Managing Construction Projects
Managing Green Building Risks

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1. INTRODUCTION

Green Building **is not** limited to new technologies. It is not limited to reduced pollution. It is not limited to environmentally friendly materials. It is not limited to long term financial savings. It is not limited to a healthy environment for humans. And it is certainly not limited to physical buildings.

Green Building **is** about changing people's and society's behavior to reduce the impact of humans on the planet and natural environment. The changes in behavior result from individuals' values, financial motivation and government laws and regulations.

There is no universal measure to compare the environmental impact of all actions. Yes, energy production and carbon omissions can be compared for using natural gas versus oil heat. But how do the environmental impacts of using a plastic bag, working at a computer, driving a hybrid car, and eating a roast beef sandwich compare? How does buying a product online compare with driving to the store?

The closest common denominator to measure unlike items is through energy. Non renewable energy, whether produced as electricity, heat or for transportation, emits greenhouse gases and other pollutants. And just about everything in our society directly or indirectly relies on energy. When gasoline prices rose to $4 per gallon, the higher

transportation and energy costs resulted in escalations in material and food prices as well. Other examples of indirect energy consumption include:

- Harvesting, processing, manufacturing and transporting materials and products use energy to arrive at the end product. [1]
- Using potable water or treating wastewater consumes energy. It requires building and maintaining the infrastructure, which includes collection, processing and distribution.
- Developing the technology and products for renewable energy has an environmental and energy impact with the materials it consumes.
- Even the collection and recycling of material waste consumes energy – although it is generally less than using raw materials.

In the United States, energy consumption is split about evenly between the three main sectors - buildings, transportation, and industry[2]. Buildings include homes, offices, schools, hospitals, retail stores, restaurants and factories. Transportation includes cars, trucks, trains, airplanes and ships. Industry includes agriculture, mining, harvesting and utilities.

While "Green Building" obviously has the greatest effect on the building sector, it also focuses to reduce energy consumption in the other areas. Automobile and other transportation manufacturers and related organizations focus on designing vehicles that run more efficiently, or use alternative fuels. Green Building encourages people to reduce their overall amount of travel. An office building and policy, for example, can accomplish this by:

- Selecting a convenient building location, reducing travel distance
- Encouraging carpooling or mass transportation
- Allowing employees to telecommute or work from home
- Utilizing web-based or teleconference calls to reduce the amount of travel

[1] Life cycle assessment (LCA) is an analysis method that takes into consideration the energy consumption and other environmental factors through all stages of a product from beginning to use to disposal. It is also referred to as cradle-to-grave analysis.
[2] http://www.eia.doe.gov/emeu/aer/consump.html

The same office building can reduce the energy consumption in the industry sector by purchasing certain types of products or materials, reducing waste and encouraging recycling.

Americans have become accustomed to a higher standard of living or level of consumption than many European and other nations. However, there are several emerging nations, such as China and India, with large populations that are developing at a tremendous rate…and consuming a tremendous amount of energy and resources. It is unrealistic and hypocritical to think that these emerging nations should slow down and limit their prosperity. *If everyone in the world, lived like the average American, the world would consume 5 times as much energy per capita as it currently does*[3].

The solution is to reduce energy usage, to increase the efficiency when energy is required, and to use energy from renewable sources. The simplest example is to open the blinds instead of turning on the light. If you have the light on, remember to turn it off when you leave the room. If you do have the light on, use an energy efficient bulb or lamp. And if you get your electricity from wind, solar or hydroelectric power, that is even better.

Just as computers and the internet changed the way of life in the 1980's and 1990's, green buildings and green technologies will define the early part of the 21st century.

[3]http://earthtrends.wri.org/text/energy-resources/variable-351.html - World Resource Institute, 2003

2. DEFINING GREEN BUILDING DESIGN AND METHODS

2.1. What is Green Design?

The combinations of green, sustainable or eco-friendly + building, design or architecture have different nuances, but all focus on the same general theme: Planning, designing, constructing, operating and maintaining a building that promotes human health and has a minimal or ultimately no impact on the environment.

Initial green efforts focused on specific issues that were important to an individual or region (water conservation in the Southwest, improved air quality in urban areas, etc). Green design incorporates all issues for a "high performance" building across the board. *The earlier in the planning phase that the commitment is made to build green, the better and less expensive the results.* The major benefits of green building are broken down into three categories:

Environmental benefits

- Enhance and protect ecosystems and biodiversity
- Improve air and water quality
- Reduce solid waste
- Conserve natural resources

Economic benefits

- Reduce operating costs
- Enhance asset value and profits
- Improve employee productivity and satisfaction
- Optimize life-cycle economic performance

Health and community benefits

- Improve air, thermal, and acoustic environments
- Enhance occupant comfort and health
- Minimize strain on local infrastructure
- Contribute to overall quality of life

Green design is not limited to the building structure itself, but considers the building, its purpose, and all direct and indirect impacts it may have.

2.2. Overview of the Construction Process and Green Technologies

2.2.1. "Build/No Build" Decisions

The first decision that an owner needs to make is whether there is a need for a new building. This varies depending if the owner is a large company or a homeowner. As a large company, does the existing infrastructure support the workforce? Is there enough physical space? Is it suited for the work the company is performing? Is the company looking to move or expand to a new location? Does the company need to meet additional manufacturing demand?

The "greenest" type of building is an existing building. The three "R's" – reduce, reuse, recycle – provide guidelines for environmental behavior and decision making. If you don't need it, then don't build it (reduce). If you can reuse an existing building, this is the next best option. Compared to a new building, renovating an existing building reduces the amount and impact of consumption, manufacturing, transportation of materials and waste, site disturbance, and additional infrastructure.

However, in some cases it is not possible or practical to reuse an existing building, and new construction is the best way to proceed. In this situation, there are many planning, design, construction and technology factors to consider.

2.2.2. Site Decision, Planning and Design

Selecting the proper site is an important decision that rests solely with the owner. Depending on how experienced and sophisticated the owner is, he may have in-house development staff that can handle this task. In other cases the owner may turn to the designer or other construction consultants, who generally do not have the experience or an understanding of the owner's business and corporate plans to provide direction.

Although this is an owner decision, if the project team is involved at this stage, it can provide valuable input on what constitutes a green building site. Below is a hypothetical situation.

After some initial research, the owner asks the project team for a recommendation of one of three options for the site of its new office building:

Site #1: Rural	Open field in a rural environment
	200,000 square foot site
	Land purchase price $100,000
	Planned 1 story building
	Natural wildlife (birds, squirrels, rabbits, and deer) live in the area. A stream runs through the wooded area at the back of the property.
Site #2: Suburban, Contaminated	A contaminated site in a rejuvenating industrial suburban area
	100,000 square foot site
	Land purchase price $25,000
	Planned 2 story building
	Labeled as a contaminated Brownfields site by the EPA, requiring some site remediation.
Site #3: Urban	An empty lot in a mid to large size city
	40,000 square foot site
	Land purchase price $250,000
	Planned 4 story building
	Located in a moderately busy area, with not much parking but a good number of shops, restaurants and other services.

Which of these is the best site for a new green office building? Site #1 certainly has its advantages. It is clean and undisturbed. There are wildlife and flowering plants. It is the prettiest and most peaceful of all three sites. Plus, the land is cheap. But how "environmentally friendly" would it be to bring in excavators, clear the land, dig up the site, construct a building, destroy a natural habitat, install roads, parking lots, sewer and utility connections, and have employees commute 60 miles round trip to work every day? While this description may distort the picture to some extent, it should at least provide a

different perspective. Green buildings attempt to limit the disturbance of land that is previously undeveloped and remains in its natural state, known as Greenfields.

