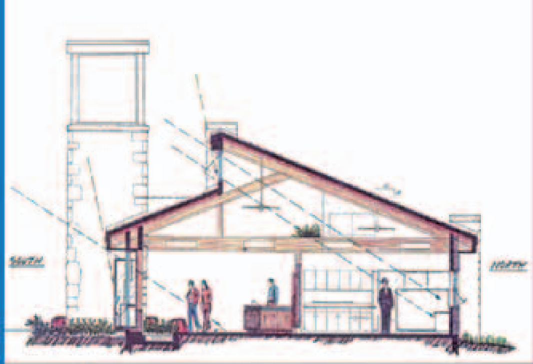
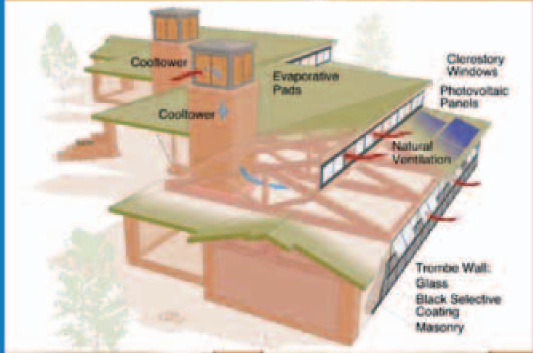
NREL National Renewable Energy Laboratory
Innovation for Our Energy Future

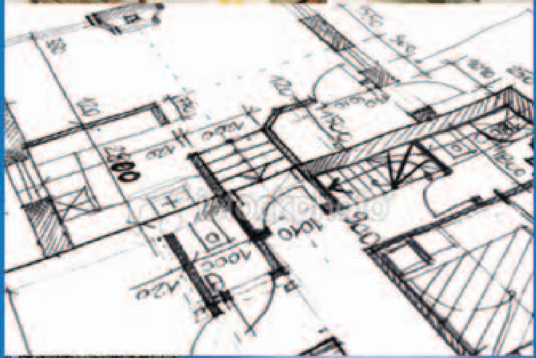
A Handbook for Planning and Conducting Charrettes for High-Performance Projects

Second Edition

Gail Lindsey • Design Harmony, Inc.
Joel Ann Todd • Environmental Consultant
Sheila J. Hayter • National Renewable Energy Laboratory
Peter G. Ellis • National Renewable Energy Laboratory







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Acknowledgments

This work was made possible under the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy High-Performance Buildings initiative. We appreciate the support and guidance of Drury Crawley, Commercial Buildings Team Lead.

We would like to thank Brent Griffith (National Renewable Energy Laboratory) and Nadav Malin (BuildingGreen, Inc.) for their contributions to the first edition, as well as Ron Judkoff, Paul Torcellini, and Lauren Poole (National Renewable Energy Laboratory) for reviewing the first edition of the handbook.

We would also like to thank Michael Deru (National Renewable Energy Laboratory) for his contributions to the second edition, as well as Stefanie Woodward (National Renewable Energy Laboratory), Victor Olgyay (Rocky Mountain Institute), and Caroline Clevenger (Stanford University) for reviewing the second edition of the handbook.

The second edition is dedicated to Gail Lindsey, who passed away in February 2009. Gail's insights and experience made this handbook a useful reference for practitioners who are looking to follow her lead in many successful charrettes.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

1000 Independence Avenue, SW
Washington, DC 20585

Prepared by the National Renewable Energy Laboratory (NREL), a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy; NREL is operated by the Alliance for Sustainable Energy, LLC.

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Foreword

Sustainable building design can most easily be achieved through a *whole-building* design process. This process is a multidisciplinary strategy that effectively integrates all aspects of site development, building design, construction, and operations and maintenance to minimize a building's resource consumption and environmental impact while improving the comfort, health, and productivity of its occupants. An integrated design can also decrease energy and operating costs, cut down on expensive repairs over the lifetime of the building, and reduce tenant turnover.

Process is key to whole-building design. Sustainability is most effective when applied at the earliest stages of a design. This philosophy of creating a good building must be maintained throughout design and construction. The prerequisites for a sustainable and high-performance building design are to:

- Create a vision for the project and set performance goals.
- Form a strong, all-inclusive project team.
- Outline important first steps for achieving a sustainable design.

The best way to achieve these prerequisites is through a high-performance charrette. A charrette is an intensive workshop in which various stakeholders and experts are brought together to address a particular design issue. This mechanism starts the communication process among the project team members, building users, and project management staff. A facilitated discussion allows the team to brainstorm solutions to meet the building users' requests and the sustainability vision for the building design. By the time the charrette concludes, the participants should have identified performance goals that meet the program needs.

The charrette should result in good communication among project team members and help them develop unified design and construction goals. For sustainable building projects, the team must consider how the design and interior function can affect the building's overall environmental impact. Design decisions address site, energy consumption, comfort, building materials, and landscaping issues. A good design will integrate these factors so the effects of one will have minimal negative impact—and may even benefit—the others. The project team for such a design should therefore have the expertise to analyze the interactive effects of various design strategies on overall energy efficiency and environmental impact. Computer simulation tools that can model building performance are invaluable resources for understanding the trade-offs associated with design decisions. Continuing to use these tools after the building is constructed provides insight into how well the building is performing compared to how it should perform.

Following the design stage, the project team documents how design decisions will influence construction and long-term building operation. Writing effective construction documents and safeguarding design goals will result in projects that are built as the original design intended. Protecting the project site during construction will ensure a safe working environment during construction and minimize the site impacts during and after construction.

Postconstruction activities guarantee continued sustainable building operation. Commissioning completed before occupation as well as continuous commissioning activities conducted throughout the life of the building ensure the building always performs as originally intended. Also, regularly educating and training the operators and occupants will encourage these groups to actively minimize the environmental impacts of their building.

Rigorously adhering to the process discussed here will facilitate the design, construction, and operation of a sustainable project. Additional information is available through the U.S. Department of Energy's Net-Zero Energy Commercial Building Initiative (see www.eere.energy.gov/buildings/commercial_initiative).

Preface

The purpose of this handbook is to furnish guidance for planning and conducting a high-performance building charrette, sometimes called a "greening charrette." The handbook answers typical questions such as "What is a charrette?" "Why conduct a charrette?" "What topics should we cover?" "Whom should we invite?" and "What happens after the charrette?" Owners, design team leaders, site planners, state energy office staff, and others who believe a charrette will benefit their projects will find the handbook helpful.

The handbook presents detailed information for every step of the charrette process, from initial planning, to conducting and facilitating the charrette, to follow-up. It gives recommendations for planning and logistics. It suggests the types of participants to invite, including technical, political, and community representatives, and how best to include key decision makers and stakeholders who can attend only portions of the event. It gives suggestions for the types of expert speakers who can motivate participants and answer their questions. It outlines the characteristics of good facilitators and offers advice for forming effective breakout groups.

The handbook will not take the place of skilled facilitators and experts in key areas. A successful charrette depends on skilled facilitators and qualified speakers with expertise in areas relevant to the project. Without these important participants, a charrette cannot adequately kick off a high-performance project.

Energy saving should be a key goal of a high-performance project, so special attention is given to incorporating a predesign energy analysis. Appendix F provides detailed guidance to help the charrette planners know what type of information to give the energy consultant and what results to expect in return. Appendix G describes the recommended analysis procedures for the energy consultant.

The handbook also includes appendices that contain samples of commonly used charrette materials, such as checklists, agendas, worksheets, invitation letters, and final reports.

Appendix A – A checklist to help guide the user through the charrette process

Appendix B – Sample agendas for several types of charrettes

Appendix C – A worksheet to help the user identify the types of participants to invite

Appendix D – Sample letters to send to invitees

Appendix E – Recommended information to provide to the participants

Appendix F – A guide to predesign energy analysis for the planners

Appendix G – A guide to predesign energy analysis procedures for the energy consultant

Appendix H – Sample evaluation forms for participants to complete

Appendix I – Sample outlines for final reports

Appendix J – List of several real projects with final charrette reports.

Acronyms

ACH	air changes per hour
AIA	American Institute of Architects
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
AV	audiovisual
CEU	continuing education unit
COTE	Committee on the Environment
ECM	energy conservation measure
EDM	energy design measure
IAQ	indoor air quality
O&M	operations and maintenance
RFP	Request for Proposal
UNCA	University of North Carolina–Asheville
USGBC	U.S. Green Building Council

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Chapter 1: Charrettes for High-Performance Projects

Understanding the difference between a workshop and a charrette and knowing a charrette's expected benefits and outcomes are important first steps in the charrette process. It is also important to determine if the project is sufficiently developed to benefit from a charrette. In this chapter, we answer basic questions about charrettes and give guidance about whether your project is ready for the charrette process.

What Is a Charrette?

A charrette is a creative burst of energy that builds momentum for a project and sets it on a course to meet project goals. It can transform a project from a static, complex problem to a successful, buildable plan. Usually, it is an intensely focused, multiday session that uses a collaborative approach to create realistic and achievable designs that work.

Charrette planners and facilitators use strategic planning to overcome conflict. Part of their strategy is to focus on the *big picture* and the *details* of a project to produce collaborative agreement about specific goals, strategies, and project priorities. Charrettes establish trust, build consensus, and help to obtain project approval more quickly by allowing participants to be a part of the decision-making process.

charrette (shar-ette') *n*. **1**. A small cart. **2**. A collection of ideas. During the 19th century, students of l'Ecole des Beaux Arts in Paris would ride in the cart sent to retrieve their final art and architecture projects. While en route to the school in the cart, students frantically worked together to complete or improve these projects. The meaning of the word has evolved to imply a collection of ideas or a session of intense brainstorming. **3**. An intensely focused activity intended to build consensus among participants, develop specific design goals and solutions for a project, and motivate participants and stakeholders to be committed to reaching those goals. Participants represent all those who can influence the project design decisions. [Fr. *charrette*]

Charrette Benefits

As a building project moves from inception to completion, it passes through predesign, conceptual design, and design development phases. As the design process continues, more decisions are made about the final building design (Figure 1).

Charrettes are most useful during the predesign phase—before important design decisions for the building form, fabric, and equipment are finalized. The benefits of using charrettes

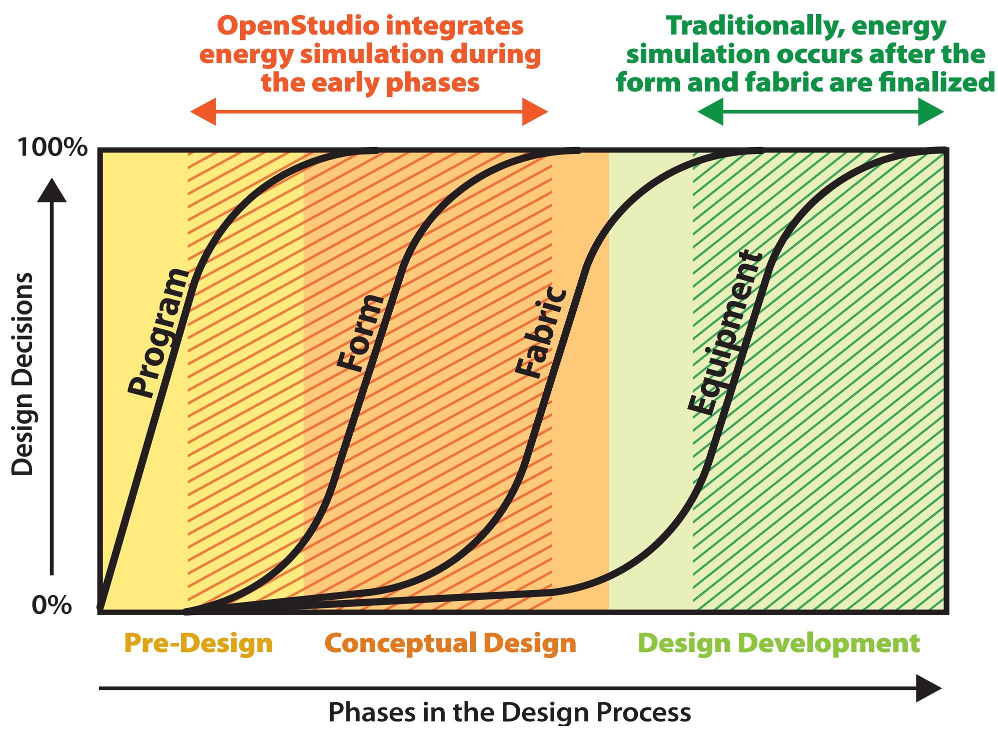

Figure 1. Design Decisions During the Design Process

early in the high-performance design process are many. Most importantly, charrettes can save time and money and improve project performance. In general, charrettes:

- Provide a forum for those who can influence design decisions to meet and begin planning the project.
- Encourage agreement about project goals.
- Kick off the design process.
- Save time and money by soliciting ideas, issues, and concerns for the project design to help avoid later iterative redesign activities.
- Promote enthusiasm for a project and result in early direction for the project outcome.

Conducting a charrette early in the design and decision-making process will:

- Establish a multidisciplinary team that can set and agree about common project goals.
- Develop early consensus about project design priorities.
- Set performance goals for energy, emissions (carbon and others), water, site, materials, waste, indoor air quality (IAQ), operations and maintenance (O&M), and other topics.
- Generate quantifiable metrics to measure the final energy and environmental outcomes against the performance goals.
- Provide early understanding of the potential impact of various design strategies.
- Initiate an integrated design process to reduce project costs and schedules and obtain the best energy and environmental performance.
- Identify project strategies to explore with their associated costs, time considerations, and needed expertise to eliminate costly surprises later in the design and construction processes.
- Identify partners, available grants, and potential collaborations that can provide expertise, funding, credibility, and support.
- Set a project schedule and budget that all team members feel comfortable following.

What Is a High-Performance Project?

A high-performance project is designed and built to minimize resource consumption, reduce life cycle costs, and maximize health and environmental performance across a wide range of measures—from energy savings to habitat protection. High-performance projects can:

- Achieve energy savings of more than 50% compared with conventional projects.
- Increase employee productivity and job retention.
- Reduce water consumption, O&M and repair costs, capital costs, and overall environmental impacts.
- Reduce tenant turnover.

Starting the Charrette Planning Process

Ask the following critical questions before beginning the charrette planning process. Understanding where the project stands relative to these issues will increase the likelihood of meeting the overall project goals. Be able to comfortably answer "yes" to these questions before planning the charrette.

Yes No

☐ ☐ **Is the project program developed?** The program includes the estimated size of the project, functions, and adjacencies of the required spaces, average number of occupants in the spaces, the time of use of the spaces, lighting and space condition (e.g., temperature and humidity) requirements, and any unique requirements for specific spaces.

☐ ☐ **Has the project site been selected or narrowed to a small number of alternatives?** Having one or more alternative sites identified will increase the likelihood that participants can work out specific design solutions. You may need to hold a site selection charrette before you plan a building charrette.

☐ ☐ **Are staff members or volunteers available to support the planning and implementation of the event?** Planning and organizing a charrette requires considerable staff support for tasks such as developing lists of participants, sending invitations and tracking responses, arranging for a meeting facility and refreshments, working with speakers, and preparing materials.

☐ ☐ **Are resources available to support the event?** The costs to conduct a charrette can vary widely. You should assume that costs will be incurred. The up-front funds to pay for mailings, photocopying, catering deposits, facility deposits, speaker costs, predesign energy analysis, and any other costs associated with preparing for the event must be available or identified when the planning begins.

☐ ☐ **Is there an overall "champion" to lead the event?** The most effective charrettes have at least one champion to ensure that the overall event schedule and tasks move forward as planned. Identify that champion early in the project. The champion should be passionately involved in the project, be able to influence project decisions, and have experience and time with the project.

☐ ☐ **For large-scale projects, such as campuses, military bases, and other developments, are the issues well defined?** These issues could include overall master planning, transportation, facilities construction or renovation, O&M, green procurement and contracting, and education and outreach.

This handbook includes guidance for conducting charrettes that integrate energy and environmental issues to significantly change the way buildings are designed, constructed, and operated. The charrette is intended to engage an interdisciplinary group of professionals in a structured process to identify, evaluate, and recommend strategies for improving the energy and environmental performance of a project. The project can be a new or renovated building or a group of buildings, such as a campus, a military installation, a national or state park, or a community center. This handbook focuses on individual building projects, even though it contains principles that apply to charrettes for projects of all sizes.

University of North Carolina–Asheville Charrette Saved Time and Money

The University of North Carolina–Asheville (UNCA) used the charrette process with positive results as it decided where the new campus facility would be sited. A one-day charrette saved the university time and money compared to a traditional design approach. Approximately 40 people from outside and inside the university gathered to discuss the relative merits of three site choices (A, B, and C). After a sustainable site issues briefing and several hours of group work, three of the four work groups independently selected an overlap area between sites A and B. The remaining group recognized the significant advantages of the overlap choice, but preferred Site C. This gave the university the required two choices necessary to take to the university board. Aided by the development costs and the buy-in information from the charrette participants, UNCA quickly settled on the overlap area. In addition to agreeing about the site for the project, which was the focus of the charrette, UNCA now has a good understanding of site C sustainable development options and costs for future considerations.

Chapter 2: Getting Started

At least three months before the event . . .

- ☐ Create a steering committee.
- ☐ Hold a kickoff meeting.
- ☐ Determine the date and location.

Initial decisions about the key issues, participants, and the best dates and locations are made during the first stages of the charrette planning process. This chapter gives suggestions for how to begin this planning process.

Create a Steering Committee

The first step in planning and organizing a charrette is to set up a steering committee to guide the planning process and ensure support from key individuals and organizations. Discussing the objectives and logistical issues with several enthusiastic and dedicated people will help generate ideas and ensure a successful event.

A group of five to eight individuals working closely together will enhance the efficiency of the planning process. In general, effective steering committee members:

- Represent a variety of interests:
  - Owner and/or owner's representative(s)
  - Charrette organizers
  - Overall facilitator
  - Local community leader(s)
  - High-profile stakeholder(s)
  - Overall project champion(s).
- Demonstrate good organizational skills.
- Encourage and accept new ideas.
- Identify and engage potential participants, partners, and speakers.

Anyone who will have an important role in planning, organizing, and managing the charrette should attend the steering committee meetings. This includes those making logistical arrangements and preparing participant packets, as well as those designing the agenda and identifying participants and speakers. As the event nears, additional people can be invited to the steering committee meetings so they can hear firsthand the decisions that are made and report on their efforts.

Hold a Kickoff Meeting

Hold a kickoff meeting to assemble the steering committee and begin the planning process. A kickoff meeting is important for defining the roles of each steering committee member and for focusing on the tasks that need to be accomplished.

The steering committee members can meet for the kickoff meeting in person, by conference call, or by videoconference. Typically, a kickoff meeting will last one to two hours. Use the kickoff meeting to begin shaping the event, not to make final detailed decisions. Ask all steering committee members to review the checklist for planning and conducting charrettes for high-performance projects before the kickoff meeting (Appendix A). During the kickoff meeting, be sure to discuss:

- Purpose
- Type and length
- Resulting products
- Agenda
- Location

- Date
- Resources to cover or defray costs
- Participants
- Motivational and educational speakers
- Facilitators to lead the charrette and breakout groups
- Partners to supply resources or buy in to the charrette process and its results, or both
- Project information for participants
- Predesign energy analysis before the charrette
- Date, time, and logistics of the next steering committee meeting.

At the beginning of the meeting, designate a steering committee member to record the discussion, prepare meeting minutes, and distribute the minutes to all steering committee members. End the kickoff meeting with a review of action items. Include in the minutes an overview of the discussions of the topics listed above and described in more detail below.

Purpose

Carefully identify the purpose of the event and the characteristics and expertise of participants needed to achieve that goal. The purpose will affect the format, along with all other decisions made during the planning process. A good understanding of the intended outcome and participant characteristics will improve the likelihood of a successful event and promote a sentiment that participation was worthwhile.

Type and Length

The charrette includes two major elements: an educational component (workshop) and an interactive planning component (collaborative exercises and optional breakout groups). Refer to Figure 2 and Table 1 to identify the purpose and type of event most appropriate for a particular project.

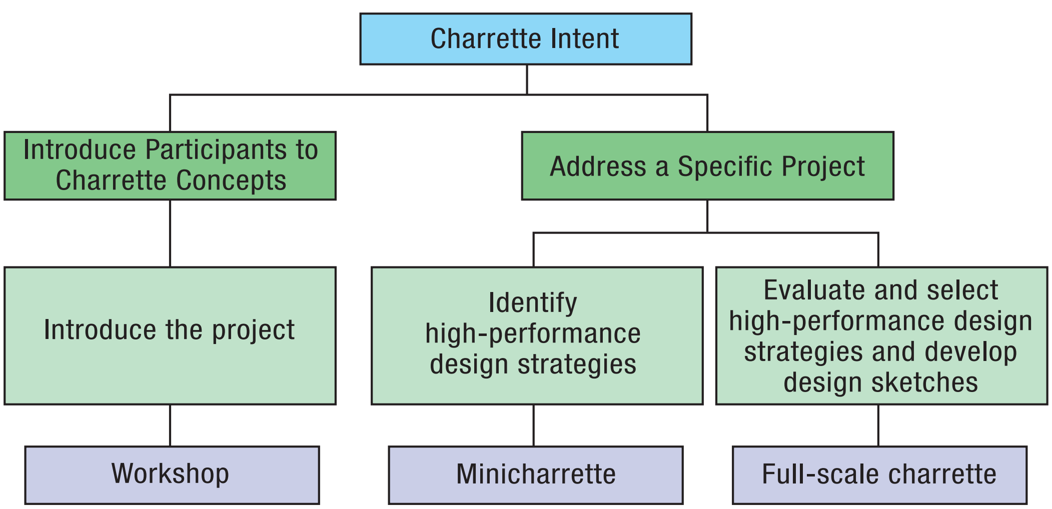

Figure 2. Flow Chart for Determining Type and Length of Charrette

Table 1. Summary of Charrettes for High-Performance Projects

Event Type	Description	Length	Purpose
Workshop	Large-group presentations and discussions	½ day	• Introduce participants with limited time to high-performance design concepts and strategies. • Introduce participants to the charrette process and engage them in "practice" charrette exercises. • Conduct a low-cost, workshop-only event.
Minicharrette	Workshop plus interactive exercises	1 to 1½ days	• Provide basic training in high-performance design topics and present the results of the predesign energy analysis (conduct in workshop format). • Encourage "buy in" acceptance for the project, generate enthusiasm, and develop promotional materials. • Set performance goals for energy, emissions, water, site, materials, waste, IAQ, and O&M. • Identify high-performance design strategies and technologies appropriate for the project (conduct in breakout groups).
Full-scale charrette	Workshop plus intensive breakout group discussions	2 or more days	• Provide basic training in high-performance design topics and present the results of the predesign energy analysis (conduct in workshop format). • Encourage "buy in" acceptance for the project, generate enthusiasm, and develop promotional materials. • Set performance goals for energy, emissions, water, site, materials, waste, IAQ, and O&M. • Identify high-performance design strategies and technologies appropriate for the project (conduct in breakout groups). • Develop design sketches based on the selected strategies and technologies (conduct in breakout groups). • Evaluate and select one or more design sketches to be developed into the project construction plans.

Resulting Products

As you discuss the purpose and type of the event, also address its desired outcomes. Make sure these desired results are achievable within set budget constraints, the proposed participants' levels of expertise, and the amount of detailed information available about the project.

The following list describes suggested reports to generate as end products for each event type. We give guidance for preparing these reports in Chapter 5 and include several sample reports in Appendix J.

- **Workshop** – A short summary of the presentations and discussions that took place during the workshop and recommendations for the next steps agreed to by participants.
- **Minicharrette** – A summary of the background information provided to the participants, including:
  - Results of the predesign energy analysis
  - A summary of the large group discussions and information presented in a workshop format
  - Recommended strategies to consider for the specific project
  - Estimated energy savings
  - Agreed-upon performance goals
  - Suggested follow-up activities.
- **Full-scale charrette** – A summary of the background information provided to the participants, including:
  - Results of the predesign energy analysis
  - A detailed summary of the large-group discussions, information presented in a workshop format, and individual breakout group recommendations
  - A detailed summary of the specific strategies that will be included in the project design and estimated energy and resource savings or performance benefits
  - Sketches and drawings to be incorporated into the project construction plans
  - Agreed-upon performance goals
  - Suggested follow-up activities.

Agenda

The agenda depends on the type of event you select. Chapter 3 gives more information about the agenda, and Appendix B contains sample agendas for each event type. The steering committee members may also offer optional activities. For example:

- Hold a reception the first or second evening of the minicharrette or the full-scale charrette. This gives participants an opportunity to network and may include local dignitaries and community groups.
- Conduct a tour of the project site before the minicharrette or full-scale charrette.

Location

Determine whether to convene the event at or near the project site. Hold the charrette at a nearby location if there are no adequate facilities at the project site or if travel to the site is difficult. After selecting a location, identify potential facilities for the event. Table 2 lists the requirements of potential facilities.

Planning tip—facility selection hints:

- Set an example by conducting the charrette in a "green" building (meeting rooms with windows are preferable).
- Investigate opportunities for donated space from event partners or cosponsors.

Table 2. Minimum Facility Requirements

Requirement	Workshop	Minicharrette	Full-Scale Charrette
Large room that can accommodate the potential number of participants (usually 25 to 50 people) in a classroom- or auditorium-style configuration, or at tables for 6 to 8 people.	☑	☑	☑
Small rooms for breakout group sessions or large room(s) that can accommodate multiple breakout groups. Breakout groups usually require a large round table for 6 to 8 people, flip charts, and wall space for hanging flip chart pages and sketches.		☑	☑
Space for resource table/library (documents, software, and other resources that may be useful to the participants during the event).		☑	☑
Optional—space for a registration table, food and beverages, event reception, exhibits, Internet and fax services, or other special needs.	☑	☑	☑

Date

Discuss potential event dates during the kickoff meeting and commit to finalizing the date soon. Many of the essential tasks to plan a charrette (Chapter 3) can be completed only after the event date is established. Consider the following when selecting an event date:

- Allow enough time to plan the event, contact participants, make logistical arrangements, ensure that participants are not already too scheduled to attend, and prepare background information for participants (including a predesign energy analysis). We recommend scheduling the event date no sooner than three months after the kickoff meeting.
- Investigate potential conflicts such as holidays or other events and conferences that could make it difficult to draw participants to the charrette.
- Investigate opportunities for coordinating the charrette in conjunction with related events to increase interest.
- Confirm the availability of key participants, speakers, and facilitators before selecting the final date.
- Schedule the event so that the project design process can continue to move forward. For example, consider scheduling briefings for city officials, meetings with funding sources, development and issuance of a Request for Proposal (RFP) to select an architectural/engineering firm, and ongoing meetings with the community soon after the charrette.

