

SUSTAINABLE BUILDING TECHNICAL MANUAL

Green Building Design, Construction, and Operations



Produced by Public Technology Inc. ■ US Green Building Council

Sponsored by U.S. Department of Energy ■ U.S. Environmental Protection Agency

Pre-Design Issues

Introduction

The conventional process for a construction project involves the initial project conceptualization, followed by pre-design, design, bid, construction, and occupancy. An environmentally responsive design process adds the elements of integrated building design, design and construction team collaboration, and the development of environmental design guidelines. These new elements must be incorporated into the project from the very beginning and carried throughout the project phases to the final occupancy of the building.

Conventional buildings often fail to consider the interrelationship among building siting, design elements, energy and resource constraints, building systems, and building function. Green buildings, through an integrated design approach, take into consideration the effect these factors have on one another. Climate and building orientation, design factors such as daylighting opportunities, and building envelope and system choices, as well as economic guidelines and occupant activities, are all factors that need to be considered in an integrated approach.

A multidisciplinary design and construction team can develop a building's functional and operational design to meet environmental and financial goals. The multidisciplinary approach allows all team members—site planners, landscape architects, architects, engineers, contractors, interior designers, lighting designers, building owners, tenants, management companies, utilities, builders, and others—to share specialized expertise and coordinate their individual design efforts to achieve a well-functioning, integrated building.

Development of green building guidelines sets both general goals for the project and specific parameters for building design, products, systems, and siting. These guidelines help to shape the project as it moves through the project phases.

Chapters 3 and 4 provide information on the pre-design phase of the construction process—the critical stage that shapes the eventual design and development of a sustainable building.

CHAPTER 3

Pre-Design

★ SIGNIFICANCE

An environmentally responsive design process, as outlined in *Figure 1*, follows the conventional process, with additional consideration given to sustainable design, materials, and systems. Activities which should occur in pre-design are discussed in this chapter; other parts of the manual discuss the activities that occur in the design, bid, construction, and occupancy phases of a building's development.

Because the pre-design stage is the first step in the building process, incorporating green building practices into the project at this juncture is critical. Decisions made during pre-design not only set the project direction, but also must prove cost-effective over the life of the project. Charting the course of the project at the very beginning by establishing green project goals, defining the process to achieve those goals, and developing a clear understanding of the expected results is vitally important. A clearly developed project framework guides the decision-making process throughout the project, incorporating issues related to site selection and design, the building design and its systems, the construction process, and building operations and maintenance.

Integrated building design is a cornerstone for developing sustainable buildings, which are efficiently combined systems of coordinated and environmentally sound products, systems, and design elements. Simply adding or overlaying systems will not result in optimal performance or cost savings. Rather, building designers can obtain the most effective results by designing various building systems and components as interdependent parts of the entire structure. This conceptual framework starts at the pre-design stage and is carried throughout design and construction to building completion and operation.

This integrated approach is well-illustrated in passive solar design strategies that combine siting, architectural, mechanical, and electrical features in a systemic manner that results in improved building function and increased occupant satisfaction. Incorporating increased daylighting into a building design, for example, will affect

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ENVIRONMENTALLY RESPONSIVE DESIGN PROCESS

PRE-DESIGN

Develop Green Vision
 Establish Project Goals and Green Design Criteria
 Set Priorities
 Develop Building Program
 Establish Budget
 Assemble Green Team
 Develop Partnering Strategies
 Develop Project Schedule
 Review Laws and Standards
 Conduct Research
 Select Site



DESIGN

Schematic Design
 Confirm Green Design Criteria
 Develop Green Solutions
 Test Green Solutions
 Select Green Solutions
 Check Cost

Design Development

Refine Green Solutions
 Develop, Test, Select Green Systems
 Check Cost

Construction Documents

Document Green Materials and Systems
 Check Cost



BID

Clarify Green Solutions
 Establish Cost
 Sign Contract



CONSTRUCTION

Review Substitutions and Submittals for Green Products
 Review Materials Test Data
 Build Project
 Commission the Systems
 - Testing
 - Operations and Maintenance Manuals
 - Training



OCCUPANCY

Re-Commission the Systems
 Perform Maintenance
 Conduct Post-Occupancy Evaluation

