A Green Building Compendium

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For The

George Gund Foundation

Cleveland, Ohio

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OVERVIEW: IMPLICATIONS FOR CLEVELAND

The purpose of this compendium is to exhibit how the green building trend is growing in the nonprofit sector, and to record how green building can enhance community development. This compendium is a planning step towards developing a shared nonprofit office space to serve as a living laboratory for building design in Northeast Ohio. It is designed to inform our community about the potential for nonprofit programs in sustainable building design and construction. It also raises the question of growing trends in "mainstreaming" green building technology, materials and practice into our community.

Although this compendium focused on green building development in the nonprofit sector, commercial developments provide some relevant applications. There are numerous commercial sector examples, especially of new buildings built for corporate headquarters.

Sustainable development is defined as the ability of the present population to meet its needs without compromising the ability of future generations to meet their needs. It is difficult to build a society predicated on equity, economic growth and environmental conservation. In the context of the built environment—how we choose to shelter ourselves at home and at work—there is a growing trend toward green building. Green building considers the relationship of the structure to human health, community vitality, and impact on the natural environment, as well as using the best available technology for the optimum economic bottom line.

In preparing this compendium we have learned that:

1. Successful green buildings exist in other communities. The nonprofit sector has been the primary facilitator, followed by local governments and the commercial sector. Nonprofits as green building tenants have benefited from improved work environments with high indoor air quality, lowered utility bills, and, for some, the ability to exhibit the environmental principles they espouse. Shared office space among nonprofit groups offers the benefit of proximity for improving communications, enhancing collaborative projects, and lowering overhead costs.

   Where nonprofit environmental organizations are building owners, ownership often supports their energy and resource conservation goals. Other nonprofit organizations, with missions not directly related to the built environment, chose to build green for good indoor environments and resource conservation reasons, and energy and resource financial considerations. The case studies presented here have varying levels of green performance, monitoring and building-related tenant programs and involvement such as recycling.

   Some nonprofit organizations are tenants in larger buildings but have planned their own space with energy and water efficiency, non-toxic materials, and sustainably grown products. Landlords have assisted in the process of building to suit, within financial limits. However, outside contractors do the construction, and some tenants pay more for additional construction costs and planning.

In reality, many small environmental nonprofit organizations cannot own their own buildings or even build to suit as tenants. Many of these organizations do the best they can to reduce energy and resource use by, say, changing light bulbs to compact fluorescents, insulating windows and doors, buying unbleached recycled paper, and purchasing energy-efficient office equipment.

2. A number of Cleveland-based nonprofit environmental, education, and human service organizations have expressed interest in shared green office space. They consider such a space an opportunity to advance their programmatic goals, attain a well-planned and healthy work environment, and be in close proximity to other organizations for joint project planning, education and programming. This approach could also help stabilize nonprofit organizations in Cleveland, by providing assured space for their growth. We plan to work with these groups in the next phase of this project to determine their needs and the dimensions of such a building.
3. <u>None of the interested local nonprofits has offered to be developer or landlord</u>. Most local environmental organizations have small staffs oriented towards programming rather than physical space development skills. We are discussing with local economic development groups their interest in predevelopment and feasibility of bringing a shared green office space demonstration project to fruition in Cleveland. Local nonprofit organizations will need to commit to be tenants once a building is identified, and before financing is sought. The goal is a green-designed and, perhaps, retrofitted "living laboratory" to be an example to other commercial and nonprofit organizations in Ohio. The combined efforts of the economic development and environmental nonprofit organizations will set the tone for other sustainable development projects in the Cleveland metropolitan region.
4. <u>Local government or nonprofit green building alliances exist in some cites and states</u>. We have received numerous requests from schools, religious institutions and commercial interests for technical assistance in retrofitting older buildings and designing new buildings along green principles. Local academics, housing specialists, economic development organizations, building contractors, architects, and interested citizens have echoed this desire. It is evident that a local program is needed to provide information, educational services, and technical assistance. Discussions have begun on a program in Cleveland to (1) work with commercial builders and professional organizations, (2) provide technical assistance to governmental institutions and nonprofits, and (3) assist in the implementation of programs such as the Great Lakes Energy Network with public schools, and the US Department of Energy's Million Solar Roof Program.
5. The major impediments to green building in the commercial and residential sectors are the lack of training, available information, and immediate sources of materials and services, not a lack of technology, ability to perform site planning, architectural and landscape design, or imagination. This can be improved on a local and regional basis through organizational change and policy directives aimed at providing incentives for green development or planning.
6. <u>Many cities and regions have improved their images with green building and ecological design</u>. There has been growth in the commercial and residential building sectors for the niche marketing of green buildings. Conservation efforts have benefited by the increased demand for sustainably grown wood products and recycled goods. By introducing green

> design efforts now, with the intent of having the standards mainstreamed in the near future, the economic development and built environment of a region can improve as its impact on the natural environment decreases.

The President's Council on Sustainable Development conducted a National Town Meeting for a Sustainable America in Detroit in May 1999. The meeting grew from the 1987 World Commission on Environment and Development efforts "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." The themes were crossing boundaries, building trust and making commitments to strengthen communities, reducing disparities in education and opportunity, and ensuring a growing economy and healthy environment. Some of Cleveland's local programs were cited as exemplary, including Earth Day Coalition's Environmental Health Project, and EcoCity Cleveland. These programs will help promote a healthier, cleaner and more biodiverse Cleveland as we enter the next century. We lack, however, the physical infrastructure, organizational capacity and political leadership to build a greater Cleveland with healthy buildings for healthy workers and students, which benefit our ecological and economic landscape. The challenge ahead for green architecture is to become more mainstream and locally accessible.

I. INTRODUCTION

Building construction and operation consumes more materials and energy than any other single activity in the US (20, 4, 125):

- Energy resources: Over 30% of total energy use, 60% of United States' generated electricity. The most significant pollution impacts in the United States parallel energy use (e.g., from burning fossil fuels: nitrous oxides, sulfur oxides, greenhouse gasses, particulates, mercury, other heavy metals, dioxins). Per capita energy use in the United States is 30% higher than in Germany and twice that of Japan. The US imports more oil today than ever before.
- Virgin resources: 40% of raw stone and processed materials such as copper, steel, and plastics, 60% of virgin wood are used for construction and fuel. (The U.S. imports 27% of its wood from Canada.)
- Water: 16% of total water withdrawals are used for construction.

Buildings, in turn, produce (4, 5, 125):

- Waste: In industrial countries, it is comparable to municipal solid waste generation. Construction of an average U.S. building generates 7 tons of debris. Along with demolition activity, 90 million tons of rubble goes into U.S. landfills annually. Three billion tons of raw materials are used each year to construct buildings. Depending on region, construction waste comprises 15-40% of landfills in the U.S. The energy consumed during construction of an energy-efficient building can be more than the building uses for heating and cooling over 50 years.
- Unhealthy indoor air quality: Poor air quality is found in 30% of new and renovated buildings.

The impact of the built environment on quality of life has become an important issue, as urban blight and environmental hazards dominate many city landscapes, and rural land is rapidly consumed by those escaping to the expanding sprawl of the suburbs. Green building practices consider a response to building impacts, and present an opportunity for creating more sustainable communities (15). While Cleveland, among many other regions, has yet to correct its current course for the built environment, many believe that the time is right for green building trends through appropriate technology and environmentally responsible building practices (20).

Compendium structure

This compendium is divided into two major sections: concepts and case studies. Under concepts we define and discuss green building, the planning process, building construction and operation, and the growing variety of green building features. We found that, for us, as non-architects, a computer analogy was easily understood, useful, and usually appropriate. "Hardware" included the building envelope, heating and air conditioning, elevators, interior walls; "software" comprised everything else: paints, carpeting, floors, doors, shelving and countertop substrate, furniture, cushion fabric, countertops, lighting, plumbing, daily operations, appliances and office

equipment. We have included an "upgrades" category for planned renovations and other improvements.

The case studies sample the growing number of green office buildings that house nonprofit organizations. We sought key examples that would assist in developing a building to benefit Cleveland's nonprofit sector, to be a local example for future commercial development.

For each case study, we describe the organization, the green building rationale and goals, the building features, the tenants, management, costs and funding, and, to the extent known, the environmental benefits of the green features in terms of pollution prevented and cost savings. We explored green buildings in the academic environment (K-12 and university), which sought to use the built environment as a teaching tool (7,8,9). Students in some universities participated in building design, documenting performance, and informing their surrounding communities. Although not a primary focus, we examined several mixed-use facilities as examples of financing and the roles that nonprofit organizations have played in re-developing urban spaces using green building principles. Mixed-use often refers to service-oriented businesses (including nonprofits), retail stores, and, in some cases, housing and communities, that occupy relatively large structures.

The appendices contain information on green building programs and efforts of federal, state and local agencies, and nonprofit and for-profit organizations, books, journals, websites and other resources; summaries of other green buildings case studies; building design tools; and some technical details on green building technologies and financing.

II. CONCEPTS

1. Green development, defined

(The primary reference for this section is [4]). Green building is, in essence, environmentally responsible design. But what defines "green" or "smart" or "responsible" varies—from energy efficiency, to prairie ecosystem restoration, to reduced automobile dependence. Successful, fully functioning green building incorporates a number of measures that, while individually beneficial, work even better together—an integration of features that provide multiple environmental benefits. Not all of it is new; many design features are old and common sense, such as returning to geographically and climatically appropriate designs. New features include high-efficiency lighting, photovoltaics, and heating, ventilation and air conditioning (HVAC) systems (4). Green building is part of the current movement towards more sustainable societies. "Sustainability" is defined as meeting present needs without compromising the ability of future generations to meet their needs. For the built environment, sustainability looks to reducing the impacts of buildings on the surrounding environment by recycling materials, reducing waste, using fewer virgin materials, minimizing toxic materials and reducing energy and water resource use (82). Green development attempts to be holistic (5).

For a general characterization, green development:

- Establishes and reinforces connections between people and place, place and nature, buildings and nature.
- Applies ecological thinking to creating places for people to live and work.
- Is more than individual buildings or their components. An energy-efficient building may have negative environmental impact if the occupants have longer automobile commutes, if it unnecessarily developed a greenfield, or if the development contributes to neighborhood dissolution.
- Seeks to minimize entire life-cycle impacts. This means using building materials that have lower production impacts, such as sustainably grown wood and recycled steel.
- Employs resource-efficient, and environmentally and community-sensitive land-use strategies. Any new development affects the larger community through land use and building layout, design and operations. Green building seeks siting to blend in with the environment, reuse developed land, restore degraded land, preserve green space and, overall, minimize environmental impacts.
- Fits the site. Building design should consider local ecosystem interactions: Surrounding vegetation may affect passive solar and daylighting design. An exposed site may need entrances that block prevailing winds.
- Uses resources efficiently. This includes energy efficiency, water and paper conservation, and other measures that also lower final costs.
- Provides a healthful indoor environment. We spend, on average, 80% of our time indoors (10).
- Is adaptable. Adaptability is considered a green design hallmark; planning for what the building might become once its use ends is part of the early planning process. (British architect Francis Duffy contends that buildings have layers that evolve at different rates. Exteriors change every 20 years, new wiring, plumbing and climate control systems

every 7-15 years, and floor plans every 3 years. Making buildings last and adapt entails separating these layers, so that the slow-changing ones don't interfere with the fast-changing ones.)

- Is durable and low-maintenance. Using non-toxic, environmentally benign materials, such as cleaning fluids, pest control practices and other maintenance, which can affect indoor air quality (IAQ) and the outside environment. (4)

Green building benefits generally include:

- Improved building durability and flexibility
- Improved occupant comfort
- Energy and water savings
- Reduced maintenance costs
- Revenue generated from recycling, and reduced outlays for building materials
- Conserved natural resources
- Reduced waste and pollution
- Anticipating future legislation, by exceeding present building code specifications.
- Reduced health and safety risk and liability
- Positive public relations (11)

Some impacts are direct and easily quantifiable, such as lower energy use and facilitating recycling by tenants. Others are less so, such as reducing automobile dependence and generating sustainable economic development locally.

Every green building is different, and "green" is often in the eye of the beholder and organization. In one instance, we visited a building that had been a featured case study in another green building book. That it was considered "green" was a surprise to the building manager. Aside from some added daylight and air circulation, there wasn't much that would be considered green. We did not include it as a case study in this compendium. The architectural design firm HOK, which has designed or is planning green offices for the Nature Conservancy, the World Resources Institute, the World Wildlife Fund, and the National Wildlife Federation, among others, has found that every organization's green building goals differ. These organizations devote considerable time thinking about green design strategies and what it means to them.

Green criteria and features are difficult to compare and assign value. How does, say, low-VOC (volatile organic compound) paint compare with energy-efficient lights? The U.S. Green Building Council developed one set of criteria, the Leadership in Energy and Environmental Design (LEED) Green Building™ Rating System (12). The LEED rating evaluates environmental performance from a whole-building perspective over a building's life cycle. LEED is intended to be a definitive standard, and provide market incentives to build "green." This voluntary, consensus-based rating system tries to balance known practices and emerging concepts. LEED is designed to self-certify new and existing commercial, institutional, and high-rise residential buildings. Credits are awarded for meeting criteria that include:

- Alternative transportation facilitation

- Asbestos avoidance or management
- Building commissioning
- Building materials
- Building siting
- Construction waste management
- Elimination of CFCs (chlorofluorocarbons, a group of ozone-depleting gasses)
- Energy efficiency
- Erosion control
- Existing building rehabilitation
- Indoor air quality
- Landscaping
- Renewable energy use
- Storage and collection of occupant recyclables
- Thermal comfort
- Water conservation
- Water quality

LEED specifications are being tested throughout the US, including the Nature Conservancy headquarters in Arlington, VA and, in Pittsburgh, buildings chosen by the Green Building Alliance (119).

2. Green vs. conventional design process, or, holistic vs. piecemeal planning

The process of green building, being holistic, tries to incorporate most concerns from the outset. It becomes increasingly difficult and expensive to add green components as the building or renovation process advances and opportunities to save capital costs through reduction or elimination of components decrease (for example, increased daylighting, more energy-efficient and less heat-producing lighting, and better insulation may reduce the size or kind of HVAC system needed) (4). Cost-effective green renovation options at the University of Michigan School of Natural Resources and Environment were limited because green planners were brought into the process relatively late (13).

A "value engineering" approach—pricing design elements individually for the cheapest available—does not capture the benefits of a whole-systems approach that recognizes that the whole project can cost less and be a better value, even if certain parts may cost more than conventional parts. Green design strives to find the lowest possible long-term cost.

"Catalog engineering"—selecting common listings from vendors' catalogs—has led to mechanical-system inefficiencies. Many engineering and design rules of thumb are obsolete. They often assume outdated (and lower) electricity rates, and rarely consider HVAC interactions (e.g., that lighting and fan power add to the cooling load, or that energy efficiency can increase usable floor space, decrease floor-to-floor height, and reduce noise, maintenance and structural requirements). Also, energy plug loads are driven by the real estate industry, to ensure that even the most energy-intensive occupants' needs are met (4).

Good green building requires integrated planning, with a vision and performance goals identified in advance. Considering a building as a whole system of integrated components is not how most commercial buildings are built. Most are designed as a compromise between various designers. In an integrated approach, everyone's decisions are made in full consultation with everyone else, so that nothing is cast in stone before it can be fully evaluated from all the different perspectives (14).

Some green buildings owned and operated by nonprofits have experienced size constraints soon after completion. This problem is neither unique to nor the result of green building design per se, but a feature of capital and real estate market constraints to which any building project is subject.

3. Efficient use of space and materials

Green building materials have included recycled waste products, "natural" materials containing no synthetic or petroleum products, are salvaged, recyclable or generate fewer air emissions. Renovating existing buildings reduces materials use, manufacturing energy and landfill loading (4). Green building techniques use:

- Renewable resources, including solar, wind and geothermal energy sources. Renewable building materials such as wood come from certified sustainably managed forests, agricultural by-products (straw), and earthen materials (clay and brick).
- Recycled and recyclable resources. Some non-renewable resources may actually be used multiple times; for example, many metals can be recycled repeatedly. Recycling reduces the disruptive and polluting effects of mining.
- Fewer materials with high "embodied energy," which is the total amount of energy required to produce or manufacture a material. This includes all energy need for mining, transportation, processing, and distribution. The cumulative energy embodied in the material and systems that make up a building may actually exceed the energy required to heat and cool the building for many years.
- Recyclable materials. Buildings are not permanent. Their materials can be a resource rather than a waste sent to a landfill after the building's useful life.
- Sustainable development practices. This means building the structure where its will have the least environmental impact. For example, building where services such as roads and utilities are already in place is preferable to building in ecologically sensitive areas. Consider redevelopment of areas and reuse of existing structures. (15)

Most designs that reduce materials or waste also save money, so there is an economic incentive for these measures as well (4). Many green materials now perform as well or better than conventional products.

4. Energy efficiency

Energy use contributes to air and water pollution, mining, drilling and deforestation. It also often increases greenhouse gas emissions. Inefficient energy use is costly for consumers. Implementing measures to increase energy efficiency in all sectors of the United States could:

- Lower energy requirements by half.
- Cut carbon dioxide emissions (the main global warming gas) by up to 70%.
- Save $2.3 trillion over the next 40 years.
- Stimulate markets for energy-efficient products, bolstering economies and creating jobs (16,17).

Building orientation and thermal massing, natural ventilation, daylighting, and other passive strategies can all lower a building's energy demand and increase the quality of the interior environment and comfort of the occupants. The efficiency of systems can be maximized through use of advanced computer modeling and life-cycle cost analysis (11).

5. Indoor air quality, health and productivity

OSHA claims that 25-50% of all commercial buildings have indoor air quality (IAQ) problems. A Journal of the American Medical Association study (uncited, in [4]) indicated that the sickest buildings have been those built or renovated in the 1970s and 1980s because they have poor ventilation and air circulation (4).

IAQ is also affected by building materials and finishes, smoking, and open combustion of appliances, high moisture levels leading to mold growth, and quantity and quality of fresh air introduced through ventilation. Carpets, paints and adhesives have been the worst contributors. About 1,500 bacterial and chemical air pollutants have been identified from paints, carpets, manufactured products and office equipment. Sick building syndrome ("SBS")--dizziness, headaches, eye and throat irritation, nausea, coughing—has gotten a lot of recent press (4). EPA considers sick buildings the fourth-largest environmental threat to human health. There is strong evidence that characteristics of buildings and their indoor environments affect health. These include communicable respiratory disease (e.g., common colds and influenza), allergy and asthma symptoms, and SBS-related symptoms such as headaches, and eye, nose, throat, and skin irritation. For example, in six studies, the number of respiratory illnesses in building occupants varied by a factor of 1.2 to 2.0 as a function of rate of ventilation with outside air, type of ventilation system, and occupant density. Allergy and asthma symptoms are often a consequence of indoor exposure to allergens that may originate indoors or outdoors (19).

Indoor air quality, natural lighting, good ventilation, heating and cooling are especially important for young children (18, 25, 37). Poor indoor air quality and lighting may affect academic performance and behavior in children (9).

Other resources used in the building industry can cause environmental damage through mining and toxic manufacturing processes. Sometimes materials can cause health problems for the inhabitants of the home if the material was made with a toxic chemical that outgasses into the indoor environment. Because Americans now spend 80-90% of their time indoors, health problems related to poor indoor air quality have risen significantly since World War II (10).

<u>Costs</u>
A 1990 American Medical Association and US Army study attributed 150 million workdays and $15 billion in lost productivity annually to poor indoor air quality in the US. Sick building

lawsuits, in which owners, builders, architects and product manufacturers are sued, are on the rise (4). The annual (1993) health-care costs for acute respiratory infections are about $30 billion. These respiratory infections result in about $35 billion in annual sick leave plus restricted activity at work. The health-care costs and productivity decreases from allergies and asthma are about $13 billion per year. Productivity losses from SBS symptoms are quite uncertain but were estimated to be around 2 percent among office workers, costing an estimated $50 billion annually (19).

Productivity

In addition to influencing health, research suggests that the indoor environment, especially temperature and lighting, can directly affect worker performance by a fraction of a percent to a few percent (19). The 2,600 engineers in Lockheed's new Sunnyvale, CA building, which uses half the energy required by California's Title 24 code, were found to work faster than in their old building. The time to turn specifications into design documents decreased 15%, allowing Lockheed to bid competitively on a contract they would not have otherwise won. The profit from that one contract paid for the entire building (20).

Improving indoor air quality

Indoor air quality is most effectively controlled through close coordination of architecture, interiors and design strategies that limit sources of contamination before they enter the building. Construction procedures for IAQ and post-occupancy user guides also contribute to good long-term IAQ (11).

Recently completed analyses suggest that improving buildings and indoor environments could reduce health-care costs and sick leave and increase worker performance, resulting in an estimated productivity gain of $30 to $150 billion annually (13). Several methods can be employed to reduce allergen exposures. Changeable building factors such as ventilation rates, indoor pollutant concentrations, and quality of building cleaning can influence the frequency and severity of SBS symptoms (13).

It is difficult to estimate the degree to which it is practical to improve relevant indoor environmental conditions. Based on ventilation rate and pollutant concentrations, the potential decrease in adverse health effects from improvements in indoor environments were estimated to be 10-30% for infectious respiratory disease, and allergy and asthma symptoms and 20-50% for SBS symptoms. The potential direct increase in office workers' performance was estimated to be 0.5-5%. For the U.S., the corresponding annual health-care savings plus productivity gains are $6 to $19 billion from reduced respiratory disease, $1 to $4 billion from reduced allergies and asthma, $10 to $20 billion from reduced SBS symptoms, and $12 to $125 billion from direct improvements in worker performance unrelated to health (19).

Productivity increases and worker absenteeism decreases in energy-efficient buildings, by 6-16%, according to a Rocky Mountain Institute study. Companies typically spend 70 times as much (per square foot) on salaries as on energy: a 1% productivity increase can save more than a company's entire energy bill (4).

Occupants close to windows report fewer health symptoms than those farther away (96). Mentally ill patients at the Way Station in Frederick, MD by all accounts appear to be helped by the open, sunny design (21). Evolutionary ecologist E.O. Wilson posits a "biophilia hypothesis:" because of our evolution; people prefer nature and natural processes to being in a closed environment with no windows (22).

Because worker salaries exceed building energy, maintenance, and annualized construction costs by a large factor, the cost-effectiveness of improvements in indoor environments will be high even when the percentage improvements in health and productivity are small. The value of projected health and productivity benefits relative to the costs of increasing ventilation and improving air filtration in a large office building were very high, approximately 50 to 1 for increased ventilation and 20 to 1 for improved filtration (19).

Construction activities
can affect IAQ. Aside from bans on lead-containing paint and asbestos, there are few requirements to protect occupants from other materials or construction activities. Dust and other particulates from carpentry and drywalling can affect workers' health. Glues, paints and solvents emit VOCs. Welders and gas or diesel generators emit combustion gasses. While fiberglass insulation does not absorb water (fostering mold), it attracts dust, which, if the insulation is installed before a vapor retarder is in place, can absorb moisture (4).

Construction activities should be sequenced to minimize contaminant sinks. Materials that absorb VOCs, such as fabric panels, carpets, ceiling tiles, furniture and movable partitions, should be installed after VOC-emitting products (paints, adhesives, sealants) have had time to air out (23). A better option would be to avoid VOC-emitting products entirely, as more high quality similar-priced alternatives have become available.

6. Economic benefits of building green

Economic benefits of building green include:

- Reduced capital costs, such as from equipment downsizing (e.g., the size of HVAC system, in response to reduced thermal loss), reduced construction costs, waste minimization (e.g., recycling old materials with high embodied energy).
- Reduced operating costs, such as energy, water, maintenance, disposal. Operating cost savings are usually easiest to see and quantify with energy, but also occur with reduced water demand, maintenance requirements and waste generation. These increase net operating income. Estimate of reduced energy use from green buildings in this compendium is on average 50% for conventional buildings. (4)
- Energy planning: Greatest savings can be achieved if all energy use is considered up front. For example, multiple glazed windows can reduce heat loss and gain, allowing smaller chillers and obviating need for baseboard radiators, further reducing costs and increasing available floorspace. Glazing allows increased daylight (without excess heat), reducing electrical lighting need. Increasing the thermal envelope allows for as much solar heat gain during winter, and shading during summer, while minimizing heat loss. The moral: glazed superwindows are more expensive than conventional to purchase, but

save money in many other areas. Other examples: 1) Upgrading building envelope insulation at the Bentall Crestwood Corporate Centre in Richmond, BC allowed for a much smaller chiller upgrade (from 200 tons to 50), saving tens of thousands of dollars. 2) Renovation of Continental Office Plaza near Chicago required new HVAC, which alone had 110-year payback. New, more efficient lighting, however, allowed smaller HVAC, which, coupled with an energy management system and selling energy savings to investors, resulted in a 1.7-year payback (4).

- Adaptability: Designing with flexibility for future upgrades can reduce long-term costs. Many European buildings have been successfully adapted over the centuries, in contrast to many buildings in the United States that, so specifically designed, are easier to demolish and rebuild than to adapt. Some new buildings in the United States are designed with the ability to adapt, for example, fuel cell technology when it becomes commercially available. (54,68,117,112)
- Market advantage: In a tight market, owners/developers can charge more for space with lower operating costs. In a softer market, they can pass savings on to tenants, lowering rent. To date, green commercial developments have had higher occupancy and absorption rates because of this advantage. Well-executed green development projects have performed well financially (4, 117).
- Reduced liability. Lenders are risk-averse, and real estate has many risks. Green building reduces health and safety risks.
- Recently, William D. Ruckelshaus, former EPA Administrator and present chairman of World Resources Institute's Board of Directors, noted that paint, carpeting and many other building industry-related companies have shown that creating sustainable products using environmentally friendly manufacturing processes is not detrimental to the bottom line. He believes that, since the cost of building a "green office" is comparable to that of a conventional one, there is no reason that green building should not become the norm (24).

7. New building vs. renovation

The United States has about 4.5 million office and public buildings. Hundreds of thousands of these are functionally obsolete, requiring extensive renovation or replacement (4).

Renovating old buildings preserves some history and generally is cheaper and has less environmental impact than new construction. Renovation retains most structural, sheathing, siding and finish materials, expending less energy (extraction, manufacture, shipping). Renovation preserves more of the embodied energy of the old structure—the wood, steel, cement and foundation, lowering economic and environmental impacts. Existing buildings are more likely to be found in populated areas that offer access to public transportation and enable occupants to walk to stores and other services (4). More important, building rehabilitation reinforces the concept of reusing existing built resources, tempering the further development, decentralization and sprawl characterizes many urban and suburban areas (20). Economic benefits of renovation include saving infrastructure, service, and travel costs. Redevelopment and reinvigoration of older urban centers has also attracted new businesses and residents.

Infill development

Infill, increasing the density of developed areas by adding new buildings, can strengthen existing neighborhoods and utilize existing infrastructure. On an individual lot basis, with less sewer, water, road and other infrastructure impacts, infill can be more cost-effective than sprawl development. Regulatory constraints, however, can make it more difficult than conventional (lower density) development (4). This is changing, with federal and local government support for brownfield development and incentives to use these spaces.

8. Green buildings as teaching tools

Many of the environmental nonprofits and academic environmental studies departments whose buildings we have featured display and teach about their buildings' green features. This is part of a growing "pedagogy of place" theme in education (7,8,9,25,29). Nonprofit organizations involved in housing and energy conservation (63,67,106) are using their buildings to teach and demonstrate the state-of-the-art in environmental design to constituents and communities. The buildings demonstrate how effective these ideas can be, and their transferability. Green developers often assume an educational role in their communities, educating about what is being proposed and why it's beneficial. Or, as with Austin, Texas (6) and a growing number of other communities, the community itself may take a leadership role.

Green (or high performance) K-12 schools have begun to appear. In many instances this trend is driven by concerns with poor indoor air quality and lighting (9,18), which may hinder children's ability to perform. Some school districts (9,28,29,30) are choosing green schools for financial reasons: lower heating, cooling and lighting costs. Some schools have integrated green building into curriculum, teaching students about energy, waste reduction, and impact of the built environment on the natural environment (25,26). Administrators, custodial staff and teachers are also incorporating green practices (9).

Building function may improve if occupants understand the vision and the specifics of how their building works. At National Public Radio, many employees not only were unaware of how their building functioned, but were surprised to learn that it was a green building. Training is important if the building operates differently from conventional ones. Building users guides, as the Way Station in Frederick, MD has developed (21), can help.

9. Shared nonprofits

Nonprofits sharing office space are becoming more widespread, as foundations are building or renovating office space for organizations to share inexpensively. Some collaboration has been driven by necessity, some because of availability. In some cities, nonprofits are being encouraged to collaborate efforts in an attempt to strengthen the local economy (31). These facilities provide nonprofits office space and equipment, often below commercial rates. The goal for many has been to find ways of reducing administrative overhead costs that burden small nonprofits and in many cases threaten their very existence (32). Low rent and other savings offered by the non-profit complexes have enabled nonprofits to direct more money into substantive services. The idea is gaining as foundations search for ways to help charities cope better with limited resources and to make their own grant dollars go further (33).

Collaboratives come in all forms, from national to local grassroots organizations, from wealthy to cash-strapped (31). Costs have ranged from less than $1 million (Preble Street Resource Center in Portland, ME) to $50 million (Wilson Historic District in Dallas, TX).

Environmental nonprofit organizations, including the Land and Water Fund of the Rockies, Conservation Consultants, Inc., and the Thoreau Center for Sustainability, all house a number of environmental organizations. These projects set successful examples of green building standards, and information exchange and collaborative projects.

Nonprofits at the NEW Center in Ann Arbor and other shared spaces have found that they have more access to equipment, space, and professional advice that they could never afford on their own, and find they reduce duplication of services and work more cost-effectively and efficiently (32,33). Participating nonprofits have created close working relationships with one another, often going next door to borrow supplies, bounce off ideas, seek advice or collaborate. Many nonprofits have also found that the availability of conference rooms, Internet access, and workshops on grant-proposal writing and other topics has improved their operations (33).

Grant makers, some of whom put their own offices in the new complexes, have found that funding nonprofit complexes is more effective than simply parceling out lots of grants for capital projects, and also saves money over the long term. Some grant makers have found that the arrangements can cost them less than capital grants to charities for individual projects (33).

Real-estate values in areas where grant makers have undertaken urban renewal efforts have increased the market value of the grant makers' properties. The Meadows Foundation financed the Wilson Historic District as a "program-related investment" because the fund could then count the dollars spent for that project as part of its minimum payout requirement (33).

Shared nonprofits have their downsides. Some donors have concluded that participating nonprofits, now paying little or no rent, no longer need their support. Some charities have become overly dependent on the foundations that house them—even though the goal of most shared facilities is to make groups more self-sufficient (33).

10. The green building trend: some observations

Green development is moving from the fringes towards the mainstream. There are many more green building-related journal articles, professional conferences and sessions at other conferences, new sections of professional societies, industry organizations (American Institute of Architects [AIA] National Committee on the Environment; American Society for Testing of Materials [ASTM], US Green Building Council; Construction Specifications Institute [CSI]) as well as government programs (U.S. Environmental Protection Agency; the Department of Energy; the National Park Service—see Appendices 1 and 3) than even in the recent past. More green products and building materials of similar price and quality to conventional have become available, fueled by and helping to fuel this green building expansion.

The City of Austin, Texas Green Building Program was the first government program geared to address environmental, social, and economic impacts associated with building. Other cities,

states and agencies throughout the US are following Austin's example (6) (see Appendix 3). In some regions of the US, nonprofit organizations are taking the lead in exhibiting green building principles and working with industry and government to build demand for green development. Many of these groups work on policy development and code changes, and also offer professional education (e.g., Green Building Alliance, Southface Institute).

New marketplace trends are providing green developers more opportunities to be environmentally responsible and make a profit. Consumers are increasingly receptive to healthy, environmentally sensitive products and lifestyles. The market appears to favor sustainable development practices (4), from product choices to housing (e.g., Prairie Crossing, IL, Dewes Island, SC).

Barriers to green building include:

- Lack of awareness. (We found this even among managers of conventional buildings that housed green offices.)
- Requires a lot of time up front.
- Financing, by conservative entities.
- Lack of immediate knowledge of resources.
- Lack of professional training.
- Lack of policy incentives. (4)

One unexpected finding was that, in a few situations, a green building could detract from an environmental organization's mission. Audubon's New York City headquarters building focused so much attention on the building, according to some, that it diluted Audubon's conservation image. Audubon may have been hurt by its own green building success, and has since taken steps to de-emphasize its green building focus.

Two national environmental organizations with which we spoke—the Nature Conservancy and the National Wildlife Federation—wanted green buildings, but only under two conditions. First, the buildings had to be no more expensive, in the long run, than conventional buildings. Second, they did not want a green building showplace, but simply a building to house staff. They didn't want their constituents to think they had strayed from their primary missions of land and wildlife conservation, on which they wanted the public to focus, rather than on their buildings. Even some cost-effective green options were vetoed because of image concerns. While green building, as any sustainable development measure, ultimately aims to increase environmental conservation, these goals were secondary to these organizations.

III. THE GREEN BUILDING PROCESS

Ideally, green building planning includes:

1. Strategic facility planning and programming. Identify and rank green objectives and goals early on. Project team vision sessions help all involved understand sustainable design issues, constraints and opportunities. Determine whether to renovate or build new, sell existing facilities or lease, consolidate or decentralize, to ensure long-term viability, resource conservation and life-cycle cost benefits (11).
2. Site work and planning. Look beyond the project site boundary to evaluate linkages to transportation and infrastructure, ecosystems and wildlife habitat and community identification. Evaluate solar and wind orientation, local microclimate, drainage patterns, utilities and existing site features to develop optimal building siting and appropriate low maintenance landscaping (11).
3. Front-loaded design. In conventional development, resource efficiency and environmental impacts are often afterthoughts. Green benefits are easier and cheaper to maximize if addressed early in planning (4). Anticipating requirements and clear documentation of design decisions can have a large impact on long-term costs, comfort and productivity of occupants and reduce environmental impacts (11).
4. End-use/least-cost considerations. Keeping planning team focused on what end users want and need is key to green design, and can achieve the greatest benefits at least cost. People don't want electricity or oil, but what they provide: light, heat, etc. (4)
5. Teamwork/whole-systems thinking. Full communication among all players from the outset is critical, for all development stages, not just architectural design. Mechanical engineers, for example, need to account for the benefits of daylighting or reduced cooling loads when considering HVAC equipment. Communities are team members, too, and local governments and citizens—who ultimately have to live with the development, whose approval is ultimately needed—should be included (4). This approach goes against recent design and engineering trends of increasing specialization.
6. Changing the approval and code process.
    - Approvals. The approvals process is often one of the most frustrating barriers to developing more environmentally and community sensitive projects. Innovative projects may become mired simply because they are unique, making developers reluctant to take them on. Getting community support early can speed up project approvals, as occurred with the Denver Dry Goods building process and Dewees Island, SC (4). Local governing bodies and citizens are important stakeholders. They may oppose green development because they do not understand it, because they oppose any new development or mistrust a developer's claims. Local governments' legitimate concerns can undermine green development because of obsolete codes and zoning laws (4). Passive solar buildings often require conventional backup heating because building officials do not trust them to work. Where regulations or codes preclude some green measures, some builders have built in flexibility in case codes change (4).
    - Building codes and state and local green building initiatives. The traditional means for causing change in building practices has been through adopting codes and ordinances that force compliance with a given standard. This can be

successful if the municipality can enforce the regulations, but it frequently creates political clashes between governing body and regulated party. These clashes often delay and compromise the enactment and intent of environmental initiatives (6). An alternative approach is a program that sells itself to the general public and building practitioners without mandatory or financial incentives, that creates mechanisms to reward good actions rather than penalize with an approvals process, as the Austin Green Building Program is doing (see Appendix 2).

> Energy codes have been developed in many cities to improve energy performance of new buildings. These codes may specify actual energy performance, prescribe insulation, window glazing and other components, or both. Performance codes, though more complicated, offer greater flexibility (and innovation over time). An example: allowing passive solar design instead of high R-value walls, which have the same net effect (4).
>
> Building to code, in most instances, does not ensures energy efficiency, but only that a less efficient design would be illegal (4).

IV. HARDWARE: CONSIDERATIONS FOR EFFICIENCY

1. Building envelope

The building envelope refers to the roof, walls, foundation, insulation, seals, doors, and fenestration (design and placement of windows). It affects energy performance through air infiltration and exfiltration, solar gains and heat loss through the windows, internal heat transfer, and heat gains and losses through the ceiling, walls, and floor. (34).

Environmentally preferable building materials can be durable and low maintenance. Some materials require more energy to produce than others, and some exhaust natural resources. Construction materials made from recycled sources are becoming widely available and can minimize a new building's environmental impact. For homes and small commercial buildings, construction using inexpensive natural materials, such as hay bales, is also becoming more commonplace in some regions of the US. Internal walls, ceilings, and floors with high thermal capacities can reduce energy use by storing solar energy, and reduce peak loads by attenuating the diurnal load profile. Improvements that increase the energy performance of these building elements reduce energy use in buildings and, ultimately, can reduce greenhouse gas emissions (34).

Given realities of performance, cost, aesthetics and availability, careful selection and specification can reduce environmental and occupant health impacts (11). For optimal energy performance, green designers suggest a variety of building materials. For instance, the windows on the south side of the building may have different specification than those on the north side. Before deciding on the materials to use, building orientation should be considered, for example, the amount of southern exposure, geographic location, and climate (35). The University of Victoria's new 127,800-ft^2 engineering laboratory wing has an efficient envelope (high-performance glazing, operational windows, light shelves) coupled with high-tech controls and high-velocity ventilation. It uses passive solar heating and natural cooling, saving 723,000 kilowatt-hours (about $25,000) annually (4).

<u>Insulation</u>

Building insulation comes in various forms, including batts and blankets, rigid board, and loose fill. Insulation is measured in terms of an R-value, the ability of a medium to resist heat transfer through it. Typical walls may be rated at R-10 to R-20, while older, single-paned windows are rated at R- 1. Although batts, usually made of fiberglass or rock wool, are typically placed between studs or floor joists, rigid foam boards, made of polyisocyanurate, extruded polystyrene (XPS or blueboard), expanded polystyrene (EPS or beadboard), or other materials, are an alternative. These boards are lightweight, provide structural support, and generally have an R-value of 4 to 7 per inch. It is also important to minimize "thermal bridges," which can allow heat to bypass the insulation, lowering R-value and eliminating the benefit of added insulation (35).

Another option for exterior walls and ceilings is to use structural insulated panels (SIPs, also called foam-core panels), thick slabs of foam insulation sandwiched between two layers of

structural materials such as plywood. SIPs can replace stud-framed construction for walls and ceilings. Although SIPs cost more than traditional building materials, they require less labor to install, so the total cost is equivalent to stud-framed walls.

One goal of building a better thermal envelope is to reduce dependence on the HVAC system. With smaller, more efficient systems, capital costs are reduced along with energy costs (39).

Windows

Windows are responsible for one-quarter to one-third of energy loss in residential and small commercial buildings. Efficient window technologies can decrease energy consumption and improve comfort levels by minimizing heating loads in the winter and cooling loads in the summer. Either way, the right windows increase efficiency through insulation and shading (17).

Windows can help insulate a building. A window's R-value can be doubled or tripled by adding glazings. The space between glazings can be filled with inert gas such as argon, and the glazings can be coated to increase the insulation value virtually to R-10. In typical applications, they can reduce heating and cooling bills by up to 28% (17).

Shading

Shading on windows can selectively block the sun's radiation while lighting the building. Low-emissivity or "low-E" coatings or films prevent the transmission of infrared heat radiation while allowing the passage of ultraviolet and visible light. This helps to keep heat out when it is warm outside and to keep heat indoors when it is cool outside (17).

Daylighting

Daylighting means using daylight for indoor lighting. Modern buildings designed for daylighting are cheaper to operate, use less energy (typically using 40% to 60% less electricity for lighting) and are more comfortable than electrically lit buildings (37,38).

Daylighting has been used for centuries—the ancient Greeks and Romans used controlled daylighting strategies in the design of their cities. In the late 1940s, the development of the fluorescent light and other advances in technology had a profound influence on the design of electrically lit buildings. By the 1960s, daylighting was all but forgotten by most building designers, but is now being rediscovered.

Natural daylight can provide most needed ambient lighting, as well as for a lot of fine work. Daylighting provides a better quality of light than fluorescent lighting. Occupants of well-designed daylit buildings report that the light is very comfortable, and there is evidence that good daylighting can improve the productivity of workers and school children (37). In addition, daylighting is a proven technology for reducing annual operating costs and daylight is available during most business hours.

Daylight is free and readily accessible. However, using sunlight without causing glare and without overheating a building can be difficult. Glare can be avoided by using windowsills, walls, louvers, reflective blinds, and other devices to reflect light deep into the building. Light shelves, and reflective ceilings and walls, can help direct sunlight deep into a building. Coupling

daylight with dimmable fluorescent lighting controlled by photocells, as in many of the buildings featured in this compendium, can automate the process, reduce the need for artificial lighting and save energy (4,17). Placing windows and skylights away from the sun's direct rays avoids overheating. For example, placing skylights on the north slope of a roof rather than on the southern exposure may reduce heat transfer. In addition, windows with new selective glazings transmit the most visible light while excluding the most solar heat (38).

