5.0 Strengthening the Business Case: Research and Data Needs

The research results and case studies that were presented in the preceding sections show that a strong business case for sustainable design and construction can be made today. Case studies described in Section 2 indicate that a well-designed building, which integrates sustainable design features in the early stages of design, can be built at about the same cost as a more typical building without those features because creative building design teams can incorporate sustainable features by reducing costs in other parts of the project. Even when first costs increase slightly, lifecycle cost reductions and short payback periods can make sustainable design very cost effective. A number of studies also show that sustainable buildings have positive impacts on occupants. Because the annual salary and benefit costs of building occupants far outweigh the annualized capital costs or the yearly costs of energy and O&M, occupant productivity gains can have a considerable impact on business costs.

Other stakeholders, such as neighbors and local and state governments, may also realize benefits such as increased protection of local natural resources, lower pollution loadings, better regional employment opportunities, and lower infrastructure needs (e.g., water and waste treatment facilities). These, in turn, can result in economic benefits to the building owner/operator in the form of easier siting of the next facility, less time to deal with complaints from the neighbors, and other indirect benefits. For government agencies, the "public good" value associated with these benefits should, in theory, be more important than it is in the private sector. Unfortunately, some of these benefits are supported mainly by a few research studies or anecdotal evidence.

Table 5-1 summarizes the status of the business case information in the various cells of the matrix presented in Section 1 (also presented in more detail in Appendix A).

The arguments supporting sustainable design will gain strength as more data and information are collected on the effects of sustainable design and construction on first costs; annual energy and other operating costs; occupant health, productivity, and well-being; environmental impacts; and other social and business impacts. Some of the areas for which data gathering may prove useful to the business case are as follows:

- **First costs.** Because projects evolve over time, there is usually no clearly defined "before" and "after" picture that would allow the costs of various features that were added or taken out of the design to be estimated. Case studies aimed at tracking cost estimates as the project evolves would be useful. First-cost information could be more widely disseminated by adding more case studies and detail to the cost information in databases such as DOE's High Performance Buildings Database. In addition, for many types of sustainable design features, very little generic cost information has been gathered. For sustainable materials, some reliable data have been collected into databases such as the Building for Environmental and Economic Sustainability developed by the National Institute of Standards and Technology[52] but further work to develop similar databases for other types of sustainable design features may be warranted. The ability to examine various classes of features (materials, energy efficiency, water, etc.) through one access point (e.g., a single website) could be very useful.

[52] Available at http://www.bfrl.nist.gov/oae/software/bees/please/bees_please.html.

Table 5-1. Status of Business Case Information

Category	Economic Benefits	Social Benefits	Environmental Benefits
Sustainable siting	Some information is available on the cost and cost savings associated with siting approaches. This study estimated cost savings associated with "natural" landscaping (resulting from reduced water and fertilizer consumption). More data like this could be gathered through case studies or analysis of vendor information.	This study found no comprehensive research done on the value society places on sustainable siting. However, some survey work or other research may have been done (e.g., in an environmental impact statement process) to examine benefits of specific sustainable design strategies, such as siting on brownfields.	No comprehensive research has been done on the environmental benefits of siting strategies. These would be site-specific. It would be feasible to estimate benefits such as CO_2 and air pollution benefits of lower energy use due to better passive solar strategies.
Water efficiency	Some information is available on the cost and cost savings of various water-saving strategies. This study estimated first costs and cost savings associated with specific water-efficiency technologies, but a wider range of technologies could be investigated. The water and cost savings in this study are based on theoretical estimates; no water monitoring studies have been incorporated into the business case report to date.	Impacts of building water consumption on current and future water supplies have not been studied in any comprehensive way (according to the research done for this study). Information on local water supply impacts may be available in cases where environmental impact statements must be completed.	This study estimated impacts on water consumption of some specific technologies. A wider range of technologies could be investigated (such as those applicable to larger buildings than those examined in this study). Also, projections of Federal facility water use and potential for reduction using sustainable design strategies would be useful.
Energy efficiency	Costs for a wide variety of energy-efficiency measures are available from various sources. This study estimated first costs and annual cost savings associated with a combination of those technologies. Some case study information has also been gathered. Further work would involve gathering costs of a wider range of technologies, especially those that should be used in larger building. Also, most of the estimates in this document have been based on models, not measured energy savings. More measured data could be gathered.	Some research results show positive effects on building occupants of certain building features, such as daylighting, which also reduce energy consumption. Although thermal comfort effects on productivity have been studied, data are sparse on the impact of particular HVAC systems and other energy-efficiency measures on occupants. One exemption is the study by Loftness et al. (2002), which compiled research results on occupant benefits of underfloor HVAC systems. This area of research might be of interest to the energy-efficiency community.	The direct air pollution and CO_2 emission impacts of energy-reducing strategies are fairly easy to estimate. Other environmental impacts of energy efficiency are site-specific and more difficult to estimate.