So perhaps site #1 is not the best choice, but why would anyone would want build an office on a contaminated site at location #2? Surely the owner would be thinking, "I don't want to put people's health at risk!" The "opposite" of a Greenfields site is a Brownfields site. A Brownfields site is previously developed land in which redevelopment or reuse may be complicated by real or perceived environmental contaminations. While a properly remediated site may still have a stigma, it will be cleaned to standards set by the government that do not jeopardize the health of occupants. Thinking about it from the environmentally friendly perspective, remediating a contaminated site and restoring habitat and natural vegetation reduces the pressure on undeveloped land and makes this site attractive and clean again. Maybe this option is not so bad after all.

There are many financial incentives associated with buying and remediating a contaminated property. Sometimes the purchase price of the land may be practically (or literally) nothing…with the caveat that the owner is responsible for cleaning and remediating the site. Additionally, federal and state governments offer significant tax discounts and credits. However, with these savings come many liabilities, legal issues and other costs. The risks are largely dependent on the type and extent of the contamination, and should be thoroughly investigated before purchasing such property.

We now turn our attention to site #3? Here the owner might think, "The city is a crowded and dirty enough place already. I'm trying to be at one with nature. Why would I want to construct another building in a busy city?" It is a valid question. Below are some reasons in favor of constructing a building in an urban environment:

1. The impact and disruption to natural habitats is significantly reduced.
2. The building footprint is smaller (by building vertically rather than horizontally), maximizing open space.
3. Building in an urban environment uses existing infrastructure, requiring minimal additional roads and utilities.
4. An urban building encourages alternative transportation, reducing the impact of automobiles. This is achieved by selecting a location that is close to public transportation (bus and rail), is close enough for people to walk or bicycle to work, and/or has limited parking, encouraging carpooling.
5. People can walk to many basic services (restaurants, shops, etc) during lunch or after work, further reducing automobile use.

Green building also focuses on providing a more natural setting out of the "concrete jungle". It emphasizes a reduced amount of hardscape (sidewalks, parking lots, pavers) and restoring open space and natural vegetation to develop and promote biodiversity.

The same is true on the residential side – an apartment building with 100 units is much more environmentally friendly than 100 separate houses. It has a smaller building footprint, uses fewer materials, and is more energy efficient.

In the end, choosing the location of an environmentally-friendly building often comes down to the other green decision – what makes sense, or what is possible, financially? Again, this is the owner's decision. While land may be cheaper in rural areas, vertical building and less additional infrastructure reduce the construction scope and costs in urban areas.

Every project is unique, and there is never a clear answer. That being said, *the answer is:* **It is "greenest" to build in an already developed area with existing infrastructure that also encourages reduced automobile travel.**

2.2.3. Energy Efficiency

After the planning phase, there are many green technologies to consider as part of the design and construction of the project. While building green considers many environmental factors, the single most important aspect is energy efficiency. This is because it directly encompasses so many other design and construction considerations. Three major considerations regarding energy are 1) Reducing demand; 2) Increasing efficiency; and 3) Recovering waste energy.

A building that is designed to *reduce energy demand* in the first place, is the most desirable. This can be accomplished by considering the building's location and orientation. Is it located in a cold weather climate where it will benefit from passive heat from sunlight? Or is it situated in a hot weather climate where it would fare better if direct sunlight was prevented from heating the building?

The type of building heating or cooling system is another consideration. Does it require active, mechanical ventilation, or will a passive system, using building openings suffice? What about a mixed mode of ventilation? If climate and other factors do not require dependence on air conditioning units, this can be a significant energy savings. The same is true for heating. If the location can instead utilize "free" geothermal heating from below the project site, this will significantly reduce the building's energy demand.

Today's buildings are more complex than log cabins or small huts, and, depending on their purpose, may require enormous amounts of energy. Green building and good design practice focuses on *increasing efficiency*. Green design tends to go a step beyond good common practice by emphasizing the benefits of long term energy use and operating costs, rather than just the upfront construction costs.

The building envelope (the outer shell of the building that includes walls, roofs, doors and windows) is an easy area to increase efficiency and retain warmed or cooled

conditioned air. Specifying and installing the correct type of windows, insulation, and roofing system can have a significant effect towards reducing a building's carbon footprint. Green roofs and cool roofs are two examples of roofing systems that have become more common in recent years.

Green or vegetated roof systems are like landscaping on top of the building. They can be designed using different types of grass or small shrubs and serve multiple benefits. Green roofs provide additional open space, which can be a rarity in city environments, promoting biodiversity and if well designed, offering a pleasant outdoor area for building occupants. This system serves as insulation, and because of the evaporative cooling during photosynthesis, also reduces the heat island effect, in turn reducing the cooling load on the building. However, the soil, vegetation and precipitation may add significant weight to the roof, and the civil or landscape engineer must coordinate their design with the structural engineer.

Heat island effect occurs when urban temperatures are higher because of solar energy retention by constructed surfaces and buildings. Cool roofs use certain types of light colored or coated materials that reflect the solar energy that reduce these temperature increases. While the material costs more, installation techniques are the same as standard roofing installation. On a hot summer day, when comparing traditional black roofs to cool roofs, the temperature *difference* can be 50ºF – 70ºF.

Exterior hardscapes (including parking lots, roads and sidewalks) also contribute to heat island effects, and their impacts can also be reduced by using lighter colored or permeable materials.

As we enter inside the building, green design uses equipment and machinery that consume less energy to achieve the same results. ENERGY STAR rated appliances and equipment (such as refrigerators, washing machine, clothes dryers, boilers, heat pumps,

and air conditioning units) meet this goal. Also, specifying appropriately sized heating and cooling units lead to increased overall energy efficiency, particularly if these systems are commissioned to ensure that they actually operate as they were intended.

A building's lighting system can easily consume one third of the building's energy consumption or more. Lighting energy efficiency can be improved by:

- Designing the appropriate quantity and location of fixtures to provide sufficient lighting.
- Specifying energy efficient fixtures with low electricity consuming light bulbs/lamps.
- Installing individual controls (so that a large area is not fully lit when only a small area is required) and motion or time sensors.

Comparing different types of lamps or bulbs with equivalent lighting levels shows significant energy savings (up to 90%) in the use of newer technologies.

Type	Incandescent	Compact Fluorescent Lamp	LED (Light Emitting Diode)
Energy Consumption	60 watts	14 watts	6 watts
% Reduction	0%	75%	90%

After a building's energy demand is reduced and efficient materials and equipment have been specified, there is the potential for realizing even further energy savings. This is through the *recovery of waste energy* from exhaust air (or water), during temperature extremes (such as those that occur during winter and summer).

Consider the following scenario: the outside temperature is 20ºF, and the internal building temperature is 70ºF. Internal air (at 70ºF) is exhausted from the building and dissipated to the outside environment. The fresh outside air replaces the exhaust air and enters the building units at 20ºF. It is then heated up to 70ºF; an **increase of 50ºF**.

Compare this to a waste energy recovery system. Before dispelling the 70ºF exhaust air, it is used to "pre heat" the incoming 20ºF outside air. This tempers the outside air so that it is now 40ºF when it enters the building units. As a result, the air only needs to be **increased by 30ºF**.

The same is true, albeit with an opposite effect, during the summer in a hot environment. Conditioned, internal exhaust air can "pre cool" the hot external air before it enters the building units.

Energy modeling and computer simulation has become a very effective tool to assist in the design process and account for the energy demand, efficiency, and waste recovery addressed above.

