Optimizing Energy Performance & Sustainability in New & Existing Buildings Through the Whole Building Design Guide

Associated Builders & Contractors, Inc.
Webinar
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What Is a High-Performance Building?


  A building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
Why is this important to you?

How can the Whole Building Design Guide help you achieve High-Performance?

Factors Influencing Current & Future Building Projects
High Performance Attributes

• Accessibility
• Aesthetics
• Cost Effectiveness
• Functionality
• Historic Preservation
• Productivity
• Security/Safety
• Sustainability

High Performance Attributes = WBDG Design Objectives

Why aren’t we succeeding in creating High-Performance Buildings?

‘Standard’ design is like a relay race where one discipline completes their work before passing the project onto the next—often with no real coordination among project team members.
What Are We Getting Now?

- Building codes are minimum
- One attribute is prominent while others are overlooked or trivialized
- Low occupant satisfaction
- Lawsuits
- Premature failures of materials & systems
- Value of investment decreases while costs of operations & maintenance increase

A Conundrum

Can we get to where we need to go from the place we came from?
Think About It ...

• To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science.

• We cannot solve our problems with the same thinking we used when we created them.

Albert Einstein

We need Creative Thinking & Innovation!

Evolution in Lighting Technology in the Last 150 Years

Whale Oil  \[\rightarrow\]  Incandescent  \[\rightarrow\]  Fluorescent

L.E.D

What’s Next?

The Point is this ...
Green Buildings & Occupant Satisfaction

What’s Working, What’s Not*

- Occupants of green buildings generally show a higher level of satisfaction with their built environment than do occupants of standard buildings, but their buildings fall short in some key areas.

- Common complaints had to do with:
  - Acoustics (too noisy, not enough privacy)
  - Thermal comfort (limited temperature control)
  - Daylighting (too much glare and light spill)

Similar results from other studies done over last few years

*HOK Post Occupancy Evaluation Report of 7 HOK-designed green buildings as reported in BD&C June 9, 2006

What Is Whole Building Design?

To achieve high-performance buildings

- It takes an Integrated Design Approach and it requires an

- Integrated Team Process
‘Whole Building’ Approach

• Materials, systems, and assemblies reviewed from many different perspectives

• Building components, sub-systems and materials are interdependent, can impact the total performance of the whole, and can perform ‘double duty’

Integrated Project Team

➢ Comprehensive Stakeholder involvement throughout the building’s life cycle

➢ Evaluation for
  ➢ cost,
  ➢ quality-of-life,
  ➢ future flexibility,
  ➢ energy efficiency,
  ➢ overall environmental impact,
  ➢ productivity,
  ➢ creativity, and
  ➢ how the occupants will be enlivened
Applying the Integrated Team Process

Who needs to be at the table at the outset of your project to ensure an integrated team process?

- Architect / Landscape Architect
- Owner, Client, Tenants
- Engineers
- Programmers
- Interior Designer
- Contractor
- Specialists (Security, Telecom, Acoustics)
- Community Members or Other Stakeholders
- Operations and Maintenance Personnel
- Others???? (Real Estate Buyer)

An Integrated Team can find a single design strategy that meets multiple design objectives
This is a tactic that can control project cost!

Building Site Selection

- Solar Access*
- Stormwater Management
- Undeveloped Land/Wetlands
- Public Transportation
- Occupant Amenities
- Compatible Functions
- Security (ATFP, CPTED)
- Disaster Avoidance

*Building orientation for passive solar heating, daylighting, natural ventilation, views, potential impacts of future development.

[Real Estate Buyer must be informed!!!!]

Note: Applies to Selecting an Existing Building, as well!
The Building as a System

- the building enclosure (building envelope system);
- the inhabitants (humans and/or animals and/or plants, etc.);
- the building services (electrical/mechanical systems);
- the site, with its landscape and services infrastructure; and
- the external environment (weather and micro-climate).

Harmonization of these elements is the key to high performing buildings.

