

Integrated Building Design Critical to High-Performance Hospitals

New construction and major renovations offer hospitals their best prospects for achieving optimal energy efficiency. Integrated building design (IBD) is a nontraditional approach that has been particularly effective in creating high-performing, environmentally friendly buildings. Such facilities often cost less to operate and sometimes cost less to build.

Integrated Building Design Team

- Architects and designers
- Construction managers
- Contractors
- Energy modelers, cost estimators
- Engineers
- Facilities managers and operators
- Integrated design facilitator/consultant
- Medical staff representatives
- Owners and senior management
- Specialty consultants



A facility built through the ongoing collaboration of all stakeholders is more likely to achieve optimal energy efficiency than one based on a succession of hand-offs. Integrated building design increases opportunities to create hospitals that have a favorable effect on patient healing, employee health, and environmental sustainability.

This fact sheet has been developed by the U.S. Department of Energy's Hospital Energy Alliance to help owners and operators employ the IBD process to lower energy consumption and resultant costs while maximizing patient comfort and environmental sustainability. Although some of the strategies considered can be undertaken using a traditional approach, IBD often produces results that otherwise would not have been attainable.

While traditional design and construction involves a series of hand-offs from one expert to the next, IBD is a collaborative approach that draws upon the needs, expertise, and insights of a multidisciplinary team (see box at left) throughout a project.

Kicking off a Project

The team can save time and money by identifying incompatible design elements and solving problems before actual design and construction begin. Typically, the team kicks off a project by holding a "charrette," an intensive workshop in which the key stakeholders generate and discuss ideas for combining low-energy-use and other greening strategies. A charrette helps cut across boundaries of a large collaborative project, allowing the team to address organizational differences, reduce difficulties, verify decisions, and expedite the design process.

Whole-Building Approach is Key

IBD's "whole-building" approach views a facility as an interdependent system rather than as separate components. This viewpoint helps to ensure that systems work harmoniously rather than against one another. Whole-building design takes into consideration such elements as site, energy, materials, indoor air quality, acoustics, operations, economics, and natural resources. Employing the whole-building approach during the initial design phase is the most important step in achieving high-performance buildings.

The Path to High Performance

There are many steps the IBD team takes in the creation and successful operation of a high-performance facility. Key phases are indicated below, with important considerations highlighted within each.

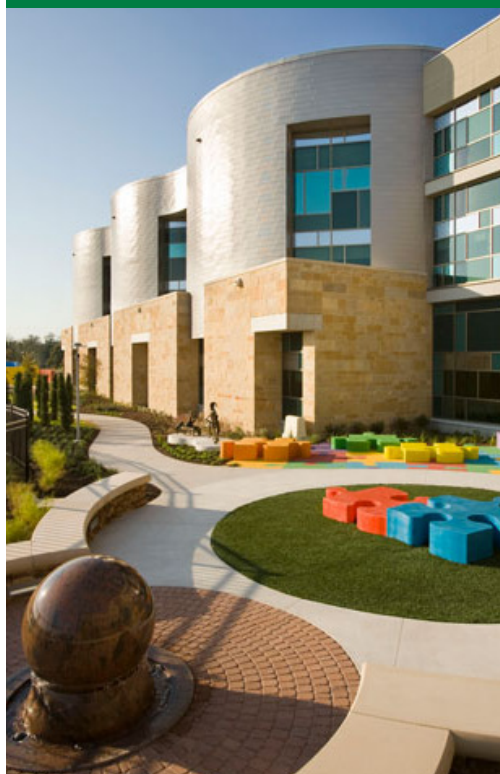
Pre-Design

During this phase, hospital management organizes its IBD team and makes broad decisions that determine the direction of the entire project. Among them:

- Establish key needs and project priorities.

- Assess and confirm project feasibility and construction requirements.
- Formulate high-performance project goals, including measurable energy performance goals, such as the following:
 - Use less than a certain number of Btu/square foot/year.
 - Achieve 30 percent energy savings over code.
- Determine financial evaluation criteria.
- Commit as an organization to the IBD process for the project. Discuss questions and concerns.

Case Study



Photos: © John Durant Photography/Karlsberger

Dell Children's Medical Center of Central Texas Austin, Texas • Opened in July 2007

Financial Investments and Benefits

- Capital budget was \$200 million.
- Construction cost was \$130 million.
- Gross capital savings were \$6.8 million (eliminated the need to build a central plant when the local utility and the hospital's parent company collaborated to build an onsite district energy plant).
- Invested \$5.8 million of these savings into energy conservation measures.

Notable Features

- "Right-sized" distributed air handling units with dedicated outdoor air units with heat recovery.
- Under-floor air distribution in administration area.
- High-efficiency lighting fixtures with daylight-harvesting system and occupancy sensors.
- Exterior stairwells that don't require climate control.
- Daylighting that reaches 90 percent of the perimeter rooms and 35 percent of treatment and diagnostic areas.
- 47,000 tons of airport runway material reused on the site.
- 92 percent of construction waste recycled, diverting 32,000 tons from landfills.

The 509,000-square-foot Dell Children's Medical Center of Central Texas is the world's first inpatient hospital to achieve Leadership in Energy and Environmental Design, or LEED®, certification at the platinum level—the highest offered through the U.S. Green Building Council. The 176-bed hospital, built on 32 acres of the "brownfield" site of a former municipal airport, serves 46 counties. This high-performance facility is the result of a collaborative effort among a broad group of internal and external stakeholders.

- Fly ash substituted for Portland cement.
- Water-efficient autoclaves and low-flow and dual-flush plumbing fixtures save an estimated 4.1 million gallons of water per year.
- Onsite 4.3 MW natural gas-fired CHP plant that supplies 100 percent of the hospital's electricity, heating, and cooling and is 75 percent more efficient than coal-fired plants.