2.2.4. Renewable energy

Now that the building uses energy as efficiently as possible, the question arises, where does the energy come from? Is it all fossil fuel based, or does it come from renewable energy sources? The most common sources of renewable energy are solar, wind, hydroelectric and geothermal. In an open electrical market you can choose which provider you want to purchase energy from and purchase it directly from a green utility company. In closed electrical markets, where there is just one utility provider, you generally have the option to pay a premium to have your electrical power provided by renewable energy. Other locations may not have the infrastructure or proximity to deliver electricity from renewable sources, and in this case, you can purchase renewable energy credits, or "green tags" to subsidize and support the development and production of renewable energy.

Another possibility for using renewable energy is to produce it on-site. This can be accomplished by installing solar photovoltaic panels on the roof or a covered parking lot. Depending on the size and location of the site, windmills can also be installed to

provide a portion of electricity. Geothermal, low-impact hydroelectric, biomass and bio-gas are other alternatives for producing on-site renewable energy. However, at the present time (unless the property and commitment is large enough), on-site renewable energy is only a supplement to the entire building's electrical demand.

In 2007 the Dallas Zoo announced plans to build a new biogas facility that would convert trash and animal waste into energy. This solid waste, including 300 pounds of elephant droppings daily, would provide enough electricity to power several buildings. The zoo expects the energy it provides and the reduced costs from not having to haul six tons of solid waste to the landfill each day, will recover the construction costs of the facility within 10 years.[4]

2.2.5. Efficient/Ecological material use

Material selection plays a major role in a building's immediate environmental effect, and has little to do with the impact over the long term. Efficient or ecological materials do not influence occupant energy consumption and behavior. It reduces the demand for virgin materials and impact of extraction, processing, manufacturing and transportation of materials and goods today. Increased preference towards these products now will help expand the green market infrastructure, making these products cheaper and more prevalent in the future.

In accordance with the environmental principles (reduce, reuse, recycle), any materials that can be reused, rather than purchased new, are the most ecological. Whether they are acquired from the existing building or another location, these materials do not require additional energy to produce, and they also divert waste from landfills. Bricks, wood, doors, and door hardware are generally the most common type of reused building materials.

[4]http://www.dallasnews.com/sharedcontent/dws/dn/latestnews/stories/110207dnmetzoowaste.2b277b7.html

When a product's label indicates that it is made with recycled material, it will usually specify whether it is post-consumer or pre-consumer recycled content. Post-consumer recycled material comes from the end user and is no longer usable for its intended purpose. This includes construction debris, curbside drop off (glass bottles, metal cans and old newspapers) and landscaping waste. Pre-consumer recycled material is diverted from the waste stream during the manufacturing process and includes fly ash, sawdust and obsolete inventories.

Bamboo is recognized as an eco-friendly material because it is a rapidly renewable resource. Rapidly renewable resources are those that can be grown or raised and harvested within a 10 year period and harvested in a sustainable fashion. But if bamboo is shipped from China, and then driven across the country, it may not be the greenest product after all. Green building projects located in the Northeast US might be considered more sustainable if they use pine or other regional materials that are harvested in a responsible fashion. While not an apples-to-apples comparison, the energy consumption of transporting bamboo halfway around the world has a greater impact than using responsibly harvested, longer growth resources from your own backyard.

2.2.6. Water management

Reducing the use of potable water as well as the resulting wastewater minimizes the burden on the municipal water supply and wastewater systems. Water management techniques include using plumbing fixtures with motion sensors and aerators to limit the flow to appropriate amounts and times. The next time you wash your hands, think about how much water is consumed when the faucet is on and your hands are outside of the stream. The automatic sensor reduces water waste while the aerator uses less water but maintains an effective flow. Low flow toilets, composting toilets, and waterless urinals are other technologies that limit the consumption of potable water and also reduce the amount of wastewater that a building produces.

In addition to utilizing less water more efficiently, using non-potable (non-drinkable) water can be just as effective. Rainwater and graywater can be captured and reused in toilets and landscaping. Graywater is untreated wastewater that has not come into contact with toilet or food waste. It comes from bathtubs, showers, bathroom sinks and laundry facilities. The water is filtered (but not to drinking standards) and then reused for toilet fixtures in place of potable water.

Efficient water management also focuses on reducing the potable water used for landscaping. This can be accomplished through using any combination of 1) plant species selection (native vegetation, reduced turfgrass); 2) efficient irrigation (micro-drip systems, an appropriate irrigation schedule) and 3) non-potable water (rainwater, graywater, or other sources).

2.2.7. Indoor environment

Green building underscores improved conditions for human health, particularly as the average American spends 90% of his time indoors[5]. Construction often produces airborne particles, mold and other air quality concerns for the health of construction workers and the building's occupants. To maintain proper indoor air and environmental quality there are several key areas that should be addressed during building design, construction and occupancy.

The building's interior should be kept clean and swept or vacuumed to reduced dust and particulates that may become airborne when disturbed. Additionally, porous organic material (such as drywall, insulation, ceiling tile, carpeting and wallpaper) should be protected and stored in a dry area so that it does not sustain moisture damage, which may lead to mold.

[5] http://www.epa.gov/greenbuilding/pubs/gbstats.pdf

It is also important to schedule and coordinate construction work appropriately. Once finishes are installed and areas of the building are completed, they should be separated from areas still under construction to prevent workers from creating or tracking in additional debris and particles. This can be accomplished by a combination of temporary barriers or creating a negative air pressure environment in the work area. In renovation projects as well, construction should be isolated from the existing, occupied spaces.

HVAC systems should not be used during construction, and ductwork should be sealed after installation. If the systems must be used, all return grills and openings should be closed or covered with temporary filters. Once construction is complete, it is often recommended to "flush out" the building of construction particles and chemicals before occupancy. During occupancy, green building practices recommend providing a higher level of fresh outside air, above the minimum code requirements. In addition to providing a comfortable, fresh air environment for the occupants, increased ventilation also removes chemicals from the building at a fast rate.

While a "new carpet smell" or "new car smell" lets you know that a product is fresh from the factory, it should also let you know that it is emitting, or off-gassing, harmful chemicals into the air. These chemicals often include Volatile Organic Compounds (VOCs), which are carbon compounds that participate in atmospheric photochemical reactions. Many products (adhesives, paints, carpeting and furniture) are now made with low levels of VOCs, formaldehyde, and other irritating or harmful chemicals, and are recommended for green building.

The interior environment of a building is not limited to air quality – it also includes and lighting and temperature concerns. Maximizing the amount of daylight and the available exterior views provides its occupants with a connection to the outdoors and a more pleasant indoor atmosphere. From a design standpoint however, there is more to

consider than simply using more and bigger windows. Designers must factor in sun glare and passive heating – unless their goal is to turn the building into a virtual greenhouse (not the environmentally friendly residence, but the building with glass roof and walls where people grow plants). Shading devices and tinted glass, as well as building orientation and architectural features (interior light shelves, floor plates and skylights) can all be used to achieve a proper design that maximizes the environment's natural light sources. The added bonus is that if a building is well lit with sunlight, it will require less electrical lighting and energy.

Installing controls that allow individuals to adjust their temperature and lighting preferences allows for a more comfortable environment. Also, it is more energy efficient for occupants to use task lighting or make local temperature changes, rather than adjust lighting or temperature controls for an entire section of the building.

2.2.8. Recycling during construction and by occupants

Building construction generates up to 2.5 pounds of solid waste per square foot[6].

Recycling during the construction process seems like an easy task to accomplish, and in some respects it is. But the construction process produces a lot of waste – wood, metal, plastic, cardboard, drywall, concrete – and unless there is a project requirement, most of this material is sent to the landfill instead of being recycled. Why? Because it is easier, cheaper and people are accustomed to throwing everything in a dumpster and have it hauled away. The exception is if demolition materials have value, like copper, in which case contractors will salvage it and sell it as scrap. The value of most material (with metals being the major exception) is not enough that haulers will pay to take it away, or even remove it free of charge. For the most part, your waste is not someone else's treasure.

