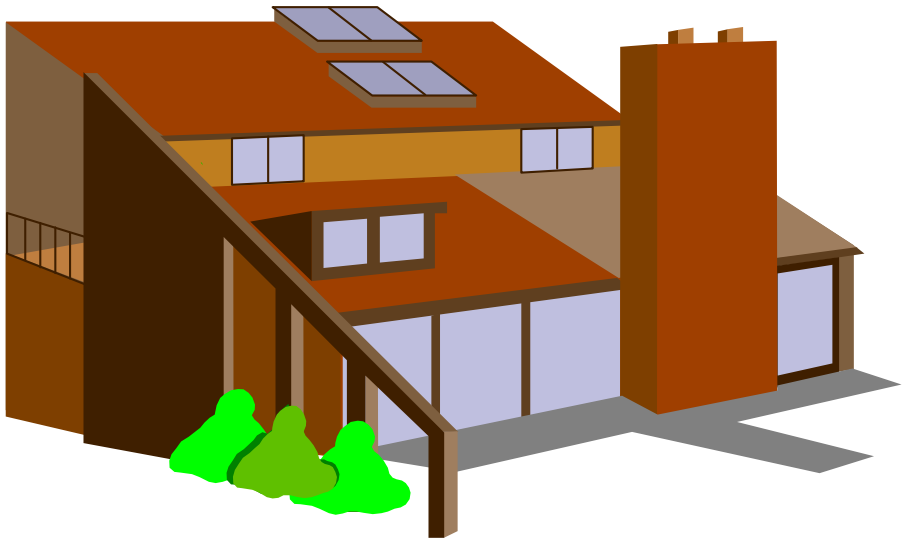
City of Toronto

ENERGY EFFICIENCY GUIDELINES FOR BUILDING DESIGN AND CONSTRUCTION



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INTRODUCTION

The main reason for the climate change is the increase of greenhouse gases in the atmosphere. The primary source of this increase is burning of fossil fuels, such as coal and oil. Making new or existing buildings more energy efficient means fewer greenhouse gases will be produced and lower emissions of smog precursors such as nitrogen oxides and carbon monoxide.

Energy efficiency not only improves local air quality but also contributes to the City goal of reducing CO_2 emissions and national goal of complying with the Kyoto Protocol.

Energy efficiency makes economic as well as environmental sense. Energy-efficient buildings cost significantly less to operate than other buildings, thus offsetting the higher initial building costs. Furthermore, these buildings have better indoor air quality, reduce noise and dust infiltration, thus improving workers' comfort, health and productivity. These factors can combine to make energy-efficient buildings more attractive to potential lessees or buyers.

PURPOSE

The intent of these guidelines is to provide direction, information and/or minimum requirements in the design of new buildings or in the upgrading of existing buildings which will achieve optimum energy efficiency without reducing the building performance or occupant comfort. These guidelines do not apply to buildings intended for occasional or unheated use, such as unheated warehouses, garages, sheds, etc.

The minimum construction standard used should be the more stringent of either ASHRAE 90.1-2004 or the Model National Energy Code of Canada for Buildings (MNECB). Published in September 1997, the MNECB is a comprehensive energy efficiency building code that takes into account variations in regional climate conditions and energy costs — a first for Canada. The MNECB establishes minimum standards of construction for building components and features that affect a building's energy efficiency.

To achieve "green building" designation, LEED Canada offers certification to buildings with high energy efficiency and low environmental impact. LEED Canada for New Construction and Major Renovations version 1.0 is an adaptation of the US Green Building Councils Leadership in Energy and Environmental Design Green Building Rating System (LEED™), tailored specifically for Canadian climates, construction practices and regulations.

The LEED Canada-NC 1.0 Rating System recognizes leading edge buildings that incorporate design, construction and operational practices that combine healthy, high-qualty and high -performance advantages with reduced environmental impacts. They provide a voluntary, consensus-based, market-responsive set of criteria that evaluate project performance from a whole-building, whole-life perspective, providing a common

understanding for what constitutes a “green building” in the Canadian context. With four possible levels of certification (certified, silver, gold and platinum), LEED is flexible enough to accommodate a wide range of green building strategies that best fit the constraints and goals of particular projects.
More information is available on Canada Green Building Council website - http://www.cagbc.org/

The designer is encouraged to take advantage of the Commercial Building Incentive Program (CBIP) sponsored by Natural Resources Canada. (http://www.cbip.nrcan.gc.ca**). Details of this and other incentive programs are outlined in Appendix A.**

ENERGY EFFICIENCY GUIDELINES CHECKLIST

The designer should use the following checklist to ensure that the building is designed to be energy efficient.

