Green Building: Leapfrogging the First Cost Barrier

Dr. Annie R. Pearce

Introduction

There are multitudinous ways to improve the green-ness or sustainability of a project, but considerably fewer ways to improve project sustainability without increasing first cost. One of the most significant barriers to creating sustainable facilities is designing projects that meet sustainability requirements without costing more than the owner can afford – the so-called first cost barrier. The challenge for you as an owner, architect, engineer, builder, or project manager is to find sustainable solutions that meet the occupant's needs for a facility, don't damage ecosystems or deplete resource bases, and don't cost more than a traditional project would cost. How can you find ways in your projects to leapfrog the first cost barrier to sustainable construction?

A variety of approaches have been tested in projects around the world to reduce the cost of building green, including increasing the efficiency with which we build and operate facilities and by avoiding costs that are traditionally associated with construction projects. For example, reducing the waste generated by a construction project can be paid for by savings in landfill fees and waste hauling. Construction recycling can result in payback by converting waste (a liability) into a useful resource needed by someone else (an asset).

In other projects, natural systems have been used to perform the functions traditionally provided by engineered systems at a significant reduction in cost. For example, living machines made of plants, snails, bacteria, and other organisms, natural drainage swales, and constructed wetlands can be used to collect and treat wastewater without requiring any input of chemicals typically needed by engineered conveyance and treatment systems. The result is healthy plants and purified water that can be safely used for other purposes.

In still other cases, any additional costs of construction have been offset by savings in the life cycle cost of construction. For example, installing more efficient but more expensive hot water heating, lighting, or HVAC systems can be paid back by savings in energy costs over the operational life of the building. Similarly, more durable but expensive materials such as concrete paving can be economically superior to less durable but cheaper materials such as asphalt if the life cycle replacement costs are considered.

How can these techniques be applied to your projects? If you're an owner who sees benefits to making your projects more sustainable, how can you systematically identify opportunities to leapfrog over the first cost barrier? To successfully green your projects without breaking your budget, there are six basic strategies to consider. Let's look at each of them in more detail, keeping in mind that they're listed in the order they should be considered in planning and delivering a project.

Solving the Right Problem

The first strategy for greening your project within a limited budget is to make sure you're solving the right problem in the first place. This means questioning the question, "how

can I pay for a new building?" and asking yourself if there might be more cost-effective and sustainable ways to meet your needs than constructing a new facility. What about leasing? Or rehabilitating an existing building? Or telecommuting or flexible work schemes? Too often, building professionals leap head first into planning and designing a facility without considering other options that might offer significant advantages in terms of both cost and sustainability. In some cases, changing the problem you're solving could result in both sustainability and performance advantages at a much lower cost than creating a new structure (see Sidebar – Solving the Right Problem). In other cases, the most appropriate solution may still be to build new, but at least considering other options early in the process can result in a different mindset about the project that translates into greater creativity on later decisions throughout the project.

The key to making sure you're solving the right problem is to focus not on solutions, but on the need potential solutions will meet. For instance, how many times have you been asked at the checkout line whether you'd prefer paper or plastic bags? If you focus on these two choices as the only options available to you, you might miss other solutions that are preferable in terms of your overall objectives. But if you phrase the question as, "How can I transport my groceries from store to home?" you open yourself to consider other options entirely, such as reusable canvas bags, grocery delivery services, or even modular shopping carts that fold up to fit in your car. You might even decide to grow some of your own food to reduce your need for groceries in the first place! From the standpoint of facility decisions, ask yourself what is the functional need that needs to be met. If you find yourself defining your problem in terms of one or more solutions, chances are you need to take a step back and reassess your options.

Integrated Design and Right-sizing

Once you've settled on a way to frame your problem that affords a broader perspective on how to meet your needs, the next step is to use an integrated design process to come up with an optimized solution. Integrated design is a term used in two fundamental ways in the building industry – first, it refers to integration of the design *team* to include stakeholders not traditionally included in the process, such as constructors, future building occupants, and community stakeholders. These stakeholders contribute to the design process in many ways, ranging from identifying potential constructability problems that could lead to construction change orders, delays, or disputes, to pointing out issues that will be critical for achieving buy-in and reducing potential implementation barriers.