Figure 1

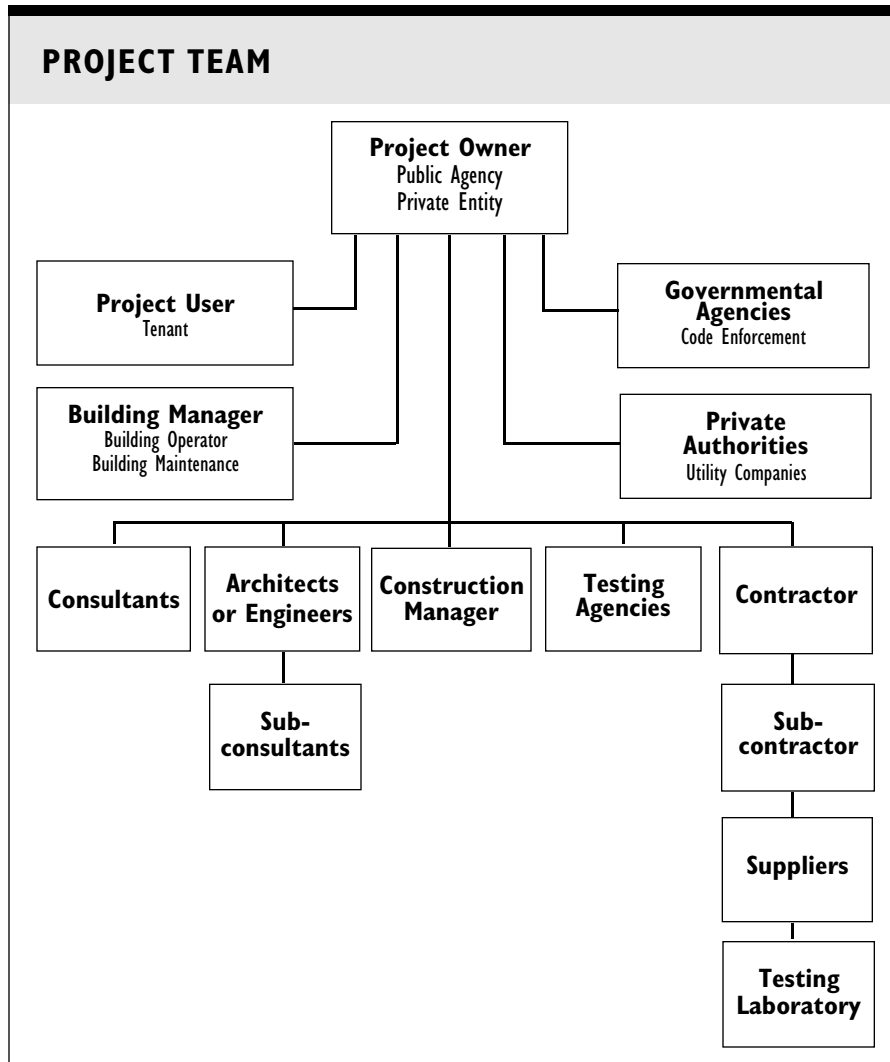


Figure 2

many other factors in the building. This strategy, which takes into account the building's orientation, as well as glazing choices and location, will permit reduction of artificial lighting. The resulting reductions in electricity use and internal heat loads will allow the downsizing of air-conditioning systems. As a result, overall energy usage and energy costs in the building are reduced, and the improved air quality and lighting conditions can result in increased productivity and health of occupants.

A team approach to design and construction is another important aspect of sustainable building that is established during the pre-design phase. This approach assures the development and implementation of an integrated building design. As illustrated in *Figure 2*, the team can comprise a wide variety of members—including the building owner, tenants, site planners, architects, engineers, contractors, local government agencies, management staff, and utility company representatives. For this approach to be successful, all parties on the design team must commit themselves to the sustainable goals of the project. Rather than working in isolation in their own areas of expertise, team members use a multidisciplinary approach in which the interrelated impacts of design, systems, and materials are recognized. Part of this process may involve education of team members to recognize the benefits of environmentally sound design or materials and to look beyond their own disciplines to conceptualize the integrated systems.

Environmental design guidelines, also an important component of green building development, direct the activities of the design team from the pre-design stage through all subsequent stages of the project. These guidelines may already exist as part of a building owner's operating policies, or may be developed for a particular construction project. If developed for a specific project, they can articulate principles that clarify the goals of the design team and rally support for the sustainable building concept from key parties such as the building owner, public officials, financiers, and the general community. The guidelines may initially state an overriding philosophy or vision, develop more defined goals in each area, and then relate specific objectives and priorities to a specific project. *Figure 3* outlines some of the green building issues—including those related to energy efficiency and renewable energy, direct and indirect environmental impact, indoor environmental quality, resource conservation and recycling, and community issues—to be considered when developing project guidelines.

