs in accordance with the design intent and the owner's requirements.

commissioning plan: document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

commissioning report: documentation of the results of the commissioning process, including the as-built state of the HVAC system and any unresolved issues found at the time the commissioning process was completed

compact fluorescent lamp (CFL): a type of fluorescent lamp designed to replace an incandescent lamp and fit into existing light fixtures formerly used for incandescent bulbs. Compared to incandescent lamps giving the same amount of visible light, CFLs generally use less power, have a longer rated life, but a higher purchase price

composite wood (also called engineered lumber): wood manufactured by binding together the strands, particles, fibers, or veneers of wood, together with adhesives, to form composite materials.

conservation: the careful utilization of a natural resource in order to prevent depletion.

construction and demolition debris: Waste building materials, dredging materials, tree stumps, and rubble resulting from construction, remodeling, repair, and demolition of homes, commercial buildings and other structures and pavements.

construction waste management plan: administrative and procedural requirements for salvaging, recycling and disposing of non-hazardous demolition and construction waste – this means it should cover waste sent to a landfill, salvaging, and recycled waste.

contaminant: An unwanted airborne constituent that may reduce acceptability of the air. (ASHRAE 62.1-2004)

conventional irrigation: watering using above-ground sprinkler heads.

cooling tower: heat removal devices used to transfer process waste heat to the atmosphere. Large office buildings, hospitals, and schools typically use one or more cooling towers as part of their air conditioning systems.

construction waste management plan: plan that covers how waste will be either disposed or reused or recycled by addressing sorting, collection, and final disposal of items used in the construction or renovation process

cradle to cradle: a term used in life-cycle analysis to describe a material or product that is recycled into a new product at the end of its useful life. An example of a closed system.

cradle to grave: the linear view of the life of a product, from creation to the end of useful life, ie disposal.

credit interpretation rulings (CIRs): process for project teams to obtain technical guidance on how LEED requirements pertain to their projects

corporate sustainability report (CSR): a third-party verified report that includes information on how the manufacturer extracts or sources materials.

custodial effectiveness assessments: a survey of building occupants that asks questions about the green cleaning program and helps determine if occupants are exposed to pollutants

daylighting: the practice of placing windows, or other transparent media, and reflective surfaces so that, during the day, natural light provides effective internal illumination.

demand response (DR): a resource that allows end-use electric customers to reduce their electricity usage in a given time period, or shift that usage to another time period, in response to a price signal, a financial incentive, an environmental condition or a reliability signal.

demand response (DR) event: A specific period of time when the demand response program administrator (utility company) calls for load curtailment from its program participants.

development density: total square footage of buildings in a particular area divided by acre amount of the same area, expressed as SF/Acre. For example 20,000 SF per acre

development footprint: the area of the project site that has been disturbed for development. This area includes the building footprint, hardscapes, and parking lots.

diversion rate: the percentage of waste materials diverted from traditional disposal such as landfilling or incineration to be recycled, composted, or re-used.(EPA)

diverse use: a distinct, officially recognized business, nonprofit, civic, religious, or governmental organization, or dwelling units (residential use) or offices (commercial office use). It has a stationary postal address and is publicly available. It does not include automated facilities such as ATMs, vending machines, and touchscreens. (USGBC)

diversity of houses: a mixture of sizes and cost of houses in an area that allows for a mixture of socioeconomic types of people in an area – i.e. young families and older couples in a neighborhood

drip irrigation: method which minimizes the use of water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters.

dry pond (detention ponds): used to store excess rainwater. Dry ponds are basins whose outlets have been designed to detain rainwater runoff for some minimum time (e.g., 24 hours). The rainwater will slowly seep into the ground to recharge aquifers or discharge

as determined by the pond design to allow pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool of water.

ecosystem: A collection of living things and the environment in which they live. For example, a prairie ecosystem includes coyotes, the rabbits on which they feed, and the grasses that feed the rabbits.