[6] USGBC Reference Guide

Construction waste can be sorted onsite or comingled for a third party waste hauler to collect and separate. Either way, recycling does add some cost to the project; whether it is additional labor to separate the material on-site, or an additional fee for another party to separate it later. Contractors are reluctant to recycle just because it is the right thing to do especially if it will increase their bid price, making them less competitive than other contractors, or reducing their profit. To ensure that recycling takes place during a project's construction phase, the owner must incur this cost by making it a project requirement for all potential contractors.

Recycling efforts initiated by the building's occupants are easier to encourage with properly labeled, accessible collection bins and a collection program in place. There is no added cost or time to the individuals to discourage them from recycling, and with the option available, most people want to do "the right thing". The majority of office-related waste is paper, food waste and packaging – most of which is easily sortable, recyclable, or compostable.

If you only recycle one item, make it aluminum cans. Producing aluminum cans from raw alumina consumes 20 times as much energy as it does to use recycled aluminum[7].

2.2.9. Building commissioning

Commissioning is a systematic process of ensuring that the building's energy related systems are installed, calibrated and performing in accordance with the documented design intent and owner's operational needs. Additionally, the commissioning process includes training facility staff and providing specified documentation so that the systems continue to operate properly. The result is a system that operates efficiently and provides a building that is comfortable, saves energy and has reduced equipment downtime.

[7] http://earth911.org/energy/energy-costs-and-conservation-facts/

While commissioning covers all building systems, the main focus is usually the Heating Ventilation and Air Conditioning systems because of its high energy consumption and detailed level of control. With today's complex and varying HVAC controls and equipment, project owners and operators rely on the design engineer and mechanical contractor to provide a system that operates efficiently, is accessible for maintenance, and can be understood and operated by facility personnel. Too often, by the time a project reaches substantial completion, the engineer has moved on to other projects and the mechanical contractor has used up most of its budget. This can result in inefficient systems that do not meet the green design intent or requirements.

Involving commissioning in the design phase throughout post construction can reduce change orders and requests for information (RFIs), ensure proper mechanical system selection, improve systems performance and produce a properly operating building from day one.

2.2.10. Green operations and maintenance

Building construction may last for one or two years. However, a building's serviceable life may be 40 or 50 years, or more. Green building sets the foundation and provides many of the tools to achieve a sustainable building over the following half century; but it is equally important that the building be operated and maintained in a sustainable fashion. While operations and maintenance may conjure ideas of repairs and cleaning, going green requires much more than just using eco-friendly cleaning products. Green operations and maintenance has as much, if not more to do with plans/policies and monitoring/measuring, than it does with specific building related work.

Writing and implementing plans and policies provides a set of guidelines and indicate a commitment to sustainable building operations. These plans and policies

express the intent with regard to the building's property and exterior, energy management, purchasing, waste management, green cleaning, and other considerations.

A plan to maintain the *building property and exterior* with minimal environmental impact, will focus on the use of appropriate products and methods for snow and ice removal, cleaning the building's exterior, painting or finishing the building's exterior, and minimizing chemical pesticides and fertilizers. Additionally, it will concentrate on reducing energy consumption and waste. Using certain types of maintenance equipment, using it less often (mowing the lawn every other week, instead of every week) and diverting landscape waste from the waste stream through mulching or composting are all effective techniques to be incorporated into such plans.

Policies regarding *energy management* are as important as a green building's technologies. It defeats the benefit of having an ultra efficient heating system if during the winter the building is heated to 78ºF at nights and on the weekends. An energy management policy establishes temperature and lighting settings based on the building's occupancy schedule.

Purchasing policies stress that ongoing consumables (paper, office supplies), durable goods (appliances, furniture), additional construction, and food should be energy efficient, made with recycled or rapidly renewable products, free of harmful chemicals, produced locally and grown organically.

Solid waste management policies focus on reducing the waste associated with the products that are purchased. It emphasizes the reuse, recycling and composting of materials where possible, and the proper disposal of other hazardous or harmful waste (fluorescent lamps containing mercury, batteries, paints, chemicals).

Green cleaning plans not only specify the use of green cleaning products, but also sustainable cleaning equipment and minimized chemical use for pest management.

It's important to know the effect of your policies and plans. This is why green operations values measuring and metering water and energy consumption. It provides indications of anomalies as well as areas that can benefit from future upgrades or renovations. Ongoing commissioning ensures that the systems operate properly and can identify preventive maintenance measures before equipment damage or failure.

3. COMPLIANCE WITH CODES AND PROFESSIONAL STANDARDS

Earlier in the green building "movement" much of the activism and regulations were on a local level. Whether in Seattle, or Los Angeles, the focus was inevitably limited to local issues and geography. As the green building movement expanded, many of these local organizations encountered the problem of translating and comparing different standards, priorities and regulations.

As a result, a number of national organizations were formed with the intent to standardize green building across the country. These organizations focus on the larger picture, but advocacy is still most effective on a local level – in the communities of those dedicated to advancing green building.

While the United States was developing these guidelines, other countries, especially in Europe had already adopted many of these as common practice. Having densely populated areas due to limited space, green behavior was already a higher priority. Necessity is indeed the mother of invention, or in this case, the motivating force for changes in attitude and behavior.

Here in the US, regionalized efforts to create green regulations had an impact on the regulations in the rest of the country. When officials in Los Angeles were forced to deal with smog and major air quality problems in the 1980's, other parts of the country were still unaffected. However, the progress made and regulations established by local California organizations have produced measurable results. Rather than reinvent the wheel, many of the national green building organizations rely upon these standards like these from local organizations and professional associations when creating sustainable policies for a national audience.

3.1. Standards Applicable to Green Building

There are several organizations committed to encouraging green building. Some focus on all building types, while others are more specific and focus on residential or school buildings. The table below lists some of these organizations and the standards or rating systems they use to encourage green building.

Organization	Standards/Rating System
United States Green Building Council (USGBC)	LEED Rating Systems (Leadership in Energy and Environmental Design)
Green Building Initiative (GBI)	Green Globes Rating System
National Association of Home Builders (NAHB)	Model Green Home Building Guidelines
Collaborative for High Performance Schools (CHPS)	CHPS Criteria

These organizations are not focused on developing new building codes, references, standards, and requirements, but are happy to rely on other specific construction, design or government associations who can more suitably address the specific issues. The national organizations listed above then tie these codes and requirements together and use them as a goal, or baseline to improve upon. Developing and incorporating green building standards across the country is too large a task for one organization on its own. Some of the specific organizations with green standards include:

- ENERGY STAR (US Environmental Protection Agency and Dept of Energy)
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- Illuminating Engineering Society of North America (IESNA)
- Green Seal
- Forest Stewardship Council (FSC)

Of the national green building organizations, the USGBC's LEED rating systems are the most widely enacted. The USGBC has over 18,000 corporate or organization members and 80 local chapters nationwide. Many governments and municipalities have

passed legislation and executive orders, specifically requiring that new buildings achieve or are designed according to LEED standards. For this reason, other sections of this paper often use the LEED systems to provide specific examples of green building standards and requirements.

3.2. Overview of the LEED Rating System and How it Works

> "To transform the ways 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 mission statement*

To reach this goal the USGBC developed the LEED rating systems to spread awareness, develop a green market infrastructure, provide guidelines and encourage changes in behavior policies. The ultimate intent is to make the benefits of green building so well recognized that it becomes commonplace, essentially phasing out the need for third party certifications and distinctions.