2. Heating, ventilation and air conditioning (HVAC)

HVAC accounts for about 40% of the energy use in U.S. commercial buildings (39).

Chillers

Most commercial buildings rely on chillers for air conditioning, especially in climates with large cooling loads. Chillers use the most electricity in many commercial buildings, and represent 23% of installed electrical capacity in the US (4). They are a prime target for energy efficiency improvements in most commercial buildings. Chillers create peaks in electric power consumption, typically during summer afternoons (39, 40).

Meeting the peak demand caused by chillers forces utilities to build new power plants. However, because chiller plants run the most when the weather is hot and very little at other times, their load factors, and the utilities' (the percentage of time a power plant generates electricity), are low. Because of that, chillers cost utilities more to serve than other loads (40).

Improved chillers. The Montreal Protocol, intended to protect the ozone layer, has begun a phase-out of CFC (chlorofluorocarbon) refrigerants. This has triggered a wave of chiller replacements that should accelerate during the next 10 years. Energy-efficiency measures in conjunction with chiller retrofits can reduce the load and the necessary chiller size, making the change more economical overall. But once the chiller is replaced, the opportunity for an integrated approach is lost. Most chiller plants are oversized, and even those that are correctly sized operate most of the time at low part-load efficiencies (40). New technologies such as direct digital controls and variable frequency drives, combined with improved design, maintenance and operation, can decrease chiller energy consumption by more than half while improving their reliability (4,40, Appendix 4).

Heating

Heating technologies for commercial buildings have become more efficient. An important consideration is proper size; an efficient heating system size should run constantly at full load on the coldest day the building is designed to handle. Although designers sometimes oversize a heating system to provide a margin of error, an oversized system will run inefficiently at partial loads through the heating season (39).

Buildings in urban areas can save energy by implementing district heating, which uses a large central heating system that pumps hot water for heating to a number of buildings. This simplifies operations and maintenance for the individual buildings and achieves economies of scale (39).

Ventilation
A commercial building's ventilation system is the primary way in which the HVAC system interacts with the building environment. Because of this, it is important to integrate the ventilation design with other strategies such as passive solar heating or natural circulation of the air through the building. (An example of what not to do: a ventilation system designed to cool the south-facing, passive solar side of a building, while heating the north-facing side of the building; ideally, the system should simply help transfer the heat from the south side to the north side.) (39)

Natural ventilation. In the UK, architects and engineers are including natural ventilation in the architectural designs of large offices and other buildings. They use passive ventilation, based on the stack effect and pressure differentials, that works even when windows are closed (41). The goal is to produce buildings with low operating budgets that respond to user needs. Daylighting is often an integral part of the design. Daylighting and natural ventilation are mutually reinforcing design strategies because they encourage high ceilings and windows as well as narrow floor plans or atrium schemes that provide access to the outdoors from both sides of interior spaces (41, Appendix 4).

3. Electrical lighting

Lighting accounts for almost one-quarter of the electricity used every year in the United States, or more than $37 billion annually. An average household dedicates 5% to 10% of its energy budget to lighting, and commercial buildings 20% to 30% (38). Much of this expense may now be unnecessary. In a typical commercial or residential lighting installation, obsolete equipment, inadequate maintenance, or inefficient use (38) wastes 50% or more of the energy. Technologies developed during the past 10 years can cut lighting costs 30% to 60% while enhancing lighting quality and reducing environmental impacts (38). The air conditioning required to compensate for inefficient electrical lighting, for example, is 3-5% of total energy use. Equally important, research in the last decade has shown that low light quality decreases employee productivity (42). As a result, the focus of high technology lighting in recent years has also been on correct optical design for the work environment.

As fluorescent lighting technology has developed, high-efficiency, high-quality lighting has become more available. More than half of U.S. lighting electricity is used in fluorescent lamps. A single compact fluorescent light replacing an incandescent light bulb in a New York City office building can keep ¾ ton of carbon dioxide out of the atmosphere over its lifetime (17)

Glare
Eliminating glare (i.e. excessive brightness from a direct light source) is essential to achieving good lighting quality. Glare types include direct, reflected and veiling reflections (38).

Energy conservation strategies
Saving lighting energy requires either reducing electricity consumed by the light source or reducing the length of time the light source is on. This can be accomplished by:

- Lowering wattage, by replacing lamps or entire fixtures.

- Reducing a light's on-time, which means improving lighting controls and educating users to turn off unneeded lights.
- Using daylighting, which reduces energy consumption by replacing electric lights with natural light
- Performing simple maintenance, which preserves illumination and light quality and allows lower initial illumination levels (17).

4. Plumbing

Lowering water consumption, through low-flow plumbing fixtures, water-appropriate landscaping and HVAC and plumbing system design, can save money in lower water and sewer bills and, indirectly, reducing the financial and environmental costs of treating wastewater and reducing the need to expand wastewater treatment facilities. Site design strategies that maximize natural filtration of rainwater and consideration of on-site biological treatment systems for building gray water and wastewater can enhance water quality (4,11).

The University of British Columbia's C.K. Choi Building uses composting toilets, saving 1,500 gallons per day, reducing burden on UBC's sewage treatment and Vancouver's water supply (4). Oberlin College's Environmental Studies Department is developing a "Living Machine" that treats wastewater with a series of filtering tanks. Filtered water collects in an outside pond containing diverse biota, and is recycled for building use (55; see Oberlin's Environmental Studies Center, below).

5. Construction

Green construction practices cover purchasing materials, minimizing site disturbance, ensuring workers' and occupants' health, efficient resource and materials use during construction, minimizing and managing construction waste, and ensuring building performance. These practices can reduce long-term environmental impacts on the site, water, waste and indoor air quality (11).

<u>Communication and supervision</u>. Designers for many of the buildings featured in this compendium held preconstruction meetings to educate and build support from contractors. While it's important to meet with subcontractors in advance, as some of the green building textbooks recommend, (4,23), it's not always realistic. The Nature Conservancy and World Resources Institute designers note that subcontractors, who do the bulk of the work, aren't involved until relatively late in the process, when contracts are bid on (43). Other green buildings such as Conservation Consultants, Inc. in Pittsburgh have worked closely with subcontractors as a teaching and learning process.

Green construction has required more supervision, monitoring and communication than conventional construction. While an added burden and expense, it is essential, in part because the practices are still so new (and evolving) to builders, and it usually saves money by preventing corrections at the end. It was a positive experience for Nature Conservancy and World Resources Institute building subcontractors, who were willing to learn. But the designer had to stay on top of the process the whole time (43).

Materials. Because green materials may cost more and be harder to find, planning ahead is important. Although National Public Radio's project managers made contractors aware of the longer lead times needed for sourcing these materials, they temporarily exhausted the green drywall market in the entire Northeastern United States. As green building has become more common, green materials are becoming more widespread and available, and price premiums are shrinking. Generic green specifications and directories have become more available in print and on-line (4). (See Appendix 1)

Reusing salvaged materials, especially in renovations, saves money and resources: it reduces the need to purchase new materials, and reduces the need for and cost of disposal. Salvaged materials usually require little additional energy to make them usable (4).

Construction waste. Waste and inefficiency can be limited during construction by recycling demolition and construction waste, reuse of on-site materials and monitoring of material use and packaging. Accommodating recycling into building design reduces waste while generating revenues (11).

The major barrier to recycling is the added effort to separate and sort waste. The construction industry, historically, has paid little to dispose of waste, but with fewer sites and more stringent environmental regulations, waste disposal costs have been rising. Tipping fees quadrupled in the US between 1985 and 1995--builders now spend 2-5% of construction budgets on job-site waste. This added cost, as much as anything, has driven waste reduction, salvaging and recycling. Some of the leading building construction companies in the US (including the largest, Turner Construction) now require all subs to do job-site waste recycling. More contractors are now being required to implement waste-management plans to avoid high disposal costs and facilitate recycling. These plans specify what wastes will be generated, how they will be managed, and by whom (4). There are also more regulatory pressures to minimize waste.

There are now several networks through which builders can exchange materials. The Body Shop's headquarters in Wake Forest, NC donated salvaged materials to a local Habitat for Humanity project, receiving a tax benefit and avoiding tipping fees (4). In Pittsburgh, the Construction Junction operates as a materials exchange (106).

Site protection. Site preservation and IAQ, usually addressed during planning and design, can be affected by poor construction practices. Post-construction, IAQ can be affected by poor cleaning practices (4). National Public Radio ran their HVAC for 10 days prior to occupancy, and experienced no IAQ problems (44).

V. SOFTWARE

1. Recycling

The average office worker generates over 100 lbs. of waste paper each year (4). Audubon House recycles about 70% of their trash, using four recycling chutes: for paper, plastics, aluminum and glass. The installation cost was $185,000. The High-Rise Recycling Corporation estimates that a standard 20-floor building can save $27,200 annually in labor costs by using chutes rather than floor-by-floor recycling, and the potential savings from reduced trash hauling can be $4,880 annually (4) (although this depends on the recycling market). But recycling chutes aren't always necessary, nor do they always work. In some buildings, the maintenance staff and can handle floor-by-floor recycling at little added cost or effort (44). National Public Radio's paper recycling volume was so large that the chute became clogged, and they had to resort to floor-by-floor recycling.

2. Building maintenance

Green buildings remain green only if they continue functioning as designed. Maintenance includes keeping solar and other systems working, maintaining mechanical systems, controlling moisture problems, maintaining IAQ and using healthful cleaning products (4, 83). Building managers need to receive training and communicate with one another to stay current on maintenance methods.

Maintaining IAQ is complex, and is influenced by the site, climate, outdoor air, building systems, construction techniques, contaminant sources and occupants. Regular HVAC maintenance helps. Mold and other biological contaminants, and the biological VOCs can they emit, can cause many IAQ problems. Basements, crawl spaces and HVAC ducts should be inspected and regularly cleaned. Leaky pipes, standing water, insects, debris and rotten wood can create IAQ problems, as can pesticide spraying (4).

One evaluation procedure is United Kingdom's Building Research Establishment Environmental Assessment Method (BREEAM), introduced in 1993 to help building managers understand and improve their buildings' environmental performance. The procedure, which became available in Canada in 1996, examines and evaluates all aspects of office operations that have an environmental impact, and recommends areas of improvement. The program addresses energy, water, paper usage, indoor air quality, waste management, commuting, business travel, and working at home. The process takes just a few days (five days for a 150-person office). (See Appendix 4)

3. Commissioning

Commissioning is an evaluation process used to ensure that buildings perform as designed. It typically measures energy management controls and temperature, pressure, and humidity throughout buildings and their mechanical systems. Facilities engineers and operators, energy

management and building commissioning experts, or IAQ experts usually do it. Commissioning can be complex in large buildings with extensive daylighting, passive ventilation and passive solar heating. Commissioning, which has come into practice only in this decade, is still rarely done outside of green buildings. Effective building commissioning is essential to ensure proper and efficient functioning of systems. Facilities operations benefit from the monitoring of indoor air quality and energy and water saving practices, waste reduction and environmentally sensitive maintenance and procurement policies. Although a post-construction activity, it should begin during predesign. Scope and time frame vary. Since commissioning evaluates performance, performance expectations can therefore be specified in building contracts. (4,11).

Commissioning costs relatively little--0.06% of the San Francisco Main Library's $100 million construction cost. The architect convinced the city that commissioning would be less expensive than fixing later mistakes. The Lawrence Berkeley National Lab estimates that commissioning can save up to 40% of a building's HVAC utility bills. Building owners have paid, on average, $\$8/ft^2$ per year in additional operating costs because of faulty HVAC design or installation. Mechanical system commissioning costs 2-5% of installed equipment cost, and the cost of operating a commissioned building is 8-20% less than an uncommissioned building. A Southern California Edison study of seven commercial buildings found that commissioning averaged $\$0.28/ft^2$, and saved 0.3-3.4 kWh/ft annually, which saved thousands of dollars for some buildings (4). Other commissioning benefits include increased equipment reliability and life-span (because of less wear and tear), increased occupant comfort and IAQ and reduced litigation. The average litigation claim for a building is $85,000. More than 70% of these claims could have been avoided had the buildings been commissioned (45). Also, commissioning is a way to educating building occupants.

Why is commissioning still rare? There seems to be a lack of awareness. Also, commissioning takes time. Inspection teams are usually not rewarded for final performance, but for quick, easy fixes of problems. Some utilities now offer commissioning services, or incentives (Seattle City Light, New England Electric). Montgomery County, MD has a commissioning manual. The federal government has mandated a commissioning policy for federal buildings. In the private sector, some companies and universities have hired third-party commissioning (4).

Recommissioning

Recommissioning reexamines building operations for adjustments. Sometimes hourly energy simulation modeling is conducted. Recommissioning, though not yet routine, appears to be cost-effective (4), as planners for the Way Station in Frederick, MD found (21).

VI. FINANCING AND REAL ESTATE ISSUES

1. Marketing

Conventional commercial buildings have been best marketed emphasizing economic return. Green buildings can have another advantage, in the form of marketing to reflect corporate values. One quarter of the American Association for the Advancement of Science's (AAAS) Washington, DC building is leasable; their city bond terms specified that lessees be like-minded, scientifically oriented nonprofits. AAAS's marketing strategy emphasized the environmentally and worker-friendly features. Within two months of opening 75% of the space was leased, by NRDC, Association for Women in Science, and the American University Research Association (2). Other green buildings have recently attracted large for-profit anchor tenants interested in sustainability (the Jean Vollum Center in Portland has Patagonia, Inc., and 4 Times Square in New York City has Conde Nast).

2. Financing

Lenders have become more accepting of innovative projects over the past two decades. Still, the ability to obtain funds is tied to track records, which most green projects do not yet posses. Lenders in Oregon believed that innovative projects require limits on risks that lenders could accept. Although pre-leasing and on-site management was important, lenders preferred working with developers with a track record, financial capability and experience in the product (4).

Lenders are most successfully approached on their own terms: cash flows, revenues, and expenses. They can better understand the benefits of resource efficiency if shown how operating expenses will be reduced, and how net operating income, cash flow and debt service are affected. The finance industry does not yet give credit to long-term energy-saving designs and other sustainability measures. Energy savings are easy to quantify; productivity and health less so (4).

Another problem some green developers face is higher initial costs. Even if the market accepts premiums, lenders may not (as occurred with Prairie Crossing, near Chicago). Lenders have perceived green development to lack comps (costs of comparative buildings), have untested markets and excessive land protection costs. Still, some lenders consider association with green development a plus (e.g., ITT Financial Real Estate Services, which helped finance the Inn of the Anasazi) (4). The Denver Dry Goods development tapped 23 different funding sources that incorporated urban redevelopment funds and housing funds (126).

<u>Sources of financing</u>
In addition to conventional sources (bank loans, venture capital, private investment), green development can tap (4):

1. <u>Public/private partnerships</u>, which have been used for depressed urban areas. The public sector provides financial assistance for projects with some public benefit, the nonprofit partners financing through tax avoidance, donations and infrastructure assistance. Examples include the Denver Dry Goods building and the AAAS and National Public Radio buildings in Washington, DC.

2. Pension funds, often the dominant equity partner in real estate ventures, while very risk-averse, can be locally controlled and socially responsible.
3. Creative use of historic tax credits, brownfields redevelopment incentives, and program-related investments in the nonprofit sector.

VII. SELECTED GREEN BUILDINGS CASE STUDIES

A. COMPLETED OR NEARLY COMPLETED BUILDINGS

1. Barney-Davis Hall, Denison University, Granville, OH

A green renovation of an historical building

Introduction

Barney-Davis Hall, built in 1903, now houses Denison University's Environmental Studies and English departments. Originally, the extent of renovation was to have been new paint and carpets. Then an elevator was added. Eventually, and through the Environmental Studies department's efforts, a fuller, and green, historical restoration was decided on. Preplanning and bids began in spring 1997, and bids were awarded in summer 1997. Construction began in fall 1997, and was scheduled for completion by summer 1998.

Education: The Environmental Studies program is primarily problem solving rather than advocacy. Barney is a real-world exercise in sustainability and environmental economical planning which provides those students and faculty involved with first-hand experience in applying the goals of environmental studies to the world outside of the classroom. The Barney green renovation has been integrated into the academic curriculum. Barney is also a tool for educating the whole community about ecological responsibility.

Size 28,000 ft^2

Goals

Mission: To provide an elegant, environmentally responsible home for the Environmental Studies and English departments, as a symbol of their aspirations, imparting their message on many levels.

The renovation project is an attempt to balance complementary historical and environmental goals. The original structure demonstrated a high degree of awareness of its surrounding environment, which has been restored using new technologies and the existing characteristics of the structure.

Historical goals:

- The renovated building will be used for its historic purpose or take on a new use that requires minimal change to the defining characteristics of the building, its site and environment.
- The historic character of Barney Hall shall be retained and preserved. Removing historic materials or altering features and spaces that characterize the property will be avoided.
- The property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development will not be undertaken.

- Changes that have occurred over time that have acquired historic significance in their own right shall be retained and preserved.
- Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize Barney shall be preserved.
- Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, when possible, materials.
- Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.
- Significant archeological resources affected by the project shall be protected and preserved.
- New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the size, scale, and architectural features to protect the historic integrity of the property and its environment.
- New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Environmental goals: The Barney renovation project is intended to produce a statement building: a place where environmental principles are upheld and demonstrated to the community. It should promote sustainability, use renewable energy sources, reduce toxic substances, recycle wastes, and serve as a laboratory and educational center for ecological themes. The ecological renovation of Barney has to balance these two critical facets; it must simultaneously be a comfortable, quiet, friendly easy place to learn and work while also demonstrating state-of-the-art ecological design. The building must be both inhabitable by any department and for any purpose without infringing on people's methods of behavior, and it must follow high standards of environmental sensitivity and sustainable design. Responsible behaviors can be encouraged, but not forced.

- Barney must be a pleasant and comfortable place to work. Air currents, noise, humidity and lighting levels, and floor and wall coverings should all be conducive to the academic environment.
- This building must demonstrate that fossil fuel reliance can be dramatically reduced, if not completely eliminated. This can be done by selecting materials that use less energy or save energy over their life span, including consideration of energy used during their harvesting, extraction, manufacturing, processing, transportation, distribution, installation, use, maintenance, recycling and disposal.
- Attention must be paid to user behavior and desires. Users should be able to control their building environment through light switches, operable windows, blinds to control natural light levels, and local thermostats.
- Barney is intended to be a working, living laboratory of sustainable design. This building should teach environmental sensitivity, respect and consciousness through its design and resource management. It should demonstrate how effective these ideas can be, and how transferable they are to other building situations.

- Local resources and local labor should be used as much as possible in the ecological renovation of Barney Hall
- The renovation must involve technologies and other innovations that promote environmental longevity. Designs and materials must be thought of in the long term and allow for changes to be made as the building continues to age and new technologies are developed.
- The emphasis on sustainability and using renewable resources takes the building back to its original plans. The initial design took advantage of natural light sources through its large windows, transoms, skylights, and even a glass floor that allowed sunlight to filter from the attic to the rest of the building. A sunken light well provided necessary ventilation to flow through the basement level. The renovation must return to these plans and should used passive and active solar energy as much as possible. The need for energy consumption in the building envelope should be reduced as much as possible.
- Barney should welcome people and look appealing, both inside and out. The floor plan designs and landscaping should take aesthetics into consideration.
- This building must consider its direct and indirect environmental impacts, both in construction and everyday use. It should be possible to engage in an exercise of the ecological accounting (life-cycle cost analysis) to demonstrate the overall value and cost-benefit of our design decisions. Part of the statement that should emerge from this building project is that "green" buildings are economical to build and operate. They seek high-value design decisions: technologies and innovations that pay for themselves either through direct reduction in resource use or through life-cycle improvements to the environment. Investing in technologies and products that do not require extensive maintenance can also reduce costs, and these should be emphasized wherever possible.

The principal of using natural materials includes: human health enhancement through the use of natural materials, restoration of original features of the building, rejuvenation of building features (e.g., natural wood trim and floors), and care in the selection of new materials, with preference for non-toxic, recycled, sustainably harvested, and local sources.

Experimental nature: Barney is a living laboratory for environmental technology. Several cutting-edge eco-friendly technologies are employed and tested for practicality and effectiveness by the faculty and students of Denison University. For instance, one bathroom may have three different models of toilets, and two different types of faucets. Barney can serve as a guideline to help other schools, businesses, organizations, and homeowners who want to make their buildings more environmentally sustainable by providing information Denison University has found about green products and energy-efficiency strategies.

Partnering opportunity: The renovation has provided the opportunity for partnership between Denison University and the manufacturers and distributors of environmentally innovative products. Permanent displays throughout the building, publicity from the re-opening of the building, and other sounding boards (such as their web page) have provided businesses with favorable exposure in exchange for playing a role in this unique project.

Features
a. Hardware

Renovation of an existing structure: No new land was purchased or cleared, and they reused and restored as many of the original features (beautiful hard wood floors, solid wood furniture, large windows for daylighting, etc.) as possible.

Light controls: Continuous dimming in rooms: banks of lights parallel to southern windows, with sensors. The sensors monitor outside light levels, and adjust the indoor light levels up or down to maintain a constant light level in the room.

Windows: R-9 value windows were installed.

HVAC: There is no in-house chiller unit, because the calculated demand (70 tons) matched the surplus in the nearby chemistry building. So they installed a ground loop linking the buildings. Heating: Barney gets its heat from two stand-alone natural gas boilers in the basement, running at 85-90% efficiency. One serves as the backup. This system avoids reliance on the central campus heating plant, which makes extensive use of coal and operates at greatly inferior efficiencies (about half). Aside from improving the overall efficiency, it avoids the air pollution contributions made by the central heating plant. The heating system is dual: forced air and radiant heat. Removing the old radiators by the windows gave more window access, which provides more options for flexibility in user space. There may be some tradeoffs in cost and efficiency. There is individual room monitoring and control.

b. Software

Waste Management: Demolition and construction waste from the renovation project have been recycled and reused as much as possible. Old radiators, windows, ceiling tiles, insulation, wallboard, and computers have been taken to recycling centers. The original wood floors, doors, cabinets, shelves, slate blackboards, and floor tiles have been restored to be used again in the new building.

Non-Toxic Policy: Special considerations were taken in choosing the carpeting, plywood, furniture, paints, finishes, and adhesives to eliminate the toxic off-gasses they bring into the building. It would be contradictory to take care in the selection of these materials only to allow for other toxic-containing products to enter the building in the future. Therefore, they have developed a policy that discourages the use of all cleaners, polishes and office products that contain toxic substances from being used in Barney-Davis Hall.

Recycled Content: Products containing some percentage of recycled content were specified for the project. Wallboard containing recycled and synthetic gypsum and paper have been used as well as carpets made from recycled plastic bottles. Ceiling and floor tiles, furniture, and insulation also contain recycled resources.

Furniture: Steel Case “green” furniture.

Office supplies: Unless specified as non-toxic, carbonless copy paper, carbon paper, white-out, permanent markers, and rubber cement will be avoided. Some office equipment, such as copiers and computers, which produce and use large amounts of toxic chemicals, will be placed in well-ventilated areas where exposure to them is limited.

Construction materials: Throughout the planning they took steps to reduce toxic chemicals in the building. They investigated products with the least amount of volatile organic compounds (VOCs), formaldehyde, ammonia, and other harmful substances. Barney's paints, finishes, carpets, furniture, particleboard, fiberboard, adhesives, insulation, sealants, and ceiling tiles will all have reduced or no toxic emissions. Denison asked their contractors not to use any cleaners, polishes, and other building materials until their Material Safety Data Sheets (MSDSs) had been examined and approved as non-toxic.

When choosing cleaning products to use in Barney, the following specifications should be followed:

- Health hazard ratings should be 0 or 1, and in no instances should products with ratings higher than 2 be used (Hazard ratings, generally included on MSDS after 1986, are classified as: 0-Insignificant; 1-Slight; 2-Moderate; 3-High; 4-Very High).
- No products containing chemicals listed as carcinogens.
- No products listed as hazardous waste or hazardous to aquatic life.
- Products that release toxic chemicals as byproducts or during decomposition should not be used.
- Aerosols should be avoided due to the harmful gases they give off (isobutane, propanol).
- Products should be biodegradable.
- No products containing any of the following toxic or hazardous chemicals: Ammonia, Benzene, Butane, 2-Butoxyethanol, Butylbenzyl phthalate, Butyl methacrylate, Chlorobenzene, Chloroform, Decane, 1, 4-Dichlorobenzene, Dioxins, Ethanol, Ethylbenzene, Ethylene glycol, Ethylphenol, Formaldehyde, Lye, Malathion, Methacrylic acid, Monoethanolamine, Naphthalene, Nitrobenzene, Ozone, Pentachlorophenol, Perchloroethylene, Petroleum distillates, Phenol, 4-phenylcyclohexane, Polyvinyl chloride (PCBs), Potassium cyanide, Styrene, Toluene, Trichloroethylene (TCE), Undecane, Urea-formaldehyde, Vinyl chloride, and Xylene.

Upgradability

Solar energy: Barney has been wired to house a 5-kilowatt photovoltaic solar panel system in the future. The photovoltaics will eventually help power Barney's lighting system with less reliance on fossil fuels. The photovoltaic system will be expanded in coming years so that it can eventually support the entire lighting system.

Natural gas: The stand-alone natural gas boilers can be swapped out easily when better heat source options become available (especially those based on renewable resources).

Temperature controls: Eventually they want to install a computer monitor in the lobby to display every room's energy use.

Tenants

Denison University's Environmental Studies and English departments.

Costs and Funding

The renovations cost $4.5 million ($16/ft^2). About $2 million came from two major donors, the rest from the university's capital fund.

Environmental benefits (Too early to determine)

Comments

How well is the newly renovated building working? It is uncertain, as they have not yet done a systematic assessment of the building. Environmental Studies Director Abram Kaplan plans to do a "lessons learned" exercise with a class next semester. He also plans to write a book about it.

HVAC: The system still has problems: (1) the ducts weren't lined (as Kaplan had urged), because lining was 30% more expensive. As a result, the system is very noisy. Now they are insulating parts of it (lined ducts would have been cheaper). (2) The ducts were poorly installed. No one on campus quite understands the system of getting the computers and boilers to work well together. Many vents are open when the computers say they are closed, and vice versa. Some ducts (and some wiring) were installed backwards. Now they are doing a careful commissioning of each room. The HVAC system probably expends as much or more energy now as before, because of operational problems.

The physical plant wanted the building linked to the main, coal-fired steam system, but Kaplan's view prevailed.

Temperature controls: Kaplan has had lots of problems with the Control Systems, Inc. (CSI) controls and the company. Denison staff doesn't yet know how to use it (the CSI technicians barely do).

Light controls: The continuous dimming system does not yet work properly.

Light shelves: Kaplan wishes they were movable up and down rather than fixed.

Windows: They are relatively inexpensive, very effective and have an 18-month payback.

Furniture: Kaplan is not happy with the quality of the Steel Case "green" furniture.

Fundraising: The timing could have been better, as the push for funding came after a major capital contribution drive.

Design

Student Involvement: Throughout the course of the project, more than 100 students have been and continue to be actively involved in virtually every aspect of the building design process, from analysis to presentations (even to the board of trustees). Students have done research on green building materials and have given recommendations to the architects and engineers (many of their recommendations have been incorporated into the final specifications). They have also developed a zero-toxics policy for the building, which states the desire to reduce the use of toxics (in cleaning products, wood finishes, adhesives, carpet off-gassing, etc.). Some students participated in the actual construction process, and others created the web page.

Denison used design charettes (SEAS, at $20K) for a three-day assessment with about 20 students, in April 1996. The process worked well. They evaluated each room's and space's potential use and design. (One result: the large conference room was left intact, and now has multiple uses. Students were educated to understand the tradeoffs.)

Website www.denison.edu/enviro/barney

References 45, 46

Contact Prof. Abram Kaplan, Anne Powell Riley Director of Environmental Studies, Denison University, Granville, OH 43023 614-587-6736 kaplan@cc.denison.edu

2. Conservation Consultants Inc. EcoCenter, Pittsburgh, PA

Green renovation of an 80-year-old firehouse.

Conservation Consultants, Inc., is a regional nonprofit organization specializing in energy efficiency, environmental education and sustainable urban redevelopment. Incorporated in 1979, CCI originally offered energy efficiency services to low income housing residents, and expanded their mission to broader issues of neighborhood sustainability. From 1989 to 1993 they inhabited a renovated "energy house" which served as their headquarters and also as an example of energy-efficient housing.

CCI expanded and outgrew its old renovated home, and in 1993 purchased an 80-year-old firehouse on Pittsburgh's Southside. From 1997 to 1998 the building underwent a green renovation. Now called the EcoCenter, it currently serves as headquarters to five environmental nonprofit organizations. The EcoCenter provides a library, exhibit area, and large meeting room.

CCI has initiated many projects, including The Green Neighborhood Initiative, an effort to transform a typical Pittsburgh neighborhood into a demonstration of energy and resource conservation. The High Performance Schools Initiative is a pilot project working in four Pittsburgh public schools to retrofit the energy, cleaning, waste disposal, landscape design, purchasing and curriculum to save energy, provide healthy study environments and a sense of place in the community and ecosystem, and to save money. They have also incubated projects

including the Construction Junction, a materials recycling facility, and wind energy research and demonstration sites.

Goals

To demonstrate the principles of adaptive reuse of an older building, and sustainable design methods and materials.

The EcoCenter was redesigned to provide a long-term shared office space for environmental nonprofit organizations, to foster working synergistically on solving environmental problems.

Size 12,000 ft^2

Features

a. Hardware

- High metal ceilings.
- Interior/exterior brick re-used in building interior, exterior and garden.
- Interior masonry chimneys converted to ventilation stack.
- Recycled steel studs.

Energy-efficient design

1. Insulation levels of R-19 in walls and R-72 in the attic (in excess of codes)
2. North stairwell configured and places as a wind break
3. Exposed interior brick walls and concrete floors provide thermal storage for heating and cooling
4. Photovoltaic (PV) array provides 2.5 kW of building's electric needs
5. Extensive daylighting coordinated with energy efficient fluorescent lighting. Task lighting and individual switches.
6. High performance operable R6 windows with gas-filled voids
7. Natural ventilation through operable windows, central atriums, and operable skylights and clerestories.
8. Gas-fired heating and air conditioning with single floor horizontal zoning.
9. Exposed duct work to eliminate heating and cooling losses.
10. Positive supply and return ducts servicing each space.
11. Floor distribution of heating and cooling with Kranz diffusers.
12. Single-zone radiant floor heating system in the ground floor conference room service by a Robur unit.
13. Programmable chronotherm space conditioning controls on each floor.
14. Surface-mounted wall Wiremond raceway minimizes penetrations.
15. Pennsylvania's first commercial use of Agriboard structural insulating panels.

b. Software
Environmentally sound building materials and techniques:

1. Non-toxic features, low-VOC paint and finishes, non-toxic insulation materials.
2. Forbo Marmoleum flooring (linseed oil, wood flour, pine rosin).

Water conservation plumbing:

1. Rainwater collection and irrigation system.
2. Low-flow toilets, faucets, and showerheads.
3. Hot water heater benefits from PV array.

Energy-efficient design:

1. Rooftop terrace shades second floor to reduce air conditioning load.
2. Operable interior blinds for daylight control.

Recycled building supplies were utilized to the extent possible to conserve embodied energy:

1. Recycled wood floors.
2. Rough lumber and shelving stock reused as framing material shelving and interior trim.
3. Recycled/refurbished kitchen on the first and second floors.
4. Reclamation of garden and outdoor space for public use.

Organization and tenants

The EcoCenter houses five environmental nonprofit organizations: Clearcorps, Pennsylvania Environmental Council, Green Building Alliance, Pennsylvania Resources Council, Inc., and Conservation Consultants Inc. CCI is the building manager and landlord.

The organizations pay market rate for their office space ($\$10/ft^2$), but no extra for maintenance, conference room, library, shared kitchen, terrace, garden space, and exhibit area in the front entrance room. The net result is a below-market-rate rent for the services and additional space provided.

Since the EcoCenter opened in October 1998 it has hosted many visitors. The building entrance features exhibits of the environmentally responsible materials, supplies, and architectural design used in the building. Tenants also display programmatic information. A green buildings library and resource center is also located on the first floor.

Tenants consider the building's best attribute to be the close proximity to one another, saving time and energy in searching out colleagues and advice. The building is comfortable, with good ventilation, high indoor air quality, lighting and shared spaces. The EcoCenter is accessible to the community, which often uses the large meeting space on the ground floor.

The EcoCenter is currently considering expanding the office space.

Costs and financing

The total costs of the capital campaign for renovation of the EcoCenter was $1.2 million. CCI received $100,000 in in-kind contributions. The architect donated 20% of his regular fee. Conservation Consultants purchased the buildings from the Pittsburgh Urban Redevelopment Authority at a 3% mortgage rate. With in-kind donations, the cost of the building was $70/ft^2.

The other nonprofit tenants have signed long-term leases for renting space in the building.

Environmental benefits

The EcoCenter opened in October 1998; environmental benefits, resources conserved and pollution prevention have not yet been calculated.

Design

Steve Lee, of the architectural firm of Tai Lee in Pittsburgh, was the primary designer. Robert Kobet, Director of Green Building Services for Conservation Consultants, Inc. worked closely with him. CCI staff was involved with design charettes and weekly design team charettes that included the electrician, HVAC engineers, and general contractor. Neighbors were encouraged to review plans prior to building permit acquisition.

Comments

CCI Executive Director Ann Jones Gerace stresses the need to get commitments from the tenants before undertaking a project of this scale. All of the current tenants seemed pleased with their office space. Some tenants have exceeded their growth trajectories and need more space.

Website www.envirolink.org/orgs/cci

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Contact Robert Kobet, AIA, Director, Green Building Services; or Mary Whitney, Eco Center Coordinator, Conservation Consultants, Inc., 64 S. 14th Street, Pittsburgh, PA 15203, 412.431.4449, Fax. 412.431.4558.

3. Dana Building, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI

A university building renovation and expansion, with some "greening"

This is a project in progress. Planning for a conventional building renovation and expansion began in early 1997. By the fall of 1998, the administration decided to include green attributes, now known as the "Greening-of-Dana" project.

The renovation consists of two distinct phases. Phase I is the construction of an infill in the inner courtyard, and of a new roof with a large skylight (May 1998-June 1999). Phase II (construction will start in May 2000), is the remodeling of the majority of spaces in the existing part of Dana.

Phase I completion is expected by July 1999. Phase II will involve major systems upgrades including new plumbing, heating, ventilation and hood exhaust systems, plus significant improvements to fire protection and handicapped accessibility systems. In addition, new program facilities will be created on the fourth floor, and spaces not renovated in Phase I or other recent projects will be completely renovated.

Size

Phase I involved the enclosure of the interior courtyard to create 11,000 ft^2 of program space, and modification of the existing roof and attic to provide 2,250 ft^2 of mechanical support space. About 39,000 net square feet of space is involved in Phase II.

Goals

- A building where environmental responsibility principles are not only taught, but upheld and demonstrated to the community.
- Promote sustainability, reduce negative health impacts, and serve as a laboratory and educational center for ecological themes.
- Simultaneously a comfortable place to learn and work, while demonstrating the state-of-the-art in environmentally conscious design.
- The building should teach environmental sensitivity, respect and consciousness through its design and resource management. It should demonstrate how effective these ideas can be, and how transferable they are to other building situations.
- Local resources and local labor should be used as much as possible in the renovation and construction. (An important part of sustainable design is that local economies and communities benefit.)

These goals were modeled on the Barney-Green Renovation project at Denison University (see above). Some means to achieve the goals:

- Energy conservation and efficiency
- Increased daylight use
- Use of renewable energies (photovoltaics, solar hot water)
- Inclusion of operation costs in selecting mechanical equipment
- Material efficiency, and increased recycled content/recycleability of building materials
- Life-cycle-based evaluation of environmental impacts
- Water conservation
- Use of rainwater for toilets
- Maximum reuse and recycling of components and materials from demolished building parts

- Everyday waste reduction programs
- Recycling as many inorganic and organic waste materials as possible.
- Improved indoor air quality
- Maximized educational impact through a multifaceted program

Features

a. Hardware

- Building-integrated photovoltaic (BIPV) elements have been specified (laminates on standing-seam metal roofing material, installed wattage: 8.2 kW, about 2,300 ft^2 on south-facing part of new roof).
- Demolition contractor will attempt to salvage as many as possible of the 90-year-old wood beams and rafters from the old roof for re-use; about 60% of the approx. 19,000 board feet are currently proposed for reuse in Dana (e.g., for some flooring, base material, hand rails); the remainder will become the demolisher's property, who is required to sell it for reuse or recycling (special dumpster for wood salvage set up).
- All concrete and metal scrap from the courtyard demolition has been sent to a recycler.
- About 5,100 paving bricks from the inner courtyard have been salvaged for reuse around the school (an effort of several students and two faculty members).
- A new skylight above each of the two stairwells for use of daylight, and a 4"/8"-gap between the stairwell walls and the stairs to allow for maximum light penetration into lower floors.
- New elevator will be traction-operated (i.e., with cables), rather than hydraulic (typically lowers electricity consumption by 30%).
- The majority of bricks from attic demolition have been reused for the new elevator-shaft, and other jobs on the new 4th floor.
- As opposed to the original plans, the crane for roof construction had been erected in the docking area, preventing the destruction of several trees and shrubs; in addition, construction companies will not use SNRE's native garden.
- All new wood is required to come from wood suppliers from a list of certified chain-of-custody companies (by Scientific Certification Systems, Inc., accredited by the Forest Stewardship Council), and the Good Wood Directory (by the Good Wood Alliance).

b. Software

- Ceiling tiles for the infill-space rooms are specified with a 69% recycled content (while this is slightly lower than other products, these tiles are fully recyclable).
- Occupancy sensors for lighting control on three infill-space floors specified.
- Metal-halide bulbs specified (as opposed to mercury-vapor) for all seven lamp fixtures for light-well illumination (combination of a 250 and a 100 Watt bulb).
- Daylight-level sensors specified for the seven 250/100 Watt lamps in the infill (total of 2,450 Watts).
- A water-based paint stripper for the lead-based paint of the courtyard walls (50% lead!) has been specified, which binds the particles, and is listed as one of the less harmful peel-

away strippers in "Buy Smart-Buy Safe, A Consumer Guide to Less-Toxic Products" by the Washington Toxics Coalition.

- General contractor for the construction of the new roof, and the fit-out of the new infill spaces will be responsible for its own electricity consumption—a disincentive to waste energy.
- Vermiculture program expanded by placing more collection bins for organic waste throughout the building.

Costs and funding

The Phase II renovation is estimated to cost $15 million. It is part of the FY2000 Capital Outlay Request submitted to the State of Michigan. The State has authorized proceeding with planning for the project. The State Building Authority will fund 75% of the cost of the project that will be determined by the architect/engineer program analysis, planning documents, and bids. The University will fund the remaining 25%.

Design

The firm of Quinn Evans/Architects of Ann Arbor, working in association with the firm of William McDonough + Partners, Architects and Planners of Charlottesville, VA, will provide green design work for the project. Ove Arup & Partners are the engineers.

School-wide design work groups have been established to work with the design firms on the following issues: classrooms, research and student research space, public space, offices, energy and green issues) technology, and administrative services and support. Design charrettes were held with the architecture and engineering firms on April 14 and 15th, on April 28 and 29th, and on May 12 and 13th (coupled with design work group meetings in between).

Comments

By fall, 1998, about a year-and-a-half after the renovation planning began, the SNRE dean approached Peter Reppe to develop green objectives. Given the timing, the extent of green innovation is limited. But he's made good inroads, and the architect has been flexible. Ideally, in order to maximize a building's green potential, the idea—how green should the project be?--should be determined one year before the planning begins.

Peter Reppe found that a systems approach was needed, with all actors and planners together, especially with someone like Oberlin professor David Orr overseeing the project.

The SNRE dean wants to document the design and planning to use elsewhere in the university.

University architects and builders have to use equipment, supplies and materials approved by the university. This process slows down and limits what can be used. (Reppe's efforts may benefit the entire university in the long run, however.)

School of Natural Resources and Environment alumni, including the two authors of this compendium, have been approached for contributions.

Peter Reppe's 1/27/99 update: "We've learned a lot from Phase I (courtyard infill), especially in terms of organizational issues of a project that wants to be 'green.' Right now I'm in the middle of preparing a "new start" for Phase II (complete renovation of the old part of Dana). This time we'll have a charrette with 'all' the relevant participants of the process before the project design starts. [I] Hope this will enable us to turn all our aspirations about a 'green design/demolition/construction/operation" into practice.'"

Web site www.snre.umich.edu/greendana/

References 7, 32, 50

Contact Peter Reppe, Research Assistant, National Pollution Prevention Center, University of Michigan, 430 E. University, Ann Arbor, MI 48109-1115; 734-936-2542; 734-647-5841 (fax); greendana@umich.edu

4. Environmental Center of the Rockies, Boulder, CO

A redesigned, retrofitted office building that serves multiple nonprofit organizations

The Environmental Center of the Rockies (ECR) is owned and operated by the Land and Water Fund of the Rockies (LAW). The LAW was initiated in 1990 to provide free legal services (counseling, assistance in dealing with governmental agencies, and litigation) to grassroots environmental and community-based organizations in the Rocky Mountain West. The Fund's goal is to increase the effectiveness of these groups in their efforts to protect the health and environment of the region by ensuring that they have access to good legal advise and litigation assistance. The original three core programs were Public Lands, Water and Toxics, and Pro Bono.