Resources To Cover or Defray Costs

Use the kickoff meeting to begin discussing the event budget and costs that will be incurred. Begin identifying who will be responsible for those costs. Finalize an event budget shortly after the kickoff meeting.

Potential costs to conduct the event include (discussed in detail in Chapters 3 and 5):

- Steering committee time and travel
- Mailings (flyers, e-mails, invitation letters)
- Charrette materials and reproduction
- Speakers' and facilitators' time and travel
- Predesign energy analysis

- Staffing support for the event
- Photographers and writers
- Facility rental
- Food
- Audiovisual (AV) equipment
- Internet connection at the facility (optional)
- Final charrette report and follow-up with participants.

Participants

Plan to invite 25 to 50 people to participate in a minicharrette or full-scale charrette. Having more than 50 participants results in a larger than optimum number of people assigned to each breakout group or additional breakout groups. Both cases increase the reporting time, the time needed to complete the charrette, and the potential that less-assertive breakout group members will refrain from participating in breakout group discussions. Fewer than 25 participants will result in fewer than three breakout groups or breakout groups with fewer than six to eight members. Either case reduces the highly charged exchanges that are usually found with groups of 25 to 50 participants. Invite more than 50 participants to a workshop only if the steering committee feels comfortable that an effective workshop can be conducted with a larger number of participants.

Figure 3 identifies several types of participants we recommend inviting to a charrette. Refer to the Participation Identification Worksheet in Appendix C for a more comprehensive list of participants, including stakeholders, specialists, community leaders, and other partners. During the kickoff meeting, settle on the approximate number of participants to invite in each category. If possible, identify specific participants. Plan to complete a list of invitees (name, affiliation, address, phone, fax, and e-mail) soon after the kickoff meeting.

Motivational and Educational Speakers

An assortment of speakers representing a variety of expertise will increase the effectiveness of the workshop. Good presenters motivate the participants and impart valuable information that the participants can apply during the charrette activities and other high-performance projects. Consider inviting the following types of speakers:

- Kickoff speaker(s) to energize and excite participants
- Local dignitaries to demonstrate support
- Project owner or project representative to explain the project and goals for the charrette
- Content experts for specific topics to be addressed, such as energy and materials
- Case study speakers to share previous experience gained from actual projects.

Identify potential speakers during the kickoff meeting, as well as other people who may be able to recommend additional speakers for specific categories (if the steering committee members are not familiar with quality speakers in specific areas). Contact potential speakers early to verify that they are interested in participating and that the proposed dates fit their schedules. Be sure to communicate the costs they may be asked to cover for their participation.

Planning tip:

The ideal mix of speakers is a combination of national and local experts. National experts can be identified through such groups as the U.S. Green Building Council (USGBC), the American Institute of Architects (AIA) Committee on the Environment (COTE), and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Local experts can be identified through local chapters of these organizations.

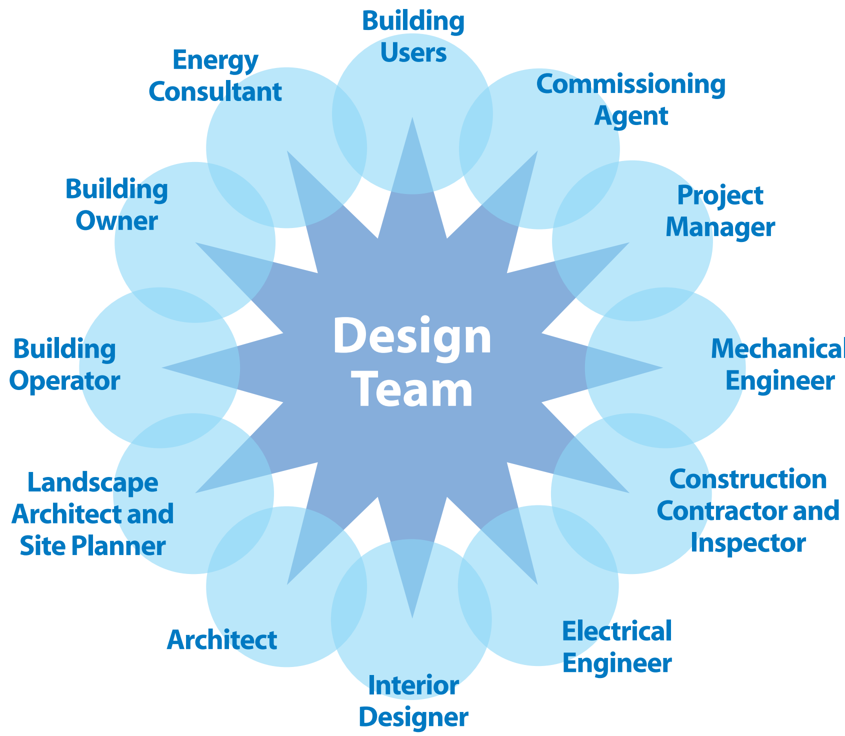

Figure 3. Areas of Expertise That Could Benefit Your Charrette

Planning tip:
Assign the content experts recruited as speakers to serve as breakout group facilitators; however, be sure they have the skills to facilitate.

Facilitators To Lead the Charrette and Breakout Groups

Good facilitators keep the group motivated and encourage participant involvement in the discussions. They foster a sense of openness and inclusion for all group members by keeping the momentum going.

Identify potential facilitators during the kickoff meeting. An overall facilitator leads the event and ensures the desired results are achieved. Breakout group facilitators perform similar functions during the breakout group discussions.

The success of the event depends almost entirely on the overall facilitator's ability to motivate the participants and keep the charrette on track. Obtain recommendations for facilitators from trusted colleagues. Select an overall facilitator who:

- Is skilled and practiced at leading group discussions and, preferably, has experience facilitating charrettes.
- Has demonstrated skill in encouraging constructive contributions from all participants and adhering to the agenda to ensure participants and organizers are satisfied with the results.
- Has a good understanding of the high-performance design process.

Contact potential facilitators soon to verify that they are interested in participating and that the proposed dates fit within their schedules. Integrate the facilitators as members of the steering committee immediately after obtaining their commitment. Their experience will prove valuable during the planning process.

Partners To Supply Resources or Buy in to the Charrette Process, or Both

Identify potential partners who could add to the charrette experience through needed expertise, credibility, funding, or support. These partners may be able to furnish monetary, product, or service donations to defray some of the costs. For example, find a partner to pay for a lunch or for a pre- or postcharrette reception.

Partners bring new perspectives or expertise to the project, particularly if the local community is involved. A well-connected steering committee will know who the potential partners are in the local area. They are also likely to have individual contacts within these organizations.

Project Information for Participants

Providing sufficient information to help charrette participants become familiar with the project will allow more time during the charrette to discuss project design solutions (less time will be required to describe the project). It will also help the participants refine the design strategies they recommend while taking part in the charrette activities. At a minimum, plan to provide the basic project information described in Appendix E.

Predesign Energy Analysis Before the Charrette

For minicharrettes and full-scale charrettes, we recommend arranging for a predesign energy analysis of the project. This analysis will involve using computer simulation tools to model a project's energy performance. The results will provide information that will help participants conceive a building that meets programmatic requirements and saves energy.

The level of detail to which the analysis is completed can vary with the type of charrette. The steering committee should plan for:

- **Workshop** – No predesign analysis necessary, unless one is conducted to illustrate how it can be used to help make early design decisions.
- **Minicharrette** – Predesign analysis of a baseline building to characterize the energy performance of a typical building on the project site that meets all the programmatic requirements.
- **Full-scale charrette** – Detailed predesign analysis, including an evaluation of a baseline building and a series of parametric analyses to identify specific design opportunities for the particular project.

Unless a member of the steering committee has the skill and the time to conduct a predesign energy analysis, a professional energy consultant will need to complete this work. The consultant should be experienced in using hourly building energy simulation programs and possess a broad knowledge of energy design alternatives. Arrange for the analysis as soon as the programmatic requirements are finalized. Be prepared to give the consultant general information about the project and site well in advance of the rest of the charrette participants—this may significantly increase the overall lead time necessary for gathering project information.

See Appendix F and Appendix G for further guidance about the predesign energy analysis.

Date, Time, and Logistics of the Next Steering Committee Meeting

At the conclusion of the kickoff meeting, set the date and time for the next steering committee meeting and assign a steering committee member to make logistical arrangements for the meeting (e.g., reserve a conference room or obtain a call-in number for a conference call). We also recommend that the steering committee set a schedule and make logistical arrangements for regular meetings throughout the entire planning period.

Review of Kickoff Meeting Action Items

Conclude the kickoff meeting by reviewing the action items that resulted from the discussion. Be sure there is a clear outcome for each action item, a date when each action item is to be completed, and a steering committee member assigned to complete each action. Assigning responsibility for actions will ensure progress is made quickly on key decisions such as the date, location, and speakers. Discuss the status of the action items at the beginning of the next steering committee meeting.

Determine Event Date and Location

After the kickoff meeting, the steering committee members must act quickly to make the key decisions. Subsequent event planning cannot be completed until these important actions are done. At a minimum, complete the following within two weeks after the kickoff meeting:

- Finalize the event date and location.
- Reach agreement on a preliminary agenda.
- Identify and contact key facilitators and speakers.
- Arrange for a predesign energy analysis of the project (if required).

Remember, the makeup of the steering committee, the decisions they make during the kickoff meeting, and the dates and location will significantly affect the event's outcome. A carefully selected steering committee and well-executed kickoff meeting will set the stage for a successful event.

Chapter 3: Planning and Developing the Charrette

Two to three months before the event . . .

- ☐ Develop an agenda.
- ☐ Confirm availability of key players.
- ☐ Confirm arrangements with the speakers.
- ☐ Invite participants and track responses.
- ☐ Provide all information for the predesign energy analysis.
- ☐ Finalize budget, expenditures, and resources.
- ☐ Make logistical arrangements.
- ☐ Assemble and distribute participant and resource materials.
- ☐ Develop evaluation forms.
- ☐ Arrange for continuing education units.
- ☐ Consider a pre-charrette survey.

This chapter covers the details of the charrette planning process. Charrettes can take more time, planning, and resources to organize than most people realize. Be sure to carefully review the sections in this chapter to avoid problems during the charrette.

Develop an Agenda

Develop an agenda to meet the specific needs of the event (see Appendix B for samples). Clearly state the goals at the top of the agenda. Developing the goals and agenda together will help the steering committee members identify their common objectives. Later, when the agenda is distributed to participants, stating the goals will help the participants better understand the purpose of the event. Although the agenda should be tailored carefully to meet the goals of the charrette, we discuss in the following sections the elements that should be included.

Welcome and Introductions

The first item on the agenda is to welcome the participants, make general announcements such as the location of the restrooms, and thank sponsors and partners. The overall facilitator generally thanks the participants for their interest, introduces VIPs, and asks the participants to introduce themselves. Following the introductions, the facilitator should review expectations and goals.

Planning tip:

Allow sufficient time for participants to introduce themselves, as networking is a benefit of a charrette. If the number of participants is large (as may be the case for a workshop) or the time is limited, ask for a show of hands of participants representing various types of expertise (e.g., architects, engineers, project leaders, and contractors) instead of having people introduce themselves individually.

Keynote Speech

Although a keynote speech is not necessary, a good speaker can motivate the participants and help them understand why their work is important. The speaker should energize and excite the participants. Generally, he or she should speak immediately after the opening formalities. The presentation will capture the participants' interest and encourage them to actively participate. If local dignitaries or VIPs are present, give them an opportunity early on the agenda to show their support.

Planning tip:

VIPs are generally given short time slots on the agenda so the event can continue if they cannot attend. If a VIP is expected to make a lengthy address, plan an alternative such as a stand-in speaker, video, or additional discussion time, in case the speaker cannot attend.

Project Overview

The owner or owner's representative should present a clear, concise overview of the project. This presentation should include the project goals and vision, status (what decisions have been made), issues and problems, and specific objectives or questions to be addressed. Reviewing the owner's presentation in draft form to ensure that appropriate material is covered in an appropriate level of detail is a good idea. Encourage the owner to establish a tone of openness and receptiveness to the ideas and suggestions generated at the event.

Technical Presentations

The first technical presentation should be an overview of the findings from the predesign energy analysis (optional for workshops). The content experts present next. These are the technical experts in areas relevant to high-performance design and the specific project. It is helpful if these speakers illustrate the successful applications of the topics presented through case study examples. Case studies prove that the concepts presented really do work and make it more likely that the participants will consider these concepts later during the charrette exercises or on their own projects.

Carefully balance the number and length of presentations. Give the speakers adequate time to present good information but not so much time that participants lose interest. Allow time for questions and discussions after each presentation.

Breakout Groups and Reporting

Minicharrette and full-scale charrette agendas include multiple breakout group discussions and large-group reporting sessions. At the conclusion of these sessions, or after the technical presentations during a workshop, conclude by reviewing the purpose of the event, making suggestions for next steps, and thanking the participants for attending.

Confirm Availability of Key Players

Facilitators

Chapter 2 gave general guidance to help the steering committee identify potential facilitators. We also emphasized the importance of gaining commitment from these people early in the planning process. In addition to the characteristics of a good facilitator, the overall facilitator must be qualified to emcee the event. This person:

- Introduces speakers.
- Handles transitions between presentations.
- Ensures that speakers and breakout groups stay on schedule.
- Facilitates question-and-answer sessions.
- Refocuses the participants after breaks and lunch.
- Possesses good group process skills as well as an understanding of the subject matter.

The overall facilitator may also be responsible for describing the goals and wrapping up the event.

Breakout group facilitators should have similar qualifications as the overall facilitator, in terms of guiding discussion groups, along with expertise in the subject matter of their breakout groups. In addition to leading breakout group discussions and encouraging full participation from all breakout group members, these facilitators should also be subject experts in high-performance design or the specific topic addressed by the breakout group.

Speakers

Refer to Chapter 2 for guidance in identifying speakers. As soon as the steering committee agrees about potential speakers, contact them and obtain commitments for participating in the event.

VIPs

Inviting VIPs to participate in all or key parts of a charrette has two primary benefits:

1. VIPs demonstrate support for the event and the project by making time in their schedules to participate.
2. VIPs develop a personal commitment to seeing a successful end to the project.

Don't include too many VIP speakers—they can slow the momentum of the group and delay "getting down to work."

Planning tip:

VIPs generally require as much advance notice of the event date and time as possible. They may not confirm their participation until just before the event.

Confirm Arrangements With the Speakers

Ask the speakers to supply a list of required AV equipment and special supplies or inform them about the available equipment and supplies. Speakers sometimes prefer to bring their own equipment. If this is the case, be sure the facility and event staff can accommodate and operate their equipment. For example, be sure that the speaker's laptop computer is compatible with the available video projector.

Encourage the speakers to submit their presentation materials before the event. If the steering committee has not seen invited speakers present similar material, ask to see a draft of their presentations. Having the final presentations before the event allows enough time for the electronic presentations from all the speakers to be loaded onto one computer. This eliminates the time otherwise needed during the event to transfer computers or load presentations. Also, the presentations can be printed, copied, and included in the participant packages.

Determine whether the speakers plan to bring additional handouts or resource materials. If so, encourage them to bring enough for all participants (provide an accurate count) or submit the handout materials with enough time before the event to reproduce the materials and include them in the participant packages.

Request that the speakers furnish travel information, including flight itineraries and hotel accommodations, so they can be contacted in an emergency or if they fail to appear on schedule.

Invite Participants and Track Responses

Finalize the participant invitation list, including contact information (name, title, company, address, phone, and e-mail address) for each invitee.

Send a "save the date" announcement as soon as possible after finalizing the invitee list, approximately two months before the event date (Appendix D). This announcement gives invitees a heads up about the event and encourages them to include it in their schedules. (Although the "save the date" announcement is optional, it encourages potential participants to hold those dates on their calendars.)

Formally invite the participants after sending a save the date announcement. Include in the invitation letter:

- Clear, concise statement of the event's purpose
- Anticipated event outcomes
- Description of the invitee's role
- Summary information
- Registration or RSVP form
- Logistical information.

Appendix D contains sample invitation letters for participants that can be modified and individualized for facilitators, speakers, local dignitaries, and VIPs. Provide enough information to stimulate the invitees to participate, but do not provide too much detail at this point. The invitation package should include:

Summary Information

- Brief description of the project, including background and site information
- Preliminary agenda
- List of speakers and facilitators
- List of invitees
- Cost to participate in the event
- Instructions for submitting the registration fee.

Registration or RSVP Form

- Date that the form must be returned (two to three weeks before the event)
- Procedure for returning the RSVP form (e.g., on-line registration on a Web site, e-mail and mail addresses, and/or fax and phone numbers)
- Responder's contact information (to be filled in by responder)
- Responder's dietary preferences (if meals are to be provided)
- Responder's area of expertise (optional)
- Responder's level of experience with high-performance design (optional)
- Form of payment, if there is a charge to participate in the event.

Logistical Information

This information may be distributed later to those who express interest in attending the event.

- Logistical information
  - Hotel information, including reservation number, group name, and rates
  - Map to the meeting facility
  - Parking options
  - Forms of public transportation available to the meeting facility, including suggested lines and stops
  - Designated entrance to use at the meeting facility
  - Security requirements, if there is controlled access to the facility
  - Emergency contact information (e.g., facility telephone number) for reaching the participants during the event.
- Whether meals are to be provided or where to go for meals
- Supplies and resources
  - Those that will be available during the event
  - Those that the participants may want to bring.
- Additional information
  - Points of interest, scheduled or optional nearby building tours.

Develop a tracking system to record and monitor the RSVPs. Tracking responses helps the steering committee members ensure a diversity of expertise is represented. Invite additional participants in a timely manner when key people on the original invitee list respond that they are unable to attend the event.

Require that all those interested in attending the event register or RSVP so the steering committee will know how many participants to expect. It may be necessary to cut off registration after a specified participant number and notify the remaining interested people that the event is full.

Planning tip:

Multiple communications are likely to be sent to invitees and participants. To save time and effort, create a mail-merge system for hardcopy mailings and a group e-mail list for electronic communications. Also, maintain an electronic record of invitee names, contact information, RSVP responses, dietary requests (if meals will be provided), and special information to make it easier to track changes, add and remove names, and forward the record to other steering committee members.

Planning tip:

For certain workshops, the steering committee may not know whom to invite. Ask the local AIA COTE or ASHRAE chapter to help send out a general mailing to solicit interested participants. If your workshop will coincide with an event sponsored by one of these organizations, place an announcement about your workshop on its Web site with the registration information about the coinciding conference.

Provide Information for the Predesign Energy Analysis

A predesign energy analysis can take several days to several weeks to complete, depending on the scale of the project and the requested level of detail. Be sure to provide all required information to the energy consultant well in advance of the charrette. Set a clear deadline when the results from the analysis are due (before the charrette date). Appendix F describes the information the energy consultant will require and what results to expect when the analysis is completed. Appendix G describes the technical details about energy analysis procedures so that you and the energy consultant can agree about the results and methods that will be used.

Finalize Budget, Expenditures, and Resources

Finalize the budget and determine whether the participants will need to pay to attend. You may need to charge a small fee to cover the cost of snacks and meals or to mail materials to the participants.

Follow up with the potential partners identified during the kickoff meeting. Obtain commitments from these partners early in the planning process to defray specific costs. Knowing at the outset what contributions to expect will enable the steering committee to more accurately estimate the out-of-pocket event expenses and determine whether to charge a registration fee.

Make Logistical Arrangements

Facility

In addition to the general facility information addressed during the kickoff meeting (Chapter 2), complete the following before selecting a facility:

- Tour the proposed facilities to determine suitability and evaluate:
  - Meeting room configurations
  - Meeting room acoustics

  - Ability for participants to easily see and hear the presenters
  - Locations for resource tables, registration areas, and food or beverage tables
  - Table size and shape for breakout group activities
  - Wall space for hanging flip chart pages and drawings.
- Evaluate the ease of access to the facility, such as transportation, security, and convenience.
- Determine if the guest lodging options are acceptable.
- Evaluate the dining and catering options.
- Fully understand and be comfortable with all contract requirements, including the cancellation clause, before committing to pay for a meeting facility.
- Ensure that the space is available after hours (e.g., evenings and weekends) if sessions are to be conducted during these times.
  - Verify that lighting, ventilation, heating, and air-conditioning are available during these times.
  - If access to the building will be restricted, clarify the access arrangements.
- Determine if the facility staff will need a list of participants before or on the day of the event to facilitate entry or parking.
- Be sure the facility is NOT under renovation during the event.

Big Versus Small

Which is better? Conducting a minicharrette or full-scale charrette in one room large enough to hold as many breakout tables as needed, or holding the breakout sessions in small, individual rooms? Holding breakout group sessions in one large room can promote spontaneous communication between the breakout groups. However, the noise level may be too high for members of individual breakout groups to easily communicate and there may not be sufficient wall space for each breakout group to post flip chart pages and drawings. On the other hand, renting many small meeting rooms may isolate and reduce beneficial interactions between groups and exceed the event budget. In all cases, keep in mind that participants need enough space around breakout groups to spread out the materials they are using and to have a good acoustic level in which to conduct discussions.

Food

Serve refreshments to help the participants stay energized during the event. Offer healthy, local food and beverages such as:

- Morning—juice, water, bagels, yogurt, and fresh fruit.
- Afternoon—water, juice, soda, fresh fruit, cookies, or protein bars.

Serving lunch during the minicharrette and full-scale charrette or before or after a half-day workshop provides an opportunity for networking, visiting exhibits, continued breakout group discussions, and touring other breakout group areas. Generally, a 30-minute

Planning tip:

If lunch is to be served during the event, be sure to include a way to indicate dietary restrictions or preferences on the RSVP form. It is a good idea to provide vegetarian meals as an option, even if none of the participants indicate a preference. If available, contract with an environmentally friendly catering service that supports local markets and uses biodegradable tableware.

lunch break is sufficient if lunch is provided. Otherwise, participants will usually need an hour or more to go out for lunch.

Typically, participants are anxious for a change of scenery and want to leave the event for dinner. Near the end of the day, discuss dining options to give the participants an opportunity to informally form their own dinner groups.

Consider holding an opening reception the evening before (or during) the minicharrette or full-scale charrette to introduce participants and encourage informal interaction with the presenters. This type of reception usually begins right after business hours and lasts for a couple hours. If you are serving food, offer appetizers, beverages, and possibly a cash bar.

Lodging

Arrange for a block of rooms at a convenient hotel if participants are traveling from out of town. You may be able to obtain a reduced conference or group rate. Periodically check with the hotel to track registrations. You may need to contact key participants, particularly speakers and facilitators, to remind them to secure their reservations.

Staffing

Successful events depend on the skill of staff people assigned to take charge of or assist with specific duties. The number of staff people needed to complete these duties depends on the size of the event. Table 3 summarizes some of the important activities staff people perform during the event.

In addition to the suggested staff support, keep these recommendations in mind when planning the event:

- Assign more than one person to help with registration to ensure an efficient process.
- Allow the logistics person to focus on logistics. If this person has other duties, an important logistics-related detail will likely not go as planned.

Table 3. Event Staff Support Summary

Duty	Description
Logistics person	• Oversees participant registration. • Ensures that refreshments and meals are served on time and when the overall facilitator expects them (may need to adjust serving times during the event according to the facilitator's direction). • Maintains communication with facility staff about meeting room comfort (e.g., temperature and lighting). • Makes certain that AV equipment is available when needed. • Runs errands.
AV equipment operator	• Sets up presentations. • Operates AV equipment (must be able to troubleshoot and solve equipment operation problems).
Photographer	• Documents the event with photos. Needs to be sure to capture any sketches and diagrams generated by the breakout groups.
Writer(s)	• Takes detailed notes during the event. Often good to have one writer or scribe (in addition to a facilitator) for each breakout group. • Completes a written report following the event.

Planning tip:

Invite public relations professionals or journalists to attend part or all of the event, including presentations and breakout group sessions. The potential publicity can be very useful in developing broad support for the project, raising project funds, and fostering public acceptance.

- Always assume there will be some type of equipment glitch and be prepared to handle it.
- Arrange for a professional photographer or assign someone skilled at using cameras to take photos throughout the event; explain to the photographer how the pictures will be used so that he or she will take the needed shots. For example, the final report might include photos of key speakers, breakout groups at work, breakout groups reporting, and the tour of the project. If the breakout groups draw site sketches, elevations, or other illustrations of their ideas, these should also be photographed. A photograph of the entire group is also good to include in the final report.
- Before the event, assign someone to take notes. Brief this person about the importance of thorough recording. Preferably, this person has some subject matter expertise.
- The report writer should be given an outline of the anticipated report before the event and should have an opportunity to review examples of charrette reports that most closely resemble the anticipated outcome.

Equipment and Supplies

Begin identifying the AV equipment and meeting supplies that will be needed early in the planning process. Determine the number needed and the cost to buy or rent each item. If possible, make a set of the meeting supplies available to each breakout group in addition to the overall facilitator. Typical AV equipment and meeting supplies are shown below.

AV Equipment	Meeting Supplies
☐ Wireless lapel microphone	☐ Flip chart note pads and easels (one per breakout group and one more for overall group)
☐ Wireless handheld microphone	☐ Rolls of masking tape or tacks for each group, depending on the surface to which flip chart pages will be attached
☐ Video projector	☐ Drafting tape†
☐ Transparency projector (if needed)	☐ Markers (variety of dark colors for easy visibility)
☐ Projection screen	☐ Drawing pens (thick for easy visibility)
☐ Laser pointer	☐ Rolls of architectural tracing paper†
☐ Electrical extension cords*	☐ Graph paper†
☐ Power strips*	☐ Architectural and engineering drawing scales†
☐ Laptop computer loaded with presentations	☐ Pads of medium-sized sticky notes
☐ USB thumb drive for last-minute transfer of presentations	☐ Blank overhead transparencies (optional) and markers
☐ Wireless or wired Internet access	☐ Duct tape (to tape electrical cords to the floor)
☐ Laptop computers for resource table (optional)	☐ Tubes or flat portfolios to store and carry charrette flip chart pages and drawings
	☐ Sets of project drawings (e.g., site plans and aerial photos)

* Determine if power should be available to all breakout groups. Breakout groups may benefit from having laptop computers and other equipment that participants might bring with them.