embodied energy: all the energy used to grow, extract and manufacture a product, transport it to the jobsite, complete the installation, and finally dispose of it at the end of its life cycle.

emergent properties: properties or patterns that a complex system has, but which the individual members do not have. The end result is that the system now has more than just the sum of its parts. For example, saltiness is a property that neither sodium or chlorine have, but when combined they create the property of saltiness

emissivity*:* of a material is the ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature. It is a measure of a material's ability to radiate absorbed energy.

energy conservation: any behavior that results in the use of less energy. Turning the lights off when you leave the room and recycling aluminum cans are both ways of conserving energy.

energy efficient: the use of technology that requires less energy to perform the same function. A compact fluorescent light bulb that uses less energy than an incandescent bulb to produce the same amount of light is an example of energy efficiency. The decision to replace an incandescent light bulb with a compact fluorescent is an example of energy conservation.

energy management system: A control system capable of monitoring environmental and system loads and adjusting HVAC operations accordingly in order to conserve energy while maintaining comfort. (EPA)

energy star portfolio manager: an interactive energy management tool
for tracking and assessing energy and water consumption across an entire portfolio of buildings

energy star rating: Energy Star ® is a program that was first developed in 1992 by the US Environmental Protection Agency (EPA) as a method to identify and promote products that are energy efficient. Products carrying this symbol provide a way for

businesses and consumers to save money, while at the same time, protect our environment.

energy use intensity (EUI): a unit of measurement that describes a building's energy use relative to its size. A building's EUI is calculated by taking the total energy consumed in one year measured in kBtus and dividing it by the total floorspace of the building. For example, if a 50,000-square-foot school consumed 7,500,000 kBtu of energy last year, its EUI would be 150. Generally, a low EUI signifies good energy performance. (energystar.gov)

environmental sustainability: Long-term maintenance of ecosystem components and functions for future generations.(EPA)

environmental tobacco smoke (ETS) : Mixture of smoke from the burning end of a cigarette, pipe, or cigar and smoke exhaled by the smoker. (EPA)

environmentally preferable products: products that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance or disposal of the product or service. (EPA)

environmental product declaration (EPD): a statement that the item meets the environmental requirements of ISO 14021–1999, ISO 14025–2006 and EN 15804, or ISO 21930–2007

environmental sustainability: long-term maintenance of ecosystem components and functions for future generations (EPA)

erosion: the carrying away or displacement of solids (sediment, soil, rock and other particles) usually by the agents of currents such as, wind, water, or ice by downward or down-slope movement in response to gravity

erosion and sedimentation control plan: a written plan that outlines strategies to reduce rainwater runoff for the purposes of reducing erosion, pollution and sedimentation of nearby bodies of water, especially important during construction where so much dirt, dust, and waster are present.

evapotranspiration: water leaving plants and soil and returning back to the atmosphere

externality: A side effect or consequence of an industrial or commercial activity that affects other parties without this being reflected in the price of the goods or services

involved, i.e. the pollution created in power generation for one state blown over another state

feedback loop: information of a result of a system returning to the system so that the system can make appropriate modifications. Think of a thermostat reading the indoor air temperature. Information must flow to make a feedback loop. Without information, changes are less likely to happen.

fenestration: any opening in a building, such as windows, doors, skylights, curtain walls, etc., designed to permit the passage of air, light, vehicles, or people.

floodplain: flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding

floor area ratio: the relationship between the total building floor area and the allowable land area the building can cover (USGBC)

flush-out: when large amounts of outdoor air are forced through a recently completed building for a period of time so that the majority of pollutant emissions from building materials, finishes, and furnishings can be removed from the building before occupancy. LEED requires a minimum 2-week flush out period to occur *after construction*, and *before occupancy*.

fossil fuels: A hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from the accumulated remains of ancient plants and animals and used as fuel. Carbon dioxide and other greenhouse gases generated by burning fossil fuels are considered to be one of the principal causes of global warming. Fossil fuels are non-renewable resources because they take millions of years to form, and reserves are being depleted much faster than new ones are being made. .