These aspects of sustainable design, along with other activities that occur in the pre-design phase, including programming, budget analysis, and site selection, set the stage for successful construction of a green building.

SUGGESTED PRACTICES AND CHECKLIST

Environmental Design Guidelines

- **Establish a vision statement that embraces sustainable principles and an integrated design approach.**

The project team, along with the client, should clearly define and articulate a vision statement that will support and enforce sustainable goals throughout the project.

- **Establish the project's green building goals, developed from the vision statement.**

The project goals should emanate from the needs and values of the client. The goals need not be specific, but should be broad statements of environmentally based ideas that can be further developed and integrated by the project team. They may include such issues as energy efficiency, indoor and outdoor environmental quality, waste minimization, and general princi-

TYPICAL GREEN BUILDING GUIDELINE ISSUES

■ Energy efficiency and renewable energy

- Building orientation to take advantage of solar access, shading, and natural lighting
- Effects of micro-climate on building
- Thermal efficiency of building envelope and fenestration
- Properly sized and efficient heating, ventilating, and air-conditioning (HVAC) system
- Alternative energy sources
- Minimization of electric loads from lighting, appliances, and equipment
- Utility incentives to offset costs

■ Direct and indirect environmental impact

- Integrity of site and vegetation during construction
- Use of integrated pest management
- Use of native plants for landscaping
- Minimization of disturbance to the watershed and additional non-point-source pollution
- Effect of materials choice on resource depletion and air and water pollution
- Use of indigenous building materials
- Amount of energy used to produce building materials

■ Resource conservation and recycling

- Use of recyclable products and those with recycled material content
- Reuse of building components, equipment, and furnishings
- Minimization of construction waste and demolition debris through reuse and recycling
- Easy access to recycling facilities for building occupants
- Minimization of sanitary waste through reuse of graywater and water-saving devices
- Use of rainwater for irrigation
- Water conservation in building operations
- Use of alternative wastewater treatment methods

■ Indoor environmental quality

- Volatile organic compound content of building materials
- Minimization of opportunity for microbial growth
- Adequate fresh air supply
- Chemical content and volatility of maintenance and cleaning materials
- Minimization of business-machine and occupant pollution sources
- Adequate acoustic control
- Access to daylight and public amenities

■ Community issues

- Access to site by mass transit and pedestrian or bicycle paths
- Attention to culture and history of community
- Climatic characteristics as they affect design of building or building materials
- Local incentives, policies, regulations that promote green design
- Infrastructure in community to handle demolition-waste recycling
- Regional availability of environmental products and expertise

Figure 3

BERKELEY UNIFIED SCHOOL DISTRICT

Berkeley, California

In 1994, the Berkeley Unified School District in Berkeley, California, enacted environmental policies that established green building goals. The school district's Materials/Indoor Air Quality Policy states:

It is the intent of the Berkeley Unified School District Facilities Program to minimize building occupants' exposure to uncomfortable and potentially harmful interior environments. This effort starts with design and construction of new and renovated facilities, and continues through the life of the facility with maintenance practices.¹

The Energy Design Standard Policy states:

The building energy design standards policy of the Berkeley Unified School District seeks to achieve three broad goals. These are:

- 1) To provide a high quality indoor environment with respect to thermal comfort, lighting, and ventilation, for student, faculty, and staff.
- 2) To reduce energy consumption and maintenance costs of the District on an ongoing basis.
- 3) To improve energy conservation awareness and education of students, faculty, and staff.²

Both policies provide additional specific green design criteria. The Materials/Indoor Air Quality Policy deals with site layout and landscape, building materials, finishes and furnishings, building systems, and construction practices. The Energy Design Standard Policy establishes specific energy performance criteria and objectives as follows:

- 1) Improve district-wide energy use/square foot by 40 percent before the year 2000.
- 2) New and substantially renovated buildings shall exceed State Energy Code (Title 24) standards by a minimum of 35 percent.
- 3) Buildings which are retrofitted for energy conservation shall, as a minimum, meet the applicable provisions of the State Energy Code even where not required by law.³

ples of sustainability. In some instances, clients, such as governmental agencies and private organizations, may already have an environmental policy that informs and supports the project goals.