† Provide this item if the breakout groups will be developing drawings for a particular project.

Arrange to have materials and supplies shipped to the facility a few days before the event. If notified in advance, most hotels will hold materials for future meetings if the boxes are clearly marked with the responsible person's name, event name, and event date.

Planning tip:

Leave plenty of time to make arrangements for obtaining equipment and supplies. Some items, such as AV equipment, will likely need to be reserved in advance.

Signs and Name Tags

Prepare the needed number of signs to direct participants to the meeting room. Signs are especially important if the facility is large or has a confusing configuration. Also, place a sign outside the meeting room at the registration table. Use easels to hold all signs so that they can be placed in easy-to-find locations.

Prepare name tags for participants and speakers. Use a large, legible font to print each person's first name. Print the person's last name and affiliation in smaller font. The large font should be no smaller than 30 points.

Exhibits

An exhibitor area is optional. Invite exhibitors who offer "green" services or products to talk with participants and distribute information. Discuss expectations with exhibitors so there is no confusion about the number of participants and their available time to interact with the exhibitors during the event. Invite participants to visit exhibitors during lunch, breaks, an opening reception, or other designated periods.

Assemble and Distribute Participant and Resource Materials

Prepare and assemble participant packages to be distributed when the participants check in at the registration table with the following suggested contents:

- **Tab 1**: Event-specific information
  - Final agenda
  - List of sponsors and contact information
  - List of participants and contact information
  - List of presenters with bios and contact information
  - List of exhibitors
- **Tab 2**: Project information (see Appendix E)
- **Tab 3**: Predesign energy analysis results (see Appendix F)
- **Tab 4**: Presentations printed as handouts for each technical presentation
- **Tab 5**: Case studies of similar high-performance projects
- **Tab 6**: Resources (useful Web sites, articles about local green buildings, and other related materials)
- **Tab 7**: Evaluation form (see Appendix H).

Minicharrette and full-scale charrette participants will find it helpful to have some of this material before the event. For example, distribute the project information and predesign energy analysis results at least two weeks before the charrette, if possible. Also, include this material in the participant packages.

Assembling the packages is time consuming, so plan to assemble them at least one week before the event. If they must be assembled just before the event, allow several hours and recruit volunteers to help. After assembly, check random samples to make sure all materials are included in the proper order.

Decide if notebooks or folders will be used, based on the quantity of materials. These should be constructed from recycled materials. Be aware that the lead time to order such items may

Lead by Example

Employ green practices when preparing participant materials:

- Use recycled paper.
- Make double-sided copies of everything except site information and other charrette working materials.
- Use notebooks or folders made of recycled or environmentally preferable materials (e.g., recycled cardboard).
- Avoid using paper when possible:
  - Give Web site addresses and information about how to order materials instead of providing all the materials.
  - Make examples of supplemental materials such as brochures and flyers available at the resource table.
  - Distribute advance materials (such as project information and predesign energy analysis results) electronically by e-mail or Web site.
- Collect name tags for use at the next event.
- Provide recycling bins for paper, cans, bottles, and composting.

be longer than for conventional products. Personalize the materials with a label containing the charrette title and date and an attractive graphic affixed to the notebook or folder cover.

Set up a resource table to showcase examples of print and electronic resources, particularly local resources. Provide participants information about how to order the resources. The resources may be useful during the charrette.

Develop Evaluation Forms

Participant evaluations can be extremely useful to event planners and to the project team. Provide evaluation forms (Appendix H) in the participant packages, and prepare a box where participants can place their completed evaluation forms. Use the comments to improve future events and to identify kudos or concerns.

Arrange for Continuing Education Units

The workshop training can qualify participants for continuing education units (CEUs). Offering CEUs may help draw participants to the event; however, this does involve extra work for the organizers. The steering committee members should decide early in the planning process if the benefits are worth the time, and sometimes the cost, of arranging to offer CEUs.

Many professional organizations such as AIA and ASHRAE have processes and procedures in place for applying to become a CEU host. These processes vary among the organizations. Contact the national offices of the organization from which the CEUs are to be granted to obtain the appropriate procedure.

Consider a Precharrette Survey

Often critical decision points are identified in advance of the charrette. Providing an online survey such as SurveyMonkey.com can generate useful information about participant opinions and interests that can be included in the project information package. The survey results can be useful for goal setting and can help to get participants excited about the upcoming event.

Chapter 4: Conducting the Charrette

This chapter gives guidance about how to manage a successful charrette. We have included lessons learned and useful tips for reaching concept and project consensus.

The day before the event . . .

☐ Visit the facility.

☐ Check supplies and participant materials.

☐ Meet with the facilitator and the speakers.

The day of the event . . .

☐ Verify logistical arrangements.

☐ Set the stage with the opening session.

☐ Describe project and charrette expectations.

☐ Create effective breakout groups.

☐ Implement successful charrette practices.

☐ Set performance goals.

The Day Before the Event

Visit the Facility

Visit the facility to check the room setup and confirm all arrangements with facility staff to avoid surprises. Confirm as many of the following as possible (some might not be possible until the morning of the event):

- The signage directing the participants to the appropriate meeting room is placed (may not be possible until the morning of the event).
- All reserved equipment is available (Chapter 3).
- The AV equipment is operating properly and any special operation requirements are clarified.
- All presentations can be opened and projected and are clear, bright, and visible.
- The room is laid out properly for seating, breakout groups, resource table, refreshments, and registration.
- The planned arrival of refreshments and lunch coincides with scheduled breaks on the agenda.

Check Supplies and Participant Materials

Check with those responsible to be sure all logistical requirements have been addressed (Chapter 3). Make sure they are prepared to handle last-minute logistical requests. For example:

- Locate the nearest photocopy shop (hotel copy services are often quite expensive).
- Locate the nearest office supply store.
- Locate all the materials that were shipped to the meeting and ensure all materials arrived as anticipated.

Meet With Facilitators and Speakers

Meet with all facilitators and speakers the evening before the event if possible, to make sure everyone has arrived, has the needed materials, and is prepared for the event. This meeting gives the facilitators and speakers an opportunity to meet one another, which will help the event flow more smoothly. At the meeting:

- Review the agenda and the roles and responsibilities of each facilitator and speaker.
- Give each facilitator and speaker a participant package so they can familiarize themselves with these materials before the event begins.

Planning tip:

Give a list of all participants to guards, receptionists, parking lot attendants, and other gatekeepers on the day of the event. Be aware that security requirements have become more stringent for government buildings; you may need to inform participants to bring more than one type of identification. Special requirements might also apply for foreign nationals.

The Day of the Event

Verify Logistical Arrangements

Arrive at the event facility at least one hour before event registration starts. With the help of the event staff and other recruited volunteers, ensure the following items are complete before the participants begin to arrive:

- The registration table is set up:
  - Alphabetize name tags to enable staff members to find participants' names as they arrive.
  - Place the participant packages so they are easy to reach for those working at the registration table (or set them on each chair or table in the meeting room).
  - Have at least two people at the registration table until the event begins. After the event begins, at least one person should stay at the table for an additional 30 minutes, or until all participants have registered.
- The meeting room is arranged properly:
  - Check the room setup (ensure tables and chairs are arranged as planned and that the planned arrangement will be effective).
  - Check the room temperature and air circulation.
  - Check the equipment:
    - All reserved equipment is present.
    - All equipment is functioning properly.
    - The presentation laptop is compatible with the video projector.
    - All presentations are loaded on the laptop and can be opened successfully.
    - The projection screen is positioned so that it can be viewed by all participants.
  - Check that the electrical extension cords are taped to the floor.
  - Check that the Internet connection is operating.
  - Check that a participant package is placed at each seat (or is available at the registration table).
  - Check that signs directing participants to the meeting room are in place.
  - Check that the first snack and beverages are set up as expected.
  - Check that the guards, receptionists, and other gatekeepers know about the event and are ready for the participants to arrive.
- Locate the restrooms, telephones, soda machines, and snack bars.
- Arrange the resource table for easiest access to the materials.
- Arrange the exhibitor area as arranged with the facility. Allow enough space around each exhibitor for participants to talk with exhibitors and view exhibits.

Set the Stage With the Opening Session

The opening session is critical to the success of the event. It MUST accomplish the following:

- Introduce the participants to one another. One important outcome will be the networking that occurs among participants. If the group has more than 25 people, limit introductions to name, affiliation, and profession. Just before the event begins, identify an individual to start the introductions and brief this person on the length of introduction he or she is to provide. Others will follow this model, so be sure it is what you want.

- Establish the goals and objectives for the event and make sure participants understand and buy in to them. Walk through the agenda, participant materials, and resources to demonstrate how the event has been designed to accomplish the goals.
- Demonstrate the owner's interest in the outcome. If the owner is enthusiastic and committed to the goals, the participants are more motivated.
- Remind all participants to turn off their cell phones.

Describe Project and Charrette Expectations

Clearly state the project description, issues, and goals, and the expectations for the charrette. At a minimum, the event sponsor or project owner should address:

- **Goals** – The results he or she desires from the project and from the charrette.
- **Project description** – A brief overview of the project with photographs and drawings as appropriate.
- **Project status** – What decisions have been made already and what work has been performed?
- **Issues or concerns** – Are there any barriers or problems that affect the project?

Review the owner's presentation before the event to ensure it will give enough information for participants to work from, but not so much that they become overwhelmed.

Create Effective Breakout Groups

Ensuring diversity among the breakout group members is important to the success of the event. Table 4 describes three methods commonly employed when creating breakout groups.

After creating the groups, check to make sure there is a good distribution of architects, engineers, landscape designers, and other experts. Make changes as needed. If the self-selection method is used to create breakout groups, ensure diversity and make adjustments so all groups have approximately the same number of members. When using any of the above methods, adjustments may be necessary if individuals are not satisfied with their assignments or if a group has fewer than three members.

Table 4. Methods for Making Breakout Group Assignments

Method	How to	Description
Counting-off method	Ask the participants to count off (1, 2, 3, and so on, up to the number of planned breakout groups)	• Apply when each breakout group will have the same task. • Effective way to separate friends and colleagues from the same firm, who are probably sitting together. • Ensures a variety of interests and expertise in each breakout group.
Self-selection method	Ask the participants to self divide into breakout groups depending on the topic of each breakout group and the individuals' area of expertise	• Apply when each breakout group will address different topics (e.g., energy, water, and site). • Allows participants to select the topic of greatest interest to them.
Predetermination of assignments method	Predetermine the members of each breakout group	• Apply when the expertise and interest of the participants is known. • Ensures knowledge and personalities are balanced within each group.

Implement Successful Charrette Practices

These practices will lead to a successful event:

- Maintain consistency in breakout group assignments. Breakout group members bond during the initial breakout group exercises. The members of each group soon learn how to work together effectively and develop a rhythm that will carry through the entire event.
- Ask the groups to keep a record of items requested, questions the group cannot answer or issues it cannot resolve, and barriers the group sees to accomplishing a specific goal. These records will be given to the owner at the end of the charrette. (See the final charrette report samples in Appendix J for examples of the types of information or issues that could be requested or questioned.)
- At lunchtime, ask the participants to eat first and then take a tour of all the breakout groups' work. For the tour, participants walk from table to table (or room to room) to view and hear a brief (3 to 10 minutes maximum) explanation of each breakout group's approaches and results thus far. One person from each breakout group remains with the group's work and explains it to the other participants. It is best if each breakout group does the tour together. The overall facilitator is the timekeeper and tells participants when to move to another group.
- Invite the owner and local dignitaries who might not have attended the entire charrette to return and hear the group reports at the end of the day during the final report-out session. Often, these guests can respond to some of the ideas on the spot and commit to specific actions.
- Ask each group to prepare a specific maximum amount of material summarizing their conclusions to use for the report-out session. For example, limit the report to four flip chart pages, one template page, or two blue boards.[1] This limitation helps to restrict the amount of time each group spends to report conclusions, and it encourages the breakout group members to focus on the most important aspects of their work. Reassure the groups that, in addition to this summary, ALL their work will be saved and given to the owners.
- Take photos of the speakers, breakout group discussions, materials produced by the breakout groups, and final presentations to ensure a complete record. Take high-resolution digital photos that can be used in a published report.
- Bring attention to the evaluation form in the participant packages during the opening session. Periodically remind the participants to fill out the evaluation forms and deposit them in the collection box labeled "evaluation forms" near the exit of the meeting room. Stress the importance of feedback.
- Gather ALL papers from the groups at the end of the event and label them carefully (Group 1, Group 2, and so on). Large carrying cases (tubes or flat portfolios) are helpful for collecting, transporting, and retaining the material.
- Review and photograph or scan all written work completed by the breakout groups (e.g., summaries and brainstorming notes written on the flip chart pages and drawings) for future use in reports, funding proposals, and press releases.

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[1] Tools sometimes used in charrettes to encourage the breakout group members to be concise with the reporting materials they produce include templates (large "posters," such as 3 feet by 5 feet, with clearly marked locations for summaries of specified breakout group discussions) and blue boards (4 feet by 8 feet foam insulation boards that can be purchased at most hardware or building materials stores) for attaching breakout group materials with thumb tacks or tape).

- Consider providing breakout groups with various materials to support the charrette goals. This might include sticky notes (perhaps color coded for various subjects), facilitator notes (including lists of "ice breakers" and open-ended questions to ask the group), and wall charts that graphically guide conversations through subject constraints and opportunities, goal setting, and group guidance.

Facilitators can either record the group's discussion on flip chart pages or ask for a volunteer scribe. It is often helpful to record audio conversations either on cassette tape or digitally. In either case, it is important to note main topic points discussed and capture the intent of the comments as closely as possible. In many cases, the scribe writes the exact words that were said. This record will be used later to summarize the event during the report-out session and to write the follow-up report.

Set Performance Goals

Often the most important outcome of the charrette is to arrive at a consensus on performance goals for the building. The goals can pertain to all aspects of the building, including energy, emissions (carbon and others), water, site, materials, waste, IAQ, and O&M. Setting performance goals during the charrette is important so all key players have a chance to participate, understand, and buy in to the goals. Studies show that clear goals made with all the key players have a much better chance of succeeding (Deru and Torcellini 2004; Torcellini et al. 2006).

Energy performance goals should be based on the baseline performance indicated by the predesign energy analysis and the energy savings estimates made by the expert participants. The predesign energy analysis ensures that the performance goals are realistic and helps to set expectations for all participants.

Chapter 5: Follow-Up and Next Steps

Within a month after the event . . .

- ☐ Hold a debriefing meeting.
- ☐ Prepare a report about the results.
- ☐ Follow up with the participants.
- ☐ Encourage the participants to stay involved.
- ☐ Analyze and summarize the evaluations.
- ☐ Evaluate the value of follow-up events.

The follow-up is an important element of the event. In this part of the process, confirmation is established on the project's goals and momentum is generated for moving the project to completion. In this chapter, we describe how to follow up a charrette, materials that must be produced, and how to produce them.

Hold a Debriefing Meeting

Conduct a debriefing meeting with the steering committee to wrap up the process of planning and conducting the charrette and to discuss the outcomes. It is best to hold this meeting on the evening or morning after the event. Use this time to review the success of the event activities, clarify the decisions and project directions agreed on by the participants, and consider the next steps. Action items resulting from the debriefing meeting should include assigning responsibilities and completion dates for the remaining items discussed in this chapter.

Prepare a Report About the Results

Always produce a written report that summarizes the results of the event. Its purpose is to document and collate the information presented and discussed. Appendix I contains a suggested outline for this report and Appendix J lists several sample reports from charrettes for high-performance projects. In many cases, these reports help promote acceptance of the decisions made.

In advance, identify individuals who will take thorough notes and photographs and be responsible for preparing a final report of the meeting. Breakout group facilitators should plan to take notes or assign a breakout group member to be a scribe. At the end of the event, these notes should be given to the person who will prepare the final report, or the facilitators should be asked to summarize their groups' work and forward it to the final report writer.

It is best to develop an executive summary (one page front and back) of the most important outcomes to accompany the more detailed report. The executive summary can be used to brief the owners, key stakeholders, event sponsors, potential providers of project funds, and other interested parties. A draft of the executive summary can usually be produced within a week after the event and can help to maintain momentum and align perceptions about the event.

Make the final report available to those who want more detail about the event and its results. Incorporate photographs from the event and scanned drawings created during the breakout group discussions to illustrate the decisions made. Circulating a draft report allows the final report to include participant comments, additions, and corrections.

A support letter or letter of commitment from the owner or key stakeholder is a valuable addition to the final report.

Follow Up With the Participants

The greening process does not end when the event is over—in fact, it has just begun. Good follow-up shortly after the event will help keep the energy and momentum going.

Try to produce the executive summary within one to two weeks after the event. Send it to all participants with a note of thanks and appreciation for their time, expertise, and energy in making the charrette a success.

Encourage the Participants To Stay Involved

Determine specific next steps and assign champions for each. Set a specific time to reconvene with a report on direct results from this charrette to share with the participants, a smaller committee, or a larger group.

Analyze and Summarize the Evaluations

Review the evaluations immediately after the event concludes. Include a summary and an analysis of this feedback in the final report. This information can also be very helpful when planning events for future high-performance projects.

Evaluate the Value of Follow-Up Events

Partners can also help to keep the momentum going. Local chapters of the AIA COTE, ASHRAE, environmental groups, and others can sponsor follow-up events to continue the networking and training that began at the event. In some cases, the event will become part of an ongoing green network in the local area.

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Appendix A: Checklist for Planning and Conducting Charrettes for High-Performance Projects

✓	Description of Activity and Timetable for Completion	Discussion (chapter/page in the handbook)
	Three Months or More Before the Event—Getting Started	**Chapter 2**
☐	Create a steering committee.	4
☐	Hold a kickoff meeting:	4
	• Identify the purpose of the event.	5
	• Identify the type and length of the event.	5
	• Identify the resulting products.	6
	• Draft an agenda.	7
	• Identify potential locations.	7
	• Select potential dates.	8
	• Plan the budget.	8
	• Identify type and number of participants.	9
	• Identify workshop speakers.	9
	• Identify overall and breakout group facilitators.	10
	• Identify potential event partners.	10
	• Prepare project information for charrette participants.	11
	• Plan for a predesign energy analysis before the event.	11
	• Plan the next steering committee meeting.	11
	• Review kickoff meeting action items.	11
☐	Determine event date and location.	12
	Two to Three Months Before the Event—Planning and Developing the Charrette	**Chapter 3**
☐	Develop an agenda:	13
	• State goals.	13
	• Identify opening activities.	13
	• Select a motivational speaker.	13
	• Select interesting speakers to present topics relevant to the project.	14
	• Determine amount of time for breakout group discussions.	14
☐	Confirm availability of key event players:	14
	• Confirm facilitators.	14
	• Confirm speakers.	14
	• Confirm VIPs.	15

✓	Description of Activity and Timetable for Completion	Discussion (chapter/page in the handbook)
☐	Provide presentation guidelines to the speakers:	15
	• Include presentation samples with instructions for use.	15
	• Obtain AV equipment requirements.	15
	• Obtain presentations and speaker handout materials.	15
	• Give speakers an accurate participant count, if the speaker plans to bring handouts.	15
	• Request detailed travel itineraries from the speakers.	15
☐	Provide all information for the predesign energy analysis:	17
	• Identify a professional energy consultant.	17
	• Determine scope of the analysis.	17
	• Provide consultant with site and programmatic information.	17/Appendix F
☐	Finalize budget, expenditures, and resources:	17
	• Determine participant registration fee.	17
	• Obtain commitments from partners to defray specific expenses.	17
☐	Make logistical arrangements:	17
	• Select a facility.	17
	• Select food and beverages.	18
	• Reserve a block of hotel rooms.	19
	• Track participant reservations at the selected hotel.	19
	• Contact expected participants who do not register by a specified date.	19
	• Assign individuals to specific event staff positions.	19
	• Identify needed AV equipment.	20
	• Reserve AV equipment (typically through the meeting facility).	20
	• Ship materials and supplies to the event facility.	21
	• Prepare signs to direct participants to the event.	21
	• Prepare participant name tags.	21
	• Identify and invite exhibitors.	21

✓	Description of Activity and Timetable for Completion	Discussion (chapter/page in the handbook)
☐	Assemble and distribute participant and resource materials:	21
	• Obtain materials for participant packages.	21
	• Assemble participant packages.	21
	• Check participant packages for completeness.	21
	• Distribute the participant packages.	22
	• Obtain materials for a resource library.	22
☐	Develop evaluation forms:	22
	• Develop evaluation forms specific to the event.	22
	• Make a collection box for participants to drop their completed evaluation forms.	22
☐	Arrange for CEUs:	22
	• Determine if CEUs are to be offered.	22
	• Arrange to offer CEUs.	22
Day Before and Day of the Event—Conducting the Charrette		**Chapter 4**
☐	Visit the facility.	23
☐	Check supplies and participant materials.	23
☐	Meet with facilitators and speakers.	23
☐	Verify logistical arrangements.	24
☐	Set the stage with the opening session.	24
☐	Describe project and charrette expectations.	25
☐	Create effective breakout groups.	25
☐	Implement successful charrette practices.	26
Within a Month After the Event—Follow-Up and Next Steps		**Chapter 5**
☐	Hold a debriefing meeting.	28
☐	Prepare a report on results.	28
☐	Follow up with participants.	28
☐	Encourage participants to stay involved.	29
☐	Analyze and summarize evaluations.	29
☐	Evaluate the value of follow-on events.	29

Appendix B: Sample Agendas

Half-Day Workshop: Setting a Project's High-Performance Goals

Goals

1. Introduce participants to integrated design and high-performance strategies.
2. Identify high-performance goals for the project in each topic area (energy, emissions, water, site, materials, waste, IAQ, O&M, and other relevant topics).
3. Motivate participants to design a high-performance project.
4. Establish next steps and a process for moving forward.

The half-day workshop could be done in a morning session from 8:00 a.m. to noon, or as an afternoon session from 1:00 p.m. to 5:00 p.m. The afternoon session allows time for morning office check-in and after-five discussion, which may be preferable.

Agenda

Noon–1:00	Site tour (optional)
1:00–1:30	Welcome, introductions, expectations, and goals
1:30–2:00	Review of project information
2:00–3:00	High-performance process and issues (Project goals identified during the high-performance goals discussion)

1. High-performance process and video (35–40 minutes)
2. Integrated design (process, benefits, costs) (15–20 minutes)

3:00–3:15	Break
3:15–4:45	Performance goals, process, issues, and case study
4:45–5:00	Review of combined goals and next steps for the project

One and One-Half Day Minicharrette

Goals

1. Introduce the concepts of high-performance green design and specific strategies.
2. Identify performance goals and potential strategies in each topic area (energy, emissions, water, site, materials, waste, IAQ, O&M, and other relevant topics)—what might be possible.
3. Identify issues and questions that will affect implementation of these goals and strategies.
4. Establish next steps and a process for moving forward.

Agenda

Note: Evening reception before next day workshop or minicharrette (optional)

Day One: High-Performance Strategies

8:00–8:30	Continental breakfast
8:30–9:30	Welcome, introductions, expectations, and goals
9:30–10:00	Review of project information

10:00–10:15	Break
10:15–11:45	High-performance process and issues
	1. High-performance process and video (35–40 minutes)
	2. Energy and emissions (or facilities/operations and maintenance for a campus or other larger project; 20–25 minutes), present predesign energy analysis results
	3. Water and site (or master planning or transportation for a campus or other larger project; 20–25 minutes)
11:45–12:45	Lunch
12:45–1:45	High-performance issues
	1. Materials and waste (or green procurement for a campus or other larger project; 15–20 minutes)
	2. IAQ and O&M (or contracting, education, community outreach for a campus or other larger project; 15–20 minutes)
	3. Other—local or project priority topic (15–20 minutes)
1:45–2:00	Q&A on project-specific issues
2:00–4:30	Breakout groups
	What issues, questions, strategies, and actions are needed?
	Four to five groups of 6–8 (maximum 10) people per group
	Groups should be made up of multidisciplinary team members
4:30–5:00	Reporting out
	Performance goals set by breakout groups and large group consensus
5:00–6:00	Site tour (optional)

Day Two: Minicharrette

8:00–8:30	Continental breakfast
8:30–9:00	Review of first day and expectations of second day
9:00–11:30	Breakout groups
	Same breakout groups as first day
	Drawings and concepts
11:30–12:00	Reporting out and next steps
12:00–1:00	Optional lunch

Two-Day Full-Scale Charrette: Developing High-Performance Strategies for a Project

Goals

1. Provide basic training on concepts and importance of high-performance green design to enable attendees to participate effectively in the process.
2. Identify high-performance goals and potential strategies in each topic area (energy, emissions, water, site, materials, waste, IAQ, O&M, and other relevant topics)—what might be possible.
3. Identify issues and questions that will affect implementation of these goals and strategies.

4. Establish next steps and a process for moving forward that includes all relevant participants/stakeholders.

Agenda

Day 1: Defining High-Performance Strategies and Setting Project Goals

8:00–8:30	Continental breakfast
8:30–9:00	Welcome and remarks from owner(s)
9:00–10:00	Charrette overview and expectations, logistics, and introductions
10:00–10:15	Break
10:15–11:00	Review of project information
11:00–12:00	High-performance issues 1. High-performance process and video (35–40 minutes) 2. Energy and emissions (or facilities/operations and maintenance for a campus or other larger project; 15–20 minutes), present predesign energy analysis results 3. Water and site (or master planning or transportation for a campus or other larger project; 15–20 minutes)
1:00–2:00	Lunch and tour
2:00–3:00	High-performance issues 1. Materials and waste (or green procurement for a campus or other larger project; 15–20 minutes) 2. IAQ and O&M (or contracting, education, community outreach for a campus or other larger project; 15–20 minutes) 3. Other—local or project priority topic (15–20 minutes)
3:00–4:30	Breakout groups What issues/questions, strategies, and actions are needed? Four to five groups of 6–8 (maximum 10) people per group Groups should be made up of multidisciplinary team members
4:30–5:00	Reporting out Performance goals set by breakout groups and large group consensus
5:00–	Overnight energy analysis of design concepts from breakout groups (optional)

Day 2: Charrette—Hands-On Drawings and Strategies

8:00–8:30	Continental breakfast
8:30–9:00	Review of first day and expectations of second day
9:00–11:30	Breakout groups Same breakout groups as first day
11:30–1:00	Lunch and tour of groups' progress
1:00–3:45	Breakout groups' drawings and concepts pulled together
3:45–4:30	Reporting out

4:30–5:00	Final wrap-up, final remarks, and next steps

Optional Kickoff Session

This session can be several hours or half a day, depending on the number of speakers invited.