- Assemble IBD team. Among the important considerations:
 - Select an IBD “champion” to drive the process.
 - Identify roles and responsibilities for members.
 - Hire design professionals experienced with IBD.
 - Hold a design charrette with the IBD team.

Design

The IBD process puts all design options on the table rather than prescribe the use of specific strategies. Many design possibilities—each with its unique set of technologies based on the team’s chosen criteria—are evaluated. Whole-building energy simulations are a part of this process. For information on energy-modeling software, see http://www1.eere.energy.gov/buildings/commercial_initiative/modeling_software.html. The team selects the best design approach only after multiple potential designs—including new iterations based on information or ideas that have come to light through this process—have been thoroughly investigated and compared.

The most effective, least expensive method of reducing a new facility’s energy consumption is to properly plan its orientation and building envelope. It’s easy to see why in this example:

- Siting a building to maximize daylighting reduces the need for electric lighting.
- Reducing electric lighting reduces the cooling load.
- A reduced cooling load requires a smaller cooling system.

Further, designing the most appropriate building envelope for a particular project often can reduce both heating and cooling requirements. Decisions of this nature, made early in the design process, are likely to have a dramatic effect on a building’s lifetime energy consumption. Additionally, any upfront savings resulting from well-thought-out design strategies can be invested in higher-quality windows or controls, which will result in even more energy savings.

Case Study



Providence Newberg Medical Center Newberg, Oregon • Opened in 2006

Providence Newberg Medical Center’s 180,000-square-foot hospital, medical office, and administrative facility used an integrated design process, energy modeling, and life-cycle cost analysis of design alternatives to become the first hospital to achieve a LEED® Gold rating. Energy-efficient technology and practices helped Providence achieve a 26 percent energy savings annually.

Financial Investments and Benefits

- Construction budget was \$63.5 million.
- Incremental project cost was \$357,000, financed partly through incentives from local utilities and Energy Trust of Oregon.
- Annual energy cost savings are \$178,000, or about 975,000 kWh of electricity.

Notable Features

- Condensing boilers operating at 95 percent efficiency, 15 percentage points over code.
- High-efficiency lighting system that uses T5 lamps and emphasizes daylighting. Programmable lighting system monitors daylighting and dims or turns off lights when not needed.
- HVAC system providing 100 percent outside air.
- Variable primary flow chiller system.
- Emergency generators are leased to utility for maximum of 400 hours per year for 10 years, in exchange for \$56,000 in incentives.

The following concerns and activities are important to achieving an optimal building design:

- Employ natural light advantageously.
 - Choose window layouts and designs that use natural light as much as possible, particularly in patient rooms and corridors.
 - Combine natural light exposure with lighting control technologies (dimming or stepping).
- Maximize shade provided by exterior landscaping to minimize heat gain in warm climates.
- Perform preliminary modeling of building performance to determine how various natural lighting strategies would affect the HVAC load.
- Design an energy-efficient building envelope.
 - Consider using green roofs to provide insulation and lower intake

temperatures. These add value by improving patient views as well.

- Contemplate installing revolving doors in high-traffic locations to minimize loss of conditioned air.
- Work as a team to treat the building envelope as a complete system so that all aspects perform optimally together.
- Investigate on-site renewable energy options, facilitating available opportunities through careful site selection. Work as a team to consider renewable generation impacts when making decisions in other disciplines, such as architectural decisions.
- Compare multidisciplinary implications of centralized vs. decentralized plant options.
- Right-size the boilers and chillers based on reduced loads from other improvements.

Construction and Commissioning

During construction, it is important for contractors and subcontractors to stay involved in the IBD process. Responsible parties must review all substitution requests carefully to determine their impact on the energy efficiency of other building systems and the ability of the facility to meet energy-performance goals.

Prior to use, the new facility should be commissioned by an independent provider to verify that it performs according to the building owner's needs,

“Many high-performance ‘green’ buildings cost no more, and even less, than their ‘brown’ equivalents—the key is integrated design.”

—Robin Guenther, Perkins+Will

its design, and contract documents. Commissioning is critical for ensuring that the design developed through the whole-building design process is successfully constructed and operated.

- Systematically evaluate all equipment to verify it is working according to specifications. Measure temperatures and flow rates from all HVAC devices and calibrate all sensors to a standard.
- Review the sequence of operations to verify that controls are providing the correct interaction between equipment.

Because members of the IBD team have firsthand knowledge of the building from pre-design through installation, they should be involved throughout the commissioning process—as well as during subsequent recommissioning.

Operations

Once construction is completed and occupancy of the new building begins, responsibility will shift from the IBD team to the energy management program team. This group is composed of representatives from across the hospital spectrum—finance, maintenance and facilities, purchasing, quality assurance, government relations, clinical operations,

and medical personnel. The team has primary responsibility for the long-term success of all energy-efficiency planning and operations.

Members develop and implement each element of the hospital's ongoing energy management plan. Programs such as EPA's ENERGY STAR® for Healthcare are helpful in creating energy management guidelines and benchmarking tools. The following are important aspects of an energy management plan:

- Monitor performance, verify that goals are being met, and identify opportunities for improvements.
- Oversee energy-efficiency operations and maintenance training and periodic recommissioning.
- Assess occupant satisfaction and fine-tune the integration of every aspect of energy efficiency.
- Identify challenges and solutions. Target opportunities for additional energy savings and energy cost savings.

For more detailed information on IBD, visit <http://www1.eere.energy.gov/femp/pdfs/29267-4.1.pdf>.

Hospital Energy Alliance

HEA is a forum in which healthcare leaders work together with DOE, its national laboratories, and national building organizations to accelerate market adoption of advanced energy strategies and technologies.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.