Achieving a Triple Bottom Line with Sustainable Design

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When properly designed and maintained, green buildings can affect the triple bottom line—financially, environmentally, and socially.

MODERN DESIGN FOCUSES on sustainable design, commonly defined as design that meets the needs of today's users without compromising the ability of future users to meet their needs. Sustainability in its simplest form, as defined by the Bruntland Commission (formally known as the World Commission on Environment and Development), describes a characteristic of a process or state that can be maintained at a certain level indefinitely. As project budgets are set, team members should understand the cost implications of sustainable design fall in three main categories:

▷ *First Cost—Capital Expenditures:* Higher-quality building materials, paperwork costs associated with pursuing Leadership in Energy and Environmental Design (LEED) certification;

▷ *Life-Cycle Cost—Operating Expenses:* Reduced resource costs, improved productivity, and employee wellness; and

▷ *Environmental Costs:* Reduced carbon footprint, minimized environmental impact.

Incorporating sustainable design elements enables owners to affect the triple bottom line through reduced environmental impact, optimized building performance, lowered operational costs, increased asset value, improved productivity, and reduced absenteeism.

To accomplish this, attention to detail is required throughout the entire development process, from proper site selection and building placement on the site; to reduced energy consumption; to a clean, maintainable, and healthy indoor environment.

When the Energy Independence and Security Act became law in 2007, Section 433 of the legislation required that all federal buildings meet the energy performance standards of the Architecture 2030 Challenge, which sets a goal of making all buildings carbon neutral by the year 2030. This challenge, initiated by Santa Fe, New Mexico–based architect Edward Mazria, has been adopted by the U.S. Conference of Mayors, the American Institute of Architects (AIA), the U.S. Green Building Council (USGBC), Leadership in Energy and Environmental Design (LEED), and the U.S. Environmental Protection Agency, to name a few.

The first step in minimizing the environmental impact of a building occurs during the site selection process. Renovations and additions benefit the environment by recycling the original structure and site work. Locating a project on a reclaimed brownfield in an urban area enables the development to tap into existing infrastructure. Choosing an urban location also allows users to access public transportation. Performing a site-specific study of the environment to observe what the sun, wind, water, temperature, humidity, and earth have to offer for building design can enhance the overall life-cycle performance of the facility. In high-density areas, restoring the original site through the use of a vegetated green roof can also reduce heating and cooling loads and avoid the excess heat absorption of the surrounding environment, known as the heat island effect.

Typically, green roofs have a minimum installed cost of $20 per square foot ($215.28 per sq m). The benefits include thermal mass effects of the soil (combined with evaporative cooling from the vegetation), stormwater management, and aesthetics when the green roof is visible to occupants. Payback for these "soft" benefits is difficult to quantify, though energy savings due to thermal massing effects may be modeled with an energy simulation. Proper design applications for green roofs include high rises, urban development projects, and buildings where occupants will have access to use the green roof. As an example, the

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McCormick Place West Hall expansion in Chicago, Illinois, used green roof areas selectively to balance the cost impact with the ability to use the green roof as part of the stormwater management strategy for the complex.

Green roof applications become cost prohibitive for buildings with large roof areas that lack occupant access. In these cases, a roof membrane with a high solar reflectance index may be a better choice as in many locations there will be no cost premium, allowing the cost of the green roof to be spread across other site-applicable technologies.

It is important to have the right size facility and optimal layout of both interior spaces and the exterior placement of the building on the site using efficient site design practices. The new JohnsonDiversey distribution center in Sturtevant, Wisconsin, for example, used a fully integrated approach to sizing the new facility. The end result is a warehouse that is credited with improving productivity and that has reduced energy and water use, all constructed within the project budget.

The selection of building materials also can be respectful of the natural environment. Choosing local raw materials extracted in an environmentally friendly way and transported short distances to the site, or using materials with recycled content, are two of many examples of sustainable material selection. Other sustainable design elements include nontoxic finishes (paint, carpet, furniture); reuse of existing materials; captured rainwater; daylighting; lighting control; high-efficiency HVAC systems; photovoltaic electricity for hot water heating; and low-flow or no-flow plumbing fixtures.