LEED certification provides a clear roadmap for sustainable design. It then ensures performance by requiring documentation that buildings are constructed and operated as planned. Specifically, LEED certification:

- Defines "green building" by establishing a **common standard** of measurement
- Promotes **integrated**, whole-building design practices that reduce environmental impact
- Raises consumer **awareness** of green building benefits
- Develops an **infrastructure** for sustainable design and building practices and stimulates green competition
- Realizes **cost savings** over the lifetime of buildings
- Validates **achievement** and recognizes environmental **leadership** in the building industry

There is no one-size-fits-all rating system that can address the needs and circumstances of every type of building. Therefore, since its inception in 1993, the US Green Building Council has developed and refined a number of different rating systems within its LEED certification process. These ratings systems focus on different types of buildings, specifically:

- New Construction and Major Renovations
- Existing Buildings: Operations & Maintenance
- Commercial Interiors
- Core & Shell
- Schools
- Healthcare
- Homes
- Neighborhood development

Each of these rating systems is divided into six key categories: 1) Sustainable Site; 2) Water Efficiency; 3) Energy & Atmosphere; 4) Materials & Resources; 5) Indoor Environmental Quality; and a "bonus" 6) Innovation & Design/Operation. The different categories contain prerequisites and credits for various planning, design, and construction considerations and achievements. A building must meet all prerequisites and can earn points for each of the credits. (For clarity, multiple points can be earned for certain individual credits. This is a way to emphasize certain green criteria, most prominently energy efficiency and transportation.) Based on the total number of points accumulated, the building may receive a recognition level of Certified, Silver, Gold or Platinum.[8]

The LEED rating systems are continuously refined, and the newest version, LEED 2009, goes into effect on June 26, 2009 (projects already registered under previous rating systems will not be effected). These changes do not affect the principles of LEED certification, but rather streamline and improve the process. LEED certification is a

[8] Visit http://www.usgbc.org/DisplayPage.aspx?CategoryID=19 for more information on all the LEED rating systems.

means to an end. The goal is not to earn points, but to achieve the intent of each credit, thereby transforming the market and the building environment.

Specific changes include a uniform point scale for all rating systems and all levels of certification. Prior to LEED 2009, each rating system had a different number of total points and points required for levels of certification.

Before LEED 2009					
Certification Level	**New Construction**	**Existing Buildings**	**Commercial Interiors**	**Schools**	**Homes**
Certified	26-32 pts	34-42 pts	21-26 pts	29-36 pts	45-59 pts
Silver	33-38 pts	43-50 pts	27-31 pts	37-43 pts	60-74 pts
Gold	39-51 pts	51-67 pts	32-41 pts	44-57 pts	75-89 pts
Platinum	51-69 pts	68-92 pts	42-57 pts	58-79 pts	90-136 pts

As shown below, LEED 2009 is uniform and consistent.

LEED 2009					
Certification Level	**New Construction**	**Existing Buildings**	**Commercial Interiors**	**Schools**	**Homes**
Certified	40-49 pts				
Silver	50-59 pts				
Gold	60-79 pts				
Platinum	80-110 pts				

Under LEED 2009, every rating system is based on 100 points for the five main categories, with ten additional points for Innovation & Design, and a new Regional Bonus category. LEED 2009 increases the available points for certain credits, giving them more weight and impact on the certification level based upon their environmental and human health impacts. The major focus is to provide more reward for the sustainable considerations that reduce the building's impact on climate change and global warming. This is reflected in the Sustainable Site and Energy & Atmosphere categories, as it stresses reduced automobile and building energy use. The reallocation of points was not done arbitrarily; it involved significant amounts of scientific research, and was based on

the framework of the EPA's TRACI (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) list.

A new Regional Bonus category allows extra points to be earned for issues that are of local or regional importance. Each USGBC chapter or regional council establishes its regional environmental priorities, and in conjunction with the USGBC creates bonus credits for which projects in the region can earn additional points. This does not change LEED to a one-size-fits-all pair of pants, but at the very least gives it an elastic waistband.

Additionally, the titles of the three major rating system will change as part of LEED 2009.

- New Construction → Green Building Design & Construction
- Existing Buildings → Green Building Operations & Maintenance
- Commercial Interiors → Green Interior Design & Construction

3.3. Examples of LEED Credits for New Construction and Major Renovations v2.2

The most common rating system is the current *LEED for New Construction and Major Renovations v2.2 (LEED NC)*. Even though LEED 2009 will be released in the near future, the majority of projects that are constructed in the next year or two will have already been registered under the LEED NC v2.2rating system. This section will concentrate on the LEED NC system, because many of these credits are also included in the other rating systems.[9]

Section 2 of this paper on "green technologies" details many of the possible strategies associated with the various LEED credits. This section will list **all** of the

[9]Visit http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220 for downloadable documents including the LEED for New Construction and Major Renovations rating system, which include summaries and details of each prerequisite and potential credit.

prerequisites and potential credits, and address the standards, calculations and specific requirements associated with **one LEED credit** from each category. Each credit format lists its intent and then outlines the necessary requirements to fulfill that intent.

3.3.1. Sustainable Sites (SS) category

Below is a list of the prerequisite and credits associated with the selection and considerations given to the building site. This category covers a wide array of environmental concerns, from transportation, to the impact on wildlife, to the impact of heat island effect on building energy consumption. Most of these prerequisites and credits are the responsibility of the owner or designer to achieve. Some credits simply provide guidelines of what is (or is not) allowed, while others may require simple or detailed calculations.

- SS Prerequisite 1: Construction Activity Pollution Prevention
- SS Credit 1: Site Selection
- SS Credit 2: Development Density & Community Connectivity
- SS Credit 3: Brownfield Redevelopment
- SS Credit 4: Alternative Transportation:
  - 4.1: Public Transportation Access
  - 4.2: Bicycle Storage & Changing Rooms
  - 4.3: Low Emitting & Fuel Efficient Vehicles
  - 4.4: Parking Capacity
- SS Credit 5: Site Development:
  - 5.1: Protect or Restore Habitat
  - 5.2: Maximize Open Space
- SS Credit 6: Stormwater Design:
  - 6.1: Quantity Control
  - 6.2: Quality Control
- SS Credit 7.1: Heat Island Effect:
  - 7.1: Non-Roof
  - 7.2: Roof
- SS Credit 8: Light Pollution Reduction

SS Credit 4.1: Alternative Transportation – Public Transportation Access	
Intent:	Reduce pollution and land development impacts from automobile use
Requirements:	Locate project within: • 1/2 mile of subway or commuter rail; OR • 1/4 mile of bus stop
Strategy:	Perform transportation survey of occupants. Site the building near mass transit

SS Credit 4.1 is one of the credits that goes beyond the walls of the building and integrates the focus of buildings with the transportation sector. It is simple to determine if this credit has been earned by measuring the distance on a map. It also demonstrates the benefits on registering for LEED certification as early in the planning and design process as possible. It is obviously much easier to change a specified material or product later in the project to gain a point than it is to change the building's location.

3.3.2. Water Efficiency (WE) category

Below is a list of the credits associated with the water consumption and efficiency of a building. This category focuses on landscaping, wastewater reduction and overall water reduction. These credits are generally the designer's responsibility to achieve.

