Executive Summary

Integrating "sustainable" or "green" building practices into the construction of state buildings is a solid financial investment. In the most comprehensive analysis of the financial costs and benefits of green building conducted to date, this report finds that a minimal upfront investment of about two percent of construction costs typically yields life cycle savings of over ten times the initial investment. For example, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of at least $1 million over the life of the building, assumed conservatively to be 20 years.[1]

The financial benefits of green buildings include lower energy, waste disposal, and water costs, lower environmental and emissions costs, lower operations and maintenance costs, and savings from increased productivity and health. These benefits range from being fairly predictable (energy, waste, and water savings) to relatively uncertain (productivity/health benefits). Energy and water savings can be predicted with reasonable precision, measured, and monitored over time. In contrast, productivity and health gains are much less precisely understood and far harder to predict with accuracy.

There is now a very large body of research, reviewed in this report, which demonstrates significant and causal correlation between improvements in building comfort and control measures, and worker health and productivity. However, these studies vary widely in specific measured correlations. Further, there has been relatively little work completed to evaluate specific, measurable benefits from green building design in California. Clearly, the benefits are significant and not zero, but the data supports a broad range of calculated benefits – in contrast to the more precisely measurable energy, water, and waste savings.

The financial benefits conclusions in this report should therefore be understood in this context. Energy, waste, and water savings as well as emissions reductions can be viewed as fairly precise, reasonably conservative estimates of direct benefits that alone significantly exceed the marginal cost of building green. Health and productivity benefits can be viewed as reasonably conservative estimates within a large range of uncertainty. Further research is necessary to better quantify and capture the precise savings associated with these benefits. Additional studies might include such measures as evaluating green building effects on insured and uninsured health effects, employee turnover, worker well being and, where relevant (e.g. in schools), test scores.

Background

"Green" or "sustainable" buildings use key resources like energy, water, materials, and land much more efficiently than buildings that are simply built to code. They also create healthier work, learning, and living environments, with more natural light and cleaner air, and contribute to improved employee and student health, comfort, and productivity. Sustainable buildings are cost-effective, saving taxpayer dollars by reducing operations and maintenance costs, as well as by lowering utility bills.

[1] Although this report was written with specific regard to California state buildings, data is national in scope and conclusions are broadly applicable to other types of buildings and for other public and private sector entities.

Over the last few years, the green building movement has gained tremendous momentum. The United States Green Building Council (USGBC), a national non-profit organization, has grown dramatically in membership. The USGBC's Leadership in Energy and Environmental Design (LEED) rating system has been widely embraced both nationally and internationally as the green building design standard. Public and private sector entities, including the cities of Santa Monica, San Diego, San Francisco, San Jose, Long Beach, Los Angeles, Seattle, and Portland; San Mateo County; the University of California; the Department of the Navy; the federal General Services Administration; and the states of Oregon, New York and Maryland have all adopted green building policies and clean energy standards. In addition, corporate entities, including Steelcase, Herman Miller, Johnson Controls, Interface, IBM, PNC Financial Services, Southern California Gas Company, Toyota, and Ford Motor Company, have constructed green buildings.

Recognizing the tremendous opportunity for California state government to provide leadership in the area of exemplary building design and construction methods, several years ago Governor Davis issued two Executive Orders that address the siting and building of state facilities:

- Executive Order D-16-00 establishes the Governor's sustainable building goal: "to site, design, deconstruct, construct, renovate, operate, and maintain state buildings that are models of energy, water, and materials efficiency; while providing healthy, productive and comfortable indoor environments and long-term benefits to Californians...The objectives are to implement the sustainable building goal in a cost effective manner…; use extended life cycle costing; and adopt an integrated systems approach.[2]"
- Executive Order D-46-01 provides guidance on the process the Department of General Services will use to locate and lease space, including such considerations as proximity to public transit and affordable housing, preserving structures of historic, cultural, and architectural significance, opportunities for economic renewal; and sensitivity to neighborhood and community concerns.[3]

The Issue of Cost

To implement the Executive Orders, the Secretary of the State and Consumer Services Agency, Aileen Adams, formally convened an interagency Sustainable Building Task Force (Task Force) comprised of over 40 state agencies, including representatives with energy, environmental, fiscal, construction, property management, and historic preservation expertise. As the Task Force set about its implementation work, the uncertainty about the "cost" of green buildings became an issue of growing importance and increased discussions.

