Environmental and Economic Impacts of Traditional vs. Green Building

Economic Impacts:

Initial Cost Premiums Compared to Lifetime Costs/Savings

A recent study of 33 green buildings in California found that the average cost of building green over traditional methods (the "premium") was about 2%, which equals about $4 per square foot. The average energy reduction from the 33 buildings was 30 percent. This alone provides savings sufficient to pay back the initial 2% premium in less than 9 years. The same study found that, over a twenty-year period, the overall net savings for a green building is between $48.87 - $67.31 per square foot, depending on the LEED rating of the building. Therefore, an initial investment of only 2% of the first costs results in savings worth more than ten times the added premium.**(5)**

Economics of Green Buildings

FINANCIAL BENEFITS OF GREEN BUILDINGS SUMMARY OF FINDINGS (PER SQUARE FOOT)(11)	
Category	**20-Year Net Present Value**
Energy Savings	$5.80
Emissions Savings	$1.20
Water Savings	$.50
Operations and Maintenance Savings	$8.50
Productivity and Health Benefits	$36.90 to 55.30
Subtotal	$52.90 to 71.30
Average Extra Cost of Building Green	(-$3.00 to -$5.00)
Total 20-Year Net Benefit	$$50 to $65

Occupant Productivity

Two studies, conducted by the Heschong Mahone Group in Sacramento, California, demonstrated that incorporation of natural light had positive results on a building's occupants. One study analyzed test score results for over 21,000 students from three elementary school districts in California, Colorado, and Washington state. Results from the Capistrano Unified School District in Orange County, California, indicated that, in one year, students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% on reading tests.**(12)** Another study examined sales levels in 108 nearly identical retail stores, of which some incorporated skylights and others did not; results showed 40% higher sales in daylight retail environments.**(13)**

A report by the U.S. Department of Energy and the Rocky Mountain Institute documents eight case studies, in which efficient lighting, heating, and cooling measurably increased worker productivity, decreased absenteeism, and/or improved the quality of work performed.**(7)**

The Lockheed Building 157 in Sunnyvale, California, was designed to be a highly energy-efficient facility. Green design elements added $2 million in design and construction costs to the $50 million, 600,000-square-foot project. The use of daylighting has resulted in a 75% decrease in electricity costs, at a calculated savings of $500,000 annually. In addition, Lockheed reports a 15% rise in production and a 15% decrease in absenteeism.**(7)**

The West Bend Mutual Insurance Company in West Bend, Wisconsin, incorporated daylighting and personal, localized controls for lighting and temperature into its 150,000-square-foot office building. The costs took only 18 months to recoup, and the company saw a 16% increase in worker productivity.**(7)**

Environmental Impact Numbers of Traditional Buildings

The design and construction of buildings has a significant impact on the environment and the economy. **Traditional buildings consume or are responsible for**:

- 45% of the world's total energy use;
- 50% of all materials and resources;
- 50% of wood use in North America;
- 35% of the world's CO_2 emissions;
- 80% of potable water use;
- 25% of freshwater withdrawal (including power plants)
- 40% of municipal solid waste destined for local landfills; and
- 50% of ozone-depleting CFCs still in use.**(1)(2)**

Structures also affect watersheds, habitat, air quality, and community transportation patterns.**(1)** A typical 1,700-square-foot wood frame home requires the equivalent of clear-cutting one acre of forest.**(3)**

Another human and environmental value often overlooked is clean water resources. Although 70% of the earth's surface is made up of water, only 3% is freshwater. In turn, only 1% of that is available for human use because the remaining 2% is severely polluted or trapped in polar ice caps.**(4)** With an ever-growing population, it is clear that the availability of safe, clean water is limited. California has already experienced mandatory water rationing.**(5)** In the U.S., we use more water on average per person than anywhere else in the world; we use triple the European average and nearly seven times the per capita average of the rest of the world.**(4)** In the U.S., nonresidential water use accounts for 53% of our total water use, of which 70% is devoted to commercial, institutional, and industrial buildings.**(6)** Clearly, ensuring that future construction is designed for water conservation would greatly reduce our demand on diminishing water supplies.