The building shell can be designed to take advantage of the climate rather than fight it. Insulation can be selected with both sustainable criteria and energy performance criteria. Exterior glazing can allow sunlight in to reduce the amount of energy used for artificial lighting. Sunlight can also be absorbed to influence HVAC loads. Even the caissons and foundations of a building can become energy piles or heat sinks. Mechanical climate control solutions include heat recovery systems, passive heating, air-side economizers, and environmentally sound refrigerants. Excess heat from industrial processes can be used to heat adjacent office spaces instead of relying on fossil fuel energy sources. Large roof areas can be used for photovoltaic energy systems for electricity or water heating. To reduce hot water heating loads, point-of-use water heaters with limited or no storage tanks cut energy use.

A few technologies available to projects at minimal cost include recycled material content, T5 fluorescent lighting, and daylighting. A growing amount of product with recycled material is available and, surprisingly, most construction material contains recycled content at current market-rate pricing. For instance, structural steel elements for commercial buildings typically contain 60 to 90 percent recycled content as commonly manufactured and represent no additional cost. In an industrial application, T5 fluorescent lighting in lieu of metal halide lighting represents a premium of $0.25 to $0.50 per square foot ($2.69 to $5.38 per sq m) and has a typical payback of approximately two years.

Daylight that is brought into a building through skylights, light wells, and clerestory panels can significantly affect building operations. Natural light will offset the use of electricity for building lighting through integrated control systems and will provide higher-quality light than artificial lighting. Better lighting can lead to more productive spaces and healthier environments for employees, in addition to reduced utility costs.

Natural light has been documented to improve performance; correctly lit spaces can decrease eye strain, lower absenteeism, and reduce health care claim costs and insurance premiums. Daylighting, when examined for a 600,000-square-foot (55,742-sq-m) warehouse facility, costs $750,000 or $1.25 per square foot ($13.45 per sq m). Energy savings attributable to the lighting controls amount to $110,000 annually, or a 6.8-year payback, or a 12 percent return on investment (ROI) on an anticipated 15-year occupancy. For retail occupancies, studies have shown positive trends in sales when the retail environment includes natural light compared with one that does not.

Selecting materials that have minimal to no off-gas toxins and appropriate construction contamination control results in an edifice with cleaner air. Monitoring contaminant levels in building air and providing higher levels of outdoor air and ventilation ensure that the indoor environment is maintained at a high level.

While designing the Exelon Headquarters project in Chicago—currently the largest LEED-CI (Commercial Interiors) Platinum project in the United States—the design team found that furniture meeting the LEED requirement of Greenguard certification was relatively common and did not increase the price of the furniture, fixtures, and equipment (FF&E) for an office interiors project. To avoid the harvest of new raw materials for new furniture, existing furniture was reused wherever possible without increasing the project's cost.

Examples of ways to achieve LEED-EB (Existing Buildings) and LEED-NC (New Construction) credits include the following:

Approximate initial cost premiums for LEED certification tend to be as follows: Certified at 1 percent; Silver at 3 percent; Gold at 5 percent; and Platinum at 10 percent or higher. According to the USGBC, the overall (including initial cost premiums and operational savings) cost premiums for Certified is 0.66 percent; Silver, 1.9 percent; Gold, 2.2 percent; and Platinum, 6.8 percent. Due to the menu-based LEED system, it is possible to select a slate of credits that has very little first-cost impact and a three- to five-year payback on any first-cost premiums. The final accounting for the Exelon project showed that LEED Platinum was achieved for a smaller premium than the design team had originally anticipated.

Some popular sustainable design elements with longer payback periods include rainwater harvesting and photovoltaic electric systems. Rainwater harvesting can be used for toilet flushing or irrigation depending on the jurisdiction. The cost of these systems ranges from $30,000 to $60,000 and has a payback of 30 to 40 years. This may be outside the bounds of normal payback consideration except in areas where water conservation is politically sensitive (i.e., desert climates, states with water-rights laws, recent drought areas, and others).