Cost / Influence Over the Quality of a Project

Influence early for optimal design outcome and reduced life-cycle cost.
WBDG Sustainable Design Topics

OVERVIEW

On an annual basis, buildings in the United States consume 30% of America’s energy and 40% of its electricity. Furthermore, buildings emit 30% of the carbon dioxide (the primary greenhouse gas associated with climate change), 40% of sulfur dioxide, and 25% of the nitrogen oxides found in the air. Currently, the vast majority of this energy is produced from non-renewable fossil fuel resources. With man’s supply of fossil fuels dwindling, concerns for energy supply security increasing (both for general supply and specific needs of facilities), and the impact of greenhouse gases on the world’s climate rise, it is essential to find ways to reduce load, increase efficiency, and utilize renewable fuel resources in facilities of all types.

During the initial design and development process, building projects must have a comprehensive understanding of the issues that need to be addressed:

- Reduce heating, cooling, and lighting loads through climate-responsive design and conservation practices.
- Employ renewable energy sources such as photovoltaic passive solar heating photovoltaics, geothermal, and geothermal storage.
- Specify energy-efficient buildings that consider performance criteria.
- Employ building performance by employing life cycle analysis programs and optimize system control strategies by using sensors, energy management sensors, and other air quality sensors.
- Monitor project performance through a policy of performance monitoring, annual reporting, and periodic re-commissioning.

RECOMMENDATIONS

- MEDICAL HEATING, COOLING, AND LIGHTING LOADS THROUGH CLIMATE-RESPONSIVE DESIGN AND CONSERVATION PRACTICES
  - Use passive solar design, site, size, and specific windows and landscape elements with solar geometry and building layout requirements in mind.
  - Use high-performance building materials, such as walls, roofs, and other assemblies based on their thermal insulation and durability requirements.

- EMPLOY RENEWABLE OR HIGH-EFFICIENCY ENERGY SOURCES
  - Renewable energy sources include solar photovoltaic, geothermal, wind turbines, and geothermal. Use of renewable energy can conserve energy, reduce waste, and decrease dependence on imported fuels. It can also eliminate greenhouse gases associated with energy use. Consider solar thermal for domestic hot water and heating purposes.
  - Evaluate the use of heat pumps to take advantage of the renewable energy technologies such as geothermal, solar hot water, and geothermal storage.

- SPECIFY EFFICIENT HVAC AND LIGHTING SYSTEMS
  - Use energy-efficient HVAC and lighting systems that meet or exceed the standards for Department of Commerce facilities, refer to the standards within UFC 3-031-01 Energy Conservation.
  - Use lighting systems that consume less than 1 foot-candle for ambient lighting.
  - Use computer Draft, approved and/or TDP-designated energy-efficiency products that meet or exceed Department of Energy standards.
  - Evaluate energy usage systems that provide energy savings in commercial and institutional strategies.
  - Integrate energy systems that operate in building automation systems with information technology infrastructure.

- OPTIMIZE BUILDING PERFORMANCE AND SYSTEM CONTROL STRATEGIES
  - Employ www.energyplus.net early in the design process.
  - Use sensors to detect occupancy and the availability of structural resistance such as doors or windows.
  - Evaluate the use of sensors and energy management systems:
    - Sensors: monitors the use of energy efficiency and management systems.
    - Energy management systems: monitors the use and access energy and water consumption like the Energy Star Portfolio Viewer.

- MONITOR PROJECT PERFORMANCE
  - Use a comprehensive, custom-designed energy plan throughout the life of the project.
  - Use metering to confirm building energy and environmental performance throughout the life of the project.
  - See also WBDG: Facility Performance Evaluation.
Sustainability and Energy Security

Energy independence and security are important components of national security and energy strategies. Today, power is mostly generated by massive centralized plants, and electricity moves along transmission lines. "Getting off the grid" means minimizing energy consumption through energy conservation and efficiency, and generating energy from local, renewable sources, such as wind, solar, geothermal, etc. (see WBGD Distributed Energy Resources, Fuel Cell Technology, Renewable Energy Resources, and Biomass Energy). Additionally, using distributed energy systems adds to building resiliency as the threats of natural disaster and damage become more frequent.

EMERGING ISSUES

Net Zero Energy Buildings Executive Order 13514 requires all new federal buildings that are entering the planning process in 2020 be designed to achieve zero net energy by 2030. There are also commercial and residential programs promoting net-zero energy. Examples of commercial residential and government net-zero energy buildings exist and can provide guidance for the development of future net-zero energy buildings. Passive survivability, which is described as the ability of a facility to provide shelter and basic occupant needs during and after disaster events without electric power, is becoming a design strategy to consider, particularly in areas of the country where storms and floods have been occurring annually or more often. Incorporate passive survivability concepts in the design of critical facilities, including on-site renewable energy sources that will be available to power the building during a major storm.