- WE Credit 1: Water Efficient Landscaping:
  - 1.1: Reduce by 50%
  - 1.2: No Potable Water Use or No Irrigation
- WE Credit 2: Innovative Wastewater Technologies
- WE Credit 3: Water Use Reduction:
  - 3.1: 20% Reduction
  - 3.2: 30% Reduction

WE Credit 3: Water Use Reduction – 20% or 30% Reduction	
Intent:	Maximize water efficiency within buildings to reduce burden on municipal supply and wastewater systems
Requirements:	Implement strategies that use 20% or 30% less water than baseline calculations (not including irrigation)
Strategy:	• High efficiency and/or dry fixtures (composting toilets or waterless urinals) • Use greywater (wastewater that has not been in contact with food or sewer waste – showers, bathroom sinks, laundry) • Automatic sensors, flow restrictors, reduced aerators
Standards:	Energy Policy Act of 1992 provides values for baseline calculations

WE Credit 3 and WE Credit 2 have some overlap. Reducing the amount of wastewater can most easily be achieved by reducing the amount of total water that is consumed. For WE Credit 3, one point can be earned for a reduction of 20% and a second point earned if water consumption is reduced by 30%. This is one of a number of credits where points are earned based on reduced consumption. In all cases LEED references a code or building standard that is used as the baseline, or 100% value. WE Credit 3 relies on the Energy Policy Act of 1992, which specifies maximum water consumption for toilet fixtures (1.6 gallons per flush), urinals (1.0 gallons per flush), sinks, showers and others, as well as assumed daily uses per building Full Time Equivalents (FTEs). High efficiency urinals can use 1.0 gallons per flush and waterless urinals (obviously) use no water. The calculations associated with WE Credit 3 are relatively straightforward, and LEED online templates make the process easier and consistent. Sample calculations are included in the LEED reference guide.

3.3.3. Energy & Atmosphere (EA) category

Below is a list of the prerequisites and credits associated with the energy consumption and environmental atmosphere impact of a building. This category addresses energy efficiency, commissioning, renewable energy and refrigerants. Most of these prerequisites and credits are the designer's responsibility to achieve. This category

contains the most available points because of the importance of addressing climate change.

- EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems
- EA Prerequisite 2: Minimum Energy Performance
- EA Prerequisite 3: Fundamental Refrigerant Management
- EA Credit 1: Optimize Energy Performance (2 - 10 points)
- EA Credit 2: On-Site Renewable Energy (1 - 3 points)
- EA Credit 3: Enhanced Commissioning
- EA Credit 4: Enhanced Refrigerant Management
- EA Credit 5: Measurement & Verification
- EA Credit 6: Green Power

EA Credit 2: On-Site Renewable Energy	
Intent:	Increase levels of on-site renewable energy to reduce environmental & economic impacts associated with fossil fuels
Requirements:	Calculate the percent of total building energy provided by on-site renewable energy systems **2.5% (1 pt) 7.5% (2 pts) 12.5% (3 pts)**
Strategy:	Assess possibility of renewable energy systems - solar, wind, geothermal, low-impact hydroelectric, biomass and bio-gas
Calculations:	Calculate baseline energy per EAc1 or Dept of Energy Commercial Buildings Energy Consumption Survey (DOE CBECS).

EA Credit 2 awards one to three points based on the percent of building energy provided by **on-site** renewable energy systems. The credit summary lists possible renewable energy systems and suggestions, but it is the designer's responsibility to design a system that incorporates the technologies to earn these points.

3.3.4. Materials & Resources (MR) category

Below is a list of the prerequisite and credits associated with the materials and resources used in a building. This category addresses reuse of buildings and materials,

waste management, and the use of a number of different types of 'environmental' materials. While the designer specifies the use of many building material types, it is the contractors' responsibility to procure, install and document building materials and products that meet these specifications. Except for the construction waste management credit, the credits do not factor-in specialty equipment and mechanical, electrical or plumbing equipment.

- MR Prerequisite 1: Storage & Collection of Recyclables
- MR Credit 1: Building Reuse:
  - Credit 1.1: Maintain 75% of Existing Walls, Floors & Roof
  - Credit 1.2: Maintain 95% of Existing Walls, Floors & Roof
  - Credit 1.3: Maintain 50% of Interior Non-Structural Elements
- MR Credit 2: Construction Waste Management:
  - Credit 2.1: Divert 50% From Disposal
  - Credit 2.1: Divert 75% From Disposal
- MR Credit 3: Materials Reuse:
  - Credit 3.1: Reuse 5%
  - Credit 3.2: Reuse 10%
- MR Credit 4: Recycled Content:
  - Credit 4.1: 10% (post-consumer + 1/2 pre-consumer)
  - Credit 4.2: 20% (post-consumer + 1/2 pre-consumer)
- MR Credit 5: Regional Materials:
  - Credit 5.1: 10% Extracted, Processed & Manufactured Regionally
  - Credit 5.2: 20% Extracted, Processed & Manufactured Regionally
- MR Credit 6: Rapidly Renewable Materials
- MR Credit 7: Certified Wood

MR Credit 3: Materials Reuse – 5% or 10% Reuse	
Intent:	Reuse materials and products to reduce the demand for virgin materials and to reduce waste from the impacts associated with extraction and processing
Requirements:	Use salvaged, refurbished or reused materials for a minimum of 5% or 10% of the total material value for the project (excludes Mechanical, Electrical or Plumbing material)
Strategy:	• Consider beams, posts, flooring, paneling, doors/ frames, cabinetry, furniture, brick & decorative items • Incorporate reuse into design • Research potential suppliers
Calculations:	• Percent is determined based on value of materials • Baseline uses material estimate OR 45% of total cost

MR Credit 3 awards one point for reusing 5% of the building's materials and a second point for 10% of the building's materials being reused, salvaged or refurbished. The percent of materials reused is calculated based on the **cost** of all building materials. The cost of all building materials can be based on an overall project estimate, or 45% of the total cost project cost. Materials or products in the MR category that fulfill the criteria of multiple credits can be applied towards all those credits. For example, material that is reused and local, also applies towards MR Credit 5.

The cost of the salvaged, refurbished or reused material must be tracked and then calculated to determine that it meets the percentages required to earn points. Maintaining organized records, receipts, delivery tickets and photographs are useful techniques in the event that questions which may arise later in the certification process can be answered quickly and accurately.

The contractor should enter all the relevant product information into a detailed log so that calculations can be performed to determine if the project meets the percentages required to earn points. It is helpful to maintain a comprehensive spreadsheet tracking

log that contains columns for all the product related credits (MR credits #3 through #7 and Indoor Environmental Quality (EQ) #4). It may be included as part of a submittal log, or a separate log organized by specification section.

3.3.5. Indoor Environmental Quality (EQ) category

Below is a list of the prerequisites and credits associated with the indoor environmental quality of the building. This category addresses indoor air quality, thermal comfort and control as well as daylighting and views. Most of these prerequisites and credits are the designer's responsibility to achieve. This category emphasizes health and comfort during construction and occupancy and is the most apparent to and appreciated by building occupants.

- EQ Prerequisite 1: Minimum IAQ Performance
- EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control
- EQ Credit 1: Outdoor Air Delivery Monitoring
- EQ Credit 2: Increased Ventilation
- EQ Credit 3: Construction IAQ Management Plan:
  - Credit 3.1: During Construction
  - Credit 3.2: Before Occupancy
- EQ Credit 4: Low-Emitting Materials:
  - Credit 4.1: Adhesives & Sealants
  - Credit 4.2: Paints & Coatings
  - Credit 4.3: Carpet Systems
  - Credit 4.4: Composite Wood & Agrifiber Products
- EQ Credit 5: Indoor Chemical & Pollutant Source Control
- EQ Credit 6: Controllability of Systems:
  - Credit 6.1: Lighting
  - Credit 6.2: Thermal Comfort
- EQ Credit 7: Thermal Comfort:
  - Credit 7.1: Design
  - Credit 7.2: Verification
- EQ Credit 8: Daylight & Views:
  - Credit 8.1: Daylight 75% of Spaces
  - Credit 8.2: Views for 90% of Spaces

EQ Credit 1: Outdoor Air Delivery Monitoring	
Intent:	Provide capacity for ventilation system monitoring to sustain to occupant comfort and well being
Requirements:	Install monitoring system to provide feedback on ventilation system performance for: • Mechanical ventilation: Monitor CO2 in dense areas (25ppl/1,000sf); non-dense provide OA measurement device • Natural ventilation: CO2 monitoring devices between 3' and 6' above floor.
Strategy:	Install CO2 and airflow measurement devices to provide info to HVAC system or Building Automation Systems to adjust settings Use alarms if automatic controls are not possible

EQ Credit 1 seeks to ensure that there is sufficient fresh air flow to the building and that 'stale' air with higher carbon dioxide concentrations is exhausted when there are higher densities than normal (such as in lobbies or conferences rooms).