All systems and services, especially the architectural, mechanical and electrical, should be closely co-ordinated with each other in order to produce the most efficient and cost effective result as possible

ARCHITECTURAL

A.1 Building Orientation

- ❑ Select the most efficient orientation and shape of the building in order to minimize energy consumption.
- ❑ Take into account the local surroundings and the environment in designing new buildings. When heating is the major concern, southern roof and window exposure should be maximized. When cooling is the major concern a building's southern roof and window exposure should be minimized. Walls facing prevailing winds should be well insulated and airtight.

A.2 Building Surrounding

- ❑ Minimize area of impervious surfaces (especially asphalt parking lots - Asphalt retains heat, raises the ambient temperature around buildings and thus increases building cooling loads. It prevents water penetration and thus contributes to flash flooding by overloading storm sewer systems).
- ❑ Install porous paving plant vegetation - Reinforced Grass Paving Systems are strong enough to support heavy vehicle loads and yet are water permeable. A catch basin and underground drain system is not required in these installations.
- ❑ Eliminate curbs along driveways and streets to increase infiltration
- ❑ Do not install roof gutters; instead, install gravel drains along the base of walls
- ❑ Install rooftop water catchments systems (cisterns) and use precipitation for

irrigation

- Design vegetated swales and shallow infiltration basins to carry stormwater, instead of pipes (these may be designed to dry out between rainfalls, or may be small permanent wetlands)

A.3 Building Envelope

- Design the building with a minimum exterior surface area (wall and roof) to minimize heat transmission for a given enclosed volume.
- All necessary air seals to be carefully detailed and/or specified for a complete air and vapour tightness.
- Minimize all cold bridges in exterior wall assemblies, for example, at junction of exterior wall, foundation wall and floor slabs on grade.
- Thermal insulation shall be as continuous as possible. At envelope locations where two planes of insulation do not physically join, the two continuous insulations shall overlap for a length of at least 4 times the distance separating them.
- Consider using solar energy wall - A ventilation system comprising a building cladding (a perforated solar absorber) and a fan and duct system. The fan system draws outdoor air through the absorber and distributes the solar-preheated ventilation air to the building interior.
- Thermal co-efficient for the building enclosure to comply with Ontario Building Code where applicable, but, in any case, be not less than:

Building Element	***R-value***
Wall	20
Roof	30
Basement (below grade)	20
Floor on slab	10

A.4 Windows

- The maximum window area shall not be greater than 35% of floor to floor wall area.
- Glass shall be double- or triple-glazed, sealed, low-conductivity inert gas filled, insulated units of the solar reflected type (low E glass). Shading co-efficient and "U" factor to be as low as practically possible.
- Metal window frames and sash shall be thermally broken (this strip of low-

conductivity material should be between 12 mm and 75 mm wide and made from vinyl, if possible)

- Windows should be shaded in the summer months and unshaded in the winter months.
- According to Canadian Standards Association's Standard A440.2 "Energy Performance of Windows and Other Fenestration Systems," an energy-efficient window system has a total window heat loss coefficient less than 2.0 W/m^2K (MNECB minimum requirement)

A.5 Interior Design

- Provide vestibules for all entrance and fire exit doors.
- Use revolving doors where frequent use is anticipated.
- Locate service area, washroom, stairs, corridors, etc., if practical, along the perimeter of the building.
- Group the spaces that have similar activities together in order to reduce the complexity of the mechanical system. proprietary
- Reflections of room surfaces shall be as follows:

Ceilings	minimum 80 percent
Walls	minimum 50 percent
Floors	minimum 20 percent

MECHANICAL

M.1 Heating, Ventilating and Air-Conditioning (HVAC) System

M.1.1 General

- Provide adequate zones of control.
- Thermostatic controls for comfort have the following characteristics:

  Heating controls is capable of adjusting the temperature of the space they serve down to at least 13°C.

  Cooling controls is capable of adjusting the temperature of the space up to at least 29°C.
- Use automated control to provide both occupied and unoccupied mode.