Green roofs and vertical gardens, sometimes referred to as "vegetable" or "vegetation" are beginning to appear as a design element in urban buildings. Be sure they don’t conflict with site security requirements, including Crime Prevention Through Environmental Design (CPTED).

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8/12/2013
Energy & Sustainability Resource Pages

- Air Barrier Systems in Buildings
- Building Enclosure Design Principles and Strategies
- Cool Metal Roofing
- Daylighting
- Electric Lighting Controls
- Energy Efficient Lighting
- Evaluating and Selecting Green Products
- Extensive Vegetative Roofs
- High-Performance EIFS
- High-Performance HVAC
- HVAC System Design for Humid Climates
- Indoor Air Quality and Mold Prevention of the Building Envelope
- Measuring Performance of Sustainable Buildings
- Natural Ventilation
- Passive Solar Heating
- Sun Control and Shading Devices
- Sustainable O&M Practices
- Water Conservation
- Windows and Glazing
Facilities Operations & Maintenance

INTRODUCTION

Facilities operations and maintenance encompasses all that broad spectrum of services required to assure the built environment will perform the function for which a facility was designed and constructed. Operations and maintenance typically includes the day-to-day activities necessary for the building and its systems and equipment to perform their intended function. Operations and maintenance are combined into the common term O&M because a facility cannot operate at peak efficiency without being maintained; therefore the two are discussed as one.

This facility O&M option offers guidance in the following areas:

- **Real Property Inventory (RPI)** — Provides an overview on the type of system needed to maintain an inventory of an organization’s assets and manage those assets.
- **Computerized Maintenance Management Systems (CMMS)** — Contains descriptions of procedures and practices used to track the maintenance of an organization’s assets and associated costs.
- **Computer-Aided Facilities Management** — Is an approach in facilities management that includes creation and utilization of information technology (IT)-based systems in FM practice.
- **O&M Manuals** — It is widely recognized that O&M represents the greatest expense in owning and operating a facility over its life cycle. The access, relevance, and timeliness of well-developed, user-friendly, O&M manuals cannot be overstated. Hence, it becomes more common for detailed, facility-specific O&M manuals to be required as part of the total commissioning process.

Operations and Maintenance for Historic Structures

INTRODUCTION

This section addresses the special nature of historic structures and how they should be treated with respect to operations and maintenance (O&M) in the ongoing use of a structure, whatever that use may be. Hidden-use of historic structures inherently comes into some measure of conflict with the desire to preserve them. These conflicts may be caused by code requirements, accessibility issues, human control (life safety), and other modern needs which can cause conflict and require compromises.

Therefore, everyone involved in the O&M of historic structures should be aware of a structure’s significant and character-defining features, past treatments, and how O&M should be applied to best preserve the structure.

The term historic structure is used throughout this resources page to include not only historic buildings, but also other types of oblivions: structures and components of cultural landscapes. While each historic structure has its unique set of needs, the principles outlined herein should generally apply. (See also INDC: Historic Preservation.)

DESCRIPTION

Operating and maintaining historic structures must take into account the following factors:

- History
- Significance of features
- Original and later construction components
Welcome to the WBDG Continuing Education System. The WBDG contains a wealth of information and is your gateway to up-to-date information on integrated Whole Building Design Technetniques and Technologies. The courses featured offer an introduction to whole building design concepts as well as more specific applications for design objectives, building operations, and maintenance.

The content of the WBDG has been developed by top architects, engineers, and building scientists. The courses are designed to be accessible to a wide range of professionals, from architects and engineers to building owners and managers. The courses are self-paced and can be completed at any time, making them a convenient way to stay up-to-date on the latest in whole building design.

Distance education is a great and very convenient way for architects, engineers, and building professionals to gain valuable knowledge about whole building design while earning continuing education credits. As a Registered CE Provider, the WBDG CE system is a source of software tools, sustainability guidelines, and technical information to help professionals design and build sustainable buildings.

For more information or to begin taking a class with the WBDG Continuing Education System, please visit the website or contact us directly.

