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Costs and Benefits of Building Green

Ms. Alexia Nalewaik, CCE MRICS, and Ms. Valerie Venters, CCC

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Sustainable development is the most vibrant and enigmatic global topic in the construction industry in more than a decade. Green buildings are the darling of the media and trendy, politically-correct owners and tenants. Building green is also a means to an end, used by public agencies to bolster community support and public image.

But what does it cost? Is popular perception correct, that green buildings cost more? Do lower lifecycle costs offset any increase in the initial construction cost? Do the benefits related to human performance and health balance the cost of sustainable design? Is building green justifiable as a business case?

This paper provides a brief overview of green building and available rating systems, followed by a discussion about the tangible and intangible benefits of sustainable design. The relative cost of green construction is debated, and the discourse concludes with some cost-savings guidance.

WHAT IS SUSTAINABLE DEVELOPMENT?

Definitions of sustainability range from broad concepts that incorporate all aspects of sustainability to narrow definitions focused on one specific sustainable feature, such as recycled content materials or energy efficiency. The American Society of Civil Engineers defines sustainable development as "…the challenge of meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and waste management while conserving and protecting environmental quality and the natural resource base essential for future development." [1] What, then, constitutes 'greenness'? Sustainable construction is a philosophy and an integrated design process, not a building style. The definition of 'what is green' varies according to the source, and may be subjective – for the purposes of this paper (while acknowledging that certification methodologies have flaws and continue to evolve), the US Green Building Council criteria will be assumed to best define a green building.

Elements of sustainable design appear in buildings constructed in many countries and at many points in time over the past several centuries [4] gaining momentum in the 1970's. Various task forces and commissions in the US were formed through the '70's, '80's, and '90's to study energy and the environment. "The modern green building movement appears to be little over a decade old" with use of the term 'green architecture' appearing in print in the United Kingdom and the US in 1990. [13]

In the US, early adopters of certification for green buildings included State and Federal agencies. The majority of these were commercial buildings – offices, libraries, courthouses, museums, and more. "Although more members and registered projects are located in California than in any other state, Pennsylvania, Massachusetts, Washington and Oregon have the most extensive, documented experience with green building and LEED"[13]. Certain large corporations (including manufacturers) and nonprofit foundations soon followed, under the mantle of corporate responsibility. With published reports on the qualitative benefits of green construction, the trend expanded to include educational institutions (both K-12 and higher learning, public and private sector) and healthcare. Growth is now being seen in the corporate private sector and residential markets, in US construction outside of the US (embassies), and in infrastructure.

RATING GREEN BUILDINGS

In 1993, the US Green Building Council (USGBC), a 501(c)(3) non-profit organization, was formed to promote green building practices and education. A 501(c)(3 exemption from US income tax. This is granted to certain non-profit organizations, designated as 501(c)(3) after the section of the US Internal Revenue Code that contains the provision. [31] The USGBC Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, launched in 2000, "…is a voluntary, consensus-based, market-driven building rating system…" that "…evaluates environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a 'green building'." [29, 30]. In the US the USGBC LEED program dominates the green building certification market, having been adopted by the US government, various States and municipalities, and private sector owners. LEED certification is recognized globally as a mark of distinction, for both new and renovated properties. Certification points are awarded in six categories: sustainable sites, water efficiency, energy and atmosphere, indoor environmental quality, materials and resources, and innovation and design. Four certification levels are available through the USGBC LEED program: certified (formerly 'bronze'), silver, gold, and platinum. The certification process itself requires registration of the project with USGBC, USGBC technical support throughout the design, construction and commissioning process, and final building certification by USGBC (which involves technical review of project documentation and certification committee review).

Other rating systems include but are not limited to the following:

- Building Research Establishment's Environmental Assessment Method (BREEAM), United Kingdom (UK).
- Civil Engineering Environmental Quality and Assessment Scheme (CEEQUAL), Institution of Civil Engineers (ICE), UK.
- Collaboration for High Performance Schools (CHPS) design criteria.
- Environmental Performance Assessment.
- Green Globes (Green Building Initiative).
- Green Star Environmental Rating System, Australia.
- Hong Kong Building Environmental Assessment Method (HK-BEAM).
- Japan Sustainable Building Consortium's Comprehensive Assessment System for Building Environmental Efficiency (CASBEE).
- Laboratories for the 21st Century Environmental Performance Criteria (Labs21 EPC), a joint project of the US Environmental Protection Agency (EPA) and Department of Energy (DOE). And,
- SPiRiT (Sustainable Project Rating Tool, US Army Corps of Engineers [USACE]).