While there seems to be consensus on the environmental and social benefits of green building, there is a consistent concern, both within and outside the green building community, over the lack of accurate and thorough financial and economic information. Recognizing that the cost issue was becoming more and more of a prohibitive factor in the mainstreaming of green building not only within California but across the country, several members of the Task Force funded an Economic Analysis Project to determine more definitively the costs and benefits of sustainable

[2] State of California, Governor's Executive Order D-16-00. August 2000. Available at: http://www.governor.ca.gov/state/govsite/gov_homepage.jsp.
[3] State of California, Governor's Executive Order D-46-01. October 2001. Available at: http://www.governor.ca.gov/state/govsite/gov_homepage.jsp.

building.[4] Sustainable buildings generally incur a "green premium" above the costs of standard construction. They also provide an array of financial and environmental benefits that conventional buildings do not. These benefits, such as energy savings, should be looked at through a life cycle cost methodology, not just evaluated in terms of upfront costs. From a life cycle savings standpoint, savings resulting from investment in sustainable design and construction dramatically exceed any additional upfront costs.

It is generally recognized that buildings consume a large portion of water, wood, energy, and other resources used in the economy. Green buildings provide a potentially promising way to help address a range of challenges facing California, such as:

- The high cost of electric power.
- Worsening electric grid constraints, with associated power quality and availability problems.
- Pending water shortage and waste disposal issues.
- Continued state and federal pressure to cut criteria pollutants.
- Growing concern over the cost of global warming.
- The rising incidence of allergies and asthma, especially in children.
- The health and productivity of workers.
- The effect of the physical school environment on children's abilities to learn.
- Increasing expenses of maintaining and operating state facilities over time.

Benefits include some elements that are relatively easy to quantify, such as energy and water savings, as well as those that are less easily quantified, such as the use of recycled content materials and improved indoor environmental quality. Prior to this report, no comprehensive analysis of the actual costs and financial benefits of green buildings had been completed, although there are a number of studies that do begin to address this very important issue.

- In October 2002, the David and Lucille Packard Foundation released their Sustainability Matrix and Sustainability Report, developed to consider environmental goals for a new 90,000 square foot office facility. The study found that with each increasing level of sustainability (including various levels of LEED), short-term costs increased, but long-term costs decreased dramatically.[5]
- A second, older study conducted by Xenergy for the City of Portland identified a 15% lifecycle savings associated with bringing three standard buildings up to USGBC LEED certification levels (with primary opportunities to save money associated with energy efficiency, water efficiency and use of salvaged materials).[6]

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[4] Funding agencies include the Air Resources Board (ARB), California Integrated Waste Management Board (CIWMB), Department of Finance (DOF), Department of General Services (DGS), Department of Transportation (CalTrans) Department of Water Resources (DWR), and Division of the State Architect (DSA).

[5] "Building for Sustainability: Six Scenarios for the David and Lucille Packard Foundation Los Altos Project," prepared for the David and Lucille Packard Foundation, October 2002. Available on-line at: http://www.packard.org/pdf/2002Report.pdf.

[6] "Green City Buildings: Applying the LEED Rating System," prepared for the Portland Energy Office by Xenergy, Inc and SERA Architects, June 18, 2000. Available at: http://www.sustainableportland.org/CityLEED.pdf.

In addition, a number of other studies document measurable benefits for enhanced daylighting, natural ventilation, and improved indoor air quality in buildings. Benefits associated with these "green" features include enhanced worker and student productivity, as well as reduced absenteeism and illness.