3.3.6. Innovation and Design (ID) category

This is a "bonus" category, with five available points. A maximum of four points are available for a combination of exemplary performance above the existing credits or innovative green building performance that is not specifically addressed in the rating system.

One additional point can be earned for this credit if a LEED Accredited Professional (LEED AP) is a principal participant of the project team. LEED APs are individuals recognized by the USGBC for having demonstrated a thorough understanding of the LEED rating systems and certification process. This individual serves to educate the project team members and streamline the LEED application and certification process.

3.4. State and Federal Regulations Unique to Green Building

More and more frequently over the past several years, federal, state and municipal governments have begun requiring LEED certification or other green standards for new construction projects. For these requirements to apply, the projects must meet certain criteria often involving government funding, and the size and cost of the building. Some laws and executive orders require that buildings achieve different certification levels, while others do not require the documentation and certification process, but necessitate that buildings must be designed and constructed in accordance with LEED standards.

On the federal level, 12 agencies or departments have requirements for LEED initiatives, many of which are listed below[10]:

Agency	Requirements
Dept of Agriculture	All new construction and major renovations must achieve LEED Silver
Dept of Agriculture – Forest Service	New construction of office buildings, visitor centers, research facilities, and climate controlled warehouses over 2,500 sf must achieve LEED Silver
Dept of Energy	All new buildings $5M or greater must achieve LEED Gold.
Dept of Health and Human Services	All construction projects with federal funds over $3M must achieve LEED certification or Green Globes certification
Environmental Protection Agency	All new buildings over 20,000 sf must achieve LEED Gold
General Services Administration	All capital building projects must earn LEED Certified, with a target of LEED Silver; GSA also requires all lease construction to earn LEED Silver
National Aeronautics and Space Administration	All new construction and major renovations are required to meet LEED Silver, and strive to meet LEED Gold
U.S. Air Force	Encourages the use of LEED for new construction or major renovations
U.S. Army	All new vertical construction projects will achieve LEED Silver; the Army has committed to adopting LEED for Homes for barracks and residences.
U.S. Navy	All applicable projects are required to meet LEED Certified level

[10] For a complete listing, visit http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852

Because of their size, government agencies are typically slower to react to changes than other organizations. That being said, many agencies are putting their support behind green building and environmental concerns. The federal government uses 10 times as much renewable energy today as it did in 2003[11].

Below is a list of the 30 states that have some LEED initiative in place, although some are much stricter than others[12]:

States with LEED Initiatives		
Arizona	Maine	Oklahoma
Arkansas	Maryland	Ohio
California	Massachusetts	Oregon
Colorado	Michigan	Pennsylvania
Connecticut	Minnesota	Rhode Island
Florida	New Jersey	South Carolina
Hawaii	New Mexico	South Dakota
Illinois	New York	Virginia
Kentucky	Nevada	Washington
Louisiana	North Carolina	Wisconsin

Below is a list of the major cities with LEED initiatives in place. There are 90 total cities with such laws and requirements.[13]

Cities with LEED Initiatives		
Atlanta	Kansas City	Salt Lake City
Austin	Los Angeles	San Antonio
Baltimore	Minneapolis	San Diego
Boston	Nashville	San Francisco
Chicago	New York	Seattle
Cincinnati	Philadelphia	St. Louis
Dallas	Phoenix	Syracuse
Denver	Pittsburgh	Washington DC
Honolulu	Portland	
Houston	Sacramento	

[11] USGBC Federal Summit 2008, Acting Director - Office of Federal High Performance Buildings, US GSA
[12] For a complete listing, visit http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852
[13] For a complete listing, visit http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852

Moving closer to home, the below table is highlights New York State and its counties, cities and municipalities with LEED initiatives. It lists the specific criteria and LEED standards, again, some more high reaching than others[14].

Government	LEED Initiatives
New York State	Encourages state projects to seek LEED certification; Dormitory Authority requires all new construction and major renovation projects to be registered with USGBC and strive for LEED Silver
Erie County	All new construction and major renovations of county facilities 2,500+ sf must achieve LEED Silver; also mandates the purchase of ENERGY STAR products where possible
Monroe County	Requires adherence to LEED standards for new county buildings and major renovations 5,000+ sf
Nassau County	Incorporates LEED in design, construction and renovation of all county buildings; certification encouraged, but not required
Niagara County	Requires all new construction and major renovations of County-owned buildings to earn a minimum of LEED Silver certification.
Suffolk County	LEED certification for Department of Public Works projects over $1M
Sullivan County	All future county facilities must meet LEED guidelines
New York City	City-funded projects required to use LEED standards; non-residential capital projects $2M+ must achieve LEED Silver; schools and hospitals must meet LEED Certified
Syracuse	All new municipal construction and major renovations must meet LEED Silver; also applies to city's public schools
Town of Babylon (Suffolk County)	LEED certification required for new construction of commercial buildings, office buildings, industrial buildings, multiple residence, over 4,000 sf

[14] For a complete listing, visit http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852

3.5. The Future of Governmental Regulation

In the 2008 presidential election campaign, both major party candidates laid out their environmental plans to reduce greenhouse gas emissions, decrease the government's consumptions, increase energy efficiency, and boost the percentage of renewable energy used in the US. The focus of these plans was not only a matter of environmental concern, but that independence from foreign fossil fuels was a matter of national security. Some of these plans include:

- By 2012, increase renewable energy to 10% of total US energy production
- By 2015, reduce government energy consumption by 15%
- By 2015, achieve 1 million plug-in hybrid cars in use
- By 2025, eliminate dependence on foreign oil
- By 2025, increase renewable energy to 25% of total US energy production
- By 2050, reduce greenhouse gas emissions by 60% or 80%

To some these goals may be viewed as lofty, to others, they may be seen as insufficient. Regardless, the major question is…how will future presidents and governments achieve these results?

The answer: the government will increase federal (and state) regulations and provide financial incentives to encourage businesses and individuals. The American Reinvestment and Recovery Act of 2009 (i.e., Economic Stimulus Package), along with other budget plans of the Obama administration have taken measures via financial incentives to encourage growth of the infrastructure and industry.

Various agencies within the federal government have already been implementing such guidelines and regulations. For example, the Department of Energy is creating a new model building code that calls for increasing energy efficiency by 30% from most current requirements. As building codes are not regulated on a federal level, this model

will provide a framework and be available for state and local municipalities for their encouraged adoption.

In fact, California recently released its 2008 Green Building Standards Code, leading the way.[15] These building codes apply to commercial and residential buildings in both the private and public sectors, and have been compared to an equivalent of LEED Silver certification. Different requirements will be phased in over the next few years as follows:

- 2009 – Voluntary effect
- 2010 – Mandatory energy efficiency components
- 2011 – Mandatory moisture control, indoor air quality, waste recycling, 20% reduction in potable water use

[15] www.bsc.ca.gov

4. LOW-COST GREEN STRATEGIES AND FINANCIAL INCENTIVES

While implementing some green design considerations cost more upfront, others can be achieved at less or no additional cost with careful planning and consideration. There is a premium for using some "green" materials…however, green building emphasizes the use of less materials. There are additional costs for using new technologies…however, they result in increased efficiency and reduced operating costs. A third party documentation and certification process, like LEED, requires more administration and coordination…however, it results in a better managed project with less changes.