A characteristic of most rating systems is a checklist for sustainability-related issues, which becomes part of the planning and programming documentation. In order to qualify for certification, the design and construction of the facility is evaluated against a rigorous rating and point system which reflects the overall sustainability of the facility.

TANGIBLE AND INTANGIBLE BENEFITS OF GREEN CONSTRUCTION

Green construction yields a number of benefits to the owner, both tangible and intangible. Sustainably-designed buildings benefit from lifecycle cost savings (including deferred replacement cost), improvements in human performance (including productivity gain, better health), and an increase in prestige [3].

Lifecycle Cost Savings

Lifecycle Costing (LCC) quantifies the total "…costs and benefits over the life of a particular product, technology or system" [13]. The savings are predominantly realized through reduced utilities costs and savings in operations and maintenance, the calculation for which is a simple act of subtracting the projected utilities and maintenance and operations costs savings over the useful life of the building from the total direct costs associated with the building components and subsystems [22].

Utilities Savings - As the cost of energy and water increase, there is more economic motivation by the owner to reduce utilities costs over the lifetime of the building. A reduction in energy use (both gas and electricity) and both internal and external water consumption (including sewerage) may reduce operational costs. Hard data is available to support this claim. In its first year of operation, one company's headquarters building "…used 42 percent less energy and 34 percent less water than standard buildings of comparable size" [16]. Ongoing scheduled maintenance can itself reduce utilities costs by properly caring for systems and equipment.

Maintenance Savings - Design and selection of materials for building and site construction may result in lower maintenance costs and longer service lives that reduce the frequency of equipment replacement. For example, native or inert landscaping conserves both water and monthly maintenance. Similarly, pollution prevention and waste management efforts reduce the ongoing cost of refuse disposal and treatment.

What evidence exists that lifecycle cost savings verifiably offset the initial cost of construction? Since LEED certification has been in existence for less than a decade and the lifetime of a building (according to US Government tax classification) is 39 years, it can be argued that no complete set of data exists for the total lifecycle cost savings realized by LEED certification. Comparative data is difficult to obtain, owing to proprietary corporate records and a small sample size [5]. Further, in the absence of a controlled study between two 'identical' buildings (one LEED certified and one not), all studies of lifecycle cost savings must therefore rely on estimates and projections based on historical evidence, abstractions from reality, not verification of quantitative data. For the purpose of lifecycle cost analysis, then, the study must rely upon an estimate or forecast of savings (including assumptions about utilities rates) instead of projected savings based on a complete set of historical data.

Savings by Design

The second largest source of cost savings is in the design of the facility. Numerous potential cost savings blur the line between green design and value engineering, such as the following: [32]

- Design flexibility and carefully considered site planning that reduce the footprint (and thus the square footage and associated systems) of the building, right-sizing the facility while satisfying the needs of the owner.
- Efficiency in infrastructure, e.g., minimized length of sewer and utility lines, savings on surface area for paving, and more.
- Downsized mechanical and electrical equipment, through the use of daylighting, natural ventilation, low- or no-flow plumbing fixtures, etc. Similarly, high efficiency systems and appropriate building siting.
- Power generation through the use of photovoltaics or other generation, and reduced peak energy use.
- Use of locally-sourced or reclaimed materials, which not only boosts the local economy but reduces transportation costs. And,
- Choosing to reduce or not use any materials, especially for interior finishes (Eisenberg, 2008).