Second, integrated design refers to a design process in which systems are developed in concert with one another rather than independently, and interrelationships between systems are exploited to optimize system performance and maximize cost savings. For instance, integrated design means that larger areas of high performance windows might be included as part of the building envelope design to provide for daylighting (raising total project cost), but the benefits of better envelope performance and reduced heat load from light fixtures are recouped by reducing the capacity of the building cooling system (lowering total project cost). Additionally, a smaller HVAC system might mean smaller pumps, fans, and motors, reduced duct sizes, smaller plenums, and reduced floor to floor height, also reducing the cost of the facility. The net increase in the total first cost of the project may be negligible if the benefits afforded by one system are captured in the

design of complementary systems. More importantly, life cycle cost savings can be considerable with these more efficiently designed systems, particularly if HVAC systems are right-sized for the facility, allowing them to operate at maximum efficiency over the life cycle of the facility.

Dematerialization

A third strategy being used to surmount the first cost barrier to sustainability is dematerialization. Dematerialization refers to the substitution of *services* to meet needs that were traditionally met by the purchase of *goods.* Office managers have successfully used this concept for years – think of the photocopier in your office that you most likely lease rather than own, and pay a per-copy charge to the company that owns and maintain the machine. Rather than take ownership responsibility (and associated liability) for equipment, you pay another company to provide the benefits of that equipment to you. That company, often the manufacturer of the equipment, has an incentive to provide the most efficient equipment possible, since it reaps its profits based on some profit margin per unit of service provided. It also has incentive to design products that can be easily repaired, upgraded, or disassembled, since it retains responsibility for the ongoing maintenance and eventual disposition of the equipment.

A growing number of building systems and components, ranging from roof systems to flooring to mechanical and electrical systems, are available as services from companies who will install appropriate systems to provide a level of performance defined in the contract on a fee or pay-for-performance basis. Some companies also incorporate maintenance services to optimize the performance of their systems (who knows better how to maintain a system than its manufacturer?). The primary advantage of dematerialization with respect to first cost is that the cost of these systems is typically shifted to an operational cost, thereby eliminating those systems from the total installed cost of the project. Often higher-performance systems can be afforded on a lease basis than could be afforded if the system were purchased and included as part of the project's first cost.

Free Resources

While the facility is being optimally planned and designed and options for dematerialization are being explored, a variety of free resources exist to assist in further reducing the first and life cycle costs of the project. Depending on the nature of the project, its location, and the type of owner, a growing number of programs exist to promote and support the use of green building principles in its delivery. In the planning and design of the facility, technical assistance can often be obtained for no or low cost from government agencies, universities, local utilities, or non-profits. State environmental or natural resources agencies are often a good starting point to learn about these programs. A wide variety of grants are also available to fund investment in specific technologies (e.g., fuel cells, photovoltaics), environmental remediation of contaminated sites, or evaluation of facilities using green building standards (e.g., the LEED™ rating system). In some cases, manufacturers or utilities are willing to provide demonstration equipment for pilot projects at reduced or no cost, particularly for owners with significant facility stock who may be interested in widespread application of those technologies. Finally, tax credits, rebates, and financing assistance programs are also available in some

locations to support the application of green technologies. The *Resources* section of this article lists several excellent compendiums of information about free resources pertaining to green building.

Holistic Cost Management - Counting All the Costs

The concept of holistic cost management considers a larger set of questions than traditional project costing from the very beginning of a project. For instance, what will be the impacts of design/construction decisions on life cycle costs? What opportunities exist to *offset* increases in first cost for design improvements (as in integrated design)? What externalities should be considered that could result in a better decision about costs?

Traditionally, project decisions are based on factors such as the costs of material, labor, equipment, and cost of money. Decisions about individual products are sometimes made on a unit cost basis without necessarily considering cost from a systems standpoint. This practice means that some products offering sustainability advantages seem more expensive than they really are. For instance, when asked why they don't use integrated building systems such as structural insulating panels or sheathed insulating concrete form blocks, many owners reply that these systems are more expensive than traditional methods such as concrete masonry construction. Yet if savings in labor cost and construction schedule were taken into account, these materials could show an immediate cost advantage to owners. For example, one federal project manager estimated a savings of $3,000 per day due to shortening the construction schedule on his project by using preengineered autoclaved aerated concrete systems – all from avoiding the cost of housing personnel in hotels instead of the facility being built as their residence. Similar or even greater savings in opportunity costs can result on many other projects as well.