Goals

1. Energize and motivate participants.
2. Demonstrate support for the project within the community and among local dignitaries.
3. Provide support for seeking additional funding for the project.

Agenda

1:00–2:30	Welcome by project owner and speeches by local dignitaries
2:30–3:00	What is possible? (green project video)
3:00–3:30	Break and networking
3:30–5:00	Panel discussion of key issues (energy, emissions, water, site, materials, waste, IAQ, O&M, and other local issues)
5:00–6:30	Reception and networking

The agenda can be shortened by eliminating the panel discussion and limiting the event to speeches followed by a reception.

Appendix C: Participant Identification Worksheet

Category of Participant	Number	Names
Owner(s) and owner representatives/developer		
Future project users/occupants		
Land/transportation planners		
Architects		
Contractors		
Landscape architects		
Engineers (civil, mechanical, plumbing, electrical, structural, HVAC, etc.)		
Interior designers Exhibit designers		
Construction specifiers (spec writers)		
Lighting designers		
Environmental building specialists (energy, emissions, water, site, materials, waste, IAQ, O&M, etc.)		
Energy consultant		
Ecologists		
Commissioning agents		
LEED Green Building Rating System-accredited professionals		
Facility managers		
Additional participants for special building types such as: • Educational facilities (faculty, students, labor unions, and administration) • Labs and science centers • Large-scale campuses, developments, and military installations		
Community leaders: • Government/political leaders • Civil/business leaders • Community service/health/religious leaders • Community economic development leaders • At-large community/neighbors		

Category of Participant	Number	Names
Partners: • Local, state, or federal agencies • Private sector corporations • Community groups		
Other:		
Total number		

Appendix D: Sample Letters

You may also want to include the definition of charrette and the event's goals and objectives in these letters.

Sample "Save the Date" Letter or E-Mail

PLEASE SAVE THE DATE:

The Institute of American Indian Arts (IAIA), a federally chartered tribal college in Santa Fe, New Mexico, cordially invites you to attend a two- and one-half day planning workshop or "charrette" to develop the strategic plan for the "IAIA Initiative for a Sustainable Future." The initiative will provide the environmental and energy blueprint for development of the IAIA campus and museum for many years to come. The event will take place on the IAIA campus November 11–13, 2009.

This promises to be a great couple of days, with experts in the field of sustainable design and development working closely with IAIA staff and students, local community, state and federal officials, and others who have an interest in sustainable design and wish to have a voice in the future of IAIA. We will identify key initiatives and action items to guide our efforts to build a more sustainable future for IAIA, our community, and our nation.

Invitations, including an agenda, a full list of invited participants, and other relevant information will be sent out in about two weeks. Meanwhile, please save the dates in your calendar and plan to attend! Hotel information for those of you arriving from out of town is attached here—please make room reservations as soon as possible.

If you have any questions, please contact ______________________________________

Telephone number ____.

The ____Group is planning and coordinating this activity on behalf of IAIA.

Warm regards,

Robert Martin
President, IAIA

Sample Invitation Letter for Workshop

Name
Title
Company Name
Address
Address

Dear ___________________:

_______________________________________(owner) and ____ (list any prominent partners) will be conducting a half-day high-performance/green workshop on _____________(date) and would appreciate and value your participation.

Greening workshops have been successfully implemented for the White House, the Department of Defense, and the National Park Service, and for numerous other public and private clients. ____________________ (owner) is excited about the opportunity to host a high-performance/green workshop and hopes that you will join in this informative and critical initiative!

This workshop will address environmental considerations for the ____________________ (owner) designs for a __________________________________ (name of project).

Approximately _____ (number) participants will consider the following topics during the half-day event:

1. Sustainable site/landscaping/transportation and water issues
2. Energy (heating/cooling systems, building envelope, lighting, and plug loads)
3. Materials and resources/waste and recycling/operations and maintenance
4. Indoor environmental quality
5. Integrated design

The workshop will engage the large group in interactive discussions regarding the feasibility of implementing specific high-performance/green strategies. In addition, the workshop participants will explore the inherent opportunities and obstacles and decide what strategies and approaches would work best for the proposed project.

We invite you to participate as a key member of this upcoming workshop. Enclosure (1) is a list of other potential participants. The workshop will meet per Enclosure (2) in the _____________Room at ___________________________________ (facility). Maps are included for your use as Enclosure (3). Site and project information is included as Enclosure 4.

Your ideas, insights, and action items will be compiled into a short report that will be easily accessible for future reference. This report will provide a listing of environmental considerations not only for this project, but also for numerous other projects. The overall goal is to make this project a model of excellence in terms of sustainable design and development and to share this knowledge with others.

Should you have any questions or need any further information, please feel free to call _________________________(name), ____________________________(position), at ______________ (phone number).

We realize that this High-Performance Greening Charrette calls for a commitment of time from your already busy schedule; however, your skills are greatly needed and we hope that you will consider joining in this effort as an important investment in this project, this community, and our country. If you cannot attend, please recommend others who can take your place. Also, please advise if we should invite anyone else.

Sincerely,

___________________________________ (charrette host)

Enclosures:

(1) Stakeholders list

(2) Agenda

(3) Maps

(4) Site and project information

Invitation Letter for Minicharrette and Full-Scale Charrette

Name
Title
Company Name
Address
Address

Dear ___________________:

____________________________________(owner) and ____ (list any prominent partners) will be conducting a "Greening Charrette" on _____________(dates) and would appreciate and value your participation.

Greening charrettes began with a Greening of the White House Charrette in the early 1990s, and have been successfully implemented for the Department of Defense at the Pentagon and for the National Park Service, and for numerous other public and private clients. ____________________ (owner) is excited about the opportunity to host a greening charrette and hopes that you will join in this informative and critical initiative!

This charrette will address environmental considerations for the ____________________ (owner) designs for a ___________________________________ (name of project).

Approximately _____ (number) participants will consider the following topics in small breakout groups during the (1½ OR 2-) day event:

1. Sustainable site/landscaping/transportation and water issues
2. Energy (heating/cooling systems, building envelope, lighting, and plug loads)
3. Materials and resources/waste and recycling/operations and maintenance
4. Indoor environmental quality
5. Big-picture issues: process, education, and community outreach

Each group will ultimately generate a report noting existing conditions, priority issues to address, and a list of short-, mid-, and long-term action items and preliminary concept drawings for the project. Names of "champions" will be noted for action items. Opportunities as well as obstacles will be noted. The large group will determine an overall priority listing for the implementation of the goals and objectives that this charrette identifies.

We invite you to participate as a key member of this upcoming greening charrette. Enclosure (1) is a list of other potential participants. The charrette will meet per Enclosure (2) in the _____________ Room at ____________________________________ (Facility). Maps are included for your use as Enclosure (3).

In addition, should you require lodging during this charrette, please make arrangements with the _________________(hotel), at ___________________(phone number). The group number for charrette reservations is____________.

Your ideas, insights, and action items will be compiled into a report that will be easily accessible for future reference. This report will provide a strong foundation for environmental considerations for this project, and for numerous other projects. The overall goal is to make this project a model of excellence in terms of sustainable design and development and to share this knowledge with others.

Should you have any questions or need any further information, please feel free to call ________________________(name), __________________________(position), at _____________ (phone number).

We realize that this High-Performance Greening Charrette calls for a commitment of time from your already busy schedule; however, your skills are greatly needed and we hope that you will consider joining in this effort as an important investment in this project, this community, and our country. If you cannot attend, please recommend others who can take your place. Also, please advise if we should invite anyone else.

Sincerely,

_____________________________________ (charrette host)

Enclosures:

(1) Stakeholders list

(2) Agenda

(3) Maps

(4) Site and project information

Appendix E: Project Information To Distribute to Participants Before the Charrette

Basic Project Information

Some important basic project information should be collected and distributed to all participants for review and familiarization before they attend the charrette. The relevant information depends on the scale of the project. For a building-scale project (addressing the design of a single building), extensive detail should be provided about the candidate sites and programmatic requirements. For a large-scale development project consisting of a complex of two or more buildings, less detail is needed for each individual building and more detail should be provided about the overall master plan, infrastructure, and facilities.

Building-Scale Project

We recommend providing the following information for a single building project.

- Project mission statement and short paragraph about the project history
- Maps of project site(s) showing topography, vegetation, structures, and infrastructure (note scale on map for participant use)
- Description (and drawings or images, if possible) of larger site context, such as population, geography, transportation modes, utility lines, and other infrastructure of the surrounding area
- Square footage of overall project and spaces
- Space requirements for the project: Define spaces, occupancy levels, use, daylighting needs, temperature ranges, and adjacency requirements
- Results from predesign energy analysis (see Appendix F).

Large-Scale Development Project

We recommend providing the following information for a larger scale development, such as a campus, military installation, national or state park, or community.

- Project mission statement and short paragraph about the project master planning
- Maps of the overall site(s) and adjoining areas showing topography, vegetation, hazardous material sites, and infrastructure (note scale on map for participant use)
- Current site master plan, transportation modes and methods, and utility lines
- Information about facilities and their O&M issues
- Status of green procurement measures, retail initiatives, and interpretation and education considerations
- Results from predesign energy analysis (see Appendix F).

In-Depth Project Information (Optional)

The in-depth large-scale project information outlined here may be included in addition to the basic project information if the steering committee members feel that the additional information will help participants understand the project.

Energy Information

- Baseline conditions
- How power is provided to the site

- Energy uses on the site
- Breakout of energy uses by type of fuel, units, amount consumed per fuel type, and total energy used (for the last two years, if applicable)
- Current HVAC systems
- Fuels/systems used on the project site and in the buildings
- Energy efficiency programs implemented or available to the project (e.g., relamping or motion sensor programs)
- Project-wide emissions
- Air pollution control strategies in use or available to the project
- Noise pollution control strategies in use or available to the project
- Radiation pollution control strategies in use or available to the project
- Monitoring and metering of energy consumption in use or available to the project
- Education/training on energy efficiency
- Cost information for energy
- Case studies/exemplary projects
- Sustainability efforts currently underway in terms of energy use.

Site and Water Information

- List of endangered species
- Exact site costs (e.g., landscaping labor and materials)
- Percentage of impervious pavement
- Current runoff/stormwater conditions
- Landfill areas (hazardous sites) and restoration efforts
- Transportation
- Partnerships
- Golf course information (e.g., fertilizers and chemicals) and costs to operate the golf course (if this type of area is part of the site)
- Lakeside and water body information (buffers, recreation, etc.)
- Water wells—well head protection areas
- Water treatment plants (average discharges)
- Airport information (location, amount used, types of planes using runway—if this type of area is part of the project site)
- Metering or monitoring information besides costs
- Land use breakout (developed land, wetlands, pavement, etc.)
- Information about erosion, wetlands, forestry, wildlife, historic register sites/buildings, etc.
- Education/training efforts on site sustainability
- Case studies/exemplary projects
- Sustainability efforts currently underway on site.

Materials, Waste, and Recycling Information

- Buildings—number of current buildings by types and square footage breakdown
- How many buildings are built every year (by square footage)
- How many buildings have been demolished (last two years)
- How many buildings are to be demolished in the next two years
- Type of construction and demolition sorting of waste underway
- Sample specification used for demolition, renovation, and new projects
- Sources of the waste stream on site (the current distribution of solid waste: paper, glass, plastics, food waste, wood/yard waste, textiles/leather, metals, other in tons per year)
- How solid waste is handled
- How hazardous waste is handled
- Project recycling programs
- Solid waste management plan (solid waste diverted from landfill and solid waste delivered to landfill in last two years)
- Hazardous waste and materials generated in last two years—breakdown of amounts and types of hazardous waste
- Solid waste generated and disposal rates
- Metering/monitoring of waste
- Restoration sites (note also in site section)
- Scrap generated and recycled in the last two years
- Education/training about waste reduction (construction/occupants)
- Cost information on waste
- Case studies/exemplary projects
- Sustainability efforts
- Note what is currently being done about the following:
  - Asbestos
  - Polychlorinated biphenyls (PCB) removal
  - Chlorofluorocarbon (CFC) reduction
  - Remediation of contaminated sites.

Operations and Maintenance

- O&M practices (e.g., energy, water, waste, and landscaping)
- Commissioning practices
- Cleaning practices
- Pest control
- Painting
- Feedback systems (e.g., lighting, glare, shades, temperature, and controls)
- IAQ management programs (e.g., checks for mold/mildew in ducts)
- Scheduled maintenance—repair and replacement of exterior and interior products and systems

- Metering/monitoring of systems
- Education/training on sustainable O&M practices
- Cost information for O&M
- Case studies/exemplary projects
- Sustainability efforts underway with O&M practices.

Big Picture: Process, Education, and Community Outreach

- Procurement—RFP, cleaning contract, etc.
- Current environmental education (e.g., for employees, vendors, and contractors)
- Green teams/sustainability charrettes
- Current exchange of sustainability information with others
- Cost information for educational endeavors
- Case studies/exemplary projects
- Sustainability efforts in the big picture.

Appendix F: Predesign Energy Analysis

A predesign energy analysis uses general information about the building and site to estimate energy performance, characterize energy uses, and identify potential energy savings opportunities. During the charrette, the results of the analysis are presented to all participants. The objective is to use results to develop design concepts that minimize energy loads and costs from the outset. Results also provide important guidance for setting energy performance goals. At this early stage in the design process, the building siting, orientation, zoning, internal organization, massing, and appearance of the facade can be manipulated to maximize performance without adding significant cost.

The energy performance of a building depends on complex interactions between the outdoor environment, indoor conditions, building envelope, and mechanical systems, so computer simulation programs are the best tool to perform building energy analyses. A whole-building computer simulation tool that calculates hourly or subhourly loads for the building is critical for all high-performance projects.

Unless a member of the charrette steering committee has the skill and time, a professional energy consultant should be hired to perform a predesign energy analysis based on information provided by the owners, architects, and engineers. He or she will perform most of the simulation work in advance. It is also very useful to have the energy consultant perform simulations during and after the charrette to test the design concepts developed by the breakout groups. The energy consultant must be given sufficient time to prepare and execute the required simulations. The lead time for the analysis depends greatly on the magnitude of the project and the desired level of analysis. Obtain a time and cost estimate for your project from the energy consultant as early as possible.

Keep in mind that energy performance is closely tied to other environmental performance measures such as carbon emissions, water use, and IAQ. If any of these measures (or others) are priorities for the project, be sure to inform the energy consultant so that he or she can include them in the predesign analyses.

Energy cost is also closely related to energy performance. Energy cost savings form the basis for earning LEED points under the Energy and Atmosphere credit. A comprehensive predesign energy analysis provides a head start for the simulation work required to calculate LEED points throughout the design process.

This appendix is intended to help the charrette organizers, owners, architects, and engineers know what type of information to give the energy consultant and what results to expect. The types of predesign energy analyses are described and tips for presenting results during the charrette are also discussed. Finally, some suggestions are made for goal setting and the next steps after the charrette.

Types of Predesign Energy Analyses

Most consultants can perform five basic types of predesign energy analyses:

- Baseline analysis
- Load elimination parametric analysis
- Sensitivity analysis
- Energy conservation measure analysis
- Utility bill analysis (if applicable).

The first four types of analyses can be performed for any building project. Utility bill analysis is mainly applicable to renovation projects or projects that will build a new version of an existing building. The following sections introduce the intent and application of each type of analysis. Examples of analysis results and ways to present them are shown later in this appendix. Remember in all cases that a predesign energy model is a simplified sketch of a potential building. Results are best used to compare and explore alternatives and will not necessarily be representative of the actual performance of the final design.

Determine with the energy consultant which specific analyses are most appropriate for the type of charrette event, budget, and available time. For all charrettes, we recommend at least a baseline analysis. For a full-scale charrette, we recommend that all analyses be performed, if time and budget permit.

Appendix G describes the methods and procedures for each type of analysis in detail. Although intended as a guide for the energy consultant, Appendix G may also help the charrette organizers understand the consultant's work and ensure that he or she has fulfilled all the analysis requirements.

Baseline Analysis

Baseline analysis (also known as base case analysis or base building analysis) characterizes the energy uses and costs that would be expected if the building were built to code with no high-performance features. In the predesign stage, the architecture and geometry have not yet been decided. The baseline building is therefore merely a box that meets all the owner's program requirements. The performance of building materials and mechanical equipment is dictated by the applicable minimum energy code requirements for the site. The most common energy code for commercial buildings is Standard 90.1 of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 1989; 1999; 2001; 2004; 2007). The applicable year of Standard 90.1 can vary by state and municipality, although the analysis is most commonly based on the 2004 or 2007 versions. California has its own energy code called Title 24 (CEC 2004; 2005).

The baseline analysis yields several results that are relevant for the charrette. Estimated total annual energy use, total annual energy cost, and peak demand provide guidance on the magnitude and profile of the anticipated energy consumption. These numbers comprise the benchmarks against which all energy conservation measures can be compared. The breakdown of end-use energy consumption such as heating, cooling, lighting, and plug-in equipment (plug loads), reveals the largest energy consumers and helps to target areas for improving energy efficiency. Energy use profiles show the variation in energy use on daily, monthly, or seasonal time scales. Such profiles can be useful when considering time-of-day demand charges or energy storage.

Understanding the energy performance of the baseline building is the first step toward setting goals and selecting high-performance features. The building simulation model developed for the baseline analysis is also a prerequisite for the remaining three types of predesign energy analyses.

Load Elimination Parametric Analysis

Load elimination parametric analysis shows the impact of individual loads on overall energy use. Individual loads include the heat loss or gain through the building envelope, solar gain through windows, infiltration heat loss or gain, and internal heat gain from people, electric lights, plug loads, and process loads. The analysis is performed by sequentially "eliminating" each load in a separate simulation (e.g., the windows, lights, or infiltration) to measure its energy impact.

The results of the completed series of simulations provide a crude means of ranking the relative importance of individual loads or components. Loads that significantly affect the whole-building energy use can be targeted first for improvement. The results also show the load contribution of key programmatic details, such as occupancy schedules or lighting power densities. Careful examination of load elimination parametric analysis results can also reveal coupling between different types of loads. For example, reducing the electric lighting load decreases the cooling load, but also increases the heating load.

Load elimination parametric analysis starts with the baseline simulation model and requires minimal additional model development.

Sensitivity Analysis

Sensitivity analysis measures the sensitivity of whole-building energy use to changes in key design parameters. Typical parameters that are analyzed include wall and roof insulation levels, window area, overhang depth, lighting power density, and equipment and system efficiency. Parameters that show significant impact on overall performance should be considered carefully. Further analysis can be used to optimize the parameter and reduce energy use.

Like the load elimination parametric analysis, crude sensitivity analysis starts with the baseline simulation model and usually does not require significant model development.

Energy Conservation Measure Analysis

Energy conservation measures (ECMs) are specific technologies or design strategies that are intended to save energy. Common ECMs include extra insulation, high-performance windows, daylighting controls, passive solar heating, natural ventilation, and high-efficiency mechanical equipment.

ECM analysis estimates the potential savings in energy consumption, energy cost, and peak energy demand for an individual ECM or combination of ECMs. The analysis allows different ECMs to be compared and the best performing configuration to be determined. The analysis is also the first step for determining whether an ECM may be cost effective.

Be sure to discuss the specific ECMs you would like to explore with the energy consultant. Some will require additional model development and some may be beyond the capabilities of the simulation program. For these reasons, ECM analysis is the most challenging task for the consultant. The consultant's ability to identify other promising ECMs can vary greatly, depending on his or her experience and judgment. You may wish to seek input from other members of the design team before submitting a final list of ECMs to the consultant.

Utility Bill Analysis

Utility bill analysis uses the utility billing history from an existing building to characterize energy use and help set performance goals. It can be used to illustrate monthly trends or to calibrate a baseline model. This analysis is useful for renovation or remodel projects. It is also useful for new construction if the new building is similar to another building in size, use, orientation, and climate type, or if the project is a new version of an existing building. For example, big box retail stores are often built from the same set of construction plans, so this type of analysis could be used for a new building in this situation.

Multiday Charrettes

If the charrette is a multiday event, the energy consultant may be able to perform additional simulations during or following each day. These simulations can answer specific design questions that arose over the course of the day, e.g., energy savings predicted for an ECM that was not considered in the original analysis. Additional work by the consultant should, however, be limited to reasonable variations on the baseline computer model and perhaps a few simple ECMs. It is probably not reasonable to expect the consultant to put together detailed simulation models of all the design sketches developed by the breakout groups. Discuss with the consultant to determine what is or is not possible.

What To Give the Energy Consultant

The consultant requires general information about the site and building before starting an analysis. This information is usually the same for all types of analyses and includes:

- Site location
- Total floor area
- Number of floors
- Applicable building energy code
- Principal building activity
- Space use descriptions (including occupancy and operation schedules)
- Special process loads (e.g., refrigeration or data center)
- Utility availability and utility companies.

Most of this information should be included in the building or project program. A sample Building Program Questionnaire is included at the end of this appendix. This questionnaire (or something similar) should be completed by the owners or architects and provided to the energy consultant. Detailed instructions for the questionnaire are also included at the end of this appendix along with a completed example.

The consultant is responsible for obtaining additional information required for the analysis. This may include weather data, utility tariffs, and building energy code requirements. See Appendix G for more information.

What To Ask of the Energy Consultant

Once the types of analyses have been selected and the required site and building information has been collected for the consultant, you are ready to decide the scope of each analysis. The scope defines how many and what types of simulations the consultant will run and the results that will be provided for the charrette. Because the options for simulations and results differ for each type of analysis, the scope should be discussed in detail and agreed upon in advance. The scope of the sensitivity analysis, for instance, should define the building parameters and the range and granularity of values that are to be examined. The scope of the ECM analysis should list the specific ECMs to be simulated. The baseline and load elimination parametric analyses have fewer simulation options but do have a variety of results options.

The consultant should summarize the raw output generated by the computer simulation into meaningful charts and tables. He or she should depict results so that participants can quickly and easily understand them when presented at the charrette. We recommend using charts for most results, but tables are useful for absolute numbers. Work with the consultant to agree on how results will be rendered.

The following sections offer options for simulations and results for each type of analysis to help formulate the scope of analysis you will ask for. Example results in the form of charts and tables are also shown below.

Baseline Analysis

A baseline analysis typically comprises one annual simulation of the baseline building model and can provide results for:

- Annual site energy use
- Annual source energy use

- Annual energy cost
- Annual energy use intensity
- Annual emissions (carbon and others) by fuel
- Annual water consumption
- Breakdown of energy end uses
- Monthly energy use
- Monthly peak electric demand
- Daily electricity demand profiles.

The annual results for site energy use, source energy use, and energy cost are typical metrics to be communicated during the charrette. Carbon emissions or water use can be of equal or greater importance for some projects. Whichever metrics are selected, these numbers form the benchmarks against which all ECMs are compared. The results are best displayed in a table such as Table F-1.

Table F-1. Baseline Annual Results Summary

	Site	Source	Cost
Annual Energy Use	2,807 Million Btu *(2,961,730 MJ)*	7,171 Million Btu *(7,565,490 MJ)*	$52,871
Annual Energy Use Intensity	52.3 kBtu/ft^2 *(594 MJ/m^2)*	133.7 kBtu/ft^2 *(1,519 MJ/m^2)*	$0.99/ ft^2 *($10.61/m^2)*

The annual results should also be presented in terms of energy use intensity. Energy use intensity normalizes the energy use on a per area basis so the results can be compared to buildings of different sizes, national averages, or high-performance benchmarks. Annual energy use intensity is a useful metric for setting performance goals.

The distinction between "site" and "source" energy is relevant in some projects. Site energy is the measure of energy consumed by end uses at the project site—essentially the same as the utility bill. Source energy, on the other hand, is the measure of energy consumed to produce and deliver the site energy. Usually site energy, source energy, or energy cost is selected as the reference metric for all of the analyses.

The annual energy results should be broken down by end use: heating, cooling, fans, pumps, plug loads, and lighting. Some buildings may have special end uses that should also be included. A supermarket, for instance, will have refrigeration as a significant end use. As far as possible, all end uses should be identified—none left as "miscellaneous."

A bar chart is a convenient way to show the relative magnitudes of the different end uses (see Figures F-1 and F-2). This quickly identifies the largest end uses that should be targeted for improvement.

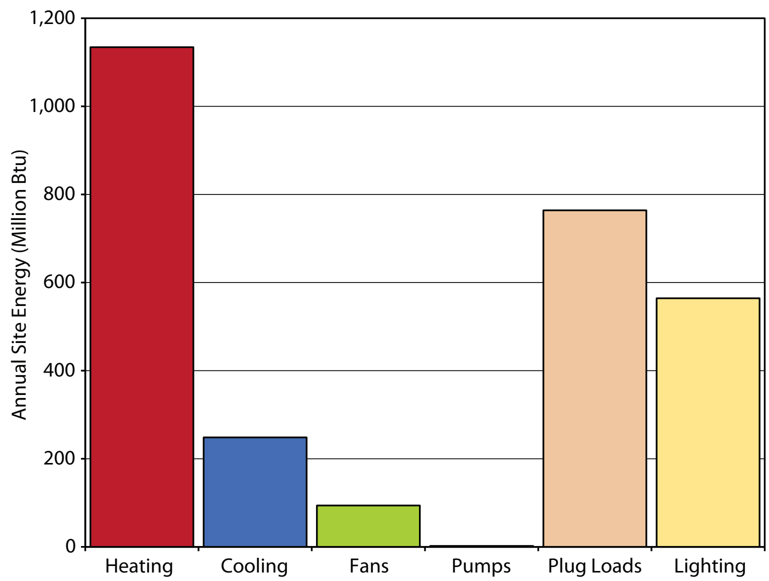

Figure F-1. Baseline Annual Site Energy by End Use

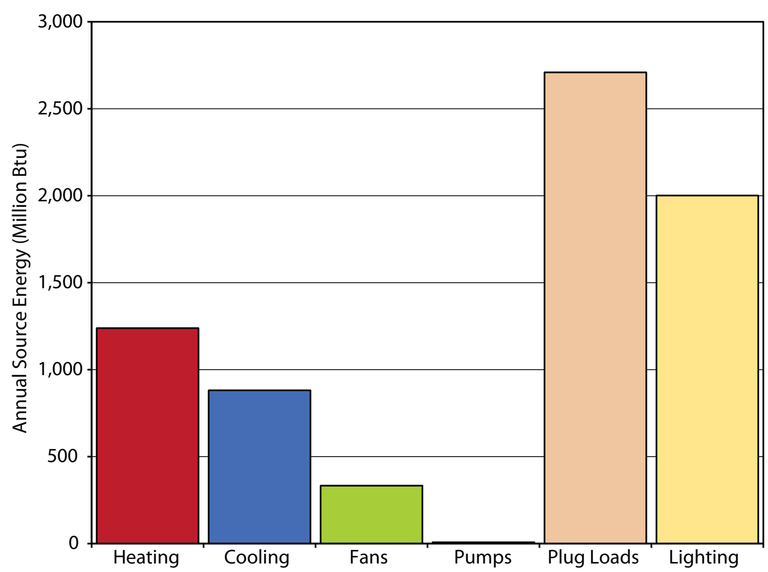

Figure F-2. Baseline Annual Source Energy by End Use

Pie charts are commonly used to display results. However, they should be used with caution because it is difficult to visually compare different slices to one another in a given pie chart, or to compare slices between pie charts. Pie charts *can* be safely used if the purpose is to compare each slice relative to the whole pie—for example, to compare percent energy end uses relative to the total (see Figure F-3). For good measure, the data values should also be labeled for each slice of the pie.