In January 1991, the LAW Fund added an Energy Project that promotes energy efficiency and renewable resources for the electric utilities in a six-state region including Colorado, Utah, Arizona, New Mexico, Nevada and Wyoming. A number of serious environmental problems result directly form electricity production that occurs in the Rocky Mountains. These include acid deposition, radioactive waste, reduced visibility, damming of rivers, global warming, human health impacts, strip mining, and urban pollution. In addition to preventing these problems LAW has been active in developing the renewable energy industry, as an environmental and economic option in electrical generation.

In late 1990, LAW conceived of an idea for leveraging scarce resources available to environmental groups, and demonstrating smart use of resources. The vision that became the Environmental Center of the Rockies is one in which several groups could live together under one roof, sharing space, capital equipment, and intellectual resources, thus producing economies of scale, as well as creating an environmental protection center.

In the spring of 1992 LAW purchased a building that, in December 1992, opened as the Environmental Center of the Rockies. The building has shared conference rooms, library and photocopiers. A common display area is open to the public. Public programs are also offered on site.

Goals

The goals of the retrofit was to provide for enhanced energy efficiency in the building envelope (walls, windows), and lighting and mechanical systems, and to:

- Provide a space in which several environmental groups can share capital equipment, intellectual resources and ideas.
- Provide significant dollar savings to nonprofit tenants.
- Demonstrate "smart" use of resources in:
    a. Energy efficiency
    b. Water conservation
    c. Sustainable landscape
    d. Building materials
    e. Alternative transportation modes
    f. Sharing of resources
- Demonstrate an environmentally sensitive commercial building.
- Provide a community resource, with educational displays and a lecture series, and a meeting place.

Additionally, the Land and Water Fund consider the Environmental Center of the Rockies an opportunity to provide a long-term investment to their financial security, by investing in the building and rental opportunities.

Size 10,000 ft^2. A half-acre garden xeriscaped for dry land surrounds the building.

Features
A. Hardware

- Interior arcade enclosed to form an airlock to prevent heat loss.
- Walls insulated to R-23.
- Attic insulated to R-38.
- High performance glazed and reflective windows.
- Ventilation system converted to a variable air volume system, so that air is not unnecessarily collected and then reheated.
- More temperature control zones.
- A direct evaporative cooling assembly added to the air supply.
- New roof made from recycled materials, including shingles made from ground-up garden hoses, was installed in 1998.
- Photovoltaic panels on roof.
- Innovative landscape design will produce a workplace habitat that will use natural landscaping (use of xeric or drought-tolerant plants) to improve water quality. It is a

demonstration project that will show how a conventional business or residential landscape can be improved to cleanse pollutants retained in stormwater runoff. Water collection at a high point in the site's northwest corner will course down an eight-foot swale. One course will lead to water the new trees in the smaller parking lot. The water will be held longer on-site before entering Skunk Creek.

B. Software

- Indirect lighting, and compact fluorescent lamps connected to daylight motion sensors.
- Ambient lighting levels decreased to 30 lumens, with indirect luminaries.
- Parking spaces reduced from 35 to 27 by providing bike lockers and bus passes for all employees (this will also improve water quality, by reducing impermeable surfaces).
- Glass, paper and metal recycling.
- Non-polluting maintenance supplies and procedures.

Environmental benefits

Energy use is reduced by 85% compared to a building of similar size and use.

Water quality benefits of xeriscape landscaping will be monitored.

Comments

The Environmental Center of the Rockies is continuing to demonstrate ecological design in an urban area. They are constantly upgrading their physical facility and adding projects, such as the xeriscape garden. The National Wildlife Federation is seeking to adapt this "workplace habitat" model for its headquarters.

Tenants

Land and Water Fund of the Rockies, National Wildlife Federation (regional headquarters), Sierra Club Southwest Office, Sinapu, Earth Island Institute.

Cost and financing

The purchase price of the building was $500,000, and building improvements cost an additional $375,000 (approximately $87/ft^2 for the building and improvements).

The Colorado Office of Energy Conservation provided a low interest loan for energy efficiency improvements. A capital campaign raised $800,000 from foundations and individuals. Photovoltaic panels were donated by a local source. The landscape project is funded jointly by the National Geographic Society and Conservation Foundation as part of 25 pilot programs on non-point source reduction. The City of Boulder provided $50,000 worth of water quality monitoring equipment.

Payback for lighting strategies is two to three years, for HVAC systems within 10 years.

Design

ENSAR Group of Boulder, CO
Denver Construction Services, Inc.
Masterplan Designs, Inc.
Clanton Engineering, Inc.
Engineering Economics, Inc.
Landscape Architects: Wenk Associates, Denver, CO; Joan Woodward, ASLA, Pomona, CA.
Landscape contractor: Jim Pokorny, ASLA, Goodland Construction, Denver, CO; Engineers: Wright Water Engineers, Denver, CO.

References 3, 46

Website www.lawfund.org

Contacts Wanda Gray, Communications, Director, Land and Water Fund of the Rockies, 2260 Baseline Road, Boulder, CO 80302; 303-444-1188, Fax 303-786-8045.

5. Environmental Technology Center, Sonoma State University, Rohnert Park, CA

A new, ecologically designed university building

The Environmental Technology Center (ETC), scheduled to open in fall 1999, is part of a growing "pedagogy of place" theme in higher education. It is designed to be a building that teaches, and has given administrators, faculty and students an opportunity to be part of the planning process. The process has engaged local architects, engineers, consultants and manufacturers.

ETC is the second phase of the EarthLab Project. The completed first phase features growing beds for sustainable food and flower production, a culinary herb garden, raised planter boxes for children and physically challenged individuals, and a passive solar greenhouse for seedling production. An urban composting demonstration site is being developed.

The ETC will be a energy-efficient building, with water-efficient landscaping, smart building controls, environmentally sensitive building materials, passive solar heating and cooling, advanced window systems and daylighting, solar electric technology, and digital communication systems.

Goals

- Provide a dynamic, interactive and integrative facility where students and community members from many disciplines can work together in applied research training, academic study and collaborative environmental projects.
- Model sustainable building techniques and technologies focusing on fundamental human needs of energy and food production.

- Produce unbiased technical information and a place for a unique applied educational experience.
- Serve as a model of public sector environmental responsibility to the entire California State university system, and for teacher training on science, technology and society.
- Provide in-house consulting services.
- Serve as a field-based education and research site for local schools, connecting pre-service teachers with in-service teachers and K-12 students.
- Serve as a classroom and mini-conference facility.
- Serve the surrounding community through demonstration, education, and consultation.

Size 2,300 ft^2.

Features

The building is designed for operational and technological flexibility, employing state-of-the-shelf technology and state-of-the-art design. The process has involved extensive front-end planning.

The structure is being designed to be flexible and easily modified in the future to provide a longer useful life. Post and beam construction to allow exterior walls to be changed in the future. The display area will have a ceiling grid to accommodate moveable partitions for display flexibility.

a. Hardware

HVAC. The primary space conditioning systems are passive solar heating and cooling. Backup heating comes from radiant active solar and a natural gas boiler. Backup cooling for the low occupancy (office) areas comes from radiant cooling with night cooling, and direct/indirect evaporative cooling for the high occupancy areas. This system avoids ozone-depleting CFCs and compression cooling. A carbon dioxide sensor will control ventilation. Occupancy and humidity sensors will control restroom area ventilation. Equipment size reduction was made possible by deciding not to schedule high occupancy events for hot season afternoons.

Passive solar

- Direct gain through windows and clerestory.
- Isolated gain through sun space.

Passive cooling

- High clerestory and other motorized openings for natural ventilation
- Nighttime precooling controlled by HVAC.
- Exterior waterfall at entry.

Thermal mass

- 4-inch concrete slab on insulated floor panels.
- 8-inch concrete masonry unit partition (all interior).
- 2-1/2 inch concrete masonry unit veneer.
- Rammed earth interior partitions.

Active solar. Provides domestic hot water for showers, and preheat for radiant heating.

Controls/monitor

- State-of-the-art HVAC controls.
- Occupancy sensors for lighting, ventilation, and back up heating and cooling.
- Dimming controls and occupancy sensors for high-efficiency electric lighting.
- All energy systems and features monitored.

Daylighting. There are south windows, skylights and a clerestory. Sunlight is reflected and diffused by light shelves, fabric banners and light tubes. The clerestory and skylights are made more efficient with fresnel lens, and prismatic glazing. Operable sun shades/screens reduce glare and control solar gain during warm weather.

Photovoltaic. The building will have some PV power (to the extent fundraising will allow). It will operate ceiling fans to lower peak demand. The ultimate goal is a 4,000-watt PV system that can power the entire building, including evaporative cooling during summer peak load. The system will be tied directly to the electric power grid to avoid batteries.

Windows

- Typical south-facing windows, pultruded fiberglass, with argon-filled, double-glazed, double low-e (solar admitting type when south facing) panes at clerestories.
- Heat mirror with insulated frames.
- Exterior operable venetian blinds.
- East windows summer-shaded by deciduous vines.
- South windows by operable sun shades; no west windows.
- Insulated obscure glass at restroom wing south room.
- Intelligent glazing that changes shading coefficient in response to temperature change, light levels or electrical stimulus.

Structure. Wood post, beam and trusses of reused lumber or locally salvaged logs or sustainable harvested trees, or at least resource efficient engineered wood products. Shear wails of OSB or agricultural waste cellulose.

Foundation. The expansive soils of this area require special engineering. Typically the foundation is 6’ to 9’-deep concrete piers with concrete grade beams. A more ecologically sound method is to remove two feet of the expansive soil compact sub base and import (from within a few miles) non-expansive soil and compact it carefully. Footings and slab on grade will use

concrete made with partial cement substitute made of rice hull ash. Slab on grade construction is susceptible to termites so instead of ground-poisoning a termite barrier of 4" of graded sand will be placed under the slab. Pier and grade beam foundations with wood framed floor with concrete fill will be evaluated as an alternative for cost, better access for future wiring changes, and sustainability.

Water. Harvest roof rain water, efficient plumbing fixtures, high-pressure showers, and waterless urinals.

Landscaping

- Drought-resistant, native, edible, medicinal, multi-use, organically grown plants.
- A wider area (than the EarthLab site) will undergo ecological remediation and microclimate improvement.
- Parking lot run off will flow through filtering swales before entering creek.
- Parking lot trees will be planted, with remediation of and native planting along the adjacent creek.

Recycled content: Insulation, rice hull ash and flyash in concrete.

Siding/exterior trim options:

- Integral colored cement with recycled wood fiber shingles/boards.
- Integral color stucco with zinc alloy expansion joints and trim.
- Exterior trim: Recycled plastic lumber.

Roofing options:

- Standing seam painted and galvanized recycled steel with integral PV panels.
- Cement fiber shingles.
- Recycled copper on clerestory roof.

Exterior wall options:

- Agriboard panels of OSB skins and straw cores.
- Composite panels of OSB skins & expanded polystyrene (EPS) cores.
- Faswall concrete masonry units (with recycled wood aggregate).
- Conventional 2 x 6 studs at 24" on center with cellulose insulation; roof purlins 2 x 10 at 24" on center with 8" recycled fabric fiber batt insulation.

Interior partition options:

- Interior partitions straw core panels with paper faces that are taped and finished in the same way as gypsum board.
- Gypsum wallboard

Other features

- Air lock entry, air infiltration sealing, blower door pressure test to assure 0.5 air changes per hour maximum.
- Glass ports to show equipment and system details.
- Operable awing with seasonal controls.
- Radiant slab cooling.
- User-friendly building monitor so students and visitors may view current, past and predicted performance under various weather and occupancy conditions.
- Reflecting pond to increase winter gain but covered with plants in summer.

b. Software

ETC used socially responsible criteria in selection of designers, suppliers and contractors.

Material selection is based on the following considerations:

- Avoid biodiversity loss, habitat alteration, stratospheric ozone depletion, and greenhouse gas generation.
- Products made from or packaged with sustainably produced renewable resources.
- Products that conserve resources, that are reused, recycled, use byproducts.
- Less toxic products (less toxic mining, manufacturing, installation, use and maintenance).
- Durable, low maintenance products that do not need painting or coatings. Consider life cycle cost and longevity, and exceed code for resistance to weather, fire, vermin, seismic activity and wind resistance
- Products that are very efficient in use of electricity, petroleum, water, etc. Low embodied energy overall; consider transportation.
- Reusable, recyclable or at least biodegradable components. Consider deconstruction.

Finishes: Durable, low maintenance.

Interior finishes: Wall and ceiling paints will be non-VOC enamels. Pastel colors will be coordinated with daylighting requirements.

Toilet wing partitions at plumbing fixtures to have lower 4' high wainscot of tile of recycled glass; fall height at shower.

Floor finish options:

- Mineral-stained, steel-trowelled rice hull concrete slab.
- Linoleum at wet lab.
- Toilet wing floor and shower tile of recycled glass.

Cost and financing

Construction is estimated to cost about $ 250/ft^2

Funders included the National Science Foundation, California Energy Commission, Sonoma State University, and numerous other local and regional entities.

Environmental benefits

Both DOE II and Energy 10 computer models calculate an 80% reduction in energy and water use below California Tile 24 Energy Codes. Thermal mass and night air cooling should provide further energy use reductions.

This is a teaching building, which will be monitored for performance in energy efficiency and pollution prevention.

Comments

Although the climate in Rohnert Park, CA is different from the Midwest, the approach and ideas behind this learning center are relevant to Cleveland.

The program endeavors to use local and bioregional architects, engineers, consultants, manufacturers and materials.

Rocky Rohwedder, Professor of Environmental Studies and Planning at Sonoma State University, commenting on the building's education potential, asks rhetorically, "if a picture is worth a thousand words, how much is a place worth?"

The owner, designer, and construction team agree that this project, in its goal to be state-of-the-art, requires extra effort and entails some extra risk at every step of the process of design, construction, occupancy and maintenance.

Design

Sonoma State University- Steering Committee Environmental Studies and Planning
Architect- AIM Associates
Peer Review - J. Doug Balcomb, National Renewable Energy Laboratory
Structural engineer - Degenkolb Engineers
Bruce King - Schematic Design Phase
Mechanical engineer - Davis Energy Group, Inc.
Electrical engineer - Interface • Norberg Engineering, Inc.
Daylighting - Loisos/Dubinier
Landscape architect - Permaculture Institute of Northern California
Civil engineer - Csw Stuber Stroeh
Material selection- E Build
Cost estimating - P H Waszink Construction Consulting
Acoustical - Sound Solutions

Website www.sonoma.edu\ensp\etc

References 8, 51

Contact Professor Rocky Rohwedder, Environmental Technology Center, Sonoma State University, 1801 E. Cotati Avenue, Rohnert Park, CA 94928, 707-664-2249

6. The International Institute for Energy Conservation, Washington, DC

A new office within an existing conventional commercial building.

Introduction

IIEC promotes sustainable energy solutions to developing countries and economies in transition, focusing on energy efficiency, renewable energy, and integrated transport planning.

The IIEC space is unique in the otherwise conventional building owned by the American Psychological Association. The space was designed to be an energy efficient showplace, egalitarian and open for staff. The openness takes advantage of natural daylighting. Renovation was completed in January 1991, and IIEC moved in July 1992.

Size The office space is 6,700 ft^2, within a conventional 380,000 ft^2 building.

Goals

As an organization that promotes the economic and environmental benefits of energy efficiency, they decided to make their office as energy-efficient as possible. Staff helped to design the space and worked with manufacturers to employ a broad range of energy-efficient technologies.

Features
a. Hardware

To minimize automobile commuting, they located next to Union Station (a train and subway station), and they have a shower for bicycle riders.

Windows: The building windows are standard double-glazed. The office interior (not part of the building envelope) has three demonstration windows, standard double-glazed to argon-filled triple glazed, with R2 to R4.5 values.

HVAC: There was not much IIEC could alter, as there is one chiller and one thermostat for the entire building. The building owners received a rebate from the utility (PEPCO) for energy-efficient fixtures. The high-efficiency chiller uses an Andover Controls energy management system.

Interior walls: Half-walls divide most offices—most are shoulder height, some are waist height—to increase natural lighting to the interior. Everyone receives some natural light.

b. Software

Lighting. Every office receives some natural lighting. The office's south side and conference room take advantage of daylighting through photo sensors coupled with dimmable ballast fluorescents (Advance Mark VII), which adjust for a constant light level based on available daylight.

All lights are fluorescent, with electronic ballasts. There is no flicker or humming because electronic ballasts run at 50,000 cycles/second. Direct/indirect luminaries, used throughout the space, provide uplighting, which gives indirect light, as well as downlighting (like conventional fluorescents). A small conference room has a 7-watt compact fluorescent in the hanging fixture; and 13-watt compacts in recessed canisters.

Lighting in individual office spaces is three lamps and two ballasts, so the fixture can have one lamp, two lamps or three lamps lit. Rooms with lots of in and out traffic (e.g., photocopying room) have motion detectors.

The storage/mail room has a demonstration comparison of standard and high efficiency fluorescent office light fixtures. The standard fixture, with four T-12 lamps and magnetic ballasts, consumes l86 watts. The high efficiency fixture, with two T-8 lamps, electronic ballast and parabolic reflectors, consumes 62 watts.

Indirect wall sconces light IlEC's hallways.

Recycling: IIEC recycles paper, cans and bottles.

Appliances: IIEC's kitchen has what were, in 1991, the most energy-efficient, widely available appliances. They have on display a 4-cubic foot Sun Frost R-4 refrigerator, currently world's most efficient unit. These super-efficient refrigerators are often used in applications outside the utility grid, and can run on solar power through a photovoltaic panel and battery configuration.

Tenants

The office has about 15 employees, and there are about 30 people in the office, including subtenants. Trammel Crow manages the APA building.

Funding

IIEC obtained most of these technologies through in-kind donations or reduced prices from US manufacturers, for demonstration purposes. Many of the companies were already IIEC sponsors.

Costs

(Unavailable to date)

Environmental benefits

The building as a whole uses 1.7 watts/ft^2. The IIEC office, when fully lit, uses only 0.85 watts/ft^2. However, with individual controls at every workstation, they use far less (about .25 watts/ft^2) in practice.

The Sun Frost R-4 refrigerator, with 4-cubic foot volume, consumes less than 60 kilowatt-hours of electricity a year--50-70% less energy than even very efficient conventional refrigerators. It can run on solar power through a photovoltaic panel and battery configuration.

Comments

Office space: Not everyone's happy about the noise level, which increased when they moved from an office with closed offices to half-walls however. But it works for this office, as it fosters teamwork.

Carpeting: The recycled carpeting generated considerable static electricity, and wore down faster. About half has been replaced by conventional.

Lighting: Task lighting is so efficient that many of the staff don't bother with overhead lighting. Ballast flickering, which occurs when lights are beginning to go, drives everyone crazy. Lighting controls: if one is sitting still in a room with motion detectors, the lights go off.

Exhibit posters on lighting and many other energy-efficient technologies were no longer displayed (exceptions: the efficient windows and refrigerator). Nor was there any mention of their green office design on their web site.

Design Burt Hill Kosar Rittleman Associates, Washington, DC

Website www.iiec.org

References 12, 37, 42

Contact Kelly Gordon, Director of Programs, The International Institute for Energy Conservation, 750 First St., NE, Suite 940, Washington, D.C. 20002, 202-842-3388, Fax: 202-842-1565, e-mail: kgordon@iiec.org

7. Adam Joseph Lewis Center for Environmental Studies Center, Oberlin College, Oberlin, OH

A new, ecologically designed university building

The new Adam Joseph Lewis Center for Environmental Studies started as a subject of a Saturday morning Environmental Studies class taught by Professor David Orr. Dr. Orr, a renowned

leader in environmental education and head of Oberlin's Environmental Studies Department, noted that "The design of buildings and landscape is thought to have little or nothing to do with the process of learning or the quality of scholarship that occurs in a particular place. In fact, buildings and landscape reflect a hidden curriculum that powerfully influences the learning process."

The Center, which will open in Fall 1999, will be a working laboratory for environmental education and one of the most advanced examples of ecological architecture in America. There is a Resource Center, an auditorium, and a two-story atrium to provide formal and informal meeting space.

Goals

The building will be a place that teaches. Its design concept will help students learn ecological competence and mindfulness of place, environmental technologies, analytical skills in assessing full costs over the building's lifetime, and how nature's principle that "waste equals food" can be adapted for manufacturing processes and building materials. Building criteria were developed in a series of 13 public charettes that included some 250 participants, including students, university personnel, community members, and design team members. The initial criteria called for a building that:

- Discharged no wastewater
- Generated more electricity that it used
- Used no materials known to be carcinogenic or mutagenic, or were endocrine disrupters
- Used energy and materials with great efficiency
- Promoted competence with environmental technologies
- Used products and materials grown or manufactured sustainably
- Was landscaped to promote biological diversity
- Met rigorous requirements of full-cost accounting, and promoted analytical skill in assessing full costs over the building's lifetime
- Promoted ecological competencies and mindfulness of place
- Was pedagogical in design and operations

Size 13,600 ft^2.

Features
a. Hardware

- Geothermal wells: Heating and cooling is derived form closed-loop geothermal wells. Water circulates through closed-loop pipes to heat pumps located throughout the building. In addition, two larger heat pumps ventilate the main building and the auditorium. Each heat pump is controlled individually, allowing the unit to reject or extract heat from the circulating water as needed. This reduces the energy use by enabling simultaneous heating and cooling within the building. Atrium heating is provided through radiant coils under the concrete slab.

- Fresh air: 100% fresh air for ventilation is provided in all occupied spaces. Return air is passed through a heat recovery unit before it is exhausted.
- Raised floor: A raised floor is employed at the first floor workspaces and on the entire second floor, providing plenum space for ducted ventilation air delivery and return, and electrical, data, and communication wiring.
- Photovoltaic panels: 3,700 ft^2 of photovoltaic (PV) array on the main south-facing curved roof will provide electrical energy for the building. Anticipated advancements in PV efficiencies should meet or exceed the building energy demand (64,000 kWh) within five years. Roof attachment detail allows for upgrades as advancements are made in PV technology.
- Sun Plaza: the Sun Plaza maps the solar year. Shadows cast by a gnomon are marked in the sun Plaza form.
- Building orientation: An elongated east-west axis optimizes passive solar performance. A vine-covered trellis provides shading on the south elevation.
- Daylighting: Daylighting is provided for all interior spaces, reducing electrical lighting needs. Direct solar gain is collected through south-facing glass in the atrium and work spaces.
- Thermal mass: Thermal mass in concrete floors and exposed interior masonry walls retains and re-radiates heat.
- Natural ventilation: Building orientation takes advantage of prevailing breezes. Operable windows in all occupied spaces allows for natural ventilation. Atrium ventilation introduces air at low levels and exhausts air at clerestory, using natural convective air flows.
- Roof insulation. R-30 and R-40 roof assemblies.
- Energy-efficient wall design: R-21 masonry cavity walls, featuring pressure-equalized rain-screen assemblies, with air barrier construction.
- Integrated building controls: Advanced, central building controls for mechanical, security, fire and Living Machine (defined below) systems.
- Energy-efficient lighting design: 0.9 watts/ft^2 connected lighting load.
- Windows: Glazing to represent the most advanced thermal insulation and shading.

b. Software

<u>Indoor air quality</u> will be maintained through:

- Low volatile organic compounds materials, paints, and adhesives used throughout the building.
- Exposed ceiling structure eliminates inaccessible ceiling plenums.
- Construction procedures that include careful review of products submittals, proper ventilation during construction, construction sequencing to limit exposure of materials to toxic compounds.
- Complete HVAC testing , balancing and commissioning before occupancy.
- Maintenance protocol to establish cleaning products and practices after building occupancy.

Material selection included:

a. Durable, low-maintenance materials are used throughout, including exterior walls (brick), interior walls (unpainted concrete masonry units) and steel structure.
b. Recycled content: Steel framing, aluminum roof windows, and curtainwall frames, ceramic tiles (restrooms), toilet partitions.
c. Certified forest products. All wood is supplied from certified sustainably managed forests, as determined from the Forest Stewardship Council. This includes the roof decking structure, glued-laminated beams, plywood and wood framing members, and veneered wood panels.
d. Products of service: The raised floor and carpeting are leased to the college by Interface (the manufacturer). The College gains the service of the floor and carpets, without the liabilities of ownership. Interface owns of the flooring, and can re-use or recycle the components when their service life is complete.

Landscape

- Indigenous landscape: A microcosm of the hardwood forests common to Northern Ohio.
- Aquatic landscape: A pond and wetland retains, processes and cleanses storm water and run-off from adjacent areas.
- Social landscape: The Sun Plaza, North Plaza, paths, and walks provide places for gathering, pedestrian circulation, learning, and leisure.
- Food-growing landscape: Orchards and gardens provide a working landscape where students can learn about growing food and fundamental ecological processes.

Plumbing: The Living Machine, a natural, solar-powered wastewater treatment system, serves as a research and teaching tool. Designed to handle 2,000 gallons per day, the Living Machine is a resilient system due to its mechanical simplicity and biological complexity. It replicates and accelerates purification processes of ponds and marshes. Diverse communities of bacteria, algae, microorganisms, plants, trees, snails, and fish interact as whole ecologies in tanks and living bio-filters. The unit recycles water for non-potable "graywater" use throughout the building.

Cost and financing

All funds were donated to Oberlin College, in a special campaign for the Environmental Studies building. They received some in-kind design, hardware and engineering donations.

The cost per square foot is approximately $290, however it includes a lot of front-loading for design and products with a short payback period.

Environmental benefits

Energy use is 21% of the average for new construction, based on Steve Winter Associates' DOE-2 Energy Models. DOE-2 predicts a typical building of this size and function to use 75,000

Btu/year. Imported energy use (from the electrical power grid) may approach zero as photovoltaic cells increase in their efficiency over a five-year period.

Wastewater production and recycling should eliminate the demand for local sewer hook-ups.

The environmental benefits, net energy use, and net waste production will be studied as part of the Oberlin Environmental Studies curriculum.

Comments

The Environmental Studies Center's performance will be studied intensively. Indoor air quality will be studied as a part of as National Institute of Science and Technology grant. The energy efficiency will be monitored in a cost analysis, and for comfort. As technologies in photovoltaic and hydrogen fuel cells change, the systems will be upgraded.

A new faculty member, with expertise in aquatic ecosystems, will be responsible for the Living Machine's maintenance and performance.

Some of the biological systems used for shading, landscaping and agriculture will take time to grow and monitor.

Oberlin College is working at exporting useful technologies and methodologies to the community beyond the college and university students.

Design

The design process was heavily front-loaded to maximize teachable moments. There were 13 public charettes including students, faculty, university administration, and members of the Oberlin community.

William McDonough, AIA, William McDonough and Partners, was the principal architect.

Amory Lovins, Bill Browing, Rocky Mountain Institute, and NASA Lewis (Cleveland, OH) advised on energy systems.

John Todd and Michael Shaw, of Living Systems, Inc., designed the wastewater system.

Professor David Orr, Oberlin College, orchestrated the entire process.

References 7, 54, 55

Website www.oberlin.edu/newserv/esc/Default.html

Contact Professor David Orr; Department of Environmental Studies, Oberlin College, Oberlin, OH 44074-1095; 440-775-8747, Fax: 440-775-8124

8. National Audubon Society, New York, NY

A mixed-use renovation of an historical building

The National Audubon Society renovated a 100,000 square foot, 100-year-old building for its national headquarters in 1992. At the time, Audubon made the organizational decision to own a building and have an office space that reflected its commitment to conservation through the structure, energy and resource use, and materials used for interior design.

Audubon wanted to reduce cost in owning the building and in construction. They chose an old building to renovate, a decision part financial and part environmental. The decision to use green products was tempered with decisions to stay on target financially. They were able to capitalize on a rebate program from a local utility, in order to purchase more energy-efficient equipment, at a lower initial investment.

Audubon used a team approach, front-loading design specifications and including contractors in decisions. Instead of each building professional working on its own, Audubon used an integrated team and synergies to find the best lighting, interior design, energy and air quality solutions to the building that could conform to financial specifications.

Audubon occupies the top five of eight floors of the building. The ground floor is retail, and the second and third floors are rented to nonprofit organizations.

Their neighborhood in New York City has become a fast growing section of the city, where many structures have been subsequently rehabilitated. Property values are rising quickly.

Size 100,000 ft^2, eight stories.

Features
a. Hardware

- Natural gas as both heating and cooling source with a high-efficiency gas heater/chiller.
- Heater/chiller located on roof of building.
- High value insulation in walls and roof.
- Recycling chutes were installed for source separation of recyclables.
- High level of fresh air ventilation, with air filters and intake away from pollution sources.

b. Software

- Heat mirror windows efficient use of outside light.
- Task lighting with high-efficiency fixtures.
- Motion sensors to control lights.

- Examination of lifecycle cost of materials during manufacture and disposal.
- Use of natural materials for rugs, carpets and padding.
- Domestic hardwoods and rainforest woods with approval by the Rain Forest Alliance (certified wood).
- Use of low toxic and low volatile organic compound paints and adhesives.
- Minimization of formaldehyde (an indicator compound) in building materials.
- Water saving plumbing devices.
- Energy-efficient office equipment.

Organization and tenants

NAS is the landlord, and occupies the top five floors. Tenants on the second through fourth floors are nonprofit organizations and pay market rate for their space. There is no exhibit space, shared conference rooms, or library space. The ground floor is retail space.

Costs and financing

The building acquisition cost $10 million (1989), and renovation $14 million, for a total cost of $24 million ($122/ft^2). Audubon strengthened the street in front of the building, which raised the total building costs to $140/ft^2.

Financing was through industrial and revenue bonds. Audubon received several rebates from Con Edison: $72,000 for air conditioning; $7,280 for high-efficiency motors; and $30,895 for high-performance lighting. The payback period was three years.

NAS estimated that a new building would have cost $33 million; they saved 27% on the building structure itself, in addition to the embodied energy in the old structure.

Environmental benefits

Overall energy consumption is 62% less than in a comparably sized conventional building.

Seventy percent of office waste is sorted and recycled.

Comments

The NAS building is well designed and comfortable, seven years after opening. Although NAS no longer considers green building a priority, and is not currently monitoring the building for environmental benefits, they have saved much money in utility bills.

Kenneth Hamilton, Director of Facilities and Services for the National Audubon Society, maintains the building, and keeps the systems operable. The only problem he has encountered is moths in the natural wool carpeting. He notes that it would be good to have discussions on green buildings management among building managers to increase information-sharing among professionals and to broaden the audience.

NAS has documented their green building design process in order to assist other organizations in green design.

Design

The Croxton Collaborative, Architects, New York City

Flack and Kurtz Engineers

References 56, 57, 58, 59

Contacts Kenneth Hamilton, Director Facilities and Services, National Audubon Society, 700 Broadway, New York, NY 10003-9562, 212.979.3179, Fax. 212.353.0347.

9. National Public Radio, Washington, DC

A building renovation

This is National Public Radio's broadcast production facilities and corporate headquarters. When the opportunity to purchase and renovate an existing building was presented, the architects, Burt Hill, completed survey and feasibility studies that assessed the relative costs of renovating an existing building to house NPR's facilities. NPR determined that the renovation of an existing building was the most attractive option. Their decision was based on several key factors: minimal disruption to their broadcast operations during construction, increase in program square footage, construction costs, time constraints, site availability in the District of Columbia, and the current real estate market.

The renovation joined two separate reinforced concrete buildings—a six story west wing, built in 1968, and a seven story east wing, built in 1978. Both buildings were gutted in the process. Both structures contain two levels below grade, much of which is garage space, with the lowest level connecting the two wings. There was an old gas station on the southeast corner; because of the fuel tank, some of the site required remediation. So, technically, this is a brownfield remediation site.

The two building halves worked with NPR's corporate structure. The technical side houses all studios and support areas, and the administrative side houses the general office areas. The technical side includes the program production areas for NPR programs produced in-house (e.g., All Things Considered, Morning Edition, Newscast, Talk of the Nation, Performance Today). Reporter workstations and library functions are accessible to all shows and staff.

The construction schedule:

Jan 91 Architects interviewed
Apr 91 Began two years of design

Jan 93 Began construction
Feb 94 NPR moved in

Size 152,000 ft^2

Goals

A green building wasn't NPR's main objective, but something the architects saw as value added to the project. NPR had a very limited budget.

The design mandate was to create a working environment that would improve individual employee work areas, along with overall corporate morale, without exceeding the budget. Selection of finish materials was based on minimizing costs—basic painted drywall, carpet tiles, vinyl flooring, acoustical tile ceilings, etc. This allowed more budget for the technical areas, which resulted in an increase in the number of news studios and the creation of NPR's first large Performance Studio, a 1,500-ft^2 two-story space that can accommodate a small chamber orchestra. This type of facility was something NPR had always envisioned in their long range plans and opens up opportunities for a whole new audience.

A healthy working environment was also essential to the NPR operation, with lighting comfort, thermal comfort, indoor air quality, and acoustic quality being key elements of the design solution.

The building is located close to a subway station, and has a shower room for bicycle commuters, in order to reduce dependence on automobile commuting.

Features
a. Hardware

Key Components:

- Interior design for renovation of public spaces including a two-story main lobby and five conference facilities with catering support space.
- Selection and specifications of new furniture for 160-170 open workstations.
- High-bay radio studio space with associated production control room for new studios, general production/performing studios, advanced audio facility, tape rooms and storage areas, electronic rooms, offices, lounge, toilets, mechanical room, and microwave steel tower for satellite transmission.
- Replacement of 200-ton air conditioning system/humidity control, sound attenuation and raised flooring, 250 kW emergency generator, four 1000 KVA transformers, power isolation, and voltage regulation.
- CCTV access security system, local annunciated alarm, controlled fire alarm system, intercom system, primary power, water, sewer, telephone, parking, sidewalks, and fencing.

The building was stripped on the inside to bare concrete. The outside was virtually untouched, except for some windows that needed recaulking. There had been bronze reflective glass, which was kept. Not all was double-glazed. But this they didn't change. Two of the existing eight elevators were determined to be unnecessary for the new building operation. The shafts for these two elevators were used for a bank of recycling chutes to move recyclable material vertically through the building.

The building has a wedge-shaped floor plan, which compelled NPR to locate the technical areas in the larger East Wing. The technical areas were stacked vertically, allowing for efficient integration of the mechanical, electrical and audio wiring systems.

For acoustical reasons, studio facilities were constructed on isolated concrete slabs with sound isolation walls and ceiling systems. All ductwork, piping, and electric conduit penetrations are isolated from both the structure and studio enclosures, as well as from each other. Main HVAC equipment (air handlers, pumps, etc.) is also independently isolated.

Daylighting: DC building codes required two hallways per floor. They put one hallway, on the north, along the windows, with offices on the other side of the hall. The two hallways converge at the narrow edge (the point) of the wedge-shaped building. Enclosed offices along the hallway perimeter of each floor have lots of glass, and are interspersed with open workstations, allowing maximum possible daylighting of interior spaces. Interior offices have windows, for daylighting, as well. Facilities that did not need daylight (e.g., studios) were placed towards the interior-most portions of the building, and the offices were placed nearer to the windows.

HVAC: The original mechanical system was mostly gutted. The original ductwork contained fibrous sound liners, which can foster mold and bacteria growth, contributing to indoor air quality problems. Therefore, the existing ductwork was removed. The central plant was upgraded with new high efficiency chillers and pumps, adding cr 60-ton air-cooled skew chiller to handle the new loads imposed by the studios. The distribution and control systems were updated for increased occupant comfort and control.

Unlined ductwork was used in the new tenant air distribution system. Studio design requirements dictated high volume, low velocity systems with larger-than-normal ductwork and critical sound attenuation requirements. The duct lining in the studio air distribution system is covered with a neoprene facing, so that the glass fiber does not come in contact with the air stream. In addition, the quantity of outside air was increased and improved filtering systems were installed on both tenant and studio systems.

Original CFC refrigerants were recovered from the machines and recycled, and replaced with the most environmentally benign refrigerant then available.

The mechanical system was re-zoned to permit portions of the building to operate independently without conditioning the entire space, saving up to 20% of the energy and increasing the user's control.

Interior walls: The gypsum wall board utilizes recycled materials in its core content and protective face paper. It is a very drywall-intensive building, because of sound studio needs.

b. Site remediation

The site was remediated by the prior owner, as a condition for purchase. There was soil contamination and, as a result of a high water table, groundwater contamination. When the site was excavated to find the fuel tanks, none was found, leading to speculation that the tanks probably had been punctured, drained and removed earlier, which resulted in far more contamination than would have otherwise occurred. Remediation required digging a 12,000 ft^2 hole 16 feet deep. The site presently has three groundwater monitors.

c. Software

Lighting: The existing lighting system was replaced with high-efficiency fluorescent fixtures, lamps and ballasts. The office areas are lit with three-lamp parabolic fluorescent fixtures wired to allow multilevel switching of the lamps. This permits occupants to select the amount of light needed for each work area and task.

The building is 95% compact fluorescent. For specialty lighting, e.g., studios, they used quartz halogen lighting, which, unlike fluorescent, can be dimmed and makes no hum. (Dimmable flourescents are now available, but they may still hum.)

Flooring: For studio flooring, they used grade 3 maple (usually a waste byproduct).

Paints and interior materials: Low VOC paints were chosen, but there was not much choice at the time. Carpets and adhesives were also specified to be low-emitting.

Other interior finish materials and furniture systems were chosen to minimize the use of formaldehyde and other objectionable chemicals. Installation of the finishes and systems furniture was staged to allow for adequate time for outgassing and venting of any emissions. The tinted particle board NPR used instead of veneer on some finishes (e.g., hallway transoms) was, at the time, state-of-the-art.

The HVAC systems were run at 100 percent outside air with 100 percent exhaust for several weeks before people moved in, to eliminate out-gassing.

Recycling: On each floor, the coffee room and copy room are adjacent to the recycling chutes, providing a central location for the collection of aluminum cans, clear glass and white paper. Newspapers are collected at designated locations on each floor. Styrofoam packaging peanuts are recycled internally.

Appliances: All appliances are EPA Energy Star approved.

d. Upgrades

NPR is planning a $40-50,000 investment this year in additional energy efficiency, in the form of triad lights and occupancy sensors (for storerooms, restrooms and corridors). They believe that this will reduce energy expenditures by 10-15% (up to about $50,000/year—see below).

NPR replaced incandescent exit lights with compact fluorescents, and shortly will replace those with even more efficient LED lights.

NPR would like to replace the halogen lights in the studios, which generate considerable heat, with fiber optic lighting.

Tenants

On a Wednesday, Thursday or Friday, when weekend shows are in production, over 500 people work in the building.

Costs and financing

Building renovation cost $11 million ($44/ft^2, calculated from gross square footage). The property cost $12.75 million ($51/ft^2) to purchase.

NPR needed a 10-year payback.

Site remediation, a cost born by the prior owner, was probably in the hundreds of thousands of dollars.

The acquisition, design, renovation, build-out, some equipment and furnishings was financed by the issuance of $34.7 million in Industrial Revenue Bonds of the District of Columbia. NPR put in several million dollars of its own capital, as well as over $1 million in grant funds and in-kind equipment contributions.

Environmental benefits

The local utility, PEPCO, provided a one-time six-figure rebate for NPR's high efficiency, variable-speed chiller motors, and high efficiency lighting.

Prior to the renovation, annual electricity costs for the two buildings was about $500,000. NPR spends about $400,000 annually.

Comments

The trash chutes were not adequately designed for newspapers, which are so voluminous that they clogged the chutes, and now are picked up nightly by the cleaning crews. The glass chute idea was probably a mistake, as the recycling companies don't want to deal with broken glass.

There has not been enough plastic to warrant a chute. Also, the signs are confusing. The result: employees don't always recycle.

Post-honeymoon corporate morale? The staff had some complaints about low partition heights, but this has little to do with "greenness," and more with management wanting more of an open newsroom environment.

The low-formaldehyde particle board used in the millwork has had problems in areas with moisture (e.g., kitchens on each floor). The laminate countertops have warped.

Many employees were unaware that they worked in a "green" building, and the NPR web site makes no mention of it.

Employees complained about the air quality in the basement gym, which has poor ventilation and mold.

Although NPR's project managers made contractors aware of the longer lead times needed for sourcing some of the more difficult-to-find materials, they temporarily exhausted the green drywall market in the entire Northeastern United States. The recycled drywall has some performance problems as well. Being softer, it cannot hold up toggleboards as well as conventional wallboard.

Energy use could be even more efficient if they segregated their facilities that require 24-hour-a-day/seven-days-a-week light and HVAC, but the present arrangement works best operationally.

NPR envisioned (and Burt Hill designed for) a five-year expansion, but NPR filled the building within three years. They now have office space off-site.

PEPCO, the local utility, was so successful with their earlier program to re-light and re-lamp DC that they ended it. Now, PEPCO gives only thermal storage rebates.