Other considerations, if taken into account, could more clearly indicate the benefits of sustainability in the built environment, such as:

- Reduced costs of consumption, waste disposal, and noncompliance
- Reduced liability and environmental risk
- Improved use of assets, particularly human assets (including increased productivity, reduced absenteeism and building-related health problems, improved morale, and better employee retention)
- Reduced operational and disposal costs
- Reuse of facilities that otherwise would be disposed
- Preparedness for future regulations and requirements

Each of these benefits reflects a potential cost savings for owners, although many of these kinds of costs are not typically associated with specific projects and the associated decision processes behind their funding. If these potential benefits can be realized, then sustainable projects will truly have an economic advantage over their traditional counterparts. The ultimate outcome of considering the full spectrum of costs associated with a project is a true picture of what costs and benefits will stem from each alternative

over its whole life cycle. If all costs are considered, then actions which might ordinarily come back to haunt the decision maker (such as endangered species habitat disturbance or use of hazardous materials) can be adequately considered for the risk they truly represent.

If at First You Don't Succeed, Try Again

All indications are pointing toward long term advantages for those who learn how to green their projects early on. Factors that may result in reduced quantifiable costs for sustainable projects in the long term include:

- Learning Curve – as sustainable products and strategies become more familiar to designers and builders, less effort will be required to use them correctly

- Economies of Scale – as demand increases for sustainable technologies in the marketplace, production and distribution networks will grow and become more efficient

- Resource Scarcity – as many of the materials presently used in building (e.g., fossil fuels, old growth timber, mineral-derived products) become more scarce, their costs will increase and the cost of using alternatives will become relatively less expensive

- Stricter Legislation – as environmental, safety, and occupational health (ESOH) regulations become more restrictive, projects that have lower risk of ESOH threats will become relatively less expensive

All of these external influences will tend to give advantage to sustainable projects from an economic standpoint, at least in the long run. In addition, significant advances are being made across the spectrum of building technologies, so don't fall prey to the assumption that the low-flow toilet you disliked ten years ago is still a poor performer. One notable technological improvement is today's low face weight carpet: while many owners are still specifying the same 24 oz carpet they have used for years, newer low weight (16 oz) carpets are available that cost less, look the same, wear better due to greater stitch density and lower pile height, are easier to clean due to reduced surface area of fibers, and use less raw materials to produce. These products and others are excellent examples of doing more with less – the true key to achieving sustainability in built facilities.

In conclusion, sustainability is becoming an important consideration for construction projects around the world. Sustainability offers a way of meeting the needs for which we construct projects, while avoiding the negative impacts traditionally caused by those projects. The ultimate goal of sustainability is our long term survival as the human race. The negative impacts of our present methods of construction can no longer be denied. The time has come to seek better ways of building that will maintain our quality of life and ensure that our children and their children can continue to live as well as we do. Thinking strategically about *how* we go about greening our projects can ensure that we are able to meet sustainability goals without breaking the project budget.

Recommended Resources

http://www.fundinggreenbuildings.com – this site is the home of an especially useful guide to funding sources for green building-related initiatives: the *Energywi$e Directory*. This binder of information, available for order from the site, has been compiled to include links, contact information, and descriptions of hundreds of relevant grant and technical assistance program. Purchasers of the directory can attend Funding Green Buildings workshops at reduced cost, and receive a periodic electronic newsletter highlighting specific funding and technical assistance programs and providing periodic updates to the *Directory.*

http://www.sustainable.doe.gov/financing/grants.shtml - this site, the Center of Excellence for Sustainable Development, shows a variety of links to different organizations and foundations to help communities fund sustainable development projects. It outlines sources of information for Federal, private foundation, and corporate grant opportunities.

http://www.buildinggreen.com/features/lc/low_cost.html - this article from *Environmental Building News* is a classic source of information on no-cost, low-cost solutions for sustainable construction. Explore the options in this article if first cost presents a major barrier for your project. Classifies recommendations by building feature and type. Also, be sure to investigate the other excellent resources available on the BuildingGreen site.

http://www.naturalcapitalism.com – The online version of the revolutionary book *Natural Capitalism*, which describes how to design sustainable projects that are economically viable.

http://www.greendesign.net – An online directory of initiatives and organizations involved with green or sustainable design around the world. Also includes descriptions of many useful references for sustainable design.

http://www.greenbiz.com - this is the comprehensive resource site for green business. Contains case studies, resources, and excellent articles on how to be green and competitive in business practice.

http://www.greenguide.com – home of the Green Building Resource Guide, the most comprehensive resource on green building products with pricing information. The Guide is available as an online subscription or in print form, and contains product descriptions and manufacturer contact information along with a price index that shows the cost of the green product with reference to an equivalent traditional product.