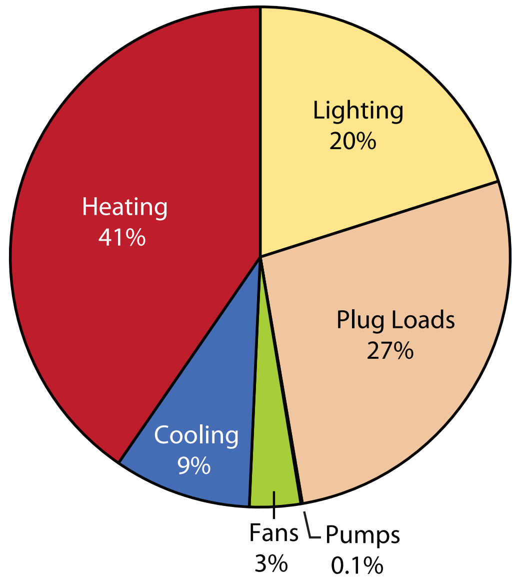

Figure F-3. Baseline Annual Site Energy by Percentage End Use

Energy end uses can be further broken down by month or billing cycle to show seasonal variations. A stacked bar chart is ideal for displaying these results (see Figure F-4). This chart is especially useful for revealing the seasonal impact of heating and cooling loads.

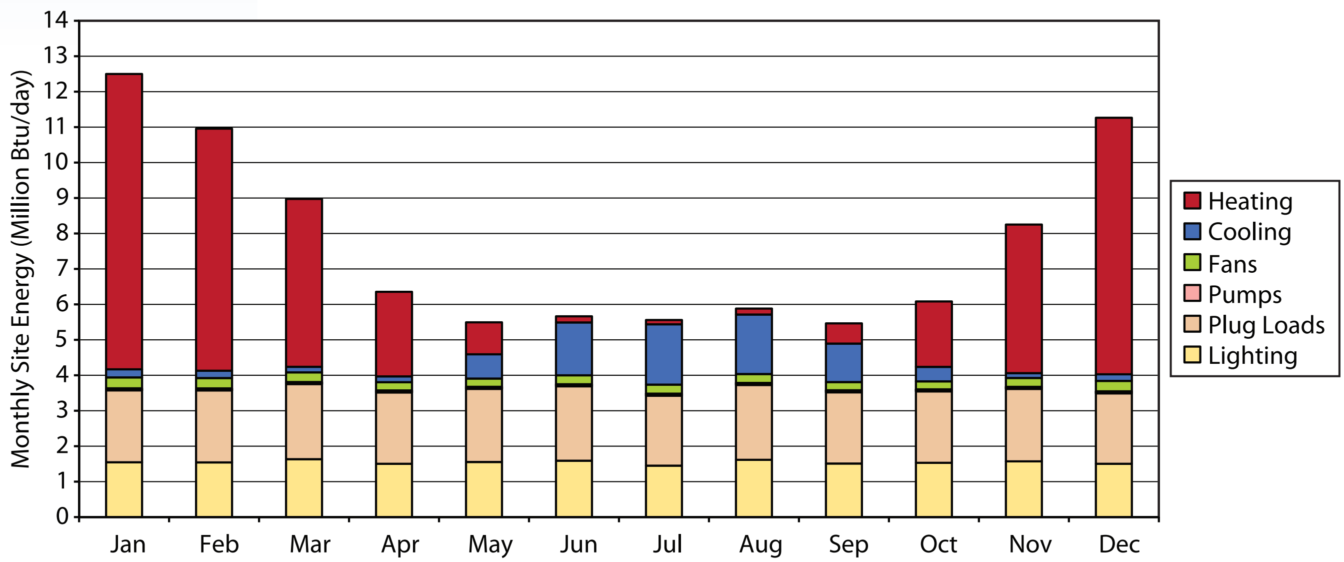

Figure F-4. Monthly Site Energy by End Use

Daily electricity demand profiles show electricity use patterns over a 24-hour period. Utility companies usually base their electricity tariffs on a combination of electricity use and peak demand incurred during a given period (such as a month). Peak demand is measured as the average power over a specified time window, typically 15, 30, or 60 minutes. Daily demand profiles can identify which end uses contribute most to the peak demand and can illustrate the opportunity for cost savings from demand management strategies.

A variety of representative daily profiles can be selected to illustrate electricity demand on different days and at different times of year. In all cases, the demand results should be broken down by end use and averaged over the same demand window used by the utility company. Figure F-5 shows the profile for December 16.

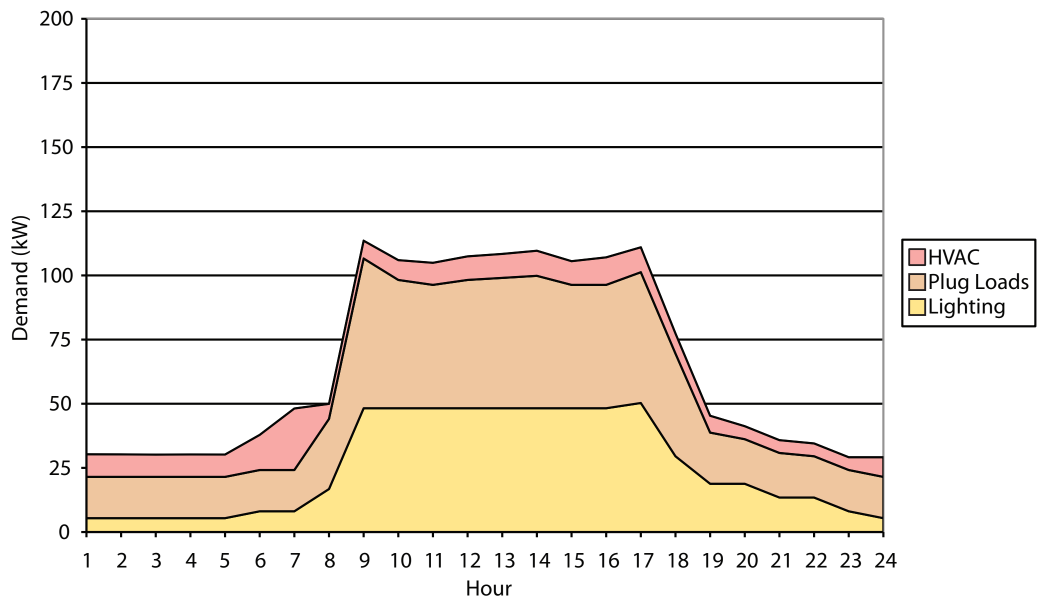

Figure F-5. December 16 Daily Profile

One or more peak demand days should be presented. A peak demand day is one that would likely set the demand charge for the month (see Figure F-6). A peak heating day, a peak cooling day, plus one for each season is desirable.

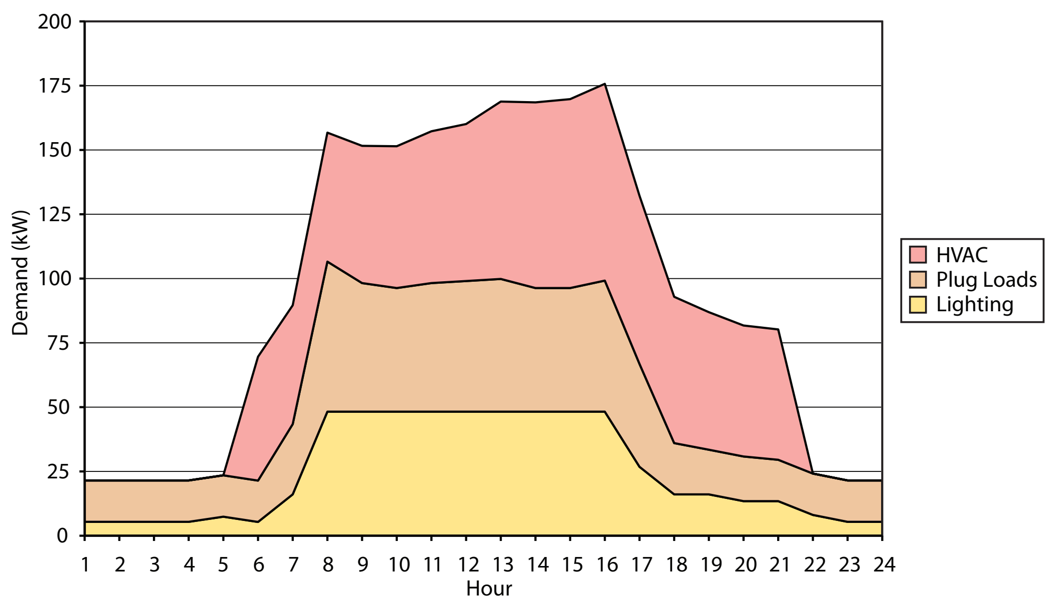

Figure F-6. August 4 Peak Day Demand Profile

The daily profile can also be averaged over a month (see Figure 7) or an entire season to create an average daily profile. These profiles can be used to illustrate general trends over longer periods and can indicate opportunities for reducing peak demand under time-of-use billing arrangements.

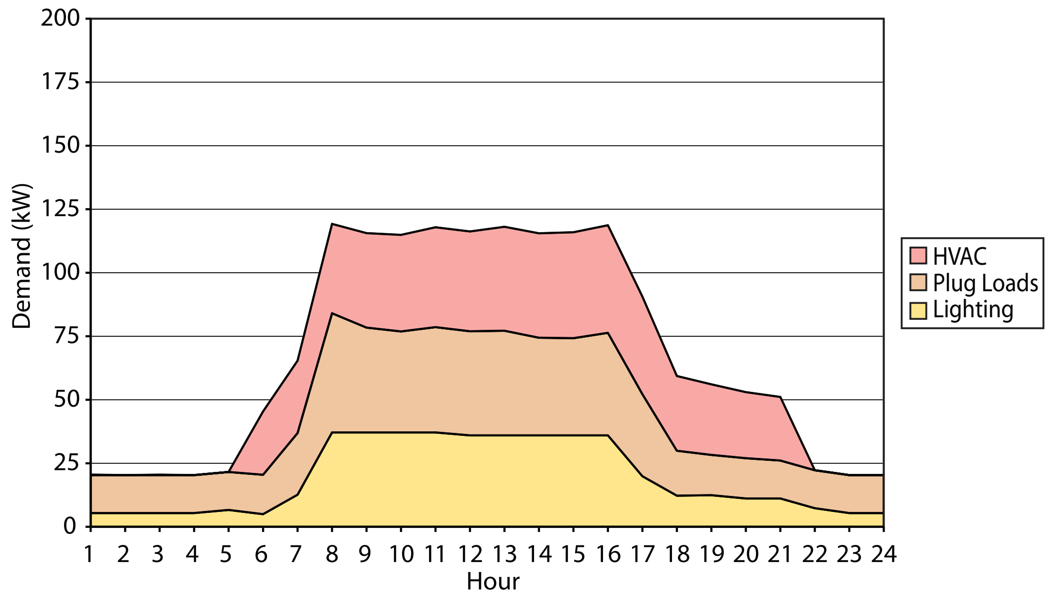

Figure F-7. August Average Daily Profile

Load Elimination Parametric Analysis

Load elimination parametric analysis consists of a set of simulations that provide a comparison of the individual energy impacts of different loads to the baseline results. To compare the simulations, select a metric such as annual site energy use or annual source energy use. Figure F-8 shows an example chart for a load elimination parametric analysis. Breaking the end uses down in each column helps to show relative changes for each load if eliminated completely.

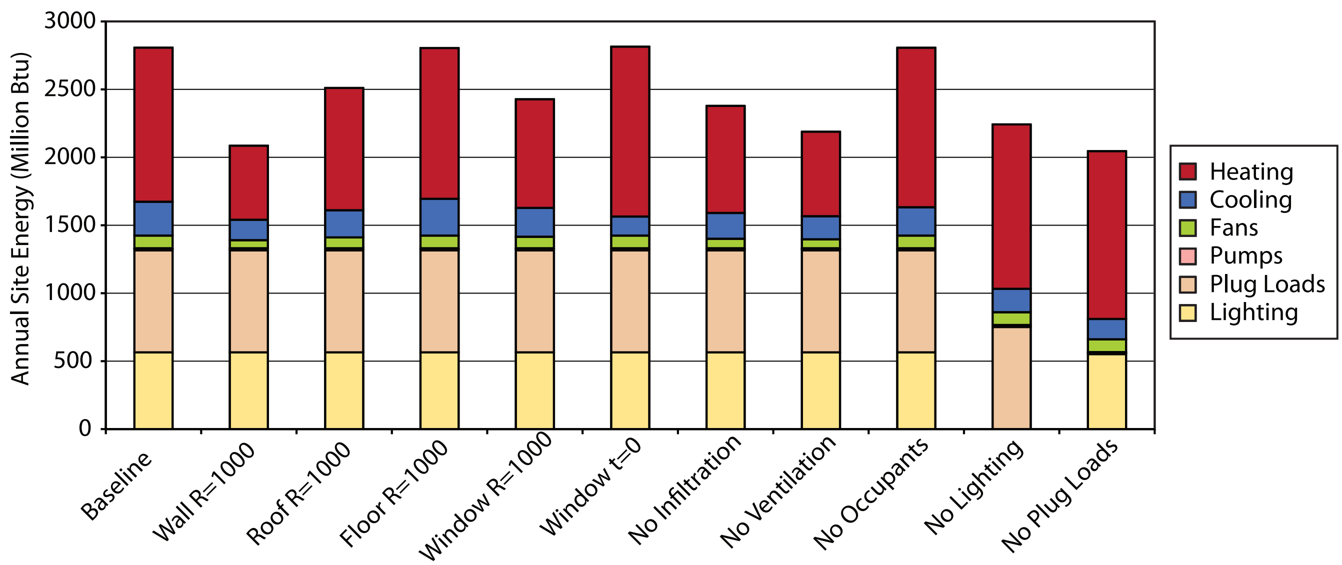

Figure F-8. Load Elimination Parametric Analysis for Annual Site Energy Use

The analysis is performed by sequentially eliminating each load in a separate simulation. A load is eliminated by setting one of the simulation parameters to an extreme value—a theoretical limit that can never be reached in practice. Because the values are extreme, the results indicate trends and relative behavior rather than actual savings. A standard list of loads to be eliminated includes:

- **Wall R = 1000.** The wall insulation level (R-value) is set to a very high number to eliminate heat transfer through the walls. This gives an idea of the theoretical limit for energy savings that could be achieved by increasing the insulation in the walls.

- **Roof R = 1000.** The roof insulation level (R-value) is set to a very high number to eliminate heat transfer through the roof. This gives an idea of the theoretical limit for energy savings that could be achieved by increasing the insulation in the roof.
- **Floor R = 1000.** The floor insulation level (R-value) is set to a very high number to eliminate heat transfer through the floor. This gives an idea of the theoretical limit for energy savings that could be achieved by increasing the insulation under the floor.
- **Window R = 1000.** The window insulation level (R-value) is set to a very high number (or U-value is set to a very low number) to eliminate heat transfer through the windows. This gives an idea of the theoretical limit for energy savings that could be achieved with better insulated windows.
- **Window $\tau = 0$.** The window transmittance (τ) is set to zero to eliminate solar gains through the windows. This gives an idea of the theoretical limit for energy savings that could be achieved by upgrading the solar performance of the windows.
- **No Infiltration.** The rate of outside air infiltration is set to zero. This gives an idea of the theoretical limit for energy savings that could be achieved by tightening up the building envelope.
- **No Ventilation.** The rate of outside air ventilation is set to zero. This gives an idea of the theoretical limit for energy savings that could be achieved by using air-to-air heat recovery.
- **No Occupants.** The internal heat gains caused by people are set to zero. This load can not usually be reduced, but it is still helpful to know its impact on energy.
- **No Lighting.** Electric lighting is set to zero. This gives an idea of the theoretical limit for energy savings that could be achieved with daylighting.
- **No Plug Loads.** Plug-in equipment loads are set to zero. This gives an idea of the theoretical limit for energy savings that could be achieved by using high-efficiency equipment.

In special cases, additional process or other loads such as refrigerated cases in a supermarket should be eliminated separately.

A significant reduction in annual energy use for any one eliminated load indicates an area where the charrette participants should investigate opportunities for energy savings. Conversely, a minimal reduction in annual energy use suggests that the particular load provides little opportunity for energy savings. Large loads related to occupants, plug loads, or process loads are often consequences of the building's programmatic requirements and leave little room for improvement.

Sensitivity Analysis

Sensitivity analysis consists of one or more sets of simulations that provide information about the sensitivity of annual building energy use to specific design parameters. Design parameters are basic properties of the building construction and geometry that can vary continuously or discretely over a range of values. Possible parameters are aspect ratio of the building footprint, window-to-wall area ratio, wall insulation R-value, window U-value, and infiltration rate. Sensitivity is indicated by the change in whole-building energy use per change in the given parameter.

One approach to sensitivity analysis is to perform several simulation runs over a range of parameter values. The whole-building energy use can then be extrapolated and interpolated to be plotted as a function of the given parameter. Figure F-9 shows an example using wall insulation R-value as the parameter.

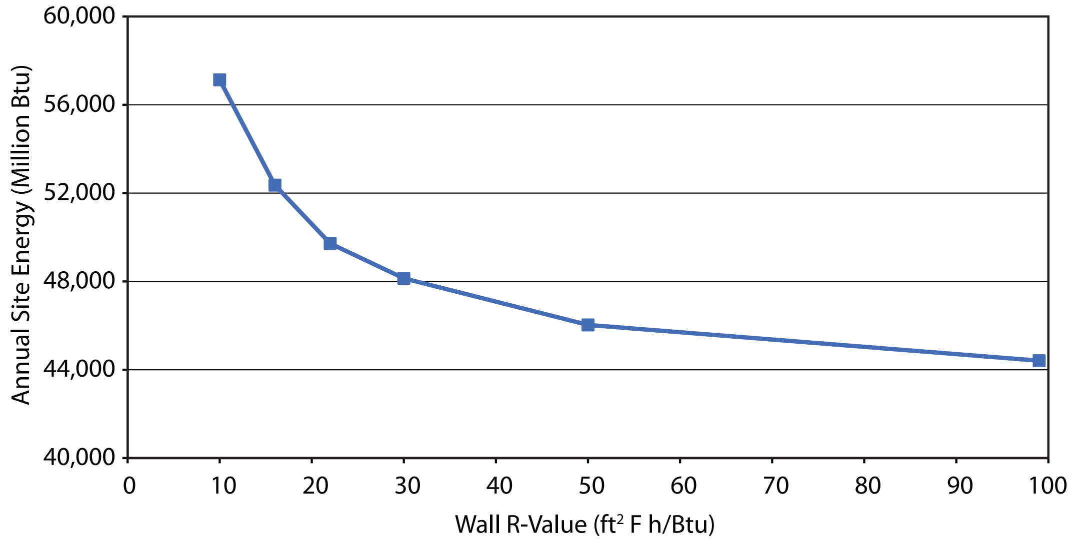

Figure F-9. Sensitivity Analysis of Wall R-Value

The curve gives an idea of the qualitative relationship between the parameter and energy use—in this case, the diminishing returns of increased insulation levels. Charrette participants can use this curve to estimate the optimal parameter value when taking into account the costs of increased insulation levels.

A related approach to sensitivity analysis that requires fewer simulation runs is to compare the baseline energy use to only two additional data points. The two simulations bracket the baseline parameter value by increasing it by a fixed value, e.g., 50%, in one run and decreasing it by the same value in the other run. The slope between the two extremes is a quantitative measure of the sensitivity. In Figure F-10, the slope indicates an energy saving of 540 million Btu/year per added R-value of wall insulation. This slope can be used to interpolate the energy savings for intermediate parameter values. Caution should be exercised when extrapolating beyond the two extreme values. As Figure F-9 demonstrates, the actual relationship between a parameter and energy use is not necessarily linear over a broad range.

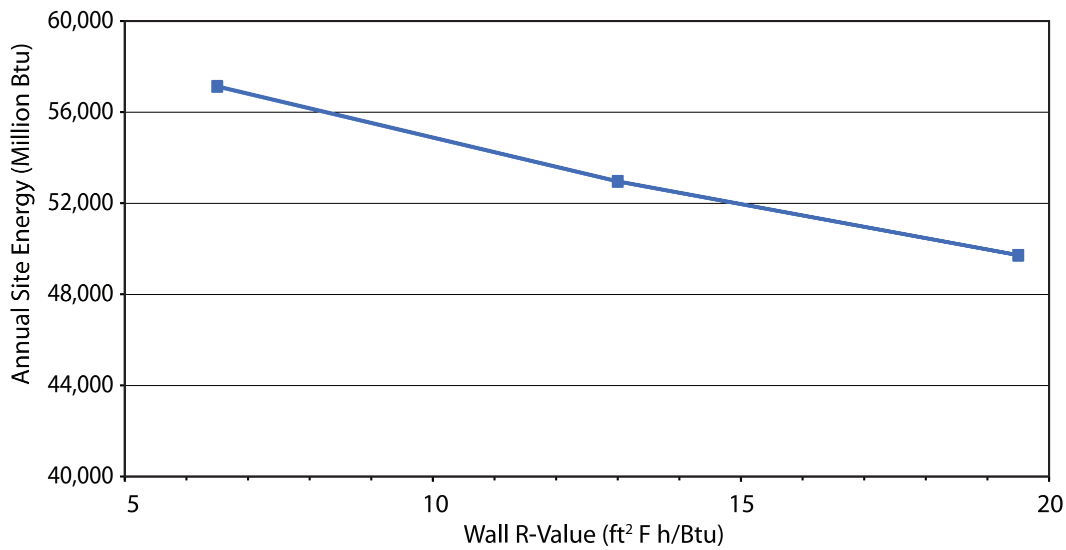

Figure F-10. Sensitivity Analysis of Wall R-Value

Energy Conservation Measure Analysis

An ECM analysis consists of a set of simulations that provide the following results:

- Potential energy savings for common ECMs
- Potential for onsite renewable energy generation
- Best-performing configuration of ECMs.

Like the load elimination parametric analysis, a metric such as annual site energy use or annual source energy use should be selected to compare the simulations. Figure F-11 shows an example chart for an ECM analysis.

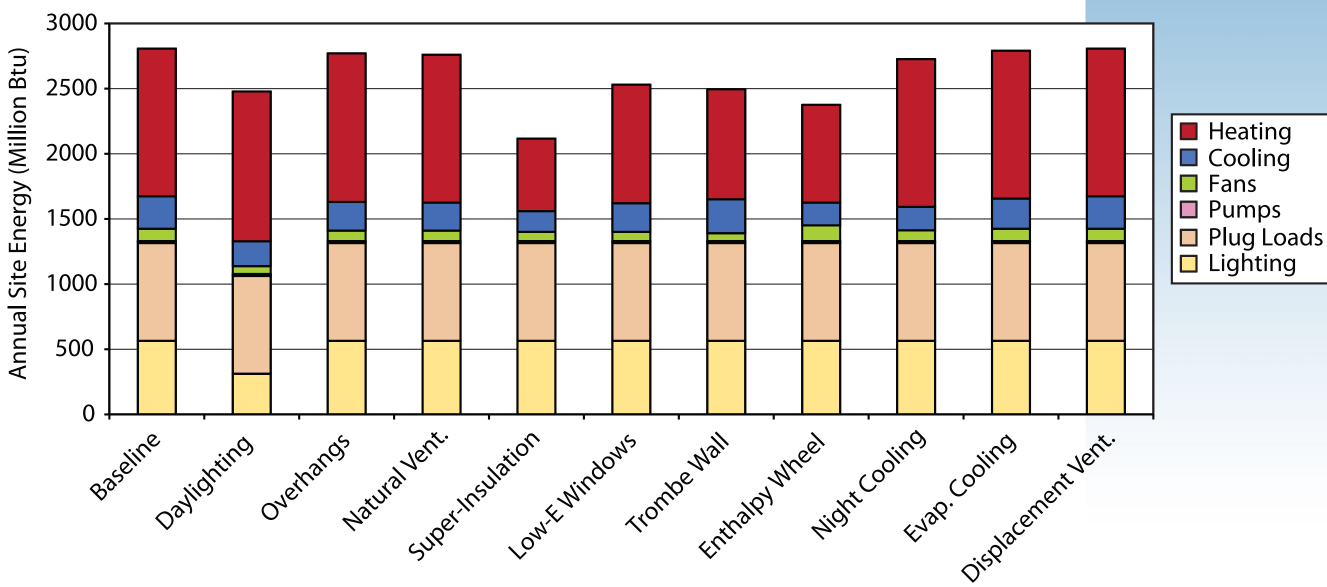

Figure F-11. Annual Site Energy Consumption for Baseline Building and ECMs

The list of ECMs will vary greatly by project. The results of the baseline analysis, load elimination parametric analysis, and sensitivity analysis may suggest favorable ECMs. Several common ECMs are listed below:

- **Extra Insulation.** Added insulation can reduce heating and cooling loads.
- **High-Performance Windows.** Several types should be explored.
- **Solar Control.** Use overhangs and fins to reduce solar gains in the summer when the sun is higher in the sky.
- **Tight Envelope.** Reducing infiltration of outside air can reduce heating and cooling loads.
- **Improved Lighting Design.** Better electric lighting design can reduce lighting power densities. Occupancy sensors can further reduce lighting energy use.
- **Daylight Integration.** Integrate daylighting with automatic dimming controls to reduce electric lighting loads and cooling loads.
- **Passive Solar Heating.** Integrated architectural devices such as sun spaces or Trombe walls can reduce heating loads and provide thermal comfort.
- **Reflective or Vegetated Roof.** White, light-colored, or vegetated roof systems can reduce heat gain in the summer to achieve annual energy savings in some climates.
- **Aspect Ratio and Orientation.** The basic shape of the building affects heating and cooling loads and can facilitate daylighting and passive solar heating.