gallons per flush: the unit of measurement by which flow rate of toilets and other flushing devices such as urinals are measured and regulated.

gallons per minute: the unit of measurement by which flowing devices such as faucets and showers are measured and regulated.

glare: a very harsh, bright, dazzling light that interferes with visibility.

global warming: An increase in the near surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but the term is most often used to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases. Increasing global temperature will cause sea levels to

rise and will change the amount and pattern of precipitation, likely including an expanse of the subtropical desert regions. Other likely effects include increases in the intensity of extreme weather events, changes in agricultural yields, modifications of trade routes, glacier retreat, species extinctions and increases in the ranges of disease.

graywater (sometimes spelled grey water or gray water): non-industrial wastewater generated from domestic processes such as dish washing, laundry and bathing. Some states and local authorities allow kitchen sink water to be included in graywater. Check local codes in order to comply with local regulations.

green building: green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands to include environmental, social, and economic concerns.

greenfield: a site that is undeveloped and in a natural state or has been used for agriculture

greenhouse gases: A gas, such as carbon dioxide or methane, which contributes to potential climate change.

green cleaning: the use of environmentally-friendly ingredients and chemicals for household, manufacturing and industrial cleaning. Green cleaning techniques and products avoid the use of chemically-reactive and toxic cleaning products which contain various toxic chemicals, some of which emit volatile organic compounds (VOCs)

green power: renewable energy such as solar, wind, biomass, hydro, and geothermal energy

green washing: advertising a product or policy to be more beneficial to the environment than is true

hard cost: purchase price of a hard asset such as masonry, wood, steel, carpet, tile, mechanical systems, roofing.

hardscape: areas where the upper-soil is no longer exposed, including paved areas, walkways, fountains, etc.

harvested rainwater: rainwater that has been collected for uses such as landscaping irrigation, toilet flushing, or other non-potable water uses

health product declaration (HPD): a standard format for reporting product content and associated health information for building products and materials.

heat islands: air and surface temperature differences between developed and undeveloped areas.

heat island effect: the ability of dark, non-reflective paved areas-city streets, rooftops, and sidewalks-to absorb and radiate heat, making urban areas and the surrounding suburbs noticeably hotter than rural towns nearby. Other contributors include reduced air flow due to tall buildings and narrow streets, calm and sunny weather, and auto exhaust.

high performance green building: a building that is energy and resource efficient.

hybrid vehicle: vehicle which has both a gas powered engine and an electric engine to achieve better fuel economy and lower emissions.

HCFC: an acroynm for hydrochlorofluorocarbons that are used in refrigerants and propellents that are known to deplete the ozone layer

HVAC system: acronym that stands for "heating, ventilating, and air conditioning". These systems seek to provide thermal comfort and acceptable indoor air quality.

impervious surfaces: mainly artificial structures--such as pavements (roads, sidewalks, driveways and parking lots) that are covered by impenetrable (impervious) materials such as asphalt, concrete, brick, and stone--and rooftops. Soils compacted by urban development are also highly impervious. These surfaces promote rainwater runoff instead of absorption into the ground.

imperviousness: resistance to penetration by a liquid and is calculated as the percentage of area covered by a paving system that does not allow moisture to soak into the ground

indoor air quality: the air quality within buildings as it relates to the health and comfort of building occupants.

indoor air quality building education and assessment model (I-BEAM): guidance tool designed for use by building professionals to help manage in indoor air quality in commercial buildings, which should be a part of indoor air quality management plans

indoor environmental quality: the concept that takes into consideration all impacts of the indoor environment on human health and performance, including indoor air quality, daylighting and views, and visual and thermal comfort.