Design Burt Hill Kosar Rittleman Associates, Washington, DC

Website www.burthill.com/html/npr.htm (architect, information on NPR's green construction)
www.npr.org (NPR's web site)

References 26, 39, 40, 41, 42

Contact Maury Schlessinger, Facilities Manager, National Public Radio, 635 Massachusetts Avenue, NW, Washington, DC, 202-414-2000

10. Natural Resources Defense Council, Washington, DC

A green office within a larger new, green building

In June 1996, the Natural Resources Defense Council's Washington DC office moved into a newly constructed, environmentally friendly building commissioned by the American Association for the Advancement of Science (AAAS). NRDC sought the best commercially available materials and technologies to minimize consumption of energy and resources and maximize use of natural, recycled and non-toxic materials. NRDC wanted to demonstrate that offices can be economical, aesthetically pleasing and environmentally friendly.

NRDC's Washington office represents the culmination of a 10-year greening process of all four of the organization's offices nationwide (New York City, Los Angeles, San Francisco). NRDC's offices demonstrate innovative energy and environmental design and provide valuable examples of what's currently possible in the field of office construction. Over 90% of the environmental materials used in Washington were not available when NRDC started this process in their New York headquarters 10 years ago.

Goals

- Demonstrate leadership in state-of-the art environmental and energy efficient office design by using the most advanced, innovative and cost-effective products available.
- Create a showcase facility that can be a learning tool and an inspirational example for the building profession.
- Use innovative, natural, renewable, low-toxic and/or recycled materials in place of conventional materials to reduce toxic emissions from unsustainable manufacturing processes and to demonstrate these materials' viability under actual conditions.
- Protect and enhance indoor air quality to ensure the health, comfort and productivity of the occupants.
- Reduce or substitute for the use of wood wherever possible to reduce the pressure of excessive harvesting on US forests; where wood was necessary or desirable, 99% of the wood used came from certified well-managed domestic forests.
- Demonstrate cutting-edge, cost-effective energy efficient design and equipment throughout the office.

Size A 20,447 ft^2 office within a 230,000 ft^2 12-story gray granite building.

Features

NRDC's report (available on their web site, below) describes, in detail, (1) the <u>environmental materials</u> used: Walls, doors, paints, flooring, ceiling tile, cabinets and shelving, wood products (furniture, wall trim, stairwell railing), countertop work surfaces; (2) <u>energy efficiency measures</u>: Lighting, appliances and office equipment, heating and air conditioning, building envelope, elevators; and (3) <u>daily operations</u>: clean water and water conservation, "green" office supplies. For each feature they include an introduction, product description of product or approach, environmental benefit, performance and cost, other considerations (e.g., flammability, environmental impacts of transporting materials, recyclability, leasing vs. purchase options, health risks), and where to get it.

a. Hardware

Building Envelope: Transom windows and light shelves in the perimeter offices and architectural notches cut into the building's facade take advantage of daylight to illuminate the interior spaces. Filled with argon and coated with a low-emissivity film, these double-glazed windows are designed to keep out unwanted heat from sun during the summer, while reflecting space heat back into the office during winter. They have an R-4.5 rating (equivalent to 5 panes of glass). Each window can open (only 3 inches so that the balance of the air conditioning system is not disrupted), providing additional fresh air and comfort for the occupants. There are 3.5 inches of fiberglass batts in the walls to achieve R-11 in the whole wall, including the windows. Four inches of rigid Styrofoam board were used in the roof for an R-21 insulating value.

Heating and air conditioning: The building uses an innovative gas-fired absorption air conditioning/heating system with two 250 ton chiller/heaters. The absorption process uses water as the refrigerant, rather than CFCs or HCFCs, and lithium bromide as a heat transfer fluid. A 60 ton electrical centrifugal chiller that uses an HFC refrigerant is run during periods of low cooling loads. To increase efficiency, variable speed ventilation fans closely match the supply of air conditioning or heating and ventilation with the demand. The system also reduces fan-use energy by supplying low volume, low speed, and heated or highly chilled air. Since ventilation energy use is related to the cube of the air speed, small reductions in air speed result in large decreases in energy use. Special variable air volume boxes in the ceiling then thoroughly mix the conditioned air with the re-circulated office air. The computer controlled ventilation system also provides additional outside air circulation, pumping 25% more fresh air into the offices than an ordinary system. Personal climate control units are installed in all perimeter offices to give people control over their own environment. Efficient variable-speed pumps supply these units with either hot or cold water depending upon the season, and each has a thermostat and a fan that can be controlled by the occupant.

Elevators: The elevators employ a 'fuzzy logic' system that records usage patterns for each floor during the day and pre-programs elevators to be ready to serve anticipated passenger loads based on historical patterns. This system reduces waiting time up to 30% and reduces energy use through optimizing the location of elevator cars to serve passengers.

Walls: Solid compressed straw panels and synthetic gypsum wallboard sandwiching steel studs.

b. Software

Paints: Both kinds have very low volatile organic compound (VOC) levels (80-99% lower than conventional).

Carpeting: A solution-dyed nylon carpet that will be recycled at the end of its life. They use carpets with a partly recycled content because fully recycled carpets don't hold up well.

Floors: True linoleum, which is made from all natural ingredients, rather than vinyl tile. The ceramic tile contains 70% recycled glass from windshields and plate glass.

Doors: Compressed straw core instead of particle board.

Shelving and countertop substrate (the material underneath the finish or laminate): made from agricultural waste straw or recycled junk mail.

Furniture: Several pieces were made of wood harvested from independently certified well-managed forests.

Cushion fabric: Created from completely re-tooled manufacturing processes that use no toxic materials and produce no waste.

Countertops: Most are finished with Environ, a material that looks like marble and feels like plastic, but is made up of newsprint, soybean flour, coloring and adhesives, using natural and recycled materials.

Lighting: Combined daylighting measures with efficient lighting equipment and energy-conserving design. Celerestory windows in the interior walls of the window offices (two-foot tall windows, located above eye level) allow natural light to be seen from nearly everywhere in the office. Daylight for all employees was key. A task/ambient lighting strategy to lower lighting levels throughout much of the office to save energy, while providing bright light on work surfaces, where it is needed most. NRDC combined many existing innovative lighting technologies, including T-8 tri-phosphor and compact fluorescent lamps, electronic ballasts, occupancy sensors, and high efficiency direct/indirect pendant fixtures. Lights are on sensors that respond to motion.

Water Conservation: Water filtration system, dishwashers that only use about 7 gallons of water compared with 20 to 25 for a standard machine, and aerators on the kitchen faucets that reduce water flow by about half. In addition, as required by the Energy Policy and Conservation Act of 1992, water-conserving fixtures in the restrooms.

Daily operations: include an economical drinking water purification system and organic, shade-grown coffee. All paper and most office supplies have significant post-consumer recycled content.

Appliances and office equipment: Energy efficient and environmentally friendly office equipment and appliances, including the widespread use of EPA Energy Star-approved computers, monitors, and printers, and energy-conserving refrigerators and dishwashers.

Tenants

NRDC's Washington, DC office has a staff of 60.

Costs and funding

NRDC paid a premium for design services, as well as for environmental and energy efficiency materials and technologies. In some cases, environmental materials were only slightly more

expensive than well-established conventional materials. In other cases they cost significantly more. NRDC incurred a $9.50/ft^2 total extra first cost for the build-out of its space. About $2/ ft^2 of this was a result of extra design costs; about $2.90/ ft^2 is attributable to environmental and energy efficiency features. The rest was for items such as the internal stair-well and additional security requirements of the building. These extra costs are part of moving up the learning curve of environmental building and the early stage in which some of these materials and practices find themselves. As many of these products mature, costs will decline, making many green products competitive with standard materials. NRDC hopes that many of the lessons learned in this process can be used to reduce the cost of building environmentally elsewhere.

There are several complexities associated with determining the costs of environmental vs. standard materials. For example, the internal stairwell cost a significant amount of money and will yield substantial gains in productivity, but is not an "environmental" feature per se, though it does improve the overall working environment. Similarly, though the environmental *Wheatboard* material used for the cabinets cost about 5% more than standard particleboard, the custom labor required to fabricate the cabinets nearly doubled their total cost. By one calculus, the cost of "being green" is double, while by another, it's essentially equivalent. Because there is no reason why cabinet manufacturers cannot use *Wheatboard* as opposed to particle board, for the purposes of NRDC's analysis, they did not attribute the extra labor costs to environmental costs.

Although many environmental design features cost more, over a building's lifetime the difference is not that high. For example, high-performance windows, generally characterized by having low-e coatings and filled with inert gases, cost 5% to 25% more than conventional double-glazed windows. However, this extra cost is quickly paid back by reduced heating and air conditioning bills and can also lead to lower capital costs through downsizing the air conditioning system.

NRDC calculated the cost differences associated with environmental versus conventional features:

Total Build-out Cost/Tenant Allowance	$46/ft^2 / $36.50/ft^2
Extra Design Costs	$1.96/ft^2 ($40,000)
Extra Cost of Environmental Measures	$2.91/ft^2 ($59,500)
Annual Operating Cost Savings (energy only)	$.73/ ft^2 ($15,000)

The AAAS building itself is energy efficient, has natural daylight, avoids ozone-depleting refrigerants in chillers, has good indoor air quality and is one of the few new buildings to be built in downtown Washington, DC. AAAS sought financial help from the city council, which helped pay for the $69 million construction through proceeds of a $52 million, low-interest tax-exempt bonds (as pass-through financing that did not come out of DC's regular budget). AAAS, in turn, hired minority contractors, offered DC-based firms first shot at construction contracts and kept more than 300 jobs within DC. The financial assistance will save AAAS about $40 million over the first 30 years of occupancy.

Environmental benefits

Lighting: The combination of daylighting measures with efficient lighting equipment and energy-conserving design uses 75% less than conventional systems. Using the most energy efficient computing equipment available reduced appliance energy by half. The lighting system, computers and appliances combined save about 70% of the energy consumed in a conventional office space.

Peak demand is 0.53 Watts per square foot vs. 2.0 Watts per square foot for standard lighting. Lighting electricity consumption is approximately 1.9 kilowatt-hours (kWh) per square foot per year, compared with 7.5 kWh/ft^2. in a conventional office (almost 75% less). NRDC spent an extra $33,000 for this lighting system, but will save about $12,000 a year in energy costs, for a 2.75-year simple payback. This lighting prevents the emission of 132,000 lb. of CO_2, 1,500 lb. of SO_2 and 470 lb. of NOx compared to conventional.

Appliances: Compared to an office using conventional appliances and non-Energy Star computers, annual energy savings for the appliances and equipment is about 26,000 kWh, resulting in reductions of 40,800 lb. of CO_2, 460 lb. of SO_2, and 150 lb. of No_x.

HVAC: The AAAS HVAC system is estimated to save 47% compared to the energy use of a system that simply complies with the building code. Although AAAS evaluated a system that used slightly less source energy than the one they used, the more efficient alternative had slightly higher pollution emissions due to the nature of the fuel mix of power generation in the PEPCO service territory. This system reduces CO_2 emissions by 2.8 million pounds, SO_2 emissions by over 2,000 pounds, and NO_x pollution by over 4,000 pounds each year. Compared with efficient electric centrifugal chillers, absorption chiller/heaters cost more per ton of cooling capacity, but they eliminate the need for a boiler so the extra cost is minimal.

Annual pollution prevented:

CO_2	170,000 lb
SO_x	2,000 lb
NO_x	600 lb

Comments

Paint: Most manufacturers now have good quality, environmentally friendly paints. This was not the case two years ago, when the building was completed. Now, quite a number of environmentally friendly materials are available at about the same price as conventional materials.

The AAAS building designers paid attention to energy performance and also realized the benefits of tunneling through the cost barrier. The building's design incorporates two deeply cut glazing bays that extend the full height of the 10-story building and draw light into the atriums. Light shelves bring daylight into workspaces. The integration of high-performance windows and

energy-efficient lighting have cut energy consumption to half that of a typical building: 90,000 BTUs/ft^2 per year versus 183,000 BTUs/ft^2 per year for a conventional office building of the same size. Energy use for lighting in the building is less than 1 watt per square foot—well below the U.S. average of 2 watts per square foot. Project architect Henry Cobb stated, "The AAAS building is no high-priced gimmick. While the costs of some of these features are more expensive initially, they save money in the long run, making the building a strong investment for a nonprofit association and readily marketable if AAAS should decide to leave."

The NRDC subcontractor that installed their straw walls lost a lot of money, and is unlikely to do it again without a hefty premium.

Design

Henry Cobb, of the architectural firm of Pei, Cobb, Freed, and Partners designed the building. New York architects the Croxton Collaborative were responsible for the energy and environmental features. Sheila Kaplan, of Planit Design Associates in Gaithersburg, MD was NRDC's project architect. Turner Construction of Arlington, VA was the construction contractor. Seattle City Light's Lighting Design Lab, helped design the lighting.

Website

www.nrdc.org/cities/building/dc/dcinx.asp
www.aaas.org/aaas/brochure.htm (AAAS)

References 2, 25, 33

Contacts Rob Watson, NRDC, 40 West 20th St. New York, NY 10011. (212) 727-4489; (212) 727-1773 fax, (212) 727-2700 switchboard, rwatson@nrdc.org. Project architect: Sheila Kaplan, Planit Design Associates, 202 Cherrywood Terrace, Gaithersburg, MD 20878, 301-921-4020, 301-527-8787 (FAX). NRDC's Washington office is located at 1200 New York Avenue, NW, Washington, DC.

11. The Nature Conservancy International Headquarters, Arlington, VA

A new, build-to-suit building

The mission of Nature Conservancy is to preserve plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. Among environmental organizations, they fill a unique niche: preserving habitats and species by buying the lands and waters they need to survive ("nature's real estate agent"). The Conservancy operates the largest private system of nature sanctuaries in the world—more than 1,500 preserves in the United States alone. Some are postage-stamp size, others cover thousands of acres. All of them safeguard imperiled species of plants and animals.

The Conservancy ran out of space in their old building. A move was necessary. They wanted a green building, but without publicity, for they didn't want their constituents to think they had

strayed from their land conservation mission. They had no desire to make the building a green showplace. Rather, they see it as simply a building to house staff. They didn't want people to think of the building, but the Conservancy's mission. Even some cost-effective options floated were not chosen because of image (e.g., indirect lighting, which they considered too unusual). And, they wanted proven technology, not experimental.

The building is a rectangle—an inexpensive design to fit-out. The top two floors are leased out, and the lobby floor has space for a restaurant. (The Conservancy has a building marketing brochure for prospective tenants.)

They are located across from a subway (Metro) station. The city and county of Arlington allowed them a 30% reduction in lower-level parking space, because of the large number of people biking or taking the subway to work. Such a reduction was unprecedented, and saved the Conservancy money as well. (Four years ago the Conservancy presented Arlington with the result of a staff survey, showing that 65% commute by other than automobile.)

Five years before construction began, the Conservancy realized that they were outgrowing their old facility. In Fall 1996 they brought in the designers (HOK). Construction began in June 1997. The Conservancy moved in November 1998.

Size

The site area is about 50-60,000 ft^2. The eight-story building occupies 20,000 ft^2 per floor. There are 160,000 ft^2 of usable floor space; the Conservancy occupies 110,000 ft^2.

Goals

- Daylighting integration
- Flexible, efficient HVAC
- Photovoltaics
- Permanent IAQ monitoring
- Automated building control system
- Sustainable woods
- Green building materials
- Local materials
- Central water purification
- Construction recycling

Features
a. Hardware

Layout: The building is about 90% open office. Private offices are located in the interior core, with clear and frosted glass-banded walls facing the hall. Open offices are closer to the windows.

HVAC: They have modular (floor-by-floor) chillers, with a gas morning warm-up. A central hydronic system was too expensive. An energy analysis showed:

Centralized roof-top chiller: 0.55-0.6 kW/ton
Modular (floor-by-floor) chillers: 1.1 kW/ton

The modular chillers are less efficient to run, but more flexible. There are some added efficiencies—but these are second-level aspects in an energy analysis, and often not included.

Windows: Every floor has floor-to-ceiling glass. Windows are double-glazed, uncoated above the light shelf, and with light shelves, for higher transmission into the interior. It has a very bright, daylit interior.

Water: Centralized water filtration and chilling.

Landscaping: A native species garden, with plantings that tell a conservation story. The garden features about 100 species of flowering plants, ferns and conifers—some native to the Washington, DC area, others from climatically similar areas of the Southern Appalachians, the Midwestern Prairies and the Pacific Northwest.

The construction process: They followed the LEED process (see Appendix). The building was initially rated silver, but now is bronze, because they decided against using recycling chutes. There was some construction waste recycling, with off-site separation.

Commissioning: Limited, and done by the construction company and the building maintenance crew.

b. Remediation

The site had been, most recently, a parking lot, and before that an auto service and gas station. One area required remediation. Remediation was done in conjunction with and paid for by VA Department of Environmental Quality and Nation's Bank (the previous owner).

c. Software

Lighting: Standard 2 x 2 downlighting. 32 foot-candle daylighting in interior-most office spaces.

IAQ: The mechanical system was run at maximum air flow for four weeks prior to occupancy to vent any outgassing.

Acoustics: White noise is emitted from speakers in the open office areas during working hours. There are also high-absorption ceiling tiles.

d. Upgrades

Photovoltaics: HOK is considering developing a photovoltaic glasstop array on the canopy, and another on the roof. (The canopy array is less efficient than the roof, but more visible.) Solarex makes the thin film material.

Funding: The Virginia Alliance for Solar Power (a state spin-off of DOE's Million Solar Roofs program) will contribute 55% of the cost. The Conservancy will implement the upgrade only if they can do so at no cost to them.

Tenants

The Conservancy has about 450 employees in this building.

Costs and financing

The basic construction (core and shell) cost $62/ft^2. The fitting out (not quite comparable with a design-only fit-out of an already built building) cost about $20/ft^2.

The building was designed with a five-year payback.

Environmental benefits

Because the Conservancy has occupied this building for only six months, they have no measure of performance.

Comments

The LEED process was beneficial in the design/build process, as a guidance tool and also as a mechanism to ensure compliance. It is performance-based, but once options are selected, it fixes prescriptions in place. It kept everyone on track, and proved to be a good scorecard. (HOK, the designer, hadn't appreciated all of these benefits when they began the process.)

The Conservancy plans to do a building recommissioning once they have occupied it for a year, when the building has gone through four seasons.

The staff wasn't involved in building planning, except for an advisory team of one person from each division, for work station design.

IAQ: Running the mechanical system for four weeks prior to occupancy seems to have worked. There have been no complaints.

Acoustics: The staff was concerned about the noise levels that so open an office might create. The white noise, coupled with high-absorption ceiling tiles, works well.

Glare: One design flaw has been the uncoated windows above the light shelves on the east, west and south sides. Staff are unable to see their computer screens for the glare. The Conservancy will install miniblinds. For now, the staff has taped up sandwich-wrapping paper to block the glare.

Education: Although the Conservancy de-emphasizes the building relative to their mission, they provide literature for self-tours of their garden. They want to encourage the public "to consider and promote greater use of native plants in gardening and landscaping."

Everyone, in most places in the building, can see windows. The office space seems very open. The staff is happy with the building.

Design Hellmuth, Obata + Kassabaum, Inc. (HOK)

Website www.tnc.org

References 25, 65

Contacts Susan Schuler, Director, Office Services, The Nature Conservancy, 4245 North Fairfax Drive, Suite 100, Arlington, VA 22203-1606. 703-841-5303, 703-841-1283 (FAX), sschuler@tnc.org

12. Nonprofit Enterprise at Work, Ann Arbor, MI

A new, conventional building on a brownfield site, which houses nonprofit organizations

Nonprofit Enterprise at Work (NEW), established in 1993, owns and operates NEW Center in Ann Arbor, Michigan. NEW Center provides office space and other resources for 22 nonprofit arts, environmental, and human service organizations, and promotes their operational efficiency.

NEW provides office space substantially below commercial rates, and office equipment, computers and kitchen facilities that tenants can share. NEW also has three large conference and meeting rooms and a professionally staffed nonprofit resources library. Low-cost consulting services, training courses and financial planning workshops are provided to tenants.

The idea was developed by focus groups consisting of civic leaders, nonprofit staff, community volunteers, business professionals and others.

Size 11,000 ft^2

Goals

- Foster collaboration among diverse nonprofits
- Provide facilities, information and support services, educational programs and leadership development.
- Reduce nonprofits' administrative overhead costs.

Features
a. Hardware

NEW was not designed to be green building per se, but its operations are very efficient and energy-saving.

- Specialized common spaces (conference rooms, copier/workroom facilities, kitchen).
- A staffed information center that houses the Nonprofit Library.

b. Remediation

Cleanup involved excavation and disposal of over 3,300 cubic yards of soil contaminated with polychlorinated biphenyls and heavy metals. Of two land parcels, the 1.2-acre southern parcel was remediated. PCBs were found in soil to depth of 6-12" below the surface, and covered most of the unpaved areas of the site. Areas containing greater than 50 ppm PCBs were random across the site, and could not be isolated. Monitoring wells installed and sampled with Michigan DNR approval showed groundwater was not affected by PCBs and metals present in the surface soils.

The remediation action plan, submitted in October 1990 and approved by Michigan DNR in December 1990, proposed evacuation and disposal of contaminated soils and concrete debris. This action was the only one considered feasible because of the limited technologies to treat PCBs, the small quantity of soils impacted and time constraints. The remedial action plan called for reducing soil PCBs to 1 ppm. It also called for reducing soil metals concentrations to background levels. The underlying aquifer was not affected by contamination, and soil removal eliminated any potential for future contamination.

Soil was excavated to 18" deep. In June 1989, 142 cubic yards of impacted soil were excavated and transported to an EPA-approved landfill in Emille, AL, and another 40 cubic yards was transported to an EPA-approved chemical waste landfill in Model City, NY.

The remediation met Michigan DNR requirements.

c. Software

NEW conducts workshops and conferences on nonprofit management (board leadership, management, human resource development, financial management, fundraising, marketing).

NEW has a new nonprofit consulting consortium, and is trying to evolve from nonprofit service provider to nonprofit leader. They do not yet have, but want to develop, back office service co-ops (e.g., shared accounting), buying co-ops (e.g., office supplies, insurance, phones, ISP), and a work wellness program (e.g., cardiovascular screening).

Tenants

1. In-house: Twenty-two nonprofits in human service, arts, and environmental causes.
2. Affiliates Program: For organizations that want the benefits, but not the physical space, at NEW Center, for $60/month.
3. A program enabling nonprofits to rent meeting space and use the facilities as needed.

Management

NEW has a Board of Trustees and an Operating Committee composed of nonprofit executives and other concerned community leaders.

Costs and funding

The land was valued at $551,985, and the building and improvements at $1,633,851. Remediation did not add proportionally to the value of the property, but afforded it market comparability with properties of similar site and zoning characteristics.

The McKinley Foundation of Ann Arbor provided a $3.5 million grant, which covered about half of the capital costs. More than half of that—much more than anticipated—went to brownfield remediation, which cut into building costs. The McKinley Foundation gave about $1 million in seed capital in 1988, and began a capital campaign to raise a total of $2.5 million to build the NEW Center building. The Kresge Foundation gave $1 million, and about $1.3 million was raised from other donors. The McKinley Foundation continues to pay for some of the building's annual operating expenses. NEW received:

- A $65,000 Ameritech grant for the library and to develop web sites for nonprofits county-wide.
- $16,000 from the Ann Arbor Area Community Foundation to establish a new, area-wide nonprofit volunteer clearinghouse (taking over some of what the recently closed United Way Volunteer Action Center in Ann Arbor had done).
- $234,000 from the Kellogg Foundation to establish low-cost consulting services for nonprofits.
- Several corporate funders sponsored programs and events, at $2,000 to $10,000 apiece. During the first three years, each trustee made a personal commitment of $5,000 per year.

At present, NEW's income is 60% earned, 40% from grants. They hope to become economically self-sufficient in the future. They are also seeking additional funding for other new programs they envision.

Nonprofit tenants pay $10.63/ft^2, about 33% under market value. Utilities are included. Tenant lease rates just cover expenses.

Comments

The McKinley Foundation, which raises money from the public, had hoped that social service and arts organizations would combine forces on more projects. Ron and Eileen Weiser, real estate developers who established the foundation, say that part of the reason for developing the project was that government cutbacks had created tensions among local groups, which faced increased competition for private dollars. This facility allows nonprofits to spend more of their time to doing what they do well, rather than so much of it fundraising. It gives these nonprofits access to equipment, space and professional advice that they could never afford on their own. In addition, these nonprofits have created close working relationships with one another, often going next door to borrow supplies, bounce off ideas or ask for advice.

NEW found that many nonprofit startups did not need office space initially, because it was so easy to work from their homes.

Outcomes have been difficult to measure. About 80% of the tenants feel that their needs are being met. NEW is trying to get their tenants to function more cooperatively. NEW has learned the importance of training and defining values.

Web site www.new.org

References 30, 31

Contact Patricia L. Denig, Facilities Manager, Nonprofit Enterprise at Work, 1100 North Main, Ann Arbor, MI 48104. 734-998-0160, pdenig@new.org

13. Southface Energy and Environmental Resource Center, Atlanta, GA

A newly built model home that includes offices, a library and exhibits

Southface Energy Institute, whose mission is to promote the development of sustainable energy and environmental technologies and policies through education, research and technical assistance (described in Appendix), in partnership with the US Department of Energy, constructed a state-of the art demonstration home. The Southface Energy and Environmental Resource Center opened in 1996, showcasing innovative ideas for saving energy, water and other natural resources, for reducing waste and using recycled materials, and for maintaining a healthy indoor environment. Additionally, it showcases smart ideas for designing accessible homes for people with physical disabilities. The building also provides offices for Southface Energy Institute, and houses an energy and environmental technology library, and numerous educational exhibits.

The ground floor and main level showcase home building innovations. The upper level houses the Southface Energy Institute.

Goals

To demonstrate state state-of-the art technologies in energy and environmental conservation, and healthy indoor air quality in a home and office space.

To demonstrate the full costs of building a conventional home without using green design.

Size 6,200 ft^2.

Features
a. Hardware

- Solar electric shingles, integrated photovoltaic shingles resembling conventional fiberglass shingles, produce 5-6 watts AC/square foot in full sun conditions.
- Building envelope: Structural insulated roof panels are constructed of 8-inch thick, R-30 panels. Other materials, including poured concrete basement walls, structural insulated panels, and blown-in insulation, and airsealing, provides approximately R-24 insulation.
- Triathalon natural gas heat pump, with an equivalent 126% Annual Fuel Utilization Efficiency, compared to 78%-95% for conventional furnaces (for the ground floor).
- Geothermal heat pump heats and cools the main and upper floors.
- Ducts are sealed with a water-based mastic to ensure airtight connections that will last.
- Ventilation and dehumidification systems maintain 30-50% relative humidity.
- Air is passed though a 30% dust spot efficiency pre-filter.
- Natural lighting is used where possible.

b. Software

- Compact fluorescents supplement natural lighting. Tubular fluorescent fixtures have energy efficient ballasts, T-8 lamps and excellent color rendition.
- Low-emission paints, with zero volatile organic compounds, including formaldehyde.
- Natural fiber carpet.
- Radon and carbon dioxide monitors.
- Cross-ventilation through operable windows.
- Wood flooring salvaged from old timbers.
- Shelving from wood products certified through Scientific Certification Systems.
- Office carpeting, leased form Interface, will be serviced, replaced, and recycled as needed by the company.
- Plumbing in the restrooms use existing water-saving devices including waterless no-flush urinals.
- Solar water heaters.
- Programmable controls for the three main zones of the building.
- Office equipment and home appliances are EPA EnergyStar-rated or more efficient than federal energy standards.
- Office is equipped to encourage telecommuting.

Landscape and grounds showcase the following principles:

- Xeriscape emphasizes use of native drought-tolerant plants with lower maintenance and water requirements. It requires no automatic irrigation or sprinkling system, and only supplemental watering.
- Consistent with Cool communities (American Forest and the US Department of Energy program to reduce urban heat islands through strategic tree plantings and light-colored surfaces).
- Graywater, or water from washing machines, showers and lavatories, which is not contaminated with human waste, is used to irrigate a planted terrace. The graywater is filtered through a subterranean gravel bed.
- Cisterns collect and store rainwater. A solar-powered pump moves the rainwater through drip irrigation lines. A hydrogen fuel cell produces about one gallon of water per hour with drains to the landscape.
- Turf grass is minimized.
- Trees were protected during construction.
- Recycled landscape materials were used for grading and mulch, including stones, wood, and concrete rubble for walkways.
- Porous concrete, allowing rainwater to pass into the gravel and percolate into the soil, was used for driveway and handicap parking. This reduces stormwater runoff and non-point source pollution, and recharges groundwater.
- Plants were selected to promote wildlife habitat.
- A demonstration community vegetable garden, in partnership with the Atlanta Gardening Alliance, led by the Atlanta Community Food Bank.
- Composting bins demonstrate household waste composting.
- Straw-bale garden cottage serves as a storage facility on site.
- Outdoor classroom is available for groups.
- The parking spaces on the lower level is constructed of Grasspave, a plastic matrix that provides support beneath the grass to allow for parking. The grass surface is permeable and allows rainwater to percolate into the soil, reducing runoff.
- Outdoor lighting is generated from the sun using photovoltaic panels and battery storage.

The garage and transportation area demonstrates how reductions in pollution generated by vehicles can improve air quality, reduce urban congestion and optimize energy efficiency. This includes demonstrations of electric cars, and hydrogen fuel-cell vehicles, bicycle parking, and information on mass transit in Atlanta. Handicap access is also demonstrated in the garage area.

Comments

Over 15,000 people visited the Resource Center in its first two years, and thousands learned of its products and technologies through the media. The Center has received design awards form the American Institute of Architects, American Society of Heating, Refrigerating and Air Conditioning Engineers, American Concrete Institute, the EPA Green Lights program and the DOE/EPA EnergyStar Program.

Southface Energy Institute has conducted over 2,500 training programs to audiences ranging from general contractors to building code officials. Some programs are on-site, and others throughout the South.

The building is available for workshops and special events.

Costs and financing

Building costs have been hard to determine because of donations, grants and loans. Over 90 government agencies, foundations and businesses have contributed to the design and construction of Southface Energy and Environmental Resource Center.

Environmental benefits

The technologies exhibited conserve energy, water and other natural resources. The building is rated in the top 10% of energy-efficient commercial buildings based on the EnergyStar benchmarking tools.

References 67, 68

Website www.southface.org

Contact Jonathon Bebb, Facility Manager, Southface Energy and Environmental Resource Center, 241 Pine Street, Atlanta, GA 30308; 404.872.3549, Fax. 404.872.5009; info@southface.org

14. The Thoreau Center for Sustainability, San Francisco, CA

A mixed-use green renovation of an historical building complex

The Thoreau Center for Sustainability, a community of organizations working for a healthy environment and a just society, opened in 1996 in the historic Letterman Hospital in the Presidio (a decommissioned US Army base in San Francisco, which became a national park in 1994). The new national park will create a global center for addressing the world's most critical environmental, social and cultural challenges. It will function as a working laboratory to produce models of environmental sustainability that can be transferred to communities worldwide. The National Park Service is leasing out many of the buildings to nonprofit and commercial tenants who will restore and pay for building upkeep.

In 1994, the Tides Foundation, a California-based organization promoting stewardship of the natural environment, whose grantmaking promotes change toward a healthy society, designed and developed a complex of historical buildings in the Presidio. Tides created a partnership with Equity Community Builders, a San Francisco-based developer of infill housing and mixed-use projects, to develop the Thoreau Center for Sustainability. Together they formed Thoreau Center Partners to serve as the leasee in a 55-year master lease with the National Park Service.

In 1995, the Thoreau Center began rehabilitating the empty and dilapidated Letterman Hospital Buildings, bringing new life to the National Historic Landmark. The Center's green architectural plan used sustainably harvested wood, recycled building materials, non-toxic paints and energy-efficient designs that maximize sunlight and natural ventilation.

The first phase, including the main hospital complex, was completed in April 1996. Phase II, which included many smaller adjacent structures, was completed in November 1997.

Size 12 buildings, occupying 183,000 ft^2. The main 73,000-ft^2 Letterman Building houses over 40 organizations.

Features
a. Hardware

Project requirements for "greening of the Presidio" mandated integration of environmental strategies and new energy-efficient building systems, while maintaining the historic integrity of the structures. Restoration had to fulfill the National Park Service's rehabilitation requirements for historic buildings, and landscaping had to conform to rehabilitation requirements of the federal tax credit programs of historic buildings. The tax credit was critical to the effort's financial viability. It also affected the extent to which new technologies (e.g., window design) could be used.

Project requirements also mandated that new architectural features be "reversible." This meant that if the building use changed in the future, new building elements and components could be removed without damaging the basic original structure.

The original building relied heavily on natural lighting and ventilation rather than on electrical lighting and large mechanical systems. The architects retained this concept, and the renovated office spaces contain a layering of private and open work areas designed to maximize daylight and natural ventilation.

Building Envelope: Cellulose insulation made from recycled newspaper and other paper products was installed in the attic, wall cavities and crawl space where possible. Double-glazed and low-e glass windows were installed in the entryway and in skylights.

Mechanical and Electrical Systems: The design followed the underlying theme that "less is more." Given San Francisco's mild climate, the designers considered a central computer-based system unnecessary. Radiators were equipped with local thermostat control for small, discrete areas. High-efficiency motors were specified.

A separately funded photovoltaic demonstration project by the National Renewable Energy Laboratory and the National Park Service was installed above the entrance skylight. This generates approximately 8 kilowatt hours per day. The lobby has a public display on PVs, a meter to monitor the energy produced and an interactive computer program to explain this alternative energy system.

b. Software

Lighting and electricity: The lighting design goal was to minimize electrical energy while still providing pleasant quality of light. The project used proven technology and fast payback. F32T8/730 fluorescent lamps and electronic ballasts provide silent, flicker-free lighting.

Corridors are lit with pendant lights using compact fluorescent lamps. Lighting controls in large office areas and common corridors are equipped with occupancy sensors, to switch off when not in use.

Special electrical outlets for recharging electrically operated cars are available.

Plumbing: Low-flow plumbing fixtures conserve water.

Materials selection: Environmental considerations were balanced with other factors such as schedule, costs, availability and aesthetics. The project environmental consultant, Simon and Associates, suggested design features based on the following criteria:

- Recycled content
- Sustainably acquired or renewable resources
- Manufacturing energy efficiency and recycling
- Low-emissions manufacturing processes
- Minimum packaging, high recycled content
- Maximum transport efficiency
- Minimum installation hazards
- Low-toxic emissions
- Durability
- Ease of maintenance
- Reusability and ability to be salvaged
- Recyclability

A complete list of manufactures, products and their descriptions is available from the Thoreau Center Partners.

Landscape design: Landscape features are included in the landmark designation. The large open grass areas, significant historic plantings, and exterior circulation patterns are all part of the historic cultural landscape (and the former use as a rehabilitation hospital). The updated, ecologically sensitive landscape design also incorporate the following sustainable landscape practices:

- Rehabilitation rather than removal of historic plant materials
- Minimization of earthwork (new grades work with the existing slopes)
- Soil building with organic amendments in lieu of synthetic fertilizers
- Water conservation through the introduction of drought-tolerant plants, low-flow irrigation systems, and the capture of rainwater for supplemental irrigation
- Excavation and use of historic drainage strictures to minimize runoff
- Replacement of evergreen trees with deciduous trees on the south sides of buildings to maximize interior daylighting
- Reduction in asphalt paving and parking areas
- Installation of alternatives to turf lawns, such as low-growing ground cover, unmown grasses and wildflowers, and decomposed granite

- Updated National Park Service standard landscape specifications through research from "green" databases and product literature on sustainable materials and products

Organization and tenants

Over 40 nonprofit and business organizations, working for social justice, community education and development, public health, and environmental stewardship occupy the building complex, which includes the main hospital building and adjacent small buildings on O'Reilly Street.

Rents range from $16 to $25 per square foot, about the same as other rental space in the city. The rental fee includes utilities, a small shared conference room space, occasional use of a larger conference room, cafeteria, informal meeting space, and parking.

Thoreau Center Partners, L.P., a partnership of Highwater, Inc., a wholly owned subsidiary of the Tides Foundation and Equity Community Builders, manage the building.

In the initial planning phase a three-day large-scale planning charrette focused on the Presidio. One hundred and fifteen local participants discussed how the entire 1,480-acre property could be used as a historic landmark and in ecologically responsible mixed-use. Other organizations are adapting the ecological design principles as a guide to historic renovation.

Cost and financing

The entire project cost $13.1 million ($72/ft^2).

Initial financing came from a conventional First Republic Bank loan, private loans, raised equity, and historic tax credits. No government funds were used. Program-related investments to the Tides Foundation helped finance Phase II.

Environmental benefits

Electricity use is estimated to have been reduced from 1.5 watts/ft^2 to an average of .75 watts/ft^2, saving 180 Mwh of electricity ($22,000) per year. Cost savings in heating and cooling are estimated to be approximately $600 per year, reflecting the mild climate.

Comments

Marsha Maytum AIA, the architect's principal-in-charge, stated that "the shared vision and commitment by all the parties involved, from the tenants, the developers, the National Park Service, and design team members, was critical to making this a model project." Noting that the design approach searched for common-sense solutions, with simple, user-friendly systems, Maytum said, "Another important lesson was learned from using the existing buildings to the best advantage—maximizing natural ventilation and daylight already available." Ms. Maytum is continuing to work on other historical and green renovations in the Presidio.

China Brotsky, Director of Special Projects, noted that Thoreau Center tenants have not done much organizational linking. Although linked by common goals, they can do more to develop synergy. Planned projects include a list-serve and buying cooperative to maximize buying power on environmentally friendly office products.

The Thoreau center has won numerous design awards, including the National Trust for Historic Preservation Honor Awards; AIA California Chapter Design Award, and the California Preservation Foundation Honor Award.

References 69, 70

Contacts

Building Manager: Mitchell Chapman, The Thoreau Center for Sustainability, The Presidio, San Francisco, CA 94129. 415.263.1750

Project Architect: Marsha Maytum, AIA, Tanner Leddy Maytum Stacy Architects, 444 Spear Street; San Francisco, CA 94105; Tel. 415.394.5400; Fax. 415.394.5400

15. The Way Station, Frederick, MD

A nonprofit health care facility that rebuilt an existing downtown site

Introduction

The Way Station is devoted to the rehabilitation of people with mental illnesses. It is a clubhouse, in the Fountainhouse model in NYC (1948): members join work areas (e.g., horticulture, maintenance). The Way Station, in turn, provides services, such as housing, to members. The building is located in the heart of the Frederick Historic District, and is designed to complement the neighborhood's historic character. The building is organized internally around a light court that extends nearly the full width of the building. Office and program spaces line the edges of the court on two floors, with a minimum of walls separating the two. Where walls are required, glazed openings provide daylight access. There is a light court with a large naturalistic garden where the primary building circulation helps foster a sense of community for occupants.

When the Way Station began planning a new healthcare facility, they wanted a building that would contribute to the patients' psychological and physical health. The Way Station's executive director had wanted to do something sustainable, and to bring the outside in. They wanted a cost-effective, ecologically sound building. But they were not allowed to make many changes to their earlier historic site.

The new site was originally motel units (in fact, one of the first motels in the US). One idea had been to put a bubble over the units. The Frederick Historic District was very good about working with them.

The design was initiated in early 1987, construction started in 1988 and the building was occupied in January of 1991. Shepard Pratt acquired the Way Station about one and one-half years ago. The mission has now extended to adolescents, and work with the Jefferson School in Frederick. Cash flow has become easier.

Size 30,000 ft^2

Goals

The building is sited to create a parklike setting that enhances the main street feel of the surrounding historic district. The building's design is holistic and energy efficient. Key concerns:

- Energy efficiency
- Human comfort
- Physical and psychological well-being
- Environmental quality

Holistic health features (many could be considered green as well) include: natural lighting; non-toxic materials and products; filtered water; frequent air exchange; organic shapes, textures and plant materials; handicapped accessibility; and open space design to assist those with spatial impairments. In addition, concern for public health prompted Way Station to develop ecologically sound and environmentally sustainable architecture. This healing, non-institutional environment fosters the productivity, creativity and well-being of members, staff and visitors.

Features
a. Hardware

Building envelope: The building form and envelope were designed for minimum auxiliary heating and cooling. The exterior walls are composed of local red brick with precast concrete trim. Interior surfaces are gypsum board over concrete block structural walls. Polystyrene insulation is between the brick and concrete block. The walls have lots of curves, at Amory Lovin's (Rocky Mountain Institute) suggestion, to be easier on the eyes.

The building's hybrid structure utilizes interior posts and beams with exterior masonry bearing walls. The primary structural elements in the light courts are glue laminated wood beams and columns. Steel members are concealed and used elsewhere. The exposed structural frame expresses a sense of order integrated with more natural curves in the walls and balconies flowing over and around the structure. The wood posts and beams were chosen to provide a warm natural effect. Floors are concrete slabs on grade and on metal deck over open web steel joists. The floor system is shallow to provide maximum ceiling heights to complement the daylighting system.

Daylighting and windows: Natural daylighting comes from a blend of light shelves, light scoops, skylights, and high-performance glazings. A sun-tracking lighting system on the roof is linked to an efficient electric lighting system that adjusts light levels according to outside conditions.

Daylight streams through skylights on the second level. Daylight is brought deep into the building by bouncing it off light shelves located in the windows on the south side, which also act as shading devices to reduce unwanted heat gain from summer sun. In the center of the building a light court serves as the central organizing feature while lighting the traffic circulation areas and adjacent rooms.