- **Air-Side Economizer.** If not already required by code, an economizer can use outside air for cooling when conditions are favorable.
- **Natural Ventilation.** Uses air flow through windows and other openings to cool the building when conditions are favorable.
- **Night Cooling.** Precools the thermal mass of the building at night to reduce cooling loads during the day.
- **High-Efficiency Mechanical Equipment.** Once the building loads are reduced, high-efficiency equipment such as chillers, air conditioners, furnaces, boilers, water heaters, pumps, and fans can save energy. Explore nontraditional alternatives such as evaporative cooling, radiant heating or cooling, displacement ventilation, and low-pressure systems.
- **On-Site Renewable Energy Generation.** Photovoltaic panels generate electricity on site to offset building consumption.

A more comprehensive list is presented in Appendix G.

The best-performing individual ECMs should be integrated into an optimal configuration. The energy saving of the optimal configuration is a good starting point for goal setting. During the charrette, some ECMs may be discarded and others added as the design concept evolves.

Presenting Results

The final results of the various analyses, in the form of a report with tables and charts, represent considerable effort on the part of the consultant. Some thought should be given to how these results will be presented during the charrette.

All results must be available in advance and presented early in the first day of the charrette so participants can use this information as they develop designs. Make sure that sufficient time is reserved in the agenda for presenting results. Generally, if available, results should be presented in the following order:

- Historical analysis
- Baseline analysis
- Load elimination parametric analysis
- Sensitivity analysis
- ECM analysis.

When possible, the consultant should present the results so that he or she can answer any questions that might arise. The consultant should also prepare a written summary that includes all tables and charts and a brief interpretation of the results. The summary should be distributed with the other advance materials so the participants have time to digest all the results. The consultant should not overwhelm the participants with the technical details of the simulation. Providing a clear graphical presentation of the results is critical. Technical details should be put in appendices.

Setting Performance Goals

Setting achievable and understandable performance goals early in the design process is crucial to achieving high-performance buildings (Deru and Torcellini 2004; Torcellini et al. 2006). Goals distill the project vision and secure commitment from the design team. To ensure goals are successfully attained, keep these points in mind:

- Goals must be set early in the design process, when changes can be made without adding to the cost of the project.

- Goals must be well-defined. Each goal should include a measurable value that can be tested and verified throughout the project.
- Goals must be embraced by the design team. Everyone must buy in to the project vision and commit to the goals. Each goal must also have a champion on the design team.
- Goals must be maintained after the design stages into construction and commissioning.

The charrette is the ideal venue for setting performance goals. Because the charrette takes place at the beginning of the design process, there is no fixed design to preclude any goal (at least for new construction). The charrette is also one of the rare occasions when the owners, stakeholders, architects, engineers, and other experts are all together in the same room. With all the players present, goals can be more effectively negotiated. When a consensus is reached, the project team will have goals to which everyone can commit.

A predesign energy analysis is essential for setting attainable energy performance goals. Without analysis, energy performance goals are typically suggested by charrette participants based on previous experience with other projects. But because every project is a unique combination of program requirements, climate, and site, goals can quickly become arbitrary guesses. If, however, a predesign energy analysis has been performed, goals can be set with greater confidence because they are based on simulation results that are tailored to the specifics of the project.

The baseline and ECM analyses are probably the most useful for setting energy performance goals. The results of the ECM analysis forecast potential energy savings compared against the benchmark results of the baseline analysis.

Some examples of well-defined energy performance goals are:

- Annual site energy use intensity lower than 40 kBtu/ft^2
- Energy cost savings of at least 60% compared to a code minimum building
- Peak electrical demand lower than 5 kW
- At least 20% of the annual site energy needs are met with on-site renewable energy sources.

After the Charrette

Ideally, energy analysis will continue to play an important role in the succeeding stages of the design process. The simulation models developed during the predesign stage form the foundation for more detailed building models. As the design evolves, detailed models help the design team to refine and optimize the broad decisions that were made during the charrette. During the construction stage, additional simulations may be needed to address unanticipated design problems. In the postconstruction stage, detailed models can aid with commissioning to verify that the building is performing as designed.

Sample Building Program Questionnaire

This questionnaire should be completed by the building owners or architects according to the building program. The building program contains the functional requirements that form the basis for developing the building design. The instructions for completing the questionnaire should also be provided to the owner or architect. Projects with multiple buildings should complete a separate questionnaire for each building. A completed example is shown at the end of this appendix.

Building Program Questionnaire

Building Description	
Location:	Principal Building Activity:
Gross Floor Area (ft^2):	Number of Floors:
Building Energy Code: ☐ ASHRAE 90.1-_______ ☐ Title 24 ☐ 10CFR434 ☐ IBC ☐ Other	

Space Descriptions	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	

Utility Availability	
☐ Electricity Company:	Contact:
☐ Natural Gas Company:	Contact:
☐ Water Company:	Contact:
☐ Other Utility Company:	Contact:

Instructions for Completing the Building Program Questionnaire

Building Description

Location – The location of the building site, generally the city and state, is sufficient. The consultant will obtain the latitude and longitude and weather data for the location.

Principal Building Activity – The main activity of the building corresponding to the Principal Building Activity categories used in the 1999 Commercial Buildings Energy Consumption Survey (CBECS 1999). The categories for Principal Building Activity are:

- Education
- Food Sales
- Food Service
- Health Care (Inpatient)
- Health Care (Outpatient)
- Lodging
- Mercantile (Retail, other than mall)
- Mercantile (Enclosed and Strip Malls)
- Office
- Public Assembly
- Public Order and Safety
- Religious Worship
- Service
- Warehouse and Storage
- Other
- Vacant

Gross Floor Area – The total floor area of the building, including all floors.

Number of Floors – The number of floors above grade and below grade, listed separately.

Building Energy Code – The governing energy code for the building that defines the minimum requirements for energy, such as insulation levels and HVAC efficiency. The consultant is responsible to determine the code requirements and apply them to the simulation models. For most commercial buildings, the energy code is ASHRAE Standard 90.1 (ASHRAE 2007), but the year of the standard must be specified: 1989, 1999, 2001, 2004, or 2007. In California, the energy code is Title 24 (CEC 2004; 2005), which is stricter than ASHRAE 90.1. For federal government buildings, the energy code is 10CFR434 (2004), which is similar to ASHRAE 90.1. The International Building Code (IBC) (ICC 2006) is another energy code.

Space Descriptions

The space descriptions allow the space uses to be more finely delineated beyond the Principal Building Activity. The descriptions are especially important for mixed-use buildings.

Activity – The main activity in the space. Select from one of the Principal Building Activity categories.

Gross Floor Area – The total floor area dedicated to this space use. The area can be specified as square footage or percentage of the total building floor area.

Occupancy/Operation Hours – The expected hours of operation and occupancy for the space. If left blank, the energy consultant will assume default values based on the Principal Building Activity. If the operation is unusual, some notes should be made here. For example, the space may be operated significantly more or less than might be expected. Notes can also be made here for unusual space conditioning requirements. An art gallery space, for instance, might have strict requirements for temperature and humidity control.

Special Equipment – Notes for special equipment or loads in the space. For example, refrigeration cases in a supermarket, or a large number of server racks in an office space, qualify as special equipment.

Utility Availability

Availability and contact information for the local utility companies. The energy consultant is responsible to obtain the relevant utility tariffs for calculating energy and water costs.

Building Program Questionnaire: Completed Example

Building Description	
Location: *Denver, Colorado*	Principal Building Activity: *Office*
Gross Floor Area (ft^2): *12,000 ft^2*	Number of Floors: *2*
Building Energy Code: ☒ ASHRAE 90.1-2007 ☐ Title 24 ☐ 10CFR434 ☐ IBC ☐ Other	

Space Descriptions	
Activity: *Office*	Gross Floor Area (ft^2 or %): *70%*
Occupancy/Operation Hours: *typical office*	
Special Equipment: *none*	
Activity: *Food Services*	Gross Floor Area (ft^2 or %): *15%*
Occupancy/Operation Hours: *restaurant hours: 11 AM-9 PM, Mon-Sat*	
Special Equipment: *cooking equipment*	
Activity: *Retail*	Gross Floor Area (ft^2 or %): *15%*
Occupancy/Operation Hours: *open 7 days/week*	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	
Activity:	Gross Floor Area (ft^2 or %):
Occupancy/Operation Hours:	
Special Equipment:	

Utility Availability	
☒ Electricity Company: *Xcel Energy*	Contact: *Bob Smith, 800-555-1234*
☒ Natural Gas Company: *Xcel Energy*	Contact: *John Jacobs, 800-555-1234*
☒ Water Company: *Denver Water*	Contact: *Judy Jones, 800-555-1234*
☐ Other Utility Company:	Contact:

Annotated Bibliography

10CFR434. (2004). Code of Federal Regulations 10 – Energy. Washington, D.C.: Office of the Federal Register National Archives and Records Administration.

The Federal Energy Code required for all federal government buildings.

ASHRAE. (2003). *ASHRAE GreenGuide*. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Detailed description of the energy design process including the predesign phase. The many "GreenTips" sprinkled throughout the guide are possible ECMs to investigate in the predesign analysis.

ASHRAE. (2004). *Advanced Energy Design Guide for Small Office Buildings*. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2004.

Good description of the energy design process, including the predesign phase.

ASHRAE. (1989; 1999; 2001; 2004; 2007). *Energy Standard for Buildings Except Low-Rise Residential Buildings*. ANSI/ ASHRAE/IESNA Standard 90.1-1989, -1999, -2001, -2004, -2007. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers.

The most common energy code for commercial buildings. The applicable year can vary by state or municipality.

CBECS. (1999). *1999 Commercial Buildings Energy Consumption Survey: Consumption and Expenditures Tables*. Washington, D.C.: Energy Information Agency. Available at www.eia.doe.gov/emeu/cbecs/. Last accessed May 6, 2009.

CEC. (2004). *Nonresidential Alternative Calculation Method (ACM) Approval Manual*. P400-03-004F. Sacramento, CA: California Energy Commission.

Part of the California energy code.

CEC. (2005). *Nonresidential Compliance Manual for California's 2005 Energy Efficiency Standards*. CEC-400-2005-006-CMF. Sacramento, CA: California Energy Commission.

Part of the California energy code.

Deru, M.; Torcellini, P. (2004). "Improving Sustainability of Buildings Through a Performance-Based Design Approach." World Renewable Energy Congress VIII and Expo, Denver, CO, August 29–September 3, 2004. Available at www.nrel.gov/docs/fy04osti/36276.pdf. Last accessed May 6, 2009.

Discusses the importance of setting clear and measurable design goals for performance.

Hayter, S.J.; Torcellini, P.A.; Hayter, R.B.; Judkoff, R. (2001). "The Energy Design Process for Designing and Constructing High-Performance Buildings." Clima 2000/Napoli 2001 World Congress - Napoli (I), September 15–18, 2001.

Good overview of the energy design process, including predesign energy analysis.

ICC. (2006). *2006 International Building Code*. Washington, D.C.: International Code Council.

Ternoey, S.; Bickle, L.; Robbins, C.; Busch R.; McCord, K. (1985). *The Design of Energy-Responsive Commercial Buildings*. New York: John Wiley & Sons.

Good explanation of the value of predesign analysis. Good description of load elimination parametric analysis with several examples. Information on simulation programs is very outdated.

Torcellini, P.; Pless, S.; Deru, M.; Griffith, B.; Long, N.; Judkoff, R. (2006). *Lessons Learned from Case Studies of Six High-Performance Buildings*, NREL/TP-550-37542. Golden, CO: National Renewable Energy Laboratory. Available at www.nrel.gov/docs/fy06osti/37542.pdf. Last accessed May 6, 2009.

Appendix G: Predesign Energy Analysis Procedures

This appendix is intended to familiarize the energy consultant with the procedures for performing a predesign energy analysis for a high-performance building project. Five types of predesign energy analysis were introduced in Appendix F: baseline analysis, load elimination parametric analysis, sensitivity analysis, ECM analysis, and utility bill analysis. The consultant should become acquainted with the expectations for results laid out in Appendix F. We assume that the energy consultant has experience with building simulation, but not necessarily with high-performance projects or predesign energy analysis. This appendix may also be useful to the owner, architect, or charrette steering committee for gaining further insight into predesign energy analysis and the work of the energy consultant.

The analysis procedures described here focus on analyzing individual buildings. If the project is for multiple buildings (such as a campus), we recommend performing separate analyses for each building. Some of the same inputs, such as weather data and utility tariffs, will be shared by all the buildings.

Analysis Tools

The primary tool for predesign energy analysis is a building energy simulation program. The program must be able to perform an annual simulation with time steps of one hour or less. We strongly recommend using a whole-building energy simulation program for all analyses. This type of analysis is essential for high-performance projects because it is the only way to capture the complex interactions between building loads and systems. Some popular whole-building energy simulation programs are EnergyPlus, DOE-2, TRNSYS, and ESP-r.

Other specialized software tools may be appropriate for analyzing a particular subsystem of a building, such as windows, airflow, daylighting, HVAC component performance, or on-site renewable energy generation. Results from a subsystem analysis can often become inputs into the whole-building simulation.

A comprehensive list of tools for building-related energy analysis is on DOE's Building Energy Software Tools Directory at www.energytoolsdirectory.gov.

Baseline Simulation Model

Developing a baseline simulation model is a prerequisite step to performing energy analyses. This model represents the building with no high-performance features. Because the architecture and geometry have not yet been decided, the baseline model is a simple box that meets the owners' program requirements and satisfies the minimum energy code requirements.

ASHRAE Standard 90.1 is the most commonly used commercial building energy code. This document is the foundation for the minimum code requirements for the majority of buildings in the United States, although each locality might have a different year of the code in place (ASHRAE 1989; 1999; 2001; 2004; 2007). The federal building code (10CFR434 [2004]) and the International Building Code (ICC 2006), as well as most state and city codes, are based on ASHRAE 90.1 with some modifications. California's Title 24 (CEC 2004; 2005) is an energy code that is distinct from ASHRAE 90.1, and is generally considered more stringent.

The 2004 and 2007 editions of ASHRAE 90.1 contain an Appendix G, which provides a performance rating method for comparing a proposed design against a *proposed design baseline*. Appendix G spells out the simulation requirements for creating the proposed design baseline model. As the name suggests, the proposed design baseline assumes there is already a "proposed design." For predesign energy analysis during a charrette, there is no design yet. Unfortunately, ASHRAE 90.1, Appendix G does not provide any guidance in this case.

The purpose of the present text (coincidentally, also contained in an Appendix G) is to fill the gap for predesign energy analysis in ASHRAE 90.1, Appendix G. A set of tables, G-2 through G-21, is included at the end of this appendix to help fill in the missing simulation parameters. Nonetheless, ASHRAE 90.1 is still an essential document for developing a baseline simulation model. ASHRAE 90.1 (and its Appendix G) will be cited in the many cases that it does provide useful inputs for the predesign baseline model.

The baseline simulation model requires the synthesis of a variety of information about the building including weather, building form, building fabric, internal loads, infiltration, HVAC system, and utility tariffs. Some of the required information is found in the Building Program Questionnaire (see Appendix F) as completed by the owner, architect, or engineer. One of the key responses in the Questionnaire is the Principal Building Activity, which determines many of the default simulation parameters found in the tables at the end of this appendix (Tables G-3 through G-21). The remaining information is contained in the applicable building energy code or ASHRAE 90.1, Appendix G. Instructions for developing the various parts of the baseline model are described below. See Table G-2 for an overview of most baseline simulation parameters.

Weather

A full year of weather data is required for all predesign energy analyses. Weather is one of the primary driving forces for the simulation, and should closely reflect the actual climatic conditions the building will experience. The data must be in hourly time steps, or shorter, if the simulation program can handle it.

Hourly weather data for many locations throughout the United States and the world are published as ready-made weather files intended for use with building simulation programs. The largest sets of weather files include the *Typical Meteorological Year, Revision 3—TMY3* (Wilcox and Marion 2008) for locations in the United States, the *Canadian Weather for Energy Calculations—CWEC* (WATSUN Simulation Laboratory 1992) for locations in Canada, and the *International Weather for Energy Calculations—IWEC* (ASHRAE 2001) for other international locations. TMY3, CWEC, and IWEC weather files are available in several formats to suit different simulation programs. A large collection of weather files from several sources can be found on the EnergyPlus Web site (DOE 2009).

If you cannot readily find a weather file for the building location in the required format for your simulation program, there are several possible solutions. If a weather file is available in a format for another program, the data can often be converted from one format to another with a utility program. Another approach is to choose a weather file that is located as near as possible to the proposed site or at least shares similar climatic conditions. There are also tools to generate a custom weather file based on a rough interpolation between nearby available sites.

Some projects might have weather data that have been measured on site. Measured weather data have the benefit of more accurately predicting some weather variables, such as patterns of wind speed and wind direction, which can depend greatly on the peculiarities of the site and surrounding terrain. Measured data can also be useful for calibrating a simulation model of a building that is to be renovated.

Historical and near-real time weather data for many sites can also be downloaded or requested by e-mail from several sources. The NREL Real-Time Weather Server (NREL 2009) connects to the National Weather Service network to access more than 4,000 weather stations around the world. Data requests are automatically sent to the user by e-mail. The National Climatic Data Center (NCDC 2009) and WeatherBank (2009) also offer Web access to near real-time weather data. Once the raw weather data are obtained, the consultant must manually convert the data into the appropriate format for the simulation program, or find a utility program to do the job.

Measured weather data sets, from on-site measurements or other sources, all share the same disadvantage. The data do not represent a typical meteorological year and should not be relied on for design purposes. The ideal solution is to produce a hybrid weather file that uses general observations from the on-site measurements to modify the typical year weather file. This will produce a better result.

Form

The building form is the architectural geometry of the building design. Form includes orientation and shape of the envelope, location and size of the windows, and zoning of the interior spaces. In the predesign stage, the form has not yet been determined. The Building Program Questionnaire provides the gross floor area of the building and the number of floors, but nothing else about form. ASHRAE 90.1, Appendix G assumes that the building form has already been designed and does not offer recommendations for predesign baseline models.

To fill the gap, Tables G-2 and G-3 in this appendix provide the necessary guidance for predesign form parameters. Table G-2 describes the general geometry for the baseline model. The shape is a square footprint that meets the required gross floor area and the number of floors. The sides of the square face the cardinal directions. The total window area is distributed equally on all exterior walls. Overhangs and horizontal glazing (e.g., skylights) are not included in the baseline model.

Table G-3 further determines the details of the geometry according to the Principal Building Activity specified on the Questionnaire. Table G-3 sets the thermal zoning of the interior space. For retail buildings and small warehouses the building is modeled as one zone per floor. For all other building types the interior spaces are modeled using a scheme of five thermal zones per floor: four perimeter zones and one core zone (see Figure G-1). Table G-3 also sets the floor-to-floor height, window-to-wall ratio, depth of the perimeter zone, and height of the plenum zone, if applicable.

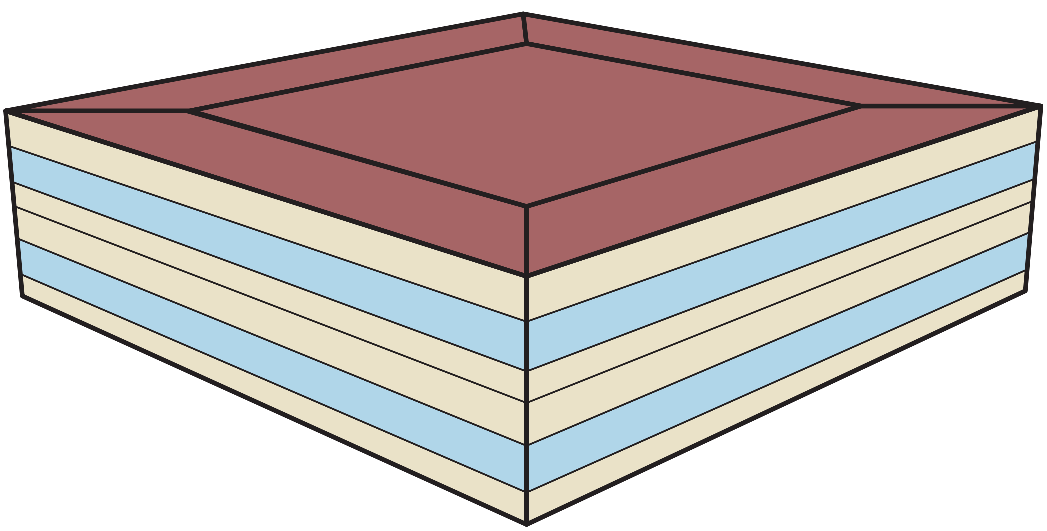

Figure G-1. Representation of a Predesign Baseline Model With Five Zones per Floor

In ASHRAE 90.1, Appendix G, the proposed design baseline model is simulated at four different orientations to achieve a solar-neutral result. The final energy result is the average of the results from the four orientations. For the predesign baseline, the square model is inherently solar neutral, so there is no need to simulate the building at multiple orientations; only one simulation is necessary.

Fabric

The building fabric is the construction composition of walls, windows, roofs, floors, and internal mass. As with form, the fabric has not yet been determined in the predesign stage. The baseline model assumptions for exterior walls, roofs, and floors come from Table G3.1 in ASHRAE 90.1, Appendix G. The U-value or R-value for exterior walls, windows, roofs, and floors comes from the minimum code standards specified in ASHRAE 90.1 (2004; 2007), Tables 5.5-1 to 5.5-8 according to the climate zone of the site location. Interior partitions, internal mass, and window shading devices (shades and blinds) are not included in the baseline model.

Infiltration

Infiltration is a heat gain or loss caused by outside air entering the building unintentionally, e.g., through seams in the building envelope. Infiltration rates are notoriously difficult to estimate. Nonetheless, here are two recommended options for establishing infiltration rates for the baseline model: one option is simple; the other is more detailed.

The simple option is to schedule the infiltration rate at 0.3 air changes per hour (ACH) for each exterior zone at all times when the HVAC system fans are not drawing outside air. When the fans are drawing outside air, schedule the infiltration rate at 0.075 ACH (25% of 0.3).

The detailed option is to first determine a highly pressurized reference value at 0.3 inches of water (75 Pa). The reference value, ACH_{ref}, is calculated separately for each exterior zone using the equation below:

$$ACH_{ref} = 0.4\ CFM/ft^2 * (\text{exterior envelope area}) * 60 / (\text{zone volume})$$

Or in SI units:

$$ACH_{ref} = 2\ L/s/m^2 * (\text{exterior envelope area}) * 3600 / (\text{zone volume})$$

The reference value is then converted to an infiltration rate for normal leakage with low pressurization at 0.0161 inches of water (4 Pa) for when the HVAC system fans are not drawing outside air.

$$ACH_{low\ press} = ACH_{ref} * (4 / 75)^{0.65} = ACH_{ref} * (0.149)$$

When the fans are drawing outside air, schedule the infiltration rate at 25% of $ACH_{low\ press}$.

Internal Loads

Internal loads consist of heat gains from occupants, electric lights, and plug-in equipment (plug loads). The Building Program Questionnaire (completed by the owner) should contain estimates for both occupancy and operation. If this information is not available, default values for peak loads in occupancy, ventilation, and plug loads should be taken from Table G-4 according to the Principal Building Activity. The electric lighting power density is set by ASHRAE 90.1, Section 9 according to the different space types in the building (similar to Principal Building Activity). Schedules for all internal loads should be taken from the tables referred to in Table G-5 according to the Principal Building Activity.

In all cases, if the Building Program Questionnaire has better information, or the owner, architect, or engineer has better knowledge about the peak loads or the intended schedules of operation, these values should be used instead of the default values. This more accurately reflects how the building will be used. However, if there is some doubt, the schedules in the tables make a good default.

Usually the space uses listed in the Building Program Questionnaire cannot easily be mapped to a simple five-zone model of the interior space. Instead, the occupancy and plug load schedules must be averaged by area into a single blended-use schedule that is applied to all occupied zones.

HVAC System

The HVAC system provides all space conditioning and service hot water needs for the building. Refer to ASHRAE 90.1, Appendix G for all characteristics of the baseline model HVAC system, including system type, system sizing, component efficiency, temperature set points, and ventilation and economizer requirements.

Utility Tariffs

A utility tariff is a set of rules for calculating utility bills and is essential for calculating annual energy costs and cost savings. Energy cost savings may be used for goal setting and constitute the principal metric for earning LEED points under the "Optimize Energy Performance" and "On-Site Renewable Energy" credits.

If the names of the utility companies are provided on the Building Program Questionnaire, the utility tariffs can usually be obtained from the company Web site or by contacting a company representative. Another resource for acquiring utility tariffs is the Tariff Analysis Project (LBNL 2008) Web site hosted by Lawrence Berkeley National Laboratory.

Predesign Energy Analyses

Once the baseline simulation model is completed, the model can be used to perform all the simulation-based predesign energy analyses. The content below focuses on the simulation procedures for each type of analysis. (See Appendix F for full descriptions of the different types of analyses, their purposes, and how to use meaningful charts and tables to organize and present results.)

Baseline Analysis

Baseline analysis characterizes the energy uses and costs that would be expected if the building were built with no high-performance features. The baseline analysis is performed by using the baseline model to run one annual simulation. All the required results should be readily available from the outputs of the simulation program. Some results may require a minimal amount of postprocessing before they can be presented as a chart or table. The baseline analysis has the most options for results, so be sure to study What To Ask of the Energy Consultant in Appendix F and discuss with the charrette organizers. At minimum, the results for the annual energy use, the annual energy cost, and the breakdown of energy end uses should be prepared for presentation.