Green buildings can save money by increasing worker productivity as well. A report by the U.S. Department of Energy and the Rocky Mountain Institute documents eight case studies, in which efficient lighting, heating, and cooling measurably increased worker productivity, decreased absenteeism, and/or improved the quality of work performed.(7) **Workers' salaries constitute the highest annual operating expense of commercial space in relation to dollars per square foot, followed by rent. In comparison, operation, maintenance, and energy costs are a much smaller percentage of operating costs (less than one-tenth). A one percent savings in salaries – or a one percent productivity gain – of $2 per square foot per year well exceeds operation, maintenance, and energy costs.**(8)

The U.S. Environmental Protection Agency estimates that direct health care costs associated with sick buildings are $30 billion annually. Another $100 billion in indirect costs – in the form of sick leave and productivity losses – are also attributed to poor indoor air quality.**(9)**

Benefits of Green Buildings

Green buildings save money because they conserve resources and enhance efficiency by:

- Maximizing energy conservation and efficiency by optimizing building orientation and integrating natural daylight and ventilation;
- Using natural insulation such as roof gardens;
- Using technology such as solar panels, fuel cells, and photovoltaics; and
- Conserving water and reducing runoff using solar water heating, contour landscaping, and water-conserving or water-recycling appliances.**(10)**

Green buildings reduce the environmental impact of the building industry by:

- Using materials that are selected based on their life-cycle environmental impacts;
- Making use of renewable energy resources;
- Minimizing the use of mined rare metals and persistent synthetic compounds;
- Applying reduce, reuse, and recycle to materials in all phases of construction and demolition; and
- Reducing harmful waste products produced during construction.**(10)**

Green buildings enhance occupant safety, health, and comfort by:

- Reducing or eliminating toxic and harmful materials and finishes;
- Applying maintenance and operational practices that reduce or eliminate harmful effects on people and the natural environment; and
- Employing personal, local control over temperature, air flow, and lighting.**(10)**

Training in Green Design

Research indicates that the initial design and construction costs of building green over conventional building has dropped significantly in recent years, and is expected to continue to decline as designers and builders gain experience and training in this relatively new field. In Oregon, the premium cost for a Leadership in Energy and Environmental Design (LEED)-certified green building dropped as local designers became more familiar with sustainable design elements – a building erected in 1995 had a 2% cost over a comparative conventional building; in 1997, 1%; and, in 2000, a 0% premium was achieved.**(5)**

Architects educated in green design better serve their clients by designing buildings that cost less to occupy and maintain. In several state studies, training has been found to be a key factor in improving compliance with energy efficiency standards.

Since most of the features that make a building sustainable are incorporated in the design phase, architects can play a pivotal role in determining how green a building is. Factors that determine a building's performance, such as site selection; orientation; foundation, walls, and roof; heating, cooling, and ventilation; and lighting,

are either directly or indirectly influenced by the design decisions of the architect.

Site Selection

Although site selection is usually based on price, a poor decision can preclude several sustainable features. Making the most out of what the site has to offer can be the difference between a high performance building and a traditional one.

Orientation

Proper orientation allows for passive solar gain and daylighting. In the northern hemisphere, south-facing windows have the greatest exposure to the sun. West-facing windows need to be carefully designed, as the low angle of the setting sun can cause overheating.

Foundation, Walls, and Roof

The envelope of the building is a significant determinant of how much energy is required to heat and cool it. The challenge in designing the foundation, walls, and roof is to minimize conductive heat loss/gain while minimizing uncontrolled movement of air into the building.

Heating, Air Conditioning, and Ventilation

Reducing the heat load of the structure allows for the installation of a smaller heating and cooling system. The importance of high quality ventilation systems is often overlooked during the design phase, but is a fundamental consideration in green building.

Lighting

U.S. Department of Energy research found that lighting and appliances consume 14 percent of the energy used in a residence. Occupants want living/working spaces that are bright and inviting. Energy-efficient buildings make use of natural daylight in high traffic areas and are designed for individual, local control to avoid wasting energy.

Legislation

Federal laws and executive orders mandating energy efficiency standards in federal buildings have produced dramatic results. The government's energy use in standard buildings has dropped 23% per square foot since 1985, saving $1.4 billion annually.**(14)**

The Federal Energy Management Program, which works with federal facilities on greening initiatives, reports that greening initiatives benefit taxpayers and set an example by:

- Making government work better and cost less;
- Using the federal government's enormous purchasing power to stimulate markets for promising U.S. energy and environmental technologies; and

- Saving taxpayers money through reduced waste disposal and materials costs and lower utility bills.**(15)**

States can provide leadership and foster economic growth by passing legislation that provides incentives for green building or requires state buildings to meet certain green criteria.

Interest in Green Building

At the end of 1999, the U.S. Green Building Council (USGBC), the founder of LEED standards, had 250 member organizations and companies. Today that number has grown to more than 4,000 members.**(16)(17)** The USGBC receives approximately 35 new applications each month for LEED certification, and there are more than 5,000 LEED-accredited professionals nationwide.**(18)**

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