Extensive use of superwindows with multiple low-emissivity coatings on suspended plastic films enables the facility to have large window areas without the energy penalty that usually results from extensive glazing. This provides warm, relaxing spaces with natural light. There are fewer windows on the north side, more on the south.

On the south side of the building, light shelves provide for a deep penetration of daylight and act as shading devices that reduce brightness levels near the window and reduce solar heat gains. Light shelves are on the outside as well as inside, and mounted about 9' high. The outside shelves provide shade in summer. "Clouds," white horizontal flags, diffuse sunlight. In summer no direct sunlight hits work surfaces.

Three SoLuminaire daylight-tracking systems provide maximum daylight penetration through skylights on the second level. These are rooftop-mounted, and channel light into the skylights. They track the sun's path, using solar-power, through three reflectors.

HVAC: An innovative mechanical system recovers heat from the exhaust air to provide plenty of fresh outside air without losing much energy.

An air delivery system using central variable air volume (VAV) concept is the primary HVAC system. The air volume of central fans is automatically adjusted based on the cooling demands of each building zone. Individual dampers are used to control the temperature at each zone. There are 28 zones, and 26 thermostats.

Cooling is from outside air whenever possible. A central chiller cools the supply air as needed. To reduce peak demand electrical costs, much of the power for AC is shifted to off-peak hours through the use of a cool storage system: ice is continuously produced and stored to make chilled water that cools the building during the day. (Although these have become almost routine in Colorado, this was the second cool storage system in use in Maryland.) Without this system, a compressor twice as large would have been necessary. A heat recovery system on the chiller is used to preheat the domestic water.

Passive solar heat gains and building conservation measures reduce heating requirements. High-efficiency gas-fired boilers provide the balance of space heat through the VAV systems. Domestic hot water is heated by solar preheat tanks in the greenhouse and the heat recovery system with gas-fired boilers as the back-up source.

Landscaping: Landscaping was designed to complement the architecture. The exterior landscaping will mature to be a natural setting providing a pedestrian park for members, staff and neighbors. Plant species and colors were selected to provide a diverse variety and for low maintenance.

Construction techniques employed common practice and materials, but applied in special ways to meet the design goals. Unique building technology, an extremely tight construction site, rock blasting, archeological excavations and an extensive stormwater management system added to the challenge of constructing the building.

b. Software

Lighting: The building's lighting design uses high-tech products and systems, but provides the low-tech feel of a warm, friendly environment. The design provides for high-quality lighting from multiple sources, optimum light levels for comfort, minimum glare, appropriate levels of contrast between light and dark surfaces, and pleasing aesthetics.

The building has 13 lighting zones, which are computer-controlled. Most areas are illuminated with indirect lighting from pendant mounted fluorescent luminaries combined with direct task lighting. Combinations of features in the same luminaire are used in adjacent areas to provide accents and flexibility. High frequency ballasts eliminate noise and flicker. They use dimmable fluorescents, manufactured by Lumitron (this was one of Lumitron's first buildings). The majority of the suspended fluorescents are indirect, although some are both. About 55% are linked to solar dimmers, which are on both north and south sides. Lighting monitors are on the roof, which is flat.

Lighting controls respond to daylight availability, room occupancy and emergency situations (with battery packs). There are automatic dimmers linked to daylight sensors. Some rooms have motion detectors to turn lights on or off. The lamps were selected for accurate color rendering (~3500°K—away from blue, towards yellow/orange) and compatibility with daylight.

Finishes: Nontoxic materials and finishes were employed throughout.

Recycling: The Way Station was the first NGO in Frederick County to institute active recycling. They contract with a pickup service, and recycle all the usual materials. They have a very low trash load.

Plumbing: Water-efficient plumbing fixtures lower water use and lessen the impact on the municipal sewage system.

IAQ: After the finishes and furnishings were installed, a complete and extensive flushing of the building with fresh air was conducted. These processes combined with the large number of plants and high fresh air ventilation rates maintain high indoor air quality.

Design and function

Charrettes: The designers held a one-week charrette, bringing together lighting designers, health care designers, landscape architects, historic preservation experts, engineers and an architectural illustrator (doing what is now mostly done by CAD) to participate in the design. They also included members as well as staff, knowing that their insights were vital to the design process.

The team developed "health-promotion techniques," such as full accessibility for disabled persons and open space designed to aid those with perceptual difficulties.

Commissioning: Commissioning lasted three days. Senior company reps worked with Randy and the builder (Kallas contractors, Hagerstown, MD). They made tapes to benefit future facilities managers.

Recommissioning: The designers conducted a recommissioning in December 1992, one year after the building was completed. This was an indicative type Post Occupancy Evaluation (POE) of the building, focusing on the building occupants and their needs. The main purpose was to gain knowledge of the building performance as a basis for continuing to improve the quality and effectiveness of the physical environment in response to the user needs.

The biggest site and building exterior concerns were moisture and water control. They recommended roof flashing and window details repair. The focus of the building interior was on color, furnishings, operation, maintenance and interior modifications. Participants agreed that the building finishes need color in order to effectively contribute to members' psychological and physiological well-being. The absence of color creates emotional sterility that may not be calming to individuals. Other evaluations and recommendations were made for furnishings, daylight fixtures, lighting, heating, ventilating, air-conditioning and domestic hot water and overall occupant satisfaction. In general, people were very pleased with the building's comfort performance.

They also studied energy performance from January 1991 through October 1992. The building averages about $.72 per square foot per year. Since building occupancy is greater than anticipated, this cost is slightly higher than expected. However, it means that there is even more of a savings and various energy efficiency measures will have a shorter pay-back period.

Upgrades

They are replacing T-12 tubes with more efficient T-8.

Tenants

About 110 members (patients) come in on a given weekday, and 30-40 on weekends. The Way Station has another, more medical site nearby. The staff at both sites is about 100.

Costs and funding

The total project cost was $5.5 million ($177/ft^2), of which $3.3 million ($110/ft^2) were building construction costs. Total project costs included site development, furnishings, archeological studies, renovation of existing buildings, asbestos abatement, design and legal fees, and land.

This was the first million dollar campaign in Frederick County, and state corporations contributed $1.1 million. The state of Maryland, eager to develop community-based mental health treatment, contributed another $1.1 million.

The design came in about $1 million over budget. They needed to scrimp on a number of areas (such as pneumatic controls, which need to be monitored constantly by Randy, instead of electronic).

Energy savings for most energy conservation measures (the solar dimmer system, for example, cost $75,000) will recover the added cost within 5 to 10 years.

Environmental benefits

Energy consumption one-third that of a conventional building of the same size in the same climate:

	Standard building	**The Way Station**
Space and Water Heating	$8,800/yr.	$2,939/yr.
Lighting and Cooling, Electric	$47,100/yr.	$16,672/yr.
Water Heating	$2,100/yr.	$734/yr.
TOTAL	$58,000/yr.	$20,345/yr.
Energy Use	66,100 Btu/ft^2/yr.	22,700 Btu/ft^2/yr.

This building could reduce coal-fired power plant pollutants by 4,800 tons of CO_2 and 42 tons of SO_2 emissions over 20 years of operation.

Comments

The project's origin was serendipitous. One of the Sunday newspapers featured an article on Amory Lovins (Rocky Mountain Institute), which was brought to the executive director's attention. Within two weeks they had contacted Lovins. Lovins, in turn, contacted Franta, who became the architect.

The variable air volume (VAV) mechanical system has proven to be a very stable system.

The original window units all failed, because moisture entered the units. They replaced all 435 units (excluding the greenhouse). The property manager, Randy Williams, believes that, since these units are manufactured at one mile altitude, breather tubes may not have been sealed properly. There is ambient air, not gas, on the inside.

The light court has proven to be a good, sunny pace to interact. Williams does not consider the sunlight diffusing "clouds " necessary.

The motor failed on one SoLuminaire daylight tracking system. The track failed on another (probably wasn't properly installed), but it ran successfully for two years. Williams thinks these are, for this building, unnecessary architectural embellishments.

Williams considered the charrette a "delightful" exercise.

The design process and the building that resulted helped develop a sense of community at the Way Station. It appears to have improved the residents' outlook on life. Way Station staff find that patients progress through rehabilitation programs more quickly than in conventional facilities. As one patient noted, "There are no dark corners in the building." The designer stresses the importance of this aspect "for people who are already troubled with dark shadows in their minds."

Design

The first architect produced a design that was too institutional, did not seem to speak to the concerns of the residents and staff, and did not reflect the organization's concern for the environment. Wanting more from its building, the Way Station scrapped the plan and brought in Boulder, CO architect Greg Franta of the ENSAR Group.

Website www.way-station.com

References 14, 34, 35, 36

Contact Randy Williams, Property Manager, The Way Station, 230 West Patrick Street Frederick, MD 21701; (301) 694-0070

16. Western Pennsylvania Conservancy, Pittsburgh, PA

Green renovation of an historical building

The Western Pennsylvania Conservancy (WPC), established in 1932, is a private nonprofit land conservation organization. Its mission is to enrich the human relationship with the natural world. They work to:

- Conserve water, land and life through the permanent protection of the region's places of exceptional ecological, scenic and recreational value.
- Protect Pennsylvania from urban sprawl through community renewal in key cities and towns.
- Preserve Fallingwater (a Frank Lloyd Wright-designed house located on Bear Run in southwestern PA) as a symbol of living in harmony with nature.
- Foster land stewardship ethics, with an emphasis on youth.
- Create cooperative partnerships to promote sustainable forestry and agriculture.

In February 1996 WPC purchased the oldest office building in Pittsburgh for its new headquarters. The building, also known as the Burke Building, was built in 1836, and survived Pittsburgh's "great fire of 1845." The building officially opened in February 1997.

WPC's new headquarters is situated in the midst of office towers and buildings in downtown Pittsburgh. The building offers an opportunity to inform and educate the general public about conservation measures and environmentally responsible building design. WPC has a Resource Center on the west side of the first floor. The Center, open to the public, features information about WPC and its conservation programs, including the headquarters building renovation.

Goals

- Ownership of headquarters building.
- Provide an example of environmentally responsible building design.
- Create a healthy, productive work environment for employees.

Size 9,000 ft^2.

Features
a. Hardware

- Adaptive re-use of an 1836 building.
- Reuse of as many existing materials as feasible, including wood beams cut from elevator shafts.
- Sealed thermal building envelope.
- Natural gas-fired heater/chiller system.
- Front exterior standstone walls insulated with a rigid, one-inch CFC-free polystyrene board.
- Other exposed walls insulated with fiberglass.
- Attic insulated with blown cellulose, providing an R-38 value on the floor, and fiberglass on vertical surfaces.

b. Software

- Modernized computer equipment, reducing the amount of heat generated by office machinery.
- Lighting levels focused where needed.
- T-8 suspended fluorescent lights.
- Transoms and clerestories to direct daylight through virtually all office space.
- Water-based paints.
- Low-toxic and non-toxic floor covering (wool carpets, and downcyclable, replaceable carpets and linoleum made of powdered cork, linseed oil, wood resin, backed with burlap or jute).
- Homosote, made of recycled newsprint, to cover walls, for sound insulation and for graphic presentations.
- Refurbished metal cabinets for kitchen.

- Removed lead-based paints from tin ceiling.
- Reused window casings and shutters, dating from 1836.

The staff, committed to make the office function as sustainable as possible, has implemented the following conservation ethics:

- Use green criteria for purchases, including a minimum post-consumer content for paper products and guidelines for avoiding hazardous materials; and purchase of organically grown coffee from cooperative farms.
- Use cloth towels and napkins.
- Use non-disposable plates and flatware.
- Compost virtually all organic materials not otherwise recyclable.
- Recycle most grades of paper, glass, metals and plastic.
- Reuse copy paper where appropriate.
- Send inter-office memos through computer network.
- Keep rubbish to under one cubic foot per month for the staff of 40.

Environmental benefits

- Lighting electricity use fell from 2.4 watts of electricity to just under 1 watt per square foot.
- Natural gas heater/chiller does not produce chlorfuorocarbons, or emit sulfur oxides.
- Heater/chiller efficiently dehumidifies and cools or heats the air and sends it to one or more of 16 thermal zones in the building.
- Pollution prevention through environmentally sensitive purchases, reduction of waste, and recycling.
- Excellent indoor air quality.

Tenants

The Western Pennsylvania Conservancy has a staff of 40.

Costs and financing

WPC funded the purchase and renovation of 209 Fourth Avenue from internal funds that are to be replaced through a capital campaign. They received grants to identify and implement energy efficiency strategies and green redesign. WPC estimates an eight-year payback period for green design enhancements.

Comments

In 1997 Western Pennsylvania Conservancy received the Governor's Award for Environmental Excellence for its headquarters building. Additionally, the building was proclaimed a City of Pittsburgh Historic Review Landmark, and received the Historic Building Award from the Building and Office Management Association of Pittsburgh.

Design

WPC worked with Conservation Consultants, Inc. (Pittsburgh PA); Rocky Mountain Institute (Snowmass, CO); Landmark Design Associates Architects (Pittsburgh, PA); Carnegie Mellon University (Pittsburgh, PA), and the Vira I. Heinz Endowment (Pittsburgh PA) to design a rehabilitated building in accordance to its historical structures and use of modern energy efficient and resource conservation technologies. Cynthia Carrow, WPC's Executive Vice President and Chief Operating Officer, oversaw the renovation.

References 79, 80, 81, 82

Website www.paconserve.org

Contact Julie Lalo, Senior Director of Public Affairs, Western Pennsylvania Conservancy, 209 Fourth Avenue, Pittsburgh, PA 15222, 412-288-2777

17. World Resources Institute, Washington, DC

A green office space within a conventional leased building

The World Resources Institute (WRI) is a Washington, DC-based center for policy research and technical assistance, providing objective information and practical proposals for policy change to foster environmentally sound development. WRI works with institutions world-wide to bring the insights of scientific research, economic analysis, and practical experience to political, business, and non-governmental organization leaders.

WRI and the designers conducted a green opportunities audit of potential buildings (efficiency of systems, access to public transportation, etc.) well in advance. They looked at 35-40 buildings, which they narrowed to 8-10 before selecting the American Psychological Association's newest building. WRI occupies the building's 8th floor, and some of the 7th floor (which houses the mail and supplies, computer, lunchroom, library and three additional closed conference rooms).

The APA building is less than two years old. It is conventional, but has better than average efficiency, with sophisticated, efficient systems. It is close to Union Station (a train and subway station), has a bike/shower room, and a good recycling program.

WRI's new offices officially opened on April 27, 1999. The process took one and one-half years. Design to bidding took three months. Planning began in July 1997. The space design was finalized in July 1998.

Size 38,000 ft^2: 32,500 ft^2 on the 8th floor, and less than 5,000 ft^2 on the 7th floor.

Goals

WRI wanted open space and open offices, a healthy indoor environment with improved air quality and access to daylight. They also wanted to embrace materials from around the world, and were concerned with eliminating any Western Hemisphere bias. Major design features:

- Green materials
- Advanced communication
- Energy efficiency
- Water conservation
- Recycling

By choosing sustainably harvested and produced materials, WRI is putting its mission to protect the environment into practice ("walking their talk"). They sought to make their new office a showplace for the best and most innovative thinking in sustainable design—as the physical manifestation of some of their most deeply-held values.

Sustainably harvested and salvaged wood products are among the materials used by the designers to reflect WRI's commitment to four core themes: biological resource management, climate, equitable development, and sustainable enterprise. Much of the planning focused on energy efficiency, types of lighting and appliances and use of sensors and smart controls. Paints and finishes, countertops and flooring, cabinets and carpentry were all chosen for their environmentally friendly materials and manufacturing processes.

WRI, like many environmental organizations, believes that a healthy environment and a strong economy can coexist. WRI, which works closely with business, also wanted to recognize individual manufacturers, and features an array of products and materials.

Features
a. Hardware

Office layout: WRI wanted to foster interactivity while providing sufficient closed office space for "heads-down" research staff. The office environment features equal sharing of space and light, quiet areas for concentration, areas for informal meetings, and conference facilities for larger gatherings and video conferencing. The new office leaves the perimeter open and groups offices and work stations in the center of the building, away from exterior walls and windows. The building is long and narrow. No employee is far from a window.

Most offices are the same size and have the same access to the windows that surround the building. All are in-board—if everyone couldn't have a window, they collectively decided that no-one would. Their old building had 150-ft^2 offices. This office has 100-ft^2 offices (for the professional staff), which they elected, and one large and 16 small conference rooms and open conference areas. The 1,800-ft^2 conference room is divisible by three. 80% are closed offices, 20% are open. The space on the outside provides ample natural light that reaches all of the offices through clerestory windows set six feet high. The administrative staff and interns generally have open offices, which are smaller (60 ft^2).

HVAC: The HVAC has 13 zones, covering both floors. Individual controls were deemed too expensive.

b. Software

Lighting: Direct/indirect pendant lights. These usually are problematic and difficult (therefore expensive) to install. However, they used a Ledalight (Canada) fixture, which hangs from the ceiling grid, and can be easily installed in 20 minutes. The Ledalights have built-in sensors, and are wired to WRI's computer LAN system, such that individuals can control the lights from their computers. Ten percent of the light shines up as indirect light, and 90% shines down. Only one light fixture was needed for each 100-ft^2 office, instead of the standard 2 x 2. The light level is better, warmer. No task lights were needed. Operating costs were lower. Light switches were unnecessary.

Wood is either sustainably harvested or, in the case of the conference room doors, recycled wood. Unmatched wood (character grade, or grade 3) was cheaper. The cost savings allowed purchase of nice metal edges for cabinets and related fixtures.

All of the wood is from independently certified sources. They also use salvaged and "character-grade" sub-premium wood to make good use of material that would otherwise be considered waste. They used renewable resources, such as bamboo and cork, for the flooring in the reception area. Some woodwork comes from Plan Forestal Estatal, a community-based forestry project in Mexico using sustainable agricultural practices to build up a local industry. In the reception area, the bamboo flooring is from a new market in China, and the cork flooring comes from Portugal and Spain, where it has been produced sustainably for centuries.

Doors on all offices are 8' high and made of compressed straw. They cost no more than conventional painted wood doors.

Other materials: Ceiling tiles have a high recycled content, and have very good color reflection. Cubicle walls are covered with recycled fabric.

They have a built-in planter wall with hydroponic vines.

Carpeting: WRI's carpet supplier, Interface, an international corporation based in the United States, is attempting to build the world's first sustainable and eventually restorative enterprise with a competitive business context.

Appliances: Appliances from Asko and Whirlpool are designed to be energy- and water-efficient; they offer cost-effective commercial alternatives to standard products.

Tenants

About 130 WRI employees on both floors.

Costs and funding

The design is built within a conventional leased office space and within a standard budget. Fit-out cost about $40/ft^2 (which included cabling, phones, moving, etc.). They considered it comparable to building conventionally.

There was lots of participation from manufacturers, who provided price reductions and donations. Labor costs for installation were full price, however.

Design process

WRI sought an "inside-out" design, in which the closed offices are on the inside of the space and the open spaces are on the outside.

They used visioning sessions rather than charrettes, in order to discuss the issues rather than to provide design options. They involved about 40 staff members, in 6-7 sessions with 7-8 people each. They held a separate session early on with WRI's top management, and then held a reconciliation session (i.e. did staff have a different vision than top management?). All involved were in fairly close agreement. The resulting planning and design document became their bible.

WRI had a 20-person committee that worked with the designer, HOK, to develop the space design. They met about once a week with the designer, who also met with WRI specialists (librarian, conference manager).

Environmental benefits

WRI's state-of-the-art communications capacity reduces the need for staff to travel as often to meetings, lessening their own greenhouse gas emissions. Improvements in their internet-based communications technology let people worldwide access more of their information electronically, which helps to reduce the demand for paper and other forest products.

Comments

Construction: The contractor (Griffith Construction) and subcontractors questioned every decision. Millworkers had never worked with some of these materials before. More communication (than in conventional construction) was essential. It was a positive experience. The subcontractors were willing to learn, and got "a kick" out of working with some of the new materials. The designer had to stay on top of construction the whole time.

A milk-based paint, used on one of the walls, proved too difficult to work with.

How well does everything function? It's too early to tell, as they moved in at the beginning of March 1999. First impressions: the design works surprisingly well, according to Nancy Kiefer, the facilities manager. They are still doing HVAC air balancing and awaiting additional controls.

The building was designed for upgradability.

Designer Hellmuth, Obata + Kassabaum, PC (HOK), Washington, DC

Website www.wri.org/office/index.html

References 25, 29, 43

Contact Nancy Kiefer, Manager, Facilities and Office Services, World Resources Institute, 10 G Street, NE, Suite 800, Washington, DC 20002, 202-729-7680, nancy@wri.org

B. GREEN BUILDINGS IN PROGRESS

1. The Jean Vollum Natural Capital Center, Portland, OR

A mixed-use redevelopment of an historic warehouse building

Since 1991, Portland-based EcoTrust has worked in coastal communities from northern California to Alaska to support promising initiatives that integrate conservation and economic development. Programs include:

- EcoTrust Consulting Initiatives, to share EcoTrust's experience in publishing, natural foods and community development.
- Shorebank Pacific, the Nation's first environmental bank, in partnership with EcoTrust, makes loans to businesses that seek to improve their bottom line by improving environmental practices. Shorebank Enterprise Pacific, a nonprofit affiliate, adds conservation to the credit process.
- Interrain Pacific, a bioregional geographic information-based network that enhances EcoTrusts's ability to display and interpret the trends of the changing economic, social and natural landscape.

Initially, EcoTrust focused largely on the rural economy in the Pacific Northwest. EcoTrust has recently entered the urban environment. A first step has been to redevelop an historic building in northwest Portland.

The building, scheduled to open in spring 2001, is named for the principle philanthropist and founding EcoTrust board member Jean Vollum. EcoTrust's goals for the Jean Vollum Natural Capital Center:

- Participate in the restoration of an urban ecosystem
- Advance the arts of ecological design
- Forge new urban-rural links

The building is a two-story brick and timber warehouse (the former Rapid Transfer and Storage Company) that occupies a full block in Portland's River District. The District is targeted for dense redevelopment as part of a regional strategy to encourage compact urban growth. The formerly industrialized neighborhood offers "opportunities" to repair the environmental damage from previous uses.

Fifteen-thousand new residents are anticipated in the River District, and several housing developments are already under construction. Neighborhood plans include waterfront redevelopment, extensive retail opportunities, public parks and transportation.

A streetcar line will connect the River District with downtown Portland along Tenth Avenue, with a stop adjacent to the Natural Capital Center. Union Station, the Central Post Office, the Willamette River waterfront, and the Pearl District neighborhood are a short walk away.

Size 80,000 ft^2

Green design process

EcoTrust developed a dynamic vision of the Natural Capital Center through design charettes. The Center is intended to be a learning center, in which goods, services and ideas are exchanged, and a building that can evolve with changes in technology.

The development will respect the integrity of the 100-year-old structure, while striving to advance ecological design. Passive solar systems and low-tech solutions will optimize natural energy and light, reducing long-term operating costs. Interior spaces will be designed with a "loose-fit" enabling the center to evolve and adapt as occupants and times change. The building will be "smart-wired" to accommodate changing telecommunications and technologies.

EcoTrust will work with contractors throughout the renovation to ensure that materials are reclaimed, reused or derived from manufacturing processes consistent with the conservation economy (e.g., certified wood).

The design process includes local architects, historical designation experts, urban planners and tenants.

Tenants

The Natural Capital Center will be a marketplace, including commercial, retail, and offices of businesses and nonprofit organizations.

Patagonia, the California-based specialty outdoor clothing maker and environmental business leader, will be the anchor tenants in the Natural Capital Center. They have agreed to lease 7,000 ft^2 of the 80,000 ft^2 building.

Cost and financing

The Jean Vollum Natural Capital Center is owned by EcoTrust Properties LLC, a subsidiary of EcoTrust. Grayco Resources, Inc. provides development management services.

The total cost of the project will be approximately $12 million ($150/ft^2). EcoTrust intends to earn a reasonable return on their equity. The entire building will be financed through $6 million in grants; $3 million in program related investments; and $3 million in traditional financing.

Rental space is estimated to be at market rates.

Comments

EcoTrust has been building the foundation for the goals of the Jean Vollum Natural Capital Center through its other programs. The philosophical basis for this project, as expressed by Jane Jacobs, is, "The city has its own peculiar virtues and we will do it no service by trying to beat it into some inadequate imitation of the non city. The starting point must be a study of whatever is workable, whatever has charm, and above all, whatever has vitality in city life, and these are the first qualities that must find a place in the architecture of the rebuilt city."

References 72, 73, 75

Website www.ecotrust.org

Contact Spencer B. Beebe, Chairman, EcoTrust, 1200 NW Naito Parkway, Suite 280, Portland, OR 97209, 503.227.6225, Fax. 503.219.8604

2. The Cleveland EcoVillage, Cleveland, OH

A national demonstration site

Cleveland's EcoVillage is a national demonstration project to develop a model urban village that will realize the potential of urban life in the most environmentally sensitive way possible. The EcoVillage will unite the latest green building ideas with New Urbanism movement thinking.

Rationale

Older cities like Cleveland are now being redeveloped, and it is vital top EcoVillage that this take into account ecological design and long-term sustainability. This project can create a model for other neighborhoods in Cleveland and for other cities across the nation. Cleveland can become a "green" city, and improving the quality of urban life can reduce pressures for urban sprawl.

Partners

The Cleveland EcoVillage project is a partnership between the Detroit Shoreway Community Development Organization (a leading neighborhood development corporation) and EcoCity Cleveland (an environmental research and planning organization). The project will involve the Greater Cleveland Regional Transit Agency, private developers, the City of Cleveland and other neighborhood development organizations and environmental organizations.

Location

The EcoVillage planning area centers on the W. 65th Street Rapid Station and surrounding neighborhood on the west side of Cleveland. It is an ethnically diverse community with residents of low to moderate incomes. Development opportunities include the Rapid Station, adjacent commercial strip, nearby church campuses, and vacant lots for in fill housing. Existing homes and businesses could be rehabilitated.

Design Concepts

The EcoVillage can become a transit-centered village, with mixed-use developments, centered on the light-rail transit station, higher density housing in proximity to transit, and pedestrian/bicycle links. Neighborhood programs for recycling, urban gardening, habitat restoration, environmental education and the development of environmental businesses and jobs are envisioned.

Funding Sources

The George Gund Foundation, Katherine and Lee Chilcote, and the Cleveland Cityworks program have supported initial planning for the EcoVillage. The Environmental Protection Agency has provided funding for the project manager. Future phases will be supported through foundations, federal agencies, financing through utilities, location efficient mortgages, and investments by private developers.

Accomplishments to Date

- Completed feasibility study and site selection process that evaluated sites throughout the City of Cleveland.
- Once the Detroit-Shoreway neighborhood was selected, the partners cultivated support of the neighborhood. In December 1997 a design charette was held to solicit ideas for the project's conceptual plan.
- City Architecture developed the conceptual plan.
- October 1998 David Cornicelli hired as Project Manager.
- Spring 1999 Purchase of first property for re-development.
- Plans for model housing units developed.

Contact David Cornicelli, Cleveland EcoVillage Project Manager, Detroit Shoreway Community Development Organization, 6516 Detroit Avenue, Cleveland, OH 44102; 216. 961.4242; ecovillage_cleve@hotmail.com

References 74, 114

3. Belmont Bay Harbor and Town Center, VA

Belmont Bay is a 302-acre development in Prince William County, VA, 18 miles southwest of Washington, DC, adjacent to the Occoquan Bay National Wildlife Refuge and the Occoquan River. It is a planned mixed-use development combining residential, office, retail, and recreational uses interspersed among an 18-hole golf course. The golf course is designed to be a buffer and provide storm runoff treatment. At the heart is a Town Center, a 60-acre new ecovillage of sorts similar in layout to Georgetown or Old Town Alexandria, with a grid of traditional streets. A 158-slip enclosed marina, currently under construction, is the focus of the harbor and should generate a demand for office/retail space for marina management offices, boat brokerages, boating services and marine retail stores. Belmont Bay is close to the Virginia Railway Express Woodbridge Commuter Rail and Amtrak Station.

Dominant features include views of the Occoquon River, direct access to the riverfront, and proximity to rich environmental resource areas. The adjacent Occoquan Bay National Wildlife Refuge comprises 643 acres of neighboring upland meadows, wetlands, and natural preserves. The environmental master plan calls for designing the village to fit with the adjacent new National Wildlife Sanctuary, which is part of the Mesa Neck system.

Groundbreaking for the town center is to begin in late spring 1999. The planning process has taken ten years, delayed largely by the rezoning process. The County approved the Belmont Bay Town Center plans on May 19, 1999.

The area outside of the planned town has some existing homes, built in the 1950s, and new housing construction that began in 1995 (these houses, close to the Woodbridge railroad station, are conventional).

Several green buildings are planned for the Town Center. A September 1998 Belmont Bay Visioning Workshop (in which the Woodbridge Institute for Sustainable Development, Prince William County staff, the Environic Corporation International, and potential development partners participated), concluded that physical facilities should be constructed as a living example of sustainable development—practical demonstrations of the interdependence and interrelationships of people and nature:

1. A major marine ecological research and education facility, to be situated at the harbor front, with access to moored research and education vessels. This building is conceived as a mixed-use facility, combining university-level research and education with office functions and exhibition spaces open to the public. The building is to be a multifaceted, roughly 90,000 ft^2, three-floor structure. About one-third will house George Mason University's Aquatic Ecology and Marine Biology program. Other tenants may include:

Prince William County Public Schools, the US Fish and Wildlife Service (as an education center), Prince William County Watershed Management Division, Virginia Department of Conservation (Recreation), Virginia Department of Environmental Quality, the Keystone Institute (an East Coast teacher training in sciences component) and the Woodbridge Institute for Sustainable Ecosystems.

Size: 90-120,000 ft^2
Cost: $20 million. For-profit, debt-financed, to be built and owned by Belmont Developers, and leased by the state of Virginia.

2. An aquarium to be set alongside a unique wetlands site. The aquarium will provide an integrated, low impact, interactive educational and resource facility for primary, secondary, and university programs as well as public exhibit and assembly space for community and outreach events.
   Size: 80-90,000 ft^2, capable of hosting 1 million visitors/year
   Cost: $40 million
3. A Science Center along the Occoquan River.

   Size: 60-75,000 ft^2

Other buildings include a 10,000 ft^2 interpretive center, a for-profit IMAX theater, and an outdoor mesocosm. Two organizational structures have been proposed:

1. A single organization responsible for securing all funding, management and operations of the facilities. Belmont Bay Development can build all the facilities. Other organizations involved would be tenants of the center's main leaseholder.
2. Multiple organizations under one governing body. Individual facilities would be developed independently.

Costs and funding

The entire Belmont Bay development is expected to cost $250 million.

The main developer is the Belmont Bay Development Corporation. Carruthers Development is the builder. A Woodbridge Refuge Committee is helping to foster public/private partnership, including Friends of Woodbridge Refuge.

The effort has received funding from the Chesapeake Bay Foundation and a foundation established by the developers (Preston Carruthers). The Woodbridge Economic Development Group and the Friends of the Woodbridge Refuge, as members of the Woodbridge Refuge Committee, are working with the U.S. Fish and Wildlife Service to establish programs at the Woodbridge Research Facility and Refuge. In doing so, the Committee is pursuing start-up funding for the site. Funds are expected to come from a combination of private and public initiatives.

Prince William County's (VA) Waterfront Action Plan

Belmont Bay is part of Prince William County's (VA) Waterfront Action Plan to enhance, promote, and provide access to the County's historical, cultural, recreational, and environmental assets along the Potomac River and Occoquan River waterfronts. The Plan targets the County's waterfront for quality economic development, environmental education and protection, recreation, and tourism, and includes:

- A general inventory of the waterfront's physical and historical features.
- A framework plan for road, bike and bridge connections.
- Two new towns on the Belmont Bay and Cherry Hill peninsulas, which are privately owned development areas along the waterfront.

Public access to individual waterfront assets along the Occoquon and Potomac Rivers is cumbersome and disjointed. The plan calls for improved signage and completing a riverfront roadway and bike paths to provide access to scenic views, parks and environmental resource areas along the rivers.

Objectives:

- Encourage significant, high-quality private investment in privately owned areas along the waterfront. Private investment will help the county progress toward its goal of a 25% non-residential tax base-a key to the county's economic competitiveness.
- Enhance preservation of environmental assets on the waterfront. Environmental protections ore in place today—such as the Chesapeake Boy Preservation Act-that would not hove existed if the County had considered the waterfront plan a decade ago.
- Establish a new level of expectation for public and private development with appropriate development standards that enhances, maintains and promotes the environmental and cultural integrity of the waterfront area.
- Establish a higher level of County environmental review for projects that affect water, wetland and forest resource areas by applying existing environmental protection measures and developing others when necessary.
- Promote the use of environmental protection tools to assure environmentally sound development.
- Increase environmental education (K-12, university-level and community) by cultivating public awareness of the natural and cultural waterfront assets through active community learning programs.
- Identify locations for environmental education programs.

References 85, 86, 87, 88

Contact Dennis Shifflet, Woodbridge Institute for Sustainable Development, 703-765-1089, dshiflett@mindspring.com

4. The Millennium Building, Washington, DC

A 27-year old commercial building undergoing a green renovation.

Size 12 stories, 240,000 ft^2

Owner Tower Companies, Rockville, MD

Designer
Boggs & Partners Architects, Sigal Construction Corp, contractor.

Cost
The green renovation features add about 10-15% to the cost of the $40 million project, but that's not factored into rents. The owners estimate that rents, to be determined by the market, will be about $30/$ft^2$--about average for the DC commercial real estate market.

Tenants are required to comply with the building's environmental standards. Mayer Brown & Platt, a Chicago-based law firm, is moving their DC office into the building. They considered the environmental standards as a plus when they rated the building. They probably would have done many of the requirements on their build-out anyway.

The owners noted that cost-conscious developers don't often pursue this approach, especially on speculative projects such as this one, which began without any commitments from tenants. They hope the Millennium Building will serve as an example of how buildings should be built in the 21st Century.

Reference 89

Contact 1909 K Street Northwest, Washington DC

5. Four Times Square, New York City, NY

This new $500 million office tower is in the heart of Manhattan's most famous commercial district. It is the first speculative office tower to be built in Manhattan since 1988. It is also the first skyscraper to embrace standards for energy efficiency, indoor air quality, sustainable materials, and responsible construction, operations and maintenance procedures. Commercial and retail tenants are encouraged to participate as responsible residents of this unique building. To that end, a library of green information and environmental guidelines was distributed to tenants and their architects. Operational costs are expected to be 10-15% lower than a comparable conventional project. Douglas Durst, president of the development company, considers Four Times Square "a shining example for the commercial real estate community." Many others have felt that, until the commercial sector adopts green building techniques, it will be difficult to open up the market for green building.

The building is leased primarily to Conde Nast publishing and Skadden Arps law firm. It will be ready to be occupied in late 1999.

Size 48 stories, 1.6 million ft^2.

Lighting

DOE-2 energy simulation modeling software was used to select preferable lighting systems. Lighting strategies include LED signage, occupancy sensors and fiber optics. The building facade is largely glass, providing excellent daylighting opportunities. Windows have high visible light transmittance glass with a shading coefficient of .30.

Energy Efficiency

Again, DOE-2 energy simulation modeling software was used to maximize energy efficiency strategies. The central cooling plant runs on natural gas. Direct-fired absorption chillers and heaters use no CFCs or HCFCs. The payback time for this equipment is approximately three

years. Other features include variable speed drives, VAV systems, and direct digital control and monitoring.

The building also generates fuel cell and photovoltaic power. The building is currently planning for two fuel cells to be located on the fourth floor. The fuel cells will generate enough electricity to cover the building's base load at night. Fuel cells are non-polluting, producing only hot water and CO_2 as by-products.

Photovoltaic panels are located in the spaces between rows of windows on the southern and eastern facades on the top 19 floors of the building. The PV installation is expected to generate 15 kW/hour of power.

Indoor Air Quality

Four Times Square will circulate 50% more indoor air than required by New York City code. Outside air enters the building at 80' and 700' to avoid street exhaust. The air is filtered and monitored, and is delivered at .20 cfm per square foot. An additional .05 cfm can be delivered at the tenants' request. Floor-by-floor air handling equipment allows individualized control and purge capability. A dedicated exhaust shaft will be provided to vent smoking and equipment rooms. Periodic air monitoring of tenant spaces will be conducted through permanent tubing. Suggested guidelines for finishes and furnishing were distributed to all tenants.

Waste Management

A careful waste management plan for demolition and construction was based on detailed estimating from all contractors. Detailed accounting of packaging, waste on site, recycled content and recyclability was required for all contractors. Base building materials were specified with recycled or recyclable materials. Separate waste chutes and adequate space for storage on the loading dock were provided. In addition, the project team, including owner, architect, engineer and construction company, have used electronic document transfer whenever possible.

Materials & Products

Products came from:

- Tate Access Floors, Inc. (access floors, carpet tile, underfloor air delivery systems)
- Dupont Flooring Systems (carpet tile)
- Gage Corporation Inc. (decorative recycled aluminum metal ceilings)
- Rochester Midland Corporation (environmentally safe cleaning supplies)
- Hudson-Schatz Painting Co. (wall covering, paint)
- Enersave (fuel cells, energy efficient systems)
- C.F. Rutherford & Associates (furniture)
- EcoWork (furniture)
- Steelcase WorkLife New York (furniture)
- Carrier Corporation (HVAC equipment)
- Trane Company (HVAC equipment)
- Hi-Rise Recycling Systems (compactors, chutes, materials separation systems)

Contacts

Architect: Fox & Fowle Architects, New York City
Construction: Tishman Construction Corporation, New York City
Construction & Demolition Recycling: Pamela Lippe, New York City
Energy Advisor:

- Rocky Mountain Institute, Snowmass, CO
- Natural Resources Defense Council, New York City
- Steven Winter Associates, Norwalk, CT Environmental Consultant:
- Ambient Labs, New York City
- Asher Derman, PhD, New York City

Developer: Durst Organization, New York City
Structural/Mechanical Engineering: Cosentini Associates, New York City
Water Conservation: Greene Mechanical Corporation, Bronx, NY
Northeast corner of Broadway and 42nd Street
New York, NY

References 4

6. National Wildlife Federation, Reston, VA

The National Wildlife Federation is the nation's largest member-supported conservation group. Their mission is to educate, inspire and assist individuals and organizations of diverse cultures to conserve wildlife and other natural resources and to protect the Earth's environment in order to achieve a peaceful, equitable and sustainable future.

NWF is planning a new headquarters building in suburban Reston, VA. They are in the process of developed schematics design and details. It will be a class B office space (low cost, standard) that should cost about $55/ft^2. They plan to move in late 2000.

NWF, like the Nature Conservancy, is not after a green building per se. They do not want to replicate the Audubon House experience, which focused so much attention on the building that it diluted the organization's conservation image. NWF, in seeking cost-effective green features, is willing to consider a longer payback (than for conventional), provided there is a payback. For them, this is a green building dilemma. If it takes money away from their conservation mission, green building, however environmentally sound, is not worth it to them.

Size 100,000 ft^2

References 25, 90

Contact Wayne Schmidt, Special Assistant To The President and Construction Project Director
8925 Leesburg Pike, Vienna, VA 22184; 703-790-4000; www.nwf.org

VIII. SUMMARIES OF OTHER GREEN BUILDING CASE STUDIES

A. ACADEMIC, NONPROFIT AND TRIBAL ORGANIZATIONS

1. Bicentennial Hall, Middlebury College, Middlebury, VT

This new multi-disciplinary science facility provides additional student laboratories and work space. The departments of Biology, Chemistry/Biochemistry, Geography, Geology, Physics and Psychology, plus a new science library, will all be housed in the new facility. Half of the lab space will be shared among disciplines to maximize flexibility, and reflects the growing need for cross-disciplinary work in the sciences.

Recycled and natural products include linoleum flooring (made from wood flour and linseed oil), mineral rock-wool insulation (spun slag, a byproduct of iron smelting), and third-party certified sustainable wood (the largest academic construction project in the country to do so). Much of this timber will come from members of Vermont Family Forests, a SmartWood-certified organization that cultivates the economic and socioeconomic benefits of family-owned forests in Vermont, keeping local economies strong.

The structure is steel girders, reinforced concrete and a load-bearing exoskeleton made of four-inch-thick limestone. The limestone came from Ontario, Canada, because of how it is mined (earth is replaced after extracting the shallow-lying material). The whole wall supports itself. The building's broad architecture minimizes its visual impact, since a narrower structure would seem to loom much taller on the horizon. Inside, a 30-foot by 65-foot glass wall in the central lounge will face the Adirondacks.

Middlebury College is an independent, residential, liberal arts college with 2,160 students.

Construction cost: $36,500,000 ($166/ft^2)
Size: 220,000 ft^2 (gross)
Design period: 15 months
Construction period: 24 months
Completion date: September, 1999 (projected)

References 47, 48, 49, 50

2. Center for Energy and Environmental Education, University of Northern Iowa, Cedar Falls, IA

The UNI Center for Energy and Environmental Education adjoins a tall-grass prairie and forest preserve, emphasizing the relationships between buildings, education, the environment and people. The building uses about one-third as much electricity as other campus buildings. By incorporating daylighting design and passive solar heating, the architects minimized the need for

conventional electrical power and heating fuel. They also chose building materials that require a minimum of energy to produce and transport, and low-maintenance and low toxicity finishes.