Improvements in the Construction Process

Reducing the impact of the construction process itself may affect the overall cost of the project. "Environmentally conscious construction practices can markedly reduce site disturbance, the quantity of waste sent to landfills, and the use of natural resources during construction. It can also minimize the prospect of adverse indoor air quality in the finished building" (Gottfried, 1996). For example:

- Site-restoration costs may be minimized by protecting the site and managing both site access and path of travel.
- Demolition debris can be reused in site work.
- Cost of repair and replacement can be reduced by protecting materials and equipment.
- Indoor air quality can be improved, and cleaning costs and waste minimized, by managing particulates and debris generated during the construction process. And,
- Site housekeeping and phasing can be used to avoid contamination.

Care taken during construction may ultimately improve the occupied facility, and reduce commissioning costs by minimizing deficiencies.

Improvements in Human Performance

Aspects of design may focus on improvements in indoor environmental quality, such as air quality, temperature control, and daylighting. In addition to the associated energy savings, there is growing evidence that sustainably-designed buildings have a positive effect on worker productivity and quality of life [3]. Occupant health and comfort may be improved in green building and liability reduced through the reduction or elimination of toxic or harmful substances, which may result in reduced absenteeism and turnover [14]. In education facilities, students retention and learning ability may improve; in the case of healthcare facilities, sustainable design may result in faster recovery time for patients. Recent willingness by insurance companies to reduce premiums for green buildings does appear to support the contention that commissioning and sustainable design improve human health, reduce 'sick building syndrome' claims, and may also reduce damage claims from both human and natural hazards.

However, most results regarding the effect of sustainable design on building occupants are qualitative not quantitative. Further, whereas lifecycle costs may well offset an initial cost increase, there is little evidence that sustainable construction provides a substantial margin of economic benefit over traditional construction, unless one attempts to quantify the less tangible improvements in occupant health and welfare. "Candidly many attempts have been made to measure such benefits but these benefits are difficult to prove as the required on-site studies themselves tend to be intrusive and disruptive thereby skew the results of such studies as past example of such studies have demonstrated" [2]. Also to be considered are many variables, not the least of which may be corporate philosophy – perhaps an owner that is enthusiastic about doing the right thing for the environment also cares about doing the right thing for their employees, implementing work-life balance initiatives which in turn result in happier, healthier building occupants.

The 'Feel-Good' Factor

There is another 'benefit' of green construction, which is social value - a compound function of public image, marketability, resource conservation, and corporate responsibility. For certain owners, the 'feel-good' factor may tip the scales in favor of sustainability, where "…choices being made to incorporate sustainability into design and construction are a result of value the client sees in the economic and environmental benefits of 'green'" [14]. In other words, certain owners may make the decision to build sustainably and certify their buildings because the argument is for them no longer purely economic – the true greening of the corporation, not just 'greenwashing', has become part of many firms' guiding principles and values [24]. For example, the embodied energy and costs associated with the production of building materials, while theoretically categorizable as a lifecycle cost, are tertiary costs borne by the greater population and perhaps thus are best associated with the societal value of green buildings. Similarly, the purchase of renewable energy from alternate sources and the purchase of carbon offset credits also represent indirect holistic value. "Greater public awareness and the corporate responsibility agenda are adding further corporate value to aspects of building sustainability that previously had to be judged solely on financial returns" [23].

There may be a "me too" domino effect of certification and the associated esteem value. "Once the scheme is established and recognized, no owner, designer or constructor will want to be without such a distinguished award and its associated prestige, political, and marketing value, and the public will expect it too" [2].

Certain corporate citizens take the calculation a step farther, and consider the impact of their economic activities on the environment - however, 'green accounting' methodologies and metrics are neither entirely consistent, nor have they yet found widespread application. Approaches to life cycle assessment (LCA) vary and not all methodologies consider the complete cradle-to-grave impact. life cycle assessment (LCA) is not to be confused with Lifecycle Costing (LCC), mentioned earlier [26]. LCA takes a whole-system approach to understanding the environmental consequences of technology choices, analyzing the cradle-to-grave impact to the planet of materials or products, including " . . . raw materials extraction and processing, intermediate materials manufacture, material manufacture, installation, operation and maintenance and ultimately recycling and waste management." [10] The assessment may include calculation of damages in such areas as global warming, pollution, consumption of minerals and fossil fuels, land use, waste sent to landfills, and noise An LCA 'cradle-to-cradle' assessment may be done if the lifecycle of the product ends at a recycling facility.