Category	Economic Benefits	Social Benefits	Environmental Benefits
Sustainable materials	Some databases of sustainable materials exist (e.g., the National Institute of Standards and Technology maintains the Building for Environmental and Economic Sustainability – BEES – database). This study estimated first costs and estimated cost savings associated with specific sustainable materials.	Some research results indicate that the use of low-emitting material such as carpeting, paint, etc., can reduce occupants' illness symptoms.	The full lifecycle impacts of sustainable materials could be investigated. Some effort has been undertaken by various research groups to do this kind of work.
Indoor environmental quality	Some costs have been gathered in databases such as BEES (see above). Cost differentials for low-VOC paint are included in the document. Cost estimates of improved ventilation are available. Further refinement and data gathering may be warranted for other features related to indoor environmental quality.	Much research has been done in this area (see Appendix F), but gaps exist. Gaps could potentially be prioritized based on the business impact of the effects.	Very little coverage of this topic is in this document or elsewhere.
Commissioning and O&M	Quite a few case studies of building commissioning have been compiled by PECI. This document includes a very cursory examination of the costs and cost savings of commissioning and O&M.	Based on the limited search for information conducted for this study, it appears that little work has been done to estimate the positive impacts of commissioning and O&M on building occupants. This topic has been discussed only qualitatively in this business case report. This is a potentially important area for business case research because occupant health impacts have potentially large financial consequences.	Estimating air pollution impacts of reducing energy use through commissioning and O&M is feasible. General information on energy savings associated with commissioning and O&M has been included in this document.

- **Annual energy cost data.** Most information about cost savings associated with sustainable buildings is based on estimates made in the design phase. For instance, energy savings are modeled using tools such as Energy-10 and DOE-2 (discussed in Section 2 and Appendix B). But, once built, the building may not perform as simulated. Meters can be used to measure actual performance and compare that against the modeled results, but metering studies can be costly and often are not performed because of budget constraints. Even when meters are present, some building operators report that they do not have the time and resources to analyze the data. This document provides information from a few case studies where actual performance has been measured and analyzed. A more widespread program to monitor energy consumption and costs by end use in both sustainable and traditional buildings could bolster the business case for sustainable design in Federal facilities.

- **Non-energy operating costs.** In addition to energy costs, annual water/sewer costs as well as general maintenance and repair costs could be monitored in sustainable buildings to help determine whether these costs are lower than those in their traditional counterparts.

- **Occupant benefits.** A number of studies indicate that sustainable buildings improve occupant productivity and have other positive impacts that can affect the bottom line, but more research is needed to quantify these effects in a way that allows decision makers to translate them into cost savings for every type of building. The Center for Building Performance and Diagnostics within the School of Architecture at Carnegie Mellon University has collated a large body of research into a tool called the Building Investment Decision Support (BIDS). BIDS allows a user to generalize the results of particular research studies to estimate potential benefits at the user's facility. Given the differences between the buildings studied in the research and each user's specific building, BIDS can provide only a hypothetical estimate of dollar benefits. More research on building occupants' health, satisfaction, and productivity in a wide range of buildings would help strengthen the business case. In particular, a better understanding is needed on how to quantify impacts on the productivity of "knowledge workers." In addition, the sustainable design community would benefit from more research that links specific sustainable design features to the corresponding occupant benefits.