- Use Direct Digital Control (DDC) system for all energy using equipment.
- Use equipment with highest practical efficiency or highest coefficient of performance (COP) under both full and part load conditions.
- Choose the systems based on building's calculated cooling load. Unitary air-conditioning equipment is often oversized, which can significantly reduce efficiency and humidity control. At low loads, the efficiency can be less than half of the full load efficiency.
- Use waste heat recovery system where economically feasible.
- Consider the use of renewable energy sources (eg. ground source heat pumps, solar walls) where practical. **(Take advantage of the Renewable Energy Deployment Initiative (REDI) sponsored by Natural Resources Canada outlined in Appendix)**

M.1.2 Ventilation

- Outside supply air for typical office space shall be based on 0.812 L/s x m² of gross floor area, or 10 L/s per person whichever is greater. (OBC 1990)
- Use Demand Controlled Ventilation (DCV) – DCV can be achieved by determining air quality by the amount of CO2. Acceptable CO2 level of air in commercial and institutional buildings is 1000 parts per million (ppm), with outdoor air concentrations at about 400 ppm. A typical control setpoint would be 800 to 900 ppm (ASHRAE). DCV can save up to 50 percent of fan energy and 10 percent of heating energy for a system during occupied hours, compared to non-optimized control systems.
- The minimum air circulation rate for occupied areas shall be 3.5 L/s for each square metre of floor area.
- Use exhaust air for ventilation of boilers room, mechanical rooms or the garage when allowed and where feasible.
- Minimize the fan operation during the unoccupied periods. Use variable speed drive where feasible (see E2 Motor section).
- Humidifiers and dehumidifiers must be provided with an automatic humidity control device. If the purpose of the humidity control is comfort, the controller must be able to prevent the use of energy to increase relative humidity above 30% or to decrease it below 60%.
- Consider using Gas-fired humidifiers. They provide clean steam humidification at an economical operating cost; these humidifiers are fuelled by natural gas or liquid propane.
- For enclosed or underground parking garage, use CO sensor to control ventilation system

M.2 Domestic Hot Water (DHW) System

- Use waste heat energy to meet hot water heating requirements.
- Use high efficiency natural gas equipment. (Take advantage of Enbridge Gas Distribution's Energy Efficiency Incentives outlined in Appendix A)
- Design or incorporate a controller to turn off the circulation pump during unoccupied hours, or use low speed in a 2-speed motor.
- Set the water temperature no higher than 45° C in the DHW system, and use local booster where higher temperature is required. Add a time delay relay to shut off the hot water booster when not in use.
- Insulate DHW piping.
- Use a separate boiler for DHW heating if DHW is the only summer load for a large boiler.
- Use reduced flow rate plumbing fixtures. Showerhead flow rate should be a maximum of 9.5 L/min. Except in dwelling units, lavatory faucets must limit the maximum water discharge to 8.3 L/min (MNECB 1997). In areas of high use consider the use of push button or other water saving valves to operate faucets.

ELECTRICAL

E.1 Lighting

- Provide adequate levels of illumination as published in the Illuminating Engineering Society's Lighting Handbook.
- Locate workstations requiring the highest level of illumination nearest the windows.
- Use fixtures, lamps and ballasts providing the highest illumination efficiency and cost effectiveness. For example use T8 or T5 lamps and electronic ballasts.
- Use compact fluorescent lamps in place of incandescent lamps.
- Use dimming fluorescent fixtures in place of incandescent fixtures.
- Use low wattage/long life exit fixtures (LED less than 5 watts).
- Use photocell control to turn off lights when natural light is sufficient for the task (daylighting).
- Consider using Indirect Lighting System. It directs indoor light to ceiling level, where it is reflected back down into the room. This provides a more uniform light with less glare. By providing more uniform lighting to a space, indirect lighting allows for a reduction in light levels. This translates into significant electricity

savings and a reduction in cooling load. For example, light levels in offices can be reduced from 500 to 300 lux.

- Provide alternate switching or dimmer controls in multi-purpose spaces with varying illuminations.
- Provide local switches for all rooms.
- Use timers and/or photocell for all exterior lighting. The timer should be capable of providing 7 days adjustments and seasonal daylight schedule variations.
- In rooms used periodically (eg. washrooms and board rooms) consider the use of occupancy sensors.