There is some data to support the claim that financial benefits of sustainable construction are "…between $50 and $70 per square foot in a LEED building, over 10 times the additional cost associated with building green" [12] although some data sources blend the quantifiable aspects of sustainability and assign a value to the qualitative benefits, in a 'balanced scorecard' fashion that includes non-financial factors [11].

THE COST OF SUSTAINABLE DESIGN, CONSTRUCTION, AND CERTIFICATION

When the concept of green building began to infiltrate mainstream consciousness, there was a common perception that green was more expensive. Why? In certain instances, green building did cost more – the technologies being implemented were new and not widely available or mass manufactured, architects who specialized in sustainable design were few and thus able to charge a premium for their services, and contractors who were unfamiliar with changes in the construction and management process (such as separate documentation of materials costs and construction/demolition debris) experienced inefficiency and productivity losses and may also have charged a premium for the burden. Add in the cost of commissioning and other soft costs incurred in order to obtain certification, and the total initial cost of the building was likely indeed higher than that of traditional construction. Construction costs are often categorized as either 'soft costs' or 'hard costs'. Hard costs include 'bricks-and-mortar' direct expenditures associated with the building itself, such as materials, equipment, and construction labor. Soft costs include all other expenditures associated with the construction project, such as architect, engineer and consultants fees, government fees (such as plan checks and permitting), taxes, costs of financing, and interest. Land costs may be treated as hard costs, or may be recorded separately. Method of allocation of expenditures between the categories varies, sometimes dramatically, and must be carefully considered when interpreting reports or studies.

To compound the effect, many owner-decision makers probably reacted first to the capital cost sticker shock[15], failing to take into consideration the lower lifecycle cost of the sustainably-designed facility, costs which in many cases may have offset the initial increased expenditure in part or as a whole. This is perhaps because the funding for capital improvements often comes from a different corporate 'bucket' within a particular fiscal year or range of years, as distinct from money allotted in the annual budget for maintenance and operations – there is little to no incentive at the corporate level to coordinate or integrate the two budgets. In this fashion, viable green construction projects met an early death because lifecycle costing was not conducted. Conducting a present-value economic analysis may yield eye-opening results – an oft-quoted source states that over the lifetime of a facility "…initial building costs account for approximately just two percent of the total, while operations and maintenance costs equal six percent, and personnel costs equal 92 percent" [10].

Current data on the cost differential between traditional construction and green building varies, depending on the source of information. One complication is in the definition of "cost," which varies from study to study, some analyses being more inclusive than others regarding soft costs. Various consultancies and the USGBC have been prolific in generating published material, all vociferously supporting the conclusion that the costs of traditional and sustainable construction are with time approaching parity – while at the same time specifically excluding design and documentation costs and noting that "…comparisons of this type [using an average square foot cost method] cannot be considered reliably meaningful…to assess what – if any – cost impact there might be for incorporating LEED and sustainable design" [18, 19]. In contrast, diverse public and private sources cite a range from two percent to eight percent in the increased initial cost of certifiable buildings, while at the same time acknowledging "…insufficient methods exist to determine the true cost by using a truly controlled study approach thereby assuring the accuracy of the actual percentage change in value" [2]. It is logical to infer that the controlled study obstacle exists in all efforts to quantify the true cost differential, whether the endeavor (or preferred Kool-Aid flavor) is to prove or disprove parity. "Virtually no data has been collected on conventional buildings to determine what the building would cost as a green building. And, surprisingly, most green buildings do not have data on what the building would have cost as a conventional building" [13]. The only assertion upon which all parties can agree is that comparisons can be manipulated to prove the point – the data for both sustainable and non-sustainable buildings is so scattered that the difference between the two data sets is moot [6, 7].

However, there is data and anecdotal evidence to support the observation that, in the near-decade since the inception of the LEED certification system, manufactured costs for components installed in green buildings have reduced, progress continues in building technology advancement, product reliability is improving, and lower pricing is becoming a reality in the marketplace. The premium paid to contractors, architects and engineers for LEED expertise, and thus the overall cost of building green, is also diminishing with time as the learning curve flattens [12]. As green buildings become more accepted, it is reasonable to expect that component aspects of green design will gradually be absorbed into everyday construction practices [5]. And, even though recent escalation has substantially increased construction costs across the board, the trend toward LEED certification continues, indicating that the costs associated with certification are for many owners not specifically a deterrent, although cost may be a barrier to higher levels of certification [6].