indoor environmental quality management plan: a plan that takes into consideration all aspects of the indoor environment and documents strategies to protect the quality of the indoor environment for occupants, especially important during construction and renovations

infill development: development that occurs within established urban areas where the site or area either is a vacant place between other developments or has previously been used for another urban purpose

integrative process: a comprehensive approach to building systems and equipment. Project team members look for synergies among systems and components, the mutual advantages that can help achieve high levels of building performance, human comfort, and environmental benefits. The process should involve rigorous questioning and coordination and challenge typical project assumptions. (USGBC)

Integrative project team: All members of the project team working towards the integrative process, including building owners, maintenance staff, planners, designers, etc. Team members collaborate to enhance the efficiency and effectiveness of every system.

integrated pest management: the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment

invasive plants: indigenous or exotic plants that spread outside cultivated areas and can damage environmental or economic resources. They grow quickly and aggressively, spreading and displacing other plants.

irrigation efficiency: the percentage of water volume beneficially used by plants to the volume of water delivered through an irrigation system. Water wasted would evaporate, fall on hardscapes, or runoff. Drip irrigation is the most efficient with a 90% irrigation efficiency rating.

LEED: LEED is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. (USGBC)

LEED category: how prerequisites and credits are grouped depending on the building type and rating system

LEED credit: part of the LEED Rating System. Projects earn points by meeting the requirements of optional credits in order to earn points towards certification.

LEED intent: part of the LEED Rating System, which specifies the environmental goal of each LEED credit.

LEED Online: the online software used to manage the entire LEED project certification process and manage credits

LEED credit checklist: Excel spreadsheet that helps project teams track their credits against requirements for certification.

LEED Credit Interpretation Ruling (CIR): ruling process for project applicants seeking technical and administrative guidance on how LEED credits apply to their projects and vice versa. (USGBC) LEED Interpretations are the result of a CIR and may determine how future project teams use LEED

LEED online: web portal and site that allows teams to register a LEED project and to upload each section of the certification application

LEED pilot credit library: potential credits and categories that may be used in up-coming versions of the LEED rating systems

LEED points: A LEED rating is achieved through earning points in each of the six LEED categories.

LEED prerequisites: part of the LEED Rating System. Within each LEED category there are prerequisites and credits. Prerequisites must be met for building certification.

LEED project boundary: the portion of the project site submitted for LEED certification. For multiple building developments, the LEED project boundary may be a portion of the development as determined by the project team.

LEED Rating System: encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria. (USGBC). There are multiple rating systems depending on the type of building project.

LEED requirements and submittals: Each LEED credit has requirements that must be met and documentation that must be submitted to prove the credit requirements were met.

LEED Technical Advisory Groups (TAG): provide a consistent source of sound technical advice with respect to products, tools and services. TAGs act in an advisory capacity in responding to credit interpretation requests (CIRs), credit rulings and credit ruling appeals while maintaining consistency, integrity and technical rigor in the development of LEED. (USGBC)

life cycle assessment (LCA): the investigation and valuation of the environmental impacts of a given product or service. LCA evaluates environmental performance. This view takes into account the whole life of a product or project (not assessing it from a single point in time).

life cycle costing (LCC): the evaluation of the total cost of a building or product over its useful life, including initial, maintenance, repair and replacement costs as well as savings. LCC evaluates economic performance.

light pollution: excessive or obtrusive artificial light that obscures the stars in the night sky for city dwellers, interferes with astronomical observatories, and like any other form of pollution, disrupts ecosystems and has adverse health effects.

light trespass: light that passes beyond the project boundary, i.e. parking lot lighting that passes into a park next to the project

load shedding: action to reduce the load on something, especially the interruption of an electricity supply to avoid excessive load on the generating plant.

location: In green building, location includes the natural context (climate, plants, wind, sun), the social context (cultural history, traditions, local regulations), and an infrastructural context (roads, local materials, utilities, public transit).

low impact development: LID is an approach to land development (or re-development) that works with nature to manage rainwater as close to its source as possible. (EPA)

market transformation: systematic improvements in a market or segment of a market to achieve a lasting share of energy-efficient products and services, i.e. High Efficiency washers replacing regular washing machines in the US.

mass transit: passenger transportation services which are available for use by the general public, such as trains, subways, and busses.

material reuse: a different term from adaptive reuse because materials are reused in a way that is the same or similar to how it was used before, i.e. saving doors in an old

project to be used as doors in the new project In LEED, this material is calculated as a percentage of total materials cost of the project.