COURSES

Select a category below to see a list of courses available:

Whole Building Design Guide (WBDG) Courses
Federal Energy Management Program (FEMP) Courses
Federal Energy Management Program (FEMP) Continuing Education Courses

E-LEARNING COURSES

These Web-based, on-demand, self-paced, and self-training courses are supportive of the Federal Building Program Training and provide up-to-date information targeted to midlevel Federal Energy, facilities, and Sustainability managers.

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FIRST THURSDAY SEMINARS

FEMP First Thursday Seminars provide training for Federal energy and environmental professionals. Leading experts address timely topics in 90-minute sessions.

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A program of the National Institute of Building Science

WBDC - The Library: Whole Building Design Guide

Design considerations and building principles for achieving a more energy-efficient, durable, and sustainable building. The WBDC can help you identify the specific actions you can take to improve the performance of your building and reduce its environmental impact.

Click a square to see a list of associated resources.
Additional Energy/Sustainable Content

• Green Building Standards & Certification Systems
• Living, Regenerative & Adaptive Buildings
• Greenhouse Gas Emissions in Federal Buildings
• Biomimicry: Designing to Model Nature
• Alternative Energy
• Net Zero Energy Buildings
• Distributed Energy Resources
• Smart (whole bldg) Controls

EcoSense in British Columbia is one of the first 3 Living Buildings certified in the world (Photo Credit: ILBI.org.)

FEMP Guide to Integrating Renewable Energy in Federal Construction

The Federal Energy Management Program Guide is available online at www.femp.energy.gov/reconstructionguide/.

The WBDG resources pages accompanying the Guide are:
• Biogas
• Biomass for Heat
• Fuel Cells and Renewable Hydrogen
• Geothermal Electric Technology
• Geothermal Heat Pumps
• Ocean Energy
• Passive Solar Heating
• Solar Ventilation Air Preheating
• Biomass for Electricity Generation
• Daylighting
• Geothermal Energy – Direct-Use
• Hydropower
• Photovoltaics
• Wind Technology
• Solar Water Heating
Renewable Energy Resource Pages

• Description: How does it work; types & cost of technology
• Application: Economics; assessing resource availability
• Design & Procurement considerations
• Operations & Maintenance
• Special considerations

The Judith Gap Wind Energy Center in Montana is comprised of 90 GE 1.5-MW turbines, for a total capacity of 135 MW
Performance Issues
Thermal Performance
Moisture Protection
Fire Safety
Acoustics
Material/Finish Durability
Maintainability
Retrofitting Existing Buildings

Retrofitting an existing building can be more cost effective than building a new facility. Designing major renovations & retrofits for existing buildings to include sustainability initiatives reduces operation costs & environmental impacts, & can increase building resiliency.

Before making what could be a major investment in the retrofit of existing buildings for energy and sustainability improvements, it is important to determine if the investment is worthwhile in perspective with other building conditions.

• Is the building structurally sound?
• Are seismic upgrades needed to meet current standards?
• Are asbestos & other contaminants present?
• Can the work be done in phases to minimize disruption to occupants?
• If a green roof is being considered, can the roof support the additional weight without costly reinforcement?
Strategies for Energy Retrofits of Existing Buildings

- **Recommission** all energy & water systems to determine they are operating at optimum performance; then upgrade **energy** & **water** systems to minimize consumption

- Determine occupancy patterns, then apply **daylight** & **HVAC** & **lighting** control sensors in appropriate locations

- Determine if **natural ventilation** & fresh air intake are feasible alternatives to reduce heating and cooling loads

- Evaluate the potential for installing **renewable energy systems** to offset part of building load

  * = WBDG Resource Page Topic

Strategies for Energy Retrofits of Existing Buildings

- Consider **solar shading devices** for windows and doors, including those that generate electricity by **PV**

- Replace existing windows w/ **high-performance windows** appropriate for climate & exposure. If building requires security upgrade, evaluate **blast resistant windows & films**

- To ensure your newly renovated building continues to perform as designed, **measure the performance** of the building regularly

- Balance the project’s **sustainable goals with its security goals** including site renovation

  * = WBDG Resource Page Topic
Strategies for Energy Retrofits of Existing Buildings

- Take the opportunity afforded by the building renovation to incorporate **sustainable operations & maintenance** practices & switch to **green cleaning products & methods**.