E.2 Motors

- Energy represents more than 97 percent of total motor operating costs over the motor's lifetime. Higher initial capital cost for a more energy efficient motor is often paid back in energy savings within 4-7 years.
- Energy-efficient motors, in general, are of a higher quality, are more reliable, last longer, have longer warranties, run more quietly and cooler and produce less waste heat than their less-efficient counterparts.
- Use high or premium efficiency motors for all applications (greater than 1 HP) which operate more than 750 hours per year. Great tool for choosing motor efficiency levels is CanMOST (this tool is available for free at: http://oee.nrcan.gc.ca/commercial/technical-info/tools/index.cfm?attr=12).
- Use variable-speed drive on large HVAC motors (greater than 5 hp) where feasible.
- Permanently wired polyphase motors must comply with the relevant appliance or equipment efficiency act, or CAN/CSA-C390 clause 4.10.
- Use low energy elevators that utilize an axial synchronous AC motor design with a gearless drive system.

Other Considerations

Smart building technology may require proper design of HVAC and space. In office environment consider using **Personal Environmental Controls (PEC).** These controls are applied to controlling individual user workstation environment services such as: ventilation, temperature, lighting, sound masking and any other controllable environmental services.

The above list does not cover all the energy efficiency possibilities available in the design and renovation of buildings. It is also recognized that as energy prices and as new technologies become available addition energy saving measures should be considered.

Appendix A: Financial Incentives

1. The Commercial Building Incentive Program

Natural Resources Canada's Office of Energy Efficiency encourages the design and construction of new, energy-efficient commercial, institutional and multi-unit residential buildings and facilities. The **Commercial Building Incentive Program (CBIP)** provides design assistance and funding of up to $60,000 for eligible organizations based on building energy savings.
CBIP program requirements are based on two documents: the *Model National Energy Code for Buildings* (MNECB) and the *CBIP Technical Guide*. The program runs from April 1, 1998, to March 31, 2007.

Determining Building Eligibility

New or extensively renovated industrial, commercial or institutional buildings that are heated and/or cooled, intended for occupancy, and constructed to CBIP criteria are eligible.To qualify for the incentive, a building must be at least 25% more energy -efficient than if it were constructed to meet the requirements of the Model National Energy Code for Buildings (MNECB). Free software tools available from NRCan Office of Energy Efficiency can help you determine if your new building design qualifies for CBIP. (http://oee.nrcan.gc.ca/commercial/technical-info/tools/software.cfm?attr=12)

Incentive Amount

CBIP helps offset the extra cost of designing energy-efficient buildings. The incentive for a building that meets CBIP criteria is calculated as a one-time financial incentive equal to twice the difference between the estimated annual energy costs if the building were constructed to the MNECB standard, to a maximum of $60,000 or the total design costs, whichever is less. The approved funding offers to building owners CBIP funding for up to six projects, or a maximum of $250,000 (whichever comes first).

For Additional Information on **CBIP**, please contact:

Commercial Building Incentive Program
Office of Energy Efficiency
Natural Resources Canada
580 Booth St., 18th Floor
Ottawa ON K1A 0E4
E-mail: cbip.pebc@nrcan.gc.ca
Fax: (613) 947-0373
Toll-free: 1-877-360-5500
Web site: http://oee.nrcan.gc.ca

2. The Renewable Energy Deployment Initiative

REDI is a 9-year (started in 1998), $51 million program designed to stimulate the demand for renewable energy systems for water heating, space heating and industrial process heating. These systems include:

- active solar water heating systems;
- active solar air heating systems; or
- high efficiency/low emissions biomass combustion systems of between 75kW and 2MW capacity.

Under REDI, NRCan undertakes market development activities and provides an incentive to encourage the private sector, federal departments and public institutions to gain experience with active solar and efficient biomass combustion systems. Corporations are eligible for a refund of 25 percent of the purchase, installation and certain other costs of a qualifying system, to a maximum refund of $80,000 per installation and a maximum of $250,000 per corporate entity. Some incentives are also provided on a pilot project basis

In order to qualify, the system hardware and installation must meet strict quality criteria:

- ✓ Water heating solar collectors and glazed air heating solar collectors must meet CAN/CSA-F378-87 (R1992) standard or equivalent.
- ✓ Biomass combustion systems must meet CAN/CSA-B415.1 standard or equivalent.
- ✓ The entire system must be made up of new equipment.
- ✓ The system must be commissioned (i.e. put into service) in the 12 months following the second party's signature on the Contribution Agreement, **AND** by **March 31, 2007**, at the latest.
- ✓ If the building is used in part for residential occupancy, the system is only eligible if the building exceeds 600 m^2 in building area **or** exceeds three stories in building height.
- ✓ The system must deliver solar energy at $0.14 / kWh or less (unit price calculation available at REDI website)

Systems that do not meet the above criteria, but which exhibit reasonable payback periods, will be considered on a case-by-case basis.