In 1991, the university received a U.S. Department of Energy grant to build an educational facility that would model the potential for greater harmony among energy use, building materials and the environment. The primary design goal was to minimize electricity consumption for lighting. An elongated design along an east/west axis maximizes exposure to the sun on its path through the southern sky and avoids the glare of low-angled rays from the east and west as the sun rises and sets.

The 6,500 ft^2 of windows are low-e argon-filled insulating glass. Glass on the south side has a high transmission value (shading coefficient of .75, and east and west sides a low shading coefficient (.55) to reduce glare and heat gain. Daylighting provides adequate illumination during most daylight hours. Advanced lighting controls work with daylight to reduce electricity consumption by keeping fluorescent lamps turned off when not needed. There are occupancy sensors for electric lighting in each room.

Size: 29,300 ft^2
Construction Cost: $3 million ($102/ft^2)
Date completed: Fall 1994

Energy efficiency features

- R-30 to R-40 ceiling (extruded polystyrene and polyisocyanurate rigid foam insulation).
- R-20 walls (extruded polystyrene sandwiched between structural block and exterior brick).
- Low-e, argon filled windows.
- High-efficiency lighting equipment and controls optimize electric lighting use.
- Energy management system shuts off zones when not in use.
- Recycled carpeting and insulation materials.
- Low embodied energy in windows and construction materials.

ENERGY COSTS	**Reference**	**UNI Center**	**Savings**	**% Reduction**
Heating	$2520	$2520	$0	0%
Cooling	$3080	$1400	$1680	53%
Lighting	$7000	$1680	$5320	77%
Fans/Pumps	$2520	$560	$1960	76%
Other Electric	$1960	$1960	$0	0%
Total	$17,080	$8120	$8960	37%

Environmental health features

- Continuous ventilation system to control air quality and humidity
- Minimal paint and carpeting

References 51

3. Center for Environmental Sciences and Technology Management, State University of New York, Albany, NY

The Center houses research laboratories, a business incubator, and the National Weather Service regional forecasting office. Site orientation and fenestration design maximizes solar efficiency.

Goal: transferring research and environmental technology from the laboratory to commercial applications.

Design: two wings connected by a three-story rotunda.

The Center has a 15 kW solar photovoltaic system designed as building-integrated sunshades. Reducing cooling loads and work-area glare, the Kawneer 1600 PowerWall Slope Glazed System is comprised of Solarex ac PV modules that generate electricity to power ventilator fans and emergency lighting. Another 5 kW array of ac PV modules is set in landscape elements south of the building.

Dedicated: 1997

References 55, 56

4. Durant Middle School, Raleigh, NC

Design goals:

- Design the best possible learning and working environment for the students, teachers and staff.
- Cut energy use by one-half to two-thirds relative to existing NC schools.

In North Carolina, lighting accounts for about one-quarter of the total energy load. Cooling accounts for another quarter. The largest energy load is ventilation.

Daylighting was the prime design objective. Daylighting reduces energy use for lighting, which helps reduce cooling loads because lighting generates heat. To achieve optimal daylighting, the architects oriented the school lengthwise on an east/west axis and placed north facing and south-facing monitors on the roof. Sunlight entering each classroom from above is diffused by a series of baffles integrated in the root monitor, causing natural light to spread evenly throughout the middle of the room. The roof has a radiant barrier that reflects over 90% of the radiant heat from

overhead. High-use areas have advanced lighting controls—motion sensors and light-level sensors in the ceiling to adjust the fluorescent lights relative to daylight.

The ventilation system in most schools operates all the time. At Durant, an integrated energy management system heats, cools and ventilates the school using natural gas for heating and an electric chiller for cooling. This system adjusts fresh air circulation to building occupancy, reducing the energy load for ventilation by about one-third. Although the annual heating load, which is a small portion of the total energy use, is higher for the Durant school (because of the greater proportion of windows), the lighting and cooling loads are dramatically lower.

Energy

60 percent overall reduction in total energy load.

Cost: Construction cost was $12.3 million, or $82.50/ft^2 (low for NC schools). Roof monitors and added glazing area added $230,000 to the cost, which was offset by the downsized cooling and electrical systems and energy savings of $165,000/yr.

Size: 1 story, 150,000 ft^2. About 1,300 students and their teachers.

Date completed: June 1995

Reference 52

5. Union 32 High School classroom, Montpelier, VT

The local junior/senior high school was overcrowded. Instead of renting portable classrooms, which tend to have financial, thermal and environmental problems, some in the community proposed building two classrooms themselves. One goal was to create a model for community-building. The project brought the community together around a school-related issue (rather than dividing it over school tax issues). Over 300 volunteers, including parents, students, teachers, professional builders and others supplied most of the labor, and the project has given the community a sense of empowerment.

One goal became, therefore, simplicity. The resulting building has a simple shape and (mostly) typical construction techniques. Another design goal was to provide a positive learning environment, incorporating natural daylighting, good ventilation, comfortable temperatures, and energy efficiency. A third goal was low cost, because the school board had budgeted only for setup and one year's rent of portable classrooms. These constraints dictated inexpensive materials and simple construction techniques.

The main school building's orientation is along a southeast/northwest axis. Placing the new building perpendicular to this gave a long side facing southeast, which makes good use of the sun for daylighting during the morning until about mid-afternoon, matching the school schedule. A band of fixed windows at the top of the southeast wall allows sun to enter the building, where it strikes light shelves. Windows below the light shelf and on all other sides of the rooms also

provide much daylight even on cloudy days. All windows below the light shelf are equipped with pull-down roller-shades to reduce glare. The southeast facing windows provide some passive solar heating.

All the lights have high-efficiency T-8 fluorescent tubes with automatic-dimming electronic ballasts.

They sealed the concrete slab, which became the finish floor, instead of carpeting, to keep dust and mold from collecting. Lumber came from local forests.

Annual energy expenses for the building are projected at just over $800, vs. over $1,500 for a reference typical building, and even higher for a portable classroom.

Building cost: just under $50,000 (under $30/ft^2). This includes some purchased labor, such as excavation, plumbing and electrical. This was less than the cost of setup and two years' rental of portables.
Size: 1,680 ft^2
Construction began: May 1996
Construction completed: August 1996

Reference 53

6. Union of Concerned Scientists, Cambridge, MA

UCS, having outgrown its rental space, purchased the top two floors of an old six-story building. Virtually all decisions were not predicated on cost or energy savings, but on providing the greatest comfort and quality for staff.

The windows begin at desk height, with insulated opaque surfaces below the sills and between the floors to improve building energy efficiency and to enhance thermal and radiative comfort below desk level. They installed double-hung windows so that employees could control ventilation in their work areas. The roof was a white membrane with enhanced insulation to improve upper floor efficiency and comfort.

HVAC: Electrically driven heat pumps are in a multi-zone configuration for heating and cooling. Heat is provided by an energy-saving (Caravan) gas-fired boiler (which also preheats the outside air portion of the fan-forced ventilation air), while a cooling tower mounted on the roof dissipates the heat during the summer cooling cycle. With support from Cambridge Electric, they installed a fully proportional variable speed motor control on the cooling tower fan drive, to maximize efficiency of operation and to minimize the demands upon the utility.

The two UCS floors have two-speed ultra-high efficiency Florida Heat Pumps. With four on each floor, and separate thermostatic control of each, the interior climate conditioning can follow the sun during the day, and be tuned to employee preference. The building's inherent energy efficiency building allowed the use of residential-sized (2- to 5-ton) heat pumps.

The building's major window-walls face northwest and northeast, providing natural shading protection through most of the working day merely from orientation. The interior design employs glass partitions in enclosed offices, as well as some open plan areas, to provide for maximum daylight penetration from the perimeter to the interior. This also adds to the perception of spaciousness.

Ceiling height constraints permitted single-lamp ceiling-mounted parabolic luminaires for all working areas. These are designed for minimum reflected computer glare. The reception and all circulation areas have compact fluorescent wall sconces. Controllable electronic ballasts operate all office and open plan area lighting.

Total thermal and lighting systems use 30-45 percent less energy than the ASHRAE recommended standards for efficient office buildings, and significantly lower than for conventional construction in the Cambridge, MA area.

In 1996, UCS installed a 2.5 kW photovoltaic array on the roof.

Size: 10,000 ft^2 (two floor of a six-floor 30,000-ft^2 building)
Cost: \$50/ft^2, well below the cost of more conventional outfitting of other floors of the same building.
Completed: July 1994

Reference 54

Two Brattle Square, Cambridge, MA 02238, (617) 547-5552

7. Wampanog Tribal Headquarters, Martha's Vineyard, MA

The Wampanog headquarters includes office space, a kitchen, large and small meeting rooms, health facilities, a library and display areas.

Goals:

- As little impact on the natural environment as possible. The tribe has always been environmentally sensitive, and wanted their tribal headquarters to reflect that.
- Honor a sacred, powerful site.
- Use low impact, environmentally sustainable technologies.

The tribe wanted integrated planning and construction. They hired a construction superintendent rather than a general contractor to oversee the entire process.

The north wall is set into the south-facing hillside. One story is above grade on the north and two stories are above grade on the south. A large deck and second story windows provide an ocean view. The siting and orientation shield the building from the harsh winter winds and cold and give it maximum exposure to the sun. Sixty-five percent of the window area faces south, which allows a good amount of passive solar heating. The R-22 walls are 2x6 construction. The

vaulted ceilings are insulated to R-40. All windows have low-e, argon-filled glazings, optimized for different orientations—south windows transmit more solar radiation than most low-e glazings; windows on the other three sides reduce summertime heat gain while providing good visible light transmittance.

Light shelves combine with south-facing windows to reflect sunlight deep into the first-floor work spaces, which are open to maximize natural light. Photosensors dim and raise lighting levels relative to available daylight. Electric lighting usage is so low that the heat load from internal sources is smaller than in most commercial buildings. This together with good insulation, low-e glazings and appropriate window placement and building orientation eliminated the need to install mechanical cooling except in the copier room, which needs dehumidification. Air quality in this tightly constructed building is maintained by a heat recovery ventilation system, which operates continuously so that each room always receives fresh air.

The building has other resource-efficient, salvaged and recycled materials such as tile made from recycled glass, carpet made from recycled plastic bottles, insulation made from recycled styrofoam containers and natural linoleum flooring. They used low-toxicity paints and finishes and non-adhesive floor covering installation.

A waterless composting toilet and graywater system, which includes extensive plantings in deep-soil beds, converts all human waste and wastewater to resources used within the building. In addition, tenants recycle.

Energy bills for a reference case building would be about $13,200 per year. The Wampanoags spending about $5,600 a year for energy use (a 53% savings).

Construction cost: $1,150,000 ($134/ft^2)--about average construction cost for commercial facilities of comparable size and quality in similar off-shore locations. The solar/energy efficiency features added only about $39,000 to the cost of the million-dollar Wampanoag building, so the tribe is saving a minimum of $7,600 each year in return for their initial extra investment of $39,000. This gives them a simple payback time of a little over five years.

Size: 8,600 ft^2
Completed: 1994

References 57

B. SHARED NONPROFIT SPACE

1. The Association Center at 120 Wall Street, New York, NY

Began operation
1992

Tenants
38 nonprofit groups

Building manager
Silverstein Properties, a for-profit real-estate company.

Financing
The New York City Economic Development Corporation designated the building to be turned into a condominium for non-profit groups, offering special tax breaks to reduce the tenants costs.

What nonprofit groups pay
Non-profit tenants receive free rent for the first year: after that rents begin at $16.74 per square foot and climb to $22.74 per square foot. (Businesses pay $25 per square foot to be in the same building.) They also receive 50-100% tax abatements on leased space and exemptions from occupancy taxes. Non-profit tenants also receive a $35/ft^2 allowance to do renovations when they move in.

What it offers
600,000-square-foot 34-story tower in Manhattan's Financial District looking out over the East River. There are no shared facilities.

Comments
The project began to keep the existing base of nonprofits in the city, and not moving elsewhere because of high real estate costs. The building is fully occupied. Two-thirds of the building is filled by nonprofits.

The Association Center is the city's only official office building for nonprofit organizations.

A monthly roundtable discussion is held with tenants, in which organizations share information with each other. The concept has been successful.

References 18, 20

2. Community Service Building, Wilmington, DE

Began operation
1997

Tenants
40 non-profit groups, plus headquarters for the Longwood Foundation and several DuPont Company offices.

Building manager
The Community Service Building Corporation, a non-profit organization

Financing
The Community Service Building Corporation bought the building from DuPont for $1 million. The Longwood Foundation provided about $8.5 million toward the $23 million cost of renovation and construction. Businesses and other private donors provided the rest of the money. DuPont donated one building as the site, and another building for a parking facility. DuPont is also leasing several floors in the new CSB for five years to provide cash flow for the project.

What nonprofit groups pay
$8 a square foot, about 50% below market value. Utilities are included in rental fees.

What it offers
Good office space (a twelve-floor, 176,000-ft^2 building with five conference rooms) and parking in a desirable address in downtown Wilmington at below-market rates. Tenants obtain shared resources, including maintenance, utilities and services, board and conference rooms, a copy center and bulk purchasing. These provide savings that are passed on in service.

Comments
The project has been a collaborative process from its inception in 1993.

References 18, 20

3. Marlan Center, Milwaukee, WI

Began operation
1992

Size
60,665 ft^2

Tenants
16 nonprofit groups

Building manager
The Sisters of St. Francis of Assisi

Financing
The Sisters of St. Francis of Assisi gave $260,000 to turn a former Catholic school into office space. They spend about $225,000 a year to operate it.

What nonprofit groups pay
Ranges from $4.46/ft^2 to $7/ft^2, depending on how much charities can afford about. This is about 50% below market rates. Utilities are included in the rent.

What it offers
Turn-of-the-century, historic building overlooking Lake Michigan. Tenants have the use of three meeting rooms, an auditorium, and a gym that can be rented for $20 an hour.

References 18, 20

4. The Red Cross Building, Ogden, UT

Began operation
1997

Size
22,000 ft^2

Tenants
Seven non-profit groups housed, plus the Dr. W.C. Swanson Family Foundation

Building manager
The Dr. W C. Swanson Family Foundation

Financing
The Swanson Foundation paid $350,000 to buy the building from the Red Cross and spent more than $1.5-million to demolish it and construct a new building in its place. The fund now provides $65,000 in annual operating costs.

What nonprofit groups pay
$6 per square foot, about one-third of market value. Utilities are included in the rental fee.

What it offers
a conference room that can be used by all tenants Also has video and teleconferencing facilities, a library, and a resource center with a computer that offers Internet access.

Comments
The Red Cross had been in a rundown building with a leaky roof and malfunctioning air systems. They spent $5,000 a month just to maintain the facility. Red Cross approached the Dr. W.C. Swanson Family Foundation in Ogden for a $20,000 grant to help make critically needed repairs. Instead, the Foundation bought the Red Cross building for $350,000, demolished it, and opened a complex at the same site that now houses its own headquarters and seven other nonprofit groups. It donated $1.5-million on the project and spends about $65,000 annually to subsidize operating costs for tenants.

References 18, 20

5. The Robert Woodruff Volunteer Service Center, Atlanta, GA

Began operation
1997

Tenants
32 nonprofit groups

Building manager
The United Way of Metropolitan Atlanta

Financing
The Robert Woodruff and the Joseph B. Whitehead Foundations gave a total of $3.2-million to the United Way of Metropolitan Atlanta to help buy the $8-million building.

What nonprofit groups pay
Average rental is $11.50 per square foot, about 35% below value. Utilities are included in the rental fee.

What it offers
300,000-square-foot building in downtown Atlanta. Tenants can share the United Way's board room.

Comments
The local Boys & Girls Club and Big Brothers/Big Sisters group, which are on the same floor, have cut expenses by sharing a receptionist. They have also started influencing each other's programs. Big Brothers/Big Sisters has guided the Boys & Girls Club through its screening process for volunteers, and the Boys & Girls Club has helped Big Brothers/Big Sisters involve children in the clubs' activities.

References 18, 20

6. Wilson Historic District, Dallas, TX

Began operation
1981

Tenants
33 nonprofit groups selected to represent a variety of organizations, plus the Meadows Foundation.

Building manager
The Meadows Foundation.

Financing
The Meadows Foundation provided almost $50-million for land, facility acquisition and

restoration of historic Victorian homes and warehouses for office space. It has also provided about $25-million over the past decade (averaging $3 million each year) to operate the buildings, primarily for property upkeep and maintenance, including a complex security system involving retired police officers who circle the complex in unmarked white cars 24 hours a day.

What nonprofit groups pay
Their own utility bills; all other costs (maintenance, security, landscaping, parking) are paid for by the Meadows Foundation.

What it offers
22-acre complex includes a park, a conference facility equipped with audio-visual equipment, and a kitchen that can be used to prepare food for large meetings. Tenants are offered management and technical assistance, including free courses on topics ranging from managing nonprofit investments to working with volunteers (other organizations must pay).

Comments
In 1981, the Meadows Foundation purchased and restored several turn-of-the-century Victorian homes in a deteriorated neighborhood. The focus was on creating a neighborhood of nonprofit agencies using rent-free office space to encourage collaboration and improved agency operations. Meadow's original intent with the project was to help turn around a seedy neighborhood racked by drug dealing and violent crime. The Wilson Historic District, part of which is listed on the National Register of Historic Places, now has colorful homes and landscaping, meticulously restored to the neighborhood's former grandeur. A zero tolerance policy toward drug dealers and other criminals has solved many of the neighborhood's problems. Real-estate values have increased, and about 20 charities are on the waiting list for space in the district.

Both the meeting space and the seminars have raised the charities' level of professionalism, making them more attractive to other grant makers, potential volunteers, and the people they serve.

The district is considered the first foundation-created communal-housing arrangement for charities.

References 18, 20

7. New Brunswick Development Corporation

Began operation
(Planned)

Tenants
Organizations with a health care or child-related focus. How many nonprofits will participate has not been determined.

Building manager
(TBD)

Financing
The New Brunswick Development Corporation (Devco), with the help of Johnson and Johnson. Johnson and Johnson provided the initial seed money to establish a base for a national effort to draw nonprofits to New Jersey and is underwriting what is anticipated to be a self-supporting effort. To date, Johnson and Johnson has donated $250,000.

What nonprofit groups will pay
Cost has not been determined.

What it will offer
By encouraging nonprofits to relocate to New Brunswick, Devco envisions a scenario where professional capabilities are expanded through a variety of shared facilities and professional services, where costly operations like database management, mail room operations and graphic design are centralized.

Comments
Devco is hoping the project will be a magnet for organizations' regional chapters or state headquarters.

A prototype of three organizations housed in one building is currently underway. Devco planned to see its first shared building in place in 1997.

References 18, 20

8. Preble Street Resource Center, Portland, ME

Began operation

Tenants
Five nonprofits and outreach services for several dozen more

Financing
PSRC had to raise the money on its own, which was difficult. They knew that in the long run they would be financially better off and would be able to provide more accessible and coordinated services, but first they had to come up with the capital funds. At the time, PSRC had an annual operating budget of $120,000 and no capital budget. They tried raising funds in the community, but did not obtain much. Mercy Hospital contributed $200,000, and opened a clinic in the building. That contribution helped PSRC gain credibility. At about the same time, the City of Portland contributed $100,000. In two years, PSRC was able to come up with $800,000 and although it has a $170,000 mortgage on its building, the minimal rents have not been raised in four years.

What nonprofit groups pay
What people can afford and what services are needed determine rents.

Comments
The Community Resource Center project originated when a small group of grassroots organizations recognized they were facing similar circumstances of limited space and inefficient operations. As the lead organization in the effort, Preble Street Resource Center (PSRC) is now the owner of the building.

References 18, 20

9. Greenpoint Manufacturing & Design Center, Brooklyn, NY

A group of woodworkers forced out of Manhattan by escalating real estate prices in the early 1980s set up shop in city-owned, abandoned net and twine factory, taking advantage of affordable space and the neighborhood's skilled work force, largely West Indian and Eastern European immigrants. The woodworkers agreed to manage the dilapidated property for the City, but as they attracted more small-shop owners like themselves over the years, the arrangement became unwieldy. The City, which had taken over the complex for back taxes, would rent to them only month by month, and refused to invest anything in the crumbling structures. Working with local politicians and neighborhood groups in the late 1980s, the woodworkers launched the nonprofit Greenpoint Manufacturing & Design Center (GMDC) and persuaded the city to turn the buildings over to them 1994, to the Greenpoint Center's Local Development Corporation (LDC). The City sold the property and the LDC utilized funds from City-assisted programs for the rehabilitation and environmental cleanup. The City removed all toxic compounds from the building, and the LDC has assisted the Center's tenants to shift to water-based wood coating technologies that reduce their environmental compliance costs, and to recycle the substantial wood waste generated within the Center.

The City/nonprofit arrangement saved the 21 businesses threatened by the building's projected demise. The Center has since more than doubled in size, creating many new business and job opportunities. From its original employment level of 110, the Center has grown to over 60 businesses with nearly 300 employees. In addition to building fine cabinets, the group also creates entrepreneurs and blue collar jobs.

Size
360,000 ft^2, in an eight-building complex—a warehouse built in the 1880s.

Tenants
Over 300 workers in 64 tenant companies, 26 of which are woodworking shops. The rest include metalworking, glassblowing, finishing and restoring shops, sculptors, jewelry designers, and photographers

Building manager
The Center is managed by a group of woodworking manufacturers, craftspeople and artisans who formed the corporation to purchase the buildings.

Financing

In 1992 the North Brooklyn Development Corporation, which helps community members find employment, the building manager, a few real estate and finance experts, and the more than 50 tenants put together the Greenpoint Manufacturing & Design Center Local Development Corporation, and applied to purchase the complex. They bought the property from New York City in 1994, for one dollar.

This industrial area organized its own self-help association to assist existing enterprises in obtaining the technical and financial assistance necessary to enable them to remain competitive within a metropolitan area, where costs of doing business are high. Funding comes from public and private financing and on the proceeds from rent. Banks, private foundations and utilities underwrote one-time predevelopment costs. State government covered the cost of providing business and resident services, such as ESL classes, environmental compliance training and computer instruction and technology upgrading. City and federal government have funded real property improvements and capital projects.

The City gave the buyers $1 million in emergency funds (which GMDC hasn't spent). The group is responsible for bringing the entire building up to code, and now pays the City $136,000 in payroll and other taxes each year. Grants from corporations such as J.P. Morgan ($40,000), foundations, and local utilities go towards improving the tenants' services.

What nonprofit groups pay

Tenants are charged a small hourly fee to use the equipment, which goes toward overhead costs and buying more machines.

What it offers

Educational and environmental services to tenants and residents, such as a business-assistance center, which includes a conference room, computer lab, a small library, and copy and fax machines. A $350,000 communal woodshop was built for the tenants, making equipment available that many couldn't afford. They offer classes ranging from computer-aided drafting to English. Working with the Board of Education, GMDC is also training a handful of teenagers who haven't performed well in high school in woodworking.

Many businesses share employees and bid on jobs together, leading some to dub the Center "business without borders."

Comments

The Center is an arts and industry complex. It hopes to create a community-based employment and education "fulcrum" that can meet the needs, interests and commitments of the participating businesses, employees, and residents.

Tenants often team up on large, multi-discipline projects, which require pooling talent.

When the building is finished, it will house 450-500 workers, three-quarters of whom will be from Greenpoint, a mostly Polish, working-class community of 37,000.

Public Advocate Mark Green has offered a two-pronged proposal that could use economically targeted investing to help GMDC and other New York City manufacturers. There are some 4,000 acres of brownfields in the city—about one-fifth of the city's roughly 20,000 total acres of manufacturing-zoned land. Green is trying to encourage the city to allocate some of the $200 million in money available for brownfields cleanup under the state's 1996 Environmental Bond Act to reclaim that land. Then if a firm wants to build a factory, the New York City Economic Development Corporation can lend it money, backed by federal community development loan guarantees, and sell the loan to one of the city's public employee pension funds. New York City has drawn on only $40 million of up to $1.2 billion in federal loan guarantees.

APPENDIX 1. GREEN BUILDING-RELATED WEB-SITES, PROGRAMS AND REFERENCES

1. US Government

Department of Energy

Exemplary Buildings Program
www.nrel.gov/research/buildings/exempbld.htm

Reducing Building Energy Consumption by Integrating Passive Solar Technology with Energy Efficient Building Design.

The Program advocates building energy efficiency through improved design. This process begins during the building's conceptual design and continues until the building is commissioned. The Program encourages architects and engineers to work with NREL researchers to maximize a building's potential energy savings. The Program provides the following services:

- Research of innovative Passive Solar and Energy Efficient design techniques
- Assistance to building designers when developing and analyzing building energy simulations to ensure an exemplary building design
- Aid in developing better design techniques using computer simulation tools
- Assistance to designers, owners, and occupants to monitor building energy use and verify that the building has met the original targets for energy consumption
- Certification for Exemplary Buildings
- Publication (case studies, technical reports, etc.) of selected Exemplary Buildings certified by the program
- Promotion of effective new building technologies and concepts Exemplary Buildings must meet at least one of the following criteria:
- Solar technologies satisfy at 75% or more of the building's energy demand
- Energy consumption is 70% less than an equivalent building built to meet the Federal Energy Code 10CFR435 (based on ASHRAE Standard 90.1) or the Home Energy Rating System (HERS) reference building
- Solar technologies reduce energy consumption by at least 30% for retrofit and renovation projects

Denver Regional Support Office
1617 Cole Boulevard
Golden, CO 80401
(800) 357-7732; (303) 275-4826; (303) 275-4830/fax
sustainable.development@hq.doe.gov

The Center customers include communities, towns and cities, as well as the federal, state, and local government agencies involved in community development. The center defines communities as cities, villages, towns and neighborhoods, as well as national parks, industrial parks and other "communities of interest." The mission is to provide communities with consultation on sustainable development, and to help them connect to other public and private programs that can assist by:

- defining what sustainable development is and how it can apply to specific organizations and communities;
- demonstrating how sustainable development is being practiced by other urban and rural communities across the nation;
- providing organizations with access to "tool kits" consisting of manuals, workbooks, data bases, case studies, and model codes and ordinances;
- helping communities identify public and private sources of technical and financial assistance.
- providing communities with information about the public participation processes other communities have found work best in planning and implementing sustainable development; and
- developing a menu of energy efficiency and renewable energy programs that fit the unique needs of individual communities.

Building Measurement and Verification Protocol
1000 Independence Avenue SW
Washington, DC 20585
(800) 363-3732

Promotes efficiency financing through a reliable means of measuring and ensuring savings from efficiency investments. Provides information on commissioning and recommissioning.

Greening Federal Facilities
www.eren.doe.gov/femp/greenfed/

Provided by Federal Energy Management Program (FEMP) of the U. S. Department of Energy, Greening Federal Facilities is a resource guide for Federal facility managers to assist them in reducing energy consumption and costs, improving the working environment of the facilities they manage, and reducing the environmental impacts of their operations. The guide highlights practical actions that facility managers, design and construction staff, and facility planners can take to save energy and money, improve the comfort and productivity of employees, and benefit the environment.

Lawrence Berkeley National Laboratory
1 Cyclotron Road
Berkeley, CA 94720
(510) 486-5000
Home Energy Saver
www.lbl.gov

Provides information on building energy analysis, building science, modeling software, high-performance windows, lighting, and more. LBL's Center for Building Science is an international leader in developing and commercializing energy-efficient technologies and analytical techniques and in documenting ways of improving the energy efficiency and indoor environmental quality of residential and commercial buildings. The *Center for Building Science News*, a publication of the Environmental Energy Technologies Division from 1993 through 1998, has been replaced by *Environmental Energy Technologies Division News*, whose first issue appeared in Spring 1999.

National Renewable Energy Laboratory (NREL)
1617 Cole Boulevard
Golden, CO 80401
(303) 275-4099

A resource center that maintains a library of technical and popular reports on residential, commercial, utility, industrial, and transportation uses of renewable energy.

NREL's Exemplary Building Program
exemplary.buildings@nrel.gov

The NREL/EBP advocates building energy efficiency by developing designs that use passive solar, renewable energy, and energy efficient technologies. The program encourages teams of builders, developers, architects and engineers to prioritize energy efficiency throughout the entire design, construction, commissioning and operation processes. An exemplary building uses energy wisely, which leads to lower operating costs. The NREL/EBP provides:

- Research on innovative passive solar/energy efficient design techniques.
- Assistance to building designers for developing and analyzing building simulations to ensure an exemplary building design.
- Aid in developing better design techniques using computer simulation tools.
- Assistance to designers, owners, and occupants to monitor the building's energy use and to verify that the building has met the original targets for energy consumption.
- Certification for exemplary buildings.
- Publication (case studies, technical manuals, etc.) of selected buildings certified by the program.
- Promotion of effective new building technologies and concepts.

An exemplary building meets at least one of the following criteria:

- Solar technologies satisfy 75% or more of the building's energy demand.
- Energy consumption is 70% less than an equivalent building built to meet the Federal Energy Code 10 CFR 435 (based on ASHRAE Standard 90.1) or the Home Energy Rating System (HERS) reference building.

Exemplary buildings use advanced-design passive solar concepts to meet these criteria. Design tactics are specific to different climates and include taking full advantage of available solar

radiation through building orientation and window size and location, increasing the thermal mass of the building walls and floors, and using day lighting as an integral part of the lighting systems. High efficiency mechanical systems suitable for the climate and building use (evaporative cooling, cogeneration, etc.) are designed to complement the passive solar features in the building. Exemplary buildings may also have active solar and photovoltaic systems, xeriscaping, wind energy conversion systems, solid waste management systems, recycled building materials, potential for recycling building components when the building is demolished, and other energy efficient and renewable technologies.

Photovoltaics
www.eren.doe.gov/pv/
www.nrel.gov/ncpv/

Million Solar Roofs Initiative:
www.eren.doe.gov/millionroofs/

National Energy Information Center
U.S. Department of Energy EI-30
1000 Independence Avenue SW
Washington, DC 20585
(202) 586-8800 (202) 586-0727/fax

Disseminates energy statistics to federal, state, and local agencies, the academic community, industrial and commercial organizations, and the public.

Solar Energy Conversion Equipment/Systems Suppliers
www.eren.doe.gov/millionroofs/yellow.html

Federal Energy Management Program (FEMP)
www.eren.doe.gov/femp
www.eren.doe.gov/femp/ordermaterials.html

Cities and Counties Related Web Sites
- Info briefs
www.eren.doe.gov/cities_counties/
- Cool Cities/Roofs
http://eande.lbl.gov/heatisland

Energy Efficiency and Renewable Energy Network (EREN)
Provides objective information to the public on issues concerning energy-efficiency and renewable energy. Gives users a gateway to information and resources from national laboratories and other organizations. Funded by DOE, operated by NCI Information Systems, Inc.
www.eren.doe.gov/

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
PO Box 3048, Merrifield, VA 22116
1-800-363-3732
doe.erec@nciinc.com

EREC responds to phone, mail, and electronic inquiries ranging from simple requests for information to complex technical queries and requests for energy-related business development assistance.

Department of Energy, Office of Energy Efficiency and Renewable Energy's (EERE) Web site information network. Funded by the U.S. Department of Energy, and operated by the National Renewable Energy Laboratory.

Environmental Protection Agency

Center For Environmentally Responsible Development
Urban And Economic Development Division
401 M Street, SW
Washington, DC 20460
(202) 260-2769; (202) 260-0174 fax

Promotes environmentally responsible development by influencing major sectors or activities (e.g., architecture, development, construction, brownfields redevelopment, mortgage lending, and building materials manufacturing) that affect regional growth and economic development. Encourages more environmentally responsible growth and development by helping to demonstrate community tools, increase access to capital, act as an information center, and by promoting positive change at the state and local levels.

Energy Star Buildings Program
www.epa.gov/buildings/

EPA's Energy Star Buildings program is a voluntary energy-efficiency program for U.S. commercial buildings and focuses on profitable investment opportunities available in most buildings using proven technologies. The Energy Star Buildings Upgrade Manual, available online from this site, is a guide for Energy Star Buildings Partners to use in planning and implementing profitable energy-efficiency upgrades in their facilities. Case studies of partners' success in implementing ENERGY STAR Buildings upgrades are available on the web site, along with downloadable software that aids the planning, management, tracking, and reporting of building upgrades.

Indoor Air Quality Information Clearinghouse
U.S. Environmental Protection Agency
P.O. Box 37133
Washington, DC 20013-7133
(800) 438-4318; (202) 484-1307
(202) 484-1510/fax

Provides information, referrals, publications, and data base searches on indoor air quality. Information includes pollutants and sources, health effects, control methods, commercial building operations and maintenance, standards and guidelines, federal and state legislation, and construction and maintenance of homes and buildings to minimize IAQ problems.

General Services Administration

GSA Design Excellence Program
18th & F Street, NW, Suite 4329
Washington, DC 20405
(202) 501-0887; (202) 501-1446; FAX (202) 501-3296

GSA is the Federal Government's landlord. It builds, operates, and maintains office buildings, court houses, border stations, laboratories, warehouses, and other federal facilities. GSA currently owns approximately 1,600 buildings and leases another 8,000. This administration designs buildings to be life-cycle cost-effective and to meet or exceed current ASHRAE standards.

US Department of Housing and Urban Development

Office Of Community Viability
Energy Division
451 Seventh Street, SW
Washington, DC 20401
(202) 708-0614, FAX: (202) 708-3363

HUD seeks to expand homeownership and affordable housing opportunities to lower-income people. Recognizing that energy efficiency is a key component of an affordable housing strategy, HUD and DOE created the DOE-HUD Initiative on Energy Efficiency in Housing. This joint program is designed to share the results of DOE's energy research with housing providers throughout the nation, thus reducing energy costs and improving the affordability and comfort in federally subsidized housing. The initiative, begun in 1990 as a five-year effort, implemented 27 projects. Two new programs continue: The Energy Partnerships for Affordable Homes, a DOE-HUD collaborative program, and the NCAT Clearinghouse for Energy Efficiency in Public and Assisted Housing.

US Commerce Department

National Institute of Standards and Technology (NIST)

Building and Fire Research Laboratory, Building Environment Division.

NIST conducts underlying research, much of it comparing predicted vs. actual results that can lead to new technologies in energy efficiency. The Building Environment Division began a Green Building Research and Demonstration Program in 1994. As part of that program, grants were given to Montana State University to evaluate a variety of green technologies that could be

incorporated into the design and construction of a new classroom/laboratory building for the campus. The Division reduces the cost of designing and operating buildings and increases the international competitiveness of the U.S. building industry by:

- Providing modeling, measurement, and test methods needed to use advanced computation and automation effectively in construction, to improve the quality of the indoor environment, and to improve the performance of building equipment;
- Conducting laboratory, field, and analytical research on building mechanical and control systems.
- Developing data, measurement methods and modeling techniques for the performance of the building envelope, its insulation systems, building air leakage, and the release, movement and absorption of indoor air pollutants
- Developing software performance criteria, interface standards, and test methods needed for the Nation's building industry to make effective use of modern computer-aided design hardware and software, and database management systems.

NIST's Building for Environmental and Economic Sustainability (BEES) software (see below) identifies building products that improve environmental performance. Building Environment Division groups:

- Indoor Air Quality Group: Develops computer simulation programs and measurement procedures to better understand air and contaminant transport phenomena in buildings.
- Thermal Machinery Group: Identifies and characterizes new atmospheric-safe refrigerants and refrigerant mixtures that contribute to energy-efficient refrigerant applications.
- Heat Transfer Group: Develops basic data and simulation models for heat, air and moisture transfer through building envelope components. It also is responsible for the development of heat pump and water heater test procedures.
- Mechanical Systems and Controls Group: Improves and lowers the cost of building services by fostering the development and use of more intelligent, integrated, and optimized building mechanical systems and controls.
- Computer-Integrated Construction Group: Develops rational techniques for defining and testing computer representations of information needed throughout the building process, from the conception of a building to its demolition.

2. State government

e Design Online
http://fcn.state.fl.us/fdi/index.html

Articles on sustainable development, high-performance buildings, building commissioning, working on the web; reviews of books, videos, and Web sites addressing best practices in community and facility design and operation; and a calendar of events. Published by the Florida Design Initiative sponsored by the Florida Energy Office. The mission is to help those who design, own, and use facilities and communities reorient toward new standards of practice that

include the design and construction of high-performance, energy-efficient, and sustainable buildings and communities through best design practices, commissioning, and life-cycle costing.

The Governor's Green Government Council
Commonwealth of Pennsylvania
www.gggc.state.pa.us
(See Appendix 3)

http://www.gggc.state.pa.us/
An annotated bibliography of green technology-related documents available at the Pennsylvania DEP/DCNR Central Library, Rachel Carson State Office Building.

3. Other Countries

Canada
Green Building Information Council
http://greenbuilding.ca/GBIC.htm

The Council is a nonprofit organization that focuses efforts on building energy and environmental performance at a national level. It will promote inter-governmental and inter-disciplinary cooperation and take the lead in technological development and information transfer. The Council considers promotion of "green" building practices a timely and practical exercise, since leadership in this area will strengthen the position of Canadian consultants and manufacturers in the international marketplace. The Council has the support of major Canadian organizations, including Environment Canada, the Royal Architectural Institute of Canada, the Association of Consulting Engineers of Canada, the International Institute for Sustainable Development and others.

The Council will complement existing skills and minimize overlap and competition with other organizations. Their goals are to find and deliver relevant information, promote an inter-disciplinary approach to environmental performance and to influence key decision-makers in the building industry. Some specific objectives include:

- Help establish mid- and long term energy and environmental performance goals for the Canadian building stock, and strategies for achieving these goals.
- Encourage the continuing development of building performance labeling systems such as the BEPAC and assist in the adoption of regional and international variants.
- Help develop consensual procedures and specifications for the quality management of the design and construction process and for the commissioning of building systems, and promote their adoption.
- Assist in developing standards of training and certification for building commissioning agents and for building labeling assessors.
- Develop and implement an intensive and sustained campaign of technical Information, training and education relating to building quality and performance. aimed at all relevant disciplines and the public.

TheC-2000 Program for Advanced Commercial Buildings
http://greenbuilding.ca/C2000/abc-2000.htm

This is a small demonstration program for high-performance office buildings, developed and sponsored by the CANMET Energy Technology Centre (CETC), Natural Resources Canada. The program emphasizes energy and environmental performance, but criteria have been developed for a wide range of other parameters. The program was launched in 1993, and thirteen buildings have been designed, some of which have been built, while others are in, or approaching, construction. The goal is to demonstrate the feasibility of achieving a high level of energy and environmental performance through the application of modern technologies. While the program has undergone continuous evolution in its structure, several elements have remained constant: the provision of incremental financial support and technical assistance to a small number of development teams for the design who agree to conform to the program's whole-building performance requirements. The program assists in the completion of projects that meet the performance criteria, to monitor their actual performance and to inform the industry of the results. Although the C-2000 program was limited to office buildings, the program criteria were applied to a program for multi-residential buildings called Ideas Challenge, which was jointly operated by CETC and the Canada Mortgage and Housing Corporation, Canada's national housing agency.

(CANMET Energy Technology Centre seeks to accelerate the development and use of clean, energy efficient conventional, alternative and renewable energy technologies, domestically and in the global marketplace. www.nrcan.gc.ca/es/etb)

The Building Research Establishment Environmental Assessment Method (BREEAM) was first introduced in England in 1993 to help building managers understand and improve the environmental performance of their buildings. The procedure, which also became available for commercial office buildings in Canada in late 1996, examines and evaluates all aspects of office operations that have an environmental impact and recommends areas of improvement. In addition to such direct impacts as energy, water, paper usage, indoor air quality, and waste management, the program addresses commuting, business travel, and working at home. The process takes just a few days (five days for a 150-person office) and can offer significant savings for both the company and the environment. In Canada, the environmental consulting firm ECD Energy and Environment Canada, Ltd. administer BREEAM. For information, contact:

ECD Energy and Environment Canada, Ltd. 165 Kenilworth Avenue Toronto, Ontario M4L 357
(416) 699-6671; (416) 699-9250 (fax)

4. Associations and NGOs

Alliance to Save Energy
1200 18th Street NW, Suite 900
(202) 857-0666 (202) 331-9588/fax

Promotes the efficient use of energy as a means to strengthen America's economy, improve the environment, make housing more affordable, and move the country toward energy independence.

Provides materials on home energy rating systems, building codes, efficient new construction and design. Programs include increasing the efficiency of new and existing residential, commercial and federal buildings, encourage the use of energy-efficient lighting by small- and medium-sized businesses, evaluate and support utility-sponsored consumer education programs, ensure that energy efficiency is considered in energy policy decisions, promote a more level playing field for energy efficiency investments, help small and medium-sized manufacturers improve energy efficiency, give companies that provide energy efficient products and services a voice in national and regional affairs, encourage communication among industry leaders, policy makers and the media to increase support for energy efficiency issues, and increase trade and investment opportunities for US businesses operating in developing countries.

American Council for an Energy Efficient Economy (ACEEE)
1001 Connecticut Avenue NW, Suite 801
Washington, DC 20036
(202) 429-8873
(202) 429-2248/fax

Publishes books and papers on industrial, commercial, and residential energy efficiency.