To the extent that the owner can afford to front some additional costs, or make certain sacrifices to keep a project within budget, he will receive pay-off in future in various forms:

- Reduced energy and operating costs
- Increased property value
- Increased rent price for leasers
- Additional marketing/public relations opportunities to attract clients and skilled employees.

Simply slapping green components, like solar panels, onto a building will invariably increase the construction costs. However, designing a building with a smaller footprint will inherently reduce the materials and labor consumed within a building. ***Therefore, to control costs and receive the full financial benefits of green building, it is crucial that the green considerations be addressed from the early planning stages.***

In addition to actual construction related costs, it is important to be aware of available financial incentives. Governments and agencies within New York offer numerous incentives or tax breaks to encourage and assist green building projects.

As part of Executive Order #111, the New York State Energy Research and Development Authority (NYSERDA) offers low interest loans for projects with energy efficient measures, including the use of building materials in accordance with LEED or other green building standards. Also, the New York State Green Building Tax Credit Program provides a tax incentive to commercial developments that utilize green building strategies[16].

Monroe County launched an initiative that directs the County of Monroe Industrial Development Agency to extend tax abatements from 10 to 14 years to encourage the private sector to implement LEED standards.

On Long Island, if a project in the Town of Babylon achieves LEED certification, the Town will refund the developer the certification fees that it paid to the USGBC.

Utility companies, including Long Island Power Authority (LIPA) and National Grid (natural gas) offer free energy audit home inspections as well as discounts and rebates for using energy start products or taking other measures to make buildings greener. It may seem counterintuitive that energy provides are encouraging, and in fact, paying people to use less of their product. With the increasing population and energy demands, more efficient energy use reduces the burden on their infrastructure and the need for new power plants.

As indicated earlier in this paper, there are many incentives and tax breaks for projects that remediate Brownfields sites. In 1997 President Clinton signed the Taxpayer Relief Act which included an incentive to encourage cleanup and redevelopment of Brownfields sites. This Brownfields Tax Incentive allows the cleanup costs to be fully

[16] http://www.dec.ny.gov/energy/1540.html

deductable in the year that they were performed. The New York State Brownfields Cleanup Program provides credits for:

1. Redevelopment costs – 10%-22% of the actual remediation and cleanup costs
2. Real property taxes – based on the number of jobs created at the site and the site's location (up to 100%)
3. Environmental remediation insurance – $30,000 or 50% of the premium costs

A comprehensive list of incentives and rebates is available at the Database of State Incentives for Renewables and Efficiency website - www.dsireusa.org. This site is a comprehensive source of information on state, local, utility and federal incentives that promote renewable energy and efficiency.

5. PITFALLS, RISKS, AND POTENTIAL LIABILITIES IN GREEN BUILDING

With any type of project, communication, planning and knowledge are key components to reducing risks and potential liabilities. The same is true with green building. Risk is best managed by those with the most direct control, but green building is a collaborative process that involves many specialists. While the owner may transfer responsibility for tasks and components of the design and construction process, the building belongs to the owner, and he controls the funds and key decisions. It is important that all parties have the same expectations and understandings throughout the project.

To reach this universal level of understanding, it is important that the project team hold periodic collaborative meetings involving the entire team - the LEED consultant, owner's representative, architect, engineers, commissioning authority, CM, contractors and subcontractors. The USGBC refers to these meetings as charrettes. The charrettes should be held throughout the course of the project, including the design and pre-construction phases. While the standard design-bid-build process does not select contractors until after the design is complete, the contractor's (or CM's) early involvement can refine the design process and add another perspective about the quality and ease of installation of some of the newer products and technologies. During the construction phase, the contractors' and subcontractors' project managers and superintendants should attend these meetings so that they can inform their workers of the green building responsibilities associated with their work. **It is important to emphasize the sustainable goals and expectations to everyone in charge, so that they in turn can emphasize to all those working on the project that this is a green building.**

A significant project risk is the failure to achieve LEED certification or the desired LEED level. This can be the fault of one or multiple parties and may result in the owner's loss of incentives, rebates, public funding or tenants. A knowledgeable and

diligent owner (or representative) is in the best position to ensure overall certification. While the designer and CM/contractor are responsible for achieving or documenting certain points, the total score ultimately rests with the owner. Because much of the burden can be placed on the owner, it is helpful and important to have an individual in charge of the LEED certification process, either a LEED consultant, a qualified owner's representative (LEED AP), or the designer. Someone must be responsible and empowered to monitor the documentation process and prepare materials for submission.

The Washington DC Green Building Act of 2006 requires a performance bond to ensure that LEED certification is achieved. If the building does not achieve certification, 4% of the bond sum is forfeited to the city's Green Building Fund. The Surety & Fidelity Association of America and the National Association of Surety Bond Producers have responded to the act and addressed a number of inconsistencies and inherent conflicts. Most notably asking, which party is to provide the performance bond, and who is ultimately responsible if LEED certification is not achieved. If a contractor provides the bond, but LEED certification is not achieved for design reasons, it begs the question of who would be liable. These groups have pointed out the owner holds the ultimate responsibility for whether the building achieves compliance with the Act's requirements. Legislators appear to have gotten ahead of themselves and not fully understand the role of a Surety, but government officials have agreed to reevaluate and address this problem in the near future[17].

Other project risks associated with green building include:

- Failure to achieve intended (or promised) energy efficiency or operating cost savings
- Improper installation of new products or due to new techniques
- Traditional risks of cost and schedule overruns

[17] http://www.bizjournals.com/washington/stories/2008/12/15/story2.html

Owners, designers and contractors have different risks. Specifically, contractors can reduce their risks through knowledge and a thorough understanding of 1) the contract, 2) project documents, 3) LEED requirements and the project goal, and 4) green building scheduling considerations.

5.1. The contract

In 2007, the American Institute of Architects (AIA) updated the B101 form of contract between the owner and the architect that addresses Green Design and LEED certification. The AIA also developed a separate contract or rider specific to LEED services (AIA B214). However, there is no "standard" owner-contractor contract that addresses LEED certification. Most of the contractor's requirements are incorporated into the project specifications. In some cases a general clause may be inserted in the contract that requires the contractor to work with the owner and designer to achieve LEED certification.

5.2. Project Specifications

There are various project specification sections that pertain to LEED requirements. Most of the standard specification sections will contain a LEED sub-section as applicable, especially relating to materials (such as low emitting materials and certified wood). However there are several specific sections under Division 1, General Conditions, including:

- 01352 – LEED Requirements
- 01500 – Construction Facilities and Temporary Controls
- 01524 – Construction Waste Management
- 01810 – General Commissioning Requirements

5.3. LEED Requirements

Informing everyone involved in the project of the LEED requirements and goals is critical to the success of the project. This can and should be accomplished through repetition, postings and even devoting a few minutes of each project or superintendent meetings to the education of different LEED topic (much like safety topics).

5.4. Schedule

The schedule for a green building can be impacted differently than a traditional construction project. Certain green materials or specialty products may have longer procurement lead times. Utilizing a smaller site layout, minimizing disturbance from deliveries, storing and protecting material onsite, and separating solid waste may require additional coordination and considerations. More time will also be devoted to commissioning, testing and balancing of advanced systems, as well as flushing out the building or testing the indoor air quality prior to occupancy.

Planning, coordination and a transformation of the green building market (more experienced professionals and lower cost of green products) will reduce project risks.