In some industries, specifically carpeting and furniture, substantial demand for green products has affected the manufacturing process and even the customer relationship (through cradle-to-grave recycling). The Los Angeles Community College District's (LACCD) $2.2 billion capital construction program, undertaken under a sustainable mandate from the District's Board of Trustees, has wielded considerable purchasing power over the past seven years:

> "LACCD has successfully gotten two industries to change their practices in the process of meeting the needs of the program. The district's purchase of furniture required successful bidders to provide furniture that was 100 percent recyclable and eliminate the use of any material that could not be recycled. Haworth and KI, two very large furniture companies, agreed to change their manufacturing process to meet the District's multi-million furniture need. Similarly, Tandus Industries, the successful bidder on the District's carpet contract, changed their manufacturing process to produce the most sustainable carpet in the industry today to meet LACCD's demand for a maximum content recycled and recyclable carpet product. In both cases, the large volume purchase also had the serendipitous effect of lowering price in both categories, saving LACCD money over what it would have paid for traditionally made products." [8].

Throughout the design and construction phases, documentation and specific tasks are required, including charrettes, energy modeling, tracking of water use, waste generation and recycled content, and various construction submittals. A "charrette" is a meeting or series of meetings that involves stakeholders and representatives from multiple disciplines, collaborating on a design solution. [27]. Certain owners address these requirements by hiring a third-party LEED certification specialty consultant; others rely upon their existing design team. Construction hard costs, soft costs and commissioning costs vary according to the size, location and complexity of the project, and the level of certification sought [28].

Commissioning is a LEED prerequisite for certification, although whole-building commissioning is not required [8]. Commissioning involves a third-party engineer to inspect building systems and ensure that they perform according to the design specifications, often conducted after construction or systems installation but prior to final occupancy. Systems that require commissioning may include mechanical, electrical, plumbing, controls, fire management, audio-visual installations, and elevators. The process includes documentation, testing and inspection at startup, correction of deficiencies, performance verification, reporting, operator training, and supply of operation and maintenance manuals. "Commissioning is one of the most significant soft costs that can be incurred on a LEED project." [27] However, because systems don't always perform as expected, because of inconsistencies in installation or manufacturing, substantial energy savings may be realized during the commissioning process. Early commissioning may also result in lower change order costs[10]. Re-commissioning could be necessary to evaluate the effectiveness of ongoing maintenance, or if there is a change in the way that the building is used after occupancy (churn typically results in inefficiency of systems that were not designed for a particular configuration or purpose, although flexibility is often a hallmark of sustainable building, which by design lessens the impact of reconfiguration). "Churn" or "churn rate" is the frequency with which building occupants and their possessions (including furniture and equipment) are moved from one place to another. The rate includes occupants who depart the facility and are replaced by other occupants, and may include adaptation of tenant improvements or layout to accommodate change.

APPROACHES TO SAVING 'GREEN' WHILE BUILDING GREEN

How then, to maximize the points obtained, and get the biggest certification bang for the buck? It is evident that the cost of obtaining each certification point may vary, depending upon the choice of design item to be incorporated. "It is one thing to assume a budgeted amount for including a bicycle rack (and cyclist shower facilities) in the project scope (worth one point) and another thing entirely to include a green roof on the facility (also worth one point)"[17]. Clearly each design element needs to be carefully considered in terms of its impact to the overall project and certification points, when point optimization is a goal. A logical strategy, then, is to first pursue points that have no financial impact, followed by other points in sequential order by cost.

Other strategies may include leasing equipment instead of purchasing, and installing products that multitask. When investigating new technologies that promise savings by design, the designer should carefully consider the reliability of the product and warranties, lest replacement cost offset the initial cost and projected lifecycle cost savings. Smart expenditures include design elements that not only meet certification requirements but are also required by local building codes or reflect soon-to-come regulatory changes (such as non- CFC-based refrigerants). Renewable energy programs are by definition low cost [8], since energy is generated not purchased. And, as always, early decision-making is less costly than late change – green building practices and involvement by professionals with experience in LEED construction should be incorporated at the outset of the project. Not only does a LEED-certified consultant gain the building one certification point, but the consultant's very involvement may result in lower costs per certification point.