American Institute of Architects (AIA)
1735 New York Avenue, NW
Washington, DC 20006
Phone: (202) 626-7300, (800) 365-ARCH (for publications only)
aia@aia.org
www.aia.org

AIA's Committee on the Environment (COTE) works to create sustainable buildings and communities by advancing, disseminating, and advocating environmental knowledge and values to the profession, the industry, and the public. Members provide the volunteer resources and expertise by helping to guide architects toward sound ecological and economic decisions. AIA's *Environmental Resource Guide* is a comprehensive compendium of information on environmentally responsive design with a life-cycle focus on the environmental effectiveness of building materials.

American Institute of Building Design
991 Post Road East
Westport, CT 06880
Phone: (203) 227-3640
Fax: (203) 227-8624

The AIBD is a professional organization involved in the design of residential buildings. The AIBD offers the quarterly publication *Design Line* to members, and seeks to influence legislation affecting the building industry. The AIBD also provides technical referrals from its membership to individuals seeking a building design professional.

American Planning Association
1776 Massachusetts Avenue, NW, Suite 400
Washington, DC. 20036
(202) 872-0611; FAX: (202) 872-0643
www.planning.org

APA and its professional institute, the American Institute of Certified Planners, foster the growth of planning (physical, economic, and social) at the local, regional, state, and national levels. Encourages planning that contributes to the public's well-being by developing communities and environments that meet the needs of people and society in an effective, sustainable manner. As such, APA promotes the development of sustainable buildings and communities.

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329-2305
(404) 636-8400
(404) 321-5478/fax

ASHRAE provides research, standards writing, and continuing education. Their sole objective is to advance the arts and sciences of heating, ventilation, air conditioning, and refrigeration for the public's benefit. The Society publishes a monthly journal, *ASHRAE Journal*.

ASHRAE sets energy efficiency standards and provides a public review and comment period when new standards are drafted. ASHRAE is authorized under EPA to set energy efficiency standards for all U.S. commercial buildings, which must be adopted by states. ASHRAE revises its standards every five years. The goal of the original ASHRAE 90.1 Standard is to "recogniz[e] advances in the performance of various components and equipment,...[and] to encourage innovative energy-conserving designs;" and to "minimize the use of energy without constraining the building function nor the comfort or productivity of the occupants."

American Society of Landscape Architects
4401 Connecticut Avenue, NW, 5th Floor
Washington, DC 20008
(202) 686-2752; FAX (202) 686-1001

Promotes environmentally sound designing and planning of parks, recreation areas, new communities, transportation enhancements and systems, residential developments, urban plazas and pedestrian areas, commercial centers, campuses, and waterfront developments. Landscape architects also develop conservation, protection and interpret plans for protected areas and historic landscape plans and provide reclamation and restoration planning, stormwater and non-point source pollution mitigation planning, among other services.

American Solar Energy Society (ASES)
2400 Central Avenue, G-1
Boulder, CO 80301
(303) 443-3130; Fax: (303) 443-3212
ases@ases.org
http://ases.org/index.html

Disseminates and transfers research on practical uses of solar energy, wind power, and photovoltaics and other renewable energy sources. ASES fosters communication among various solar professionals and organizes an annual national solar conference. The ASES/PSIC Buildings for a Sustainable America Education Campaign is a nationwide effort to make policymakers, building professionals and consumers more aware of the benefits of applying sustainable energy principles to building design and construction. The Society has a bimonthly magazine, *Solar Today*.

Association of Energy Engineers
4025 Pleasantdale Road, Suite 420
Atlanta, GA 30340
Phone: (770) 447-5083
Fax: (770) 446-3969
info@aeecenter.org
www.aeecenter.org

The Association of Energy Engineers (AEE) publishes numerous handbooks on a wide variety of energy technologies and energy management techniques. The AEE also conducts seminars, conferences, and certification programs for energy and environmental professionals. The AEE can provide referrals to appropriate AEE members for individuals and companies seeking professional assistance. The Association publishes the newsletter *Energy Insight* three times per year.

Buy Recycled Business Alliance

2408 N. 67th Street, Wauwatosa, WI 53213
Phone: 414.453.1077
Fax: 414.453.0526
wbrba@aol.com
www.buyrecycled.org

Center for Maximum Potential Building Systems, Inc.
8604 FM 969
Austin, TX 78724
Phone: (512) 928-4786; Fax: (512) 926-4418
cmpbs@greenbuilder.com
www.greenbuilder.com

A nonprofit ecological planning and design firm that works with public entities, professional organizations, community groups, universities, and individuals in pursuit of sustainable development policies and practices for undertakings ranging from individual buildings to entire regions. Their objective is to enhance the environmental and economic performance of projects, while strengthening local economic development. The Center emphasizes the integration of building systems with climatic design techniques, resource conserving utility systems, and regionally appropriate building materials.

Center for Resourceful Building Technology (CRBT)
P.O. Box 100
Missoula, MT 59806
(406) 549-7678
(406) 549-4100/fax
crbt@montana.com
www.crbt.org

Performs research and educates the public on a variety of issues related to housing and the environment, with particular emphasis on innovative building materials and technologies that place less stress on regional and global resources.

Center for Renewable Energy and Sustainable Technology (CREST)/Sustainable Energy & Development Online (Solstice)
http://solstice.crest.org/

Certified Forest Products Council
14780 SW Osprey Drive, Suite 285
Beaverton, OR 97007
Phone: 503.590.6600
Fax: 503.590.6655
cfpc@ix.netcom.com
www.certifiedwood.org

City of Austin Green Building Program
Planning, Environmental & Conservation Services Department
P.O. Box 1088,
Austin, TX 78767-9949
512.499.3029
Fax: 512.499.3518
www.greenbuilder.com
(See Appendix 3)

Energy Center of Wisconsin
595 Science Drive Madison, WI 53711-1060
608.238.4601
Fax: 608.238.8733
ecw@ecw.org

Energy Design Update
P.O. Box 1709-Ansonia Station
New York, NY 10023
Phone: (212) 662-7428
Fax: (212) 662-0039
ned.nisson@energy.com
www.cutter.com

Energy Design Update (EDU), a monthly newsletter, provides information on energy-efficient housing, energy research, and green building design and construction. It also serves as a professional referral service. It maintains a list of subscribers, categorized according to services provided and geographical location. EDU provides a link between qualified subscribers and people seeking the services of builders, architects, designers, or consultants specializing in energy-efficient building design and construction.

Energy Efficient Building Association, Inc.
1300 Spring Street, Suite 500
Silver Spring, MD 20910
Phone: (301) 589-2500
Fax: (301) 588-0854
info@eeba.org
www.eeba.org

The Energy Efficient Building Association, Inc. (EEBA) is a nonprofit organization that provides a broad range of building technology information. The Association supplies information on energy-efficient housing design, construction, and operation, as well as information on products and research related to energy-efficient buildings. EEBA members include the general public, building industry professionals such as builders, contractors, engineers, architects, utility representatives, educators, and government representatives. They publish a quarterly newsletter, *EEBA Excellence*.

Energy Outreach Center (EOC)
Olympic Renewable Resources Association
512 East 4th Avenue
Olympia, WA 98501
(360) 943-4595
(360) 943-4977/fax

Provides information on efficient building design and construction, renewable energy, and transportation planning.

Environmental Building News
Route 1, Box 161
Battleboro, Vt. 05301
(802) 257-7300; Fax: (802) 257-7304
www.ebuild.com/index.html

A monthly newsletter for current information on green building design and construction, ecological issues, book reviews, and sustainable resources.

Environmental Law Institute
1616 P Street, NW, Suite 200
Washington, DC 20036
(202) 939-3839; FAX: (202) 939-3868
keiner@eli.org
www.eli.org

Provides research, publications and training programs for a board constituency of environmental professionals in government, industry, private law firms and environmental groups. Its work on sustainable development includes research studies and reports recommending legal and policy changes for promoting sustainability, both in the United States and in other countries. In Virginia, ELI has published *The Blueprint for Sustainable Development of Virginia* (1994) and *Building on the Blueprint* (1996).

Environmental Resources and Sustainable Building Technology Guide
www.nwbuildnet.com/nwbn/environmental.html

Sponsored by NorthWest BuildNet, this site is a guide to environmental and sustainable building news, resources, organizations, and hazardous and toxic waste data. See the Builders Environmental Guide for information on companies and organizations, events, experts, and energy efficiency topics. Also available from this site are guides to environmental publications particularly relevant to builders. The NorthWest BuildNet parent site serves as an online guide to a wider range of construction resources in the Pacific Northwest.

Environmental Defense Easy Tips You Can Use to Make Your Office "Greener"
www.edf.org/pubs/EDF-Letter/1998/Sep/o_office.html

Green University Program
George Washington University
Institute For The Environment
Rice Hall, Suite 603
2121 I St., NW
Washington, DC 20522
(202) 994-2277

The Program began as a grassroots movement to implement sustainable practices into all aspects of life at GWU. In 1994, GWU and the EPA formed a partnership. The Institute for the Environment was created to carry out the program. Its mission is to commit the resources and expertise of the University to create a sustainable future. The program efforts will infuse a strong, positive environmental ethic into all activities, including education, research and service, while developing sustainable facilities on the GWU campuses.

Global Green, USA
1600 South Main Street
Los Angeles, CA 9029-3600
310-577-1885; FAX: 310-577-1886
ggusa@globalgreen.org
www.globalgreen.org

Global Green USA, the American affiliate to Green Cross International, works in cooperation with individuals, industry, and government to promote sustainable development. Its follows the guiding principles of Green Cross International: building the capacity to prevent and respond to human-made environmental disasters; creating resource-efficient, sustainable communities, and creating a global value shift through environmental education and the media. Global Green recently established the Greening Affordable Housing Initiative to promote resource-efficient, sustainable communities across the globe. The first step is the Environmental Initiative Partnership (EIP), created in conjunction with Habitat for Humanity's International Department of Environment. EIP assists Habitat affiliates by providing guidance in the designing, building, and maintaining of resource-efficient, affordable housing through education, training, and resource development.

The Green Building Products and Materials Resource Directory
www.recycle.net/recycle/ncra

This database was prepared by the North Carolina Green Building Council (NC GBC), a part of the North Carolina Recycling Association, formed in 1994 to promote more resource efficient practices within the building industry. (See Appendix 3)

Green Seal
1730 Rhode Island Ave, NW, Suite 1050
Washington, DC 20036
(202) 331-7337; FAX: (202) 331-7533

Helps organizations and individuals make environmentally responsible choices. Identifies environmentally responsible products with a Green Seal of Approval. Hundreds of products now bear Green Seal's environmental seal, including paper products, appliances, office equipment, paints, cleaners, chemicals and dozens of other common products, both individual and institutional consumers are attacking many of the world's most pressing environmental problems.

Habitat for Humanity International
Environment Initiative
Department of Environment
121 Habitat Street
Americus, Ga. 31709-3498
(912) 924-6935; FAX: (912) 928-3655

Habitat for Humanity is a non-profit, ecumenical Christian organization committed to building simple, decent houses for those who need affordable shelter. The Environmental Initiative is an education and training program that supports the thousands of volunteers who organize and maintain Habitat affiliates. The Initiative assists affiliates in providing houses that are resource-efficient and easy to build and maintain. The volunteers raise the funds, procure the land, select and work with a family in need of shelter, and design and build the house.

Institute for Environmental Negotiation
Department of Urban and Environmental Planning
Campbell Hall
University Of Virginia
Charlottesville, Va. 22903
(804) 924-1970; FAX: (804) 924-0231
ed7k@virginia.edu

In 1981, IEN was established at the University of Virginia to provide mediation and consensus building services to governments, citizen organizations and businesses dealing with conflicts and complex policy choices related to land use and the natural and built environments.

Local Government Commission (LGC)
1414 K Street, Suite 250
Sacramento, CA 95814
(916) 448-1198
(916) 448-8246/fax

Helps communities to be proactive in their land planning and encourages the adoption of programs and policies that lead to more livable land-use patterns. Center programs can help jurisdictions increase transportation alternatives, reduce infrastructure costs, create more affordable housing, improve air quality, preserve natural resources, and restore local economic and social vitality.

National Association of Home Builders (NAHB)
1201 15th Street, NW
Washington, DC 20005
Phone: (800) 368-5242
Fax: (202) 822-0400
info@nahb.com
www.nahb.com

A national trade association for residential construction professionals. The NAHB provides a variety of services to its members, including information on energy-efficient building design. NAHB has 160,000 members, including more than 50,000 builders who build more than 80% of all US homes.

National Association of Home Builders Research Center
400 Prince George Boulevard
Upper Marlboro, Md. 20774-8731
(301) 249-4000; FAX: (301) 249-0305

The research center was founded in 1964 as a separately incorporated, wholly-owned, not-for-profit subsidiary of the NAHB. The center studies all aspects of home building, and tests and certifies building products. Its programs benefit home builders and home buyers. With funding from the US Department of Energy, the center launched a national voluntary energy efficiency program for new homes in 1992. The program is designed to achieve a 50% reduction in the amount of energy used in home heating and cooling by the year 2000. The research center assists local home builders' associations (HBAs) throughout the US to create more energy-efficient homes. The center built a Resource Conservation Research House in the NAHB Research Home Park. The house is built of products containing recycled materials, less precious materials, energy-saving products, and products requiring less maintenance.

National Institute of Building Sciences, Building Environment and Thermal Envelope Council
1201 L Street NW, Suite 400
Washington, DC 20005
(202) 289-7800
(202) 289-1092/fax

Identifies and coordinates research and other programs on building envelope energy, the indoor environment, thermal energy performance, and new technologies and construction techniques.

Oikos
Iris Communications, Inc.
482 East 53rd Avenue
Eugene, OR 97405
Phone: (800) 346-0104 or (541) 484-9353; Fax: (541) 484-1645
iris@oikos.com
http://oikos.com/
Resources for Environmental Design Index: www.oikos.com/redi/index.html

A source of information for energy-efficient and environmentally friendly construction including back issues of the *Energy Source Builder* newsletter, Resources for Environmental Design Index (REDI) database of green building materials, and the Iris Catalog of books, videos and software for green design and construction. Operated by Iris Communications, Inc.

Passive Solar Industries Council
1511 K Street, NW, Suite 600
Washington, DC 20005
Phone: (202) 628-7400
PSIC@aecnet.com
www.psic.com

Promotes the use of energy-efficient passive solar design and construction. Provides information on solar building design and retrofit issues, daylighting, insulation, and windows. It offers professional training, consumer education, and analysis tools nationwide, in addition to publications, software, and videos on passive solar design.

Public Technology, Inc.
1301 Pennsylvania Ave., NW
Washington, DC 20002
(202) 626-2441; FAX: (202) 626-2498
http://pti.nw.dc.us

PTI is a research and demonstration organization that focuses on the development of new technologies for local governments. PTI's sponsoring organizations are the National Association of Counties, National League of Cities, and the International City/County Management Association. For the past 15 years, PTI has been working on developing sustainable buildings and providing technical support for local government projects that deal with energy conservation and renewable energy policies. PTI has also published the *Local Government Sustainable Building Guidebook* and the *Sustainable Buildings Technical Manual*. In addition, PTI sponsors workshops on sustainable building techniques

Rocky Mountain Institute (RMI)
1739 Snowmass Creek Road
Snowmass, CO 81654-9199
(970) 927-3851 (970) 927-3420/fax
www.rmi.org

Fosters the efficient and sustainable use of resources as a path to global security. RMI focuses its research on several interlinked areas, including energy, transportation, green development, water and agriculture, economic sustainability, and security, all supported through a vigorous media outreach. Applying end-use/least-cost principles to real-estate, RMI's Green Development Service works with real-estate and building professionals to promote cost-effective, state-of-the-art practices that save resources, create more compact and efficient communities, produce comfortable and healthful interior spaces, enhance productivity, and improve developments' financial performance. RMI's Green Development Service consulting work has included the high-profile "greening" of the White House and a feasibility study for a similar renovation of the Pentagon, a "green" prototype store for the nation's largest retailer, environmentally responsive student housing, a model redevelopment of an inner-city site, and the relocation of a flood-stricken town. In addition, GDS helps demonstrate the profitability of green development through books and papers, and produces educational tools for designers and developers.

Scientific Certification Systems (Certified Sustainable Wood Products)
1939 Harrison Street, Suite 400
Oakland, CA 94612
510.832.1415 Fax: 510.832.0359
www.scs1.com

Smart Wood Program (Certified Sustainable Wood Products)
C/o Rainforest Alliance
65 Bleeker Street
New York, NY 10012
212.677.1900
Fax: 212.677.2187
smartwood@ra.org

Solar Energy Industries Association
122 C Street, NW, 4th Floor
Washington, DC 20001-2109
(202) 383-2600, Fax: (202) 383-2670
www.seia.org

The Solar Energy Industries Association (SEIA) provides information on solar manufacturing, contracting, and design is available SEIA publishes the quarterly, *Solar Industry Journal*.

Solstice
info@crest.org
http://solstice.crest.org/

This site provides energy efficiency, renewable energy, and sustainable technology information and connections including the Solar Energy Research and Education Foundation (SEREF) and the Straw Bale Mailing List. Operated by the Center for Renewable Energy and Sustainable Technology (CREST).

Southface Energy Institute
241 Pine Street
Atlanta, GA 30308
(404) 872-3549 (404) 872-5009/fax

Specializes in energy-efficient construction techniques for the southern climate. The institute offers a home-building school and energy audit and duct-sealing services. (See Appendix 3.)

Sprawl Watch Clearinghouse
www.sprawlwatch.org

A resource center providing information, advice, and referrals on issues related to sprawl, smart growth and livable communities. The Clearinghouse helps advocates, grassroots organizations,

public officials, developers, planners, policymakers, architects and others revitalize existing communities and reduce urban sprawl.

Urban Ecology, Inc.
405 14th Street, Suite 900
Oakland, CA 94612
(510) 251-6330 (510) 251-2117/fax
Works with communities to rebuild in balance with nature.

Urban Land Institute
1025 Thomas Jefferson Street NW, Suite 500
Washington, DC 20007
(202) 624-7000 (202) 624-7140/fax

Produces a monthly magazine, *Urban Land*, which occasionally features case studies and articles on green development.

U.S. Green Building Council (USGBC)
90 New Montgomery Street, Suite 1001
San Francisco, CA 94105
(415) 543-3001 (415) 957-5890/fax
usgreen@well.com

1825 I Street NW, Suite 400
Washington, DC 20006
(202) 429-2081; FAX (202) 429-9574

A nonprofit trade association to promote the understanding, development, and accelerated implementation of "green building" policies, programs, technologies, standards and design practices. Membership is offered to manufacturers, utilities, building owners, real estate advisors, scientific and technical organizations, and nonprofit trade associations. The Council's newsletter, *Green Building Report: An Update from the US Green Building Council*, is published quarterly by *Building Operating Management Magazine*, a publication circulated to over 65,000 building owners. Programs include:

- Green Building Rating System: The Leadership in Energy and Environmental Design (LEED) Building rating system is a consensus-based, market driven national building rating system designed to accelerate the development and implementation of green building practices. The system is designed for rating new and existing commercial office buildings. Certification will be awarded to all applicants earning two thirds of the available credits and meeting all prerequisites. The third ballot draft of the system has been completed and is currently being voted on by USGBC members.
- ASTM Liaison Committee: The American Society for Testing Materials (ASTM) is a voluntary, consensus-based standard setting organization, whose open membership includes approximately 340,000 technical professionals from public and private sectors. In 1992, ASTM's Green Building Subcommittee, E-50.06, was formed. The Council

originates and accelerates green-building-oriented standards development through the subcommittee for both commercial and residential facilities and operations. Currently, the subcommittee is working on establishing standards for: Life Cycle Assessment; New and Existing Residential Buildings; Environmentally Sound Forest Management Approaches to produce Wood Products; Stewardship for Cleaning of Commercial and Industrial Buildings; and Sustainable Site Planning.

Watt Watchers of Texas
The Energy Center
The University of Texas at El Paso
P. O. Box 68-660
El Paso, Texas 79968
888 US-WATTS; Fax: 915 747-5317
Email: watts@utep.edu
www.wattwatchers.org

Encourages student involvement in the way school buildings and its occupants use energy, and the end result can mean saving thousands of dollars each year. The program has operated successfully with students from grades 3 to 12.

The Wisconsin Green Building Alliance
16 N. Carroll Street, Suite 840
Madison, WI 53703-2726
608-280-0360
608-280-0361
wei@itis.com
www.wi-ei.org/GBA/
(See Appendix 3)

5. Books, journals and catalogs

Environmental Resource Guide, AIA. Includes information on green building products.

Building Design Assistance Center (BDAC) Sources, Florida Solar Energy Center (FSEC), 1993. Available from FSEC, Attn: Wanda Dutton, Building Design Assistance Center, 1679 Clearlake Road, Cocoa, FL 32922, Phone: (407) 638-1430 or (407) 638-1430 or (407) 638-1000, Fax: (407) 638-1439 or (407) 638-1010, BBS: (407) 638-1456, Email: info@fsec.ucf.edu; Web site: www.fsec.ucf.edu/. $5.00. Free BDAC bulletin board download using Kermit protocol. Available BDAC Sources (directories) include Efficient Glazing Systems, Energy Design Software, Energy Management Systems, Insulation Systems and Radiant Barriers, Lighting Products, Motors and Drives, and Roofing.

Clean Washington Center
Department of Trade & Economic Development
2001 Sixth Avenue, Suite 2700

Seattle, Wash. 98121
206-464-7040

Offers a wide range of reports documenting the use of recycled and recovered materials, including the *Directory of Recycled Content Building and Construction Products*.

Ecological Design, Sim Van der Ryn and Stuart Cowen, Washington DC: Island Press, 1995.

The Ecology of Architecture; A complete guide to creating the environmentally conscious building, Laura Zeiher, Whitney Library of Design, 1996.

The Environmental Resource Guide
John Wiley & Sons, Inc.
Technical publication designed to inform building professionals about making environmentally informed choices on which materials and designs to use in building.

Green development: integrating ecology and real estate. Rocky Mountain Institute. 1998. John Wiley & Sons, New York. 522 pp.
Explores "how incorporating environmental concerns into the real estate development process would result in better places to live that were more profitable for their creators and investors." The book developed through site visits and surveys, looking at how buildings were developed, the process and the barriers. They feature case studies, and found that the successful ones shared common threads and an integrated process. They examine 120 case studies and feature 80 in the book, spanning a range of "greenness."

The Green Pages: the Contract Interior Designers' Guide to Environmentally Responsible Products and Materials, A. Fuston and K. Nadel, biannual. Available from The Green Pages, 399 4th Street, Brooklyn, NY 11215, (718) 369-2578, Fax: (718) 369-2349, Internet: (Email) greenpgs@idt.net; Web site: http://www.ecoexpo.com/noframe/co/GreenPages155.html 300 pp., $49.50 each (loose-leaf).

GreenClips
415.928.7941
GreenClips@aol.com
A summary of news on sustainable building design and related government and business issues published every two weeks. Architectural researcher and environmental consultant Chris Hammer of Sustainable Design Resources publishes GreenClips in San Francisco. GreenClips is written by Chris Hammer and James Richert. Guide to Resource Efficient Building Elements (GREBE) (6th Ed.), T. Mumma, 1997, updated annually. Available from the Center for Resourceful Building Technology (CRBT), P.O. Box 100, Missoula, MT 59806, (406) 549-7678, Fax: (406) 549-4100, Email: crbt@montana.com; Web site: www.montana.com/crbt/ . 117 pp., $25.00 (softcover).

Annual publication listing thousands of recycled content products, including numerous building materials. Two web sites host GreenClips archives for reference and research:
http://solstice.crest.org/sustainable/greenclips-info.html (keyword search)
www.greendesign.net/greenclips (browse contents)

The Hannover Principles/Design for Sustainability. William McDonough, New York: William McDonough Architects, 1992.

Healthy by Design - Building and Remodeling Solutions for Creating Healthy Homes, David Rousseau and Jim Wasley, Hartley & Marks, 1997. Healthy by Design - Building and Remodeling Solutions for Creating Healthy Homes, David Rousseau and Jim Wasley, Hartley & Marks, 1997.

Healthy House Building - A Design and Construction Guide, John Bower, Unionville, IN, House Institute, 1993.

The Natural House Book, David Pearson, Simon & Schuster, Rockefeller Center, 1230 Avenue of the Americas, New York, NY 10020, phone 201.767.5937.

The Official Recycled Products Guide
PO Box 577
Ogdensburg, NY 13669
1-800-267-0707

Residential Construction Waste Management: A Builder's Field Guide, How to Save Money and Landfill Space, Peter Yost and Eric Lund, National Association of Home Builders, NAHB Research Center, 1997.

Your Natural Home: The Complete Sourcebook and Design Manual for Creating a Healthy, Beautiful, and Environmentally Sensitive House, Janet Martinelli and Paul Bierman-Lytle, Boston: Little, Brown and Company, 1995.

A Primer on Sustainable Buildings
Rocky Mountain Institute
Information on the placement, configuration, ecology, and operations of sustainable buildings.

REDI Guide, B. Sullivan, updated bimonthly. Available from Iris Communications, Inc., (see NGO list). 135 pp., $25.00. Free access is available to the REDI Guide on the Iris's Web site.

A Resource Guide to Recycled Content Construction Products, City of Los Angeles, Solid Waste Office, January 1997, updated annually. 16 pp., Free
Integrated Solid Waste Management Office
433 South Sprint Street, 5th Floor, Mail Stop 944
Los Angeles, CA 90013
(213) 847-1444 Fax: (213) 847-3054
iswmo@san.ci.la.ca.us

Sourcebook for Sustainable Design, A. St. John, Architects for Social Responsibility, 1992. 110 pp., $25.00
Boston Society of Architects
52 Broad Street
Boston, MA 02109
(617) 951-1433, ext. 221
Fax: (617) 951-0845
bsarch@architects.com
www.architects.org

The Sustainable Building Sourcebook, W. Doxsey, D. Seiter, City of Austin Green Building Program, 1992 (sections added/updated periodically). 452 pp., $25.00. Also available free for viewing at the City of Austin's Green Building Program web site.
City of Austin Green Building Program
Environmental and Conservation Services Department
206 East 9th Street, Suite 17.102
Austin, TX 78701
(512) 499-3500, Fax: (512) 499-2859
www.greenbuilder.com/sourcebook

Sustainable Building Technical Manual
Public Technology, Inc.
1301 Pennsylvania Ave., NW
Washington, DC 20002
1-800-PTI-9876
A comprehensive source of information on constructing green buildings.

Sustainable Construction Materials Project Phase III Reports, Forintek Canada Corp., 1995. Available from Forintek Canada Corp. (see under "Commercial organizations"). Can. $250.00 to $320.00 (depending upon affiliation) for the entire set.

6. Resource guides

American Institute of Architects Environmental Resource Guide, 1735 New York Avenue, NW Washington DC, phone 800.365.2724.

Construction Materials Recycling Guidebook, Pamela Winthrop Sauer, Metropolitan Council, Attn: Data Center, Mears Park Center, 230 E Fifth Street, St. Paul, MN 55101, phone 612.291.8140.

Construction Resources: A Waste Reduction Guide for Wisconsin Builders and Contractors, Solid and Hazardous Waste Education Center, UW Extension, Madison, WI, 608.262.0910.

Environmental Building News Product Catalog, Environmental Building News, RR 1 Box 161, Brattleboro, VT 05301, email ebn@ebuild.com, phone 802.257.7300.

Good Wood Directory, Certified Forest Products Council, 14780 SW Osprey Drive, Suite 285, Beaverton, OR 97007, phone 503.590.6600.

Green Building Resource Guide, John Hermansson, Tauton Press, website: www.greenguide.com/

GreenSpec - Specifications for Environmental Sustainability, Kalin Associates Inc, 1996, 154 Wells Avenue, Newton Centre, MA 02159, phone 617.964.5477.

Green Pages, Andrew Fuston, Kim Plaskon Nadel, 45 East 25th Street, 14th Floor, New York, NY 10010-2941.

Guide to Resource Efficient Building Elements, 4th Edition, Center for Resourceful Building Technologies. P.O. Box 3866, Missoula, MT 59806, phone 406.549.7678.

The Harris Directory, BJ Harris, 508 Jose Street, Suite 913, Santa Fe, NM 87501-1855, phone 505.995.0337.

Healthy House Building: A Design and Construction Guide, John Bower, Healthy House Institute, 7471 North Shiloh Road, Unionville, IN 47468, phone 812.332.5073.

Interior Concerns Resource Guide, Victoria Schomer, 131 W. Bithedale, Mill Valley, CA 94941, phone 415.389.8049.

The Professional's Green Building Guide Book, North Carolina Recycling Association, 7330 Chapel Hill Road, Suite 207, Raleigh, NC 27607, phone 919.851.8444.

The Sourcebook for Sustainable Design, Andrew St. John, Editor, Boston Society of Architects, 52 Broad Street, MA 02109, phone 617.951.1433 x221.

Sustainable Building Technical Manual, US Green Building Council, phone 415.543.3001.

WasteSpec, Triangle J Council of Governments, P.O. Box 12276, Research Triangle Park NC 27709, phone 919.549.0551.

7. Software

Athena, Forintek Canada Corp.(see under "Commercial organizations"). or
JKM Associates
8 Granville Avenue
Ottawa, Ontario K1Y 0M4, Canada
(613) 722-8075, Fax: (613) 722-9628
jkmeil@fox.nstn.ca.

Building for Environmental and Economic Sustainability (BEES), National Institute of Standards and Technology (NIST) with the U.S. Environmental Protection Agency (EPA), 1998.

Windows-based software to identify building products that improve environmental performance with little or no increase in cost.
Barbara C. Lippiatt
NIST Building and Fire Research Laboratory, Building 226, Room B226
Gaithersburg, MD 20899-0001
(301) 975-6133, Fax: (301) 208-6936
blippiatt@nist.gov
www.bfrl.nist.gov/oae.html

DOE
Energy Analysis Software Directory
www.eren.doe.gov/buildings/tools_directory/

EPA
The EPA offers free software (developed in its Energy Star Buildings and Green Lights programs) to analyze building energy upgrades, and the Pacific Northwest National Laboratory offers free pollution prevention software. QuikPlan software from the EPA helps plan, manage, track, and report on building energy upgrades. Its users construct a database of facility utility data and upgrade costs, choose actions for each facility, and view long-term financial and energy effects. The EPA's QuikChill software performs economic and energy analyses of new centrifugal chillers, upgrades, and retrofits. QuikChill is particularly useful for plants facing CFC-phaseout issues. QuikFan software from the EPA assesses the cost-effectiveness of upgrading variable-air-volume (VAV) fan systems. The EPA's ProjectKalc software analyzes potential lighting upgrades, providing comprehensive energy and economic analysis of upgrades involving controls, relamping, delamping, tandem wiring, and other factors. ProjectKalc's users can modify its database of costs, labor time, and performance. P2-Edge software from the Pacific Northwest National Lab helps incorporate pollution prevention, or P2, strategies in the design of products, processes, and buildings. This software uses examples, pictures, and references to support its more than 200 suggestions for building P2 into projects. To download the EPA software, visit http://www.epa.gov/buildings/esbhome/tools/software.html. For a free copy of P2-Edge, email kim.fowler@pnl.gov.

The Harris Directory of Recycled Content Building Materials (2nd Ed.), B. J. Harris, 1997 (biannual updates). $45.00 postpaid, $69.00 with semiannual updates (PC-Windows and Macintosh). Included with the Directory is a free copy the companion booklet *On Behalf of the Planet, A Handbook for "Green" Living: Simple Solutions for Complex Issues*.
Stafford-Harris, Inc.
522 Acequia Madre
Santa Fe, NM 87501
(888) 844-0337 or (505) 995-0337
Fax: (505) 995-1180
bjharris@igc.apc.org.

The National Park Service Sustainable Design and Construction Database, Release 2.0, 1996. Free (PC-Windows version).
National Park Service

Denver Service Center
Technical Information Center, M/S PGT P. O. Box 25287
Denver, CO 80225-0287
(303) 969-2130, Fax: (303) 969-2557
Rosa_Padgett@nps.gov
www.nps.gov/dsc/dsgncnstr/susdb/

The Sustainable Design Resource Guide: Colorado and the Western Mountain Region (3rd Ed.), American Institute of Architects, Denver Chapter, 1997. 200 pp., $29.95 (loose-leaf, PC-Windows, or Macintosh version).
AIA Denver/SDRG
1526 15th Street
Denver, CO 80202
(303) 446-2266, Fax: (303) 446-0066, or Scott Rodwin at (303) 499-4074.

8. Specific product data bases

Harns Directory(data base available on disk only)
522 Acequia Madre
Santa Fe, NM 87501

REDI Guide
Iris Communications
www.oikos.com

Guide to Resource Efficient Building Elements
Center for Resourceful Building Technology
P.O. Box 100, Missoula, MT 59806
(406) 549-7678

9. Commercial resources

Forintek Canada Corp.
2665 East Mall
Vancouver, BC V6T 1W5
Canada
Phone: (604) 222-5743, Fax: (604) 222-5690
Phyllis@van.forintek.ca
www.metla.fi/archive/forest/1996/03/msg00022.html

Hellmuth, Obata + Kassabaum, P.C.
Sustainable Design Group
Canal House, 3223 Grace St., NW
Washington, DC 20007
202.339.8700; Fax: 202.339.8800
sandy.mendler@hok.com

www.hok.com/sustainabledesign
HOK offers the following Sustainable Design Resources:

- Case Studies
- Healthy and Sustainable Building Materials Database©: Information on the environmental and health impacts of building materials throughout their life cycle. A system of product categories facilitates comparison between products that fulfill similar functions. General issues and recommendations guide initial decision making, while detailed manufacturer specific information helps the design team develop final material selections and specifications.
- Sustainable Design Guide
- Sustainable Design Newsletter (quarterly)
- HOK Product Questionnaire. A system of evaluating currently available building products. To participate in the product-specific environmental research, download and print out the Questionnaire, complete the entire form, and return by mail, with associated MSDS sheets, testing information and product literature to HOK.
- Environmental Issues and Recommendations. A wide range of environmentally preferable building materials. Material categories on this site are arranged according to standard 5-digit CSI division format.
- References

APPENDIX 2. SELECTED NATIONAL PROGRAMS

1. US Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System Criteria

The LEED Green Building ™ Rating System is a voluntary, consensus-based, market-driven building rating system based on existing proven technology. It evaluates environmental performance from a whole building perspective over a building's life cycle. LEED ™ is intended to be a definitive standard for what constitutes a "green building" and provide market incentives to build "green."

LEED is a self-certifying system designed for rating new and existing commercial, institutional, and high-rise residential buildings. It is a feature-oriented system where credits are awarded for satisfying each criteria. Different levels of green building certification will be awarded to applicants that earn two thirds of the available credits and meet all prerequisites. The system is designed to be comprehensive in scope, yet simple in operation.

The rating system is based on accepted energy and environmental principles and tries to balance known effective practices and emerging concepts. LEED System development has been open to public scrutiny and has involved the participation of virtually all segments of the building industry.

Eligibility
All commercial buildings as defined by standard building codes are eligible for consideration as a LEED Building. Commercial occupancies include offices, retail and service establishments, institutional buildings (libraries, schools, museums, churches, etc.), hotels and residential buildings of four or more habitable stories.

Criteria
For classification as a LEED Building, applicant buildings must satisfy all of the prerequisites and a certain number of credits to attain different LEED Building classifications. Having satisfied the basic prerequisites of the program, applicant buildings are then rated according to its degree of compliance (on a percentage basis) with the credit system listed in the Appendix. The program also has guidelines for program administration, certification, documentation, denial or termination of certification, dispute process, application fees and pilot phase participation.

LEED Tally Sheet

Applicants must meet all of the Prerequisites as well as score the requisite number of points in the desired LEED Building category.

A total of 44 credits, plus 4 bonus credits (which may be counted toward certification) are available under the LEED Building Rating System with four categories of certification:

- Platinum: for buildings earning 81% (36) or more of the available credits

- Gold: for buildings earning 71-80% (31-35) of the available credits
- Silver: for buildings earning 61-70% (27-30) of the available credits
- Bronze: for buildings earning 50-60% (22-26) of the available credits

In addition, the USGBC presents an award for the "Green Building of the Year" for the LEED Building with the highest score of the year.

Prerequisites (11)
Asbestos Avoidance or Management
Building Commissioning
Elimination of CFC's
Energy Efficiency
Erosion Control
Indoor Air Quality
Smoking Ban
Storage & Collection of Occupant Recyclables
Thermal Comfort
Water Conservation
Water Quality—Lead

Building Materials (7 Credits)

1 or 2 Credits for low VOC materials
1 credit for 1 or 2 measures; 2 credits for 3.

a. Limit VOC content in adhesives
b. Limit the VOC content in architectural sealants
c. Limit the VOC content in paints and coatings

1 Credit for use of local materials
1 Credit for resource use
1 Credit for advanced resource reuse
1 Credit for recycled content
1 Credit for advanced recycled content

Construction Waste Management (2 Credits)
1 Credit for management plan
1 Credit for advanced management plan

Energy (10 Credits)
Energy Efficiency (7 Credits) (Note: points are NOT additive, except for Heat Recovery, Natural Ventilation and Bonus Credit)

1 Credit for:
EPA Green Lights Partnership

or

California Title 24 Lighting

2 Credits for:
EPA Energy Star Building Certification

or

Exceeding ASHRAE 90.1 by 20%

- 3 Credits for exceeding ASHRAE 90.1 by 30%
- 4 Credits for exceeding ASHRAE 90.1 by 40%
- 5 Credits for exceeding ASHRAE 90.1 by 50%

1 additional Credit for Natural Ventilation, Heating and Cooling
1 additional Credit for Waste-Heat Recovery System

Renewable Energy (3 Credits)
1 Credit for 10% of building energy from on-site renewable sources
2 Credits for 20% of building energy from on-site renewable sources
3 Credits for 30% of building energy from on-site renewable sources

Existing Building Rehabilitation (2 Credits)
1 Credit for maintaining 75% of the structural shell when renovating and existing building
2 Credits for maintaining 100% of the structural shell when renovating an existing building

Indoor Air Quality (3 Credits)
1 Credit for construction IAQ management plan
1 Credit for advanced construction IAQ management plan
1 Credit for permanent air monitoring system

Landscaping (3 Credits)
1 Credit for erosion control
1 or 2 Credit for reducing heat islands
-- 1 Credit for 1 0r 2 measures; 2 Credits for 3

a. shade cover
b. reflective roofing materials
c. reflective surface

Occupant Recycling Equipment (1 Credit)
1 Credit for occupant recycling systems and equipment

Ozone Depletion/CFCs (2 Credits)
1 Credit for eliminating CFC, HCFC and Halon use in mechanical and fire suppression
1 Credit for eliminating CFCs and HCFCs in building materials

Siting (3 Credits, plus 1 Bonus Credit)
1 Credit for reduced habitat disturbance or building rehabilitation
1 Credit for site restoration
1 Credit for infill development or building rehabilitation
1 Bonus Credit for brownfield development

Transportation (3 Credits, plus 1 Bonus Credit) 1 or 2 Credits for alternative transportation facilities
(1 Credit for 1 or 2 measures, 2 Credits for 3 measures)

a. bicycle racks
b. shower and changing facilities
c. transit and pedestrian-facility physical linkages or carpool parking

1 Credit for efficient building location
1 Credit for alternative fueling facilities

Water Conservation (4 Credits)
1 Credit for water-conserving fixtures
1 Credit for gray water recovery system
1 Credit for water-conserving cooling towers
1 Credit for water efficient landscaping

Water Quality (2 Credits. Plus 1 Bonus Credit)
1 Credit for surface runoff filtration
1 Credit for surface runoff reduction
1 Bonus Credit for biological waste treatment

2. Building Design Tools

Building designs and features are influenced by environmental performance, conventional performance and cost. The following are a few of the more useful design tools that have been employed by green designers (2):

- Physical building models. Many architects rely on physical models to help a client understand what a finished building will look like and to understand such aspects of the building as daylighting and passive solar design. Many architects now use three-dimensional computer modeling, although some consider physical models superior. Sophisticated sun models with high-intensity lights that travel in an arc over the building are sometimes used to simulate time of day and year.
- Three-dimensional CAD models. Sophisticated computer modeling is increasingly used by architects to provide careful analysis and visual images of the finished space.

Daylighting models, for example, demonstrate how deeply sunlight penetrates into a building and how shadow patterns change throughout the day at different times of year.

- Mock-ups. Actual full-size mock-ups of wall sections or building elements help designers and clients understand how a building will look and perform. (The design team for the United Parcel Service headquarters built models of various aspects of the building, including a 30-foot wide, two-story mock-up of an interior office space.)
- Energy modeling programs. Sophisticated energy modeling programs are widely used in building design, including DOE-2, Energy 10, Power DOE, REM-Design, and HOT-2000. Modeling energy performance is more accurate than relying on rules of thumb or simple calculations to determine mechanical system sizing and building energy loads. The simulation results often differ from the designer's intuition.
- Computational fluid dynamics. These are used to determine how air will move in a building (when sophisticated passive ventilation designs are being used, for example). Complicated equations are translated into easy to understand visuals that show fluid flow patterns, eddies, airflow velocities, pockets where cold or warm air would collect.