Load Elimination Parametric Analysis

Load elimination parametric analysis shows the impact of individual loads on annual energy use. The analysis consists of a set of annual simulation runs. Each simulation run is a modification of the baseline model that sequentially eliminates a specific load. The standard list of loads to be eliminated includes:

- **Wall R = 1000**. The wall insulation level (R-value) is set to a very high number.
- **Roof R = 1000**. The roof insulation level (R-value) is set to a very high number.
- **Floor R = 1000**. The floor insulation level (R-value) is set to a very high number.
- **Window R = 1000**. The window insulation level (R-value) is set to a very high number.
- **Window τ = 0**. The window transmittance (τ) is set to zero to eliminate solar gains.
- **No Infiltration**. The rate of outside air infiltration is set to zero.
- **No Ventilation**. The rate of outside air ventilation is set to zero.
- **No Occupants**. The internal heat gains caused by people are set to zero.

- **No Lighting**. Electric lighting is set to zero.
- **No Plug Loads**. Plug-in equipment loads are set to zero.

The results of the load elimination parametric analysis should be presented in a single chart that compares all the elimination runs against the baseline run. The loads that significantly affect the annual energy use can be targeted for improvement with an appropriate ECM during the ECM analysis. For instance, significant energy savings for the "Window R = 1000" case indicates that it is a good idea to try triple- or quadruple-pane windows as an ECM.

Sensitivity Analysis

Sensitivity analysis consists of one or more sets of simulation runs that provide information about the sensitivity of annual energy use or cost to specific design parameters. Design parameters are basic properties of the building construction and geometry that can vary continuously over a range of values. Possible parameters include aspect ratio, window-to-wall area ratio, wall insulation R-value, window U-value, and infiltration rate. Sensitivity is indicated by the change in whole-building energy use per change in the given parameter.

Use the results of the load elimination parametric analysis to inform the selection of parameters for the sensitivity analysis. Load elimination parametric analysis achieves a crude estimation of sensitivity by using an all or nothing approach. By eliminating a load, the analysis reveals if there is any sensitivity to the related parameter. If a parametric elimination case does not show a significant reduction in energy consumption, we already know that the building is not very sensitive to that parameter, and there is no need to perform a sensitivity analysis on that parameter.

Load elimination parametric analysis, however, does not help to quantify the sensitivity. The procedure for sensitivity analysis is to perform several simulation runs over a range of parameter values. The slope of the curve defines the sensitivity to the parameter.

Energy Conservation Measure Analysis

ECMs are specific technologies or design strategies that are intended to save energy. ECM analysis quantifies the potential energy savings for an individual ECM or combination of ECMs.

The first step for the ECM analysis is to make a list of ECMs that should be evaluated. The owner and architect will likely have some ideas for ECMs that they would like to try out. There is also a short list of ECMs that are almost always winners. This includes tight building construction, overhangs, and daylighting controls. An extensive list of ECMs used in high-performance projects is shown in Table G-1 to generate ideas. This list is by no means exhaustive; creative ECMs are always possible.

Once the list of ECMs has been prepared, the next step is to evaluate them with simulations. As with the other types of analyses, the starting point is the baseline model. For some simple ECMs, such as extra insulation, modifying the baseline model and rerunning the simulation might require only minor changes. Other ECMs, such as building form changes to facilitate daylighting and passive solar heating, can require additional model development that results in a new simulation model that is quite different from the baseline model.

Table G-1. Some Suggested ECMs

ECM	Purpose	Simulation Notes
Form		
Window size and placement	Reduce solar gains; reduce heat losses.	Reduce glazing on east and west walls.
Overhangs	Reduce solar gains in the summer.	Mount horizontally above windows.
Fins	Reduce solar gains at certain times, usually in morning or afternoon.	Mount vertically on the sides of windows.
Daylighting design	Replace electric lighting with natural daylighting to reduce energy use and waste heat from lights.	Plenty of southern exposure (for the northern hemisphere) with sufficient windows. Most zones are within 15 ft of perimeter. Stairstep design. No energy savings unless used with daylighting controls to automatically dim the electric lights.
Passive solar heating design	Provide passive solar heating during the day.	Plenty of south-facing windows (for the northern hemisphere) with sufficient transmittance and internal mass inside to absorb heat. Zone temperatures must be allowed to float.
East–west orientation and increased aspect ratio	Minimize solar gains. Optimize for daylighting and passive solar heating.	Must be combined with daylighting design and/or passive solar to achieve energy savings.
Sunspace	Provide passive solar heating during the day.	Passive solar heating zone. More glazing and internal mass than a typical zone. Heat can circulate to other zones. Also can be sealed off from rest of building because the temperature falls at night. Sunspace temperature must be allowed to float.
Natural ventilation design	Design to take advantage of prevailing winds to ventilate and cool when outside temperatures are appropriate.	Requires manual or automatic operable windows. May require a separate air flow analysis.
Fabric		
Extra insulation, exterior walls	Reduce heat gains and losses to the outside.	Increase the R-value of the construction.
Extra insulation, roof	Reduce heat gains and losses to the outside.	Increase the R-value of the construction.
Extra insulation, under slab	Reduce heat gains and losses to the ground.	Increase the R-value of the construction.
Extra insulation, foundation	Reduce heat gains and losses to the ground.	Increase the R-value of the construction. May be difficult to model.
Better windows	Reduce heat gains and losses to the outside.	Use triple- or quadruple-pane insulated windows and/or low-e.
Tight envelope construction	Reduce heat gains and losses caused by infiltration.	Reduce the infiltration ACH.
Trombe wall	Provide passive solar heating with a lag so that heat is delivered at night.	Should be used with overhangs or a removable cover to prevent heating in the summer. Use a selective surface or double-pane glazing for better performance.

Table G-1. (continued)

ECM	Purpose	Simulation Notes
Double facade	Reduce heat gains and losses to the outside.	Model as a facade zone with a large window area and interzone windows to the building zones.
Reflective roof	Reduce solar heat gains.	Increase the roof solar reflectance.
Green roof	Reduce heat gains and losses to the outside.	Roof planted with grasses or plants. Difficult to simulate. Increase insulation and thermal mass.
Internal Loads		
Optically efficient electric lighting fixtures	Reduce energy use and waste heat from lights.	Reduce the required lighting power density to achieve the same light levels.
Electric lighting located in return air stream	Reduce waste heat from lights.	Heat from lights never enters the zone.
ENERGY STAR electric equipment	Reduce energy use from plug loads.	Reduce the plug load power density.
Occupancy sensors for lights and equipment	Reduce energy use from lights and plug loads.	Match lighting and plug load schedules to occupancy schedules.
Daylighting		
Daylighting controls	Replace electric lighting with natural daylighting to reduce energy use and waste heat from lights.	Use automatic dimming controls to reduce electric lighting when natural daylight is sufficient. Use light-colored surfaces to allow light to penetrate deeper into the zone. Use for any zone with a source for daylight.
Light shelves	Allow daylight to penetrate deeper into the interior.	Must be paired with a window. No energy savings unless used with daylighting controls to automatically dim the electric lights.
Skylights	Allow daylight into core spaces.	No energy savings unless used with daylighting controls to automatically dim the electric lights.
Tubular daylighting devices	Allow daylight into core spaces.	No energy savings unless used with daylighting controls to automatically dim the electric lights.
Clerestory windows	Allow daylight into core spaces. Also avoid glare.	No energy savings unless used with daylighting controls to automatically dim the electric lights.
HVAC System		
HVAC system type	Air system or water system.	
More efficient fans	Reduce fan energy use.	Decrease the fan power.
More efficient pumps	Reduce pump energy use.	Decrease the pump power.
Variable-speed fans	Reduce fan energy use.	Fan power varies with system demand.
Variable-speed pumps	Reduce pump energy use.	Pump power varies with system demand.
Larger ducts	Reduce fan energy use by reducing system pressure drop.	Decrease the pressure drop for the fan.
Larger pipes	Reduce pump energy use by reducing system pressure drop.	Decrease the pressure drop for the pump.
High-efficiency chiller	Reduce chiller energy use.	
High-efficiency boiler	Reduce boiler energy use.	
High-efficiency furnace	Reduce furnace energy use.	
High-efficiency water heater	Reduce water heater energy use.	
Instantaneous water heater	Reduce water heater standby losses.	

Table G-1. (continued)

ECM	Purpose	Simulation Notes
Heat pump water heater		
Evaporative cooler	Cool air by adding humidity.	Effective in dry climates.
Ground-source heat pump		
Nighttime cooling		
Radiant heating	Provide space heating radiantly.	Lower thermostat heating set points because radiant heat is more comfortable.
Precooling	Reduce on-peak cooling energy use.	
Energy recovery ventilation	Recover sensible and latent energy from exhaust air.	
Displacement ventilation		
Under-floor air distribution		
Ice storage system	Produce and store ice during off-peak hours for cooling use during peak hours.	May not be an energy saving measure, but can be a cost saving measure.
Solar hot water system	Use solar collectors to heat water to offset hot water consumption.	Must be combined with a storage tank. Different types of solar collectors are available.
On-Site Energy Generation		
Photovoltaic system	Generate electricity to offset consumption.	
Wind turbine	Generate electricity to offset consumption.	
Microturbine	Generate electricity and waste heat to offset consumption.	Combine with a water tank to store recovered waste heat.
Fuel cell	Generate electricity and waste heat to offset consumption.	Combine with a water tank to store recovered waste heat.

When considering on-site energy generation, it is a good idea to check with the electricity utility company to determine if it has agreements for grid interconnection and net metering.

Utility Bill Analysis

Utility bill analysis uses the utility billing history from an existing building to characterize energy use and help set performance goals. It can be used to illustrate monthly trends or calibrate a baseline model. Utility bills from recent years are usually available from the owner or can be downloaded from the utility company Web site. Utility bills provide numbers for monthly consumption and cost. Demand charges are also included if part of the tariff, and can be treated like simulation results from the baseline model and displayed in a simple chart.

Baseline Model Parameters and Schedules

Table G-2. Baseline Input Determination

	Parameter	Input Source
Program	Building Name	Building Program Questionnaire
	Principal Building Activity	Building Program Questionnaire
	Location (city, state, latitude, longitude, elevation)	Building Program Questionnaire
	Weather file	Building Program Questionnaire
	ASHRAE 90.1 climate zone	Building Program Questionnaire
	Available energy types	Building Program Questionnaire
	Relevant energy code	More stringent of ASHRAE 90.1-2007 or local building codes
Form	Gross floor area	Building Program Questionnaire
	Number of floors	Building Program Questionnaire
	Aspect ratio	Square building with sides facing cardinal directions
	Window-to-wall ratio	Table G-3
	Window locations	Evenly distributed on all exterior walls
	Shading geometry	None
	Azimuth	Square building with sides facing cardinal directions
	Thermal zoning	Table G-3
	Perimeter zones	Table G-3
	Core zones	Table G-3
	Return plenums	Table G-3
	Floor-to-floor height	Table G-3
	Glazing sill height	3.6 ft (1.1 m)
Fabric	Exterior walls	
	Constructions	90.1-2007 Table G3.1
	U-value or R-value	90.1-2007 Tables 5.5-1 to 5-5.8
	Dimensions	Based on inputs from form (above)
	Tilts and orientations	Vertical and facing four cardinal directions
	Roof	
	Construction	90.1-2007 Table G3.1
	U-value or R-value	90.1-2007 Tables 5.5-1 to 5-5.8
	Dimensions	Based on inputs from form
	Tilts and orientations	Horizontal
	Window	
	Dimensions	Based on exterior wall dimensions and window-to-wall ratio
	U-value	90.1-2004 Tables 5.5-1 to 5-5.8
	SHGC	90.1-2004 Tables 5.5-1 to 5-5.8
	Foundation/ground floor	
	Foundation type	Slab-on-grade
	Construction	90.1-2007 Table G3.1
	F-factor or R-value	90.1-2007 Tables 5.5-1 to 5-5.8
	Dimensions	Based on inputs from form (above)

Table G-2. (continued)

	Parameter	Input Source
Fabric (continued)	Interior partitions	None
	Construction	None
	Dimensions	None
	Internal mass	None
	Construction	None
	Dimensions	None
	Thermal properties	None
Infiltration	Infiltration	See text
	Schedules	Opposite of fan schedule (see below)
Internal Loads	Lighting	
	Power densities	90.1-2007 Section 9
	Schedule	See Table G-5
	Plug loads	
	Power densities	Table G-4
	Schedules	See Table G-5
	Occupancy	
	Number of people	Table G-4
	Schedules	See Table G-5
	Service hot water	
	Equipment	90.1-2007 Table G3.1
	Schedules	See Table G-5
HVAC	System type	90.1-2007 Table G3.1.1A/B
	Heating type	90.1-2007 Table G3.1.1A/B
	Cooling type	90.1-2007 Table G3.1.1A/B
	Fan control type	90.1-2007 Table G3.1.1A/B
	Distribution and terminal units	90.1-2007 Table G3.1.1A/B
	HVAC sizing	90.1-2007 Section G3.1.2.2
	Air conditioning	90.1-2007 Section G3.1.2.2
	Heating	90.1-2007 Section G3.1.2.2
	HVAC efficiency	90.1-2007 Sections G3.1.2 & G3.1.3
	Air conditioning	90.1-2007 Sections G3.1.2 & G3.1.3
	Heating	90.1-2007 Sections G3.1.2 & G3.1.3
	HVAC control	
	Supply air temperature	90.1-2007 Section G3.1.3
	Chilled water supply temperatures	90.1-2007 Section G3.1.3
	Hot water supply temperatures	90.1-2007 Section G3.1.3
	Set point schedules	See Table G-5
	Economizers and heat recovery	90.1-2007 Section G3.1.2
	Ventilation requirements	Table G-4
	Fan schedules	See Table G-5
	Supply fan power	90.1-2007 Sections G3.1.2 & G3.1.3
	Supply fan volumetric flow rate	90.1-2007 Sections G3.1.2 & G3.1.3

Table G-2. (continued)

	Parameter	Input Source
HVAC (continued)	Supply fan pressure drop	90.1-2007 Sections G3.1.2 & G3.1.3
	Pump power	90.1-2007 Section G3.1.3
Utility Rates	Electricity	
	Demand rate ($/kW)	Based on location
	Energy ($/kWh)	Based on location
	Service charges ($/month)	Based on location
	Taxes (% of total)	Based on location
	Natural Gas	
	Gas utility rates (virtual)	Based on location
	Energy ($/therm [$/GJ])	Based on location
	Service charges ($/month)	Based on location
	Taxes (% of total)	Based on location

Table G-3. Baseline Building Form Parameters

Principal Building Activity	Floor-to-Floor Height[1] (ft)	Plenum Height[1] (ft)	Zones[1]	Perimeter Zone (ft)	Window-to-Wall Ratio
Office	13	4	5	15	0.40 [2]
Warehouse (<30,000 ft²)	15	N/A	1	N/A	0.03 [3]
Warehouse (≥30,000 ft²)	20	N/A	5	20	0.03 [3]
Education (primary)	13	4	5	N/A	0.18 [3]
Education (secondary and university)	13	4	5	20	0.18 [3]
Retail	15	N/A	1	N/A	0.15 [3]
Food Sales	20	N/A	5	15	0.15 [3]
Service	18	N/A	5	15	0.15 [1]
Food Services	13	4	5	15	0.175 [3]
Health Care (inpatient)	13	4	5	15	0.25 [3]
Health Care (outpatient)	13	4	5	15	0.25 [3]
Lodging	10	3	5	20	0.21 [3]
Assembly	18	3	5	20	0.15 [1]

[1] Assumption
[2] Limits of ASHRAE 90.1-2004 Table G3.1
[3] Huang and Franconi 1999

Table G-4. Benchmark Building Loads

Principal Building Activity	Occupancy ft²/person (m²/person)	Ventilation cfm/person (L/s·person)	Plug Loads W/ft² (W/m²)
Office	275 (25.5)[1]	17 (8.5)[2]	1.3 (14)[3]
Warehouse (<30,000 ft²)	5,000 (465)[3]	0.06 cfm/ft² (0.3 L/s·m²)[2]	0.1 (1.1)[3]
Warehouse (≥30,000 ft²)	15,000 (1,394)[1]	0.06 cfm/ft² (0.3 L/s·m²)[2]	0.1 (1.1)[3]
Education (primary)	75 (7)[1]	15 (7.4)[2]	0.8 (8.6)[4]
Education (secondary and university)	75 (7)[1]	15 (7.4)[2]	0.8 (8.6)[4]
Retail	300 (28)[1]	16 (7.8)[2]	0.5 (5.4)[3]
Food Sales	300 (28)[1]	15 (7.6)[2]	1.5 (16.1)[3]
Service	300 (28)[3]	19 (9.0)[2]	1.0 (10.8)[3]
Food Services	100 (9)[1]	10 (5.1)[2]	2.25 (24.2)[4]
Health Care (inpatient)	200 (19)[1]	25 (13)[2]	2.2 (23.7)[4]
Health Care (outpatient)	200 (19)[1]	25 (13)[2]	2.2 (23.7)[4]
Lodging	250 (23)[1]	11 (5.5)[2]	0.7 (7.5)[4]
Assembly	50 (5)[1]	6 (2.8)[2]	0.4 (4.3)[4]

[1] ASHRAE 1989
[2] ASHRAE 2004b (value for education buildings represents an average of several education space types)
[3] Assumption
[4] Huang and Franconi 1999

Table G-5. Baseline Building Schedules

Principal Building Activity	ASHRAE 90.1–1989 Schedule Name	Tables of Schedules
Office	Office	Tables G-6 and G-7
Warehouse	Warehouse	Tables G-8 and G-9
Education	School	Tables G-10 and G-11
Retail	Retail	Tables G-12 and G-13
Food Sales	Retail	Tables G-12 and G-13
Service	Retail	Tables G-12 and G-13
Food Services	Restaurant	Tables G-14 and G-15
Health Care	Health/Institutional	Tables G-16 and G-17
Lodging	Hotel/Motel	Tables G-18 and G-19
Assembly	Assembly	Tables G-20 and G-21

Table G-6. Office Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.00	0.00	0.00	0.05	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04
2	0.00	0.00	0.00	0.05	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04
3	0.00	0.00	0.00	0.05	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04
4	0.00	0.00	0.00	0.05	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04
5	0.00	0.00	0.00	0.05	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04
6	0.00	0.00	0.00	0.10	0.05	0.05	0.40	0.30	0.30	0.08	0.08	0.07
7	0.10	0.10	0.05	0.10	0.10	0.05	0.40	0.40	0.30	0.07	0.07	0.04
8	0.20	0.10	0.05	0.30	0.10	0.05	0.40	0.40	0.30	0.19	0.11	0.04
9	0.95	0.10	0.05	0.90	0.30	0.05	0.90	0.50	0.30	0.35	0.15	0.04
10	0.95	0.30	0.05	0.90	0.30	0.05	0.90	0.50	0.30	0.38	0.21	0.04
11	0.95	0.30	0.05	0.90	0.30	0.05	0.90	0.50	0.30	0.39	0.19	0.04
12	0.95	0.30	0.05	0.90	0.30	0.05	0.90	0.50	0.30	0.47	0.23	0.06
13	0.95	0.30	0.05	0.80	0.15	0.05	0.80	0.35	0.30	0.57	0.20	0.06
14	0.95	0.10	0.05	0.90	0.15	0.05	0.90	0.35	0.30	0.54	0.19	0.09
15	0.95	0.10	0.05	0.90	0.15	0.05	0.90	0.35	0.30	0.34	0.15	0.06
16	0.95	0.10	0.05	0.90	0.15	0.05	0.90	0.35	0.30	0.33	0.16	0.04
17	0.95	0.10	0.05	0.90	0.15	0.05	0.90	0.35	0.30	0.44	0.14	0.04
18	0.95	0.05	0.05	0.50	0.05	0.05	0.50	0.30	0.30	0.26	0.07	0.04
19	0.30	0.05	0.05	0.30	0.05	0.05	0.40	0.30	0.30	0.21	0.07	0.04
20	0.10	0.05	0.05	0.30	0.05	0.05	0.40	0.30	0.30	0.15	0.07	0.04
21	0.10	0.00	0.00	0.20	0.05	0.05	0.40	0.30	0.30	0.17	0.07	0.04
22	0.10	0.00	0.00	0.20	0.05	0.05	0.40	0.30	0.30	0.08	0.09	0.07
23	0.05	0.00	0.00	0.10	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04
24	0.05	0.00	0.00	0.05	0.05	0.05	0.40	0.30	0.30	0.05	0.05	0.04

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-7. Office Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	55	55	55	13	13	13	off	off	off	off	off	off
2	55	55	55	13	13	13	off	off	off	off	off	off
3	55	55	55	13	13	13	off	off	off	off	off	off
4	55	55	55	13	13	13	off	off	off	off	off	off
5	55	55	55	13	13	13	off	off	off	off	off	off
6	55	55	55	13	13	13	off	off	off	off	off	off
7	70	70	55	21	21	13	75	75	off	24	24	off
8	70	70	55	21	21	13	75	75	off	24	24	off
9	70	70	55	21	21	13	75	75	off	24	24	off
10	70	70	55	21	21	13	75	75	off	24	24	off
11	70	70	55	21	21	13	75	75	off	24	24	off
12	70	70	55	21	21	13	75	75	off	24	24	off
13	70	70	55	21	21	13	75	75	off	24	24	off
14	70	70	55	21	21	13	75	75	off	24	24	off
15	70	70	55	21	21	13	75	75	off	24	24	off
16	70	70	55	21	21	13	75	75	off	24	24	off
17	70	70	55	21	21	13	75	75	off	24	24	off
18	70	70	55	21	21	13	75	75	off	24	24	off
19	70	55	55	21	13	13	75	off	off	24	off	off
20	70	55	55	21	13	13	75	off	off	24	off	off
21	70	55	55	21	13	13	75	off	off	24	off	off
22	70	55	55	21	13	13	75	off	off	24	off	off
23	55	55	55	13	13	13	off	off	off	off	off	off
24	55	55	55	13	13	13	off	off	off	off	off	off

Table G-8. Warehouse Internal Loads Schedule From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
2	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
3	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
4	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
5	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
6	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
7	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.15	0.02	0.02	0.02
8	0.15	0.00	0.00	0.40	0.04	0.04	0.50	0.10	0.15	0.10	0.02	0.02
9	0.70	0.20	0.00	0.70	0.20	0.04	0.80	0.20	0.10	0.30	0.06	0.02
10	0.90	0.20	0.00	0.90	0.24	0.04	0.90	0.40	0.10	0.36	0.12	0.02
11	0.90	0.20	0.00	0.90	0.24	0.04	0.90	0.40	0.10	0.36	0.12	0.02
12	0.90	0.20	0.00	0.90	0.24	0.04	0.90	0.40	0.10	0.46	0.17	0.02
13	0.50	0.10	0.00	0.80	0.04	0.04	0.90	0.10	0.10	0.57	0.04	0.04
14	0.85	0.10	0.00	0.90	0.04	0.04	0.90	0.10	0.10	0.43	0.04	0.04
15	0.85	0.10	0.00	0.90	0.04	0.04	0.90	0.10	0.10	0.38	0.02	0.02
16	0.85	0.10	0.00	0.90	0.04	0.04	0.90	0.10	0.10	0.40	0.02	0.02
17	0.20	0.00	0.00	0.90	0.04	0.04	0.90	0.10	0.10	0.30	0.02	0.02
18	0.00	0.00	0.00	0.30	0.04	0.04	0.10	0.10	0.10	0.18	0.02	0.02
19	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.10	0.03	0.02	0.02
20	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.10	0.03	0.02	0.02
21	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.10	0.03	0.02	0.02
22	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.10	0.03	0.02	0.02
23	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.10	0.03	0.02	0.02
24	0.00	0.00	0.00	0.04	0.04	0.04	0.10	0.10	0.10	0.03	0.02	0.02

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-9. Warehouse Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	55	55	55	13	13	13	off	off	off	off	off	off
2	55	55	55	13	13	13	off	off	off	off	off	off
3	55	55	55	13	13	13	off	off	off	off	off	off
4	55	55	55	13	13	13	off	off	off	off	off	off
5	55	55	55	13	13	13	off	off	off	off	off	off
6	55	55	55	13	13	13	off	off	off	off	off	off
7	55	55	55	13	13	13	off	off	off	off	off	off
8	70	55	55	21	13	13	75	off	off	24	off	off
9	70	70	55	21	21	13	75	75	off	24	24	off
10	70	70	55	21	21	13	75	75	off	24	24	off
11	70	70	55	21	21	13	75	75	off	24	24	off
12	70	70	55	21	21	13	75	75	off	24	24	off
13	70	70	55	21	21	13	75	75	off	24	24	off
14	70	70	55	21	21	13	75	75	off	24	24	off
15	70	70	55	21	21	13	75	75	off	24	24	off
16	70	70	55	21	21	13	75	75	off	24	24	off
17	70	55	55	21	13	13	75	off	off	24	24	off
18	55	55	55	13	13	13	75	75	off	off	off	off
19	55	55	55	13	13	13	off	off	off	off	off	off
20	55	55	55	13	13	13	off	off	off	off	off	off
21	55	55	55	13	13	13	off	off	off	off	off	off
22	55	55	55	13	13	13	off	off	off	off	off	off
23	55	55	55	13	13	13	off	off	off	off	off	off
24	55	55	55	13	13	13	off	off	off	off	off	off

Table G-10. School Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
2	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
3	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
4	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
5	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
6	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
7	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.05	0.03	0.03
8	0.05	0.00	0.00	0.30	0.05	0.02	0.40	0.15	0.15	0.10	0.03	0.03
9	0.75	0.10	0.00	0.85	0.15	0.05	0.90	0.25	0.15	0.34	0.03	0.05
10	0.90	0.10	0.00	0.95	0.15	0.05	0.90	0.25	0.15	0.36	0.05	0.05
11	0.90	0.10	0.00	0.95	0.15	0.05	0.90	0.25	0.15	0.36	0.05	0.05
12	0.90	0.10	0.00	0.95	0.15	0.05	0.90	0.25	0.15	0.46	0.05	0.05
13	0.80	0.10	0.00	0.80	0.15	0.05	0.90	0.25	0.15	0.57	0.05	0.05
14	0.80	0.00	0.00	0.80	0.05	0.05	0.90	0.15	0.15	0.83	0.03	0.05
15	0.80	0.00	0.00	0.80	0.05	0.05	0.90	0.15	0.15	0.61	0.03	0.03
16	0.45	0.00	0.00	0.70	0.05	0.04	0.80	0.15	0.15	0.65	0.03	0.03
17	0.15	0.00	0.00	0.50	0.02	0.02	0.60	0.15	0.15	0.10	0.03	0.03
18	0.05	0.00	0.00	0.50	0.02	0.02	0.60	0.15	0.15	0.10	0.03	0.03
19	0.15	0.00	0.00	0.35	0.02	0.02	0.45	0.15	0.15	0.19	0.03	0.03
20	0.20	0.00	0.00	0.35	0.02	0.02	0.45	0.15	0.15	0.25	0.03	0.03
21	0.20	0.00	0.00	0.35	0.02	0.02	0.45	0.15	0.15	0.23	0.03	0.03
22	0.10	0.00	0.00	0.30	0.02	0.02	0.40	0.15	0.15	0.22	0.03	0.03
23	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.12	0.03	0.03
24	0.00	0.00	0.00	0.02	0.02	0.02	0.15	0.15	0.15	0.09	0.03	0.03