MERV or Minimum Efficiency Reporting Value : standard comparison of the efficiency of an air filter. The MERV scale ranges from 1 (least efficient) to 16 (most efficient), and measures a filter's ability remove particles from 3 to 10 microns in size. Developed by ASHRAE or American Society of Heating, Refrigerating and Air-Conditioning Engineers

metering: measuring the amount of resources used over a period of time, such as water or electricity.

Montreal protocol: an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion

native or indigenous plants: Native plants are adapted to local conditions and are easier to grow and maintain. This low-maintenance approach means savings in both time and money. Once established, native plants better withstand variations in local climate such as droughts and freezes.

natural (or passive) ventilation: uses the natural forces of wind and buoyancy to deliver fresh air into buildings through doors, windows, or other designed opening (chimneys)

negative feedback loop: a system where the output may signal the system to stop changing, i.e. a thermostat - at a certain point the temperature feedback will tell the system to cut off

nested system: systems within systems that are related because they affect and effect each other

net-zero energy: a project that can produce all the energy it requires on site yet still might be connected to the regular utility grid, for example, using power from the grid when there is no wind, and providing power to the grid from wind turbines on windy days to the point where power used from the grid equals power given to the grid

nonpoint source pollution: pollution of water generally results from multiple sources vs just one source, examples are runoff from roads, drainage from buildings, seepage, runoff from farmland. Pollution in a river may not be exactly pinpointed because most pollution is nonpoint.

non-potable water: water that is not treated to drinking water standards and is not meant for human consumption.

non-renewable resource: a natural resource that cannot be produced, re-grown, regenerated, or reused on a scale which can sustain its consumption rate. These resources often exist in a fixed amount, or are consumed much faster than nature can recreate them. Fossil fuels (such as coal, petroleum and natural gas) and nuclear fuel are some examples.

off-gassing (outgassing): the slow release of a gas that was trapped or adsorbed in some material. Off-gassing can be significant if it collects in a closed environment where air is stagnant or recirculated and the gas has negative health effects. New car smell is an example of off-gassing.

on-site wastewater treatment: Using local systems to treat waste generated on-site and avoid adding waste to public facilities

open system: a system that constantly takes in items from outside the system , used them and then released them as waste. This system has no feedback loop. Think of a normal home where groceries, products, or water come into the home, are used and then released as waste water or garbage.

outdoor air: air that enters into a building either naturally through pre-designed openings in the building or through the ventilation system

open grid pavement: pavement that is less than 50% impervious and contains vegetation in the open cells

open space: ground areas that are vegetated and pervious. Green roofs can be considered open space but only for urban areas.

ozone: (O3) is a gas composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground-level is created by a chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Ozone has the same chemical structure whether it occurs miles above the earth or at ground-level and can be 'good' or 'bad,' depending on its location in the atmosphere. (EPA)

passive design: building design that takes advantage of the local climate to provide some or all of the heating, cooling, lighting and ventilation needs of the occupants.

pedestrian access: allowing pedestrians to walk between areas without interference from walls, highways or other barriers

peak demand: the maximum electricity load at a specific point in time or over a period of time

performance monitoring: A continuous process of collecting and analyzing data to compare how well a project is working against expected results of the project based on performance indicators. The goal is use the indicators to achieve efficiency where possible.

perviousness: being able to allow water or air to filtrate through.

photovoltaic energy (PV) : the application of solar cells for energy by converting sunlight directly into electricity

pollutant: any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems. (EPA)

pollution: the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the physical systems or living organisms .