- For historic buildings, **update systems appropriately** to maintain a balance between the need for energy & water savings with the character of the original building fabric.

- Develop a plan to optimize the recycling and reuse of demolition debris & **construction waste** to minimize waste to landfill.

- Determine if a **cool roof** or **green roof** are cost effective ways to reduce heat island effect & stormwater runoff.

* = WBDG Resource Page Topic

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Determine Building Air Tightness

- **Before upgrading to High-Efficiency HVAC, check air tightness of building envelope.**

- **ASTM E1827 Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door.**

- **ASTM E779, Determining Airtightness of Buildings Air Leakage Rate by Single Zone Air Pressurization.**

- Also check for stuck dampers, dirty filters, bad sensors, faulty or incorrect wiring.

Blower Door Testing
Wagdy Anis WJE
Building Enclosure Councils
BETEC
Measurement & Verification

- If the building is metered, review last two years of utility bills to determine if consumption [not cost] has risen
- Plan on installing meters for electric, gas, water and any other utilities
- Smart meters and submeters are preferable to monitor real-time consumption, control demand and increase tenant accountability [cost control]

Additional Resources

- WBDG Case Studies
- FEMP High Performance Federal Buildings Database
- DOE‐EERE Commercial Buildings: Design, Construct & Renovate
- LEED for Existing Buildings: Operations & Maintenance (LEED‐EBOM)
- The Green Globes Continual Improvement Tool for Existing Buildings (CIEB)
- Sustainability for Historic Buildings
Advanced Energy Retrofit Guides

The Advanced Energy Retrofit Guides (AERGs) were created to help decision makers, planners, designers, and implement energy improvement projects in their facilities. With energy managers in mind, they present practical guidance for kick-starting the process and maximizing green building investments. Each guide is typically 4-6 pages long and is focused on either a building sector or specific technology. The guides provide a broad range of options, strategies, and resources to help energy managers take specific actions at any stage of the retrofit process, resulting in energy savings for many years to come.

One of the most important gaps in the current literature is to identify and explain end-use cost and energy savings methods and data. The AERGs address this gap by providing any comprehensive analysis with methods for calculating the cost-effectiveness of energy improvements. These methods are supplemented with examples using the FEMP, Commercial Reference Buildings, and by detailed case studies demonstrating how organizations have successfully implemented similar solutions.

Examples of AERGs are available for download:
- Advanced Energy Retrofit Guide for Office Buildings
- Advanced Energy Retrofit Guide for Industrial Buildings
- Advanced Energy Retrofit Guide for Energy Data
- Advanced Energy Retrofit Guide for K-12 Schools

An AERG for healthcare facilities is also currently under development.
SUSTAINABILITY AND HISTORIC FEDERAL BUILDINGS

Integrating the Requirements of the National Historic Preservation Act with the Requirements of Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance

May 2, 2011

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
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<tbody>
<tr>
<td>INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>INTEGRATED PLANNING AND DESIGN</td>
<td>6</td>
</tr>
<tr>
<td>REUSING HISTORIC BUILDINGS</td>
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Are people getting the message that WBDG is the best resource to achieve high-performance buildings?

WBDG averages 500,000 unique visitors per month from all over the globe who download over 6 million documents each month
Getting to High-Performance

- An energy-efficient, high-performance building is best achieved using the integrated design approach.
- Conduct charrettes & project team meetings from concept through planning, design & construction (include O&M folks).
- So, now you know that the best resource available to plan, design, construct, operate & maintain New Buildings and major Building Renovation Projects is the Whole Building Design Guide.

National Institute of Building Sciences Annual Conference

Building Innovation 2014 is a gathering place for building community leaders to convene for five impactful days of information sharing, networking and a content-rich conference and educational program, offering sponsors and exhibitors a great opportunity to support the Institute’s efforts, reach their target audience, showcase their products and services, and gain valuable exposure and recognition for their contribution to the built environment.

http://www.nibs.org/?page=conference2014
To Achieve High-Performance Buildings & Meet the Challenges of the Future

You need ....
- Vision
  - Creative Thinking
    - Knowledge
    - Information
    - Tools

You provide the Vision & Creative Thinking... WBDG will provide the rest!

Whole Building Design Guide

Thank you for your time!

QUESTIONS??

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