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-11. School Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	55	55	55	13	13	13	off	off	off	off	off	off
2	55	55	55	13	13	13	off	off	off	off	off	off
3	55	55	55	13	13	13	off	off	off	off	off	off
4	55	55	55	13	13	13	off	off	off	off	off	off
5	55	55	55	13	13	13	off	off	off	off	off	off
6	55	55	55	13	13	13	off	off	off	off	off	off
7	55	55	55	13	13	13	off	off	off	off	off	off
8	70	55	55	21	13	13	75	off	off	24	off	off
9	70	70	55	21	21	13	75	75	off	24	24	off
10	70	70	55	21	21	13	75	75	off	24	24	off
11	70	70	55	21	21	13	75	75	off	24	24	off
12	70	70	55	21	21	13	75	75	off	24	24	off
13	70	70	55	21	21	13	75	75	off	24	24	off
14	70	55	55	21	13	13	75	off	off	24	off	off
15	70	55	55	21	13	13	75	off	off	24	off	off
16	70	55	55	21	13	13	75	off	off	24	off	off
17	70	55	55	21	13	13	75	off	off	24	off	off
18	70	55	55	21	13	13	75	off	off	24	off	off
19	70	55	55	21	13	13	75	off	off	24	off	off
20	70	55	55	21	13	13	75	off	off	24	off	off
21	70	55	55	21	13	13	75	off	off	24	off	off
22	70	55	55	21	13	13	75	off	off	24	off	off
23	55	55	55	13	13	13	off	off	off	off	off	off
24	55	55	55	13	13	13	off	off	off	off	off	off

Table G-12. Retail Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.04	0.11	0.07
2	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.05	0.10	0.07
3	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.05	0.08	0.07
4	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.04	0.06	0.06
5	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.04	0.06	0.06
6	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.04	0.06	0.06
7	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.04	0.07	0.07
8	0.10	0.10	0.00	0.20	0.10	0.05	0.40	0.30	0.15	0.15	0.20	0.10
9	0.20	0.20	0.00	0.50	0.30	0.10	0.70	0.50	0.30	0.23	0.24	0.12
10	0.50	0.50	0.10	0.90	0.60	0.10	0.90	0.80	0.30	0.32	0.27	0.14
11	0.50	0.60	0.20	0.90	0.90	0.40	0.90	0.90	0.60	0.41	0.42	0.29
12	0.70	0.80	0.20	0.90	0.90	0.40	0.90	0.90	0.80	0.57	0.54	0.31
13	0.70	0.80	0.40	0.90	0.90	0.40	0.90	0.90	0.80	0.62	0.59	0.36
14	0.70	0.80	0.40	0.90	0.90	0.60	0.90	0.90	0.80	0.61	0.60	0.36
15	0.80	0.80	0.40	0.90	0.90	0.60	0.90	0.90	0.80	0.50	0.49	0.34
16	0.70	0.80	0.40	0.90	0.90	0.60	0.90	0.90	0.80	0.45	0.48	0.35
17	0.70	0.80	0.40	0.90	0.90	0.60	0.90	0.90	0.80	0.46	0.47	0.37
18	0.50	0.60	0.20	0.90	0.90	0.40	0.90	0.90	0.60	0.47	0.46	0.34
19	0.50	0.20	0.10	0.50	0.50	0.20	0.80	0.70	0.40	0.42	0.44	0.25
20	0.30	0.20	0.00	0.60	0.30	0.05	0.80	0.50	0.15	0.34	0.36	0.27
21	0.30	0.20	0.00	0.50	0.30	0.05	0.70	0.50	0.15	0.33	0.29	0.21
22	0.00	0.10	0.00	0.20	0.10	0.05	0.40	0.30	0.15	0.23	0.22	0.16
23	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.13	0.16	0.10
24	0.00	0.00	0.00	0.05	0.05	0.05	0.20	0.15	0.15	0.08	0.13	0.06

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-13. Retail Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	55	55	55	13	13	13	off	off	off	off	off	off
2	55	55	55	13	13	13	off	off	off	off	off	off
3	55	55	55	13	13	13	off	off	off	off	off	off
4	55	55	55	13	13	13	off	off	off	off	off	off
5	55	55	55	13	13	13	off	off	off	off	off	off
6	55	55	55	13	13	13	off	off	off	off	off	off
7	70	70	55	21	21	13	75	75	off	24	24	off
8	70	70	55	21	21	13	75	75	off	24	24	off
9	70	70	70	21	21	21	75	75	75	24	24	24
10	70	70	70	21	21	21	75	75	75	24	24	24
11	70	70	70	21	21	21	75	75	75	24	24	24
12	70	70	70	21	21	21	75	75	75	24	24	24
13	70	70	70	21	21	21	75	75	75	24	24	24
14	70	70	70	21	21	21	75	75	75	24	24	24
15	70	70	70	21	21	21	75	75	75	24	24	24
16	70	70	70	21	21	21	75	75	75	24	24	24
17	70	70	70	21	21	21	75	75	75	24	24	24
18	70	70	55	21	21	21	75	75	75	24	24	off
19	70	70	55	21	21	13	75	75	off	24	24	off
20	70	70	55	21	21	13	75	75	off	24	24	off
21	70	70	55	21	21	13	75	75	off	24	24	off
22	55	70	55	13	21	13	off	75	off	off	24	off
23	55	55	55	13	13	13	off	off	off	off	off	off
24	55	55	55	13	13	13	off	off	off	off	off	off

Table G-14. Restaurant Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.15	0.30	0.20	0.15	0.20	0.20	0.35	0.35	0.35	0.20	0.20	0.25
2	0.15	0.25	0.20	0.15	0.15	0.15	0.35	0.35	0.35	0.15	0.15	0.20
3	0.05	0.05	0.05	0.15	0.15	0.15	0.35	0.35	0.35	0.15	0.15	0.20
4	0.00	0.00	0.00	0.15	0.15	0.15	0.20	0.20	0.20	0.00	0.00	0.00
5	0.00	0.00	0.00	0.15	0.15	0.15	0.20	0.20	0.20	0.00	0.00	0.00
6	0.00	0.00	0.00	0.20	0.15	0.15	0.20	0.20	0.20	0.00	0.00	0.00
7	0.00	0.00	0.00	0.40	0.30	0.30	0.40	0.40	0.40	0.00	0.00	0.00
8	0.05	0.00	0.00	0.40	0.30	0.30	0.40	0.40	0.40	0.60	0.00	0.00
9	0.05	0.05	0.00	0.60	0.60	0.50	0.60	0.60	0.60	0.55	0.00	0.00
10	0.05	0.05	0.00	0.60	0.60	0.50	0.60	0.60	0.60	0.45	0.50	0.00
11	0.20	0.20	0.10	0.90	0.80	0.70	0.90	0.90	0.90	0.40	0.45	0.50
12	0.50	0.45	0.20	0.90	0.80	0.70	0.90	0.90	0.90	0.45	0.50	0.50
13	0.80	0.50	0.25	0.90	0.80	0.70	0.90	0.90	0.90	0.40	0.50	0.40
14	0.70	0.50	0.25	0.90	0.80	0.70	0.90	0.90	0.90	0.35	0.45	0.40
15	0.40	0.35	0.15	0.90	0.80	0.70	0.90	0.90	0.90	0.30	0.40	0.30
16	0.20	0.30	0.20	0.90	0.80	0.70	0.90	0.90	0.90	0.30	0.40	0.30
17	0.25	0.30	0.25	0.90	0.80	0.60	0.90	0.90	0.90	0.30	0.35	0.30
18	0.50	0.30	0.35	0.90	0.90	0.60	0.90	0.90	0.90	0.40	0.40	0.40
19	0.80	0.70	0.55	0.90	0.90	0.60	0.90	0.90	0.90	0.55	0.55	0.50
20	0.80	0.90	0.65	0.90	0.90	0.60	0.90	0.90	0.90	0.60	0.55	0.50
21	0.80	0.70	0.70	0.90	0.90	0.60	0.90	0.90	0.90	0.50	0.50	0.40
22	0.50	0.65	0.35	0.90	0.90	0.60	0.90	0.90	0.90	0.55	0.55	0.50
23	0.35	0.55	0.20	0.50	0.50	0.50	0.60	0.60	0.60	0.40	0.40	0.40
24	0.20	0.35	0.20	0.30	0.30	0.30	0.60	0.60	0.60	0.25	0.30	0.20

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-15. Restaurant Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	70	70	70	21	21	21	75	75	75	24	24	24
2	70	70	70	21	21	21	75	75	75	24	24	24
3	70	70	70	21	21	21	75	75	75	24	24	24
4	55	55	55	13	13	13	off	off	off	off	off	off
5	55	55	55	13	13	13	off	off	off	off	off	off
6	55	55	55	13	13	13	off	off	off	off	off	off
7	55	55	55	13	13	13	off	off	off	off	off	off
8	70	55	55	21	13	13	75	off	off	24	off	off
9	70	55	55	21	13	13	75	off	off	24	24	off
10	70	70	70	21	21	13	75	75	off	24	24	24
11	70	70	70	21	21	21	75	75	75	24	24	24
12	70	70	70	21	21	21	75	75	75	24	24	24
13	70	70	70	21	21	21	75	75	75	24	24	24
14	70	70	70	21	21	21	75	75	75	24	24	24
15	70	70	70	21	21	21	75	75	75	24	24	24
16	70	70	70	21	21	21	75	75	75	24	24	24
17	70	70	70	21	21	21	75	75	75	24	24	24
18	70	70	70	21	21	21	75	75	75	24	24	24
19	70	70	70	21	21	21	75	75	75	24	24	24
20	70	70	70	21	21	21	75	75	75	24	24	24
21	70	70	70	21	21	21	75	75	75	24	24	24
22	70	70	70	21	21	21	75	75	75	24	24	24
23	70	70	70	21	21	21	75	75	75	24	24	24
24	70	70	70	21	21	21	75	75	75	24	24	24

Table G-16. Health/Institutional Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
2	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
3	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
4	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
5	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
6	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
7	0.00	0.00	0.00	0.10	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01
8	0.10	0.10	0.00	0.50	0.20	0.05	0.70	0.50	0.30	0.17	0.01	0.01
9	0.50	0.30	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.58	0.20	0.01
10	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.66	0.28	0.01
11	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.78	0.30	0.01
12	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.83	0.30	0.01
13	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.71	0.24	0.01
14	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.82	0.24	0.01
15	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.78	0.23	0.01
16	0.80	0.40	0.05	0.90	0.40	0.10	0.90	0.65	0.40	0.74	0.23	0.01
17	0.80	0.40	0.00	0.30	0.40	0.05	0.60	0.65	0.30	0.63	0.23	0.01
18	0.50	0.10	0.00	0.30	0.40	0.05	0.60	0.65	0.30	0.41	0.10	0.01
19	0.30	0.10	0.00	0.30	0.10	0.05	0.60	0.40	0.30	0.18	0.01	0.01
20	0.30	0.10	0.00	0.30	0.10	0.05	0.60	0.40	0.30	0.18	0.01	0.01
21	0.20	0.10	0.00	0.30	0.10	0.05	0.60	0.40	0.30	0.18	0.01	0.01
22	0.20	0.10	0.00	0.30	0.10	0.05	0.60	0.40	0.30	0.10	0.01	0.01
23	0.00	0.00	0.00	0.30	0.10	0.05	0.60	0.40	0.30	0.01	0.01	0.01
24	0.00	0.00	0.00	0.30	0.10	0.05	0.40	0.40	0.30	0.01	0.01	0.01

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-17. Health/Institutional Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	70	70	70	21	21	21	75	75	75	24	24	24
2	70	70	70	21	21	21	75	75	75	24	24	24
3	70	70	70	21	21	21	75	75	75	24	24	24
4	70	70	70	21	21	21	75	75	75	24	24	24
5	70	70	70	21	21	21	75	75	75	24	24	24
6	70	70	70	21	21	21	75	75	75	24	24	24
7	70	70	70	21	21	21	75	75	75	24	24	24
8	70	70	70	21	21	21	75	75	75	24	24	24
9	70	70	70	21	21	21	75	75	75	24	24	24
10	70	70	70	21	21	21	75	75	75	24	24	24
11	70	70	70	21	21	21	75	75	75	24	24	24
12	70	70	70	21	21	21	75	75	75	24	24	24
13	70	70	70	21	21	21	75	75	75	24	24	24
14	70	70	70	21	21	21	75	75	75	24	24	24
15	70	70	70	21	21	21	75	75	75	24	24	24
16	70	70	70	21	21	21	75	75	75	24	24	24
17	70	70	70	21	21	21	75	75	75	24	24	24
18	70	70	70	21	21	21	75	75	75	24	24	24
19	70	70	70	21	21	21	75	75	75	24	24	24
20	70	70	70	21	21	21	75	75	75	24	24	24
21	70	70	70	21	21	21	75	75	75	24	24	24
22	70	70	70	21	21	21	75	75	75	24	24	24
23	70	70	70	21	21	21	75	75	75	24	24	24
24	70	70	70	21	21	21	75	75	75	24	24	24

Table G-18. Hotel/Motel Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.90	0.90	0.70	0.20	0.20	0.30	0.30	0.30	0.40	0.20	0.20	0.25
2	0.90	0.90	0.70	0.15	0.20	0.30	0.25	0.30	0.40	0.15	0.15	0.20
3	0.90	0.90	0.70	0.10	0.10	0.20	0.20	0.20	0.30	0.15	0.15	0.20
4	0.90	0.90	0.70	0.10	0.10	0.20	0.20	0.20	0.30	0.15	0.15	0.20
5	0.90	0.90	0.70	0.10	0.10	0.20	0.20	0.20	0.30	0.20	0.20	0.20
6	0.90	0.90	0.70	0.20	0.10	0.20	0.30	0.20	0.30	0.25	0.25	0.30
7	0.70	0.70	0.70	0.40	0.30	0.30	0.50	0.40	0.40	0.50	0.40	0.50
8	0.40	0.50	0.70	0.50	0.30	0.40	0.60	0.40	0.50	0.60	0.50	0.50
9	0.40	0.50	0.50	0.40	0.40	0.40	0.50	0.50	0.50	0.55	0.50	0.50
10	0.20	0.30	0.50	0.40	0.40	0.30	0.50	0.50	0.40	0.45	0.50	0.55
11	0.20	0.30	0.50	0.25	0.30	0.30	0.35	0.40	0.40	0.40	0.45	0.50
12	0.20	0.30	0.30	0.25	0.25	0.30	0.35	0.35	0.40	0.45	0.50	0.50
13	0.20	0.30	0.30	0.25	0.25	0.30	0.35	0.35	0.40	0.40	0.50	0.40
14	0.20	0.30	0.20	0.25	0.25	0.20	0.35	0.35	0.30	0.35	0.45	0.40
15	0.20	0.30	0.20	0.25	0.25	0.20	0.35	0.35	0.30	0.30	0.40	0.30
16	0.30	0.30	0.20	0.25	0.25	0.20	0.35	0.35	0.30	0.30	0.40	0.30
17	0.50	0.30	0.30	0.25	0.25	0.20	0.35	0.35	0.30	0.30	0.35	0.30
18	0.50	0.50	0.40	0.25	0.25	0.20	0.35	0.35	0.30	0.40	0.40	0.40
19	0.50	0.60	0.40	0.60	0.60	0.50	0.70	0.70	0.60	0.55	0.55	0.50
20	0.70	0.60	0.60	0.80	0.70	0.70	0.90	0.80	0.80	0.60	0.55	0.50
21	0.70	0.60	0.60	0.90	0.70	0.80	0.95	0.80	0.90	0.50	0.50	0.40
22	0.80	0.80	0.80	0.80	0.70	0.60	0.90	0.80	0.70	0.55	0.55	0.55
23	0.90	0.80	0.80	0.60	0.60	0.50	0.70	0.70	0.60	0.45	0.40	0.40
24	0.90	0.80	0.80	0.30	0.30	0.30	0.40	0.40	0.40	0.25	0.30	0.20

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-19. Hotel/Motel Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	70	70	70	21	21	21	75	75	75	24	24	24
2	70	70	70	21	21	21	75	75	75	24	24	24
3	70	70	70	21	21	21	75	75	75	24	24	24
4	70	70	70	21	21	21	75	75	75	24	24	24
5	70	70	70	21	21	21	75	75	75	24	24	24
6	70	70	70	21	21	21	75	75	75	24	24	24
7	70	70	70	21	21	21	75	75	75	24	24	24
8	70	70	70	21	21	21	75	75	75	24	24	24
9	70	70	70	21	21	21	75	75	75	24	24	24
10	70	70	70	21	21	21	75	75	75	24	24	24
11	70	70	70	21	21	21	75	75	75	24	24	24
12	70	70	70	21	21	21	75	75	75	24	24	24
13	70	70	70	21	21	21	75	75	75	24	24	24
14	70	70	70	21	21	21	75	75	75	24	24	24
15	70	70	70	21	21	21	75	75	75	24	24	24
16	70	70	70	21	21	21	75	75	75	24	24	24
17	70	70	70	21	21	21	75	75	75	24	24	24
18	70	70	70	21	21	21	75	75	75	24	24	24
19	70	70	70	21	21	21	75	75	75	24	24	24
20	70	70	70	21	21	21	75	75	75	24	24	24
21	70	70	70	21	21	21	75	75	75	24	24	24
22	70	70	70	21	21	21	75	75	75	24	24	24
23	70	70	70	21	21	21	75	75	75	24	24	24
24	70	70	70	21	21	21	75	75	75	24	24	24

Table G-20. Assembly Internal Load Schedules From 90.1-1989 (With Addendum L)

Hour	Occupancy			Lighting			Plug Loads*			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.30	0.30	0.20	0.70	0.70	0.00	0.00	0.00
9	0.20	0.20	0.10	0.40	0.30	0.30	0.80	0.70	0.70	0.00	0.00	0.00
10	0.20	0.20	0.10	0.40	0.50	0.30	0.80	0.80	0.70	0.05	0.05	0.05
11	0.20	0.20	0.10	0.40	0.50	0.30	0.80	0.80	0.70	0.05	0.05	0.05
12	0.80	0.60	0.10	0.75	0.50	0.30	0.90	0.80	0.70	0.35	0.20	0.20
13	0.80	0.60	0.10	0.75	0.50	0.65	0.90	0.80	0.80	0.05	0.00	0.00
14	0.80	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.05	0.00	0.00
15	0.80	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.05	0.00	0.00
16	0.80	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.05	0.00	0.00
17	0.80	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.05	0.00	0.00
18	0.80	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.00	0.00	0.00
19	0.20	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.00	0.00	0.00
20	0.20	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.00	0.65	0.65
21	0.20	0.60	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.00	0.30	0.30
22	0.20	0.80	0.70	0.75	0.50	0.65	0.90	0.80	0.80	0.00	0.00	0.00
23	0.10	0.10	0.20	0.25	0.50	0.00	0.70	0.80	0.20	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.00	0.00	0.00

* The plug load schedules were created by adjusting the lighting schedules from ASHRAE 90.1-1989 to increase the night and weekend values.

Table G-21. Assembly Thermostat Set Point Schedules From 90.1-1989 (With Addendum L)

Hour	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1	55	55	55	13	13	13	off	off	off	off	off	off
2	55	55	55	13	13	13	off	off	off	off	off	off
3	55	55	55	13	13	13	off	off	off	off	off	off
4	55	55	55	13	13	13	off	off	off	off	off	off
5	55	55	55	13	13	13	off	off	off	off	off	off
6	70	55	55	21	13	13	75	off	off	24	off	off
7	70	70	70	21	21	21	75	75	75	24	24	24
8	70	70	70	21	21	21	75	75	75	24	24	24
9	70	70	70	21	21	21	75	75	75	24	24	24
10	70	70	70	21	21	21	75	75	75	24	24	24
11	70	70	70	21	21	21	75	75	75	24	24	24
12	70	70	70	21	21	21	75	75	75	24	24	24
13	70	70	70	21	21	21	75	75	75	24	24	24
14	70	70	70	21	21	21	75	75	75	24	24	24
15	70	70	70	21	21	21	75	75	75	24	24	24
16	70	70	70	21	21	21	75	75	75	24	24	24
17	70	70	70	21	21	21	75	75	75	24	24	24
18	70	70	70	21	21	21	75	75	75	24	24	24
19	70	70	70	21	21	21	75	75	75	24	24	24
20	70	70	70	21	21	21	75	75	75	24	24	24
21	70	70	70	21	21	21	75	75	75	24	24	24
22	70	70	70	21	21	21	75	75	75	24	24	24
23	70	70	70	21	21	21	75	75	75	24	24	24
24	55	55	55	21	21	21	off	off	off	off	off	off

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Appendix G contains useful information about developing a baseline model for a proposed building design.

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Appendix G contains useful information about developing a baseline model for a proposed building design.

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Onebuilding.org Web site. www.onebuilding.org. Last accessed May 6, 2009.

Home to multiple mailing lists for users of building energy simulation programs, including the popular BLDG-SIM listserv.

Ternoey, S.; Bickle, L.; Robbins, C.; Busch, R.; McCord, K. (1985). *The Design of Energy-Responsive Commercial Buildings*. New York: John Wiley & Sons.

Good explanation of the value of predesign analysis. Good description of load elimination parametric analysis with several examples. Information on simulation programs is very outdated.

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Appendix H: Sample Evaluation Forms

Workshop Evaluation Form

1. What was the most positive aspect of the workshop?

2. If this workshop were to be held again, what three changes would you suggest to make it more effective?

3. Was the time for the workshop too short, too long, or just right?

4. What do you see as an immediate action item you can undertake in terms of sustainability after participating in this workshop?

5. Other feedback that you would like to share:

Evaluation Form

Please rate sessions from 5 (Excellent, Very Valuable) to 1 (Poor, Not Valuable). Please explain any ratings of "1" so we can learn from your comments.

	Excellent		Satisfactory		Poor
	5	4	3	2	1
Welcome and Introductions **Comments/Suggestions:**					
Session 2 **Comments/Suggestions:**					
Session 3 **Comments/Suggestions:**					
Session 4 **Comments/Suggestions:**					
Session 5 **Comments/Suggestions:**					
etc.					

In the questions that follow, please circle the number that best describes your opinion or circle Yes or No to answer the question. Use the last page of the form to continue your comments or for overall comments.

1. Overall, was the charrette content useful and applicable to your current work?
   [right on target] 5 4 3 2 1 [missed the mark]

2. Was the material appropriate for your background?
   [too advanced] 5 4 3 2 1 [too elementary]

3. Should any topics have been deleted from the charrette?
   Yes (please explain) No

4. Should any topics have been added to the charrette?
   Yes (please explain) No

5. Do you have any suggestions for improving the participant materials?

6. How would you rate the overall charrette facilitator?
   [very knowledgeable] 5 4 3 2 1 [not knowledgeable]

7. What additional training would be useful to you?

8. Other comments?

Name (optional)

Appendix I: Sample Report Outline

Executive Summary

1. Charrette Process
2. Charrette Planners and Participants
3. Group 1 Plan
4. Group 2 Plan
5. Group 3 Plan
6. Etc.
7. Appendices
    - Charrette agenda
    - Participant list
    - Presentation handouts
    - Site and project information
    - Predesign energy analysis results
    - LEED Green Building Rating System or other relevant codes, standards, or evaluation tools
    - High-performance buildings Web sites
    - Charrette evaluation summary.

Appendix J:
Real Projects With Final Charrette Reports

This appendix lists several real projects that successfully used a high-performance charrette to kick off the design process. The documents linked below are good examples of final charrette reports.

- **Boston National Historic Park Greening Charrette** – Boston National Historic Park comprises several historic sites within Boston, including the Charlestown Navy Yard and the U.S.S. Constitution. The goal of this charrette was to develop specific actions that combine historic preservation and sustainability for the park, with a focus on the Navy Yard. This event was the second in a series that will eventually reach all of the National Park Service Centers of Environmental Innovation.
  www.wbdg.org/pdfs/charrette_bnhp.pdf
- **UNC–Asheville New Science Building Greening Charrette** – In an effort to incorporate sustainable design elements into the University of North Carolina's new science building, a two-day charrette was conducted to document and quantify the energy and environmental initiatives. During the charrette planning, partnerships were established with the U.S. Department of Energy to help fund and assist in the charrette process and documentation.
  www.wbdg.org/pdfs/charrette_unc.pdf
- **Greenprints Charrette, Southface Energy Institute** – Southface Energy Institute hosted its annual Greenprints Conference in Atlanta, Georgia, in 2002. One of the conference highlights was a one-day high-performance buildings charrette for the institute's new building. Early in the design process, Southface representatives conveyed that energy and environmental considerations were critical; in fact, one of Southface's project goals was to be a net-zero energy user. The charrette focused on that net-zero energy target as well as other goals highlighted by the use of the nationally recognized LEED Green Building Rating System.
  www.wbdg.org/pdfs/charrette_southface.pdf
- **NCSU High Performance Charrette College of Design** – As part of the early schematic design process for this project, North Carolina State University embraced the idea of holding a high-performance charrette. The charrette focus was to incorporate environmental excellence and high performance in the design of the University's Leazar Hall Renovation by using the high performance guidelines developed by the Triangle J. Council of Governments. Funding assistance was obtained from the North Carolina State Energy Office, the U.S. Department of Energy, and the Triangle J. Council of Governments.
  http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/33425i-d.pdf
- **Simon Fraser UniverCity** – Several charrettes were held to create a plan outlining the desired goals for a new community, called "UniverCity, the Community at Simon Fraser," with respect to its community character and social composition as it is developed over time. The plan addresses four key aspects of planning that are considered critical to the long-term community character and composition: social diversity, housing mix, commercial and community services, and environmental sustainability.
  www.cmhc-schl.gc.ca/odpub/pdf/63214.pdf

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1617 Cole Boulevard, Golden, Colorado 80401-3305
303-275-3000 • www.nrel.gov

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

NREL/BK-550-44051 • September 2009

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