positive feedback loop: system where a energy is taken from the output of a system and reapplied to the input, or A produces more of B which in turn produces more of A. i.e. population growth – Adults make children whom in turn make more Adults

post-consumer material: recycled material generated from the waste of household, commercial, industrial, or institutional end-users

post-consumer recycled content: the percentage of material in a product that was consumer waste. The recycled material was generated by household, commercial, industrial, or institutional end-users and can no longer be used for its intended purpose. It includes returns of materials from the distribution chain. Examples include construction and demolition debris, materials collected through recycling programs, discarded products (e.g., furniture, cabinetry, decking), and landscaping waste (e.g., leaves, grass clippings, tree trimmings). (ISO 14021)

potable water: water that is of sufficiently high quality so that it can be consumed or utilized without risk of immediate or long term harm by humans or animals.

pre-consumer content: content from industry scraps that was diverted from the waste stream and used for other purposes. Examples include sawdust, wood shavings, wood chips, and print overruns. Excluded are materials that are re-incorporated into the same manufacturing process that generated it.

process water: water used for building systems such as boiler feed water, cooling water for heat exchangers, chillers, etc.

potable water: Drinking water is water that is of sufficiently high quality so that it can be consumed or utilized without risk of immediate or long term harm

previously developed site: a site that was previously built on, has been graded, or contained a parking lot, roadway, or other structure.

prime farmland: previously undeveloped land that is suited for agriculture

raingarden: similar to a bioswale, a depression with vegetation that filters and slows down rainwater to reduce peak discharge rates

rainwater harvesting: the process of collecting (commonly from a roof), storing, and using rainwater

rapidly renewable materials: materials and products are made from plants that are typically harvested within a ten-year cycle or shorter and are grown and harvested sustainably.

refrigerant: substances used to transfer heat during the mechanical cooling process within air conditioning and refrigerator systems. They act as the heat carrier which changes from gas to liquid and then back to gas in the refrigeration cycle.

regenerative: similar to cradle-to-cradle, processes that restore, renew or revitalize their own sources of energy and materials, creating sustainable systems that integrate the needs of society with the integrity of nature. i.e a building or community that might create more energy than it uses, or purifies rainwater before it leaves the project site

regional material: material that is sourced and manufactured within 500 miles of the project. Usually expressed as a percentage of total project material.

renewable energy: energy generated from natural resources - such as sunlight, wind, tides and geothermal heat - which are naturally replenished

renewable energy certificates (RECs) : also known as Green tags, Renewable Energy Credits, or Tradable Renewable Certificates (TRCs), are tradable environmental commodities in the United States which represent proof that 1 megawatt-hour (MWh) of electricity was generated from an eligible renewable energy resource.

retrocommissioning: when an existing building undergoes the commissioning process to discover if improvements or changes should be made to improve the building.

reuse: a strategy to use existing materials in a similar or different capacity

salvaged materials: materials from construction sites or existing buildings that are reused in the same or different capacity. Examples can include flooring, brick, beams, and doors.

sick building syndrome: used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified.

site disturbance: the area of the project site that is impacted by construction activity, LEED project should attempt to limit site disturbance

smart growth: developing in areas near transportation, housing, and jobs therefore leaving open spaces and farmland free from development

soft cost: an expense item that is not considered a direct construction cost. Soft costs include architectural, engineering, financing, and legal fees, commissioning, and other pre- and post-construction expenses.

solid waste management policy - plan that identifies a diversion rate goal and covers how waste will be either disposed or reused or recycled by addressing sorting, collection, and final disposal of items in an existing building.

solar reflectance (SR): the fraction of solar energy that is reflected by a surface on a scale of 0 to 1. Black paint has a solar reflectance of 0; white paint (titanium dioxide) has a solar reflectance of 1. The standard technique for its determination uses spectrophotometric measurements, with an integrating sphere to determine the reflectance at each wavelength. The average reflectance is then determined by an averaging process, using a standard solar spectrum, as documented by ASTM Standards E903 and E892.