Designers use several methods of predicting natural airflow to refine design and predict performance. Physical models are built of Plexiglas or Perspex at a small scale—between 1:20 and 1:100. These are tested using saline water with dyes added for visualization in a process that is documented by video. Then quantitative measures of flow velocities of temperatures are established based on densities of the samples of the saline solution. Thus the effects of friction and diffusion, as well as convection, can be scaled. These measurements can then be expanded by computer analysis. Another method, Computational Fluid Dynamics, provides computer-generated scaled graphics and values for sections through a proposed building. In both cases, the graphic form of the experimental information is visually important in the conversations among architect, engineer and building science researcher in arriving at a recommended design. But in all cases empirical judgment is critical concerning both inputs and interpretation (23).

3. EPA's Energy Star Buildings program

http://www.epa.gov/buildings/esbhome/tools/software.html

EPA's Energy Star Buildings program is a voluntary energy-efficiency program for U.S. commercial buildings. The program focuses on profitable investment opportunities available in most buildings using proven technologies. A central component of the program is the five stage implementation strategy that takes advantage of building system interactions, enabling building owners to achieve additional energy savings while lowering capital expenditures. Through these actions, Partners can expect to reduce total building energy consumption by 30% on average.

Why Participate?

The energy to operate buildings in the U.S. contributes to a host of environmental problems. By implementing EPA's ENERGY STAR Buildings Program, buildings decrease energy use and pollution, and increase profits. As of January 1, 1998, 444 organizations had joined, representing 1.7 billion square feet of floorspace.

Benefits
Participants receive multiple benefits by joining the program:

- Savings
- Customer support
- Public recognition
- Workshops
- Publications
- Software
- Account managers
- Information about finance opportunities
- The Energy Star Building Ally Program
- Ally Services and Products Directory (ASAP)
- The Energy Star
- Buildings Upgrade Manual

The Plan
Partners and EPA sign a Memorandum of Understanding (MOU) that spells out each party's responsibilities.
The program's five-stage implementation strategy provides a framework for making comprehensive efficiency upgrades in a range of commercial building types. Partners are encouraged to follow the five stage implementation strategy in upgrading buildings:

1. Green Lights
2. Building Tune-Up
3. Other Load Reductions
4. Fan System Upgrades
5. Heating and Cooling System Upgrades

One advantage of this approach is that it can reduce the size of equipment and therefore its cost. Another advantage is that it is gradual. Partners can evaluate energy-efficiency options on a single stage at a time. They can also invest money in stages, rather than all at once.

Green Lights Program
Current Green Lights Partners can join ENERGY STAR Buildings by signing the ENERGY STAR Buildings MOU.

Savings
Twenty-two companies agreed to complete comprehensive building efficiency upgrades in a single building over two years. These ENERGY STAR Showcase Partners demonstrated that the comprehensive ENERGY STAR Buildings strategy maximizes energy savings at a profit; rates of return ranged from 17% to 50%. Furthermore, the ENERGY STAR Showcase Building projects offered an opportunity to field-test and refine EPA's technical support materials.

Building Allies
Members of the energy efficiency equipment and service industries join ENERGY STAR

Buildings as Allies. Allies join the ENERGY STAR Buildings Program by signing an Ally Memorandum of Understanding (MOU). Any organization, including those within or subject to review by a parent organization, that has financial and operational control of any of its own facilities may join ENERGY STAR Buildings.

Allies agree to market the ENERGY STAR Buildings program and promote the benefits of energy-efficient equipment and services to their customers in addition to undertaking building energy efficiency upgrade projects.

APPENDIX 3. SELECTED LOCAL AND STATE GREEN BUILDING INITIATIVES

1. Georgia
Southface Energy Institute
241 Pine Street
Atlanta, GA 30308
(404) 872-3549, (404) 872-5009/fax
www.southface.org

The mission of Southface Energy Institute (SEI) is to promote the development of sustainable energy and environmental technologies and policies through education, research and technical assistance. Incorporated as a nonprofit organization in 1978, SEI has been featured in consumer and professional publications, ranging from *Southern Living* to *Popular Science*. Additionally, SEI has received awards for excellence from the U.S. Department of Energy, U.S. EPA, the American Institute of Architects, the American Society for Heating, Refrigerating, and Air conditioning Engineers, the American Concrete Institute, and community and environmental organizations. SEI conducts the following programs:

1. Technical assistance:

- Energy Audit Services. SEI has provided over 400 energy audits on single-family, multi-family and commercial buildings.
- Homeless shelter Audit and Inspection Program though a contract with the Georgia Department of Community Affairs.
- Home Energy Ratings and Energy Star. SEI has been contracted by the DOE/EPA Energy Star Program.
- Design Review and Building Evaluation. SEI has performed over 250 reviews.
- Sustainable Design and Construction, SEI facilitates the process.
- Energy Research. SIE conducts field research on renewable energy systems and building performance.
- Demand- Side Management (DSM). SEI works with Georgia Power in developing residential DSM. It has also worked with other corporations and utilities in the South. In conjunction with the Climate Institute, Southface conducted a study for the City of Atlanta which identified DSM measures estimated to save the city over $1.5 million annually.
- Building Energy Codes. With funding from the Energy Foundation, SEI coordinated a multi-state task force to develop a simplified commercial energy code. They have provided energy code assistance to seven southern states.

2. Professional training. Since its founding, SEI has conducted over 2,500 training programs for audiences ranging from general contractors to building code officials. Many of these programs have been sponsored by government agencies, and utility and state energy offices. Programs have included energy and resource efficient construction, energy codes, energy retrofits, the

Southface Homebuilding School, DSM, home energy ratings certification, and the annual *Greenprints: Sustainable Communities—By Design*.

3. Consumer education. Each year, SEI programs reach over 25,000 consumers directly and indirectly through the media. Target audiences range from home owners to children.

4. Affordable housing. Southface has designed and constructed several innovative resource efficient houses for families in need. SEI frequently partners with the Atlanta Empowerment Zone, Habitat for Humanity, and Sustainable Atlanta.

5. Energy-efficient construction. In 1996 Southface, in partnership with many agencies and businesses, opened the Southface Energy and Environmental Resource Center, a 6,200 square foot, state-of-the art demonstration house.

2. New York
The Green Building Tax Credit
Contact: Ashok Gupta, Senior Energy Economist
Natural Resources Defense Council
www.nrdc.org

Legislation proposed in New York State would provide incentives for developing environmentally sound buildings by helping to defer some of the initial costs associated with green building design. The Green Building Tax Credit legislation would provide tax credits to building owners and tenants who invest in measures to increase energy efficiency, improve indoor air quality and reduce the environmental impacts of commercial and residential buildings in New York State.

This bill is the result of a collaborative effort among the business, real estate and environmental communities (including Associated Builders and Owners of Greater New York, Inc., Building Owners and Managers Association of Greater New York, Inc., New York Building Congress, Real Estate Board of New York, the Carrier Corporation, Environmental Business Association, Natural Resources Defense Council, the Sierra Club and others). The Building & Construction Trades Council of Greater New York, representing labor and management organizations in New York City's building and construction industry, see the legislation as a way to advance economic opportunity and job creation while being sensitive to environmental and community concerns, and bridge gaps with traditional opponents of development. By promoting new, efficient technologies and better indoor air quality, this bill will result in a cleaner environment, save money and improve the quality of life in a way that will attract new, high-tech industries and jobs, other businesses and working families to New York State. It represents a progressive approach to addressing environmental issues, which makes good economic sense.

New York State Energy Research and Development Authority (NYSERDA)

NYSERDA, a public benefit corporation created in 1975, uses innovation and technology to solve some of New York's most difficult energy and environmental problems in ways that improve the State's economy. NYSERDA is committed to public service, striving to be a model

of what taxpayers want their government to be: effective, flexible, responsive and frugal. NYSERDA recently co-sponsored, with the University of Buffalo a technical workshop entitled "Building for the Future: Sustainable Building Design and Construction Training Workshop."

3. North Carolina
The North Carolina Green Building Council
www.recycle.net/recycle/ncra

The North Carolina Green Building Council (NC GBC) was formed in 1994 by the North Carolina Recycling Association and the North Carolina Department of Commerce Energy Division to promote Green Building practices in the state and region. The mission is to promote a balance between environmental and economic endeavors throughout the natural and built environs. Membership includes members of other non-profits, architects, builders, contractors, realtors, utility representatives, and government officials.

The Council has sponsored a number of green building conferences (annual Southeastern Green Building Conferences & Exhibitions, a Green Homes, Green Communities conference). A web-based Green Building Products and Materials Resource Directory (http://www.recycle.net/recycle/ncra/GBDWelc.html) provides information on environmentally friendly products and energy and resource efficient building materials. Because a sustainability approach favors the use of local resources, the principal focus is on North Carolina based products and distributors. The Directory is intended to assist in the selection of products that will be used in the NCRA's "green" headquarters building, which will function as an educational facility as well. In addition, the Directory provides information on environmentally friendly building products and helps manufacturers, distributors, architects, other designers, engineers, developers, and building clients to with sustainable design, building, and development.

4. Oregon
Oregon Office of Energy
503-378-4040 or 1-800-221-8035
www.energy.state.or.us

The Oregon Office of Energy works to ensure that Oregon's energy future is built on a least-cost mix of conservation, renewable and conventional energy resources and to clean up nuclear waste. Their web site provides case studies of green building commissioning (Aster Publishing Building, Eugene, Oregon State University Library, Corvallis, Local Government Center, Salem, Highrise Office Building, Portland). To encourage investments in conservation, the Office offers loans, rebates, grants and tax credits to households, businesses and public agencies to finance a portion of the costs of the conservation projects they install. The Office also:

- Demonstrates the workability of new energy-saving technologies
- Provides technical information to consumers on ways to save energy
- Trains building operators to run their equipment efficiently
- Recommends energy standards for homes, buildings and appliances
- Determines what energy-saving measures are cost-effective

- Promotes regulatory reforms that put conservation on a more equal footing with conventional resources

As of 1995, the Office's programs had saved enough electricity to eliminate the need to build a new power plant and enough natural gas, oil and other fuels to heat 300,000 homes for one year. In addition, those energy savings cut the energy costs for Oregon businesses, households and public agencies by more than $200 million a year.

5. Pennsylvania

The Governor's Green Government Council
www.gggc.state.pa.us

The Governor's Green Government Council was created in 1998 to help Pennsylvania state government adopt "environment-friendly" operation policies and practices. The mission of the council is to put environmentally sustainable practices into state government's planning, policymaking and regulatory operations. Membership includes all executive agencies. Independent agencies are encouraged to participate. Agencies will focus on planning and operations, particularly energy efficiency in areas such as building design and management, procurement of environmentally friendly commodities and services, vehicle purchase and recycling.

Green Building Alliance, Pittsburgh, PA
www.gbapgh.org
The Green Building Alliance (GBA) is a non-profit organization that facilitates the cost effective and integrated use of environmentally responsible and technologically appropriate site and building design, construction, and operation practices to create more livable places for all persons now and in the future.

GBA evolved in two phases. Phase I, the period between GBA's beginning in 1993 and its new direction in July 1997, was devoted to coalition building among and education of a forward-thinking group of professionals interested in green building. Phase II began in July 1997, with full operational funding from the Heinz Endowments. Phase II began with a planning process that included: an inventory of local organizations and programs; an examination of similar organizations across the US; informal interviews with the leadership of potential partner organizations; input provided through the University of Pittsburgh's Green Construction Symposium and the GBA Smart Building Roundtable; and a planning retreat that included past GBA participants along with a variety of new persons from other building industry sectors.

The GBA Strategic plan evaluates the activities undertaken during Phase I. It also discusses the planning process and lays out a detailed plan of operation and programs for the next three years that includes the following areas:

- Education: Educational programs will be established to raise public awareness and increase local knowledge regarding the benefits of building green to our economy, environment and well being of all persons.

- Technical assistance: Technical informational resources will be made available and financial programs will be identified to facilitate the implementation of green building practices.
- Research and development: Research will be undertaken to generate the data necessary for advocating and effecting major changes in programs or policies that are barriers to the implementation of green building practices.
- Development projects: Key development projects will be directly assisted, documented, and promoted to provide good, local examples of green building practices.

The Green Building Alliance has been successful at working with the City of Pittsburgh in setting sustainable building criteria for the new convention center. There recent workshops have included Building Better: Green Building to Improve Your Clients' Bottom Line. GBA is also serving as a site for testing LEED ratings projects, in cooperation with the United States Green Council.

York Foundation
20 West Market Street
York, PA 17401-1203
info@yorkfoundation.org

Marcus B. Sheffer
Energy Opportunities
717.292.2636
msheffer@cyberia.com

The York Foundation, a Community Foundation in York PA, underwrites an Energy Program serving nonprofit organizations and the general community by providing technical services, financial assistance, and energy education, to build the financial capacity of York County nonprofit organizations through energy savings. The foundation provides an energy consultant (Marcus B. Sheffer) who assists organizations implement energy efficient retrofits and design. The foundation also provides grants and loans to organizations. The Foundation maintains an energy efficiency technology center in their offices to provide hands-on educational opportunities.

The Foundation recently sponsored a training session for professions on the DOE-2 model for energy efficiency.

6. Texas

City of Austin Green Building Program
Planning, Environmental & Conservation Services Department
P.O. Box 1088,
Austin, TX 78767-9949
512.499.3029
Fax: 512.499.3518
www.greenbuilder.com

The Austin program, begun in 1991, ties voluntary actions by builders to the city's long range planning goals, and has been a model for Santa Monica, CA, Tucson, AZ and other cities. It endeavors to make sustainable practices more mainstream, providing the building industry training and tools, and marketing the benefits to consumers and the construction industry.

The Green Building Program offers a membership program for builders and architects who have made a commitment to build "green." They also provide associate memberships for manufacturers, suppliers, and real estate agents that are associated with green building techniques and materials. Program staff provide a full range of Green Building consulting services to help construction professionals design and build better buildings. They also provide publications to assist when choosing green building materials and systems. Publications include the *Sustainable Building Sourcebook*, *Green Building Newsletter* (available by email), *Green Home Buyers Checklist*, *Municipal Building Guidelines*, and *BEST Case Studies*. They offer monthly training seminars for building professionals on a wide variety of topics.

The City of Austin implemented a Sustainable Communities Initiative (SCI) in 1996 as a way of bringing together diverse views to plan for the needs of the future as well as the needs of the present. The SCI reflects the international trend to embrace sustainable development as a way to meet these challenges. SCI staff facilitates and supports the development of economic, social, and environmental improvements that serve the entire Austin region. The Austin Citizen's Planning Committee completed a series of recommendations that offer a framework for sustainable development. SCI staff support these efforts while adding successful ideas from other regions and around the world. SCI staff recommend coordinating water resources, air quality, and planning activities region wide and developing sustainable community indicators and "green" economic development. The mission and goals touch on every area of community life and cut across traditional political boundaries. It will require changes in logistics, attitudes, and understanding, including:

- Responsive and proactive governance that uses systems-based reasoning.
- Use and development of technology that reinforces the long-term outlook.
- Resource use that builds toward renewables, phases out non-renewables, and stresses efficiency.
- Preserving and valuing heritage.
- Planning and development that is participatory, comprehensive, long range, and integrated with sustainability goals.
- Education that supports diversity, creates respect for and understanding of social and physical interdependence, and develops skills for managing the transition to sustainability.
- Developing synergism among the region's sustainability activities.

The Initiative's development and initial elements include:

- The social, economic, and environmental perspectives and components of sustainable region-wide activities
- Municipal operations
- Capital improvements planning

- Regional planning

7. Wisconsin

The Wisconsin Green Building Alliance
16 N. Carroll Street, Suite 840
Madison, WI 53703-2726
608-280-0360
608-280-0361
wei@itis.com
www.wi-ei.org/GBA/

Founded in 1997 by design and construction professionals who recognized the need to educate themselves and their colleagues about sustainability. They promote the development and use of ecologically sustainable materials and practices within Wisconsin's built environment. Membership includes design and construction industry representatives including: architects, builders, contractors, developers, facility managers, interior designers, landscape architects, consultants, engineers, realtors, urban planners, educators and environmental organizations. WGBA provides a variety of resources including: an annual green building conference, educational forums and site visits to green demonstration projects, a quarterly newsletter and an annual assessment survey to keep abreast of the needs of the industry.

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APPENDIX 4. ADDITIONAL GREEN BUILDING BACKGROUND INFORMATION

I. HEATING, VENTILATION AND AIR CONDITIONING

Chillers

Improved chillers

One innovation, which the Way Station in Frederick, MD and other buildings are using, is cool storage (also called thermal storage), which entails using a chiller during night hours to generate ice or some other material that has a low latent heat (such as eutectic salts). During peak cooling hours, the material provides extra cooling to the building. This approach lessens the building's electrical load during peak hours and allows the chiller to be operated at a steady load, extending the chiller's capacity and operating life (www.eren.doe.gov/buildings).

Another approach to commercial air conditioning is evaporative cooling, which relies on the latent heat of evaporation to cool air as water is evaporated into it. Evaporative cooling is appropriate in hot and dry climates. Desiccant evaporative cooling extends the application of evaporative cooling into more humid climates. This is achieved through the addition of a desiccant wheel to dry the incoming air. The energy penalty of desiccant cooling is that the desiccant must be regenerated by passing hot, relatively dry air through it. Typically, the warm exhaust air from the building is further heated and then passed through the desiccant. Natural gas or waste heat often heats the exhaust air. Despite this energy penalty, desiccant cooling technologies are more energy efficient than chillers and can result in significant energy savings. Desiccant evaporative cooling is feasible in many commercial buildings throughout the US, and is a CFC-free method of cooling buildings (www.eren.doe.gov/buildings).

Ventilation

Building ventilation is a complex design problem: there are a broad range of fluid dynamics phenomena in and around buildings, including jets, plumes, natural convection, mixed convection, gravity currents, and wakes. The air-flow phenomena in buildings are often complicated by their interaction with the outdoor thermal environment and by complex openings (doors and windows) in the building envelope (www.eren.doe.gov/buildings).

To account for these complex phenomena, building designers should apply fluid-flow principles when designing a ventilation system. Many building air-flow problems have been tackled by applications of fluid-flow concepts and computational fluid dynamics. In many situations, these computational approaches have made it possible to stop relying on old "rule of thumb" approaches, and instead quantitatively design and evaluate ventilation systems (www.eren.doe.gov/buildings).

Natural ventilation

In the UK, architects and engineers are including natural ventilation in the architectural designs of large offices and other buildings. They use passive ventilation, based on the stack effect and pressure differentials, that works even when windows are closed. More important, supplying

fresh air to building interiors has introduced a new discipline into the three-dimensional design of public buildings that now informs the work of a number of leading architects involved in major projects (23).

"Naturally ventilated" is actually "assisted natural ventilation" or "low energy ventilation." The goal is to produce buildings with low operating budgets that respond to user needs. Daylighting is often an integral part of the design. Daylighting and natural ventilation are mutually reinforcing design strategies because they encourage high ceilings and windows as well as narrow floor plans or atrium schemes that provide access to the outdoors from both sides of interior spaces (23).

"Naturally ventilated buildings" organize the airflow patterns architecturally with dispersed and controlled fresh air inlets near floor level. The higher ceilings preferred for daylighting are an advantage for displacement ventilation because of the buoyancy of warmer air. But natural exhaust is only possible when there are several stacked floors, each contributing its spent stale and warmed air to flues or exhaust towers at the top of the system. This ductless ventilation works best with open planned offices and at least three floors. Atriums and stairwell towers typically provide the exhaust path to accommodate the stack effect. The higher the outlet, the better the buoyancy works without assistance, so two critical dimensions are the total height of the stack and the height from the ceiling of the top floor to the top of the stack (23).

Air "freshness" is a natural aesthetic preference. Culturally, all of these aspects outweigh any advantages of sealed buildings, air conditioned with refrigerated air and often dependent on continuous electric lighting. Operating costs and the environmental price of air conditioned buildings reinforce the preference for buildings conditioned passively, creating open systems that can respond more directly to outside conditions. Britain has six standards for fresh air ventilation rates. In nonsmoking offices they range from .2 to .6 cubic feet (5 to 16 liters) per person per second. Choice of standard has a major impact on energy costs (23).

In contrast to the American practice of forced circulation of small quantities of conditioned air at high velocity rates near the ceiling, the British practice is for large quantities of fresh air to be introduced at low velocity rates, preferably near the floor. The principle of displacement ventilation involves the gentle introduction of fresh and cool air at the bottom of the space. As air is warmed in a space, primarily by people and office equipment, it rises, and is replaced by the cooler air from the floor that gradually mixes and becomes tempered. The stale warmest air collects against the ceiling, above head height, where it can be exhausted. This naturally developed airflow pattern is a more selective strategy for removing stale air and pollutants from their sources than a full mixing of fresh air throughout the space (23).

II. LIGHTING

Energy conservation strategies

When making changes designed to increase the energy efficiency of lighting, it often pays to redesign the building's entire lighting system. This can improve lighting quality, make visual tasks easier, and save 50% or more on energy costs.

Often, light levels can be reduced without reducing light quality by:

- Redesigning visual tasks. For example, use a better printer with darker printing.
- Reducing light levels where there are no visual tasks. Provide the minimum light necessary for safety, security, and aesthetics.
- Reducing light levels for visual tasks where those levels are currently excessive.

To cut energy consumption from lighting while enhancing light quality:

- Establish ambient illumination at minimum acceptable levels.
- Provide task lighting at the optimal level depending on the difficulty of visual tasks
- Increase the efficiency of lamps, ballasts, and fixtures.
- Improve light quality by reducing glare and brightness contrast.
- Use daylighting where possible and practical.

Lamp efficiency

Only a few technologies currently dominate the U.S. market. Approximately 1.5 billion fluorescent luminaires in the U.S. are the standard arrangement: 2-foot by 4-foot fixtures that house 4-foot, T12 tubular lamps powered by electromagnetic ballasts.

Standard fluorescent lighting can be made more efficient by installing T8 lamps and electronic ballasts. Electronic ballasts, first introduced in the U.S. in 1979, use approximately 25% less electricity than magnetic ballasts. In addition, they can drive the more efficient T8 lamps, thus providing greater system savings.

Lamps are recessed into the ceiling or mounted on the ceiling's surface. Light is reflected down onto the work plane by white-coated sheet steel. Light reflected by a diffuse surface, such as a white painted surface, cannot be directed or controlled and may be absorbed within the luminaire.

Specular reflectors, reflective metal panels within the luminaire, concentrate light on the works surface. In this combination, two rather than four lamps can provide adequate light. The energy and money saved, and pollution prevented are illustrated below:

Luminaire	**Annual energy use per luminaire**	**Annual energy cost per luminaire**	**Payback period**	**Total annual pollution prevented**
Back luminaires: (2) 4 lamps, T12, 40-watt	752 kWh	$47.37	—	—
Front luminaires: (3) 2 lamps, T8, 32-watt	248 kWh	$15.62	2.5 years	1,444 lbs CO_2 4.5 lbs SO_2 1.8 lbs NO_x

Lighting controls

Lighting controls (occupancy sensors, dimmers, ambient light sensors, office wall switches) can improve the overall lighting quality, and reduce energy consumption by providing the correct amount of light when and where needed.

a. Occupancy sensors turn on lights when someone enters a room and automatically turn them off when the room is vacated. An infrared occupancy sensor detects heat, an ultrasonic sensor detects motion. These are efficient and convenient alternatives to the standard light switch, which must be physically turned on and off. Occupancy sensors can be mounted on the walls or the ceiling.
b. Dimmers. Automatic dimmer controls work in conjunction with light sensors to provide constant light levels. Manual dimmers allow individuals to adjust lighting levels. Since continuously dimmable electronic ballasts appeared on the market in the 1980s, dimmers have been used in conjunction with fluorescent lamps.
c. Ambient light sensors are photoelectric controls that dim or turn off artificial lights in response to the amount of natural light entering a room. Thus, a room receives artificial light only when it is needed. This can save considerable energy.
d. Wall switches allow people to control the lights in their own work space, rather than having one central switch for a large area. In addition, dual switching enables individuals to vary light levels as needed for their space.

Luminaries

Luminaires, or fixtures, house the lamp and, often, the ballast. Luminaires affect light quality, direction, and output. Fixture design, as well as overall attention to lighting quality, has changed to reflect the widespread introduction of computers into the workplace. For instance, it is important to control the brightness of reflections in the screen of a video display terminal.

Lighting maintenance

Maintenance is vital to lighting efficiency. Light levels decrease over time because of aging lamps and dirt on fixtures, lamps, and room surfaces. Together, these factors can reduce total illumination by 50% or more, while lights continue drawing full power. Basic maintenance can help prevent this.

Lighting uses and design

Lighting uses are often divided into three categories. Ambient lighting provides security and safety, as well as general illumination for performing daily activities. Task lighting provides enough illumination for tasks, without illuminating entire areas. Accent lighting illuminates walls so they blend more closely with naturally bright areas like ceilings and windows.

Designing an optimum lighting system involves gauging light quantity and quality.

- Lumens express the quantity of light emitted by a lamp source, and compare brightness of different lamps. All lamps are rated in lumens. For example, a 100-watt incandescent lamp produces about 1750 lumens.
- Illumination, the distribution of light on a horizontal surface, is measured in foot-candles. A foot-candle of illumination is a lumen of light distributed over a 1-square-foot area. The amount of illumination required varies with visual task. Ideal illumination is the minimum foot-candles necessary to allow you to perform a task comfortably and proficiently without eyestrain. The Illuminating Engineering Society says that illumination of 30 to 50 foot-candles is adequate for most office and home applications. Difficult and lengthy visual tasks require 200-500 foot-candles. Lighting systems providing only security, safety, or visual comfort require 5-20 foot-candles of illumination
- Color Rendering Index (CRI) measures the ability of a light source to render colors accurately compared with a reference source such as incandescent or natural daylight.
- Efficacy, a measure lamp efficiency, refers to lumens per watt, the light output of a lamp divided by the number of watts required to produce the lumens.

Light quality

Light quality describes how well people in a lighted space can see to do visual tasks and their visual comfort. Light quality is important to energy efficiency because spaces with higher quality lighting need less illumination. High-quality lighting is fairly uniform in brightness and has no glare. For example, direct intense sunlight streaming through the windows of a room with dark brown carpets and dark wall paneling will likely give too much contrast in brightness. Eyes will constantly adjust to the differing brightness. Making this area visually comfortable would involve using lots of artificial lighting with a high illumination level. Alternatively, in a pale-colored room bathed in soft light, one can hardly tell where the light is coming from because no one area of the room appears much brighter than another. The walls, ceiling, floor, and work surfaces are relatively the same light hue. People can perform tasks faster and with fewer mistakes with this type of high-quality lighting. Also, lighting such a room requires far less artificial lighting.

Glare

Direct glare results from strong light from windows or bright lamps shining directly into eyes. Reflected glare is caused by strong light from windows or lamps that is reflected off a shiny surface. Veiling reflection is a special type of reflected glare that can obscure contrasts and reduce task clarity. Veiling reflections occur when light is reflected into your eyes from a work surface, such as a printed page or a computer screen.

Types of lighting

There are four basic types of lighting. Incandescent lighting is the most common type of lighting used in residences. They are the least expensive to buy but the most expensive to operate. Fluorescent lighting is used primarily in commercial indoor lighting systems. High-intensity discharge lighting is used only for outdoor lighting applications. Low-pressure sodium lighting is used where color rendering is not important, such as highway and security lighting.

Fluorescent lamps

Tubular bulbs vary in diameter from T5 (5/8") to T12 (1 ½"). In many commercial applications, lighting fixtures use 4-foot long T8 (1" diameter) or J72 lamps. T8 lamps are more efficient than the larger T12 lamps because of the T8's smaller diameter, requiring less electricity. Also, T8s use more efficient phosphor coatings, which improve color rendering.

1. Compact fluorescent lamps

   Compact fluorescent lamps, or CFLs, are efficient fluorescent lamps that can replace incandescent lamps because they are similar in size to incandescents. CFLs use one quarter the energy of standard incandescent bulbs. Although CFLs cost 10-20 times more than comparable incandescent bulbs, they last 10-15 times as long. CFLs first appeared on the U.S. market in the early 1980s and are now used in many commercial buildings and residences. The high first cost of CFLs, compared to the cheaper incandescent, is paid back quickly through savings in electricity bills. These efficient lamps have also become a more economical option when utilities provide incentives for installing them or when energy costs increase.
2. Ballasts

   More than any other single lighting component, the ballast is fundamental to improving the efficiency of the entire lighting system. A fluorescent lamp works by striking and maintaining an electrical arc between two electrodes. The ballast starts the arc and regulates its power. Its main functions:
   - Provide the correct voltage to establish an arc between the two electrodes
   - Regulate the electric current flowing through the lamp
   - Supply the correct voltage for lamp operation and to compensate for voltage fluctuations within a certain range

   Until the 1970s, all fluorescent lamps used electromagnetic (also called magnetic) ballasts. Magnetic ballasts have aluminum or copper wire around a steel core. Until 1978, electromagnetic ballast capacitors were manufactured using PCBs. When disposed of, these older ballasts must be treated as hazardous waste. Magnetic ballasts operate at a voltage frequency of 60 hertz (Hz).

   Electronic ballasts use electronic, solid-state circuitry to start and regulate fluorescent lamps. Electronic ballasts operate at frequencies of 25 kilohertz (kHz) or higher. This higher frequency allows the lamps to convert power to light more efficiently, saving energy. Electronic ballasts lose less power and produce less heat. As a result, less air-conditioning is required to offset the added heat load from lighting systems, saving more energy. Because electronic ballasts operate at higher frequencies, they produce much less noise and flicker than magnetic ballasts. This improves the quality of fluorescent lighting, with increased user comfort. Some electronic ballasts are now dimmable, a feature that can add to overall energy savings.

1. Luminaries

   Luminaires are classified based on the amount of vertical light distribution—how much light they direct above or below the horizontal plane. Physical characteristics of the

room, type of work performed, and maintenance conditions affect the selection of different luminaires. Manufacturers use the coefficient of utilization, or CU, to measure luminaire efficiency. The CU is the percentage of light emitted by the lamps that reaches the work surface. The CU varies according to room size and shape, wall and ceiling color and finish, and the height of the fixture from the floor.

a. Indirect. Indirect luminaires direct 90-100% of the light output toward the ceiling at angles above the horizontal. Light reaches the work plane after being reflected the walls and ceiling. These luminaires are appropriate for offices, schools, and other locations that require minimal shadows and little reflected glare.
b. Direct-indirect. Forty to sixty percent of the light emanating from a direct-indirect luminaire is directed down toward the work plane at angles below the horizontal. Although illumination at the work plane results primarily from the direct light emitted by the luminaire, the indirect characteristic of the luminaire also diffuses some of the light up towards the ceiling and out into the office. This can help create an open, airy feeling to the space, while minimizing glare.
c. Direct. Ninety to 100 percent of the light from a direct luminaire is aimed downward at angles below the horizontal. Direct luminaires can produce efficient illumination on the working area, but often at the expense of light quality. Direct luminaires can cast glare and shadows in the work place.

References 12, 38

III. FINANCING AND REAL ESTATE ISSUES

(Most of this section comes from [4])

1. Marketing

Comps

Comps (comparisons) provide information about market demand for products or features, and for price, size, design, quality and amenities. Comps focus on what is easily compared—square footage and related attributes—and usually don't consider green value-added features. Banks usually will not lend without comps. As green building increases, more green comps should become available.

Market analysis for green development

Market analysis evaluates prospective customers and their needs. Visual preference surveys (such as of community members), which show or model various alternative features, can help determine the market, and increase community support. Focus groups can help explore target market preferences. So can illustrating successful green projects elsewhere.

One company, MERRITT Signature Development Alliance, sees a market for environmentally sensitive commercial office renovations. They estimate that most of the 3 billion ft^2 of office space built in the 1980s has a 20-year useful life, and will soon need renovation. MERRITT is trying to capitalize on product differentiation, providing commercial space with lower operating cost and greater worker comfort.

Commercial buildings are historically best marketed emphasizing economic return. Buildings will probably need to demonstrate that they provide a significant return above the Internal rate of return (IRR). They need to show the financial viability and return on capital, reduced operating costs, etc. as well as the additional advantages of positive image and environmental recognition. MERRITT suggests targeting specific audiences rather than mass marketing green commercial development .

2. Leasing

Leases vary by region, building type and market. They generally do not favor resource efficiency. Owners have no market incentive to improve efficiency when tenants, but not the owners, benefit from savings but don't bear capital costs. Some landlords even make money from excessive tenant energy use, through mark-ups.

Operating cost savings provide more negotiation flexibility to owners/developers, and, if less expensive and more healthy, can lead to faster absorption rates, lower vacancy rates and help retain tenants.

3. Financing

Real estate lending is cyclical, with boom and bust cycles. In flush times, money is readily available, even for junk projects. But some good green projects could not get funding during bust cycles.

Another problem some green developers face is higher costs. Even if the market accepts premiums, lenders may not (as occurred with Prairie Crossing, near Chicago). Green development negatives perceived by lenders: lack of comps, untested markets, land protection costs. Still, some lenders consider association with green development a plus (e.g., ITT Financial Real Estate Services, who helped finance the Inn of the Anasazi).

Diverse or mixed-use projects have a harder time with financing because of traditional lending practices. Lenders prefer one large tenant rather than many small ones. Yet many large, single use buildings have gone bankrupt because a large tenant (e.g., IBM, Wal Mart) has moved out and no one moved on. Projects flexible enough to serve diverse users have higher lifetime occupancy rates, according to the Rocky Mountain Institute. (But if so, why aren't lenders aware of this?)

<u>Debt vs. equity</u>
Green developers may do best getting an option on a property and demonstrating that a market exists through presales, or to bring in substantial equity investment (in which investors own a percentage above what is financed by debt), such as occurred at Spring Island, SC.) Although it's easier to get a loan than to raise money, equity financing buys more time to work out a plan that everyone will be satisfied with, and generally gives the developer more control. Also, no debt, no interest payments, which provides "a more patient approach to development."

Appraisals
Developers depend on appraisals for financing. Green developments, not well understood, tend to be undervalued. Appraisals tend to be biased towards the conventional, and don't consider pedestrian amenities, nearby services, better infrastructure and other "externalities." (Nevertheless, the educational/demonstration value became part of the appraisal value of the Real Goods Solar Living Center in Hopland, CA.)

Mortgages
Some lenders now provide energy-efficient mortgages (EEM) for homes.

Financing energy efficiency
Many utilities and government agencies offer financial assistance to encourage energy efficiency, from design assistance to rebates for installing energy-efficient measures. More than 170 electric, gas and combination utilities offer some incentive or rebate for commercial customers. Some have cut back, however, such as PEPCO in the metropolitan Washington, DC area.

1. Third-party companies, a.k.a. Energy Service Companies (ESCOs), provide one-stop shopping for commercial buildings. They conduct energy audits, provide financing, select and install energy-efficient measures, and monitor energy savings. They often pay up front and bill customers in monthly installments, which are usually lower than conventional energy bills.

Still, financing these measures can be difficult. Expected paybacks may not meet required thresholds for investment. Historically, the results have been mixed, making lenders leery. DOE estimates a current need of $100 billion to finance cost-effective retrofits in the public and commercial buildings sectors, but financing has been available for only about 5% of those. However, DOE has been trying to create a secondary market for energy-efficiency with public and private partners, allowing immediate recovery of energy improvement investments, much like the secondary mortgage market, which aggregates individual mortgages [has it in fact happened?]. This would provide a large, low-cost source of funds.

2. Utility companies have financed may demand-side management (DSM) programs, finding it more cost-effective to invest in energy conservation than to build new generating capacity. This has not occurred with either Cleveland-area utility.

IV. OTHER GREEN BUILDINGS CASE STUDIES

1. Crosbie, M.J. 1994. *Green architecture: a guide to sustainable design*. Rockport Publishers, Rockport, MA. 191 pp.

Hotel/Resort

- Conference/Cultural Center and Hotel, Northern California

Office/Commercial

- National Public Radio, Washington, DC
- International Institute For Energy Conservation, Washington, DC
- Natural Resources Defense Council, New York, NY
- National Audubon Society, New York, NY

Institutional

- Frankfurt Daycare Center, Frankfurt, Germany
- Spring Lake Park Visitors' Center, Santa Rosa, CA
- Boyne River Ecology Centre, Shelbourne, Ontario
- Oseh Shalom Synagogue, Laurel, MD
- Center For Regenerative Studies, California State Polytechnic University, Pomona, CA
- Arizona State Desert Museum, Tucson, AZ
- Boyce Thompson Arboretum Visitor Center, Superior, AZ
- Aquatorium, Chattanooga, TN
- Saudi Arabian Pavilion, Seville World Expo, Spain
- Camp Tweedale, Oxford, PA
- Women's Humane Society Animal Shelter, Bensalem, PA
- Alice C. Tyler Village Of Childhelp East, Lignum, VA
- Virginia Merrill Bloedel Education Center, Bainbridge Island, WA

Industrial

- Photovoltaic Manufacturing Facility, Fairfield, CA
- The Body Shop, U.S. Headquarters, Wake Forest, NC
- VeriFone Worldwide Distribution Center, Costa Mesa, CA

Retail

- Wal-Mart "Eco-Mart" Retail Store, Lawrence, KS
- The Body Shop, Retail Store, Cary, NC
- BEST Forest Building, Richmond, VA

Mixed use

- Ross's Landing Plaza and Park, Chattanooga, TN
- Dewees Island Master Plan, Dewees Island, SC

Residential

- Hill House, La Honda, CA
- Camino Con Corazon, Baja California Sur, Mexico
- Palmetto House, Miami, FL
- House in the Keys, Islamorada, FL

- Hoagie House, Suburban Washington, DC
- Case Bedroom/Bath Remodel, Kentfield, Marin County, CA
- Brunsell Residence, Raleigh, NC
- Louis Residence, Sea Ranch, CA
- Price Residence, Takoma Park, MD
- Berman/Gentner Addition, Washington, DC
- Carleton Residence, Chevy Chase, MD
- Davenport Residence, McLean, VA
- Bridge House, Bainbridge Island, WA
- Guest House, Suburban Seattle, WA
- Paulk Residence, Seabeck, WA

Other structures

- Natchez Street Pavilion (a sand dune walkover), Seaside, FL
- Project Potty (a park restroom), Pima County, AZ
- Avenue Number Five (a pedestrian artery), Seville World Expo, Spain

2. Rocky Mountain Institute. 1998. *Green development: integrating ecology and real estate*. John Wiley & Sons, New York. 522 pp.

Office/Commercial

- American Association for the Advancement of Science Building (AAAS), Washington, DC
- National Audubon Society, New York, NY
- Crestwood Corporate Centre Building No. 8, Richmond, BC, Canada
- Energy Resource Center, Southern California Gas, Downey, CA
- International Netherlands Group (ING) Bank (formerly the Nederlandsche Middenstandsbank [NMB]), Southeast Amsterdam, The Netherlands
- United Parcel Service Headquarters, Atlanta, GA

Institutional

- C.K. Choi Building, Institute of Asian Research, University of British Columbia, Vancouver, BC, Canada
- Engineering Laboratory Wing, University of Victoria, Victoria, BC, Canada
- San Francisco Main Library, San Francisco, CA
- The Way Station, Frederick, MD

Hotel/Resort

- Boston Park Plaza, Boston, MA
- Inn of the Anasazi, Santa Fe, NM
- Maho Bay, Virgin Islands National Park, US Virgin Islands

Industrial

- The Body Shop, U.S. Headquarters, Wake Forest, NC
- Herman Miller SQA, Zeeland, MI
- VeriFone Worldwide Distribution Center, Costa Mesa, CA

Retail

- Real Goods Solar Living Center, Hopland, CA
- Tolman Creek Shopping Center, Ashland, OR

Mixed use

- 2211 West Fourth Avenue (a four-story building), Vancouver, BC, Canada
- Denver Dry Goods Building (retail, office, housing), Denver, CO
- Hamilton (community: residential. commercial, retail), Novato, CA
- Haymount (community: residential, office, light industrial, college campus), Caroline County, VA

Residential

- Dewees Island®, Dewees Island, SC
- Prairie Crossing, Grayslake, IL
- Santa Lucia Community Preserve, Monterey Peninsula, south of the Carmel Valley, California
- Spring Island, a barrier island in Beaufort County, SC
- Village Homes, Davis, CA

3. Hellmuth, Obata + Kassabaum, Inc. Sustainable Design Case Studies

www.hok.com/sustainabledesign/casestudies/casestudies.html

Office/Commercial

- SC Johnson Headquarters, Racine, WI
- Nortel Brampton Centre, Ontario, Toronto, Canada
- Turner Feature Animation, Glendale, CA
- Federal Reserve Bank of Minneapolis, Headquarters and Operations Center, Minneapolis, MN
- U.S. Environmental Protection Agency, Environmental Research Center, Research Triangle Park, NC

Institutional

- Missouri Historical Society, Museum Expansion and Renovation, St. Louis, Missouri

Mixed use

- Fort Bonifacio Master Plan, Manila, Philippines

Other structures

- Coors Field's Constructed Wetlands, Denver, CO

4. US Green Building Council. Case Studies
www.usgbc.org/resource/cs.htm

Office/Commercial

- Ridgehaven Green Building Demonstration Project, Environmental Services Department headquarters building, City of San Diego, CA
- Energy Resource Center, Southern California Gas, Downey, CA

Industrial

- Herman Miller SQA, Zeeland, MI

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