□ Establish green design criteria.

The design criteria, which are more specific than the goals, should begin to clarify the most important and relevant aspects of the project. For example, they may include a certain level of improvement in energy efficiency over conventional usage, indicate a percentage of renewable energy strategies and equipment to be used in the project, stipulate requirements for sensitive site design, provide guidelines for indoor environmental quality, and indicate levels of resource conservation and recycling. In addition, they may indicate that life-cycle assessment be used to analyze the direct and indirect environmental impacts of building-material selection, and that broad community-related environmental issues, such as preservation of existing green spaces or reuse of historic structures, be addressed.

□ Set priorities for the project design criteria.

– Prioritize design options based on environmental guidelines and project constraints. Priorities should flow from the vision statement, the goals, and the design criteria, and should support of the project's environmental policy. The design team, may, for example, decide that energy efficiency, indoor air quality, or several combined criteria are the main priorities for a project. Design criteria need to be prioritized in the context of the project's budget and scheduling constraints. The realities of these constraints may allow some design criteria to be included, but exclude others deemed less important by the team, or less

achievable with current technology. It is also possible that the project design could be flexible enough to allow incorporation of additional criteria at a later, more practical date. Setting priorities will provide the critical direction needed by the design team in making project decisions related to design, products, and systems.

- Seek to incorporate additional green measures through this process. Prioritizing criteria also may allow the design team to justify additional green measures for the project, by using the projected financial savings of one priority, such as energy conservation, to balance the costs of other green measures. Green building materials, for example, though environmentally significant, may not have the same direct financial payback as energy savings and may have higher up front costs than conventional products. Total project costs can remain reasonable, however, if savings from the energy-efficiency measures can offset the costs of other features.

Building Program

□ Develop a building program detailing the project's green building requirements.

A building program develops a clear statement of the building owner's or client's expectations for the building—and the function of the entire building and its various rooms and related structures—within the budget, schedule, and physical constraints of

the project. The building program should include both a general and a room-by-room description of the project. The project's environmental vision and goals and its design criteria and priorities should also be included in the building program. More specifically, the program should state include the criteria for energy efficiency and renewable energy, indoor air quality, materials selection, waste and demolition recycling, and any other clearly defined green requirements. In addition, the building program can take into consideration the broader community context of the building, and strive to reflect local design as influenced by cultural and climatic factors, as well as consider ease of pedestrian and mass-transit access.

Project Budget

□ **Develop the project and building construction budget.**

Determine relevant design fees and construction costs, including those for all green building measures, for the project.

- Institute life-cycle-cost analysis for the project's green design and construction measures (see Chapter 1, "The Economics of Green Buildings," and Chapter 2, "Selecting Environmentally and Economically Balanced Building Materials").
- Seek the advice of a design professional and cost consultant with green building experience.
- Because many green and sustainable building practices are relatively new to the industry, allocate adequate contingencies for additional research and analysis of options.

Design Team Selection

□ **Create a design and construction team that utilizes the whole-building integrated design approach.**

Select team members who are committed to the project vision. The project team should include representatives from all aspects of the building project, from site planning to construction to building operations. Team members should be willing to think beyond their own specialty and understand that the building is a system of interrelated processes and products. *Figure 2* illustrates the basic members of a project team.

□ **Develop a Statement of Work (SOW) and a Request for Qualifications (RFQ), in preparation for hiring appropriate design professionals.**

The SOW includes the project criteria, including green building issues. The RFQ identifies the skills required for participation in the project, including green building expertise.

□ **Select a team leader and encourage communication and integration among team members.**

The team leader's role is to integrate the design team process. The leader must have good communication skills and be well-grounded in the principles of sustainable design and construction. Additionally, the building owner, working with the team leader, can be a strong resource by supporting and emphasizing the importance of green building goals to the project.

□ **Determine the most appropriate method for contractor selection, given the project goals.**

This includes determining the construction contract type, such as public bid, invited bid, negotiated contract, and design-build. Green building goals may be more easily achieved with negotiated contracts than with bids, as the contractor can be carefully selected and hired at an earlier stage and can be actively involved in the building design team process. Prequalification of contractor and pre-selected or invited bids are other options for achieving these results. By prequalifying contractors, the owner can select those with experience and interest in green building practices.