For Additional Information on **REDI**, please contact:

Renewable Energy Deployment Initiative
Renewable and Electrical Energy Division
Natural Resources Canada
580 Booth Street, 17th Floor, Ottawa Ontario, K1A 0E4
Telephone: 1-877-722-6600 (Toll Free)
Fax: (613) 995-0087
Email: redi.penser@nrcan.gc.ca
Web site: http://www.nrcan.gc.ca/redi

3. Energy Innovators Initiative (EII)

Natural Resources Canada's Office of Energy Efficiency (OEE) wants to help you improve energy efficiency in your existing buildings. The **Energy Innovators Initiative (EII)** works with a network of partners and service providers across Canada to provide financial incentives, publications, training and tools for commercial business, public institutions and other eligible organizations. After joining the EII, members can access Energy Retrofit Assistance (ERA) funding.

Energy Innovators Initiative provides:

1. Funding for energy management plans, audits, feasibility studies and other retrofit planning activities in your existing buildings. EII members could receive up to 50 percent of eligible costs or up to $1 per gigajoule (1 GJ = 277.8 equivalent kilowatt hours) of annual energy consumption in the affected buildings – whichever amount is less – to a maximum of $25,000.

2. Funding for project's development, management, materials, labour, monitoring and tracking, staff training, awareness and for other retrofit implementation projects in your existing buildings. Measures for efficient lighting, the building envelope, motors, controls, heating, ventilating, air conditioning and other energy-saving projects may be eligible. EII members could receive up to $7.50 per gigajoule (1 GJ = 277.8 equivalent kilowatt hours) of annual energy savings or up to 25 percent of eligible costs – whichever amount is less – to a maximum of $250,000.

Applications for ERA funding must be submitted by January 31, 2006. All work must be completed and final documents submitted by February 28, 2007.

City of Toronto is EII member since 2003,

For Additional Information on City's involvement with EII, please contact:

Jim Kamstra
Manager, Energy& Waste Management
Facilities and Real Estate
City of Toronto
55 John Street, Metro Hall, 2nd Floor
Toronto, ON, M5V 3C6
Tel: 419-392-8954
Fax: 516-392-4828
Email: JKamstra@toronto.ca

4. Green Municipal Fund

The Green Municipal Fund (GMF), established in 2000, consists of a $550-million endowment from the Government of Canada to stimulate investment in innovative municipal infrastructure projects. The Fund supports partnerships, leveraging both public and private sector funding to encourage municipal actions to improve air, water and soil quality, and to reduce greenhouse gas emissions.

Summary of Eligibility Criteria:

The project must have the potential for verifiable reductions in the energy intensity or improvements in the environmental effectiveness of systems in one or more of the following six municipal service areas:

- ✓ Energy, including energy-efficient building retrofits, renewable energy, and community energy systems.
- ✓ Air.
- ✓ Water.
- ✓ Solid waste management.
- ✓ Sustainable transportation services and technologies.
- ✓ Sustainable community development.

The applicant must demonstrate a commitment from a public and/or private sector source(s) to contribute to the project activity's financing.

The environmental infrastructure project should demonstrate a direct economic benefit to the municipality involved.

Funding Limits

Planning initiatives, feasibility studies, and field tests: the Funds contribute up to 50 per cent of eligible expenses to a maximum grant of $350,000.

Capital installations: the Funds provide loans covering 15 to 25 per cent of eligible expenses to a maximum of $20 million for a municipal government. Municipal governments borrow at a low, preferred rate. The Fund also offers loan guarantees, flexible repayment options, impartial financial advice, links to other financial sources and partners – and no brokerage fees.

Pilot installations: the Funds offer a combination loan and grant up to 50 per cent of eligible expenses to a maximum of $20 million for a municipal government.