Photovoltaic systems usually cost approximately $8,000 to $10,000 per kW and have a 30- to 40-year payback without incentives. California, New York, and New Jersey have incentives that lead to paybacks in the five- to ten-year range combined with federal incentives. In the right markets, energy service corporations (ESCOs) will purchase and maintain the system in exchange for a contractual agreement for the building owner to provide the space necessary to support the system and purchase the energy it provides. As energy prices rise and photovoltaic manufacturing increases, the payback on these systems will shorten.

An example of a cutting-edge, integrated design is solar shading. Currently in the early design phases, this technology is under review for a new mixed-use development in Pasadena, California, that provides new residential space through townhouse, condominium, and live/work units in addition to office and retail space in the form of a six-story office tower. As part of the project, a small portion of the office/retail space will be devoted to a new restaurant that will use shaded outdoor patio seating. Evacuated tube solar collectors will be used not only to shade the sun, but also as a heating source for the office tower's hot water. It is estimated that the solar collectors (measuring approximately 128 square feet/12 sq m) will be able to provide enough hot water to satisfy all of the core hot water utility needs for the tower.

The cost to occupy a building will far exceed the cost of construction over the life of ownership or lease term. A workplace where people feel better and are happier is desirable, resulting in a likely decrease in absenteeism and turnover while overall productivity trends upward. Even an increase in productivity of just 1 percent can provide the necessary payback to meet economic bottom-line requirements.

The societal impact is the third bottom line. It is best addressed through coordinated teaming with local jurisdictions and by seeking productive community input early in the design process to create a healthy working space for employees that adjacent neighbors find compatible for their neighborhood. UL

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The Carbon Solution: Cap-and-Trade or Tax?

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Though cap-and-trade is viewed as more politically feasible, a carbon tax is more likely to achieve lower carbon emissions. In addition, it can do so with less investment in new infrastructure, as tax collection systems already are in place.

GLOBAL CLIMATE CHANGE is a pressing contemporary issue, and consensus is mounting that anthropogenic carbon dioxide emissions are a root cause. International negotiations in Kyoto, Japan, in 1997, and, more recently in Bali, Indonesia, last year, focused on reining in these emissions. At Kyoto, an agreement was reached that, if followed, would result in substantial emission reductions for more than 50 countries. The method chosen to achieve these reductions was carbon trading.

Although carbon trading is popularly believed to be the most politically tenable solution to global warming, there are some who view it as a poor choice for altering global emission levels. The proposed alternative is a carbon tax, which would be a strictly enforced government intervention, as opposed to a market-based solution.

Carbon trading—or "cap-and-trade"—is the commoditization of carbon dioxide. Annual caps are placed on all emitters in concert with timetables for reaching a predetermined level of emission reduction. If a country or company manages to exceed allotted emission requirements, it can sell unused emission credits on the open market. As time moves forward, total emission credits are reduced, which causes prices to rise through artificial scarcity. This rise in price acts as an incentive to pursue alternatives to high-carbon fuels.

The most often–cited example of a successful cap-and-trade system is the U.S. Environmental Protection Agency's sulfur dioxide (SO_2) trading scheme. Begun in the 1990s to control acid rain, the total value of the SO_2 market today is estimated at $2 billion in annual trades. The program reportedly has worked well, resulting in a reduction of emissions that has been faster than required and below the costs projected. However, the success of the SO_2 market does not guarantee success for a CO_2 market as fundamental differences exist between the natural cycles of the two gases. Anthropogenic sources of SO_2 are easily identified and far exceed the number of natural sources. Because of this, reducing anthropogenic SO_2 emissions creates a great overall impact. The same cannot be said for CO_2.

The longer life of atmospheric CO_2 and its complex natural cycle make it significantly more difficult to regulate. A 2006 editorial in *Science* magazine illustrates this complexity