Whichever contract type is selected, very carefully defined specifications, including environmental procedures, need to be developed and implemented. Contract or bid documents should clarify rules for submissions and substitutions of green products and systems. (See Chapter 17, “Specifications,” for further discussion.)

Partnering

□ **Implement a partnership-oriented process for the project.**

Partnership is the best way to pursue established project goals and criteria, following the whole-building integrated design approach; to establish and maintain communication among the team members; and to resolve issues related to design changes, problems with product availability, and other issues quickly. It is also a forum to discuss new techniques and strategies for green building design and to develop new and creative solutions that benefit from the skills and knowledge of all team members. A partnering process should be in place throughout the project, starting with the design phase and continuing through the construction and pre-occupancy phases.

Project Schedule

□ **Develop a project schedule that incorporates the additional steps of an environmentally responsive design process, illustrated in *Figure 1*.**

The schedule should be sensitive to additional research, unconventional techniques or materials, additional systems testing, pre-occupancy commissioning, or other green practices that may be used for the project in connection with its green design criteria.

Laws, Codes, and Standards

□ **Prepare and review a list of the appropriate and applicable laws, codes, local ordinances, statutes, and industry-related standards relevant to the project.**

In addition to the typical laws and guidelines followed on most projects, some will be relevant specifically to a green building. Examples include:

- Local or state environmental quality and energy efficiency laws, such as the California Environmental Quality Act (CEQA), which requires an environmental analysis for any project that may have a significant effect on the environment.
- Standards produced by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), which address energy efficiency, indoor air quality, thermal comfort, ventilation rates, and building commissioning, and are useful when developing designs and specifications for systems and products related to space conditioning.
- Other standards, such as the American Society for Testing and Materials (ASTM) life-cycle standards and the Illuminating Engineering Society's lighting standards, and specification guidance from the Construction Specification Institute (CSI). (See Chapter 17, “Specifications,” for more information on green specifications, and Chapter 25, “The Future of Green Building,” for more information on standards.)

Research

□ **Research green projects that are complete or about to be completed.**

Prepare a binder of information about these projects for reference. As appropriate, visit the projects and meet with their design teams. This exer-

cise can produce valuable information about existing green building practices and feedback on current green design and construction procedures and products. It is also a good way to educate a team, and the building owner, about green buildings prior to starting a project.

Site Selection

□ Evaluate project site selection, based on green criteria.

In many projects, the site is selected prior to commencement of the design phase. Ideally, the design team should be involved in site selection and should assess the appropriateness of the site relative to green design criteria. A team may decide if the site takes maximum advantage of solar access, existing vegetation, and natural geological features, as well as analyze the site's accessibility from existing transportation corridors and its ability to meet other needs of the building owner, tenants, and visitors. (See Part III for additional site information and selection criteria.)

NOTES

- ¹ Materials/Indoor Air Quality Standards Committee, "Materials/Indoor Air Quality Policy" (Berkeley, Calif.: Berkeley Unified School District Office of Facilities Planning, June 15, 1994).
- ² Energy Design Standards Committee, "Energy Design Standards Policy" (Berkeley, Calif.: Berkeley Unified School District Office of Facilities Planning, June 15, 1994).
- ³ Ibid.

CHAPTER 4

Local Government Information: Pre-Design Issues

IMPLEMENTATION ISSUES

Local governments have the unique ability to be both owners and clients in designing the form and function of their community buildings. The pre-design phase allows local government to incorporate sustainable building criteria in its determination of where a building should be built, the function of the building, the materials used for construction, and the building's relationship to the local community.

It is during the pre-design phase that green building guidelines need to be developed and used in an integrated approach to building design. This approach encourages local governments to evaluate such factors as future energy usage, environmental impacts, water usage, site impacts, indoor air quality, waste reduction, transportation and parking, community access, operations and maintenance costs, and local economic impacts. It is also an opportunity to establish guidelines that require life-cycle costs be used to evaluate energy and water systems, as well as building products. Life-cycle cost analysis involves calculating the total costs and savings of conventional versus higher-efficiency systems or environmentally sound products.

Local governments can also require design and construction teams to have expertise in resource-efficient design and construction and to ensure that citizens and building occupants have an opportunity during the pre-design phase to contribute their ideas on building use, building design, and access to the site.