For example:

- One study performed by the Heschong-Mahone group looked at students in three cities and found that students in classrooms with the greatest amount of daylighting performed up to 20% better than those in classrooms that had little daylight.[7]
- A study at Herman-Miller showed up to a 7% increase in worker productivity following a move to a green, daylit facility.[8]
- A Lawrence Berkeley National Laboratory study found that U.S. businesses could save as much as $58 billion in lost sick time and an additional $200 billion in worker performance if improvements were made to indoor air quality.[9]

Report Methodology and Format

This report is the first of its kind to fully aggregate the costs and benefits of green buildings. Specifically, the bulk of this report reviews and analyzes a large quantity of existing data about the costs and financial benefits of green buildings in California. Several dozen building representatives and architects were contacted to secure the cost of 33 green buildings compared to conventional designs for those buildings. The average premium for these green buildings is slightly less than 2% (or $3-5/ ft^2, see *Implications for California,* pg.18), substantially lower than is commonly perceived. The majority of this cost is due to the increased architectural and engineering (A&E) design time necessary to integrate sustainable building practices into projects. Generally, the earlier green building gets incorporated into the design process, the lower the cost.

A literature review conducted for this report revealed that there is sufficient data from which to construct reasonable estimates about the value of many green building attributes. Historically, both private firms and public agencies do not recognize the full financial value of green buildings. They usually acknowledge some benefits from lower energy and water use, but completely ignore or critically undervalue other, often significant, financial benefits of green buildings during the design and construction decision-making process.[10] For most of these benefits, such as emissions reductions and employee productivity, there are multiple methods that can be used to derive values of benefits, as well as a large range of values that can be assigned to them. In most cases,

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[7] Heschong Mahone Group, "Daylighting in Schools: An Investigation into the Relationship Between Daylight and Human Performance," 1999. Available at: http://www.h-m-g.com; Follow up studies verified the rigor of analysis and subsequent research continues to show positive correlation between daylighting and student performance.

[8] Judith Heerwagen, "Do Green Buildings Enhance the Well Being of Workers?" *Environmental Design and Construction Magazine*. July/August 2000. Available at: http://www.edcmag.com/CDA/ArticleInformation/coverstory/BNPCoverStoryItem/0,4118,19794,00.html.

[9] William Fisk, "Health and Productivity Gains from Better Indoor Environments," summary of prior publications (see Appendix J), with figures inflation-adjusted for 2002 dollars and rounded.

[10] See, for example "CEC Environmental Performance Report." Available at: http://www.energy.ca.gov/reports/2001-11-20_700-01-001.PDF. 2003 EPR will be finalized and available in October 2003 as part of the *Integrated Energy Policy Report*.

there is no single "right" answer. Nonetheless, the report underscores that based on the body of existing data, it is possible to determine reasonable, conservative estimates of financial benefits for a range of green building attributes.

The report also reveals the need for further research and analysis. In all areas, consistently conservative assumptions were made in view of data limitations. Additional research will help to refine cost and benefit estimates and likely lead to increased financial benefit calculations for green building. Additionally, throughout the report, the reader is directed to online databases and publications for the most accurate and relevant information. In many instances, these referenced documents are available online, and URLs are provided in the footnotes.

Conclusion

The benefits of building green include cost savings from reduced energy, water, and waste; lower operations and maintenance costs; and enhanced occupant productivity and health. As Figure ES-1 shows, analysis of these areas indicates that total financial benefits of green buildings are over ten times the average initial investment required to design and construct a green building. Energy savings alone exceed the average increased cost associated with building green.

Additionally, the relatively large impact of productivity and health gains reflects the fact that the direct and indirect cost of employees is far larger than the cost of construction or energy. Consequently, even small changes in productivity and health translate into large financial benefits.

Figure ES-1. Financial Benefits of Green Buildings Summary of Findings (per ft^2)

Category	20-year NPV
Energy Value	$5.79
Emissions Value	$1.18
Water Value	$0.51
Waste Value (construction only) - 1 year	$0.03
Commissioning O&M Value	$8.47
Productivity and Health Value (Certified and Silver)	$36.89
Productivity and Health Value (Gold and Platinum)	$55.33
Less Green Cost Premium	($4.00)
Total 20-year NPV (Certified and Silver)	**$48.87**
Total 20-year NPV (Gold and Platinum)	**$67.31**

Source: Capital E Analysis

Despite data limitations and the need for additional research in various areas, the findings of this report point to a clear conclusion: building green is cost-effective and makes financial sense today.