solar reflectance index (SRI): a measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. It is defined such that a standard black surface (initial solar reflectance 0.05, initial thermal emittance 0.90) has an initial SRI of 0, and a standard white surface (initial solar reflectance 0.80, initial thermal emittance 0.90) has an initial SRI of 100. To calculate the SRI for a given material, obtain its solar reflectance and thermal emittance via the Cool Roof Rating Council Standard (CRRC-1). SRI is calculated according to ASTM E 1980. Calculation

of the aged SRI is based on the aged tested values of solar reflectance and thermal emittance.

square footage of a building: total area in square feet of all spaces in a building, including rooms, stairwells, elevators, and hallways.

street grid density: centerline miles/square mile, a centerline mile is measuring a particular road down its center. Higher street grid densities are beneficial for pedestrians.

submeter: meters placed on smaller portions of a larger system, ie submeters monitoring water use on each floor of a project

sustainable: meeting the needs of the present without compromising the ability of future generations to meet their own needs (EPA)

sustainable forestry: the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.

sustainable purchasing policy: gives preference to the purchase of environmentally preferable products and the companies that supply them

systems thinking: viewing the world as an interrelated set of systems that can influence one another

thermal comfort: Human thermal comfort is defined by ASHRAE as the state of mind that expresses satisfaction with the surrounding environment (ASHRAE Standard 55). Maintaining thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC design engineers.

transportation demand management: an attempt to reduce peak period transportation use, such as allowing flex time in which employees may come to work before or after rush hour

triple bottom line: an expanded baseline for measuring performance, adding social and environmental dimensions to the traditional profit measure, so decisions are viewed in the long term with their impact on people, the planet, and profit.

underground parking: under building, tuck-under, or a stacked parking structure that minimizes the need for exposed parking and parking lots.

United States Green Building Council (USGBC): a member-based nonprofit organization whose mission is to transform the way buildings and communities are designed, built, and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life. The USGBC created the LEED Rating system.

value engineering: a review process that identifies and selects the lowest lifecycle cost options in design, materials and processes that achieves the desired level of performance, reliability and customer satisfaction.

vegetated (green) roof: a roof of a building that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane.

ventilation rate: the rate at which indoor air enters and leaves a building, usually expressed in LEED as the number of changes of outdoor air per hour (air changes per hour, or "ach") ASHRAE 62 prescribes proper ventilation rates to ensure pollutants and carbon dioxide are removed from a space

volatile organic compound: compounds that have a high vapor pressure and low water solubility and therefore can enter the air easily. Many VOCs are human-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, and refrigerants.

wastewater: The spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter (EPA)

water balance: an accounting of all water volumes that enter and leave a space over a period of time

water pollution: the presence in water of enough harmful or objectionable material to damage the water's quality (EPA)

waste diversion: see also diversion rate, waste materials diverted from traditional disposal such as landfills or incineration to be recycled, composted, or re-used.(EPA) Measured in tons.

waste management plan: see construction waste management plan

waste stream audit: a review of consumables waste of a project. Essentially, finding out what makes up the projects waste can help determine ways to increase recycling or reduce waste through other methods

waste-to-energy: the conversion of nonrecyclable waste materials into usable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery

waterless urinal: urinals that do not use water at all. These systems can save anywhere between 15,000 and 45,000 gallons (approx. between 56,800 and 170,000 liters) of water per urinal per year.

wet pond (retention pond): a pond designed to hold a specific amount of water indefinitely

xeriscaping: landscaping and gardening in ways that reduce or eliminate the need for supplemental irrigation. It is promoted in areas that do not have easily accessible supplies of fresh water and is catching on in other areas as climate patterns shift.

zoning: method of land use regulation used by local governments in most developed countries. Zoning may be use-based (regulating the uses to which land may be put), or it may regulate building height, lot coverage, and similar characteristics, or some combination of these.