- **Other benefits to the building owner and the public.** Aside from the impacts of indoor environmental quality on occupants, very little research has been conducted on the social impacts of other aspects of sustainable design. Many hypothesized relationships between sustainable design features and impacts on both occupants and society at large described in the previous sections are supported by only a few studies or by anecdotal evidence. Data-gathering methods could be developed to investigate the validity of the following arguments for sustainable design:
  - Employee turnover is substantially lower in sustainable buildings.
  - Green buildings experience lower occupant complaints and less on-call maintenance costs.
  - Property values increase in the vicinity of green buildings.
  - Sustainable building improves the market for recycled products.
  - Green buildings are a factor in attracting the most desirable employees.

  These factors may be as important to the business case as first costs and energy savings, so further research to gather data on these topics through surveys and other means may be warranted.

- **Environmental benefits.** Some of the potential research activities on environmental benefits of sustainable design in Federal facilities might include the following:
  - Develop a better profile of the environmental impacts of Federal facilities
  - Benchmark "best practices" with regard to environmental impacts, so comparisons can be made across facilities
  - Improve monitoring and analysis of energy and water consumption in Federal facilities, especially new, green buildings and quantitatively assess the environmental improvements (e.g., reductions in energy, air emissions, and water consumption)
  - Share lessons learned and case studies that quantify environmental improvements
  - Continue to track studies assessing the environmental impacts of buildings and methods to place economic values on environmental improvements.

In November 2002, FEMP convened a workshop of individuals knowledgeable about the business case for sustainable design from various government agencies, academia, and the private sector.

The purpose was to discuss data and research needed to make a stronger business case for sustainable design (FEMP is expected to publish a report on this workshop in the near future). Small groups of workshop participants discussed research needs in three areas: direct cost savings associated with sustainable design and construction, occupant productivity and well-being, and strategic business considerations. Some of the recommendations of the participants, summarized in Table 5-2, overlap with and build on the suggestions described above.

Table 5-2. Key Recommendations from Participants in the Sustainable Design Business Case Workshop

Direct Costs	Productivity and Well-Being	Strategic Business Considerations
• Gather cost data (e.g., dollars per ft^2, normalized by building type and location) for many sustainable design projects so that analysts can estimate statistically significant differences in first costs between traditional and sustainable buildings • Use DOE's High Performance Buildings website to compile case studies • Understand the differences between the costs for incremental improvements that marginally improve a building's environmental performance versus costs for sustainable buildings derived from integrated design • Develop consistent protocols for data collection, reporting, and use	• Develop a better understanding of productivity and how it can be measured for a whole variety of job types, including knowledge workers, as well as the impacts of sustainable design and construction on productivity • Better define the critical building features (both sustainable and other features) that impact health, well-being, and productivity to be included in controlled studies • Focus on causal links between building features and health (e.g., disease transmission) using controlled studies (perhaps using methods, data, and results from other fields of research) • Develop a more definitive understanding of the relationship between daylight; natural ventilation; and views on health, well-being, and productivity • Conduct cross-sectional studies of high-performance buildings compared with conventional buildings using survey tools	• Identify methods to better understand risk and liability, occupant health effects, employee retention, and other key impacts of sustainable design • Develop a common standard for assessing environmental (broadly defined) impacts of sustainable facilities • Develop a method to allow all levels of managers to build their own business case for sustainable projects (within the context of their agencies and management priorities) • Work with a broad range of stakeholders to develop ways to better understand the strategic benefits of sustainable design and consider ways to study the market-transforming effects of systems such as LEED