LOCAL ACTIONS

- The city of Austin, Texas, passed a local resolution in 1994 that requested city staff to develop sustainable building guidelines for municipal buildings, encourage voluntary private sector compliance with the city's sustainable building guidelines through education and promotional endeavors, and promote opportunities to involve at-risk youth in green building projects. The ultimate goal of the resolution is to make Austin a model sustainable city.

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By December 1994, the city's Departments of Environmental and Conservation Services and Public Works developed Volume I of the *Sustainable Building Guidelines*. The guidelines are based on Austin's successful Green Builder Program for residential buildings, which received international honors at the 1992 United Nations Conference on Environment and Development.

Volume I, *Principles of Sustainable Building Design*, encourages the broad goals of energy efficiency, water conservation, and healthy structures; the use of recycled-content materials; the integration of environmental concerns, green construction, and waste-reduction practices; and procedures and guidelines for building longevity. Specifically, it aims to:

- Reduce aggregate energy use over the base line by 10 percent.
- Reduce electrical energy demand over the base case by 20 percent.
- Reduce water consumption for similar building type and site square footage by 30 percent.
- Optimally recycle or reuse construction and demolition materials generated by the project.
- Recycle 75 percent of operational waste.
- Select building materials that emphasize sustainability standards.
- Increase building longevity through durable construction elements and adaptable design.
- Achieve a healthy indoor air quality.

Volume I outlines a design process that features a team-oriented and integrated design approach. Steps in Austin's design process include: 1) development of a program-specific base line; 2) site analysis; 3) characterization of energy needs; 4) economic analysis; and 5) development of project-specific goals.

An appendix to the *Sustainable Guidelines* document includes other useful information, such as a preferred plant list for the region, materials suppliers, and resources. Volumes II and III will focus on specifying for sustainability and operations and maintenance for city facilities, respectively.

- In 1994, the city of Portland, Oregon, also adopted Sustainable City Principles that encourage elected officials and municipal staff to develop connections between environmental quality and economic vitality, to include long-term effects and cumulative environmental impact in decision-making, to ensure commitment to equity, to use resources efficiently and prevent additional pollution, to purchase products based on long-term environmental and operating costs, and to educate citizens and businesses about their role in implementing these principles.

Putting policy into practice, Portland developed a design services Request for Proposals (RFP) for a new municipal building. The RFP designates environmentally sensitive design and construction as priorities of the city and indicates that design and siting decisions will be based on long-term environmental impact. Areas of special focus in the RFP include recycled construction and building materials, energy efficient systems and fixtures, and water-conserving plants in the landscape. Portland also made recommendations for the composition of the design team, including specific expertise in energy-efficient design, and provided mechanisms for input from a Citizens' Task Force and city staff. These groups will meet during the design process to provide direction on siting, building design, and programs offered at the facility.

- The city of Santa Monica, California, is formulating a set of Sustainable Development Guidelines for construction and development projects within the city. These guidelines are intended to foster environmental responsibility without unreasonable increases in building cost or limits on construction practices. When complete, Santa Monica's guidelines should be beneficial to the environment and conducive to the future growth of the city.

►The American Institute of Architects (AIA) has carried out a series of design charrettes in communities around the country to increase public and professional awareness of, and involvement in, environmental design projects. These intensive, short-term workshops bring together design professionals, builders, policymakers, financiers, and community organizations to explore the benefits of sustainable development practices. AIA design charrettes have examined a range of projects, including the environmentally sound development of a water aquifer; redevelopment of neighborhoods, inner-city areas, and downtown commercial areas; and reuse of a historic courthouse and a closed landfill site. The charrettes provide an opportunity to develop community support at all levels for implementation of green building practices in community projects.

LOCAL OPTIONS

- Adopt a resolution or policy to direct future building toward green practices.
- Institute life-cycle cost analysis for procurement of building systems and materials for municipal projects.
- Build local public support for green buildings by establishing a green building task force or support activities of existing local organizations.
- Hold a design charrette to focus attention on local green design efforts for public or private building projects.
- Establish a pre-design green team for municipal buildings that includes green design professionals, community members, and building occupants.
- Conduct an environmental scan of existing buildings to assess baseline energy and water usage, indoor air quality, and site characteristics, and to estimate future resource needs and costs.
- Conduct a baseline analysis of institutional issues that affect green building policy implementation—for example, procurement policies, zoning, building codes and standards, operations and maintenance policies, recycling policies, and economic policies.

→ RESOURCES

Resources for the Local Government Information chapters are located in the Appendix.