If sustainable design social value and lifecycle cost savings matter to the owner, but the certification process itself is perceived to be a burden, then it may be an option to save money by not pursuing certification. Between 2000 and 2005, there is evidence that only 167 buildings were certified by the USGBC, with 1772 projects registered but failing to complete the certification process [25]. It would appear that some owners, considering the cost of administration, commissioning, and certification, are choosing to apply green building principles during the design phase but are omitting the steps required to formally obtain the USGBC plaque – a fraction (approximately one percent) of private-sector projects have applied for certification [21]. This is also evidenced in the public sector at the State, Federal and Government levels where, while some entities require USGBC certification, others allow voluntary certification, specifying only that buildings shall be designed to meet the requirements for certification. Most explicitly, the US Air Force "…has established a goal that all Military Construction projects by 2009 will be capable of achieving LEED certification, but do not have to be formally certified" [9].

One way to offset costs is to take advantage of various incentives and programs that are available. A sampling of options found in the US includes the following:

- Rebates for use of Energy Star rated products, US Environmental Protection Agency (EPA) program.
- Rebates or reduced utility rates for commissioned buildings.
- Solar tax credits.
- State tax abatement credits for certification.
- Equipment pilot programs.
- Department of Energy (DOE) research grants.
- Focus on Energy's incentive and renewable energy grants.
- US Environmental Protection Agency's (EPA) Green Lights program.
- American Water Works Association's WaterWiser program.
- WasteCap.
- Other programs (see **The Energywise Construction Funding Directory**).
- Grants for energy modeling, commissioning and related costs.
- Preferred zoning considerations.
- Expedited permit reviews.
- Green Building Loan Fund, Pittsburgh (Heinz Endownment).
- Kresge Foundation grants.
- Reduced insurance premiums for commissioned buildings. And,
- Energy service company financing and installation.

Although there have been advancements in funding mechanisms for green construction, through grants and incentive programs, it appears that these mechanisms do not necessarily drive the owner's decision to build sustainably; the motivation comes primarily from financial gain (the competitive advantage yielded through improved profitability or premium pricing) and corporate philosophy [20]. There is, however, some anecdotal evidence that grants, incentives and programs can be used to offset the cost of pursuing certification.

These suggestions are by no means exhaustive. Other cost savings concepts are limited only to the imagination of the design and construction team.

Not just a building style, sustainable development is a design, construction, and lifestyle philosophy with both tangible and intangible benefits.

Benefits from lifecycle cost savings on utility costs and maintenance costs make building green especially attractive to owners, and certain aspects of sustainable design mirror value engineering principles in right-sizing the building and systems. Other benefits may be gained by improvements in the construction process or improvements made for the quality of life of the building occupants. The "feel-good" factor or social value is taking the decision to build green out of the economic equation and moving it to the principles and values of corporate responsibility. As with most project work, early decision-making is less costly than late change, and building green is no exception to that rule - the early involvement of professionals with experience in LEED construction is a key factor in a successful green construction project.

In the early years of building green, the technology was new and unfamiliar; consultants/contractors with green knowledge were in short supply and charged premiums for their services. However, today, building green is taking on a new perspective, manufactured material costs have reduced, and consultant / contractor premiums have diminished as the learning curve flattens. Some industry data indicates that green construction is more expensive than traditional building, with other conflicting studies indicating that green construction is no more expensive – since the LEED certification concept is still young, comparative data and controlled studies are hard to obtain. The primary cost difference appears to be driven by the level of certification sought and soft costs including commissioning, with many innovative design/construction options and incentives available to offset the initial costs of building green.

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Ms. Alexia Nalewaik, CCE MRICS
Moss Adams, LLP
analewaik@mindspring.com

Ms. Valerie Venters, CCC
Venters Consulting, LLC
vcllc@comcast.net