About the Author

Dr. Annie Pearce is the Director of the Sustainable Facilities and Infrastructure Program at Georgia Tech Research Institute and a founder and principal of the Urban Genesis Institute, a for-profit organization dedicated to urban revitalization through sustainable technology. She has been involved with sustainable design as a teacher and researcher for over ten years, and has worked as a trainer and researcher across the United States and

abroad. Georgia Tech's Sustainable Facilities and Infrastructure Program provides applied research solutions, training, technical assistance, and information for all facets of sustainable facilities and infrastructure. For more information about the ideas in this article or to contact Dr. Pearce, see http://maven.gtri.gatech.edu/sfi.

Sidebar: Solving the Right Problem

Consider this scenario: your project budget is a little more than half of what you originally requested, so you decide to use sustainability principles to get the project done with the budget you have. Sound impossible? Not if you're the Air Force Reserve Command in charge of building a fire station at its Homestead Air Reserve Station in Homestead, FL. This 26,000 square foot project, to be completed by mid 2002, embodies a broad array of sustainable design and construction strategies, and has resulted in what its occupants believe will be a better building than would have been constructed under the original scenario.

The fire station was originally proposed as a new building on a greenfield site, needed to replace the existing, undersized fire station that suffered from a leaking envelope, poor internal traffic patterns, and an outdated communication system. When the project team learned that the amount of money available for construction was only $2.9 million instead of the $4.9 million originally requested, they decided to tackle the challenge by thinking outside the box, not downscoping the original plan. The original problem, how to build a new fire station under a very constrained budget, became a question of how to house fire fighting operations given the budget provided. By rephrasing the question to focus on the needs in terms of functional performance, other options beyond building a new fire station were able to be considered, such as the option to rehabilitate and expand the existing fire station. Under the direction of Col. John Mogge, then the MAJCOM Civil Engineer for Reserve Command, the team conducted a three-day sustainability charrette to come up with a design strategy for rehabilitating the existing fire station using sustainability principles.

The savings from reusing the main structure of the facility as well as avoiding the need for extension of infrastructure services to a new site afforded the opportunity to provide for firefighters' needs within the constrained budget. Additional savings were realized from including a percolation trench, which avoided the need for expanding the base's stormwater treatment systems. The contractor on the project was able to recycle nearly all demolition and construction waste on site, not only virtually eliminating tipping fees for solid waste, but also in many cases generating a revenue stream from selling segregated waste products to recyclers. The Air Force project manager for the project, Mr. Bill Cadle, commented on another side benefit of the alternative waste practices during construction, saying that clean up actually happened on a daily basis on the site to ensure proper separation, increasing construction efficiency and reducing the risk of accidents. The payoff from a safety standpoint was a project with zero lost time incidents.

A major key to the success of the project, according to Cadle, was the sustainability charrette at the beginning of the project. Using an innovative approach to procuring construction services, the contractor for the project was competitively selected at the *beginning* of the project, in time for contractor staff to participate in the planning and

design process. Facility management, operations, and maintenance staff from the base were also included in the charrette process, along with the future occupants of the facility, representatives of the Wing command, and project management and procurement personnel from the headquarters level and the Air Force Center for Environmental Excellence. The charrette was a tangible culmination of the efforts of Col. Mogge, whose idea it was to champion this project as a sustainability pilot for AFRC. Through Mogge's efforts, the Wing Commander was sold on the idea of a sustainable fire station from a public relations standpoint, and personnel both at the base level and headquarters level were firmly committed to sustainability goals for this project. The charrette was used as both a planning and decision process for the facility program, as well as a means to educate and align all project stakeholders with the sustainability goals of the project.