ForAdditional Information on Green Municipal Funds, please contact:

Application Coordinator
Federation of Canadian Municipalities
Green Municipal Funds
24 Clarence Street
Ottawa, Ontario K1N 5P3
Telephone: (613) 241-5221
Fax: (613) 244-1515

5. Enbridge Gas Distribution's Energy Efficiency Incentives

Design Assistance Program (DAP)

Enbridge Gas Distribution's new Design Assistance Program (DAP) offers qualified proponents a fixed DAP incentive of $4,000 to undertake design activities aimed at improving a building's energy and environmental performance - whether it is a new building, an addition to an existing building or a major renovation.

New Building Construction Program

Enbridge Gas Distribution's New Building Construction Program (NBCP) helps you offset the costs of designing more energy efficient buildings for commercial, institutional or multi-family use. The program provides an incentive for energy savings that will result from adding efficiency measures to a reference design building. Enbridge will pay $0.075/m3 of projected annual natural gas savings to a maximum of $15,000.

MultiCHOICE Program

When you implement multiple energy management initiatives through Multi*CHOICE* you are eligible for up to $30,000 per building in incentives from Enbridge Gas Distribution. The level of the incentive increases for each additional measure installed and is based on the m³ of gas saved. This one-time incentive is calculated on the basis of the projected first-year natural gas savings and is remitted on project completion.

For more information on this and other Enbridge Programs please check their website:: http://www.cgc.enbridge.com/B/B05-17_financial_incentives.asp

6. City of Toronto Energy Efficiency Retrofit Revolving Fund

The City of Toronto has established in its 2004 budget, Revolving Fund of $20 million to finance energy retrofit projects exhibiting favourable investment returns, in order to facilitate achievement of the City's carbon dioxide (CO_2) and energy consumption reduction objectives.

- ✓ To be eligible for funding a program must be able to repay the financing from net operating cost savings.
- ✓ To be considered for funding the projects have to have passed through an initial stage consisting of an energy audit and/or incorporating a third party guarantee.
- ✓ Projects will be evaluated and ranked using payback and net present value. (The payback should be less than 8 years)
- ✓ The rate of return on a project should be higher than the City's cost of borrowing
- ✓ Each program will be responsible for monitoring and reporting energy consumption and associated savings through the City's quarterly variance reporting.

For more information on Revolving Fund please contact:

Jim Kamstra
Manager, Energy& Waste Management
Facilities and Real Estate
City of Toronto
55 John Street, Metro Hall, 2nd Floor
Toronto, ON, M5V 3C6
Tel: 419-392-8954
Fax: 516-392-4828
Email: JKamstra@toronto.ca

7. Other financial incentives programs:

Alternative Funding Programs and Resources Guide 2003.
A quick reference guide of funding programs, resources and contact information.
It can be found on the FCM's Green Municipal Fund website:
http://kn.fcm.ca

Appendix B: Additional Resources

Advanced Buildings Technologies & Practices
A building professional's guide to more than 90 environmentally-appropriate technologies and practices. The site, also, showcases numerous case studies.
http://www.advancedbuildings.org

Greener Buildings
The resource for environmentally responsible building development is a free, Web-based resource to help companies of all sizes and sectors understand and address building design, construction, and operation in a way that aligns environmental responsibility with business success. http://www.greenerbuildings.com

Efficient Windows Collaborative (EWC)
Gateway to information on how to choose energy-efficient windows
http://www.efficientwindows.org/index.cfm

Benefits Guide: A Design Professional's Guide to High-Performance Office Building Benefits by Advanced Buildings
Help for architects and designers working with real estate developers and corporate, public sector, and institutional owners who are constructing or renovating office buildings. It includes a list of quantifiable high-performance building benefits, as well as how they benefit the building owner.
http://www.resourcesaver.org/file/toolmanager/CustomO16C45F54749.pdf
Other publications answering the questions what and how to build green available on
http://www.poweryourdesign.com/products.htm

High-Performance Buildings Database
This U.S. DOE site offers detailed profiles of homes, commercial interiors, office buildings, retail sites, and campuses from around the world. Each case study covers the structure's materials, energy and water systems, indoor environment, and land use. Also find information on project costs and financial resources, as well as news on the latest in high performance building research.
http://www.eren.doe.gov/buildings/highperformance/case_studies

Energy & Environmental Building Association
The Energy Efficient Building Association promotes a systems approach to ensure energy efficiency, building durability, occupant comfort and health, and environmental responsibility. Its Web site provides downloadable information for energy- and resource-efficient buildings and assists small, low-rise commercial buildings with specific criteria for design, construction, and comprehensive rehabilitation. http://www.eeba.org/